

**REPORT OF THE PANEL TO REVIEW THE
V-22 PROGRAM**

HEARING
BEFORE THE
COMMITTEE ON ARMED SERVICES
UNITED STATES SENATE
ONE HUNDRED SEVENTH CONGRESS
FIRST SESSION

MAY 1, 2001

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REPORT OF THE PANEL TO REVIEW THE V-22 PROGRAM

TUESDAY, MAY 1, 2001

U.S. SENATE,
COMMITTEE ON ARMED SERVICES,
Washington, DC.

The committee met, pursuant to notice, at 10:09 a.m., in room SH-216, Hart Senate Office Building, Senator John Warner (chairman) presiding.

Committee members present: Senators Warner, Smith, Inhofe, Santorum, Roberts, Allard, Sessions, Collins, Bunning, Levin, Lieberman, Reed, Akaka, Bill Nelson, E. Benjamin Nelson, and Dayton.

Committee staff members present: Romie L. Brownlee, staff director; Judith A. Ansley, deputy staff director; Anita R. Raiford, deputy chief clerk; and Scott W. Stucky, general counsel.

Professional staff members present: Charles S. Abell, Charles W. Alsup, John R. Barnes, Ambrose R. Hock, George W. Lauffer, Patricia L. Lewis, Thomas L. MacKenzie, and Richard F. Walsh.

Minority staff members present: David S. Lyles, staff director for the minority; Peter K. Levine, minority counsel; Creighton Greene, and Michael J. McCord, professional staff members.

Staff assistants present: Beth Ann Barozie, Thomas C. Moore, Jennifer L. Naccari, and Michele A. Traficante.

Committee members' assistants present: Dino L. Carluccio, assistant to Senator Smith; John A. Bonsell, assistant to Senator Inhofe; Robert Alan McCurry, assistant to Senator Roberts; Douglas Flanders and Charles Cogar, assistants to Senator Allard; Arch Galloway II and Scott Douglass, assistants to Senator Sessions; Kristine Fauser, assistant to Senator Collins; Derek Maurer, assistant to Senator Bunning; Menda S. Fife, assistant to Senator Kennedy; Barry Gene (B.G.) Wright, assistant to Senator Byrd; Frederick M. Downey, assistant to Senator Lieberman; Elizabeth King, assistant to Senator Reed; Davelyn Noelani Kalipi, assistant to Senator Akaka; William K. Sutey, assistant to Senator Bill Nelson; Eric Pierce, assistant to Senator Ben Nelson; and Brady King, assistant to Senator Dayton.

OPENING STATEMENT OF SENATOR JOHN WARNER, CHAIRMAN

Chairman WARNER. Good morning.

The Armed Services Committee meets today to receive testimony on the report prepared by The Panel to Review the V-22 Program. The panel is chaired by Gen. John R. Dailey, United States Marine

Corps (Retired), who is currently the Director of the National Air and Space Museum. We welcome you, General Dailey. He is joined by Norman Augustine, former Chairman and Chief Executive Officer of both the Martin Marietta Corporation and Lockheed Martin Corporation. We welcome you, Norm.

Gen. James B. Davis, United States Air Force (Retired), who has a long career of public service both in the military and since his retirement. We welcome you, General Davis.

Dr. Eugene E. Covert, Professor Emeritus in the Department of Aeronautics and Astronautics at the Massachusetts Institute of Technology. We welcome you.

Gentlemen, I appreciate your public service on behalf of not only the Department of Defense, but all Americans who are deeply concerned about this program. We are fortunate to hear your views discussed here today.

Appearing on the second panel of today's hearing are Gen. James L. Jones, the Commandant of the Marine Corps, and Gen. Charles R. Holland, Commander in Chief of the United States Special Operations Command. These two branches of our military are the initial users of this aircraft. General Jones and General Holland will offer their responses to the panel's conclusions and recommendations and such other views as each wish to share.

The Panel to Review the V-22 Program was established by then-Secretary of Defense Cohen, a former member of this committee, in December 2000 after a second tragic and fatal mishap involving the V-22 in the span of 8 months: one in April 2000 and the second in December 2000. Twenty-three marines died in these two mishaps.

The committee this morning, once again, expresses our compassion to the families and their loved ones. Mishaps, accidents, and tragedies such as this are the risks that our men and women of the Armed Forces must share, but it is our responsibility in every way possible to limit those risks when it is humanly possible, and that is why we are here today.

Secretary Cohen asked the panel to address several aspects of the V-22 program affecting the strategy and effectiveness of the aircraft. These aspects included training, engineering, design, production, quality control, suitability to satisfy operational requirements, performance, and safety of flight. The panel conducted its duties in public, in accordance with the Federal Advisory Committee Act. Secretary Cohen chose a distinguished group of individuals to serve on this panel, and we are privileged to have them with us today.

I remain greatly concerned, as I have throughout a number of years of service on this committee, about this program. I recognize that it offers considerable performance improvements in range, speed, and payload over the helicopters currently in use. I must question, however, whether the increased performance is worth the additional cost and apparently the increased risk to those who must operate these aircraft associated with this dramatic technology.

I recognize that this technology is one of a kind, and if it is successful, the United States of America will have cutting edge technology which far transcends the use by the U.S. military and per-

haps other militaries. If it works, this technology has the opportunity to be introduced into the private sector and civilian aircraft. Therefore, there is more at stake than just the service requirements.

I have had the opportunity to review the panel's report, which was posted on the Internet at midnight last night. There are numerous conclusions and recommendations, key among these being that the program is not ready for either full-rate production or operational use at this time. I am concerned whether the issues identified by the panel report can be resolved even with a restructured program. There appear to be significant issues with design, engineering, production, training, and reliability.

General Dailey, I understand that as panel chairman, you will be making a statement for the entire group.

Now, Senator Levin and I have been on this committee for 23 years. We have seen a number of times when issues have been brought before this committee which, you might say, have high drama, but it is my hope—and I talked it over with my distinguished ranking member—that we are not here today for drama. We are here to receive the facts as a part of our oversight responsibilities.

In due course, this committee will receive the report of the Inspector General and then eventually we will receive the views of the Secretary of Defense, with whom I spoke first thing this morning about this hearing. So, we should not judge this hearing as one which will be dispositive of this program. There is much hard work to be done. I hope we can do it in a very objective and fair way.

But we come back again to what we are asking of our young men and women of the U.S. military in this program and in others as we proceed to push the cutting edge of technology, which is a necessary responsibility of this Nation if we are to remain free to work with our allies in that cause.

Senator Levin.

STATEMENT OF SENATOR CARL LEVIN

Senator LEVIN. Thank you, Mr. Chairman.

This is, indeed, a very important hearing. Lives have been lost through accidents and through tragic failures. The V-22 program is operating under a significant cloud of doubt right now. We will have to decide whether to proceed with the program and, if so, how.

I have supported the V-22 program in the past. It was my belief that, if it could be made to work safely and reliably, the V-22 had the potential to provide significant capability to the Marine Corps and our Special Operations Forces. I also joined others in the hope that the aircraft might have the potential for spinning off to support civilian aviation applications.

Whether I continue to support the V-22 program will depend on whether this hearing, as well as subsequent hearings, develop sufficient facts to make conclusions as yet to be determined. I hope to explore a number of significant questions about the program, including the following:

- How did we get within a couple of weeks of approving entry into full-rate production for a program with the sig-

nificant safety problems identified by The Panel to Review the V-22 Program—including crash-worthy fuel tanks, flight control system reliability, downwash concerns and production quality—and open questions about combat effectiveness—including reliability, availability, and maintainability?

- Why were we flying the aircraft with 19 people on board last April when it is clear, at least from hindsight, we did not have a good understanding of the vortex ring state condition within the V-22 flight envelope?
- When and using what benchmarks will we be able to decide whether the V-22 program should move forward?
- What caused the squadron commander to tell maintenance personnel in the squadron to falsify maintenance data to make the V-22 look more reliable?
- Were there others involved in keeping the truth about maintenance reliability data from decisionmakers?

Some of those issues are going to be explored this morning. Others are going to be explored in later hearings and by other panels.

These latter questions raise such serious doubts that they needed to be addressed outside of the Department of the Navy and outside of the Marine Corps. That is why Senator Warner and I wrote to Secretary Rumsfeld on January 24 to urge that he conduct an external review. The Department Inspector General is now engaged in such a review. This is an important step, because only an external review of the allegations about the program can reestablish confidence in the program on the part of Congress, the public, the military, and the families who have lost loved ones.

We are going to clearly have to hear from others before we can make a decision on the future of the V-22 program. That includes hearing from the DOD Inspector General, V-22 acquisition officials, and, as the chairman said, Secretary Rumsfeld himself.

I join the chairman in expressing appreciation to the panel members for their continuing service to this Nation in their review of the V-22 program. They are highly qualified and well-known to the members of the committee. We look forward to reviewing the results of their independent judgments on this program.

Thank you, Mr. Chairman.

Chairman WARNER. Thank you, Senator Levin. I would like to take this opportunity to note that the opening statements of Senator Thurmond and Senator Kennedy will be inserted in the record in their entirety, as they were not able to be here today.

[The prepared statements of Senator Thurmond and Senator Kennedy follow:]

PREPARED STATEMENT BY SENATOR STROM THURMOND

Thank you, Mr. Chairman:

Mr. Chairman, I find it ironic that the committee is again holding a hearing on the V-22. It was 10 years ago that Secretary Cheney sought to cancel the V-22 program on the grounds of affordability. Today, almost 20 years after the program was started by the Army, the committee is again considering the state of the program.

In the early 1990s, I supported Secretary Cheney's effort to cancel the program. I did so because of cost and the uncertainty of the technology. Today, despite the tragic loss of life as a result of a series of crashes, I believe we need to continue the development of the program. In my judgment, it has demonstrated the very ca-

pabilities that make it essential to our Marine Corps and our Special Operations Forces.

I want to congratulate the members of The Panel to Review the V-22 Program. Their exhaustive report provides the foundation for not only continuing the program, but also ensuring that the appropriate corrective actions are taken.

Mr. Chairman, Secretary Rumsfeld is concluding his strategic review of our national security requirements. I appreciate the difficult decisions that he is facing, however, as he is considering the challenges facing our Armed Forces, I hope he will consider the V-22 as an integral part to the continued viability of our Marine Corps. Thank you, Mr. Chairman.

PREPARED STATEMENT BY SENATOR EDWARD M. KENNEDY

I welcome the committee's hearing on this important issue. I look forward to reviewing the findings and recommendations of The Panel to Review the V-22 Program, and to our committee's consideration of the status and future of the V-22 program.

Clearly, there is a need to transform our military to more effectively meet the threats and challenges of the future, and I believe that tiltrotor technology can play a significant part in this transformation. But, as with any new development in technology, tiltrotor aircraft should be extensively and thoroughly tested to minimize the problems and the risks to those who fly on these aircraft.

Unfortunately, the current V-22 program turns out to have been a classic case of "buy before you fly". What has taken place, so far, in this program is disappointing, and we cannot continue in this way. The pressure to move forward by cutting corners in order to maintain timelines puts lives at unnecessary risk, and wastes money.

As a result of the second tragic accident last year, concerns about V-22 reliability and maintainability began to be adequately addressed, and redesign of the suspect hydraulic system was finally considered. We have a much better opportunity now to evaluate the entire program objectively and consider recommendations for the future of this program. Hopefully, the lessons being learned from this program will be applied to other vital programs of the Department of Defense overall.

[Whereupon, at 10:20 a.m., the committee recessed, to reconvene in executive session, and resumed the hearing at 10:22 a.m.]

Chairman WARNER. Thank you General Dailey for waiting. We are ready to receive your report.

STATEMENT OF GEN. JOHN R. DAILEY, USMC, (RET.), PANEL CHAIRMAN; ACCOMPANIED BY NORMAN R. AUGUSTINE, PANEL MEMBER; GEN. JAMES B. DAVIS, USAF, (RET.), PANEL MEMBER; AND DR. EUGENE E. COVERT, PANEL MEMBER

General DAILEY. Thank you, Mr. Chairman, distinguished members of the committee. We are pleased to appear today to discuss the findings and recommendations of The Panel to Review the V-22 Program. Secretary of Defense Cohen determined that the accident history of the V-22 aircraft and other testing issues required an independent review of the program. I would like briefly to review our activities.

The panel was commissioned on December 15, 2000, and met with the Deputy Secretary of Defense on December 28, 2000. Fact-finding activities started on January 11, 2001. These consisted of briefings on the Marine Corps and Special Operations Command mission requirements, the ability of the V-22 aircraft to meet the requirements, and the program status. We were briefed by the Program Manager, the Director of Operational Test and Evaluation, and the General Accounting Office. We spoke to the Naval Air Systems Command, test personnel, pilots, maintainers, and contractors.

In March we conducted site visits. We visited the training squadron at Marine Corps Air Station, New River, North Carolina, and the Special Operations Command at MacDill Air Force Base, Florida. After a visit at Bell Helicopter in Fort Worth and Amarillo, Texas, we concluded our visits at Boeing Helicopter in Philadelphia, Pennsylvania. During this time, we toured the flight line, training facilities, maintenance spaces, factories, and engineering laboratories, and flew the V-22 simulator.

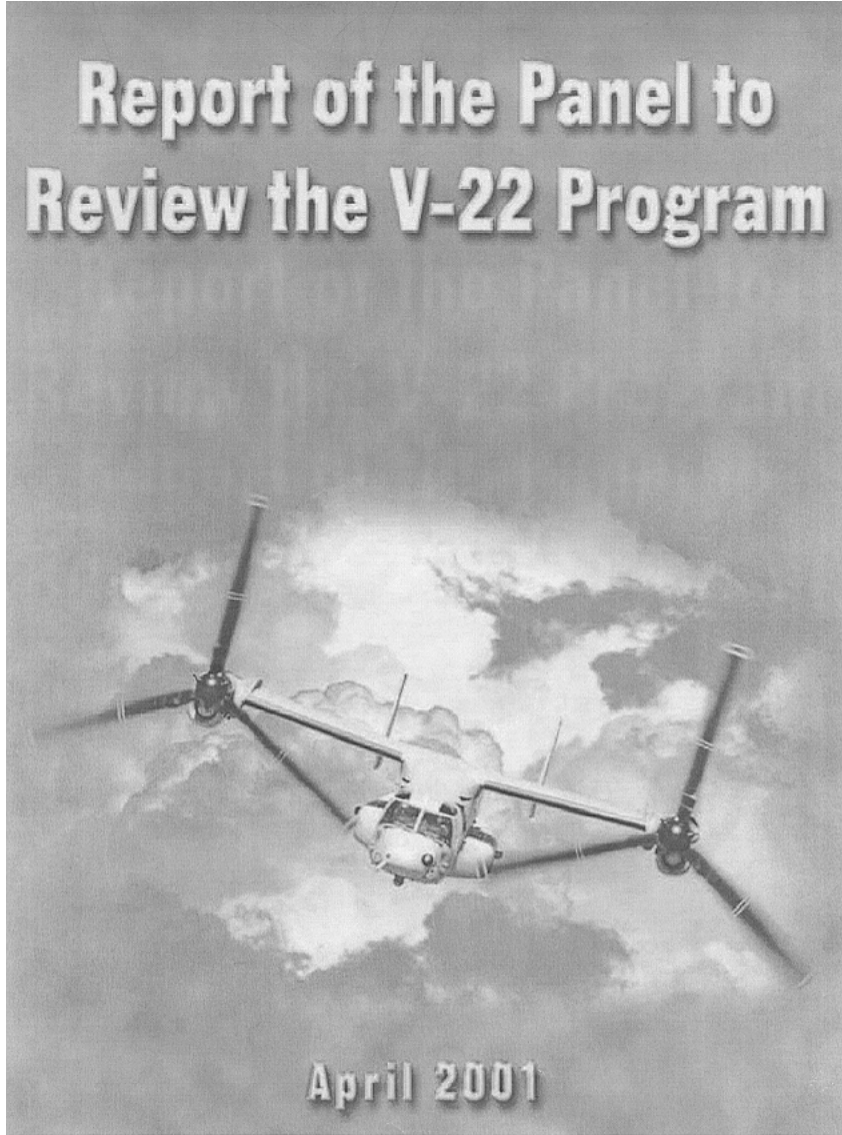
On March 9, 2001, we conducted an open meeting to provide the general public the opportunity to submit information to the panel about the V-22 program.

On April 18, 2001, we held an open meeting to conduct public deliberations in preparation for submitting our recommendations to the Secretary of Defense. Our purpose today is to present a summary of our findings, conclusions, and recommendations and, with your permission, submit a copy of our report for the record.

Chairman WARNER. Without objection, it will be admitted.

[The Report of The Panel to Review the V-22 Program follows:]

Report of the Panel to Review the V-22 Program



April 2001



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 PANEL TO REVIEW THE V-22 PROGRAM
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April 30, 2001

Chairman
 John R. Dailey

Panel Members
 Norman R. Augustine
 James B. Davis
 Eugene E. Covert

Executive Secretary
 Gary J. Gray

MEMORANDUM FOR THE SECRETARY OF DEFENSE

SUBJECT: Report of the Panel to Review the V-22 Program


The Panel to Review the V-22 Program is pleased to present its final report as requested in Secretary Cohen's December 15 memorandum. The Panel addressed many factors that affect flight safety and combat effectiveness of the V-22 aircraft. The report includes our findings, conclusions and recommendations.

We would specifically like to thank the following organizations for providing the requisite information and knowledge to allow the Panel to comprehend the issues and make meaningful recommendations in a very short timeframe: the V-22 Program Office; the Marine Medium Tiltrotor Training Squadron - 204 (VMMT-204); the United States Marine Corps; the United States Air Force; the United States Special Operations Command (SOCOM); the Naval Air Systems Command; the Naval Safety Center; the Helicopter Marine Experimental (HMX-1) Squadron; the Director, Operational Test and Evaluation, Office of Secretary of Defense; and the General Counsel, Department of Defense.

The Panel believes the V-22 aircraft has a unique capability and is the only existing aircraft that can fulfill the mission requirements of the Marine Corps and SOCOM. We believe that the requirement is justified and that the V-22 aircraft has demonstrated its ability to satisfy the requirement.

The Panel found no evidence of an inherent safety flaw in the V-22 tiltrotor concept. We recommended that the program be continued, but restructured. The Panel found that the V-22 aircraft lacks the maturity needed for full-rate production or operational use and made recommendations for corrective action.

On behalf of the entire Panel, I thank you for giving us the opportunity to serve the Department of Defense in this serious matter.


 John R. Dailey

Attachment:
 As stated

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Gary J. Gray
Executive Secretary

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EXECUTIVE SUMMARY

The Secretary of Defense, citing safety and operational testing issues, established an independent review of the V-22 Program. He appointed General John R. Dailey, USMC (Retired), Mr. Norman R. Augustine, General James B. Davis, USAF (Retired), and Dr. Eugene E. Covert to the Panel to Review the V-22 Program. The charter called for an examination of relevant factors as they relate to safety and combat effectiveness.

The Panel visited contractor engineering and production facilities, the V-22 training squadron, and United States Special Operations Command Headquarters. The review included public inputs, discussions with the Government and contractor program managers, engineers and test pilots. Panel members also flew the engineering and training simulators and examined operational aircraft as well as the production lines. Briefings were given on a variety of technical issues by Navy and contractor engineers, safety professionals and test pilots.

The V-22 completed its Operational Evaluation with mixed results. On one hand, the aircraft satisfied all 13 of its Key Performance Parameters (including range, speed, and payload). On the other hand, the aircraft fell short of requirements for reliability, availability, and maintainability suggesting that the aircraft and its logistics support system have not yet matured to the point of adequate supportability.

The need for a capability of the type the V-22 was designed to satisfy appears to be justified, and by its demonstrated performance, the V-22 has shown unique potential to meet that need. There is no evidence that the V-22 concept is fundamentally flawed, however, the aircraft is not ready for operational use in a number of key respects, chief among them system reliability, and maintainability. Further, the Program shows signs of underfunding as evidenced by inadequate MV-22 spares and logistics support in the out-years, the use of aircraft for maintenance trainers, and a lack of reserves for program contingencies.

Based on its findings, the Panel recommends that the Department proceed with the V-22 Program, but temporarily reduce production to a minimum sustaining level to provide funds for a Development Maturity Phase. The report contains a number of specific recommendations regarding upgrades to the reliability and maintainability of the hydraulic system, improvement and verification of technical publications and aircrew procedures. Various operational restrictions should be imposed until the Development Maturity Phase has progressed to the point where known risk issues have been properly addressed and confidence in aircraft reliability, maintainability and logistics supportability have returned. Finally, the spares and logistics support for the Program should be fully funded in order to allow the Marines and Special Operations warfighters the best opportunity to make use of the demonstrated capabilities of the aircraft.

RECOMMENDATIONS

SAFETY IMPLICATIONS OF THE TILT ROTOR CONCEPT

Recommendation: Continue to develop mitigation strategies to limit the potential for autorotation and the risk (probability and severity) of asymmetric thrust conditions.

THE MIRANA ACCIDENT AND VORTEX RING STATE

Recommendation: Use the results of the planned high-rate-of-descent flight tests to update operating limitations, procedures, the Naval Aviation Training and Operating Procedures Standardization (NATOPS) manual, pilot training (including the flight simulator), and a cockpit warning system.

Recommendation: Configure the pilot training simulator with the capability to provide vortex ring state training to the maximum extent possible based on model limitations and information available. At a minimum, include avoidance training.

Recommendation: If testing indicates poor natural aerodynamic warning, the aircraft should be configured with a cockpit warning system.

Recommendation: Develop techniques and procedures for inter-aircraft coordination during formation-decelerating conversions.

Recommendation: If flight test results point to the need for flight limitation that includes airspeed of 40 knots indicated airspeed or less, procure or develop a more accurate airspeed indication system for the aircraft.

THE NORTH CAROLINA ACCIDENT AND FLIGHT CONTROL SYSTEM RELIABILITY

Recommendation: Improve hydraulic system component reliability.

Recommendation: Take steps to mitigate the risk of loss of hydraulic system integrity (e.g., chafing, fittings, leaks, vibration).

RECOMMENDATIONS

Recommendation: Develop techniques, tools, and methods for timely identification of hydraulic-line chafing.

Recommendation: Add acoustic sensors to the test nacelle and reevaluate the adequacy of current test nacelle environmental instrumentation in light of recent reliability problems.

Recommendation: Assess the process used by V-22 contractors to predict component reliability numbers and take steps to improve.

Recommendation: Develop appropriate controls (design and life-cycle support) for all exceptions to the flight control redundancy requirements (not just those that are single-point failures).

Software Reliability

Recommendation: Conduct an independent flight control software development audit of the V-22 Program with an emphasis on integrated system safety.

Recommendation: Conduct a comprehensive flight control software risk assessment prior to return to flight.

Recommendation: The V-22 Program should not return to flight until the flight procedure and flight control software test cases have been reviewed for adequacy and have been evaluated in the integrated test facilities.

AUTOROTATION

Recommendation: Reassess the requirement for autorotative flight in view of the low need, low probability of improvement and the existence of alternatives.

Recommendation: Reassess the capability of the V-22 to conduct power-off-glides. Explore design and operational techniques to optimize power-off-glide capability (e.g., minimize proprotor drag commensurate with auxiliary power requirements).

Recommendation: Ensure that the full flight simulator used by pilots at Marine Corps Air Station, New River accurately emulates both autorotative and power-off-glide simulations to the degree required for effective pilot training.

Recommendation: Reassess the requirement for (and priority of) autorotative flight in view of the low probability of improvement and the existence of alternatives.

DOWNWASH EFFECTS ON TACTICAL OPERATIONS

Remote Area Operations

Recommendation: Continue to develop procedures and techniques for the high downwash “desert brownout” situation, and incorporate them into the training manuals and syllabi.

Recommendation: Restrict tactical unit night operations in landing zones that have the potential for brownout until procedures and techniques are developed and approved.

Personnel Deployment/Recovery from Hover (in and out of ground effect)

Recommendation: Revalidate the requirements for personnel deployment and recovery operations.

Recommendation: If the requirements remain valid, then incorporate appropriate hoist and ladder systems into the aircraft as soon as possible.

Recommendation: Conduct follow-on testing and evaluation to address tactics, techniques, and procedures to be used in the conduct of personnel deployment and recovery operations.

External Load Operations

Recommendation: Conduct follow-on test and evaluation to further refine tactics, techniques, and procedures and to ensure that external operations can be conducted safely and effectively.

PILOT TRAINING

Recommendation: Provide adequate funding for aircrew ground training, aircraft simulators, and upgrades to training devices.

RECOMMENDATIONS

Recommendation: Publish updates to the MV-22 NATOPS manual, and verify with VMNT-204 pilots before the first operational flight to support pilot/squadron transition and re-currency training.

Recommendation: Convene an out-of-cycle NATOPS manual conference prior to the first squadron operational flight to assure consistency and adequacy of emergency procedures and operational limitations. Develop an expeditious process to incorporate changes from this conference and from ongoing test and evaluation activities.

CRASHWORTHY FUEL TANKS

Recommendation: Configure (by retrofit or test) all operational aircraft with crashworthy fuel cells at the first opportunity (see later recommendation with respect to retrofit funding),

and, in the meantime

Recommendation: Communicate the interim risk acceptance rationale to the operational community.

PRODUCTION QUALITY

Quality Trends

Recommendation: The contractors, Defense Contract Management Agency, and Services need to remain actively involved in quality assessments and improvements.

Recommendation: Take appropriate steps to resolve quality-related findings of the Tiger Team as soon as their results are available.

OPERATIONAL TEST CREW SELECTION AND ASSIGNMENT

Recommendation: As the testing program proceeds, test managers (contractor, Naval Air Systems Command (NAVAIR), and operational) should continue to ensure the appropriate experience and qualifications of all flight crewmembers.

Recommendation: As V-22 development and testing continue, all responsible organizations should take all reasonable steps to ensure that operational test aircrews are

not subjected to undue risk. Thoroughly assess all known and suspected high-risk flight regimes.

Recommendation: Until the aircraft is ready for deployment, flying should be restricted to mission-essential personnel. Assess operational risk factors before authorizing increased risk flights (e.g., assaults, night flying, weather flying, etc.).

SYSTEM SAFETY

Organization and Process

Recommendation: Develop a consistent approach to measuring overall risk level in development and operational programs to aid decision makers in risk trades. Consider use of probabilistic risk assessment techniques to comply with the most recent risk category definitions published by the Naval Air Systems Command.

Director, Operational Test and Evaluation (DOT&E) Safety Issues and “Implications” vs. NAVAIR Safety Risk Posture

Recommendation: To aid decision makers, the Defense Operational Test and Evaluation organization and Navy Operational Test and Evaluation Force should consider the use of standard risk indices (i.e., Risk Assessment Codes) when reporting safety issues.

RELIABILITY AND AVAILABILITY

Recommendation: Reassess and revalidate the current set of V-22 reliability and availability requirements to assure appropriate expenditure of resources on engineering changes.

MAINTAINABILITY

Recommendation: Modify the nacelle to improve the spacing/protection of critical components, maintenance working space, access, and the overall maintainability of this critical aircraft area. The redesign activity for this modification should include at least the following:

RECOMMENDATIONS

- a. More quick-access panels;
- b. High-reliability alternatives to the Mini-Mark fastener;
- c. User-friendly inspection access for critical parts and other exceptions to the flight control system redundancy design requirement;
- d. Shortening of the hydraulic lines between switching valves and swashplate actuators (if feasible).

INTERACTIVE ELECTRONIC TECHNICAL MANUAL (IETM)

Recommendation: Assess the options for V-22 technical publications (electronic and paper).

Recommendation: Provide adequate developmental support to the training squadron for the selected system.

Recommendation: Properly validate and verify the technical publications as soon as possible.

Recommendation: Transition as soon as possible from the Universal Numbering System to the standard Work Unit Code logistics system.

Recommendation: Standardize performance, support, testing, and funding requirements for electronic technical manuals across all platforms and Services.

**MAINTENANCE AND AVAILABILITY REPORTING NAVAL
AVIATION LOGISTICS COMMAND MANAGEMENT INFORMATION
SYSTEM (NALCOMIS) (OPTIMIZED)**

Recommendation: NAVAIR should correct the deficiencies and incompatibilities that are resident in the NALCOMIS (Optimized) system as soon as possible.

Recommendation: NAVAIR should provide a set of guidelines and metric algorithms to all organizations that use NALCOMIS readiness data for planning, budgeting and other resource decision-making.

DIAGNOSTIC CAPABILITY

Recommendation: Fix the individual deficiencies associated with Aviation Maintenance Event Ground Station (AMEGS), IETM, and NALCOMIS (Optimized). After each system demonstrates adequate reliability, integrate these three systems as soon as possible.

Recommendation: In the short term, expedite software cross-references for AMEGS and IETMs.

Recommendation: Provide appropriate training on AMEGS for the VMMT-204 maintainers.

Recommendation: Expedite the plan to reduce the V-22 false-alarm rate in both the aircraft and ground systems, with priority on aircraft software.

MAINTENANCE TRAINING

Recommendation: Fully fund and support the maintenance training system.

Recommendation: Consider the eventual replacement of the aircraft being used as maintenance trainers with maintenance trainers designed for that purpose.

Recommendation: Retrofit and modification of maintenance training aircraft (when appropriate) should occur at the same time or prior to those changes being incorporated in tactical aircraft.

Recommendation: Adequately budget for maintenance-training aircraft spares.

THE JOINT PROGRAM AND SYSTEMS ENGINEERING

Recommendation: Constant attention must be paid by both the Navy and the Bell Boeing Joint Program Office to the potential for lapses in systems engineering integration discipline as team members try to solve problems outside of established processes.

Recommendation: As the program proceeds, both NAVAIR and the contractors should ensure a high level of continuity in the program's Integrated Product Teams, Analytic Integration Teams, and key management positions.

RECOMMENDATIONS

Design Trades

Recommendation: For the next phase of system and requirements reviews, risk trades, and engineering changes, the program should assess its trade-study priorities and perform updates consistent with today's priorities—i.e., safety, reliability, and maintainability.

Risk Management

Recommendation: The Defense Systems Management College risk management course should use the V-22 Program risk management process as an example of how to incorporate risk into everyday program management.

PROGRAM COMMUNICATIONS

Recommendation: Review information flow requirements between the V-22 Program, Bell Boeing, and the customer, and develop a funded plan to increase the responsiveness to operator needs. (Attention needs to be given to meeting similar requirements for the Air Force and Special Operations Command (SOCOM) during CV-22 introduction).

Recommendation: Supplement the standard formal reporting to and from the Osprey Support Center with informal feedback to facilitate the exchange of information to and from the operators.

Recommendation: Both the Government and Bell Boeing should increase the management visibility of the Osprey Support Center and decrease the turnaround time for relevant problem-resolution status.

Recommendation: Bell and Boeing CEOs, the V-22 Program Manager, and the Joint Program Office meet monthly to review program status until the current concerns are resolved.

PROGRAM DEVELOPMENT RESERVES

Recommendation: A funding reserve should be provided and protected during the DoD budget process for unknown contingencies for CV-22 development and to address the additional design and development and the Development Maturity Phase recommended by the Panel.

CV-22 BLOCK 0 DEVELOPMENT

Recommendation: Remove the CV-22 Block 0 funding ceiling and fund at the required levels. Retain the funds in the program until the Secretary of Defense considers the Panel's specific recommendations.

ENGINEERING PRODUCTION CHANGES

Recommendation: Temporarily reduce production to a minimal sustaining rate until both the aircraft design and manufacturing processes mature. Funds generated by this reduction in aircraft should be protected in the DoD budget and made available for a "Development Maturity Phase" and increased production engineering changes. (See subsection 4.8 Program Funding).

Recommendation: Establish an Aircraft Procurement Navy-5 funding line and provide funds. Assure that CV-22 retrofit is covered with funding line and funds, as appropriate.

SPARES AND LOGISTICS SUPPORT PLANNING AND PROVISIONING

Recommendation: Fund spare parts levels and logistics support based on the results of the independent cost estimate and actual experience to date.

Recommendation: Fund additional engineering change proposals to improve reliability and to reduce spare parts requirements.

PROGRAM FUNDING

Recommendation: Proceed with the V-22 Program as the best alternative for the stated mission need.

Recommendation: To address the specific actions identified in this report, temporarily reduce the production rate to a minimum sustainable level and reprogram funds that are freed to the Research, Development, Test, and Evaluation account to apply to the Development Maturity Phase. Incorporate resulting changes into the production line as early as possible. Funds generated by this reduction in aircraft should be protected in the

RECOMMENDATIONS

DoD budget and made available for the Development Maturity Phase and increased production engineering changes.

Recommendation: Once the Development Maturity Phase is complete, establish a maximum economic production rate and buy out the remaining aircraft with firm, fixed-price, multiyear procurements to help recover total program cost and schedule.

SUMMARY CONCLUSIONS AND RECOMMENDATIONS

Summary Recommendation: Validate and prioritize requirements; delete those that are invalid or that rank poorly in cost/ benefit terms.

SAFETY

Summary Recommendation: Improve reliability, then verify by extensive test/fix/test in challenging environments.

Summary Recommendation: Expand safety risk assessments to include off-nominal conditions, with emphasis on flight control software, and hydraulic and power train systems. Retrofit crashworthy fuel cells into all operational aircraft.

Summary Recommendation: Extend high-rate-of-descent testing, formation flying (and other deferred flight tests as appropriate) to sufficiently define and understand the high-risk portion of the flight envelope under all appropriate flight conditions. Add a VRS cockpit warning system and appropriate simulator training.

Summary Recommendation: Make the flight manuals correct, explicit, and simple.

OPERATIONAL EFFECTIVENESS AND SUITABILITY

Summary Recommendation: Fix the existing maintenance publications system or adopt a new approach, such as the system currently being used by the F-18 or the one planned for the AH-1.

Summary Recommendation: Provide better physical access to obstructed areas for inspection and maintenance by ground crews, and substantially refine the diagnostics system.

Summary Recommendation: Explore the suitability and limitations of the aircraft in such activities as tactical formation approaches, fast roping, and desert/night operations.

RECOMMENDATIONS

PROGRAMMATICS

Summary Recommendation: Proceed with the V-22 Program, but temporarily reduce production to a minimum sustaining level to provide funds for a Development Maturity Phase, and keep to a minimum the number of aircraft requiring retrofit.

Summary Recommendation: Implement a phased approach to return to operations with flight-readiness reviews before each phase.

Summary Recommendation: Purchase adequate spares and logistics support.

Summary Recommendation: Establish sufficient funding reserves to permit the Program Office to deal with unforeseen and unforeseeable circumstances without disrupting the entire flow of the program.

Summary Recommendation: Increase formal and informal feedback among all members of the V-22 team.

Summary Recommendation: Initiate monthly executive-level program management meetings and continue throughout the Development Maturity phase. These meetings should involve the Chief Executive Officers of both Bell and Boeing, the Navy Program Manager, representatives of the users (Marine and Special Operations Command), and the Joint Program Office Director. Action items should be assigned and monitored.

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INTRODUCTION

BACKGROUND

On December 11, 2000, an aircraft assigned to the Marine Corps' first operational MV-22 Osprey squadron crashed during a night training mission in a wooded area near Jacksonville, North Carolina, killing all four Marines on board. This was the second fatal accident for the new aircraft in 8 months, the previous mishap having been during a night Operational Evaluation (OPEVAL) test flight in Arizona, resulting in the loss of 19 Marines. The Marine Corps suspended flight operations until the most recent accident was fully understood and any new safety risk could be dealt with for the remaining aircraft.

The Assistant Secretary of the Navy for Research, Development and Acquisition was scheduled to make a full-rate production decision in early December, but the mishap, as well as several suitability issues raised during OPEVAL, caused the Marine Corps to request that the decision be delayed until the mishap investigation was completed.

On December 15, the Secretary of Defense, citing the mishap and testing issues, established an independent review of the program, which was termed The Panel to Review the V-22 Program. He appointed General John R. Dailey USMC (Retired), Mr. Norman R. Augustine, and General James B. Davis, USAF (Retired) to the Panel.

In a follow-up memorandum, the Secretary of Defense approved the Panel's charter and added a fourth member, Dr. Eugene E. Covert. The charter required that the Panel report its findings and recommendations to the Secretary of Defense and estimated a 3- to 4-month effort (depending on the availability of mishap investigation results).

The Panel charter is attached as Appendix A.

THE PANEL

The Panel to Review the V-22 Program consists of four members: General John R. Dailey, USMC (Retired); The Honorable Norman R. Augustine; General James B. Davis, USAF (Retired); and Dr. Eugene E. Covert. General Dailey is the Panel Chairman. The Panel was established subject to the Federal Advisory Committee Act (FACA).

In accordance with FACA guidelines, the Department of Defense (DoD) appointed Mr. Gary J. Gray to serve as the Panel's Designated Federal Official, and also as the Panel Executive Secretary. The Panel was also authorized a small professional and administrative staff. The biographies of the Panel and key staff members are provided in Appendix B.

INTRODUCTION

OBJECTIVE AND SCOPE

As established in the Secretary's charter, the purpose of The Panel to Review the V-22 Program is to conduct an independent, high-level review of the V-22 Program to include safety of the aircraft, recommend any proposed changes or corrective actions, and report the results to the Secretary of Defense. The charter listed five factors as they might affect safety and combat effectiveness of the aircraft:

- 1) Training
- 2) Engineering and design
- 3) Production and quality control
- 4) Suitability to satisfy operational requirements
- 5) Performance and safety of flight

In conducting the "high-level" review, the Panel assessed all aspects of the program with concentration on the five general factors above. The Panel had neither the resources nor the charter to perform detailed investigations of recent mishaps, nor to provide exhaustive analyses or audits of any of the known technical or programmatic issues facing the V-22 Program. Rather, the Panel kept its findings to the major issues, using the experience and expertise of its members and staff to recommend general solutions to significant problems related to safety, effectiveness, and programmatic.

APPROACH

The Panel used the technical staff to coordinate briefings and site visits during the assessment. They invited officials from the Government and contractor program offices to brief them on history and current status of all aspects—technical and programmatic—of the V-22 Program. To get the user perspective, they visited the Marine training squadron at MCAS New River, Jacksonville, North Carolina, and the Special Operations Command Headquarters at Mac Dill Air Force Base, Tampa, Florida. They also visited contractor engineering and production facilities in Philadelphia, Fort Worth, and Amarillo. They exercised engineering and training simulators; received V-22 maintenance training lectures; and talked with production line supervisors, Marine and Air Force pilots, and maintainers. The Panel talked with Navy and contractor engineers, safety professionals, and test pilots on a variety of technical issues.

The Panel organized into subpanels to analyze the various issues that surfaced during the fact-finding events. As a FACA Panel, they received a great deal of unsolicited input from members of the public, Government, and industry. Twice during the review, the Panel held open meetings, once to receive input from the public and once for formal deliberations. The schedule of fact-finding and open deliberations is included in Appendix C.

Consistent with FACA guidelines, the Panel used publicly available information from previous studies, Mishap Investigation Reports (MIRs), and cost and alternative assessments. For neither of the two most recent major accidents has the MIR been

released, so the Panel based its findings on its own interviews and the results of the two relevant Judge Advocate General investigations. The Panel coordinated its review with an ongoing Defense Department Inspector General (IG) investigation concerning alleged falsification of certain aircraft material readiness information in the V-22 training squadron at Marine Corps Air Station New River, North Carolina. A letter confirming the consistency of Panel findings with that investigation is attached as Appendix D.

The results of the Panel's review are described in general terms in Section 1 (General Observations) and Section 3, (Summary Conclusions and Recommendations). Specific discussion, conclusions, and recommendations are included in Section 2 (Specific Findings).

HISTORY

THE TILTROTOR CONCEPT

The idea of using a tiltrotor concept for an aircraft dates back to the late 1940's and early 1950's. The first successful demonstration of tiltrotor feasibility was with the Bell Textron XV-3 under contract with National Aeronautical and Space Administration (NASA) and the Army. This 4,800-pound research aircraft was powered by a single, internally mounted radial reciprocating engine. It used a combination of transmissions, driveshafts, and gearboxes to drive the wingtip-mounted rotors and to rotate them up and forward for helicopter and airplane mode, respectively. From the mid-1950's through the early 1960's, the XV-3 made 250 test flights, including 110 full conversions from helicopter mode to airplane mode and back.

THE XV-15 PROTOTYPE

Once the XV-3 demonstrated the feasibility of tiltrotor, NASA and the Army proposed the development of a new tiltrotor aircraft—the XV-15, awarding Bell Textron a contract to build and test two aircraft in July 1972. The XV-15 weighed 13,000 pounds and was powered by two turboshaft engines. The aircraft flew in helicopter mode in May 1978 and airplane mode in July 1979. By 1981, the test team had expanded the aircraft's envelope to 21,000-foot altitude and 300 knots cruise airspeed, and the Department of Defense formally began the Joint Services Advanced Vertical Lift Aircraft (JVX) Program. The goal of this program was to meet the needs of all four military services for a vertical takeoff and landing (VTOL), medium lift transport aircraft. In 1982, the Joint Services Technical Assessment concluded that tiltrotor technology was the optimal candidate to meet the joint Services' needs.

THE V-22 OSPREY

The Deputy Secretary approved initiation of the program after a Milestone 0 Review in December 1981 to satisfy the multi-mission, multi-Service need. The Army led the original program. In 1982, the program was transferred to the Navy when the Army withdrew from the program because of affordability.

INTRODUCTION

In April 1982, Bell Helicopter Textron and Boeing Helicopters teamed to pursue the JVX program jointly. A year later, they received a preliminary design contract to validate the design and to reduce risk in the aircraft's full-scale development (FSD) phase. In 1984, the Government designated the JVX as the V-22. Shortly thereafter, the Secretary of the Navy chose the name "Osprey" for the new aircraft.

FULL SCALE DEVELOPMENT

Under the oversight of the Naval Air Systems Command, Bell Boeing began preliminary design work in June 1985. With successful completion of the Preliminary Design Review, the Government formally approved Full Scale Development (FSD) at the Milestone II Review in April 1986. The objective of the program was to develop the V-22 with the intent of producing 913 aircraft for the Army, Navy, Marine Corps, and Air Force. The plan called for Initial Operational Capability (IOC) for the Marine Corps version in 1992. Critical Design Review was held in December 1986. Seventeen months later, the first FSD aircraft was rolled out, and it made its first flight on March 19, 1989. A month after the first flight, the Secretary of Defense determined that the V-22 was not an affordable program, and he requested no more funds for development. Production was terminated in December 1989. Congress disagreed with the Administration's decision and continued to fund FSD, including development efforts to mature the tiltrotor technology, upgrade the drive system, and continue flight test using the FSD aircraft. It was during this time (June 1991) that the first V-22 was lost in a vertical takeoff accident due to miswiring of the flight control system rate gyros. Then, a second FSD aircraft and its seven military and contractor occupants were lost due to a nacelle fire during landing approach to the airfield at Quantico Marine Base, Virginia in July 1992. Following an analysis in October 1992, the Navy ordered continuation of V-22 development. Bell Boeing, a joint venture of Bell Helicopter Textron, Fort Worth, Texas, and Boeing Helicopter, Philadelphia, Pennsylvania, was awarded a contract for the Engineering and Manufacturing Development (EMD) of four production-representative MV-22 aircraft.

ENGINEERING AND MANUFACTURING DEVELOPMENT (EMD)

The objective of EMD was to mature the design of the MV-22 through flight test of production-configured aircraft, to continue to fly two of the FSD aircraft on a risk reduction program, and to complete operational testing in support of a go-ahead for full production (Milestone III). The plan called for Initial Operational Capability (IOC) for the MV-22 in the second quarter of Calendar Year (CY) 2001. The total production planned are as follows: 360 MV-22, Marine Corps variants; 50 CV-22, Special Operations Command variants; and 48 HV-22, Navy variants. The System Design Review, Preliminary Design Review, and Critical Design Review were accomplished by December 1994. The first CV-22 flew in February 2000, 3 months before the end of the MV-22 EMD flight test.

LOW RATE INITIAL PRODUCTION

In April 1997, after a successful Defense Acquisition Board review, the Under Secretary of Defense for Acquisition and Technology authorized the V-22 to proceed into Low

Rate Initial Production (LRIP). At the same time, he directed the CV-22 Overarching Integrated Product Team (OIPT) to review the CV-22 Program prior to full funding of production and report back to him. Future V-22 production decisions were delegated to the Navy, subject to the satisfaction of defined exit criteria. Subsequent reviews and approvals were conducted by the Assistant Secretary of the Navy (Research, Development and Acquisition) in March 1998, March 1999, and March 2000 (LRIP Lots 1, 2, and 3). At the March 2000 review, the Navy provided approval for MV-22 Lot 4 full funding and MV-22/CV-22 Lot 5 Advanced Acquisition Contract production funding. The first V-22 major accident in nearly 8 years killed 19 Marines in April 2000, when an Operational Evaluation (OPEVAL) pilot lost control of the aircraft during a high-rate descent to a desert runway at night. Following OPEVAL, the Assistant Secretary of the Navy (Research, Development and Acquisition) decided to postpone the Milestone III decision pending resolution of reliability and availability deficiencies that were raised during OPEVAL. Then, in December, another fatal accident occurred during a training mission when a Low Rate Initial Production aircraft assigned to the first operational squadron crashed during a routine night approach near New River, North Carolina. Pending the results of the latest mishap investigation, the V-22 aircraft are grounded, and the Milestone III decision awaits the results of that investigation as well as the findings of this Panel.

SECTION 1: GENERAL OBSERVATIONS

In reviewing the V-22 Program, the Panel noted an aircraft that had completed its Operational Evaluation with mixed results. On one hand, the MV-22 satisfied all 13 of its Key Performance Parameters, thus introducing a new technology to the United States arsenal with unprecedented range, speed, and payload and combat survivability capabilities for its mission. On the other hand, poor demonstrated availability and maintainability results suggest that the aircraft and its logistics support system have not yet matured to the point of adequate supportability. Further, its reliability and safety have caused the Department of Defense to question its technological maturity. In addressing this dichotomy, the Panel found it appropriate to answer eight fundamental questions. These questions are answered in the text below, followed by specific findings that treat them in more detail.

QUESTION 1: IS THERE A NEED FOR A CAPABILITY SUCH AS THAT OFFERED BY THE V-22?

In the evolving global geopolitical circumstances wherein confrontations among major powers seem somewhat less likely and engagements involving smaller groups ranging from terrorists to mid-sized nations seem more probable, the type of capability identified for the V-22 would seem to be important. Such a capability includes the capacity to deploy rapidly over long distances and to engage in surprise operations by virtue of the flexibility inherent in an extended operating range and the ability to carry out missions in a single period of darkness. As an example, the Desert One mission involved 2 days of hiding in the desert... a mission that could have been carried out by a V-22-like aircraft in a single period of darkness. The high political stakes involved in such missions make it imperative that they be carried out successfully when undertaken.

QUESTION 2: ARE THERE REASONABLE ALTERNATIVES TO THE V-22?

There are no existing aircraft capable of carrying out the V-22 mission, although there are aircraft, or combinations of aircraft, that can carry out lesser missions or execute the V-22 end mission with more time and reduced probability of success. Existing inventory aircraft are aging and will require replacement in the years ahead. Most of the current generation of aircraft are out of production and would be costly to reintroduce into production. New developmental programs likely would focus on technology and concepts very similar to that represented by the V-22.

Past experience indicates that the greatest source of waste in defense acquisitions is in stopping partially completed programs, a practice that usually merely exchanges known problems associated with the current developments for unknown problems associated with the yet-to-be-developed systems. That is, if the operational need is legitimate and the fundamental concept being pursued is sound, one is generally best served by seeking

to resolve whatever problems have been encountered in the ongoing development. The two caveats noted are, however, vitally important.

QUESTION 3: IS THE V-22 CONCEPT OR ITS IMPLEMENTATION FUNDAMENTALLY FLAWED?

The V-22 is a very complex flying machine, both aerodynamically and mechanically. This is a consequence of the need for multiple proprotors, the need to limit the diameter of the proprotors to allow safe shipboard clearance, the requirement to fold the wings and proprotors to permit compact storage aboard crowded ships, and the need to tilt the engine nacelles. There have been five major accidents involving the V-22, and its predecessor, the XV-15, that resulted in extensive loss of life and loss of aircraft. Of those, the basic causes in one instance was entirely unrelated to the unique concept of the V-22, two were related only in a highly indirect manner to that concept, and two were aggravated by the side-by-side proprotor V-22 configuration. None had as its fundamental cause the tiltrotor concept. It appears that there is no basic inherent flaw in the tiltrotor approach, although such a configuration does tend to be unforgiving because of its propensity to roll when certain malfunctions (other than engine failure) occur that affect one side of the propulsion system and not the other. To date, the XV-15 and the V-22 have accumulated approximately 6,000 total flying hours.

QUESTION 4: DOES THE V-22 PROVIDE THE PERFORMANCE CAPABILITY NEEDED TO ACCOMPLISH THE PRESCRIBED MISSIONS?

The V-22 has demonstrated the ability to meet the prescribed missions within the uncertainty band inherent in performance requirement measures. Certain tactical usage questions remain to be resolved, such as fast-roping, tactical formation approaches, and night desert operations.

QUESTION 5: IS THE V-22 ADEQUATELY RELIABLE TO INITIATE OPERATIONS?

The V-22's reliability at this point is clearly inadequate to be utilized by operational units now or in the immediate future. Higher than predicted component failure rates and lack of appropriate attention to flight-critical hardware have combined to reduce dependability and increase risk. To attempt to push the aircraft in this state into routine operations would further discredit the basic concept of the tilt-rotor aircraft and very likely result in the inability to carry out the prescribed missions and possibly produce further casualties.

QUESTION 6: IS THE V-22 MAINTAINABLE BY OPERATIONAL UNITS?

At the present time, the V-22 falls far short of being a tactically maintainable aircraft due to the confluence of a number of factors, which include the inadequacy of spares, a non-functional technical manual system, an unreliable diagnostics system, and poor accessibility to critical components in the nacelles.

SECTION 1: GENERAL OBSERVATIONS

QUESTION 7: IS THE V-22 AFFORDABLE?

The V-22 is a very expensive aircraft. Nonetheless, it is unlikely that any new aircraft capable of carrying out a mission in the general regime of that specified for the V-22 would cost significantly less. Indeed, any new aircraft of comparable performance would likely cost more, even if sunk costs were excluded in the comparison (as they should be in addressing future economic decisions). It is, of course, difficult to make a case for the V-22 as compared to the purchase of two CH-47s except for those missions that simply cannot be conducted by CH-47s (of which there are a number). However, overall costs, including personnel, support aircraft, etc., make the argument for the V-22 more compelling.

Given the relatively small procurement quantities affordable with today's overall defense acquisition budget, it is in fact extremely difficult to make a case for any new development of any type. Under the current circumstances, one must presumably consider new developments in the context not only of purchasing a limited number of new articles of equipment but also in terms of purchasing an "insurance policy" that permits modern, more capable systems to be put into production more quickly should the need arise in the decades ahead.

QUESTION 8: HAS THE DEPARTMENT OF DEFENSE ACQUISITION PROCESS SERVED THE V-22 DEVELOPMENT WELL?

The answer to this question is clearly "no." To begin with, the process has not permitted the creation of financial reserves to deal with unforeseen and often unforeseeable contingencies that arise even in the best-managed development activities. The 2-year cycle required to obtain additional funding (even if the funding is then available) in DoD acquisitions is incompatible with the pace of the change in technology and the schedule of reasonable development pursuits. As a result, in the case of the V-22, funding limitations, aggravated by contractor performance shortfalls, have resulted in such occurrences as the use of production aircraft to serve as maintenance trainers, insufficient spares, and inadequate technical publications and other logistics support.

In addition, the V-22 Program was initially structured to introduce a number of new capabilities simultaneously, thereby compounding the risk associated with the program. These new capabilities include a conceptually new design (a compound aircraft), an all-electronic maintenance manual system, a unique logistics numbering system, and a new operational-readiness reporting system...all while seeking to fulfill multi-Service needs and being vulnerable to an inadequate supply of spares (dictated by budgetary constraints). The consequences of these circumstances have been exacerbated by the fact that communications between users and developers, particularly contractors, have been sufficiently limited (not uncommon in DoD development activities) to the extent that confidence and morale among those who will be called upon to maintain and operate the system is low...often simply due to lack of information (in both directions).

DoD budgeting practices that invariably underestimate the impact of inflation in the economy tend to further exacerbate funding issues. DoD testing of new systems has evolved over the years to become largely a report card for possible program cutbacks or cancellations, such that engineering tests for the sake of exploring and verifying designs

are no longer pursued to an adequate extent. Finally, programs having met system performance goals tend to transition from the development phase into limited and then full production and subsequent operation prior to having adequately demonstrated the all-important operational characteristics of mission reliability and field maintainability.

SECTION 2: SPECIFIC FINDINGS

This section is organized into four subsections:

1. The Need for the V-22—a summary of the many requirements and alternatives analyses conducted over the last 20 years;
2. Safety—a discussion of the several safety issues and mishaps, and Panel findings regarding the safety of the tiltrotor concept and of the specific V-22 design;
3. Combat Effectiveness—the Panel’s findings in the area of operational suitability;
4. Programmatic—a discussion of various program management and resources findings.

1 THE NEED FOR THE V-22

The stated need to replace medium lift helicopters for multiple-Service use is well documented in a series of studies conducted over the last 20 years. U.S. Marine Corps CH-46E and CH-53D medium lift helicopters began military service in the early 1960s and are now experiencing technical obsolescence; escalating maintenance costs; reduced reliability, availability, and maintainability (RAM); and significant performance degradation. Current and projected CH-46E and CH-53D deficiencies include the following:

- 1) Inadequate payload, range, and airspeed
- 2) Lack of ability to communicate, navigate, and operate in adverse weather conditions, day or night
- 3) Lack of self-deployment or aerial refueling capability
- 4) Inability to operate in a Nuclear, Biological, Chemical (NBC) environment
- 5) Insufficient threat detection and self-protection capabilities
- 6) Unacceptably high maintenance and inspection rates
- 7) Limited communication capability for embarked troop commanders

Marines support the MV-22 Program because the aging CH-46E and the CH-53D provide limited or no capability to perform many of the missions in which the MV-22 is most effective. The V-22 alternative also supports the Marine Corps’ doctrine of Expeditionary Maneuver Warfare, crisis response, and naval forward-presence operations.

The U.S. Special Operations Command (SOCOM) uses a variety of fixed- and rotary-wing aircraft to perform special operations missions, the oldest of which are the MH-53J/M Pave Low medium lift helicopters with an average age of 30 years. The current inventory of aircraft lacks the self-deployment capability and performance

required to maximize the probability of success for assigned clandestine missions, especially those that must be conducted during one period of darkness. Current and projected SOCOM aircraft deficiencies include the following:

- 1) Inadequate combat radius and speed to execute multiple, concurrent major theater war and national missions without incurring additional support requirements (e.g., strategic airlift, in-flight refueling sorties, and associated logistics tails) all resulting in an increased operational signature.
- 2) Inadequate growth potential for emerging, self-protection aircraft systems due to space/weight and design limitations.

Air Force and SOCOM support for the CV-22 is based on a mission need, first stated in 1981, that, from the current options, only the CV-22 aircraft can satisfy. The CV-22's distinct advantage over helicopters in speed, range, payload, and increased survivability provides greater operational effectiveness. If restricted to using existing helicopters, SOCOM would not be able to accomplish some missions, and others would incur a much greater operational risk and still require force structure changes. The CV-22 requires less sustainment infrastructure and strategic airlift than helicopter alternatives. SOCOM already has reduced tanker and helicopter infrastructure in anticipation of receiving the CV-22.

The result of the Service needs was a Joint Operational Requirements Document (JORD) with 19 Key Performance Parameters (KPPs) (13 of which are unique to the MV-22), and nearly 300 other requirements. The major KPPs were the requirement for V/STOL capability, 500-mile range, 240-knot cruise speed, self-deployability, shipboard compatibility and the ability to carry 24 combat equipped troops.

While the Panel did not review Special Access Programs or Defense Advanced Research Projects Agency (DARPA) studies, the Panel is unaware of any existing or conceptual aircraft capable of carrying out the V-22 mission as defined by the JORD. There are a number of existing aircraft that could carry out lesser missions or execute the V-22's end mission with more time or reduced probability of success. Existing inventory aircraft are aging and require replacement in the years ahead. Most of the current generation of aircraft are out of production and would be costly to reintroduce into production. New development programs likely would focus on technology and concepts very similar to that represented by the V-22.

Conclusion: The helicopter assets that the V-22 was designed to replace are aging and approaching obsolescence. For the Marine Corps and SOCOM, the combination of speed, range, payload, survivability, and self-deployability demonstrated by the V-22 offer the warfighter the greatest probability of success of any existing or envisioned alternatives while minimizing casualties.

SECTION 2: SPECIFIC FINDINGS

2 SAFETY**2.1 OVERVIEW**

Two MV-22 aircraft and 23 Marines were lost in an 8-month period, just as the aircraft was completing its OPEVAL and just as the first operational squadron was preparing to take on its role of introducing the aircraft to the Fleet Marine Force (FMF). That brings to four the total number of V-22 losses since first flight in March of 1989 (three losses prior to fleet introduction). To put the safety history of the V-22 in perspective, Table 1 compares major (Class A) mishaps for the pre-fleet introduction years of several other new aircraft types.

Aircraft Type	Years	Flight Hours	Class A Mishaps	Cum. Rate (Mishaps per 100,000 ft hours)
V-22	1989 - 2000	3883	3	77
F-14A	1970 - 1973	3813	3	79
F-16A	1975 - 1979	3993	2	50
F-18 A/B	1978 - 1982	4922	3	61
H-60 (all types)	Not Available	Not Available	1	Not Available

Source: Naval Safety Center; Headquarters Marine Corps Safety Office

Note: All data are for development and operational testing phases.

Table 1: Comparative Mishap Rates during Pre-Fleet Introduction

Although the number of V-22 mishaps during pre-fleet introduction is not inconsistent with those of recent new fighter types, it is higher than the only other medium lift helicopter, and the number of fatalities is higher than all of the others in the comparison combined. Questions that are raised by the recent mishaps include the following:

- 1) Is there an inherent safety flaw in the V-22 tiltrotor concept?
- 2) Is flight crew training and assignment adequate?
- 3) Is system reliability adequate?
- 4) Is the system safety program adequate?
- 5) Is the quality program adequate?

To address these questions, the Panel reviewed the findings of the major mishaps (including one XV-15 and four V-22 losses [three pre- and one post-fleet introduction]), as well as all reported hazards, minor mishaps, and safety-related deficiency reports during testing. The Panel also heard from Government and contractor system safety

engineers, test pilots, operational aircrew, maintenance crew, quality managers, system engineers, and experts on the subject of high-rate-of-descent hazards in rotorcraft. The Findings section includes discussions of V-22 unique safety issues, the safety implications of V-22 reliability deficiencies, and the V-22 Program's approach to system safety engineering. The Panel was sensitive to the fact that neither Mishap Investigation Report (MIR) for the last two major mishaps has been released. The Panel did not conduct an independent investigation of either mishap; however, the results of the public portions of the Judge Advocate General (JAG) reports, along with limited discussions with engineers and pilots, were used to develop findings that relate to mishap causal factors.

2.2 SAFETY IMPLICATIONS OF THE TILTROTOR CONCEPT

The Panel examined the reports summarizing the five major tiltrotor mishaps to address the question of inherent tiltrotor technology risk. Each mishap had its own particular cause factors. The Panel examined not only all of the mishaps but also the current safety risk posture as represented by the system safety program. To provide balance, the Panel also examined those unique features of tiltrotor technology that mitigate risks common to helicopters. In its assessment, the Panel compared those aspects of the V-22 that are unique to the tiltrotor concept with a notional medium lift, shipboard-based assault helicopter designed with today's state-of-the-art systems and materials.

TILTROTOR MAJOR MISHAPS

- 1) In 1992, one of two Bell XV-15 prototype aircraft crashed due to a maintenance error. A safety wire was left off a castellated nut that secures the proprotor to the governor linkage. When the governor disconnected, the proprotor surged to the maximum pitch setting and rolled the aircraft on its back. The aircraft was low when this happened, and the crew survived the inverted impact. This failure cannot be considered tiltrotor unique, as such a maintenance error could cost loss of any aircraft; however, the roll response was unique to the tiltrotor configuration.
- 2) In 1991, Engineering Manufacturing Development (EMD) Aircraft 5 was lost during vertical takeoff on its first flight due to a miswiring of two of three rate gyros in the flight control system. The reverse gyro feedback caused the pilot to lose roll control shortly after liftoff, and the aircraft crashed wing and proprotor first. The aircrew survived the mishap, and there was no post-crash fire. This type of production or maintenance error would pose a safety risk to any fly-by-wire aircraft and is therefore not a tiltrotor-unique hazard.
- 3) A fatal accident in 1992 at Marine Corps Base, Quantico, Virginia was caused by the nearly simultaneous loss of an engine and the pylon mounted drive shaft that was providing redundant power to that engine's proprotor. Seven crewmembers and contractor passengers were lost. The reason for the engine failure was compressor stall and fire due to oil ingestion. Oil had leaked from the proprotor gearbox area and pooled in the lower inlet lip area, dumping into the engine during nacelle conversion. The uncontained fire quickly destroyed the

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interconnect driveshaft. The only part of this story that would be considered unique to the tiltrotor configuration is the concept of rotating the engine up to a vertical position. NAVAIR has since mitigated that risk for subsequent aircraft by the addition of fluid drains and interconnect fire protection.

- 4) The April 2000, Mirana, Arizona, mishap was a case in which the mishap pilot, while flying as wingman on a night formation approach, developed a high sink rate at low speed and most likely entered a regime of disturbed aerodynamics called vortex ring state (VRS) or power settling. The result was asymmetric loss of lift and accompanying roll at too low an altitude to recover before ground impact. All rotorcraft have the propensity for VRS-induced power settling, but the tiltrotor has several characteristics that are inherently unique—some good, some bad:

Good Characteristics

- Relatively high disc loading theoretically means that the tiltrotor needs a higher sink rate than a comparable size helicopter does to enter VRS (V-22 tests will verify).
- If the altitude is high enough, the roll-off will cause the aircraft to exit VRS (self-correcting), whereas some helicopters must be manually flown out of VRS (again, V-22 tests will verify).
- Rapid rotation of the nacelles only a few degrees promises to be a good way to avoid impending VRS relatively quickly (assuming pilot warning is adequate).

Bad Characteristics

- Relatively high disc loading makes it easier to develop a high rate of descent in a tiltrotor craft as compared to an equivalent helicopter (confirmed by pilots).
 - The tendency for the tiltrotor to respond to asymmetric VRS with an uncommanded roll will pose a higher risk of adverse outcome if it happens at low altitude (wing-first impact for the tiltrotor vs. hard landing for the helicopter).
- 5) The December 2000 mishap in North Carolina resulted from a loss of a hydraulic line, causing degradation in system redundancy, combined with an inappropriate flight control software design feature (one that had gone unnoticed in laboratory tests or flying aircraft for over four years). The mishap occurred during a routine night-practice instrument approach. This hardware-failure-combined-with-software-defect scenario would pose a safety risk to any fly-by-wire aircraft. However, during the V-22 mishap, the yaw excursions that came from the asymmetric response of one proprotor compared with the other was part of the loss-of-control situation. It is difficult to envision a similar directional control situation for a helicopter configuration, although a like response could be

expected from a two-engine, fly-by-wire, propeller-driven aircraft with a similar combination of failures.

MINOR MISHAPS AND HAZARD REPORTS

There have been 36 minor incidents reported to the Safety Center by the Defense Contract Management Agency (DCMA) and the flight test community since September 1998. The most serious of these are listed:

- 1) In October 1998, an aircraft aborted a flight for failure of the Engine Air Particle Separator (EAPS) hydraulic quick disconnect. The hydraulic leak sprayed throughout the nacelle area, causing smoke but no fire.
- 2) Three days later, the same aircraft experienced a small fire in the nacelle external to the engine compartment when the EAPS hydraulic line failed.
- 3) In February 1999, during shipboard trials, the test pilot experienced roll pilot induced oscillations. There was no damage, as the pilot waved off the approach. The flight control software was modified to correct a lateral axis flight control problem.
- 4) In February 2000, an aircraft experienced a fire in the right nacelle. Maintenance error was involved in this incident, as hydraulic fluid leaked from a B-nut on a pressure elbow reducer.

Of the remaining incidents, 4 involved the loss of a piece of the aircraft in flight, 11 were ground-support equipment damage incidents, 6 were maintenance errors, 2 were bird strikes, 1 was a flying quality complaint during external load testing, and 8 were minor design deficiencies.

The Naval Safety Center database contains four hazard reports covering the time from June through August 2000. The most serious of these is in-flight loss of the interconnect drive shaft due to a coupling failure. As this is a backup system only, the crew was able to make a safe landing. One hazard report covers in-flight opening of the cabin door, and two discuss in-flight loss of hardware: one prop blade tip cap and one prop rotor blade grip fairing.

The Panel heard from OPEVAL pilots that on at least two occasions they had experienced large uncommanded roll excursions while flying in formation (probably due to flying through the lead aircraft's disturbed air). These instances were not written up as hazard reports but are being treated by the Naval Air Systems Command as potential issues with regard to formation flight distance limitations. During development testing, the formation flying was limited to that required to ensure a safe distance limitation for conduct of OPEVAL tactical maneuvers.

The V-22 incidents and hazards are not dissimilar from those associated with fixed-wing and helicopter configurations. None of them is entirely unique. If the comparison is limited to helicopters, then the roll oscillations at the ship and the roll excursions in formation flight would have to be considered unique to the tiltrotor concept. All of the others appear to be generic in both cause and effect.

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TILTROTOR-UNIQUE RISK AREAS

The Panel reviewed NAVAIR's current listing of open and closed V-22 Safety Action Records (SARs) for those risk issues that could be considered uniquely inherent in the tiltrotor concept. None of the high-risk issues is tiltrotor unique. Of all the medium-risk issues, approximately 5 percent are directly or indirectly tied uniquely to the tiltrotor concept, as compared to a notional fly-by-wire medium lift helicopter. The most relevant examples are listed in Table 2.

Safety Action Record Title	Comments
Departure from Conversion Attitude Control	Failure of automatic flight control system during conversion could cause loss of control
Failure Conversion Actuator	Loss of conversion capability: must land at last nacelle angle setting; could cause loss of aircraft if no runway available and nacelles at low (high speed) angle
Uncommanded Wing Stow Lock Pin Retraction	Wing movement in flight could result in loss of control
Longitudinal Trim Change with Nacelle Angle Change	Negative (aft stick) trim during accelerating transition poses risk of loss of flight path performance during low-light-level or instrument conditions (helicopters need forward stick during accelerating transition)
Invalid Angle of Attack	Bad signal to flight control system could cause improper flight control response and loss of control
V-22 Autorotation Characteristics *	Relatively high disc loading makes autorotation more problematic than for equivalent weight helicopter
Power Settling *	See Mirana mishap discussion above

* Autorotation and power settling per se are not unique tiltrotor risks, but depending on altitude, once in autorotation or power settling situation, tiltrotor configuration lends itself to a potentially worse outcome than for equivalent helicopter configuration.

Table 2: Tiltrotor-Unique Safety Risk Issues

POSITIVE SAFETY ASPECTS OF TILTROTOR

Of the 11 enhancing characteristics reported by the OPEVAL test team, 4 involved tiltrotor-unique safety features:

- 1) The high airspeed (demonstrated 258 knots maximum cruise speed) significantly reduces susceptibility to ground fire during the en route portion of the mission.
- 2) The rapid decelerating transition capability gives the aircraft lower vulnerability to enemy ground fire in the landing zone.

- 3) The expanded range inherent in the tiltrotor concept gives the Marine Expeditionary Unit or Special Operations Force more mission coverage, and by its nature, that same capability gives the pilot more options for landing sites, both nominal and emergency.
- 4) Pilot situational awareness in the landing environment is enhanced through the use of nacelle conversion vice pitch attitude to decelerate.

Of the operational performance capabilities the tiltrotor concept enables, several have positive safety implications:

- 1) The ability to transition to airplane mode after an engine failure and perform a precautionary landing on a runway means there should rarely be a need for two-engine-out autorotation.
- 2) Lack of tail-rotor further reduces the need for autorotation capability (compared to single-rotor helicopters).
- 3) Lack of dependency upon a synchronization driveshaft for safe flight (compared to tandem-rotor helicopters, for which failure of the synchronization shaft with rotors turning is catastrophic).
- 4) Substantial separation of engines (less chance that one adverse event will take out both engines).

Conclusion: Tiltrotor technology introduces several safety-related challenges, as well as safety enhancements, to the medium lift mission.

Conclusion: When considered in total, tiltrotor-unique risks do not appear to be prohibitive.

Conclusion: All known tiltrotor-unique risks appear to be manageable through design modifications and operational procedures and techniques.

Recommendation: Continue to develop mitigation strategies to limit the potential for autorotation and the risk (probability and severity) of asymmetric thrust conditions.

Specific recommendations are included in Subsections 2.3 The Mirana Accident and Vortex Ring State, 2.5 Autorotation, and 2.6 Downwash Effects on Tactical Operations.

2.3 THE MIRANA ACCIDENT AND VORTEX RING STATE

In April 2000, an MV-22 was destroyed, killing 19 Marines at a simulated remote landing site at the Mirana Arizona airport during a night OPEVAL exercise. The pilot of the second of a flight of two MV-22s lost control of the aircraft during a high-sink-rate descent and was unable to regain control before hitting the ground in a nose-down inverted attitude.

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The Judge Advocate General investigation (Lt. Col. Morgan letter 5830, B 0525, July 21, 2000) listed two causal factors:

Primary Cause: The mishap aircraft's flight profile in the terminal area (high descent rate/low airspeed) most likely resulted in the aircraft experiencing a vortex ring state (power settling) and/or blade stall condition, which resulted in departure from controlled flight and the subsequent mishap.

Contributing Factor: Nighthawk 71's (Flight Lead) poor crew coordination and situational awareness were contributing factors to the mishap.

The pilots involved were members of the Multi-service Operational Test Team (MOTT) assigned to HMX-1, the Marine Corps' Quantico, Virginia, based rotary-wing operational test squadron. The four pilots involved were all highly experienced in other aircraft types, with V-22 flight time ranging from 86 to 97 hours each. Each was fully qualified and current. Three of the four pilots had extensive CH-53 helicopter backgrounds before joining the V-22 Program. The fourth, the right-seat pilot-in-command of the mishap aircraft, was an experienced C-130 pilot with just over 50 hours in helicopters before joining the V-22 team.

The lead aircraft pilot was preparing to land his two-aircraft formation at a specified landing spot on the Mirana airfield, but the combination of tailwind, late execution of his en route letdown, and the night-time environment all contributed to his setting up a higher-than-normal rate of descent. Meanwhile, the wingman was having difficulty maintaining position during the decelerating transition. He was 11 seconds behind the leader in initiating his nacelle conversion, the leader having begun his conversion without signal, and having used maximum 8 degrees per second nacelle rotation rate. As the lead aircraft slowed to Vertical Takeoff and Landing (VTOL) mode, the wingman found himself ballooning to an 800 (+) feet per minute (fpm) climb, followed directly by a 3900 (+) fpm descent, presumably to try to maintain position on the lead aircraft. As the two aircraft approached 40 knots, the wingman was too far forward (3 o'clock high, according to the lead aircraft crew chief). He was moving back to his proper 45-degree azimuth position when he apparently entered vortex ring state, lost control, and crashed.

Vortex Ring State (VRS) is a phenomenon wherein the combination of low forward speed and high rate of descent causes the upward flow of air around a rotor to approach the same velocity as the downwash produced by the rotor. When this happens, the rotor loses lift, and addition of power makes the lift loss worse. Vortex ring state could be considered an intermediary state between a power-on, lift-producing state, and a power-extraction, autorotating state.

The Panel was briefed on the subject of High Rate of Descent (HROD)/low-speed flight characteristics by the helicopter aerodynamics instructor at the Naval Test Pilot School and the Bell Boeing lead test pilot for the V-22. One of the key points they made was that, although the V-22 has proprotors (highly twisted roots like propellers, and long flat blades like rotors), it should be considered a helicopter when it comes to low-speed HROD operations. Like all helicopters, the V-22 can experience VRS or "power settling" when it approaches flight conditions in which very low forward speed is combined with a high rate of descent and the addition of power. Once experienced, the only way to recover from the situation is to increase forward speed, avoid adding power,

and fly out of the condition. The mishap showed that the V-22, with its wingtip-mounted proprotors, could enter an asymmetrical VRS condition if the pilot (or the automatic flight control system) applies directional (yaw) control when the aircraft is close to the VRS boundary. In VTOL mode, directional control is achieved by differential rotor plane change—the proprotor plane inside the turn pitches backward, and the proprotor plane outside the turn pitches forward. In effect, the directional control will cause the inside proprotor to enter VRS (and lose lift) as the outside proprotor stays out of it (and continues to produce lift). The resulting asymmetric lift condition causes an uncommanded roll and, depending on altitude available for recovery, potential loss of the aircraft. The pilot and the automatic stability augmentation system can exacerbate this roll when they try to counter it with a roll command in the opposite direction. When the mishap aircraft lost control, its flight condition was 40 knots, in excess of 2000-fpm sink rate, descending through 300 ft. altitude.

In 1995, The V-22 System Safety Program produced a Safety Action Record (SAR) titled “Loss of Thrust/Lift, Loss of Proprotor Thrust, Settling” based on several hazard analyses. The risk level assigned was 1D (potentially catastrophic, remote probability of occurrence). The SAR included several thrust loss situations, including power settling. There was no mention of roll response or asymmetric VRS. The control listed for this hazard was “Training.”

Power settling, is a phenomenon well known to helicopter pilots. All military helicopter pilots receive training and demonstrations of power settling in basic flight training. Marine helicopter student pilots are taught the 800/40 warning in ground school, and it is repeated in the TH-57 (basic trainer) Naval Aviation Training and Operating Procedures Standardization (NATOPS) manual. Depending on the type of rotorcraft, it manifests itself as a substantial loss of lift, most commonly preceded by a very noticeable aerodynamic vibration. If it happens at high enough altitude, the pilot, feeling the warning vibration, can usually fly out of it by lowering the nose, avoiding addition of power, picking up forward speed, and then flying out of the condition. If it happens at too low an altitude, the result is a hard landing or worse. Helicopter pilots are trained to stay away from high sink rates at low speeds, not only because of this phenomenon, but also to be in a better position to react to an untimely engine failure. According to Naval Safety Center records, there were six Navy/Marine Corps helicopter power-settling mishaps from 1988 to the present, including five Class C (hard landings with some damage) and one Class A (total loss) mishap. The Naval Safety Center analyst believes there may have been more VRS mishaps that were misdiagnosed as “settling with power” or other causal factors.

Due to a wording error, the preliminary V-22 NATOPS manual in effect at the time of the mishap included nothing on the subject of power settling or VRS. There was a warning to avoid sink rates in excess of 800 fpm at airspeeds below 40 knots calibrated airspeed (KCAS) that was erroneously placed in the “Emergency Procedures” paragraph entitled “Settling with Power.” Settling with power is not power settling. It manifests itself as a higher than desirable sink rate when the power available is less than the power required. (Of interest in the area of communications is that both the system safety analyst who wrote the 1995 SAR on power settling, and the NAVAIR engineer who wrote the NATOPS warning were former Army trained helicopter pilots. In the Army and Air

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Force, the terms “power settling” and “settling with power” mean exactly the opposites of the same terms in Naval aviation). The NAVAIR Interim Flight Clearance in effect at the time of the mishap did not include any warnings or operating limits related to power settling. The mishap investigation report is not officially released yet, but Panel discussions with several members of the MOTT suggest that there may have been less than appropriate concern for power settling among OPEVAL pilots prior to the mishap. The poor coverage of the topic in NATOPS may have been a contributor. Three of the four pilots involved in the mishap were experienced CH-53 pilots. The fourth had the most recent formal training in VRS in the helicopter transition-training program. All four were handpicked based in part on demonstrated flying skills. Although they undoubtedly violated a warning in the NATOPS, it is not obvious from their actions that the pilots clearly understood the safety threat.

In other helicopter manuals, power settling is discussed in the “Flight Characteristics” sections. Of the USMC helicopters in use today, only the UH-1 and AH-1 NATOPS contain a warning and a airspeed and vertical speed reference (40 KCAS and 800 fpm) similar to the V-22 warning. The warning is printed in the “Flight Characteristics” section rather than in the “Emergency Procedures” section. There is no warning and no specific sink rate or airspeed limit in the CH-53 or CH-46 NATOPS. None of the helicopter manuals includes any reference to power settling or low-speed sink-rate limits in the “Operating Limitations” section. After the mishap, NAVAIR changed the V-22 NATOPS to include a discussion of VRS in the “Flight Characteristics” section and warnings and to add new procedures (including the need to minimize lateral directional inputs) under the title “High Rate of Descent in VTOL mode” in the “Normal and Emergency Procedures” sections. The change also made specific mention of 800- fpm sink rate in the “Operational Limits” section, and it substituted 80-degree nacelle for the old 40 KCAS, a point that some pilots told the Panel may be unnecessarily restrictive. The same warning also was added to the NAVAIR Interim Flight Clearance for the remainder of OPEVAL.

Another issue that must be considered with respect to VRS in the V-22 is the aircraft’s propensity for rapid development of sink rate and the rotary-wing-common problem with airspeed indicator inaccuracies at and below 40 knots indicated airspeed (KIAS). During OPEVAL, test pilots demonstrated on a flight simulator that by pulling the thrust control lever all the way back, the aircraft could go from level flight to 3000 fpm (+) sink rate within 3 seconds at 40 KIAS with nacelles at 90 degrees. In addition, as is the case with all helicopters, standard airspeed indicator systems suffer from disturbed air flow at low forward speeds. Any warnings or flight limitations need to consider that point, and program officials should be alert for improvements in airspeed sensing and indicating technologies if VRS risk mitigation is to be effective.

During development testing before the accident, the integrated test team, consisting of contractor and Patuxent River developmental test pilots, flew a limited number of test points to verify that the 800 fpm at 40 knots or less NATOPS warning was safe. For safety purposes, these tests were conducted above 10,000 ft. The tests included 10 data points below 40 knots, 7 of which were at sink rates above 800 fpm. The worst cases tested were 1700 fpm at 8 knots and 1600 fpm at 40 knots. Receiving assurance from the MOTT that the 800/40 limit would be acceptable for the OPEVAL, NAVAIR chose not

to continue the testing to explore the V-22 VRS characteristics or natural warning signs. After the mishap, NAVAIR called for a thorough investigative flight test program to find the boundaries of VRS, characterize its handling qualities, and establish the basis for a new flight limitation, if appropriate, pilot procedures, and, if warranted, a cockpit warning system. The fleet grounding temporarily stopped work on this series of tests at 57 data events. The test pilots to date have entered full VRS seven times, all below 40 knots, and at sink rates between 2,600 and 3,900 fpm. They have noted some thrust fluctuation as they approach the VRS threshold, but in general, there appears to be less aerodynamic warning than exists in most helicopters as they approach power-settling conditions.

When the testing is completed, its results will be used to determine an appropriate flight envelope that allows mission accomplishment and at the same time provides adequate margin for such factors as turbulent air, various wind conditions, and formation flying. The apparent limited warning of impending power settling causes some to suggest the need for a cockpit aural warning. Most also see the need to modify the simulator to support VRS avoidance training. To go beyond that and actually provide realistic VRS simulation probably would be a difficult (and possibly unnecessary) enhancement because it would necessitate the addition of highly complex aerodynamics modeling, a task that other aircraft trainers have found to be impractical.

In summary, the V-22 community appears to have been poorly prepared for the situation that caused the Mirana accident. The NATOPS manual did not properly address VRS; the test program had not fully defined it; and although the engineering and system safety program forecast power settling for the V-22 in the right circumstances, they failed to forecast the violence of the roll response, or to clearly communicate the issue to one another. The accident itself has made the entire community aware of the real potential and disastrous consequences of VRS. That fact alone is the biggest single risk mitigator for this hazard in the future, but it must be followed by appropriate testing, procedures, flight limits, cockpit cues, and especially training, or this same mishap will happen again as memory of the mishap dims and the rotary-wing experience level and quality of the pilots reduces to normal levels. The unwritten root cause of the mishap may have been poor communications among engineers (power settling vs. settling with power) and between the operators and the engineers, a topic covered in subsection 4.3 *Program Communications*.

Conclusion: Performance of the mishap flight crews was inconsistent with the risk of vortex ring state (power settling) in the V-22.

Conclusion: Although the current 800-foot-per-minute sink rate at 80 degree nacelle angle or less flight limitation may offer adequate safety margin, the envelope, warning signs, and flight characteristics of V-22 vortex ring state are still not well defined.

Recommendation: Use the results of the planned high-rate-of-descent flight tests to update operating limitations, procedures, the NATOPS manual, pilot training (including the flight simulator), and a cockpit warning system.

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Recommendation: Configure the pilot training simulator with the capability to provide vortex ring state training to the maximum extent possible based on model limitations and information available. At a minimum, include avoidance training.

Recommendation: If testing indicates poor natural aerodynamic warning, the aircraft should be configured with a cockpit warning system.

Conclusion: Night formation flight approaches require inter-aircraft coordination, especially during early nacelle conversions.

Recommendation: Develop techniques and procedures for inter-aircraft coordination during formation-decelerating conversions.

Conclusion: If future operating limitations include a 40-knot indicated airspeed (or less) limit, then the V-22 airspeed indication system may not be adequate, as it is unreliable below 40 kts.

Recommendation: If flight test results point to the need for flight limitation that includes airspeed of 40 kts indicated or less, procure or develop a more accurate airspeed indication system for the aircraft.

2.4 THE NORTH CAROLINA ACCIDENT AND FLIGHT CONTROL SYSTEM RELIABILITY

In December 2001, an MV-22 crashed in North Carolina during a routine training mission. The mishap investigation is ongoing, but the Panel received a briefing by the Senior Member of the Mishap Board on preliminary results, and late in its study was able to review the recently released JAG investigation report. The factors involved in the mishap include both a hydraulic line failure and a flight-control-system software anomaly that was introduced when the pilot repeatedly reset the flight control system. Neither one of these two failures by itself would necessarily result in a mishap, but the combination produced a loss of control, airspeed, altitude, and aircraft and crew.

The V-22 Flight Control System (FCS) is a complex integrated fly-by-wire system with redundant computers, command paths, electric power, and hydraulic actuation systems. It also has an automatic fault detection, isolation, and redundancy management system. The JORD does not specify an overall FCS reliability number, but it does specify triply redundant FCS computers and an overall mission reliability of at least 85 percent for a 3-hour mission (threshold). The NAVAIR-detailed requirement for the V-22 specifies a total FCS reliability of one catastrophic failure in 10 million flight hours. Compliance

with this requirement is demonstrated by analysis, which is the industry standard for this type of requirement. It is based on the system architecture (including redundancy), as well as predicted reliabilities for all components. Table 3 compares the V-22 requirement with other aircraft requirements. It should be noted that the V-22 reliability standard is stricter than the Military Standard (MIL STD) suggests, for either transport or rotary-wing aircraft.

Type Aircraft (Reference)	Reliability (prob. of catastrophic failure)
V-22 (NAVAIR spec)	1×10^{-7} failures per flight hour
C-17 (USAF spec)	1×10^{-7} failures per flight hour
Class III military transport (MIL-F-9040D)	5×10^{-7} failures per flight hour
Rotary-wing aircraft (MIL-F-9040D)	25×10^{-7} failures per flight hour
F-18 (NAVAIR spec and MIL-F-9040D fighter)	100×10^{-7} failures per flight hour
Boeing 777 (Federal Aviation Regulations)	0.01×10^{-7} failures per flight hour

Table 3: Comparison of Flight Control System (FCS) Reliability Requirements

HARDWARE REDUNDANCY:

One goal of the FCS design is to keep the aircraft in an “operational” state after the first failure (where operational means no degradation in handling qualities), and “safe” after the second failure (where safe means capable of safe flight to landing). This Fail-Operational, Fail-Safe (FO/FS) objective was met in most instances; however, as is the case with most aircraft, there are exceptions. One category of exception comprises mechanical parts known as the Critical Parts List. A critical part is defined by NAVAIR (SD-572-1) as “one, the single failure of which during any operating condition could cause loss of the aircraft or one of its major components, loss of control, ... or which may cause significant injury to occupants of the aircraft.” The current list includes approximately 70 single-point failure points in the proprotor and associated drive system and 30 in the landing gear system. It is debatable whether failures in the landing gear system would necessarily result in catastrophic loss of the aircraft considering the slow speed of most takeoff and landing evolutions. It is clear, however, that certain proprotor and proprotor-drive-system mechanical failures could result in catastrophe if they occurred in flight. Every aircraft has a Critical Parts List, and the size of the V-22 list is not remarkable. The contractor is required to provide extra risk mitigation for the parts on the Critical Parts List. These parts are designed with high-design margins and reliability and are given special attention by the quality control and Government oversight inspectors.

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The second category of exception to FO/FS is the first failure that results in less than operational capability. The hydraulic line failure that was a cause factor in the December mishap is an example of such an exception. Most of the hydraulic system is FO/FS. After loss of a single hydraulic system upstream of the nacelle-mounted switching valves, the system automatically switches to the backup hydraulic system with no loss of control power (FO). However, if, as in the mishap, the failure happens in the short stretch of line between the switching valve and the actuator, one of the two hydraulic systems that normally power the actuator is automatically isolated. As a result, all actuators to that swashplate are slower and are somewhat sluggish compared to their normal operation. For this case, the proprotor on the affected side reacts to control inputs slower than the rotor on the non-affected side. This condition has been shown in simulations to be a degraded but flyable mode of flight (FS); and pilots are trained in the proper techniques and procedures in their flight simulator. The NATOPS describes the handling qualities as “severely degraded” and advises landing as soon as possible.

A previous similar hydraulic failure was discussed by the Panel in its April 18 public deliberation as being indicative of the low priority the V-22 community seemed to place on the exceptions to the FO/FS requirement. In February 2000, an OPEVAL V-22 experienced a hydraulic 2/3 failure on the right side (the December North Carolina mishap began with a hydraulic 1/3 failure on the left side), and the pilot was able to land without incident. The line was replaced and the aircraft returned to service. The difference in that case was that the failure happened shortly after liftoff, and the pilot simply set the aircraft back down on the same long runway from which he had just lifted off. Had there been a high crosswind or gusty conditions, the pilot might have had more difficulty. Another difference in the February case was that the pilot did not perform the flight control reset procedure prescribed by NATOPS for such failures because he was so close to landing, and did not have time to do it. That kept him from having the software induced complication experienced by the mishap pilots. The North Carolina mishap showed that the degraded system is relatively intolerant of unpredicted flight software anomalies, not just the predicted subsequent hydraulic failures, wind conditions, or improper pilot procedures.

It is not uncommon for aircraft (especially rotorcraft) hydraulic systems to suffer leaks or worse failures. For that reason, the V-22 hydraulic system was designed with multiple redundancies in order to meet the 10^{-7} goal. Most other helicopters are designed with dual redundant flight control systems, some of which have reduced flying qualities after the first failure. This extra level of redundancy in the V-22 design should provide the pilots with an extra level of safety, and confidence than they are used to in legacy systems. Unfortunately, the as-installed reliability of the V-22 hydraulic system components is being adversely affected by the close proximity of the hydraulic lines to other lines, structure, and wire bundles with unexpectedly abrasive cover materials. The cramped spaces and high vibration and acoustic environment of the engine nacelles can cause failure of clamps and fasteners (e.g. “click-studs”), and chafing of the hydraulic lines, as well as other parts. This fact makes the need for redundancy even more important to flight safety and suggests the need for even more than the normal safeguards for those redundancy exceptions.

Due to its location and to the limited placement of inspection panels on the nacelles, the line that suffered the failure in the mishap was not inspectable. The titanium hydraulic tube failure was caused by rubbing by a plastic-coated electric wire in close proximity. Had the entire length of the tube been visible to the maintenance inspector, and had wear been detectable (which is not clear in the present design), the mishap might have been avoided. Whether it is with better access panel placement or borescopes, the maintainers need to be able to see these critical "exceptions" to hydraulic system redundancy.

Conclusion: The V-22 flight control hydraulic components are experiencing failures at higher rates than predicted. Flight safety is, therefore, highly dependent on the redundancy features in the system.

Recommendation: Improve hydraulic system component reliability.

Recommendation: Take steps to mitigate the risk of loss of hydraulic system integrity (e.g., chafing, fittings, leaks, vibration).

Recommendation: Develop techniques, tools, and methods for timely identification of hydraulic line chafing.

Recommendation: Add acoustic sensors to the test nacelle and reevaluate the adequacy of current test nacelle environmental instrumentation in light of recent reliability problems.

Conclusion: Inaccurate predictions of component reliability affect spares planning, squadron staffing, and flight safety.

Recommendation: Assess the process used by V-22 contractors to predict component reliability numbers and take steps to improve.

Conclusion: Current Naval Air Systems Command policy requires that special attention (material, tolerances, quality inspections, tracking, etc.) be applied to all single-point failure modes in the flight control system, but it does not require any special attention be given to other exceptions to the redundancy design criterion.

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Recommendation: Develop appropriate controls (design and life-cycle support) for all exceptions to the flight control redundancy requirements (not just those that are single-point failures).

SOFTWARE RELIABILITY

The fly-by-wire flight control system is highly dependent on high quality computer hardware and software. The logic that is the basis for the many flight control laws and algorithms must be consistent with the overall requirement for FO/FS. This implies that if the aircraft suffers any single failure in the electrical, mechanical, or hydraulic parts of the system, there cannot be any software logic characteristic or failure that would result in an unsafe condition. The integrated flight control system must be designed, analyzed, and tested with these facts in mind.

Boeing has the lead role in development and testing of the integrated flight control system. Their Philadelphia facility has the capability to conduct integrated hydraulics, flight loads, and software testing using the Flight Control System Integration Rig. Before the mishap, the facility had limited pilot-in-the-loop capability, and they had not tested the software against the particular degraded hydraulics state experienced in the North Carolina mishap. During the downtime, and in response to the preliminary mishap investigation results, Boeing has upgraded the capabilities of the integrated simulation facilities and is in the process of validating a set of off-nominal and failure scenarios that had been checked only by analysis during the 1996 validation and verification of the flight software. Boeing also has begun validating all flight control system emergency procedures with pilot-in-the-loop simulation runs. In addition, the company is holding an integrated flight control system review with participation from "graybeard" experts from within and outside the company to review the requirements and the implementation of the requirements in the design.

Conclusion: The North Carolina mishap identified limitations in the V-22 Program's flight control software development and testing. The complexity of the V-22 flight control system demands a thorough risk analysis capability, including a highly integrated software/hardware/pilot-in-the-loop test capability.

Recommendation: Conduct an independent flight control software development audit of the V-22 Program with an emphasis on integrated system safety.

Recommendation: Conduct a comprehensive flight control software risk assessment prior to return to flight.

Recommendation: The V-22 Program should not return to flight until the flight procedure and flight control software test cases have been reviewed for adequacy and have been evaluated in the integrated test facilities.

2.5 AUTOROTATION

The JORD states that the V-22 must be capable of performing a survivable emergency landing with all engines inoperative, and identifies the requirement for the aircraft to be capable of conducting a power-off glide/autorotation. The Panel members heard from the Director of Operational Test and Evaluation that, "Basic rotorcraft engineering analysis indicates that the V-22 will have a difficult time achieving a stable autorotation following a sudden power failure at high power settings, and that the probability of a successful autorotational landing from a stable autorotative descent is very low." According to a white paper provided by the V-22 Program Office, the capability of the V-22 to perform autorotations was examined during the developmental phase of testing. "V-22 developmental testing included autorotative descents in the aircraft and autorotations to landing in the simulator... The V-22 has demonstrated stable autorotative descents as described above in flight test and offers enough control to the pilot to touchdown at a survivable rate of descent, but evaluations in the simulator have shown limited repeatability of making a safe landing at the touchdown phase. This is largely due to the small amount of energy in the rotor system available to the pilot for managing descent rate and speed at touchdown."

The proprotor disc of the V-22 is relatively small when compared with those of helicopters. The size of the disc was defined in large part by the requirement to accommodate shipboard operations. The twisted proprotor blades were designed as a compromise that would permit hover performance in the helicopter mode and turboprop cruise performance in the fixed-wing mode. From an autorotative perspective, these designs result in higher rates of descent, higher airspeeds, and less rotor energy at the bottom of an autorotation available to convert to lift. This necessitates run-on landings at higher airspeeds (60kts) than helicopters at the bottom of the autorotative descent. NATOPS contains preliminary procedures (currently being revised) for autorotation. While not fully tested in Developmental Test (DT), the intent is to give the pilot the procedures that would maximize the probability of a favorable outcome should an autorotation occur. FMF pilots are not cleared to conduct autorotations except in emergencies; practice autorotative descents also are not allowed. All pilot training for autorotation and airplane mode power-off glide is via simulator.

While autorotations may be problematic for the V-22, development test pilots have concluded from simulation and high altitude tests that an airplane mode glide landing can be performed with repeated success to a hard surface runway. They believe its performance will be similar to other fixed-wing aircraft with similar glide characteristics. V-22 pilots receive simulator training in the proper techniques for unpowered airplane mode landings, but as with autorotations, they do not yet practice them in the aircraft.

The probability of the V-22 being forced to execute an autorotation vice a power-off glide is low. The combination of high engine reliability, large separation between engines, lower vulnerability to ground fire than CH-46/53 predecessors, and the lack of a

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tail-rotor make the chances of an autorotation lower for the V-22 than for a typical helicopter. It also must be stated that the V-22 is a hybrid aircraft designed to an employment concept requiring 70 percent of its airborne life to be spent in airplane mode and only 30 percent of its airborne time spent in conversion or helicopter mode. To further reduce the possibility that the aircraft would be forced to perform an autorotation, V-22 pilots are trained to transition to (or stay in) airplane mode after a single engine failure. Helicopter and conversion modes are allowed to accommodate landing, but this proactive strategy places the aircraft into the safest possible posture should the second engine or interconnect drive shaft (ICDS) fail. One note of concern, however, is that according to the NATOPS emergency procedure for single engine flight, at the conclusion of the airplane mode flight, aircraft should be landed vertically. According to the Bell Boeing test pilot, this discontinuity is probably due to the lack of experience among the V-22 community with glide landings, and the lack of sufficient developmental test in this area.

Conclusion: The V-22 has less autorotative capability than most helicopters and more than any fixed-wing aircraft.

Conclusion: The high disc loading of the V-22 limits the potential for improvement to its autorotative capability.

Conclusion: The V-22 has less power-off glide capability than most fixed-wing transport aircraft and more than any helicopter.

Conclusion: Employment concept, design features, and pilot training will limit the probability of an autorotation having to be conducted.

Recommendation: Reassess the requirement for autorotative flight in view of the low need, low probability of improvement and the existence of alternatives.

Conclusion: The V-22 community does not appear to place enough emphasis on the glide-landing capability of the aircraft as an alternative to autorotation, especially in the one-engine-out procedures.

Recommendation: Reassess the capability of the V-22 to conduct power-off glides. Explore design and operational techniques to optimize power-off glide capability (e.g., minimize proprotor drag commensurate with auxiliary power requirements).

Recommendation: Ensure that the full flight simulator used by pilots at Marine Corps Air Station, New River accurately emulates both autorotative and power-off glide simulations to the degree required for effective pilot training.

The NATOPS procedure includes procedures for two engine-out cases, but not for the case where an engine and interconnect drive shaft (ICDS) are lost. The V-22 System Safety Manager indicated that, based on commercial failure data for the Rolls Royce Allison AE 1107C engine, the probability of two engine failures within the same one-hour flight is predicted to be 1×10^{-10} . A similar analysis predicts failure of one engine coupled with an ICDS failure at 4×10^{-8} . This scenario caused loss of an aircraft and crew in 1992 at Quantico, Virginia. Of note here is that the chance of the V-22 losing one engine and having a subsequent ICDS failure is almost two orders of magnitude greater than the probability of the aircraft having a dual engine failure, yet the NATOPS procedures do not cover that case.

Conclusion: There are no emergency procedures in NATOPS for a single-engine failure coupled with an ICDS failure, a situation that would require a power off glide landing or an autorotation.

Recommendation: Reassess the requirement for (and priority of) autorotative flight in view of the low probability of improvement and the existence of alternatives.

2.6 DOWNWASH EFFECTS ON TACTICAL OPERATIONS

During briefings conducted in January and in a subsequent white paper presented to the Panel, the Director of Operational Test and Evaluation raised concerns that the high-velocity, turbulent downwash field generated by the V-22 had direct negative consequences on several of the V-22's required functions. These included: remote operations to unprepared surfaces, personnel deployment and recovery in a hover, and external load operations. In addition, the V-22 Commander, Operational Test and Evaluation Force (COMOPTEVFOR) OPEVAL report identified downwash effects as a major deficiency for the successful deployment of the aircraft. The report stated, "...because of 'brown out' conditions, experienced pilots found it very difficult to land in a desert environment at night while using Night Vision Devices (NVDs). Downwash also impacted all direct-assault missions utilizing ropes. Techniques for ropers will have to be developed to enhance their capability to fight once on the platform." Separate discussions with USMC and USAF OPEVAL pilots yielded a variety of opinions on the level of risk associated with downwash and the potential to be able to successfully mitigate the risk with the development of tactics, techniques, and procedures (TTPs).

There is no question that the high disk loading of the V-22 generates strong downwash effects. The question that must be addressed is, "Can the negative consequences addressed by DOT&E and the OPEVAL report be overcome adequately by tactics, techniques, and procedures (TTPs)?" The answer to this question will require a considerable amount of additional testing.

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REMOTE AREA OPERATIONS

Landing a helicopter at night in a desert environment using Night Vision Goggles (NVGs), has always been an extremely challenging task for aircrew. With its indiscernible shifts in topography, varied soil composition, and constantly changing illumination effects resulting from changes in the reflectivity of the terrain, desert NVG flying poses many risks. Over the years, significant improvements have been made to both the capabilities of aircraft NVD systems and the associated TTPs to utilize them.

The V-22 incorporates the latest in NVD technology, to include the latest generation of NVGs, an NVG Head-Up Display (HUD), and Forward Looking Infra-Red Radar (FLIR). While these NVD systems will help in the development of TTPs during desert operations in follow-on testing, an important advantage of the V-22 is its expanded area of influence. The V-22 will be able to range a significantly greater number of acceptable landing zones than a helicopter. Landing zone selection will be one of the considerations when mitigating the risks of downwash-induced brownout, although there will be occasions when a sand or snow landing is the only choice, and for those cases, appropriate techniques will be required.

Conclusion: The downwash in the V-22 is inherently greater than in most helicopters;
however,

Conclusion: The V-22 is configured with Night Vision Device capability and has the range to reach a far greater number of landing zones than a helicopter.

Conclusion: Testing in a desert environment, particularly at night, to date has been insufficient to fully develop appropriate techniques and procedures.

Recommendation: Continue to develop procedures and techniques for the high-downwash "desert brownout" situation, and incorporate them into the training manuals and syllabi.

Recommendation: Restrict tactical-unit night operations in landing zones that have the potential for brownout until procedures and techniques are developed and approved.

PERSONNEL DEPLOYMENT/RECOVERY FROM HOVER (IN AND OUT OF GROUND EFFECT)

The OPEVAL report, in its evaluation of alternate insertion and extraction techniques, reported, "Of all of the operational scenarios, the one in most jeopardy is direct action assaults because of downwash and safety concerns." The JORD requires that the aircraft have the capability to employ the following:

- Two fast ropes off the ramp and one out the cabin door to quickly deploy personnel in a hover. (Threshold)

- Fast Rope Insertion and Extraction System, Stabilized Extraction Rigging, and rope ladders through both the ramp and cabin door. (Threshold/USSOCOM)

The MV-22 demonstrated the capability to effectively employ one fast rope off the ramp and one fast rope out of the aft cargo hook opening, but it did not demonstrate the capability to fast rope out of the cabin door. Additionally, to reduce the effects of downwash, hover altitudes of 65 to 75 feet were maintained, which exposed both the aircraft and ropers to potential threats for a greater period of time. The V-22 Operational Test Director agreed that fast rope proved to be the most difficult of the Alternate Insertion/extraction (AIE) operations conducted during OPEVAL. Follow-on test and evaluation will be conducted to develop TTPs, in an effort to address AIE operations.

A number of lessons were learned during fast-rope operations conducted during Military Operations in Urban Terrain (MOUT) evaluations as part of OPEVAL. It was found that the extremely stable hovering characteristics of the MV-22 were an enhancing feature during rope operations. Pilots also developed the technique, during this testing, of positioning the engines off the edge of the rooftop to reduce downwash effects on the ropers. It also was noted that downwash had the potential to be enhancing for some areas of low-intensity conflict. It may be an effective method to use to control unarmed crowds.

The Program Office does not believe that fast-roping operations from the cabin door is an option worth pursuing and has recommended a JORD change for an alternative location to meet this requirement. The Rappel mission and the Special Patrol Insert and Extraction (SPIE) mission were executed effectively by the MV-22, although rappelling was not accomplished through the cabin door. The V-22 was assessed as having the capability to meet the ORD requirement for helocast (personnel or small boat exit out of the aft ramp) by traditional techniques under daylight conditions. Night helocasting was not accomplished due to the lack of a precision (coupled) hover. Over-water recovery of a Special Operations Force (SOF) team was not evaluated because of the lack of both a rope ladder system and a suitable hoist. The OPEVAL report did assess these missions to be at risk due to the anticipated effects of downwash. The Program Office indicates that there is currently no suitable certified rope ladder either available or planned. It is currently investigating improvements to the hoist (the development of which is unfunded) and alternate locations for its incorporation.

The concept of personnel deployment from a hovering V-22 has been partially demonstrated. Several JORD requirements in this area remain to be demonstrated but could be jeopardized due to the high downwash velocities and lack of side cabin door and hoist capability.

Conclusion: The concept of personnel deployment from a hovering V-22 has been only partially demonstrated, and techniques and procedures need to be developed.

Recommendation: Revalidate the requirements for Personnel Deployment and Recovery operations.

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Recommendation: If the requirements remain valid, then incorporate appropriate hoist and ladder systems in to the aircraft as soon as possible.

Recommendation: Conduct follow-on testing and evaluation to address tactics, techniques, and procedures to be used in the conduct of Personnel Deployment and Recovery operations.

EXTERNAL LOAD OPERATIONS

The white paper from DOT&E states that while external load operations conducted during OPEVAL demonstrate that such operations are possible, “they remain a significant challenge.” The paper goes on to state that, “New procedures and training may mitigate this problem, but the safe and effective accomplishment of this key USMC mission requirement remains a serious concern.” The OPTEVFOR report of OPEVAL did not consider this to be an issue, but there are some unknowns concerning the proper procedures to minimize the chance of injury to the ground crew while working in the downwash on external payload activities.

Conclusion: While external load capability was demonstrated successfully during OPEVAL, there remain several challenges to its successful operational introduction.

Recommendation: Conduct follow-on test and evaluation to further refine tactics, techniques, and procedures and to ensure that external operations can be conducted safely and effectively.

2.7 PILOT TRAINING

The Panel examined the pilot and aircrew training system for adequacy. Panel members received briefings from the Program Office and from VMMT-204, and ground school and simulator training personnel. Panel members also flew training sessions in the flight simulator, and reviewed the MV-22B Training and Readiness (T&R) manuals, the NATOPS flight manual, and the VMMT-204 Flight Standardization Manual.

The MV-22 pilot and crew chief flight training syllabi are contained in Volumes 8 and 10, respectively, of the MV-22B Tiltrotor, NATOPS flight manual, which is currently in draft form for final staffing. These volumes provide the templates for standard MV-22 units and define the squadron’s core capability and basic aircrew qualification requirements, as well as the sorties required to maintain core skills. They also contain the Programs of Instruction (POIs) for basic, transition, and refresher aircrews, as well as POI for instructor aircrew. The aircrew T&R syllabi use the stairstep approach to training throughout all four phases of flight training—combat capable, combat ready, combat qualified, and full-combat qualification. VMMT-204 is tasked with conducting all combat-capable training. The other three phases of flight training will be conducted in

tactical squadrons. While Volumes 8 and 10 are well thought out and provide a logical sequential approach to training and readiness, they do include a number of sortie requirements that will require waivers until appropriate flight clearances are received. These include defensive air combat maneuvers, night externals, air-to-air gunnery, and certain alternative insertion and extraction techniques.

The requirements for aviation ground and simulator training are integrated within each of the four phases of flight training. Aircrew will not fly an aircraft or simulator event without first completing the corresponding Integrated Multimedia Instruction (IMI) lesson or lessons for the event. The IMI, a series of computer-based interactive lesson plans, demonstrated to the Panel members during their visit, is state-of-the-art and is a significant improvement over previous ground training tools used by training squadrons.

Simulator flights are used to begin each stage of training and prior to the introduction of a new skill. The amount of simulator flight time flown by pilots during combat-capable training is consistent with that flown in fixed-wing syllabi but is significantly greater than that currently flown in helicopter syllabi. The capability of the new generation of simulators has been maximized in the MV-22 syllabus without sacrificing actual aircraft flight time during training. Current simulator capability at MCAS New River for the MV-22 ranges from the Cockpit Procedural Trainer (CPT), an instrument trainer with no visual or motion capability, to the Operational Flight Trainer (OFT), the device used to train the initial cadre of students. Although it is a full-motion simulator, the OFT does not compare to the capability demonstrated by the newest simulator at New River the Full Flight Simulator (FFS). The FFS is a state-of-the-art industry standard and is a Federal Aviation Agency (FAA) Level D simulator built by Flight Safety International. The FFS is fully "networkable," meaning pilots under instruction will be able to man multiple networked devices and train together. The USMC Simulator Master Plan outlines the requirement for four FFSs and three Flight Training Devices (FTDs) to be built at Marine Corps Air Station New River. The FTD is an FFS equivalent by every measure except motion. It also will have the capability to be networked.

The FFS uses actual aircraft mission computers, whose software is modified at the same time that actual aircraft on the flight line are modified. Flight control software in the FFS is emulated as opposed to using actual flight control computers. This is a cost-savings initiative; flight control software is much more stable than mission computer software is. The Panel is concerned that changes in aircraft flight control software will be emulated concurrently for the FFS. Often, this area does not receive adequate attention.

Future training plans call for students destined for the V-22 community to receive some amount of two-engine turboprop experience. The Panel views this as a good approach, considering the amount of time the V-22 will spend in the airplane mode and the need for the pilots to feel comfortable with the airplane-mode, single-engine procedures and power-off glide procedures.

Conclusion: The MV-22 aircrew flight training syllabi and their integration with ground training and simulator flights appear to have been well thought out and documented.

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Conclusion: The IMI ground training and Full Flight Simulators are state of the art.

Conclusion: The MV-22 Standardization Manual adequately addresses flight standardization within VMMT-204.

Conclusion: Although adequate now, historical precedent suggests that funding may not remain stable throughout upcoming budget cycles.

Recommendation: Provide adequate funding for aircrew ground training, aircraft simulators, and upgrades to training devices.

The MV-22 Flight Standardization Manual developed by VMMT-204 promulgates standardized procedures to be used for the conduct of instructional flights within the squadron. The manual is intended as a supplement to the NATOPS Flight Manual, the Instrument Flight Manual, the MV-22 Tactical Manual, and the MV-22 T&R Manual. The manual was drafted by pilots who participated in both developmental and operational testing of the V-22 and contains descriptions of flight maneuvers that are not described or covered in sufficient detail in these manuals. The MV-22 Tactical Manual, identified in Volume 8 as NWP 3-22.5, has not yet been published. A draft Operational Tactics Guide (OTG) is under development by the Advanced Tilt-Rotor Training Unit (ATTU). The ATTU was developed to aid in the transition of USMC squadrons to the MV-22. After the first MV-22 tactical squadron completes ATTU training, the OTG will be forwarded to the MV-22 Tactical Manual Model Manager, MAWTS-1, where it will be reviewed and published.

NAVAIR is currently the Model Manager for the MV-22B NATOPS manual. The preliminary manual was first published in August 1999, just prior to the beginning of OPEVAL. The Panel found the relatively large size of the MV-22B NATOPS manual to be consistent with the fact that the V-22 is a complex aircraft and the first operational tiltrotor aircraft. The OPEVAL report stated that the manual "lacked adequate content, accuracy, and clarity." This is unsatisfactory, but not unusual for a preliminary NATOPS manual. However, implementing appropriate changes to the NATOPS manual should have been expedited initially. Since OPEVAL, eight interim changes have been incorporated into the NATOPS manual. At the latest MV-22B NATOPS manual conference in October 2000, more than 1,400 changes were made to the manual. The updated manual is scheduled to be published in May 2001.

The Panel agrees with the Program Office that once the magnitude and frequency of the changes to the manual decrease, VMMT-204 should assume the responsibility as model manager for the MV-22 NATOPS.

Conclusion: At this early stage in its development, the relatively large size of the V-22 NATOPS manual is considered consistent with the fact that the V-22 is a complex aircraft and is the first operational tiltrotor aircraft.

Conclusion: The V-22 NATOPS manual is undergoing the same developmental growth experienced by previous new aircraft manuals; however, because of the challenges currently facing the MV-22, extraordinary effort needs to be placed on the NATOPS manual so that it reaches the necessary level of maturity before training resumes.

Recommendation: Publish updates to the MV-22 NATOPS manual, and verify with VMMT-204 pilots before the first operational flight to support pilot/squadron transition and re-currency training.

Recommendation: Convene an out-of-cycle NATOPS manual conference prior to the first squadron operational flight to assure consistency and adequacy of the “Emergency Procedures” and “Operating Limitations” sections. Develop an expeditious process to incorporate changes from this conference and from ongoing test and evaluation activities.

2.8 CRASHWORTHY FUEL TANKS

The JORD requires that the aircraft fuel tanks, both permanent and auxiliary, be crashworthy. The tanks must be self-sealing and nitrogen inerted. The aircraft in the first two Low Rate Initial Production (LRIP) lots (aircraft 11 through 22) are configured with extensible fuel bladders in the sponsons. The extensible tanks are designed to dissipate energy by expanding or deforming under crash loads, thus minimizing the chance of bladder leak. The auxiliary tanks were still in development during OPEVAL, so the test aircraft was configured with an interim non-operational auxiliary tank on a waiver. The extensible wing tanks have yet to be tested for crashworthiness.

When subjected to the MIL STD 65-ft. drop test, the sponson extensible fuel tank passed, but because it was not configured in a test sponson for the drop, the results are inconclusive. The Program Office changed the sponson tank design effective with Lot 3 and subsequent to a non-extensible design. When tested, the new design failed, developing a small leak. The tank was redesigned and successfully tested; however, the new design will not be installed until the LRIP Lot 4 (aircraft 30 and subsequent). Due to lack of retrofit funding, the program had to satisfy itself that flying the earlier aircraft with non-compliant sponson fuel tanks would be acceptable. The program conducted a risk assessment and determined that the marginal additional risk to the operators of flying the early LRIP aircraft with non-compliant sponson fuel tanks was medium (RAC 1D).

During the Panel’s visit to VMMT-204, flight crew personnel expressed concern about the program decision to fly the LRIP Lots 1-4 aircraft indefinitely with non-compliant sponson fuel cells. This is another case where communications among operators and engineers may be lacking; however, some of the concerned aircrew were witnesses to the Mirana mishap, and they want assurance that they are not taking undue risk. It should be noted both of the recent accidents involved impact forces significantly higher than anything that even compliant fuel tanks could tolerate. No one thinks compliant fuel tanks would have prevented those fires.

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Conclusion: Although the program risk assessment satisfied the Program Manager that the non-compliant sponson fuel cells are safe for flight, the concerns expressed by the training squadron should be addressed and communicated.

Recommendation: Configure (by retrofit or test) all operational aircraft with crashworthy fuel cells at the first opportunity (see later recommendation with respect to retrofit funding),

and, in the meantime,

Recommendation: Communicate the interim risk acceptance rationale to the operational community.

2.9 PRODUCTION QUALITY

The Panel received briefings from the Program Office and contractor managers on the status of the V-22 Quality Program. Among the topics discussed at the production plants was the history of quality issues during EMD and LRIP, as well as several quality-improvement efforts that are under way. The Panel also received briefings from the Defense Contract Management Agency (DCMA) managers at Bell and Boeing. They accompanied the Panel on its tours of the production line and discussed their roles in providing quality oversight for the Program Manager.

QUALITY TRENDS

Quality of the production aircraft was a sizable problem for the program early in LRIP. One of the first LRIP aircraft had nearly 150 discrepancies upon receipt by the operational unit. While many of those discrepancies were paperwork problems, there were a substantial number of hardware defects. The first part of the OPEVAL was adversely affected by a variety of production quality issues (configuration problems and assembly defects). This was the reason the OPEVAL results were stated separately for the two parts of the test period (before and after February 22, 2000).

One of the reasons for early program quality issues was the tight tolerances and cramped quarters in the nacelle. Another was the transition of final production from Fort Worth to Amarillo, with a completely new workforce. As LRIP continued to produce aircraft, the quality deficiencies went down until today, the quality performance learning curves at all three contractor locations appear to be as planned or better. For example, the number of "customer squawks" decreased by 35 percent from 1999 to 2000 at the Amarillo facility, compared to a goal of 15 percent. Extensive technical and quality assurance surveillance along with manufacturing product audits already have been coupled with fleet readiness drivers to improve the quality of delivered aircraft. A DCMA and Boeing quality assurance report reduced discrepancies from a high at Aircraft No. 18 of 1,882 discrepancies to a low of 260 discrepancies with aircraft No. 29.

Although most quality trends have been improving over the last two years, there have been some stubborn problems in the quality area. Three examples are listed:

- 1) Click-studs (fasteners that are glued to the composite structure to secure various items on the airframe; e.g., acoustic blankets, wire bundles, brackets, etc.

Observation:

- Improper surface preparation for bonding of click-studs to composite aircraft structure results in failed mounting brackets for subcomponents.

Corrective action:

- Redesign to reduce the overall requirement for click-studs;
- Implemented new tooling to maintain closer location tolerances for installing click-studs; and
- New installation procedures and adhesives are being evaluated.

- 2) Non-standard manufacturing

Observation:

- Improper drilling and trimming of panels that prevent interchangeability

Corrective action:

- Tools verified to facility gage;
- Inspection added immediately following trim;
- Created 3-D models of the nacelle assembly, including all contours and edge of parts (periphery) (EOPs) identifying 20 to 30 mismatches;
- Procured a laser radar system to verify tool EOPs to the nacelle models (delivery March 12, 2001); and
- Trim tools are being redesigned to assure consistent trimming of the panels; also, additional locators are being added to the assembly fixtures to assure proper locations.

- 3) Wiring harness and hydraulic line routing anomalies (not in accordance with blueprints).

Observation:

- Special emphasis on nacelles; and
- 24 Liaison Engineering Trouble Action Requests (LETARS) generated on hydraulic and electrical installations.

Corrective action:

- Special inspections initiated;
- Electrical and hydraulic training initiated;
- Installation and Inspection Instruction developed;
- Top-down engineering audit of nacelles in progress;

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- Nacelle audit identified design and manufacturing enhancements that are being addressed by Bell and NAVAIR; and
- Expanded engineering audit in progress for the fuselage, wing, and empennage.

These quality problems are part of the current listing of "Top Readiness Drivers" listed in Appendix F.

CONTINUOUS IMPROVEMENT FOCUS

Bell and Boeing have in place a system of continuous process improvements. Bell's development of an Operations Improvement Strategy to focus the organization into Centers of Excellence has resulted in an improvement of core manufacturing competencies. The investment in high-tech equipment and personnel training programs has improved manufacturing quality, throughput, and schedule compliance to a level at which the companies are now industry leaders in composite materials construction. Boeing also showed the Panel several quality improvement changes that are in work on the plant floor or planned.

TIGER TEAM

Shortly after the North Carolina mishap, Bell Boeing established a "Nacelle Tiger Team" to reassess the reliability, maintainability, and quality problems associated with the nacelle, especially with respect to the hydraulics system. In April 2001, the Tiger Team role was expanded to examine the entire aircraft. The ongoing V-22 Tiger Team has given the program preliminary indications that production and manufacturing variances may still be a problem. Such variances in aircraft construction can seriously affect reliability and maintainability, as each aircraft would have unique configurations. Placement of nacelle panel drill holes, click studs (bonding and location), wire harness, and hydraulic routing anomalies have all been addressed. Apparently, standardization issues are being resolved. Results of the Tiger Team analysis will determine the actual status.

Conclusion: Bell Boeing Managers, the V-22 Program Manager, DCMA representatives and the Services appear to be paying special attention to the top fleet degraders, and to other quality issues in production and final assembly;

however,

Conclusion: Preliminary results of the Tiger Team, including quality and configuration variances in the nacelles, indicate a potential concern that needs to be addressed carefully.

Recommendation: The contractors, Defense Contract Management Agency, and Services need to remain actively involved in quality assessments and improvements.

Recommendation: Take appropriate steps to resolve quality-related findings of the Tiger Team as soon as its results are available.

2.10 OPERATIONAL TEST CREW SELECTION AND ASSIGNMENT

During a segment covering the V-22 on “60 Minutes,” a close relative of a crewmember who died in the Mirana mishap commented that her Marine was not a test pilot and thus should not have been involved in the test flight. An OPEVAL pilot’s widow at one of the Panel’s open meetings made a similar comment. The Panel staff talked to the Commanding Officer of the Fleet Replacement Squadron and the Marine Corps’ rotorcraft operational test squadron, HMX-1 about this issue to determine whether the OPEVAL may have violated longstanding test crew assignment policies.

The V-22 operational test and evaluation (OT&E) aircrew were all volunteers assigned to Marine Helicopter Test Squadron One (HMX-1) in Quantico, Virginia. Pilots and crew chiefs from HMX-1 were assigned to the first three OT&E events (OT IIA, B, and C) from 1994 through 1997, where there was limited flight activity. Then, in anticipation of more flying, Headquarters Marine Corps held a V-22 OT&E pilot selection board in early 1997 to bring in another six dedicated V-22 operational test pilots for the upcoming OT IID and E (OPEVAL) events scheduled for late 1998 and 1999, respectively. The following requirements were listed as selection criteria used by the board:

- Captain or major with at least 6 years of commissioned service;
- Qualified helicopter or C-130 aircraft commander;
- Active duty, completed first operational squadron tour;
- Willing to commit to 4 years’ service following transition; and
- Tactical endorsement.

Using these criteria, the V-22 OT&E Selection Board picked six pilots (out of 120 volunteers) for assignment to HMX-1 and its MOTT in March 1997. They began their training later in the year under the supervision of the earlier chosen (nine) operational test pilots and the V-22 Development Test (DT) pilots (military and contractor) who had been flying the FSD and EMD programs at Philadelphia, Fort Worth, and Naval Air Warfare Center (NAWC) Patuxent River. To accrue their flying time, they were formally designated as “DT copilots” and were authorized to fly on low-risk DT flights. Enlisted flight crewmembers were also volunteers having been assigned to HMX-1 for duties involving operational flight test of CH-46, CH-53, and MV-22 aircraft.

In accordance with longstanding HMX-1 policy, the training syllabus for aircrew was typical of any transition training program in an operational squadron, with 98 simulator flights and 31 aircraft flights required to qualify as a Tiltrotor Aircraft Commander (TAC). The squadron also provided training for its aircrew involving standard test planning and report writing. By its nature, OT&E is flown by operational aircrew with fresh fleet experience within a NAVAIR developed and defined flight envelope. There is neither a need nor a desire for them to be trained engineering test pilots. Moreover, it

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was not policy to fly MOTT crewmembers on developmental flights, even with experienced DT pilots. There was a single exception to this rule during DT, when one of the MOTT pilots flew as co-pilot on a combination training and data-gathering flight. This exception to policy was approved by both the MOTT and NAWC chains of command, based on the low risk involved with that particular flight.

Operational test flying does not expand the flight envelope or develop or certify new procedures. That work is left to the DT flight crew and engineers working for NAVAIR. The purpose of OPEVAL is to evaluate the aircraft in as close to an operational environment as is feasible within the limits cleared by NAVAIR at that point. Obviously, any major safety related issues should have been raised in design, analysis, simulation, experimental flight test, and development flight test. Before OPEVAL, NAVAIR conducted an extensive Flight Readiness Review, the purpose of which was to decide if the envelope cleared to date was adequate to demonstrate operational requirements, and if the aircraft was safe to hand over to operational test crews.

Part of this issue could be a perception by the public that the OPEVAL aircrews were being forced by the system to participate in developmental flight test inappropriately. In retrospect, the lessons learned from the Mirana mishap are the type of lessons that are more appropriately predicted and verified during engineering analysis, wind tunnel, flight simulation and developmental flight test. OPEVAL should not be discovering major safety issues, and so it is understandable why the public questions have been raised. However, at the time of crew assignment, it appears that the standards for crew selection, assignment and training were adhered to by HMX-1. The crewmembers were highly skilled, well trained volunteers. They are all aware that the reason the Service goes to all the trouble to pick experienced, highly qualified people for HMX-1 is that operational testing of a new aircraft carries with it higher risk (in the form of uncertainty) than exists in other well established aircraft. This same thinking must be included when it comes time to fly combat troops in the aircraft on demonstrations and operational tests, and the question should be asked, is it necessary to the test or mission to have real troops in the back?

Conclusion: The process for crew selection, training, and assignment to V-22 OPEVAL test flights was consistent with longstanding policy.

Recommendation: As the testing program proceeds, test managers (contractor, NAVAIR, and operational) should continue to ensure the appropriate experience and qualifications of all flight crewmembers.

Conclusion: By its nature, early operational testing is characterized by a level of risk higher than that of fleet operations (thus the requirement for experienced aircrew) but less than that of the development test phase.

Recommendation: As V-22 development and testing continue, all responsible organizations should take all reasonable steps to ensure that operational test aircrews are not subjected to undue risk. Thoroughly assess all known and suspected high-risk flight regimes.

Recommendation: Until the aircraft is ready for deployment, flying should be restricted to mission-essential personnel. Assess operational risk factors before authorizing increased risk flights (e.g., assaults, night flying, weather flying, etc.).

2.11 SYSTEM SAFETY

ORGANIZATION AND PROCESS

The Panel staff members were briefed on the system safety engineering discipline as practiced by the V-22 Program. The Navy System Safety Manager is located at the Naval Air Warfare Center (Aircraft Division), Naval Air Station Lakehurst, New Jersey, along with all of the NAVAIR rotary-wing system safety engineers. This geographic setup is an obvious challenge that the System Safety Manager and the program staff acknowledge as unfortunate but workable. (Note: the fixed-wing system safety engineering staff is located at Patuxent River, very close to NAVAIR headquarters.) The System Safety Manager's primary point of contact in the Program Office is the Assistant Program Manager (APM) for System Engineering (Class Desk), who serves as the chairman of the System Safety Working Group (SSWG).

As is normally the case with new aircraft, the JORD has no specific overall safety requirement in terms of predicted mishap rates or probabilistic risk levels. Nor does the aircraft detailed specification specify an overall probabilistic risk prediction or goal. However, many of the JORD requirements have direct safety implications. For example, the flight control system design is required to show by analysis a catastrophic failure probability of one in 10 million flight hours. Other requirements for factors such as handling qualities, egress capability, flight control system redundancy, etc., are all part of the safety requirements. In addition, the V-22 detailed specification requires adherence to MIL STD 882B, the DoD system safety process bible. (Note: the current version is 882D, a substantially less prescriptive standard than the B version used by the V-22 Program. The system safety engineer's job is to manage the program's efforts in compliance with that standard.)

According to the System Safety Manager, the program has complied with the MIL STD guidelines to perform preliminary hazard analysis, various types of final hazard analyses, and safety assessments as part of the NAVAIR system engineering program throughout the several phases of aircraft development, test, and operations. From these analyses, as well as other sources of Navy operational and safety reporting information (Hazardous Material Reports [HMRs], Engineering Investigations [EIs], Quality Deficiency Reports [QDRs], and Hazard Reports [HAZREPs]), the system safety team identifies and analyzes safety risks. The team members categorize the risks using a standard NAVAIR

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matrix (severity and predicted frequency of occurrence) and then report these risks to the program and track progress made in mitigation. They have what appears to be an active Government/contractor team consisting of the APM (System Engineering) and the System Safety Manager, plus three system safety engineers each from Bell and Boeing and one from Rolls Royce.

The key element of the system safety reporting and tracking system is the Safety Action Record (SAR). The SAR is issue based. It describes in summary detail the safety threat or issue of interest, including history and origin (i.e., results of a design hazard analysis, results of an engineering investigation requested by an operational squadron, or a hazard resulting from a mishap). The SAR then describes the system safety assessment of risk both at the time it originally appeared in the SAR system and at the current time after most recent mitigation actions are complete. A SAR stays “open” as long as there are outstanding mitigation actions. Once the program has determined that no other actions are warranted, the SSWG formally closes the SAR. A recent summary of closed SARs by risk level is shown in Figure 1.

		1	2	3	4
		CATASTROPHIC (Fatal Injury or System Loss)	CRITICAL (Severe Injury or Major Damage)	MARGINAL (Minor Injury or Minor Damage)	NEGLIGIBLE (No Injury or Minor Damage)
A	FREQUENT (Likely to Occur Frequently)				
B	PROBABLE (Will Occur Several Times in the Life of the Program)				
C	OCASIONAL (Likely to Occur Sometime in the Life of the Program)	2	3		
D	REMOTE (Unlikely but Possible to Occur in the Life of the Program)	80	19	3	
E	IMPROBABLE (So Unlikely, it can be Assumed Occurrence may Never be Expected)	64	13	2	

Source: Naval Air Systems Command Jan '01 Safety Action Records

Figure 1: V-22 System Safety Program: Closed Risk Status

One of the Panel’s staff members recently completed a detailed assessment of the system safety program as practiced by another NAVAIR program, the AV-8B. By comparison, the V-22 system safety program appears to be better managed and more robustly supported than the AV-8B system safety program, although the latter has improved substantially since the assessment. Of long-term concern is the lack of travel funds for

operational personnel in the Marine Corps. Although squadron support of the SSWG is good now, history says that in time, it will find itself a mostly-NAVAIR-engineer activity, with little or no operational support.

Conclusion: The V-22 System Safety Program appears to be appropriately staffed and engaged with other engineering activities.

Conclusion: The number and type of risk issues being tracked by the program do not appear to be abnormal for an aircraft at this stage of development;

however,

Conclusion: The program uses an overly conservative standard to define the “remote” risk level for its various safety issues; the result is that the risk-level categories by themselves are of limited use to the decision maker in risk mitigation trades.

Recommendation: Develop a consistent approach to measuring overall risk level in development and operational programs to aid decision makers in risk trades. Consider use of probabilistic risk assessment techniques to comply with the most recent risk category definitions published by the Naval Air Systems Command.

DOT&E SAFETY ISSUES AND “IMPLICATIONS” VS. NAVAIR SAFETY RISK POSTURE

During his January 12 briefing to the Panel, the DOT&E Director showed a series of charts that listed 724 subsystem or component failures that occurred during the 9-month, 522-sortie OPEVAL. The charts highlighted a substantial number of these failures (177) as having “safety implications.” In preparation for the staff visit, the Panel asked the NAVAIR System Safety Manager to review the DOT&E conclusions with the intent of describing the safety implications.

The NAVAIR assessment pointed out that the DOT&E analysts had used Maintenance Action Forms (MAFs) to list the failures. These forms are the documents used by the operational maintenance technicians to record the failure and its circumstances, usually immediately after the flight is completed. Some of the MAFs result from pilot discrepancies and others from post-flight inspection by the maintenance team. MAFs by themselves are not reported to NAVAIR and are not usually a data source for the system safety engineer unless they are included as backup information in an Engineering Investigation (EI) or Hazard Report (HAZREP) or other safety related report to NAVAIR.

In his review of the MAFs, the System Safety Manager determined that approximately 15 of the failures related to SARs, all of which are categorized as medium risk. He saw nothing new in the data, which correlated to the relatively low incidence of safety-related reporting during OPEVAL. In other words, the failures addressed by the OPEVAL maintenance team were not the kind that would lead to hazard reports to NAVAIR and the Naval Safety Center. An example was the hydraulic system, in which hydraulic leaks (relatively common in the V-22) were listed as potential fire hazards. This issue has a

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long system safety history in the program, including substantial redesign after the loss of a Full Scale Development aircraft in 1992 due to what was most likely a nacelle hydraulic leak fire. Since that time, the SAR that covers “fire due to hydraulic leaks” has been downgraded to a Category 1D risk in the NAVAIR system, which acknowledges that although hydraulic leak fire is in fact a risk, it is not a high risk, as currently understood, controlled, and accepted by the program. In addition, apparently nothing happened in OPEVAL in the way of new failure modes, sites, or characteristics to change that status.

Conclusion: Although at least one new safety issue (VRS) came out of the Operational Test and Evaluation of the V-22, there were neither new safety issues nor changes in V-22 hazard risk-level assignments because of the Director, Operational Test and Evaluation analysis of the tests.

Recommendation: To aid decision makers, the Director, Operational Test and Evaluation organization and Navy Operational Test and Evaluation Force should consider the use of standard risk indices (i.e., Risk Assessment Codes) when reporting safety issues.

3 OPERATIONAL EFFECTIVENESS AND SUITABILITY

3.1 OVERVIEW

The recent OPEVAL gave the V-22 a mixed grade with respect to its capability to perform its mission. The aircraft did well in the performance-related demonstrations, including cruise speed, range, self-deployment, shipboard compatibility, and internal and external payload capability. The aircraft met or exceeded all Key Performance Parameters, along with 90 percent of the threshold requirements of the Joint Operational Requirements Document, against which it was evaluated during flight test. A listing of results is included as Appendix G. The most important shortcomings were in the reliability, availability, and maintainability areas. The Director, Operational Test and Evaluation (DOT&E) analysis of the V-22 test results concluded that the aircraft is “operationally effective, but not operationally suitable.”

The following are the major questions to be answered in this area:

- Does the V-22 provide the performance capability needed for the missions?
- Is the V-22 maintainable by operational units?
- Is the maintenance training adequate?
- Are the reliability and availability adequate?

The Panel reviewed the results of the OPEVAL and Government and contractor developmental tests and conferred with V-22 Program officials, contractor engineers, and

production personnel. The Panel also examined production and operational flight hardware, flew several engineering and training simulators, reviewed maintenance publications and reporting and training systems, and held discussions with military maintainers and crew chiefs to understand the nature of the aircraft and its support systems and its deficiencies.

3.2 RELIABILITY AND AVAILABILITY

The DOT&E report cited substantive reliability deficiencies as part of the reason for its conclusion that “operational testing has failed to confirm the operational suitability of the MV-22.” The three primary measures of system reliability were Mean Flight Hours Between Abort (MFHBA), Mission Reliability (MR), and Mean Flight Hours Between Failure (MFHBF). MFHBA is measured as the number of flight hours divided by the number of mission aborts. MR is the ratio of missions completed without an abort to total missions flown. MFHBF was calculated by dividing the total flight hours by the total number of failures (all failures, major and minor). (Note: the DOT&E report used the term Mean Time Between Failure [MTBF] throughout, even though only actual flight time was measured).

Because of several potentially non-representative production-related difficulties encountered by the test team in the early months of the OPEVAL (October 1999 through February 22, 2000), the DOT&E report lists these measurements before and after that date. Although the better numbers occurred in the second period, the report still found concern with the demonstrated MFHBF. Table 4 shows the results of the OPEVAL for the three requirements.

Measure	USMC Requirement		Entire MV-22 OPEVAL (804 flt hrs)	Since Feb 22 (540 flt hrs)
	Threshold	Objective		
MFHBA	17.0 hours		13.9 hours	18.0 hours
MR	85%		81%	85%
MFHBF	1.4 hours	2.0 hours	0.6 hour	0.7 hour

Table 4: Reliability Results: MV-22 OPEVAL

For reference, CH-46, CH-53D, and HH-60H are currently showing 0.89, 0.82, and 1.32 MFHBF, respectively.

Of the nearly 1,200 non-production failures that occurred during the 804.5 hours of testing, more than a third were with flight control (including hydraulics) and drive and propotor systems. Table 5 shows the number of failures for each of the top 10 contributors by subsystem.

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Affected Subsystem	Number of Failures	Primary Contributor
Hydraulic Power System	170	Fluid level imbalances
Drive System	80	Gearbox temperature exceedances
Proprotor System	76	Sheared pins, cracked panels, fairing damage
Flight Controls	69	Swashplate actuator hydraulic leaks
Flight Control Computers	69	Multifunction displays
Fuel System	61	Leaks
Wiring	53	Harnesses and brackets
Landing Gear	52	Tire wear
Nacelle Assembly	48	Mini Mark fasteners
Electrical Power	47	Batteries

Table 5: OPEVAL Subsystem Failures

In his discussion of this topic with the Panel, the Program Manager pointed to two reasons for the substantial underachievement in MFHBF: 1) a very late 30 percent increase in the JORD requirement for MFHBF (1999), well after the design for the Low Rate Initial Production (LRIP) aircraft used in OPEVAL was complete; and, 2) poorer than expected performance by the hardware in the nacelle due to the severe vibration (and acoustic) environment faced by the 5000-psi hydraulics system. The 30 percent increase in JORD requirement happened because of a plan by OPTEVFOR to measure failure rates against flight hours rather than operating hours, as originally planned. The Program Office and Services did not change the threshold number to account for the measurement difference. Estimates are that approximately 30 percent of all operational time is on the ground (maintenance and pre- and post-flight operations).

The fixes for OPEVAL reliability problems are in various stages of design, test, and installation. Appendix F shows a prioritized list of "top fleet readiness drivers," including background, issues, and actions as of February 28, 2001.

The program has plans addressing all of the major reliability challenges, and a schedule showing the system meets the 1.4-hour threshold in 2003. Figure 2 shows the timeline and several of the important reliability initiatives in work to allow the aircraft to meet the MFHBF threshold.

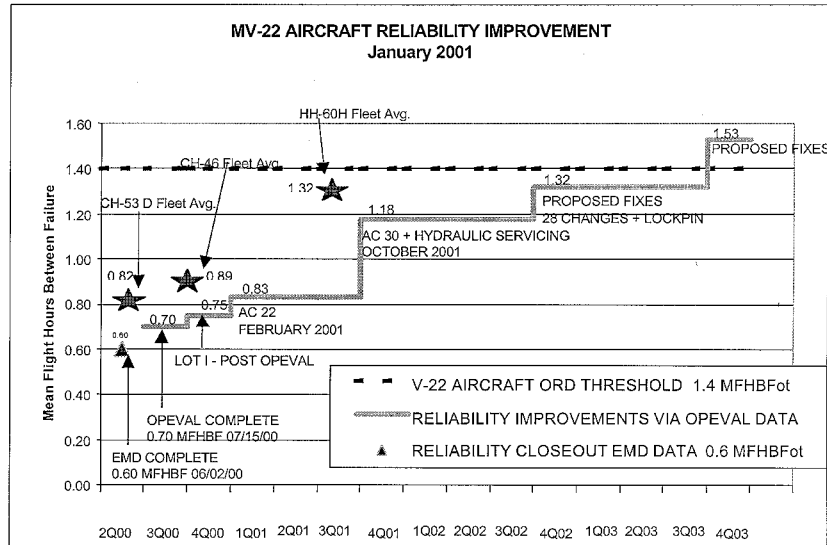


Figure 2: MV-22 Reliability Improvement Plan

The plan results in a 218 percent improvement in MFHBF performance. Of note is that the planned reliability upgrades only improve MFHBA from 18 to 23 hours, or 128 percent. This difference suggests that some amount of time and effort will be spent on reliability improvements that are not necessarily important to mission accomplishment.

Conclusion: The operational availability of the V-22, as demonstrated in the Operational Evaluation, is inadequate. However, not all measures used by the test team are equally important (i.e., mean time between failure vs. mean time between abort).

Recommendation: Reassess and revalidate the current set of V-22 reliability and availability requirements to assure appropriate expenditure of resources on engineering changes.

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3.3 MAINTAINABILITY

The V-22 fell short of its maintainability requirements during OPEVAL with 18.6 maintenance man hours per flight hour MMH/FH compared to a threshold of 11 hours or less. For reference, the CH-46 fleet average is 15.8 hours. One of the biggest contributors to this number was the time spent on hydraulics system discrepancies, and nacelle related problems.

During its visit to the Fleet Replacement Squadron at New River, the Panel heard from the maintainers that one of their biggest challenges is conducting work within the nacelle. They said that several factors made maintenance and inspection of the nacelles very difficult: tight quarters; poor inspection access; inadequate access panel fasteners; and interference between hydraulic lines and other potentially abrasive structures, lines, and wire bundles.

Among other things, the nacelle houses the engine, accessories, engine-driven gearbox, and rotor drive system. It also includes hydraulic flexible and rigid hydraulic lines carrying 5,000-pounds per square inch (psi) fluid, as well as proprotor flight control system actuators and critical mechanical components. One of the reasons for the relatively high 5,000-psi operating pressure is to allow for smaller actuators that help minimize nacelle size (and drag). Mechanics with maintenance experience on other rotorcraft told the Panel members that the V-22 nacelle is the tightest engine/rotor system working space they had experienced.

The normal maintenance access panels give the maintainer only a limited view or access to the nacelle components. To gain access to some of the important parts of the nacelle, they must unfasten a multitude of "Mini-Mark" Government Furnished Equipment (GFE) structural panel fasteners. These fasteners have a very poor record on the V-22. During OPEVAL, for example, they were one of the most common failures. Moreover, when a mini-mark fastener breaks, pieces of it often fall into the nacelle area, creating the potential for foreign-object damage. To completely open all access panels on a single nacelle takes in excess of 11 man hours, not counting fastener failure/replacement time. The Mini-Mark fasteners are required for structural load panels, but apparently, not all of the panels carry loads. This raises the question, "Why not redesign the non-structural loaded panels for quicker, more reliable fasteners for maintainer-friendly access to the nacelle?"

Other factors that add to the maintenance challenge with the nacelle are lack of consistent configuration from one airframe to the next, the high failure rate of the click studs (covered in reliability section of this report), poor maintenance publications, and the normal operational issues that apply to all types of aircraft (poor lighting, weather conditions, oil, dust, etc.).

NAVAIR and Bell Boeing engineers and technicians attached to the Osprey Support Center provide the squadron personnel special support in New River. In addition, the NAVAIR initiated Tiger Team is examining all aspects of the nacelle, including those affecting maintainability.

Conclusion: The tight fit of critical hardware, lack of adequate quick access, and poor reliability of access panel fasteners combine to make the nacelle a significant

maintainability challenge. The effect, at best, is high maintenance man hours and, at worst, missed critical failure precursors.

Recommendation: Modify the nacelle to improve the spacing/protection of critical components, maintenance working space, access, and the overall maintainability of this critical aircraft area. The redesign activity for this modification should include at least the following:

- a. More quick-access panels
- b. High-reliability alternatives to the Mini-Mark fastener
- c. User-friendly inspection access for critical parts and other exceptions to the flight control system redundancy design requirement
- d. Shortening of the hydraulic lines between switching valves and swashplate actuators (if feasible)

3.4 INTERACTIVE ELECTRONIC TECHNICAL MANUAL (IETM)

During the Panel's visit to VMMT-204 they were briefed on and given a demonstration of the IETM, which has taken the place of paper maintenance publications within the squadron's maintenance department. The Panel was struck by the poor demonstrated performance and capability of this system and requested and received additional briefings from Bell Boeing and the Program Office. The questions that need to be answered are: "Can the V-22 IETM be fixed? Is it worth fixing? Are there alternatives to IETM that are worth pursuing?"

IETM has been designed to be an interactive database that will contain all of the maintenance publications and the configuration data for every aircraft in a squadron. When fully developed, it will integrate multiple information sources into a single system, thus providing a wealth of information to the maintainer. Its electronic interfaces will reduce manual data entry. It has the potential to be integrated with The Naval Aviation Logistics Command Management Information System (NALCOMIS) and with The Aircraft Maintenance Event Ground Station (AMEGS). Updated IETM "drops" will be done electronically every 45 days, ensuring that the squadron has the latest changes to its technical manuals. It will provide the squadron with the capability to rapidly and easily deploy detachments, minimizing pack-up requirements. It will assist maintenance training by providing graphics and text on a portable electronic display device (PEDD) that is easily transportable.

The problem is that IETM as currently fielded does not meet the requirements of the Marines in the maintenance department of VMMT-204. The issues with IETM observed by the Panel are the same issues identified in both the COMOPTEVFOR OPEVAL Report and the DOT&E Beyond LRIP Report: IETM does not provide adequate content, accuracy, organization, and clarity to fully support maintenance activities.

Additionally, although the process to update and correct deficiencies with IETM is in place, it responds too slowly to adequately support the fleet. For example, since February 2000,

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VMMT-204 has submitted 447 Technical Publication Deficiency Reports (TPDRs), of which 164 remain open. The turnaround time for TPDRs ranges from 2 to 3 months.

The Joint Integrated Maintenance Information System (JIMIS) developed by Grumman Melbourne Systems to support the J-STARS Program was chosen in 1993 for authoring and presentation of IETM software for the V-22 Program. The JIMIS software was provided to the V-22 Program for IETM as Government Furnished Equipment (GFE). Boeing Helicopter is the lead integrator for IETM. Significant deficiencies addressed during OPEVAL and witnessed by the Panel included the following:

Incomplete data

- No Integrated Parts Breakdown;
- No mirror image graphics for multiple systems; and
- No schematics for fuel, hydraulics, or electrical systems.

Inaccurate maintenance procedures

- Numerous tasks are documented under the wrong; system/subsystem listing;
- Erroneous torque values; and
- Inconsistent part number references.

Poor organization of data and procedures, and lack of clarity

- Non-user-friendly navigation system; and
- Differences in Bell and Boeing references (schematics).

Poor integration of logistics support

- V-22 is the only aircraft using the Universal Numbering System (UNS); and
- No technical or support manuals are available for UNS.

As stated in the OPEVAL report, "Maintenance of the MV-22 was hampered by the immaturity and lack of clarity of the IETM. Without accurate IETM, maintainers spent many hours troubleshooting fixes to problems that should have been readily identified. Utilizing IETM also proved to be a cumbersome process due to the poor organization of the manuals. When coupled with the inaccuracies of the IETM, an exorbitant number of man hours were expended trying to determine correct maintenance procedures." IETM hardware and supporting software is immature and developmental in nature; significant development and testing needs to be accomplished before it is ready for fleet introduction. Further, maintenance personnel within VMMT-204 estimate that, on average, 15 percent of maintenance time is lost due to IETM deficiencies. Some of the more complicated tasks can involve substantially more IETM-unique lost time than that.

Conclusion: As currently fielded, IETM fails to meet the needs of organizational maintenance.

Conclusion: Significant development and testing is required for IETM as designed prior to operational deployment.

Recommendation: Assess the options for V-22 technical publications (electronic and paper).

and if an electronic publication approach is the best alternative, and the training squadron continues to be the best place to develop it,

Recommendation: Provide adequate developmental support to the training squadron for the selected system.

Importantly, as the contractor validated 100 percent of the maintenance procedures prior to OPEVAL, only 15 percent was actually accomplished on the aircraft, and the remainder was validated through tabletop review or simulation. While this may be the standard practice for validation, it apparently missed important flaws in the data.

Conclusion: Based on the poor performance of the IETM thus far, technical publication validation was inadequate. Additionally, NAVAIR and the Program Office have not yet verified the same technical publication procedures in the IETM. This process needs to be accomplished as soon as possible.

Recommendation: Properly validate and verify the technical publications as soon as possible.

The poor integration of logistics support within IETM is another area of concern to the Panel. The V-22 is the only naval aircraft that utilizes the Universal Numbering System (UNS). UNS is a numbering system for referencing technical data, aircraft systems, and related aircraft equipment. The IETM, using UNS logic, was designed to provide a functional numbering system consistent across all data; provide audit trail methodology in developing quick, easy, and accurate fault detection/isolation; and pursue Joint Service Operational Requirements. The Navy canceled UNS conversion in 1996; however, the V-22 Program Office determined that it would be financially infeasible to go back and reestablish the Logistics Support Analysis (LSA), Logistics Support Analysis Record (LSAR), and other infrastructure to support a return to the standard Work Unit Code (WUC) used by all other naval aircraft. The V-22 Program is using the UNS structure as its work unit code equivalent. The structure forms the basis of the Logistics Control Number (LCN). The LCN ties the UNS information to the LSAR, which is used for provisioning, publications, maintenance plans, task analysis, and analysis of data failure. This numbering structure has been rolled directly into IETM and is used to help navigate within IETM. Unfortunately, because UNS is task based and was constructed to support troubleshooting, individual parts are split into functional UNS buckets. What this means, according to a V-22 IETM Limitations Document published by Naval Aviation Depot Cherry Point on 13 March 2001, is that "essentially, there is no good way to search for parts data in the IETM."

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Currently, neither a fleet UNS manual nor a V-22 UNS users' guide exists. Both of these documents are in development, with no estimate of a completion date available. VMMT-204 maintainers are working with AIR 3.0 and SPAWAR personnel to overcome reporting problems associated with UNS.

Conclusion: Use of UNS rather than WUC will create long-term difficulties for the V-22 Program. The maintenance and upgrades of a logistics system that is unique within naval aviation has limited potential to succeed and will prove very costly. Additionally, when deployed, the V-22 logistics system will be incompatible with the logistics system of other aircraft in a composite squadron.

Recommendation: Transition as soon as possible from the Universal Numbering System to the standard Work Unit Code logistics system.

During the Panel's review of the IETM, both Bell and Boeing provided briefings on other IETM systems undergoing development. The Boeing effort for F-18 has been successful, although it apparently had its own startup problems. Bell is beginning an effort to bring electronic technical manuals to the AH-1 Program using a standard work unit code logistics base and a different set of application software than either the F-18 or the V-22.

Conclusion: There appears to be no standardization or specified requirements within DoD for Integrated Electronic Technical Manuals, and each program office is on its own to determine the solution that works for them and what they can afford. This can impact deployed units that share the same organizational and intermediate level maintenance facilities (e.g. amphibious ship with composite squadron).

Recommendation: Standardize performance, support, testing, and funding requirements for Electronic Technical Manuals across all platforms and services.

3.5 MAINTENANCE AND AVAILABILITY REPORTING NALCOMIS (OPTIMIZED)

On February 26, 2001, the Panel members received a briefing on the Naval Aviation Logistics Command Information System (NALCOMIS (Optimized)), the Navy's new automated maintenance management system, by the Assistant Commander for Logistics for NAVAIR. VMMT-204 was the first USMC squadron to utilize NALCOMIS (Optimized), and there had been a significant reduction in reported aircraft readiness by Navy squadrons that had transitioned to the new system of maintenance data management.

NALCOMIS (Optimized) is part of the Navy's initiative to fully automate its aviation maintenance environment. As planned, the system will provide Navy planners with total asset visibility, to include total numbers of aircraft, location, and material condition. It will track utilization so that it can quantify requirements and trend reliability to determine

readiness and refine budget requirements. More specifically, NALCOMIS (Optimized): reports maintenance transactions in near real-time, tracks actual equipment configuration data, locates parts and material through connectivity with supply departments, allows instant access to readiness data by authorized users on the network, maintains electronic log books, and includes standard interfaces for aircraft-specific diagnostic programs (F/A-18E/F, V-22, JSF).

NALCOMIS (Optimized) began Developmental Test in April 2000, at the same time it was introduced at VMMA-204. Operational Test of the system was scheduled to begin in March 2001. Briefers told the Panel that due to the accuracy and reporting discipline inherent in NALCOMIS (Optimized), squadrons utilizing the new system could expect to see reductions in both Mission Capable (MC) and Full Mission Capable (FMC) rates. HSL-40, the first unit to adopt NALCOMIS (Optimized), reported in November 1999 MC and FMC rates of 64.4 and 63.3, respectively, under legacy NALCOMIS. Then, one year later, under NALCOMIS (Optimized), it reported MC and FMC rates of 26.6 and 16.7. Under the new system, Direct Maintenance Man Hours (DMMH) also could be expected to drop significantly. In fact, HSL-40's data indicates that these rates were effectively cut in half. Other documented effects include a rise in both Not Mission Capable Maintenance (NMCM) and Not Mission Capable Supply (NMCS) rates. While the drop in reported readiness rates was expected with the move to a more rigorous system of analysis, the problem the Navy is working with is how to quantify the new readiness numbers relative to the Chief of Naval Operations' established MC and FMC readiness goals, which were based on legacy NALCOMIS. What does an MC rate of 26.6 percent, measured in NALCOMIS (Optimized), mean in terms of the ability of a squadron to accomplish its mission?

The Panel's visit to VMMA-204 included a briefing on NALCOMIS (Optimized), during which numerous issues and concerns were identified. These included the following:

- 1) The system complies with the 4790.2H Naval Aviation Maintenance Publication (NAMP), which has not yet been published. The fleet is working from the 4790.G. No information or waivers were provided to the Marine Aircraft Wing or the squadron granting permission to deviate;
- 2) There is currently no way to correct invalid data. The system is allowing errant work orders to be transmitted;
- 3) Lack of system reliability requires the Maintenance Administration Work Center to back up all documentation manually;
- 4) Reports generation is not user-friendly;
- 5) Responsiveness to identified system Trouble Reports is time-consuming because of the requirements to approve, design, and implement the fix;
- 6) No contingency exists to fix or fly aircraft if the new system fails. No paper copies of records exist; and
- 7) The system does not currently interface with either V-22 aircraft diagnostic systems or the V-22 IETM.

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Conclusion: NALCOMIS (Optimized) is experiencing a high number of deficiencies in the squadron environment.

Recommendation: NAVAIR should correct the deficiencies and incompatibilities that are resident in the NALCOMIS (Optimized) system as soon as possible.

On April 10, 2001, the Navy's Commander of Operational Test and Evaluation stated that, "based on operational testing and identified deficiencies of NALCOMIS (Optimized) from March 13, to date, an unsatisfactory outcome is likely for this FOT and E (follow-on-test and evaluation)." He recommended that the system be decertified and that all fielding stop. Observations of NALCOMIS (Optimized) performance identified problems associated with mission failures, training inadequacies, and data transfer integrity. Additionally, the lack of understanding of the significance of MC and FMC rates under NALCOMIS (Optimized) and the inability to effectively compare those rates to CNO readiness goals has resulted in the squadron having to report its readiness rates using both Legacy NALCOMIS and NALCOMIS (Optimized).

Conclusion: Inclusion of NALCOMIS (Optimized) with draft documentation in VMNT-204, as it faced the requirement to field a new aircraft without verified maintenance publications, coupled with an immature IETM, clearly complicated the challenge.

Conclusion: Baseline data for NALCOMIS (Optimized) has not yet been developed to properly evaluate performance of reporting units.

Recommendation: NAVAIR should provide a set of guidelines and metric algorithms to all organizations that use NALCOMIS readiness data for planning, budgeting and other resource decision-making.

3.6 DIAGNOSTIC CAPABILITY

The object of the diagnostics test conducted on the V-22 during OPEVAL was to determine whether the V-22 diagnostic capability would be adequate, reliable, and accurate. The DOT&E evaluation stated that "since the vast majority of fault detections were invalid (i.e., false alarms) the diagnostic system overall was of little, if any, assistance to the operation or maintenance of the aircraft." The Panel received a demonstration of the diagnostic capability of the aircraft while visiting VMNT-204. Based on this demonstration, the Panel requested and received additional briefings on the V-22 diagnostic capability from both Bell Boeing and the Program Office to determine the adequacy of the V-22 diagnostic system.

The V-22 Operational Requirements Document requires that the aircraft have a Data Storage System (DSS) able to accommodate the downloading of maintenance data in 15 minutes or less to support maintenance debriefings, allow the rapid sorting and correlation of data points, and provide effective guidance for maintenance personnel. The V-22 accomplishes this task with its mission data loader (MDL), which, at periodic intervals during flight, automatically records built-in-test (BIT) data results, engine performance parameters, and other data. Upon landing, aircrew and maintenance personnel download these flight data to the Data Transfer Module DTM. The DTM cartridge is then removed from the aircraft and is used to download information to an Aircraft Maintenance Event Ground Station (AMEGS). AMEGS reads both Vibration and Structural Life Engine Diagnostics (VSLED) and Full-Authority Digital Engine Control (FADEC) data.

Maintainers at VMMT-204 spoke very highly of the diagnostic capabilities of this system. They recounted one instance in which AMEGS-displayed VSLED data indicated higher than normal vibrations emanating from an engine drive shaft. The resulting inspection revealed an improper washer stack-up. OPEVAL results stated that the V-22 diagnostic system demonstrated the capability to be adequate, reliable, and accurate. Both fault detection (FD) and fault isolation (FI) exceeded their threshold and objective values, but the false alarm (FA) rate failed by a large margin, as indicated in Table 6.

Measure	Threshold/Objective	Demonstrated in OPEVAL
Fault Detection	> .70 / .85	.92
Fault Isolation	> .70 / .85	.87
False Alarm Rate	< .25 / .15	.92

Table 6: Results of OPEVAL Diagnostics

The FA rate is the probability that a diagnostic Built-in-Test (BIT) will indicate a failure when none has occurred. FA rate is calculated as the number of incorrect diagnostic failure indications divided by the total number of diagnostic failure indications. The FA rate continues to plague maintenance troubleshooting as well as flight operations. While the warnings and cautions displayed to the aircrew are considered accurate, the excessive amount of advisories has created excessive aircrew workload and inaccurate readiness indications. To help reduce the maintenance workload while FA improvements are being developed, a "ghost list" was created to identify specific conditions under which an identified fault did not indicate a system problem. The "ghost list" is displayed on the AMEGS for easy reference.

A deficiency of the AMEG system identified by both the MOTT and VMMT-204 maintainers is that the system displays only six-figure Hex fault isolation codes. Two associated problems with this system are: 1) only the contractor can decode these codes; and 2) the maintenance publications contained in the IETM used by troubleshooters uses UNS codes that are logistics based. The lack of integration among AMEGS, IETMS, and NALCOMIS (Optimized), is identified in the DOT&E report as follows:

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AMEGS, VSLED, and IETMS were not integrated with each other or with the Naval Aviation Logistics Command Management Information System (NALCOMIS). Each stand-alone system required manual transfer of common data elements from one system to another. Manual processes introduced additional errors, added maintenance delay time, and reduced the utility of BIT systems.

Integration of these disparate systems will take some time to accomplish. In the interim, the Program Office has developed a ground-based fix for the AMEGS hex code problem that will be incorporated on the aircraft. AMEGS version 2.2.1 will be released in May and will provide a cross-reference table automatically tying the IETM logistics UNS codes to the hex codes currently displayed by the AMEGS. This integrated system will provide maintainers with a greater degree of troubleshooting capability. In the long term, UNS codes are being considered for addition into the aircraft's Mission Computer AMEGS database, allowing codes to be displayed on the maintainer flight summary in the cockpit. This system will also significantly enhance the ability of the aircrew to identify potential maintenance problems in flight.

Conclusion: The AMEGS has the potential to be a powerful diagnostic tool for the maintainer, but the marginally integrated AMEGS, IETM, and NALCOMIS systems, all of which suffer from their own development problems, create undue workload for the maintainer in identifying and understanding system performance and maintenance issues.

Recommendation: Fix the individual deficiencies associated with AMEGS, IETM, and NALCOMIS (Optimized). After each system demonstrates adequate reliability, integrate these three systems as soon as possible.

and,

Recommendation: In the short term, expedite software cross references for AMEGS and IETMs.

and,

Recommendation: Provide appropriate training on AMEGS for the VMMT-204 maintainers.

There is a strong synergistic relationship between detecting and isolating a fault and a false alarm. Therefore, the Program Office is not willing to arbitrarily reduce the detection and isolation capability of the diagnostic system in an effort to reduce the false-alarm rate. The Program Office does have a plan in place to reduce the number of false alarms. J VX Application System Software (JASS) Release 2.6 will fix 28 false-alarm indications. The software is scheduled for release for flight test in August 2001 and to the fleet in November 2001. Additionally, AMEGS Version 2.2, which was completed in February of this year, has the capability, when selected, to remove from the display those items on the "ghost list," making it easier to see the remaining indications. Training is

ongoing at MCAS New River on the new version of AMEGS. Other initiatives that the Program Office is taking include an analysis of additional software such as diagnostic file filters, hardware changes, and the incorporation of subsystem software updates that have less propensity to trigger false alarms and remove the need for reference to the “ghost list.”

Conclusion: The timing of improvements in the current plan to reduce the false-alarm rate is inadequate to meet program needs.

Recommendation: Expedite the plan to reduce the V-22 false-alarm rate in both the aircraft and ground systems, with priority on aircraft software.

3.7 MAINTENANCE TRAINING

Consistent with its charter to review the adequacy of V-22 training, the Panel received briefings from the Program Office on the V-22 maintenance training system. Additionally, both Bell and Boeing and personnel from VMMT-204 and the Fleet Replacement Enlisted Skills Training (FREST) unit located at MCAS New River in Jacksonville, North Carolina, briefed Panel members.

In 1996, the Department of the Navy invested \$41 million with Bell Boeing for the development and procurement of the Naval Aviation Maintenance Trainer Suite (NAMTS) for the V-22. NAMTS was to be located at the FREST schoolhouse. The mission of the V-22 FREST is to “provide consolidated/co-located tiltrotor maintenance training, in partnership with the Air Force, utilizing state-of-the-art training systems and strategies.” NAMTS was to consist of four composite maintenance trainers (CMTs) and four composite maintenance procedures trainers (CMPTs) that were designed to replicate more than 1,335 maintenance tasks. Reflectone was chosen as the contractor for NAMTS through full and open competition in 1997. Reflectone subsequently stopped work on the project in December 1999 and was officially released from the contract through a no-fault mutual rescission signed in May 2000. With \$14 million remaining from the original investment of \$41 million, Bell Boeing and PMA-205 (the Program Manager responsible for V-22 maintenance training systems) agreed that low-fidelity Parts Task Trainers would be built and that separate contracts would be let for an Integrated Multimedia Instruction (IMI) suite and high-fidelity CMTs. These three separate systems were to be integrated into a maintenance training system to replace the cancelled NAMTS. Until the CMTs were received, VMMT-204 would provide two to three aircraft to the FREST to allow maintenance students to complete their hands-on training. Boeing’s initial bid for the CMTs was \$130 million, which was determined to be unaffordable by the Program Office, and the development of CMTs was cancelled. Bell Boeing was awarded a \$20 million contract to develop an IMI capability for the V-22. IMI consists of three subsystems: an instructor-led classroom Computer-Aided Instruction (CAI) curriculum, Interactive Course Ware (ICW) that is self-paced and instructor supervised, and a computer management system to oversee the process of IMI and to handle such responsibilities as student enrollment, data collection and reporting, and testing.

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The current maintenance-training system calls for the use of actual aircraft in the place of CMTs. PMA-205 will be responsible for converting three aircraft to trainers with fault insertion capability. Each conversion is expected to take 6 weeks. The first aircraft conversion is scheduled to begin in October 2001. In the interim, VMMT-204 will supply additional LRIP aircraft to meet the FREST's training requirements. The second part of the maintenance training system, the Part Task Trainers (being built by both Bell and Boeing), is in the process of being developed and fielded. The FREST currently has a Powerplant Part Task Trainer in place, and Boeing is working on the fielding of Part Task Trainers for Sponsons, Landing Gear, and the Airframe. Delivery of these systems is expected to take place over the next 18 months. The final part of the maintenance training system, IMI, is currently being delivered to the FREST. Bell is expected to complete delivery of its portion of the software by June 01 and Boeing by September 01. The Panel members were shown the capabilities of IMI during a briefing at MCAS New River on 5 March 2001. IMI is a state-of-the-art system that is a quantum leap over current maintenance training systems.

Conclusion: Until adequate maintenance training systems are in place, the loss of NAMTS will have an impact on the capability of both VMMT-204 and the FREST to accomplish their missions of training pilots and maintainers. The three systems procured should address this deficiency adequately if they are properly funded and supported.

Recommendation: Fully fund and support the maintenance training system.

Regarding the use of actual aircraft as maintenance trainers, the Panel members recognize that there are both advantages and disadvantages. Among the advantages are:

- 1) Actual aircraft have a higher physical and functional fidelity;
- 2) The maintenance of the trainers will mirror that of operational aircraft;
- 3) Ground support equipment will not have to be modified;
- 4) Spares will be available through the supply system; and
- 5) Hardware and software configuration can be simplified through the utilization of the ECP process.

The disadvantages of utilizing actual aircraft as maintenance trainers are as follows:

- 1) Early production aircraft generally require numerous modifications before configuration stabilizes. The training aircraft supplied to the FREST will require these modifications, which will take them out of service for a certain length of time, thus necessitating augmentation by aircraft from VMMT-204 and the resultant downturn on operational readiness;
- 2) The Panel is concerned whether the actual aircraft being used for maintenance trainers are properly spared;

- 3) Additional ground support equipment will be required to be purchased, maintained, and supported by the FREST; and
- 4) Aircraft components are not designed to withstand the multiple remove and replace cycles required for training, and the associated cost and quantity of spares may be excessive and must be planned and budgeted for.

Conclusion: There are advantages and disadvantages to using actual aircraft as maintenance trainers,

however,

Conclusion: Under the best circumstances, a real aircraft cannot replace a properly engineered maintenance trainer. The disadvantages outweigh the advantages and complicate the maintenance training for the other services,

and,

Conclusion: To be effective, maintenance trainers must be properly funded for spares and fleet modifications.

Recommendation: Consider the eventual replacement of the aircraft being used as maintenance trainers with maintenance trainers designed for that purpose.

Recommendation: Retrofit and modification of maintenance training aircraft (when appropriate) should occur at the same time or prior to those changes being incorporated in tactical aircraft.

Recommendation: Adequately budget for maintenance-training aircraft spares.

4 PROGRAMMATICS

4.1 OVERVIEW

The Panel reviewed the V-22 program, including its structure, budget and schedule, and considered recommendations to improve upon it. In summary, the program was proceeding as well as can be expected, given the significant fiscal constraints, and the plan to introduce not only a new aircraft but also a new and unique maintenance and logistics support concept at the same time.

The V-22 Risk Management Program and Systems Engineering processes are success stories despite significant challenges posed by the joint venture arrangement of having two prime contractors to deal with instead of a prime contractor/subcontractor arrangement. Intense communications are required to have success in these areas;

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however, it was obvious to the Panel that greater communication was required with the user community to keep them informed of program actions.

A common theme the Panel found throughout its assessment was inadequate resources to execute the planned program. Inadequate resources in development and early production essentially delayed program maturity. Once fielded, spares and support were inadequate to sustain fleet operations and are projected to remain low throughout the life of the program. To accommodate a higher cost than originally planned, yearly aircraft procurement rates were reduced to live within near-term budget constraints.

4.2 THE JOINT PROGRAM AND SYSTEMS ENGINEERING

The two major mishaps in 2000 and the results of the OPEVAL show that many of the issues and challenges of the V-22 Program cut across traditional design and development disciplines. Inadequate integration of flight control hardware, software and pilot human factors was an issue in the North Carolina mishap. Technical publication development and validation is another systems engineering issue. Further, the assurance disciplines of system safety, reliability, maintainability, and quality all depend upon a solid and open systems engineering approach for success. A potential threat to good systems engineering and integration is the relatively unusual 50/50 joint program work share (design and production) used by the two prime airframe contractors, Boeing Helicopters and Bell Helicopter Textron. Considering the number of cross-functional issues in the program, the Panel reviewed the organizational and management approach of the V-22 Program to determine if this dual prime concept with shared integration responsibilities might be putting an undue strain on the program's systems engineering efforts. The Panel also looked at how the V-22's design trades and risk management are accomplished.

ORGANIZATIONAL APPROACH

Bell and Boeing split the engineering and production work and the profits 50/50. They have a joint process for transferring work for cases in which it looks like the 50/50 split is challenged, or when one company's skills were more suitable for a given task than those of the other were. Contractor interface with the Government is through a Joint Program Office (JPO) located near the NAVAIR Program Office at Patuxent River. The JPO is a relatively small office with representatives from both companies. (NAVAIR has a separate contract with Rolls Royce Allison for engine production and support). The JPO is headed by a Program Director, who is a Bell or Boeing employee on a rotating basis. The Bell and Boeing Program Managers at their respective sites in Fort Worth and Philadelphia report programmatically to the Program Director.

The systems engineering effort for the NAVAIR Program is headed by the Deputy Program Manager Systems Engineering (Class Desk). On the contractor side, The V-22 Systems Engineering Management Plan for Engineering and Manufacturing Development (EMD) (last changed in 1993) outlines the organizational structure and the various responsibilities for the contractor team members. Systems engineering tasks and activities are pervasive throughout the program and fall under the overall responsibility of the Technical Director, who reports to the JPO Program Director. The NAVAIR

contractor team uses Integrated Product Teams (IPTs) and Analysis and Integration Teams (AITs) with negotiated leadership and participation by the Government and the two companies, according to their respective responsibilities and strengths.

Although the responsibility for systems engineering falls on the Bell Boeing JPO, that office has no systems engineering capability beyond management. Both Bell and Boeing provide the staff and functional policy guidance for all systems engineering tasking at their respective sites. Each company has its own techniques, formats, and organizational heritage for the various systems engineering disciplines; however, the Systems Engineering Plan specifies the process and standards to be used by the joint program. Where there is conflict, the JPO policy takes precedence. The breakdown of design responsibilities by company is shown in Appendix G. Each company, through the IPT and AIT structure, handles its unique integration and assurance issues. Integration issues that cross company boundaries such as electrical systems, flight control system, maintenance publications, and crew training, are managed by the JPO, again through IPTs and AITs with joint membership and reporting to the JPO Technical Director.

This organizational approach to systems integration and program management carries with it the risk of omission. The JPO does not have a systems engineering staff of its own, so there is some degree of delegation and decentralization of the discipline, a real challenge for the JPO technical director and Navy Class Desk. In discussions with the key people involved, it was apparent to the Panel that any risk to systems engineering inherent in the dual prime contractor approach is at least partly mitigated in the V-22 Program by a combination of positive factors:

- Strong systems engineering management by the NAVAIR Program Office;
- Close coordination of issues among all organizations by the contractor JPO;
- An active inclusive risk management program;
- Good communications and working relationship between Bell and Boeing team members (at all levels); and
- Dedication to the concept by upper management in both companies.

And most importantly, according to NAVAIR, Bell, and Boeing managers,

- Continuity and corporate knowledge among the key members of the team (many of whom have been on the project in excess of 10 years).

As time goes on, and people on the Government and contractor side move to other positions, it will be important to maintain continuity and corporate knowledge. By its nature, a single prime contractor who is also the systems integrator is generally the optimal approach to systems engineering; however, at this late date, and in view of the importance of consistency in the program, the Panel sees no value in changing basic contractual or organizational structure. However, NAVAIR should take steps to minimize the threat to key personnel continuity through the critical post-OPEVAL development and early production phases still ahead.

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Conclusion: The Bell Boeing Joint Program Office is a critical feature in the V-22 contractor organization, especially with regard to program integration.

Recommendation: Constant attention must be paid by both the Navy and the Bell Boeing Joint Program Office to the potential for lapses in systems engineering integration discipline as team members try to solve problems outside of established processes.

Conclusion: Possibly the most important ingredient in the V-22 Program's systems engineering effort is continuity among its key personnel.

Recommendation: As the program proceeds, both NAVAIR and the contractors should ensure a high level of continuity in the program's Integrated Product Teams, Analytic Integration Teams, and key management positions.

DESIGN TRADES

One of the key features of the EMD Systems Engineering Plan was its treatment of trade studies. Early in development, trade studies were used to weigh the effects of various design solutions against the requirements. No program has the luxury in funding, time, or even technical feasibility to maximize its design across all requirements; there are always optimization trades to be done. The V-22 systems engineering program prioritized the various design requirements by category, putting the highest weight on those design requirements related to range, shipboard compatibility, speed, and payload capability. They ranked reliability and maintainability requirements at roughly half the weight of the major performance measures. Safety-related requirements were spread throughout the weighting scale, with human factors at just over half of the maximum weight factor, and crashworthiness, handling qualities, and one-engine-inoperative performance at the lower end of the scale. This relative ranking can easily justify a decision to develop a 5000-psi hydraulic system with its component weight and volume (thus payload, range, and speed) advantages, even at the expense of reliability and maintainability.

Although most design trades for EMD were conducted in the early to mid-1990s, there continues to be a need for requirements updates, risk mitigation strategies, design upgrades, engineering changes, etc., for an aircraft at this early stage. Considering the nature and importance of the flight test supportability discrepancies and mishap investigation results, the program would do well to update the trade study weights consistent with current priorities, as necessary. This update would provide proper and consistent guidance to the engineering team for its ongoing systems engineering activities.

Conclusion: Although the V-22 was not intentionally designed to be unreliable or unmaintainable, the results of the OPEVAL are relatively consistent with the systems engineering trade study weighting scheme...*the aircraft performed as it was designed!*

Recommendation: For the next phase of system and requirements reviews, risk trades, and engineering changes, the program should assess its trade-study priorities and perform updates consistent with today's priorities—i.e., safety, reliability, and maintainability.

RISK MANAGEMENT

In considering the long history of technical, cost, and schedule issues with the V-22 Program over the years since inception, the Program Manager has refined the risk management process, making it an integral part of overall program management. In the briefing and ensuing discussion, it was clear to the Panel that this program has taken classical risk management to a level not often seen in large Government programs. In any number of programs, risk management, if formally done, is treated as a distinct process, in addition to, rather than as an integral part of system engineering. Most often, it is accomplished by designating a program management team member as part-time "risk manager." Some of the larger programs hire support contractors to provide process support, or in some cases, independent analysis support (independent of the prime contractor). Some major programs have an IPT (e.g. Naval Sea Systems Command Program Executive Officer Carriers) or a standing risk board (National Aeronautics and Space Administration (NASA) Space Station Program) that meets periodically to discuss and assign status to risks, but they are not necessarily part of the engineering change process or the everyday program management system. According to the V-22 Program Manager, he is the Risk Manager, and his philosophy is to "create an open, honest, risk-aware culture in which risk management is considered to be a normal, healthy aspect of sound overall program management."

The program has a large risk-management support team of approximately 20 full-time-equivalent people from several program office support contractors. They help the process by running the systems, managing the electronic risk database, providing independent risk assessments as required, and tracking the status and mitigation plans. Because the risk process is integral to the program management process, the Program Manager believes it allows him the best chance of heading off problems before they happen, or at least minimizing their probability and/or severity when avoidable.

The scope of the V-22 risk management program is broad. Anything that can threaten technical performance, cost, or schedule is fair game. Safety risks are handled independently by the NAVAIR system safety team, using MIL STD 882 standards and the System Safety Working Group chaired by the Class Desk. However, if a safety issue comes out of that process as an "unacceptable risk," it is tracked and worked by the program in the risk management process as a technical risk. A safety issue is not passed off to the program; however, as the system safety team independently tracks the status

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and mitigation efforts and continues to independently reassess risk level as new modifications or controls are put in place.

The analysis part of the V-22 risk management process is usually qualitative in nature, with the exception of certain quantitative specification compliance issues (i.e., reliability and performance requirements). Because of this, the program does not treat risks statistically, nor are mathematical uncertainties used as they are in some programs. The categorization of risks uses the three-level ranking technique common to many programs: high, moderate, and low. Although the program uses risks to create "risk adjusted" cost projections, its officials have had some trouble finding a reasonable approach to risk adjusted schedule prognostications. The Program Manager stated that they have gone through several starts and stops with various techniques for applying risk to program schedules in a quantitative way, and all have fallen short.

The Program Manager points to cost and schedule performance indicators consistently over 99 percent (better than most other programs managed by the Naval Air Systems Command). He believes that future success in the program depends on its continued integrated, open processes. He pointed out that the risk management process received high marks in an independent audit chartered by the Assistant Secretary of the Navy for Research, Development and Acquisition (ASN (RDA) in March 1994, and that the system is even better today.

Conclusion: The V-22 Program risk management approach appears to be robustly supported by management and appears unusually well coordinated with other program activities. In spite of its minimal use of state-of-the-art quantitative risk assessment techniques, it appears to be better coordinated and managed than risk management systems found in other major programs.

Recommendation: The Defense Systems Management College risk management course should use the V-22 Program risk management process as an example of how to incorporate risk into everyday program management.

4.3 PROGRAM COMMUNICATIONS

During visits to both Government and contractor facilities, the Panel members were struck by the lack of awareness by officials of both organizations with some of the issues and concerns being raised by the Marines and Airmen of VMMA-204. More significantly, many of the VMMA-204 personnel did not know if their technical issues were being addressed. The latter concern was becoming a morale problem. The issues of concern covered three areas: the aircraft, the maintenance system, and enlisted maintenance training.

As mentioned in the VRS discussion, the knowledge among MOTT pilots of the risk of VRS in the V-22 was limited before the Mirana mishap. Although the engineering community was aware of the potential and had a formal Safety Action Record on the subject, this level of understanding was not shared by all of the pilots. The lack of understanding of the system safety program and its functions is not unique to the V-22.

During a Harrier program system safety risk assessment in 1999¹, this lack of connection between system safety and squadron level aviation safety was very apparent. Factors included: lack of system safety training at the Naval Safety School; lack of formal ties between risk acceptance rationale and risk controls; insufficient participation (usually due to lack of travel money) in the System Safety Working Group; and lack of policy guidance from the Chief of Naval Operations. The answer pursued by the Harrier program was to improve informal communications and increase travel funding for squadron participation in safety reviews. If the V-22 Program and operational community do not take special care to maintain a strong communications link between the operators who take the risks and the Program Manager who accepts the risk on their behalf, there will be ample opportunity in the future for another avoidable mishap.

The loss of the second V-22 in December 2000, followed by the grounding of the squadron and the appointment by the Secretary of Defense of this Panel, as well as the ongoing DoD Inspector General Investigation, all have had an impact on the members of VMMT-204. Significant concern was expressed during the Panel's visit with the squadron that the problems that they had been dealing with for some time were not being addressed adequately. The combined NAVAIR Fleet Support Team (FST) and Joint Program Office (JPO), Osprey Support Center (OSC) located at MCAS, New River works closely with the squadron every day to help with problems, communicate issues to and from NAVAIR and the contractor facilities, and otherwise facilitate communications.

Conclusion: While standard legacy reporting processes are being used properly, they appear to be inadequate to the expressed desires of the operators.

Recommendation: Review information flow requirements between the V-22 Program, Bell Boeing, and the customer, and develop a funded plan to increase the responsiveness to operator needs. (Attention needs to be given to meeting similar requirements for the Air Force and SOCOM during CV-22 introduction).

Issues that result in changes to the aircraft are another source of frustration for the operators. Specific complaints included: Mini-Mark fasteners that fell apart and created both a foreign-object damage hazard and high workload for maintainers; lack of adequate inspection panels on the aircraft (particularly around the nacelle area); and oil leaks from the engine. Although the normal reporting system for such anomalies appeared to be intact and working, the lag time, or lack of status updates on engineering changes, was an area of concern to the operators.

One example of poor feedback was the case of the steel sleeve that was installed on the Interconnect Drive Shaft as an interim heat protective measure after the 1992 accident at Quantico. This sleeve was later removed when the permanent fixes were installed in the aircraft nacelle to reduce the probability of hot air reaching the shaft in the event of an

¹ AV-8B Risk Management Process Review, an Independent Assessment by Fulton Corporation, dated 31 May 1999.

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engine fire. Apparently, the crew chiefs had grown to appreciate the risk mitigation offered by the sleeve, and they had concerns when modified aircraft arrived without a sleeve and with little or no explanation at their level. Another example was the information received by the squadron that their aircraft probably would not be retrofitted with new crashworthy sponson-mounted fuel tanks, while other squadrons would have the new tanks installed at the factory. This expressed concern probably overstates the problem, but armed with limited information, the Marines were rightfully troubled.

Finally, the Panel heard from several sources that the relationship between the developmental and operational test pilot communities was less than cooperative; causing an environment that was not always conducive to good communications. Part of that problem is an apparent long-standing prohibition by OPTEVFOR of sharing all but the most serious information with NAVAIR during the conduct of OPEVAL. Such things as hardware failures and maintenance problems are held for months before being relayed to the developers. Further, there has been a historic problem throughout Marine Corps tactical aviation with operators failing to write hazard reports (HAZREPs) for close calls, minor incidents, etc. These things are usually a judgment call, and in the press of operations, often operators do not bother with the HAZREP because there was no injury or damage. At the very least, these communications problems can be frustrating to the engineering and aviation safety community and their efforts to improve the aircraft.

Conclusion: There is not enough communication of engineering change activities from the engineering community to the operators and visa versa, considering the state of the V-22 in its development and introduction.

Recommendation: Supplement the standard formal reporting to and from the Osprey Support Center with informal feedback to facilitate the exchange of information to and from the operators.

Another area of concern revolves around the maintenance department and the challenges that it faces in dealing with the new IETM electronic publication system, the AMEGS, and the new NALCOMIS (Optimized) reporting system. These systems would be a challenge to introduce to a well-established legacy aircraft, but trying to develop them while introducing a new aircraft has turned out to be something more. Again, the communications systems for all of these areas are established and working, but the operational maintainers involved are not necessarily updated on the status of their anomaly and deficiency reports until much later than would be the case if they were active participants in a development test program.

Other areas of concern are late delivery of the ground maintenance training system and the overall uncertainties of the program exacerbated by the ongoing limited distribution mishap, JAG, and IG investigations and press speculation.

It was clear to the Panel that both the Program Office and Bell Boeing are aggressively working to resolve all of the issues that were addressed by the squadron and that they are trying to touch the operators through an actively engaged OSC. However, the squadron personnel are not adequately being informed of the status of relevant issues (particularly

safety-related issues) in a timely manner. In a well-established operational squadron environment, the formal communications links and reports are generally adequate for their purpose. For an aircraft system at this stage in its development, and with this level of uncertainty for its immediate and long-term future, there is a need to keep the participants “in the loop” to a greater extent than the formal reporting systems would allow. More informal updates, factory visits by the operators (some already completed at this writing), and frequent squadron visits by the engineers and managers would help. Eventually, when the aircraft is flying, and the Marines and Airmen are busy training and building new squadrons, this need for extraordinary communications will subside, and, with the possible exception of the system safety program, the formal reporting system should suffice.

The maintainers of VMMT-204 gave the OSC high marks for the cooperation and support provided to them. Both the Government and Bell Boeing need to be more proactive in utilizing the OSC as a conduit to VMMT-204. In addition, the OSC should act as a conduit for the vetting of VMMT-204 concerns to both organizations. They probably will not be able to step beyond normal reporting by themselves; they will need program and contractor management help.

Conclusion: The Osprey Support Center appears to be an appropriate vehicle to improve the communications flow throughout the operations and engineering and support community,

however,

Conclusion: The management attention provided by the contractors appears to be at too low a level, and the feedback for operational problems is too limited and slow.

Recommendation: Both the Government and Bell Boeing should increase the management visibility of the Osprey Support Center and decrease the turnaround time for relevant problem-resolution status.

Recommendation: Bell and Boeing CEOs, the V-22 Program Manager, and the Joint Program Office meet monthly to review program status until the current concerns are resolved.

4.4 PROGRAM DEVELOPMENT RESERVES

The V-22 Program lacked funding reserves to address unexpected contingencies during development. Design maturity was effectively delayed because needed changes could not be made during development and were deferred to production. In addition, reserves during early production were insufficient, thereby delaying design maturity further. (See Subsection 4.6 Engineering Production Changes.)

Resources to address unforeseen and unforeseeable circumstances that occur, even in the best-managed development programs, are required or design maturity is effectively deferred to the production phase. Additional reserves during the development phase are much more efficient since changes can be made quickly and do not force costly

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production cut-ins and even more costly retrofit. The complexity of the V-22 aircraft also suggests that a higher level of reserves is required.

The Navy's unwritten budget policy for development is to cut any management reserves from any budget requests prior to submission to the Office of the Secretary of Defense. Since there is a 2-year window to obtain additional resources through the traditional budget process, the program went through significant program restructures to accommodate shortfalls. These shortfalls resulted in such actions as modified training devices and deferred spares and logistics support. CV-22, which is still in development, is still not fully funded to the current estimate and does not have any development reserves.

Conclusion: Reserves are needed to address unknowns for even the best managed programs. No reserves for V-22 development and early production resulted in a lack of design maturity commensurate with proposed full-rate production in December 2000. CV-22 probably will have some unknown contingencies arise that are not funded.

Recommendation: A funding reserve should be provided and protected during the DoD budget process for unknown contingencies for CV-22 development and to address the additional design and development and the Development Maturity Phase recommended by the Panel.

4.5 CV-22 BLOCK 0 DEVELOPMENT

In December 1994, the Deputy Secretary of Defense specified the funding responsibilities for the V-22 Program. The Navy would fund MV-22 development and production. The Navy also would fund CV-22 development with no cost limit specified. The Air Force would fund the basic MV-22 airframe. The United States Special Operations Command (SOCOM) would fund CV-22 special operations forces unique equipment.

On April 4, 1997, the Under Secretary of Defense for Acquisition and Technology approved the Navy's request to enter low-rate initial production and associated documentation. In addition, future production decisions were delegated to the Navy.

The Navy and SOCOM negotiated an agreement that split the JORD requirements into a baseline CV-22 aircraft needed for Initial Operational Capability (IOC) and the replanned product improvement program (now Block 10, which SOCOM accepted as its responsibility). In November 1997, the Navy and SOCOM signed an agreement whereby the Navy agreed to fund the CV-22 development effort for the Block 0 program to a maximum amount of \$560 million (raised from \$550 million). CV-22 Block 0 EMD projected cost increases are estimated at \$657 million, or \$97 million over the cap. The Program Manager projects that the funding cap will be exceeded by June 2002, with no source for additional funds identified.

Conclusion: The funding cap restricts accomplishment of minimal essential requirements for Initial Operational Capability. If the cap is removed, funding responsibility must be identified. Because the aircraft is currently grounded and the monthly spending rate has slowed, the program is vulnerable to funds migrating to other

Service programs. If this occurs, funds may not be available to complete necessary work recommended by this Panel.

Recommendation: Remove the CV-22 Block 0 funding ceiling and fund at the required levels. Retain the funds in the program until the Secretary of Defense considers the Panel's specific recommendations.

4.6 ENGINEERING PRODUCTION CHANGES

If the aircraft design does not mature in development (see previous issue on Funding Reserves in Development), aircraft modifications in LRIP aircraft will be necessary and more extensive. The Department of the Navy typically allows 2 percent of the program budget for engineering changes at mature production, with higher rates allowable prior to that point. Mature production is usually defined as the point at which full-rate production is initiated. The 2 percent rate does not consider the complexity of the aircraft system and the changes required based on fleet or production line experience. The budget allowance for V-22 production engineering changes in the first four LRIP lots was less than 1 percent (cumulative rate).

Additionally, in order to modify a fielded MV-22 (retrofit), a separate funding line (Aircraft Procurement Navy-5) and full funding is required. To date, neither the funding line nor the funds has been established. Since CV-22s are not in production, retrofit is not an issue at this time; however, CV-22 will need to avoid this same problem.

Conclusion: Engineering changes have not been adequately funded during LRIP. Temporarily reducing the production rate to a minimum sustaining rate would free up funds for further development efforts. It also would allow engineering changes to be incorporated into the production line as soon as possible. However, reducing aircraft allows the funds to be vulnerable to other Service priorities. If this occurred, the funds would not be available for further development efforts.

Recommendation: Temporarily reduce production to a minimal sustaining rate until both the aircraft design and manufacturing processes mature. Funds generated by this reduction in aircraft should be protected in the DoD budget and made available for a Development Maturity Phase and increased production engineering changes. (See subsection 4.8 Program Funding).

Conclusion: Aircraft retrofit of fielded aircraft will be required for MV-22 and CV-22.

Recommendation: Establish an Aircraft Procurement Navy-5 funding line and provide funds. Assure that CV-22 retrofit is covered with funding line and funds, as appropriate.

SECTION 2: SPECIFIC FINDINGS

4.7 SPARES AND LOGISTICS SUPPORT PLANNING AND PROVISIONING

The V-22 aircraft provides a significant advancement in warfighting capability. However, the introduction of this technology into the military logistics system must be supported with adequate spare parts and support. The adverse impact of inadequate spare parts on readiness was demonstrated during OPEVAL, as components failed at higher rates than predicted and spare parts levels were inadequate. Lack of replacement parts for frequently failed components resulted in delivery delays to the users and/or cannibalization of other aircraft on the production line at Amarillo, Texas, to support Operational Evaluation and recently the operational training squadron. The initial support allowance list was projected at approximately 1,600 components. The current spare parts requirement now stands at more than 6,000 components.

More than \$700 million in spares funding was reduced in the out years by allowing five amphibious ships to share two sets of V-22 spares. A Naval Center for Cost Analysis (NCCA) independent cost estimate for spares, including those spares budgeted in the Navy Inventory Control Point account, was roughly \$840 million ("then-year" dollars) higher than the Navy Fiscal Year (FY) 2002 Budget Estimate Submission for FY 2001 through FY 2013. The NCCA estimate did not take into account any sharing of spares aboard ship, but rather, estimated spares based on a percentage of recurring flyaway cost after examining historical spares costs on other Navy rotary and fixed-wing aircraft.

In addition, the NCCA assessment of logistics support (other than spares) was roughly \$550 million (then-year dollars) higher than the Navy FY 2002 Budget Estimate Submission in support cost for FY 2001 through FY 2013. This included training equipment, technical publications, and other Integrated Logistic Support (ILS) and Government Production Engineering Support. These estimates were based on examining historical ILS costs on Naval rotary and fixed-wing aircraft as a percentage of recurring flyaway adjusted to reflect MV-22 unique program requirements (e.g., power by the hour vice tradition engine depot rework).

The Navy routinely funds spare parts to a level of approximately 85 percent of the program manager's requirement. The rationale for the Navy's approach is twofold: 1) a high level of unique spare parts that are redesigned or replaced result in excess unusable inventory, and 2) assumed commonality between platforms could yield cross-program efficiencies. However, the Navy's approach does not take into account the introduction of a new technology or capability. As the year progresses and actual rates develop, the Navy can and does supplement programs in need. In fact, the V-22 Program has received 100 percent of its requested funds based on the Navy's spares model, albeit later than needed. The problem is that actual spares requirements have tended to be higher than predicted by the model.

Conclusion: Production line experience and field data collected at VMMT-204 indicate that spare-parts availability was inadequate to sustain fleet operations.

Conclusion: The independent cost estimate by the Naval Center for Cost Analysis indicates that planned funding for spares and logistics support in the out years is

insufficient.

Recommendation: Fund spare-parts levels and logistics support based on the results of the independent cost estimate and actual experience to date.

Recommendation: Fund additional engineering change proposals to improve reliability and to reduce spare parts requirements.

4.8 PROGRAM FUNDING

V-22 PROGRAM COST

In the FY1996 President's Budget submission, the Department of Defense increased its total funding commitment from \$6.6 billion (which did not include production) to \$52.9 billion. This change added 523 total aircraft, including 425 for the Marine Corps' MV-22 variant, 50 for the Special Operations Command's CV-22 variant, and 48 for the Navy's HV-22 variant.² Although this was a large investment by any measure, much of the required funding was outside the Future Years Defense Program period (FY 1996 – FY 2002) that was under consideration at that time.

The FY 2001 President's Budget (the most current budget approved by Congress) is substantially less, at \$38.1 billion. This reduction was primarily in procurement and was due to the lowering of the inflation indices in the FY 1997 President's Budget, a reduction of 65 aircraft in the FY 1999 Quadrennial Defense Review (QDR), and aggressive cost-reduction efforts.³

The savings attributed to lower Office of Management and Budget (OMB) inflation indices are substantial at over \$6 billion. Recent experience negotiating the FY 2001 production contract, currently on hold, suggests that these indices are optimistic and that contractors are experiencing significantly higher rates (5 percent versus 2 percent for Office of Management and Budget). The above factors and aggressive cost reduction efforts resulted in a reduction in average procurement unit cost from \$87.9 million in the FY 1996 President's Budget to \$67.3 million in the FY 2001 President's Budget (composite unit cost in then-year dollars of all variants). This was a significant unit cost reduction, particularly when logic would suggest that the QDR reduction of 65 aircraft would increase the average unit cost.

Yearly budget execution is another matter. In FY 2000, two V-22 aircraft were deferred annually from the planned procurement profile in order to award the FY 2000 procurement contract within the budgeted dollars. This slide in aircraft to the out years

² Comparison of December 1993 and December 1994 Selected Acquisition Reports (SARs).

³ Comparison of December 1994 and December 1999 SARs.

Section 2: Specific Findings

resulted in an increase in the total procurement program of almost \$900 million.¹ A similar deferral of aircraft annually and increase in total procurement would have been required to award the FY 2001 procurement contract with the available FY 2001 budget dollars. These FY 2001 potential increases were primarily due to: higher inflation and rates recently negotiated by the Defense Contract Management Command, a reduction in the anticipated learning curve efficiencies, and increased content. Based upon the reliability and maintainability issues discussed in earlier sections of this report, the Panel believes the program is not mature enough for full-rate production or operational use. The Program should restructure by reducing production to a minimum sustainable level in order to provide funds for a Development Maturity Phase. This approach will also keep the number of aircraft requiring retrofit of any changes to a minimum. This Development Maturity Phase should be characterized by a phased approach to return to operations, including flight readiness reviews before each phase. To begin the Development Maturity Phase, the FY 2001 quantity must be reduced, and a congressional reprogramming request will be required to convert those procurement dollars to Research Development Test and Evaluation (RDT&E) dollars. The FY 2002 procurement quantity also must be reduced and converted to RDT&E, ideally in a revised FY 2002 President's Budget submission.

COST OF ALTERNATIVES

As mentioned in Subsection 1: The Need for the V-22, the Panel reviewed past studies, all of which compared the V-22 with existing aircraft or notional upgrades to existing aircraft. The Panel members were unaware of any future design ideas that could be considered reasonable alternatives nor did they review any Defense Advanced Research Projects Agency (DARPA) studies or Special Access Programs. Previous studies of alternatives for the stated mission of the V-22 have consistently shown that the V-22 capabilities exceed those of the alternatives. However, it is also consistently the most expensive. Table 7 shows a cost comparison of the V-22 with other potential helicopter alternatives.

Aircraft	Average Unit Flyaway Cost FY 2001 Constant \$ M
MV-22	\$47.6 – \$51.4
CH-53 (Upgraded)	\$42.8 – \$43.3
CH-53E	\$36.3 – \$37.1
EH-101	\$33.8
S-92	\$25.2 – \$27.2
UH-1Y	\$9.4 – \$10.0
CH-60	\$20 – \$22

Note: Currently the Office of the Secretary of Defense, Program Analysis and Evaluation Division, is updating the analysis of alternatives to the V-22. These cost data presented are consistent with their ongoing analysis.

Table 7: MV-22 and Possible Alternative Costs

¹ Comparison of December 1998 and December 1999 SARs.

The lower cost for the MV-22 is the baseline program (Milestone III, December 2000). The upper limit assumes a restructured program that slows production for several years to allow for additional design iterations and testing. The V-22 sunk cost is approximately \$12 billion in then-year dollars through the end of 2001.

CH-46E and CH-53D alternatives are not shown because reintroducing these aircraft into production is not feasible. They are out of production and the alternatives described above are already in production or minimal efforts would be required to get them back into production.

To complete its look at alternatives, the Panel also reviewed a recent DoD assessment on the industrial base implications of V-22 cancellation. While not a factor in the Panel's conclusions, the analysis showed that Bell U.S. operations would be the most seriously impacted should the program be canceled. Not only would cancellation put the viability of Bell's Fort Worth and Amarillo facilities in doubt, it could be prohibitive to their ability to remain in the military helicopter market. V-22 is very important to the Boeing Philadelphia facility, where cancellation would cause a loss of capability and result in a very strong dependence on the Comanche program for continued viability. V-22 termination would also likely create discrete supplier base issues—particularly for those that rely on V-22 for a large percentage of their business base. A review should be done to ensure that technologies important to other DoD programs are not lost. Finally, at facilities doing both V-22 and other DoD work, the cost (primarily due to increased overhead apportionments) of these other DoD programs will increase. The effects of the Panel's recommended restructure will have to be evaluated in more detail by the Department.

Conclusion: The V-22 is the most expensive option; however, it is also the most capable and the only alternative that is capable of performing all of the stated missions of both the Marine Corps and Special Operations Command.

Recommendation: Proceed with the V-22 Program as the best alternative for the stated mission need.

Conclusion: Reducing yearly production rates and sliding aircraft to the out years allows the program to proceed without impacting other near-term DoD priorities; however, deferral of aircraft and a lower yearly profile will cause the total program procurement cost, and resulting average unit procurement cost, to increase substantially.

SECTION 2: SPECIFIC FINDINGS

Recommendation: To address the specific actions identified in this report, temporarily reduce the production rate to a minimum sustainable level and reprogram funds that are freed to the Research, Development, Test, and Evaluation account to apply to the Development Maturity Phase and increased production engineering changes. Incorporate resulting changes into the production line as early as possible. Funds generated by this reduction in aircraft should be protected in the DoD budget.

Conclusion: Higher production rates in the out years, coupled with multiyear procurement, could offset the additional cost of deferring aircraft to later years.

Recommendation: Once the Development Maturity Phase is complete, establish a maximum economic production rate and buy out the remaining aircraft with firm, fixed-price, multiyear procurements to help recover total program cost and schedule.

SECTION 3: SUMMARY CONCLUSIONS AND RECOMMENDATIONS

The need for a capability of the type the V-22 was designed to satisfy appears to be justified, and by its demonstrated performance, the V-22 has shown unique potential to meet that need. There is no evidence that the V-22 concept is fundamentally flawed; however, the aircraft is not ready for operational use in a number of key respects, chief among them system reliability and maintainability.

At this point, the soundest management approach for the V-22 Program is to restructure the program by temporarily reducing production to a minimum sustaining level while simultaneously initiating a Development Maturity Phase. Until completed, restrictions should be placed on operations. Passenger flights, night operations, and selection of aircrew all should be limited until the phase has progressed to the point where known risk issues have been properly addressed and confidence in the maintenance program has returned. The Development Maturity Phase should be initiated immediately and substantially completed prior to significant production or deployment.

The Development Maturity Phase should consist of subphases with a flight-readiness review by high-level Government and contractor leaders for each stage of operations (developmental flight test, operational flight test, training squadron operations, and start and deployment of the first tactical squadron). The Development Maturity Phase should focus on the following factors:

NEED

Summary Recommendation: Validate and prioritize requirements; delete those that are invalid or that rank poorly in cost/ benefit terms.

SAFETY

Summary Recommendation: Improve reliability, then verify by extensive test/fix/test in challenging environments.

Summary Recommendation: Expand safety risk assessments to include off-nominal conditions, with emphasis on flight control software, and hydraulic and power train systems. Retrofit crashworthy fuel cells into all operational aircraft.

SECTION 3: SUMMARY CONCLUSIONS AND RECOMMENDATIONS

Summary Recommendation: Extend high-rate-of-descent testing, formation flying (and other deferred flight tests as appropriate) to sufficiently define and understand the high-risk portion of the flight envelope under all appropriate flight conditions. Add a VRS cockpit warning system and appropriate simulator training.

Summary Recommendation: Make the flight manuals correct, explicit, and simple.

OPERATIONAL EFFECTIVENESS AND SUITABILITY

Summary Recommendation: Fix the existing maintenance publications system or adopt a new approach, such as the system currently being used by the F-18 or the one planned for the H-1 upgrade program.

Summary Recommendation: Provide better physical access to obstructed areas for inspection and maintenance by ground crews, and substantially refine the diagnostics system.

Summary Recommendation: Explore the suitability and limitations of the aircraft in such activities as tactical formation approaches, fast roping, and desert/night operations.

PROGRAMMATICS

Summary Recommendation: Proceed with the V-22 Program, but temporarily reduce production to a minimum sustaining level to provide funds for a Development Maturity Phase and keep to a minimum the number of aircraft requiring retrofit.

Summary Recommendation: Implement a phased approach to return to operations with flight-readiness reviews before each phase.

Summary Recommendation: Purchase adequate spares and logistics support.

SECTION 3: SUMMARY CONCLUSIONS AND RECOMMENDATIONS

Summary Recommendation: Establish sufficient funding reserves to permit the Program Office to deal with unforeseen and unforeseeable circumstances without disrupting the entire flow of the program.

Summary Recommendation: Increase formal and informal feedback among all members of the V-22 team.

Summary Recommendation: Initiate monthly executive-level program management meetings and continue throughout the Development Maturity phase. These meetings should involve the CEOs of both Bell and Boeing, the Navy Program Manager, representatives of the users (USMC and USSOCOM), and the Joint Program Office Director. Action items should be assigned and monitored.

APPENDIX A –
CHARTER AND MEMORANDUM FROM THE
SECRETARY OF DEFENSE



OFFICE OF THE UNDER SECRETARY OF DEFENSE
3000 DEFENSE PENTAGON
WASHINGTON, DC 20301-3000

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[Signature]

MEMORANDUM FOR SECRETARY OF DEFENSE
DEPUTY SECRETARY OF DEFENSE

THROUGH: UNDER SECRETARY OF DEFENSE (ACQUISITION
TECHNOLOGY AND LOGISTICS)
PRINCIPAL DEPUTY UNDER SECRETARY OF DEFENSE *q/b*
(ACQUISITION, TECHNOLOGY AND LOGISTICS)
DIRECTOR, DEFENSE RESEARCH AND ENGINEERING

FROM: DIRECTOR, STRATEGIC AND TACTICAL SYSTEMS *Hans Mark 1/3/01*
[Signature]
Approved by: Deputy Director, Land Warfare
Prepared by: Gary Gray/DOUSD(A&TYS&TSLW/January 3, 2001/1697-0638

SUBJECT: V-22 Review Panel Charter

PURPOSE: To obtain your approval of the charter.

DISCUSSION:

- On December 15, because of the V-22's accident history and other testing issues, you appointed an independent high-level panel to review of the program. (Tab B)
- General John R. Dailey (USMC Retired) will serve as panel chair. Norman R. Augustine, General James B. Davis (USAF Retired), and Dr. Eugene R. Covert will be the other members serving on the panel.
- Attached is the charter that establishes the panel, subject to the Federal Advisory Committee Act requirements for filing and publication of the charter.

COORDINATION: ARA; Comptroller; Legislative Affairs; Director, Administration and Management; and General Counsel concur. See Tab C.

RECOMMENDATION: Approve the attached charter at Tab A.

SECDEF Decision:
[Signature] Approved **SECDEF HAS SEEN**
_____ Disapproved **JAN 5 2001**
_____ Other: _____



14717-2001

CHARTER
PANEL TO REVIEW THE V-22 PROGRAM

A. Official Designation: Panel to Review the V-22 Program

B. Objective and Scope of Activity: Conduct an independent, high-level review of the V-22 program to include safety of the aircraft and recommend any proposed changes or corrective actions, and report the results to the Secretary of Defense. The panel shall comply with the Federal Advisory Committee Act (FACA), as amended, 5 USC, App. II, and DoD Directive 5105.4, the "DoD Federal Advisory Committee Management Program."

C. Period of Time Required: It is estimated that the panel members will take three-to-four months to complete their work.

D. Official or Sponsoring Proponent to Whom the Committee Reports: Secretary of Defense.

E. Support Agency: The Under Secretary of Defense for Acquisition, Technology, and Logistics will provide the Designated Federal Official, who will also serve as Executive Secretary for the Panel. The Secretaries of the Military Departments, Chairman of the Joint Chiefs of Staff, and Director, Administration and Management, will provide cooperation and assistance to the panel as it carries out its review.

F. Duties and Responsibilities: The panel should address the following factors, as they affect strategy and combat effectiveness:

- Training
- Engineering and design
- Production and quality control
- Suitability to satisfy operational requirements
- Performance and safety of flight

G. Membership. The panel will be composed of four members. General John R. Dailey (USMC Retired) will serve as panel chair. Mr. Norman R. Augustine, General James B. Davis (USAF Retired), and Dr. Eugene E. Covert will be the other members serving on the panel. All members have substantial expertise, knowledge, and experience necessary in matters related to the V-22 review. Travel and per diem entitlements will be honored as prescribed in Chapter 57, Title 5 U.S.C.

H. Estimated Annual Operating Costs in Dollars and Work-Years: It is estimated that total cost for travel, per diem, consultant fees, and staff support will not exceed \$600,000 and 1.0 staff-years.

I. Number of Meetings: The Panel will meet as often as necessary to fulfill its responsibilities within the three-to-four month time frame.

Termination Date: Thirty days after submission of the report of the Panel

Date Charter is Filed:



THE SECRETARY OF DEFENSE
1000 DEFENSE PENTAGON
WASHINGTON, DC 20301-1000

DEC 15 2000

MEMORANDUM FOR GEN (RET) JOHN R. DAILEY, USMC
MR. NORMAN R. AUGUSTINE
GEN (RET) JAMES B. DAVIS, USAF

SUBJECT: Review of the V-22 Program

On December 11, 2000, an MV-22 crashed, killing all 4 Marines on board. The cause of the accident is unknown at this time. The V-22 has experienced three other accidents since 1991. The Marine Corps suspended flight operations and requested a delay of the full-rate production decision until the cause of the most recent accident is fully understood.

The V-22 aircraft are intended to meet the Marine Corps amphibious and vertical assault mission, the Navy strike rescue mission, and the special operations needs of the Air Force and Special Operations Command (SOCOM). Variants of these aircraft will replace or supplement a range of aging platforms. As a result, the V-22 will make up a sizable component of our modernization program and warfighting capability.

The V-22's accident history and other testing issues necessitate that we undertake an independent, high level review of the program. You are hereby appointed to conduct this review, to include safety of the aircraft, and to recommend any proposed corrective actions. You should complete your review and report to the Secretary of Defense as soon as possible. Specifically, you should address the following factors, as they affect safety and combat effectiveness:

- ⇒ Training
- ⇒ Engineering and design
- ⇒ Production and quality control
- ⇒ Suitability to satisfy operational requirements
- ⇒ Performance and safety of flight

SIGNER'S COPY



By copies of this memorandum, I request the Secretaries of the Military Departments, Chairman of the Joint Chiefs of Staff, and Director, Administration and Management, to provide full cooperation and assistance to the panel as it carries out its review. I have asked General Dailey to serve as the Chair of the group. The Under Secretary for Acquisition, Technology and Logistics will provide an executive secretary for the panel.



cc: Secretary of the Army
Secretary of the Navy
Secretary of the Air Force
Chairman of the Joint Chiefs of Staff
Director, Administration and Management

APPENDIX B

PANEL MEMBERS AND STAFF BIOGRAPHIES

GENERAL JOHN R. DAILEY

John R. (Jack) Dailey, retired United States Marine Corps general and pilot, assumed the duties of director of the National Air and Space Museum in January 2000. General Dailey comes to the Museum from the National Aeronautics and Space Administration (NASA), where he had been the Associate Deputy Administrator since retiring from the United States Marine Corps in 1992. At NASA, he led the Agency's reinvention activities.

His career in the Marine Corps spanned 36 years and included extensive command and staff experience. He has flown over 6,000 hours in a wide variety of aircraft and helicopters. During two tours in Vietnam, he flew 450 missions. He was promoted to the rank of general and named Assistant Commandant of the Marine Corps in 1990. He has numerous personal decorations for his service in the Marine Corps and NASA.

While at NASA, General Dailey served on the President's Management Council, co-chaired the Aeronautics and Astronautics Coordinating Board, and was a national delegate to the Research and Technology Organization supporting NATO. He also serves as national commander of the Marine Corps Aviation Association and is a member of the Early and Pioneer Naval Aviators Association ("Golden Eagles").

General Dailey was born on February 17, 1934, in Quantico, Virginia, and earned his Bachelor of Science degree at the University of California, Los Angeles, in 1956. He and his wife, the former Mimi Rodian of Copenhagen, Denmark, live in Fairfax, Virginia. They have two grown children, Lisa Bader and Nils Dailey.

HONORABLE NORMAN R. AUGUSTINE

Norman R. Augustine was born in Colorado, attended East Denver High School and Princeton University where he graduated with a BSE in Aeronautical Engineering magna cum laude, an MSE, and was elected to Phi Beta Kappa, Tau Beta Pi and Sigma Xi. He holds honorary doctorate degrees in a variety of fields from many colleges and universities.

Beginning in 1965, he served in the Pentagon in the Office of the Secretary of Defense as an Assistant Director of Defense Research and Engineering. Joining the LTV Missiles and Space Company in 1970, he served as Vice President, Advanced Programs and Marketing. In 1973 he returned to government as Assistant Secretary of the Army and in 1975 as Under Secretary. Joining Martin Marietta Corporation in 1977, he served as Chairman and CEO from 1988 and 1987, respectively, to 1995, having previously been President and Chief Operating Officer. He served as President of Lockheed Martin Corporation upon the formation of that company in 1995, and became Chief Executive Officer on January 1, 1996, and later Vice Chairman and Chairman. He served as President of Lockheed Martin Corporation upon the formation of that company in 1995 and became Chief Executive Officer on January 1, 1996, and later Vice Chairman and Chairman. Mr. Augustine is Chairman and Principal Officer of the American Red Cross, is a former member of the Policy Council and Chairman of the Education Task Force of the Business Roundtable and a former Chairman of the National Academy of Engineering.

Mr. Augustine is co-author of *The Defense Revolution* and *Shakespeare In Charge* and author of *Augustine's Laws* (printed in four languages) and is listed in *Who's Who in America* and *Who's Who in the World*. He is married to the former Meg Engman of Stockholm, Sweden, and they are the parents of a son, Greg, an electrical engineer, now deceased, and a daughter, René, an attorney serving as Counsel to the Senate Judiciary Committee and married to Mark Alanic, an investment banker and former NBA player.

GENERAL JAMES B. DAVIS

In August of 1993, General J. B. Davis concluded a 35-year career with the United States Air Force as a combat fighter pilot, commander and strategic planner and programmer. He has served as a commander of a combat fighter wing, of the U.S. Air Force's Military Personnel Center, Pacific Air Forces, and United States Forces Japan. On the staff side, he served as the Director and Programmer of the U.S. Air Force's personnel and training, Deputy Chief of Staff for Operations and Intelligence Pacific Air Forces, and served his last two years on active duty as the Chief of Staff, Supreme Headquarters Allied Powers Europe (NATO).

During his military career he has had extensive experience in operations, intelligence, human resource management, and political/military and international affairs. He has commanded a nuclear capable organization of about 6,000 personnel and a joint service organization of about 60,000 personnel and several sizes in between.

After retirement from the military, General Davis has remained involved in his area of expertise, lecturing and speaking on international and aviation affairs. In February 1995, General Davis was nominated by the Speaker of the House of Representatives and confirmed by the Senate to sit on the Presidential Base Closure and Realignment Commission that reviewed the Secretary of Defense's closure list for 1995. In July 1995, the commission sent recommendations to the President Clinton, which were accepted and became law. Additionally, General Davis served on the Congressional Commission on Servicemember's and Veteran's Transition Assistance (The Dole Commission.) He is currently the president of a Japanese corporation and is the CEO of the American subsidiary. He served as the "Safety Czar" for Value Jet Airlines and continues to assist commercial airlines in strategic planning.

General Davis has a BS degree in Engineering from the U.S. Naval Academy, a Masters degree in Public Administration from Auburn University at Montgomery, has attended multiple professional schools and is a National Defense University Capstone Senior Fellow.

DR. EUGENE E. COVERT

Dr. Eugene E. Covert attended the University of Minnesota and earned his Bachelor of Aerospace Engineering and Master of Science degrees. He was awarded the Sc.D. from the Massachusetts Institute of Technology (MIT).

He currently serves as the Director of the MIT Center for Aerodynamic Studies and the Wright Brothers facility. He is the T. Wilson professor emeritus in the Department of Aeronautics and Astronautics at MIT. From 1952 to 1996 he has held positions as T. Wilson Professor of Aeronautics, MIT, Professor, Department Head, Associate Professor, Research Engineer and Associate Director. He has had a long and distinguished career in MIT.

Dr. Covert was Chairman (1982-1986) of the USAF Scientific Advisory Board, member of the NASA Aeronautics Advisory Committee (1985-1989), Vice Chairman and Chairman of the Aeronautics and Space Engineering Board (1988-1990), and National Research Council Committee on NASA Program Changes (1981 to present).

In addition to being the chief scientist of U.S. Air Force, Dr. Covert has also served as Chairman of the Air Force Scientific Advisory Board, as a member of the NASA Aeronautics Advisory Committee, and as Chairman of the AGARD Power and Energetics Panel.

He has served as a consultant for the Defense Science Board (1987-1994), Hercules Aerospace Corporation (1963-1994), Alliant Technology (1997-1998), Sverdrup Technology, Inc. (1976-present), United Technology corporation 1987-1990, Lockheed-Martin (1994-1997), TASC (1994-1998) and IDA (1995-present).

He is an honorary fellow of the AIAA, a Fellow of the Royal Aeronautical Society and the AAAS, and a member of the National Academy of Engineering. He is listed in *American Men and Women in Science*, *Who's Who in America*, *Who's Who in American Education*, *Who's Who in Science and Engineering*, and *Who's Who in the East*.

GARY J. GRAY

For almost 10 years, Mr. Gray has had oversight responsibility for DoD's high visibility rotary wing programs. Mr. Gray has considerable expertise in the Department of Defense's Planning, Programming and Budgeting System and participated in the 1997 Quadrennial Defense Review. In December 2000, Mr. Gray was assigned as Executive Secretary to the Secretary of Defense's high-level, independent Panel to Review the V-22 Program.

Mr. Gray moved to the Office of the Secretary of Defense (OSD) in the Office the Assistant Deputy Under Secretary for Land Warfare (in February 1989, as a participant in a Rotational Development Assignment). Since working in OSD, Mr. Gray's experience has broadened substantially. In addition to continuing his work on tank ammunition, he has expanded duties to include tactical missile systems, combat vehicles, tactical data systems and helicopter/tiltrotor systems.

He acquired technical management experience in 1978 as lead engineer for a 120MM kinetic energy tank round which was a cooperative effort with the Federal Republic of Germany (GE) and culminated in a successful Feasibility Demonstration in Germany within six months. Mr. Gray continued as Lead Engineer until accepting a systems engineering position as Program Director for the 105MM Tank Gun Enhancement Program for upgrading the M1 and M60A3 tank fleets. Mr. Gray transferred to the Office of the Project Manager for Tank Main Armament Systems in January 1983 as Deputy, and later, Senior Item Manager for the 105 Tank Gun Enhancement Program. Between these two roles, he contributed to the Type Classification of a new 120MM KE round, which was used extensively in Operation Desert Storm. In April 1988, he accepted the position as Senior Item Manager for the Armament Enhancement Initiatives Program where across-the-board responsibilities included programming and budgeting, streamlined acquisition and Congressional liaison.

Mr. Gray was born in Bayonne, NJ. His degrees include a Bachelor of Science in Mechanical Engineering in 1975 and a Master of Science in Management Engineering in 1979. Mr. Gray did his Master's thesis on *Management of a Producibility Study* based on his assigned responsibilities and practical experience. Both degrees are from the New Jersey Institute of Technology in Newark, NJ. Mr. Gray is married with two children and lives in Vienna, Virginia.

COLONEL CARL A. STEEL, USAF

Colonel Carl A. (Andy) Steel is Commander of the 305th Support Group, McGuire Air Force Base, New Jersey. As Commander, he is responsible for approximately 1,100 people and a \$2.2 billion physical plant consisting of 500 facilities and 1,900 family housing units. He directs the base civil engineering, security forces, services, communications, and mission support squadrons.

Colonel Steel was a distinguished graduate of the Pennsylvania State Reserve Officer Training Corps program in 1978 after receiving a Bachelor of Medical Sciences degree. He is a command pilot with over 3,000 flying hours in the UH-1N and the B-52H.

His degrees include: 1978 -Bachelor of Medical Sciences, Pennsylvania State University; 1981-Master of Business Administration, Troy State University; 1981-Squadron Officer School, Maxwell Air Force Base; 1991-Master of National Security and Strategic Studies, Naval War College; 1995-Air War College, Maxwell Air Force Base.

His assignments include: 1978 – 1979: Student, Undergraduate Helicopter Training, Fort Rucker, Alabama; 1979 - 1982: UH-1N pilot, Detachment 9, 67 Air Rescue and Recovery Service, Zaragoza AB, Spain; 1982 – March 1984: Instructor/Evaluator Pilot and Chief of Operational Analysis, 1550 Aircrew Training and Test Wing, Kirtland AFB, New Mexico; August 1984 – April 1985: Special Events Project Officer, Washington DC; April 1985 – April 1986: Executive Officer, Office of the Deputy Chief of Staff for Plans and Operations, Headquarters United States Air Force, Washington, DC; April 1986 – February 1987: Student, Fixed-Wing Qualification Program & Bomber Qualification Training, Combat Crew Training and Test Wing, Randolph AFB, Texas and Castle AFB, California; February 1987 – August 1990: Pilot/Flight Commander/Operations Officer, 20th Bomb Squadron, Carswell AFB, Texas; August 1990 – August 1991: Student, Naval War College, Newport, Rhode Island; August 1991 – August 1993: Deputy, Chief of Assignments, Air Force Colonel's Group, Pentagon; August 1994 – July 1995: Student, Air War College, Maxwell AFB, Alabama; July 1995 – June 1997: Commander, 85th Flying Training Squadron, Laughlin AFB, Texas; June 1997 – July 2000: Director, Manpower, Personnel, and Administration Directorate, Headquarters, United States European Command, Stuttgart, Germany; August 2000 – Present: Commander, 305th Support Group, McGuire AFB, New Jersey

COLONEL RAYMOND E. SCHWARTZ III, USMC

Colonel Raymond E. Schwartz III, USMC, was commissioned in June 1977 upon graduation from Fairfield University in Fairfield, Connecticut. He was designated a Naval Aviator in October 1979 and upon completion of initial training in the CH-46 Medium Assault Helicopter at MCAS New River in Jacksonville, North Carolina, was transferred to HMM-265 in Kaneohe, Hawaii, for service with the Fleet Marine Force. His subsequent assignments included tours at Marine Aviation Weapons and Tactics Squadron One (MAWTS-1) in Yuma, Arizona, from 1984-88; Operations Officer for HMM-165 from 1988-91 (Desert Shield/Storm); Air Officer for the 3rd Marine Regiment 1991-92; Air Command and Staff College 1992-93; Assistant for USMC programs and POM systems coordinator for the Director Air Warfare N88C 1993-96; Executive Officer and Commanding Officer HMM-263 1997-99; National War College 1999-2000.

Colonel Schwartz holds a Bachelor of Arts in Political Science from Fairfield University 1977; Masters in Political Science from Auburn University 1993, and a Masters in National Security Strategy from the National War College, 2000.

He is presently serving as the Deputy, Marine Aviation Plans, Policy and Budget Branch, HQMC.

BRYAN O’CONNOR

Mr. Bryan O’Connor has over 25 years in leadership and staff positions in aerospace operations, research and development and flight-test. As a Marine pilot, he performed duties as Aviation Safety Officer for the first U.S. Marine Corps Harrier squadron. He led the team that performed the first Navy Preliminary Evaluation of the YAV-8B, Harrier II prototype. He served as Deputy Program Manager (Acquisition) for the AV-8B Program at NAVAIRSYSCOM. He participated in two missions as a NASA Space Shuttle Pilot Astronaut. He founded and led the NASA Spaceflight Safety Panel. Upon retirement from the Marine Corps in 1992, he served as Deputy Associate Administrator for Space Flight and Director of the Space Shuttle Program. He led the team that redesigned the International Space Station. He accumulated over 5000 hours in over 40 types of operational and R&D fixed wing and VSTOL aircraft, and nearly six million miles in 253 orbits of the earth in the Space Shuttle. He is the recipient of several awards including the Distinguished Flying Cross and the NASA Distinguished Service Medal. Member of Marine Corps Aviation Association, American Institute of Aeronautics and Astronautics, Association of Space Explorers, and Society of Experimental Test Pilots.

Mr. O’Connor has a BS in Engineering, United States Naval Academy, 1968; an MS Aeronautical Systems, University of West Florida, 1970; he attended the Aviation Safety Officer Course; Naval Postgraduate School; and the Naval Test Pilot School, 1976. Other formal training includes various management courses at NASA, University of Houston and George Washington University.

He is currently a leader of Futron Corporation’s Washington, D.C. based Engineering Division, as well as the Aerospace Safety and Dependability Franchise. He is responsible for the technical content of the company’s system safety, reliability and technical risk management services. He served as program manager for U.S. Marine Corps aviation risk management studies in support of the Harrier Review Panel. He is a lead consultant on FAA Reusable Launch Vehicle Safety study. He was an advisor to DOE on nuclear safety issues, and to NASA on a variety of safety and risk management issues, including a major probabilistic risk assessment for the International Space Station.

APPENDIX C
PANEL FACT-FINDING ACTIVITIES

January 11 and 12, 2001	Fact-finding Briefings, Program Overview
February 26, 2001	Fact-finding Briefings, Mishap Briefings, New Readiness Reporting System
March 5-8, 2001	Fact-finding Trips
	V-22 Training Squadron, Marine Corps Air Station, New River, NC
	Special Operations Command, Tampa, FL
	Bell Helicopter, Fort Worth and Amarillo, TX
	Boeing Helicopter, Philadelphia, PA
March 9, 2001	Open Meeting: Public Comments
April 12 and 13, 2001	Fact-finding Briefings, Final Information Requests
April 18, 2001	Open Meeting: Panel Deliberations

APPENDIX D
INSPECTOR GENERAL MEMORANDUM FOR
CHAIRMAN



INSPECTOR GENERAL
DEPARTMENT OF DEFENSE
400 ARMY NAVY DRIVE
ARLINGTON, VIRGINIA 22202-4704

APR 30 2001

MEMORANDUM FOR CHAIRMAN, PANEL TO REVIEW THE V-22 PROGRAM

SUBJECT: Panel to Review the V-22 Program

This responds to your staff's verbal request of April 25, 2001, for information regarding the allegation that aircraft flight status records at the Tilt-Rotor Training Squadron 204, Marine Corps Air Station, New River, North Carolina, were falsified. Although our investigation is nearly complete, it remains active and therefore, I cannot provide you information concerning the results at this time. However, I have read the Panel's draft report and it is my opinion that none of the information gathered by the Panel contradicts information that we have independently developed during our investigation to date.

I trust you will find this information helpful to your review. Should you have any questions, please contact me or Mr. James L. Pavlik, (703) 604-8300.

A handwritten signature in cursive script that reads "Robert J. Lieberman".

Robert J. Lieberman
Deputy Inspector General

APPENDIX E
TOP TWELVE FLEET READINESS DRIVERS



24 April 2001

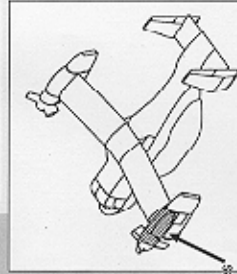
Top 12 Fleet Readiness Drivers



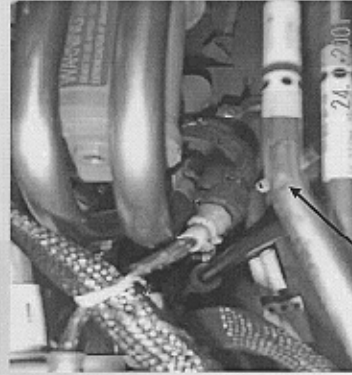
Nomenclature

- 1 Hydraulic Lines
- 2 ICDS Inspection
- 3 Constant Frequency Generator #1
- 4 EAPS
- 5 Click Studs
- 6 Swashplate Actuators
- 7 Mini-mark fasteners
- 8 Blade Fairings
- 9 Interface Units
- 10 Bonding Straps
- 11 IRS Transition Panel
- 12 Lower Crew Door

#1 Readiness Driver Hydraulic Lines



Location of
Chafed Tubes



Chafing

Background

- Chafing against electrical harnesses, clamps, baffles, structures, etc, primarily in the nacelles. This is driving excessive removal rates.

Issues

- Damage limits too conservative (?)
- Clearance requirements not always being met
- IETM.
- Tubes are not readily available in supply.
- O, I and D-levels do not have the capability to manufacture tubes.

Actions

- Lab examination of environment conditions for hydraulic line clamps.
- NAVAIR testing to expand damage limits.
- Review of clearance requirements in work. A/C 21, EI's, etc.
- Wrap hydraulic lines with teflon tape, centered around support clamp locations.
- Update IETM.
- Bell-Boeing will establish suitable substitute matrix for Rynglock end fitting replacements to welded end fittings.




#1 Readiness Driver Hydraulic Lines (Cont.)




Status 24 April 2001

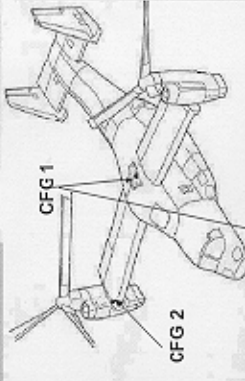
- Review data from Amarillo nacelle inspections.
- Test to evaluate environment conditions and permanent fixes on hyd line clamps-ECD May 02.
- Test to expand damage Limits - ECD Aug 03.
- Bell is working on IETM update for teflon addition - ECD May 01.
- MALS-26 to have manufacture capabilities - ECD May 01
- NADEP CP will have capability to manufacture tubes upon receipt of Bell-Boeing suitable substitute matrix and bend data.



#3 Readiness Driver

Constant Frequency Generator #1





CFM1

CFM2

Background:

- Two CFGs per aircraft provide AC power
- Only CFGs installed in position 1 are failing

Issues:


- Failure due to rain and possibly moisture
- Generator directly under hinge; rain water drips into Mid-Wing Gear Box (MWGB), falls onto the CFG and seeps into Generator Control Unit (GCU)

Actions:


- Interim: seal GCU via Accessory Bulletin
- Permanent: redesign internal components to prevent water related failures
- Seal access panel or divert rain water

Status: 24 April 2001


- Accessory Bulletin 912 released to the fleet
- Interim generator fix being implemented; all available generators are modified
- Contract in work for long term internal fix
- RAMEC to seal hinge tested in Amarillo; final evaluation pending water test report
- New vendor Lot 6 (more robust requirements)

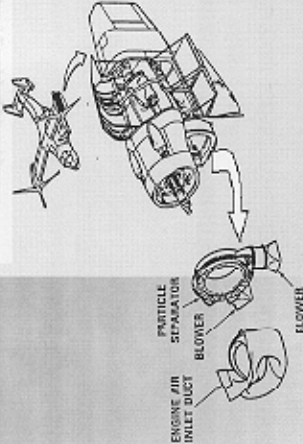


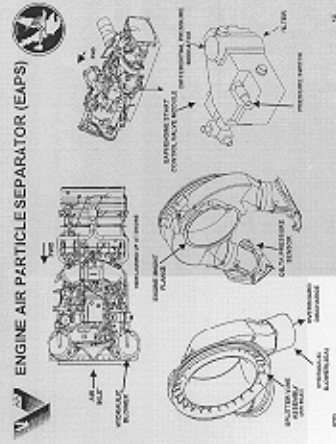
Looking forward above MWGB



#4 Readiness Driver EAPS Overview







Background

- High frequency of EAPS failure warnings
- Low reliability of EAPS blowers
- High frequency of shaft seal leakage

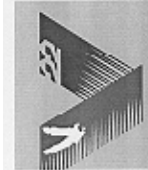
Issues

- Design discrepancies of internal blower motor parts
- Pneumatic delta-P sensors unreliable
- Shaft seal design under modification

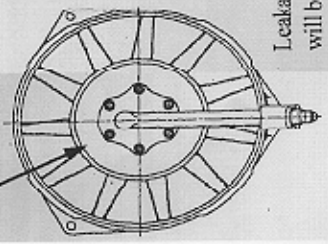
Actions

- Vendor has modified blowers to the "B" model to improve reliability
- "B" model is installed on fleet acft via AVB-908
- Pneumatic pressure switches to be replaced with hydraulic pressure switches (ECP V-22-0137)
- Shaft seal design improvements suggested in new "C" model, still under consideration

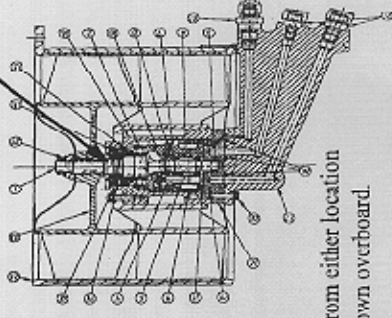
#4 Readiness Driver EAPS Status



Shaft seal leakage can exit blower from cover plate



Shaft Seal Leakage



Leakage from either location will be blown overboard.

Status: 24 April 01

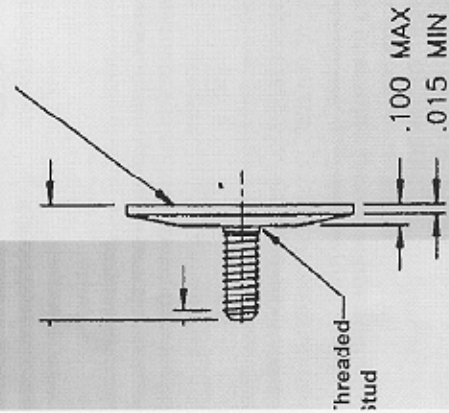
- Accessory Bulletin (AYB) 908 to replace unmodified blowers with reworked blowers that serial numbers end with "E" suffix has been released. AYB-908 complete on A/C 165433, 165435, 165437, 165438, 165439, 165441, 165442
- Awaiting Bell-Boeing proposal for funding and approval of ECP V-22-0187
- Proposed "C" shaft seal design change waiting authorization



5 Readiness Driver Clickstuds



Base



Background

- Clickstuds bonded to the structure to secure various items on the airframe (ie., acoustic blankets, wire bundles, etc.) are disbonding from structure.

Issues

- Manufacturing and field repair bonding quality.
- Field repair room temperature cures require 5-7 days.
- Fleet requests authorization to reposition clickstuds, when required.

Actions

- Improve factory and field bonding techniques.
- Evaluate room/low temp. & rapid curing repair adhesives.

Status: 24 April 2001

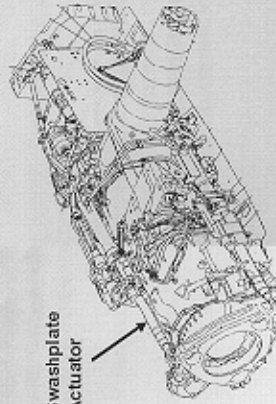
- Additional training for manufacturing and fleet repair personnel on adhesive bonding techniques.
- Ongoing evaluation of alternative materials.
- ERAC 42 released
- ADHG sets delivered to VMMT-204
- Clickstud repositioning currently requires Engineering disposition



#6 Readiness Driver Swashplate Actuator



FLIGHT CONTROL ACTUATORS



Swashplate Actuator

VIEW NO. UP383 MAGELLE
DATE: 10/2000 BY: [unreadable]

Background

- Swashplate Actuators experiencing hydraulic leaks and PFBIT failures

Issues

- Swashplate actuator leaks
- Discrepancy exists between the PFBIT and the Acceptance Test procedures.

Actions

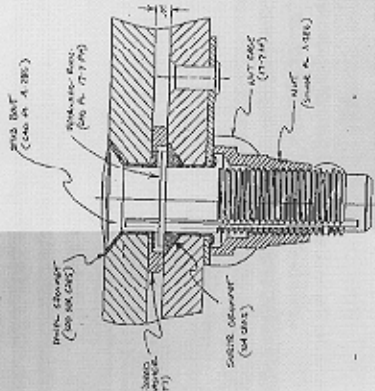
- Design Change to Dash 115 removes MCV dynamic seals for leakage improvements
- ERAC 39 increases LVDT PFBIT tolerances with an accompanying software change to supersede the ERAC workaround

Status 24 April 2001

- CCP 10716 authorized incorporation of improved -115 actuators for Lot 4 delivery
- PFBIT software change has been incorporated into FCC software version 12 and retrofit into version 11.3



#7 Readiness Driver Mini-Mark IV Fasteners



Typical Mini-Mark IV

Background

- Alternate fastener from FSD. However, high failure rate coupled with prodigious application is driving excessive maintenance

Issues

- Nutage and retaining ring failures
- High procurement/replacement cost
- FOD hazard

Actions

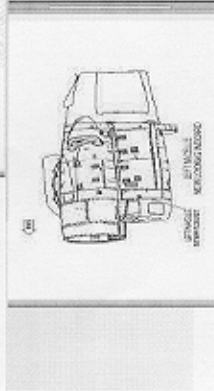
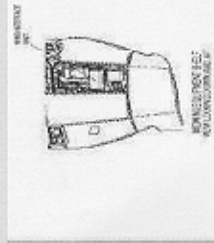
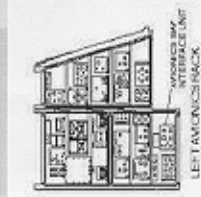
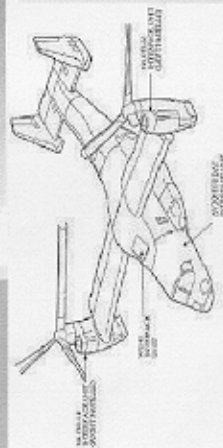
- Fairchild effort to improve fastener reliability
- Bell/Boeing study to reduce quantity of Mini-Mark IV and replace with standard fasteners
- SBIR to evaluate improvements and alternative designs

Status: 24 April 2001

- OEM and Bell/Boeing studies on-going
- SBIR in Phase I
- Reviewing alternatives from 01Mar01 mtg w/ Fairchild
- Fairchild, Bell-Boeing, FST and VMMT-204 met on 11 Apr 01 at Bell.



#9 Readiness Driver Interface Units



Background:

- IUs provide data bus interface for equipment not data bus compatible (MIL-STD-1553)
- Four IUs per aircraft (avionics bay, wing, 2 in nacelle)

Issues:

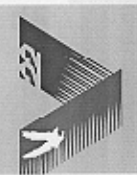
- Failures due mostly to internal Resistor Network (RN) failures
- IUs failures was assigned 1D RAC because failures could result in a safety of flight risk.
- Due to quality discrepancy in manufacturing process
- Results in moisture intrusion and component failure

Actions:

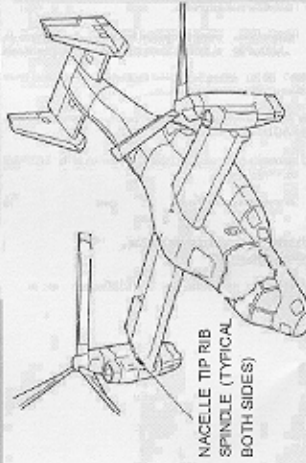
1. Vendor (Vishay) has been drop as the vendor.
2. Ohmcraft has been brought on as the new vendor because Network Resistor's manufacture by Ohmcraft have proven to be more reliable..
3. Boeing and Gov't to determined the method of which to retrofit the IUs.
 1. Replace RN that are flight critical and the rest by attrition.
 2. Perform a 100% retrofit of all IUs.

Status: 24 April 2001

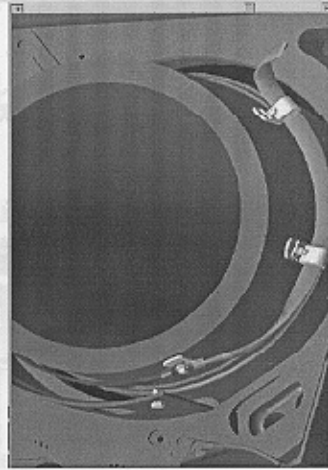
- Deliver improved IUs with new aircraft tail # not defined)
- ASB is in development to retrofit IUs with Ohmcraft resistors.
- Resistor networks will be replaced with a Discrete Resistor in A/C 52



#10 Readiness Driver Bonding Straps



NACELLE TIP RIB
SPINDLE (TYPICAL
BOTH SIDES)



Nacelle Tip Rib Spindle Straps

Background:

- Straps provide lightning path between the nacelle and wing
- Strap failures during OPEVAL and in Fleet
- Consumable items with no repairs
- FST provided procedures for straps for O-Level manufacture
- Performed EI (#WC2EI-V22-00-0162)
- Manufacture procedures developed for ALL bonding straps

Issues:

- Straps continue to fail
- Majority of failures pertain to 120-172 style straps

Actions:

- Short Term - FST provide authorization for shrink sleeve on terminal ends for manufactured and supply straps
 - Long Term - Investigate new material/design for straps. Investigate Bell Wiring be cog for straps instead of Airframes.
- Status: 24 April 2001**
- Investigating new material/designs and routing for straps as part as overall Nacelle Inspection task
 - Bell revising Bell Standard 120-172 to correct the usage of the wrong size terminal lug for width of straps



#12 Readiness Driver Lower Cabin Door



Background

- While in hover the lower main cabin door fell open.
- Investigation revealed that the flush latch and assembly was broken. Pins had retracted and door unlatched.

Issues

- Latch and handle assembly does not latch door securely.
- Upper door and lower door are difficult to close.

Actions

- EI request submitted by VMMT 204 to V22 FST.
- Preliminary EI response shipped exhibit to Boeing for engineering investigation.

Status: 24 April 2001

- Final Bell EI report complete.
- Design changes currently in work to change handle material, step material, relocate door fittings and add witness holes.
- Boeing and FST inspected all aircraft at VMMT-204 on April 4-5. Found seals interfering with closing doors, excessive force required to engage pins, tracks badly damaged, rivets pulling through in track, and spring to retract pins into door ineffective.
- Detailed report of findings expected week of 16 April.

APPENDIX F
JORD SUMMARY

JORD Requirements

(M)/ (C)/ (Y) Requirement

012 C The aircraft will have the ability to operate from air capable ships without reconfiguration or modification.

017 B The total time to execute a short notice launch shall be less than 60 minutes (T)/15 minutes (O) of mission receipt.

018 C Regardless of facilities available, the aircraft must have the capability to scramble launch with equipment necessary for flight operations within 30 minutes (T)/15 minutes (O) from crew arrival at the aircraft.

019 B The aircraft and its components must be protected from and be resistant to the effects of sand and dust

020 B The aircraft and its components must be protected from and be resistant to the effects of snow and ice (T).

021 B The aircraft and its components must be protected from and be resistant to the effects of salt-laden air (T).

022 B The aircraft must be capable of operations in temperatures ranging from +120 deg F/49 deg C to -65 deg F/-54 deg C (T). The aircraft must be capable of operating in +120 deg F/49 deg C to -20 deg F/-29 deg C range without modification kits or additional support equipment to cool, heat, or operate the aircraft. Modification kits may be used to achieve operations in temperatures below -20 deg F/-29 deg C.

023 B The aircraft shall be capable of operations in moderate icing without adaptive kits (T).

025 M USMC Maximum Cruise Airspeed - 240 KTAS (T)/270 KTAS (O) at 3000 ft MSU/91.5 deg F/33.05 deg C, maximum designed gross weight (internal payload), and maximum continuous power.

Current Status Lot Status Lot Status Lot Status Lot

5 6 7 8

G/Y/R G/Y/R G/Y/R G/Y/R

Y Y G Y Y Y G

Comments

Port elevator on LHA has been demonstrated. Retractable refuel probe will allow use on all elevators.

AWAITING CV/OT&E

FINAL SDC IMPELLER FIX AND WINDSHIELD FIXES FURTHER OPERATIONAL TESTING REQUIRED

SINGLE POINT ENGINE RINSE WILL BE VALIDATED IN MV FOT&E

OPERVAL DID NOT TEST EXTREME LOW TEMP. COMPONENT AND SUBSYSTEM QUALIFICATION TESTING DEMONSTRATED COMPLIANCE

Limited icing evaluation to be conducted at Pax winter of 00-01. Natural icing tests scheduled winter 01-02.

CURRENT STATUS
 G Full Capability Exists or Threshold Met
 Y Limited Capability Exists
 R No Capability or Threshold Not Met

STATUS: AHEAD OF RECOVERY PLAN
 ← Ahead of Recovery Plan
 → Recovery Plan on Schedule or Not Required
 Behind Recovery Plan

PROJECTION OF STATUS FOR LOT PRODUCTION
 G Complete Meets Production Lot with Low Risk
 Y Current Plan Meets Production Lot with Low or Medium Risk
 R Current Plan Does Not Meet Production Lot
 N/A CV Specific Requirement to Be Tested in CV OT-IH

JORD Requirements

(M)Y
(C)Y
(B)oth

Num	(C)Y	(M)Y	Requirement	Current Status	Status Lot	Status Lot	Status Lot	Status Lot	Status Lot	Comments
026	C		USOCOM Maximum Cruise Airspeed - 230 KTAS (T)/250 KTAS (O) at sea level, 0 ft PA, 59 deg F/15 deg C, in moderate turbulence, and at mission gross weight per defined mission profile.	G	5	6	7	8		
026	C		USOCOM Maximum Cruise Airspeed - 230 KTAS (T)/250 KTAS (O) at sea level, 0 ft PA, 59 deg F/15 deg C, in moderate turbulence, and at mission gross weight per defined mission profile.	G	5	6	7	8		
028	B		Instantaneous G Loading - +3.5 to -1 instantaneous G's in fixed wing mode, and +3.0 to -0.5 instantaneous G's in the helicopter mode.	G						OPEVAL DID NOT RECORD G'S DURING TESTING.
029	B		Air Combat Maneuver (ACM) - The aircraft must be capable of performing air combat maneuvers (ACM) (T).	R						
031	B		Shipboard short takeoff (STO) with a maximum takeoff roll of 300 ft, all engines operating, with the mission profile specific weights, with 15 knots of headwind across the deck.	G						FLIGHT TEST, ANALYSIS, SIMULATION PLANS IN PLACE (UNFUNDED FY-03 ISSUE)
032	B		Ground-based STO from a dry/hard runway and clear a 50 ft obstacle, with a maximum takeoff roll of 3000 ft, all engines operating, at maximum gross weight, zero wind, 89.8 deg F/0 ft pressure altitude.	G						
033	B		One Engine Inoperative - The aircraft must be capable of operating at not less than 1,000 ft MSL (T)/7,500 ft MSL (O) using maximum continuous power, with the payload and 60% of the fuel required at engine start for the applicable mission profile.	G						
034	B		Power Off Glide/Autorotation - The aircraft must be capable of performing a survivable emergency landing with all engines inoperative (T).	Y						POWER-OFF GLIDE (GREEN), AUTOROTATION (RED) NATOPS PROCEDURES IN PLACE
037	B		Internal Payload, Cargo - Must carry an 8000 lb/3629 kg (T)/10,000 lb/4536 kg (O) internal load.	G						
038	B		Internal Payload, Cargo Space - Space must be sufficient to allow for the safe transportation of one light vehicle with trailer and sufficient seating for 4 personnel (1 air crew member and 3 vehicle crew members) with a combined maximum gross weight of 8,000 lbs/3629 kg.	G						

CURRENT STATUS
 G Fuel Capability Exists or Threshold Met
 Y Limited Capability Exists
 R No Capability or Threshold Not Met

STATUS ARROW
 ▲ Ahead of Recovery Plan
 ↔ Recovery Plan on Schedule or Not Required
 ▼ Behind Recovery Plan

PROJECTION OF STATUS FOR LOT PRODUCTION
 G Complete or Meets Production Lot with Low Risk
 Y Current Plan Meets Production Lot with Low or Medium Risk
 R Current Plan Does Not Meet Production Lot
 N/A CV Specific Requirement to be Tested in CV OT-IH

JORD Requirements

Num	(M)/ (B)/alt	Requirement	Current Status Lot				Status Lot				Comments	
			G/Y/R	G/Y/R	G/Y/R	G/Y/R	G/Y/R	G/Y/R	G/Y/R	G/Y/R		
039	B	Internal Payload, Cargo Space - Space must be sufficient to allow for the safe transport of four tandem-loaded 48" X 48" skid boards/platforms or two 463L half pallets (54" X 88") with a maximum gross weight of 4,000 lb/1814 kg (T)/5,000 lb/2268 kg (O)	G									Cargo rollers redesigned in A/C 19 and subsequent. VALIDATE IN OT-IIIA
040	B	Internal Payload, Cargo Space - The aircraft shall use, to the maximum extent possible, existing material handling equipment (MHE) for upload/download of internal cargo when required.	G									
041	B	Internal Payload, Cargo Space - Space must be sufficient to allow for the safe transport of small boats (T).	G									
042	B	Internal Payload, Cargo Space - Space must be sufficient to allow for the safe transport of 12 liters (T).	G									
043	B	Internal Payload, Internal Loading - Loading capability must provide configurations flexibility and support rapid reconfiguration of the cargo area. Routine reconfiguration changes required to convert from one mission to the next must be achievable in field and shipboard environments by organizational level maintenance personnel.	G									Cargo rollers redesigned in A/C 19 and subsequent. VALIDATE IN OT-IIIA
044	C	Internal Payload, Internal Loading - Cabin reconfiguration timing from deployment to employment and/or employment to deployment configuration with one internal auxiliary fuel tank for installation/removal (to include operational checkout and servicing/defueling) will not be greater than 2 hours (T), 4 hours for two internal tanks (O).	G									CV IOT&E
045	B	Internal Payload, Internal Loading - Must incorporate a cargo winch to aid in cargo on-loading/off-loading (T).	G									
047	B	External Payload - The aircraft must provide single and dual point external load capability (T).	Y									NIGHT EXTERNALS RESTRICTED. LPIA RADALT UNDER INVESTIGATION.

CURRENT STATUS
 G Full Capability Exists or Threshold Met
 Y Limited Capability Exists
 R No Capability or Threshold Not Met

STATUS/ARROW
 ▲ Ahead of Recovery Plan
 → Recovery Plan on Schedule or Not Required
 ▼ Behind Recovery Plan

PROJECTION OF STATUS FOR LOT PRODUCTION
 G Complete or Meets Production with Low Risk
 Y Current Plan Meets Production Lot with Low or Medium Risk
 R Current Plan Does Not Meet Production Lot
 N/A CV Specific Requirement to Be Tested in CV OT-IIH

JORD Requirements

Num	(M)Y (B)with	Requirement	Current Status Lot		Status Lot		Status Lot		Comments
			G/YR	G/YR	G/YR	G/YR	G/YR	G/YR	
048	B	External Payload - The aircraft must provide selectable automatic, and electrical load release options from the cockpit and crew stations (T).	G						
049	B	External Payload - The aircraft must provide a manual emergency load release option from the cabin area as well as a center fuselage belly portal for inflight access to the external cargo hook(s) and load observation (T).	G						
050	B	Self-Deployment Capability - The aircraft must have a self-deployment range greater than or equal to 2100 nm with one refueling (T) 2100 nm with no refueling (O) on a tropical day. Fuel capacity must permit arrival over destination with enough usable fuel remaining to increase the total planned flight time between refueling points by the greater of 10% or 20 minutes at Best Endurance Velocity (Vbe) at 10,000 ft MSL. Crew fatigue considerations dictate that the 2100 nm leg be flown in 12 hours or less (T) 8 hours (O) USMC.	G						
051	B	Avionics - A redundant and fully integrated avionics suite is required (T).	G						
052	B	Avionics - The avionics suite must automatically control avionics systems to minimize crew workload, particularly at night, in low-level, adverse weather, and increased threat environments, and allow for graceful degradation of navigation capability.	G						CV IOT&E
053	C	Avionics - The Control Display Unit must allow ability to manipulate multifunction displays (T) USSOCOM(P3).							P3, BLOCK 10 INCORPORATION
054	B	Avionics - Avionics displays will be Night Vision Device (NVD) compatible and allow two pilot independent operations.	G						
055	B	Avionics - Electromagnetic compatibility and frequency spectrum assignments must be compatible with air strike packages and shipboard operations (T).	G						

PROJECTION OF STATUS FOR LOT PRODUCTION
 G Complete or Meets Production Lot with Low Risk
 Y Current Plan Meets Production Lot with Low or Medium Risk
 R Current Plan Does Not Meet Production Lot
 NA CV Specific Requirement to Be Tested in CV OTHH

STATUS ARROW
 ↑ Ahead of Recovery Plan
 → Recovery Plan on Schedule or Not Required
 ↓ Behind Recovery Plan

CURRENT STATUS
 G Full Capability Exists or Threshold Met
 Y Limited Capability Exists
 R No Capability or Threshold Not Met

JORD Requirements

Num	(M)/ (C)/ (B)/with	Requirement	Current	Status Lot	Status Lot	Status Lot	Status Lot	Status Lot	Comments
			Status G/Y/R	5 G/Y/R	6 G/Y/R	7 G/Y/R	8 G/Y/R		
056	C	Mission Computer - The Mission Computer must integrate the radar (USSOCOM only).	G						CV IOT&E
057	B	Mission Computer - The mission computer must integrate Infrared Sensor System (ISS) and other navigation equipment to provide sensor update capability to the navigation system in use (T).	G						VALIDATE IN OT-III
058	B	Mission Computer - The mission computer must be able to hold and process at least 200 Navigation Reference Points (NRP) (T).	G						
059	B	Mission Computer - The mission computer must be able to work in conjunction with the Digital Map (DM) to store, continuously update, and display DM threat intervisibility based on altitude (T).	G						
060	C	Mission Computer - The system must retain mission data using an internal backup power source for a minimum of 15 minutes (T)/30 minutes (O).	R						NO FEASIBLE CHANGE, PMA RECOMMENDS ORD CHANGE
063	B	Flight Control Computers - The aircraft must incorporate triply redundant flight control computers (T).	G						
064	B	Flight Control Computers - The aircraft must provide the aircraft pilot in command the capability to override nacelle position inputs from the copilot from either	G						
065	B	Flight Control Computer - The aircraft must provide the ability for either pilot to obtain maximum reserve power from the engines during critical phases of flight (T). To the maximum extent possible, aircraft controllability will not be limited during reserve power operations (T/P3).	R						ECP IN-HOUSE BUT NOT YET FUNDED, TRADE STUDY INITIATED FOR CV UNIQUE CONCERNS
067	B	A Standard Digital Flight Data Recorder (SDFDR) capable of removal/replacement without special tools is required (T).	G						
068	B	Data Storage System (DSS) - A DSS with removable and portable nonvolatile solid state data storage medium (cartridge, disk, etc.) is required (T).	G						

CURRENT STATUS
 G Full Capability, Exceeds or Threshold Met
 Y Limited Capability, Exceeds or Threshold Met
 R No Capability or Threshold Not Met

STATUS ARROW
 ▲ Ahead of Recovery Plan
 → Recovery Plan on Schedule or Not Required
 ▼ Behind Recovery Plan

PROJECTION OF STATUS FOR LOT PRODUCTION
 G Current Plan Meets Production Lot with Low or Medium Risk
 Y Current Plan Meets Production Lot with Low or Medium Risk
 R Current Plan Does Not Meet Production Lot
 N/A CV Specific Requirement to Be Tested in CV OT-IH

JORD Requirements

Num	(M/V) (C/V)	(B/Wh)	Requirement	Current Status G/Y/R	Status Lot 5 G/Y/R	Status Lot 6 G/Y/R	Status Lot 7 G/Y/R	Status Lot 8 G/Y/R	Comments
069	B		Data Storage System (DSS) - The DSS must allow the uploading, storing, and downloading of data between the aircraft's onboard integrated avionics system and computerized ground support systems (T).	G					
070	B		Data Storage System (DSS) - The DSS must allow the segregated downloading of classified and unclassified data and provide the capability to destroy classified information with minimal crew actions required (T).	G					
072	B		Data Storage System (DSS) - The DSS must interface with the appropriate service-unique mission planning system (T). Single point entry of mission planning and cryptographic data is desired (O).	G					
073	M		Data Storage System (DSS) - There must be an identified medium to accommodate the downloading of maintenance data in 15 minutes or less (T) to support maintenance debriefings, allow the rapid sorting and correlation of data points, and provide effective guidance for maintenance personnel (T). The unit/medium used to accept and process maintenance data must be compatible as a front end load to the Naval Aviation Logistic Command Management Information System (NALCOMIS) (T).	Y					SOFTWARE CHANGE INWORK TO MAKE MORE USER FRIENDLY
074	C		Data Storage System (DSS) - There must be an identified medium to accommodate the downloading of maintenance data in 15 minutes or less (T) to support maintenance debriefings, allow the rapid sorting and correlation of data points, and provide effective guidance to maintenance personnel (T). The unit/medium used to accept and process maintenance data must be compatible as a front end load to the USAF Core Automated Maintenance System (CAMS) and the future Integrated Maintenance System (IMDS) (T).	Y					SOFTWARE CHANGE INWORK TO MAKE MORE USER FRIENDLY
076	B		Automatic Flight Control System - An AFCS capable of altitude, airspeed, and heading hold is required (T).	G					

CURRENT STATUS
 G Full Capability Exists or Threshold Met
 Y Limited Capability Exists
 R No Capability or Threshold Not Met

STATUS ARROW
 ▲ Ahead of Recovery Plan
 → Recovery Plan on Schedule or Not Required
 ▼ Behind Recovery Plan

PROJECTION OF STATUS FOR LOT PRODUCTION
 G Complete or Meets Production Lot with Low Risk
 Y Current Plan Meets Production Lot with Low or Medium Risk
 R Current Plan Does Not Meet Production Lot
 N/A CV Specific Requirement to Be Tested in CV OT-IH

JORD Requirements

(M)V
(C)V
(B)oth

Requirement

Automatic Flight Control System - The ability to make a flight director coupled approach is required (T). The coupled approach shall provide automatic precision hover with vertical hold capability adjustable from 5-4900 ft Above Ground Level (AGL) (T/F3).

Joint Survivor Avionics - The survivor avionics must be capable of providing survivor identification and location and must be capable of handling multiple survivors simultaneously (T).

Communications - The aircraft is required to provide a simultaneous use, highly reliable, jam resistant, long range, secure voice and digital data burst communications capability (T). Communications must optimize interoperability and commonality with other DoD and civil systems (T).

Communications - Communications are required to be effective at ranges varying from within a formation to Over-the-Horizon (OTH) (T).

Communications - Aircraft communications capabilities must include: UHF, VHF, AM/FM and Satellite Communications (SATCOM) (T).

Communication, Secure Voice and Data Communications - All UHF-SATCOM voice and data communications will be narrow band secure voice and data capable in accordance with Joint Staff directive MCM-105-94 of 31 August 1994 to ensure joint interoperability with all existing and planned UHF SATCOM radios (T).

Communication, Secure Voice and Data Communications - All voice and data communications will be secure capable (T).

PROJECTION OF STATUS FOR LOT PRODUCTION
G Completion Meets Production Lot with Low Risk
Y Current Plan Meets Production Lot with Medium Risk
R Current Plan Does Not Meet Production Lot
N/A CV Specific Requirement to Be Tested in CV OTH

STATUS ARROW
▲ Ahead of Recovery Plan on Schedule or Not Required
→ Recovery Plan on Schedule or Not Required
▼ Behind Recovery Plan

CURRENT STATUS
G Full Capability Exits or Threshold Met
Y Limited Capability Exits
R No Capability or Threshold Not Met

Current Status Lot Status Lot Status Lot Status Lot Status Lot Status Lot
G/Y/R G/Y/R G/Y/R G/Y/R G/Y/R G/Y/R G/Y/R G/Y/R

R R R R R R R R
G G G G G G G G
G G G G G G G G
Y Y Y Y Y Y Y Y
G G G G G G G G
G G G G G G G G
G G G G G G G G
G G G G G G G G

Comments
JASS 2.7 WILL CORRECT
CV IOT&E
SEE INDIVIDUAL COMMENTS ON REQUIREMENTS 81 THROUGH 96 (JOINT POINT PAPER TO EXPLAIN COMMUNICATION ISSUES)
LIMITED OVER THE HORIZON CAPABILITY, CV IS CURRENTLY GREEN. PR 03 FUNDING REQUEST FOR LOT 9 MV INCORPORATION LIMITED SATCOM CAPABILITY.
CV IS CURRENTLY GREEN. PR 03 FUNDING REQUEST FOR LOT 9 MV INCORPORATION
DOT&E WILL VERIFY WITH MOTT

JORD Requirements

Num	(M/V) (C/Y)	Requirement	Current		Status Lot		Status Lot		Status Lot		Comments
			GYR	G	GYR	G	GYR	G	GYR	G	
087	C	Communication - All UHF SATCOM radios will be both 5 and 25 khz Demand Assigned Multiple Access Capable (DAMA) to ensure joint interoperability with all existing and planned DoD UHF SATCOM radios (TUSOCOM). The radio will be certified by Joint Interoperability Test Center to ensure DAMA Compliance.		G							CV IOT&E
088	M	Communication - All UHF SATCOM radios will be both 5 and 25 khz Demand Assigned Multiple Access Capable (DAMA) to ensure joint interoperability with all existing and planned DoD UHF SATCOM radios (TUSOCOM/P3). The radio will be certified by Joint Interoperability Test Center to ensure DAMA Compliance.									P3 (PR 03 FUNDING REQUEST FOR LOT 9 MV INCORPORATION)
090	B	Communication - The aircraft must have an intercom (I).		G							
091	C	Communication - In addition to the cyclic and communications cord in the cockpit, a "hands off" (foot and voice) activated intercommunications capability will be provided for each of the three cockpit crew members (TUSOCOM/P3).		Y							P3 (EE STATION HAS NO FOOT SWITCH PMA RECOMMENDING ORD CHANGE)
092	B	Communications, Troop Commanders Station - provide a dedicated antenna jack compatible with a man-portable VHF (FM) radio and access to the aircraft's radios in the troop/cargo compartment (I).		G							
096	C	Communications, Troop Commander's Station - The troop commander's station provides a dedicated Troop Commander SATCOM antenna jack (TUSOCOM/P3)							G		BLOCK 10 INCORPORATION
098	B	Identification Friend or Foe (IFF)/Selectively Improved Flagging (SIF) - The IFF/SIF has Mode IV capability (I).		G							VALIDATE OT-III
100	C	Identification Friend or Foe (IFF)/Selectively Improved Flagging (SIF) - The IFF/SIF is Mode S level 3 compatible with foreign and domestic navigation and identification systems is required (TUSOCOM). (I)		G							CV IOT&E

CURRENT STATUS
 G Full Capability Exists or Threshold Met
 Y Limited Capability Exists
 R No Capability or Threshold Not Met

STATUS ARROW
 ▲ Ahead of Recovery Plan
 → Recovery Plan on Schedule or Not Required
 ▼ Behind Recovery Plan

PROJECTION OF STATUS FOR LOT PRODUCTION
 G Complete or Meets Production Lot with Low Risk
 Y Current Plan Meets Production Lot with Low or Medium Risk
 R Current Plan Does Not Meet Production Lot
 N/A CV Specific Requirement to Be Tested in CV OT-III

JORD Requirements

Current Status Lot Status Lot Status Lot Status Lot

Status 5 6 7 8
G/Y/R G/Y/R G/Y/R G/Y/R

(MIV)
(CV)

Num (B)oth

Requirement

Comments

102 M Identification Friend or Foe (IFF)/Selectively Improved Flagging (SIF) - DON-standard IFF capability (T).

VALIDATE OT-III A

103 C Communications, Multi-mission Advanced Tactical Terminal (MATT) - The aircraft must include a MATT or feasible follow-on capability (T).

CV IOT&E

104 B Communications, Global Navigation System - Global Air Traffic Management System (GATM) capability to meet air transport category requirements for domestic and foreign air traffic management operations is required (T/P3)

P31 CV BLOCK 20 INCORPORATION. PR 03 FUNDING REQUEST FOR MV INCORPORATION. CURRENT PROJECTED STATUS - GREEN.

107 B Mission Planning System - The aircraft design must include a mission planning capability which, at a minimum, integrates imagery, weather information, digital map, and communications functions (T).

IMPROVEMENTS WILL BE VALIDATED IN OT-III A

108 B Mission Planning System - The capability to modify/update mission data while airborne is required (T).

110 B Navigation - The navigation subsystem must incorporate redundant sources of precise location data (T).

111 B Navigation - Aircraft navigation capabilities include Global Positioning System (GPS).

112 B Navigation - Aircraft navigation capabilities include Inertial Navigation System (INS).

113 B Navigation - Aircraft navigation capabilities include Very High Frequency Omni-directional Range (VOR).

114 B Navigation - Aircraft navigation capabilities include Instrument Landing System (ILS).

115 B Navigation - Aircraft navigation capabilities include Tactical Air Navigation (TACAN).

INS CAPABILITY PROVIDED. HANDSET ALIGNMENT WILL BE VALIDATED IN OT-III A

CURRENT STATUS
G Full Capability Exists or Threshold Met
Y Limited Capability Exists
R No Capability or Threshold Not Met

STATUS ARROW
▲ Ahead of Recovery Plan
→ Recovery Plan on Schedule or Not Required
▼ Behind Recovery Plan

PROJECTION OF STATUS FOR LOT PRODUCTION
G Complete or Meets Production Lot with Low Risk
Y Current Plan Meets Production Lot with Low or Medium Risk
R Current Plan Does Not Meet Production Lot
N/A CV Specific Requirement to Be Tracked in CV OT-III A

JORD Requirements

Num	(M)V (C)V (B)with	Requirement	Current		Status Lot 5		Status Lot 6		Status Lot 7		Status Lot 8	
			G/Y/R	G	G/Y/R	G/Y/R	G/Y/R	G/Y/R	G/Y/R			

116	M	Navigation - The aircraft must navigate to within GPS accuracy with a maximum error accumulation of 0.8 nm/hour (T). This performance must not be degraded by hostile jamming or deceptive countermeasures.	G									
117	C	Navigation - The aircraft must navigate a tactical profile to the full combat radius of the aircraft and locate a landing zone within two times the rotor diameter (T)/one times the rotor diameter (O), at night, in 1/4 mile visibility, from 100 ft AGL.	G									CV IOT&E
118	C	Navigation - The aircraft must demonstrate a 200 nm extended over-water navigation segment wherein the navigational accuracy of the aircraft must locate a landing zone within two times the rotor diameter (T)/one times the rotor diameter (O), in 1/4 mile visibility, at night, from 100 ft AGL.	G									CV IOT&E
119	C	Navigation - The aircraft must navigate the appropriate profile to a first-pass, coupled approach to a hover over the landing zone with no reliance on visual/sensor position updates by the crew during the flight (T). The same capability is required with the failure of one navigation subsystem given periodic visual/sensor position updates by the crew.	R		G							CV FOT&E
120	C	Navigation - The navigation system must provide groundspeed based on time-on-target calculation to a target waypoint to within plus or minus 10 seconds. Time-on-target calculation to the waypoint must be calculated and displayed independent of the flight plan steering (T).	G									CV IOT&E
121	B	Digital Map (DM) - A DM capable of presenting a plan view using Defense Mapping Agency (DMA), Digital Terrain Elevation Data (DTED), aeronautical charts, and photos (T).	G									

CURRENT STATUS
 G Full Capability Exists or Threshold Met
 Y Limited Capability Exists
 R No Capability or Threshold Not Met

STATUS ARROW
 ▲ Ahead of Recovery Plan
 → Recovery Plan on Schedule or Not Required
 ▼ Behind Recovery Plan

PROJECTION OF STATUS FOR LOT PRODUCTION
 G Complete or Meets Production Lot with Low Risk
 Y Current Plan Meets Production Lot with Low or Medium Risk
 R Current Plan Does Not Meet Production Lot
 NA CV Specific Requirement to Be Tested in CV OT-III

JORD Requirements

Num	(M)/ (C)/ (B)/th	Requirement	Current Status Lot				Status Lot				Comments	
			5 G/YR	6 G/YR	7 G/YR	8 G/YR	5 G/YR	6 G/YR	7 G/YR	8 G/YR		
123	B	Digital Map (DM) - DM must include zoom capability in all scales, contour lines, elevation color banding, cultural features, sun shading, and EOB and flight plan overlays (T).	G									
124	B	Digital Map (DM) - DM must be integrated with the mission computer to provide unslaved manual navigation selection which updates the selected navigation program and provides an autoback capability to any selected NRP (T).	G									
125	C	Digital Map (DM) - The DM must interface with CONSTANT SOURCE and MATT or feasible follow-on terrain anomalies identified by other terrain sensors not identified in DTED; and be capable of receiving and displaying threat intervisibilities regardless of aircraft altitude (T).	G									CV IOT&E
126	C	Digital Map (DM) - The DM must be compatible with SOF-unique mission planning system and the Air Force Mission Support System (AFMSS) (T).	G									CV IOT&E
127	C	Multi-Mode Radar (MMR) - The MMR must be integrated to allow the aircraft to conduct Terrain Following/Terrain Avoidance (TF/TA) flight operations 300 ft (T)/100 ft (O), day and night, in VMC and IMC including adverse weather conditions without the loss of terrain following capability (T).	G									CV IOT&E
128	C	Multi-Mode Radar (MMR) - With one engine inoperative (OEI), TF/TA command must reflect accurate TF/TA capability (T/P3).									Y	P3: BLOCK 10, TF/TA COMMANDS WILL SUPPORT OEI, TF/TA PERFORMANCE WILL BE SIGNIFICANTLY DEGRADED
129	C	Multi-Mode Radar (MMR) - The MMR must have capabilities for TF/TA, ground mapping, weather detection, beacon mode, obstacle warning, and multifunction operation over multiple frequencies (T).	G									CV IOT&E

CURRENT STATUS
 G Full Capability Exceeds or Threshold Met
 Y Limited Capability Exists
 R No Capability or Threshold Not Met

STATUS ARROW
 ▲ Ahead of Recovery Plan
 → Recovery Plan on Schedule or Not Required
 ▼ Behind Recovery Plan

PROJECTION OF STATUS FOR LOT PRODUCTION
 G Complete or Meets Production Lot with Low Risk
 Y Current Plan Meets Production Lot with Low or Medium Risk
 R Current Plan Does Not Meet Production Lot
 N/A CV Specific Requirement to Be Tested in CV OT:IIH

JORD Requirements

(M/V)

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Current Status Lot Status Lot Status Lot Status Lot

Num	(C/V) (B/oth)	Requirement	3 G/Y/R	4 G/Y/R	5 G/Y/R	6 G/Y/R	7 G/Y/R	8 G/Y/R	Comments
131	B	Infrared Sensor System (ISS) - An ISS with contrast tracking (thermal reference), geo reference autotrack capability compatible with mission requirements, and four modes of stabilization (Flight Path Vector (FPV); Fix (Search, Fixed-Point Tracking and Update/Store); Hover; and Unslaved) is required (T).	Y						ISS DOES NOT HAVE CONTRAST TRACKING. REQUIRES NEW FLIR, UNFUNDED
132	B	Infrared Sensor System (ISS) - The ISS must be integrated with the mission computer for navigational update capability in the unslaved mode and be able to autotrack to a navigational reference point in the slaved mode (T).	G						
133	C	Infrared Sensor System (ISS) - The capability to record ISS data (including symbology (T)) and voice (O) on a standard "off-the-shelf" camcorder is required (T).	G						CV IOT&E
134	M	Night Vision Goggle Head-up Display (NVG HUD/Helmet Mounted Display (HMD) - An integrated NVG HUD is required (T).	G						
136	B	Radar Altimeter - A radar altimeter incorporating audio low warning is required(T).	G						
137	C	Radar Altimeter - A Low Probability of Detection/Low Probability of Intercept (LPD/LPI) capability is required (T).	R						LPIA TESTING CURRENTLY PLANNED AS PART OF MV FOT&E.
138	B	Ground Collision Avoidance and Warning System (GCAWS)/Enhanced Ground Proximity Warning System (EGPWS) - A GCAWS with voice warning is required (T). The voice warning feature must be capable of being disabled by the aircrew in the cockpit for low-level flight operations (T).	R	R	G				JASS 2.7 INCORPORATION
140	B	External Lighting - A Landing Light for use with or without NVGs is required (T).	G						
141	B	External Lighting - Hover Lights for use with or without NVGs are required (T).	G						

CURRENT STATUS
 G Full Capability/Exists or Threshold Met
 Y Limited Capability Exists
 R No Capability or Threshold Not Met

STATUS ARROW
 ▲ Ahead of Recovery Plan
 → Recovery Plan on Schedule or Not Required
 ▼ Behind Recovery Plan

PROJECTION OF STATUS FOR LOT PRODUCTION
 G Complete or Meets Production Lot with Low Risk
 Y Current Plan Meets Production Lot with Low or Medium Risk
 R Current Plan Does Not Meet Production Lot
 N/A CV Specific Requirement to Be Tested in CV OT-III

JORD Requirements

(M)Y (C)Y
 Num (B)with Requirement

Current Status Lot Status Lot Status Lot Status Lot Status Lot
 G/Y/R G/Y/R G/Y/R G/Y/R G/Y/R G/Y/R

Comments
 POSITION LIGHTS NOT NVG COMPATIBLE, PMA RECOMMENDS ORD REVIEW.

ECIP FOR DUAL MODE OPERATIONS AND TO INCREASE LIGHT SIZE

IR searchlight not dimmable, PMA RECOMMENDS REQUIREMENT REVIEW

CV IOT&E

PROJECTION OF STATUS FOR LOT PRODUCTION
 G Complete or Meets Production Lot with Low Risk
 Y Current Plan Meets Production Lot with Low or Medium Risk
 R Current Plan Does Not Meet Production Lot
 N/A CV Specific Requirement to Be Tested in CV OT-IH

STATUS ARROW
 ▲ Ahead of Recovery Plan
 → Recovery Plan on Schedule or Not Required
 ▼ Behind Recovery Plan

CURRENT STATUS
 G Full Capability Exists or Threshold Met
 Y Limited Capability Exists
 R No Capability or Threshold Not Met

Num	(M)Y (C)Y	(B)with	Requirement	Current Status	Lot Status	Lot Status	Lot Status	Lot Status	Status Lot
				G/Y/R	G/Y/R	G/Y/R	G/Y/R	G/Y/R	G/Y/R
142	B		External Lighting - Position Lights for use with or without NVGs is required (T).	Y					
143	B		External Lighting - Anti-collision Lights for use with or without NVGs are required (T).	G					
144	B		External Lighting - Aerial Refueling Lights for use with or without NVGs are required (T).	G					
145	B		External Lighting - Formation Lights for use with or without NVGs are required (T).	Y					
146	B		External Lighting - Blade Tip Lights for use with or without NVGs are required (T).	G					
147	B		External Lighting - Search Lights, controllable by either pilot, and capable of providing visible and dimmable IR illumination for use with or without NVGs are required (T).	Y					
148	B		External Lighting - Probe Lights, controllable by either pilot, and capable of providing visible and dimmable IR illumination for use with or without NVGs are required (T).	G					
150	C		External Lighting - Covert external lighting is required (T).	G					
151	B		Internal Lighting - Internal lighting for cabin, cockpit, and exits capable of normal and emergency illumination is required (T).	G					
152	B		Internal Lighting - Internal lighting must be NVG compatible, self-contained, automatic, and permanently installed (T).	G					
153	B		Internal Lighting - Emergency lighting must not require aircraft power for operation in emergency conditions and must be capable of being manually secured after activation (T).	G					

JORD Requirements

Num	(M)/ (C)/ (B)/oth	Requirement	Current Status Lot Status Lot Status Lot Status Lot								Comments
			5 G/Y/R	6 G/Y/R	7 G/Y/R	8 G/Y/R	8 G/Y/R	8 G/Y/R	8 G/Y/R	8 G/Y/R	
154	M	Ballistic Tolerance - The aircraft must be resistant to flight critical damage imposed by hits in vital areas by 12.7 millimeters (mm) (T)/14.5 mm (O) Armor Piercing incendiary (API) projectiles at 90 percent of their respective muzzle velocities. Greater levels of ballistic hardening/tolerance are desired and should be incorporated if achievable without significant aircraft performance or cost penalties.	G								ECP is in work to address issues with wheel well fire suppression.
155	B	Seating - Crashworthy seats are required for all crew members and passengers in the cargo area (T).	G								
156	B	Fuel Tanks - Permanently installed crashworthy fuel tanks must be self-sealing (lower one third) (T)/self-sealing entire tank (O) and nitrogen inerted (T).	G								
157	B	Fuel Tanks - Internally carried crashworthy cabin auxiliary fuel tanks must be nitrogen inerted (T) and self-sealing (T)/USSOCOM(OUSMC) to allow aircraft to deploy directly to a target area.						G			CV IOT&E LOWER 1/3 IS SELF-SEALING
158	B	Floatation - The aircraft must be capable of remaining afloat and upright, with engines secured, for two hours in Sea State 4 (International Code for State of Sea Scale) after a controlled ditching (T).	G								DEMONSTRATED THROUGH MODELING AND SIMULATION
161	B	Crash Position Indicator (CPI) - A CPI capable of being installed and removed without special tools by one person is required (T).	G								DOT&E WILL VERIFY WITH MOTT
163	B	Fueling/Defueling - The aircraft must include accommodations for both permanently installed internal tanks, and removable auxiliary tanks. Installation must be simple and easily accomplished in field and shipboard environments by organizational level maintenance personnel (T).	G								CV IOT&E

PROJECTION OF STATUS FOR LOT PRODUCTION
 G Complete or Meets Production Lot with Low Risk
 Y Current Plan Meets Production Lot with Low or Medium Risk
 R Current Plan Does Not Meet Production Lot
 N/A CV specific Requirement to Be Tested in CV OT-IH

STATUS ABBREV
 ← Ahead of Recovery Plan
 → Recovery Plan on Schedule or Not Required
 ↔ Behind Recovery Plan

CURRENT STATUS
 G Full Capability Exceeds Threshold Met
 Y Limited Capability Exists
 R No Capability or Threshold Not Met

JORD Requirements

Num	(M)Y (C)V (B)oth	Requirement	Current Status Lot Status Lot Status Lot Status Lot Status Lot								Comments
			5	6	7	8	8	8	8	8	
			G/Y/R	G/Y/R	G/Y/R	G/Y/R	G/Y/R	G/Y/R	G/Y/R		
164	B	Aerial Refueling - An aerial refueling receiver capability compatible with current USMC and USAF tanker assets utilizing probes and (high, low, or variable speed drogues is required (T).	Y								MMKC-130 CLEARED AIRPLANE MODE ONLY. TEST PLANNED TO CLEAR C-130J AND KC135. KC-10 HOSE WHIP ISSUES PREVENT FURTHER TESTING AT PRESENT AND VSD IN DEVELOPMENT BY USAF.
165	C	Aerial Refueling - The capability to aerial refuel with one engine inoperative from a K/MC-130 tanker is required (T).	R								REQUIRES OET TEST UTILIZING VSD. VSD IS STILL UNDER DEVELOPMENT BY USAF.
167	B	Ground Refueling - A single-point pressure refueling system, capable of operating with or without engines running, and a gravity refueling capability are required (T).	G								
168	B	Defueling - An integral pressure defueling capability is required (T).	G								
169	B	Fuel Dumping - The capability to dump/jettison fuel at 800 pounds per minute (T) is required/1000 pounds per minute is desired (O).	G								VALIDATE IN OT-III A
170	B	Fuel Purge System - The capability to purge all nonessential fuel lines after refueling or transferring fuel between tanks (T).	G								
171	B	Shipboard Compatibility - Full shipboard compatibility with all capable ships is required (T).	G								
172	B	Shipboard Compatibility - A blade fold/wing slow system allowing both automatic and manual (backup mode) fold/stow in winds up to 45 knots from any direction (T).	G								
173	B	Shipboard Compatibility - The capability to engage and disengage propellers in windspeeds up to 45 knots	G								
174	B	Shipboard Compatibility - the capability to sustain winds up to 60 knots from any direction without damage to the aircraft once folded, stowed, and tied	G								SHIPBOARD DYNAMIC INTERFACE TESTING ONGOING, AND WILL CONTINUE FOR THE LIFE OF THE AIRCRAFT. FOT&E WILL CLEAR REMAINING LHA/LHD SPOTS AND NIGHT STO.

PROJECTION OF STATUS FOR LOT PRODUCTION
 G Complete or Meets Production Lot with Low Risk
 Y Current Plan Meets Production Lot with Low or Medium Risk
 R Current Plan Does Not Meet Production Lot
 N/A CV Specific Requirement to Be Tested in CV OT-III

STATUS ARROW
 ▲ Ahead of Recovery Plan
 → Recovery Plan on Schedule or Not Required
 ▼ Behind Recovery Plan

CURRENT STATUS
 G Full Capability Exists or Threshold Met
 Y Limited Capability Exists
 R No Capability or Threshold Not Met

JORD Requirements

Num	(M)/ (C)/ (B)	Requirement	Current Status Lot			Status Lot			Comments
			G/Y/R	5	6	7	8	G/Y/R	
175	B	Shipboard Compatibility - The capability to launch and recover from a maximum deck displacement of +~3 deg pitch and +-8 deg roll displacement from 0 deg centerline (T).	G						
176	M	Shipboard Compatibility - The capability to stow below deck on aircraft carriers, LHA, and LHD class amphibious assault ships (T).	G						
177	C	Shipboard Compatibility - The capability to stow below deck on aircraft carriers, LHA, and LHD class amphibious assault ships (T) without removing the aerial refueling probe (T).	R	R	G				RETRACTABLE REFUEL PROBE WILL ALLOW USE ON ALL ELEVATORS
178	B	Shipboard Compatibility - The aircraft must be resistant to the corrosive effects of the maritime environment and allow for freshwater wash of the airframe and engines (T).	G						SINGLE POINT ENGINE RINSE WILL BE VALIDATED IN MV FOT&E
179	B	Shipboard Compatibility - The capability to embark and operate 24 (T)/30 (O) aircraft from an LHA or LHD size ship with six JMWX-capable spots available for use.	G						DEMONSTRATED THROUGH MODELING AND SIMULATION, WILL ADDRESS ISSUES IN FOT&E
180	B	Cabin Restraining Devices - Cabin cargo heading tie-down fittings shall be accessible and compatible for attachment of aircrew personnel restraining devices (gunner's belt) are required.	G						
181	M	Reliability, Mission Reliability (MR) - MFR must be at least 85% for a three hour mission (T).	G						
182	C	Reliability, Weapon System Reliability (WSR) - WSR must be greater than or equal to 0.77 is required (T)/greater than or equal to 0.84 is desired (O) for a four hour mission. This scenario assumes 100 percent of the missions will be flown at night as discussed in mission description.	Y						CV IOT&E .71 TO .84 BASED ON MV DATA EXTRAPOLATED TO CV CONFIGURATION
183	B	Reliability, Availability/Mission Capable (MC) Rate - An MC rate greater than or equal to 82% is required (T)/greater than or equal to 87% is desired (O).							DOT&E VIEWS STATUS AS RED. PMA VIEWS STATUS AS YELLOW (RM&A POINT PAPERS WILL BE PROVIDED)

CURRENT STATUS
 G Full Capability Exceeds or Threshold Met
 Y Limited Capability Exceeds
 R No Capability or Threshold Not Met

STATUS ARROW
 ▲ Ahead of Recovery Plan
 → Recovery Plan on Schedule or Not Required
 ▼ Behind Recovery Plan

PROJECTION OF STATUS FOR LOT PRODUCTION
 G Complete or Meets Production Lot with Low Risk
 Y Current Plan Meets Production Lot with Low or Medium Risk
 R Current Plan Does Not Meet Production Lot
 N/A, CV Specific Requirement to Be Tested in CV OTHH

JORD Requirements

Num	(M/Y) (C/Y)	Req/Requirement	Current Status Lot		Status Lot		Status Lot		Comments
			G/YR	G/YR	G/YR	G/YR			
185	M	Maintainability, Scheduled/Preventive Maintenance - Ten hours continuous flight operation without exceeding scheduled/preventative maintenance inspection items is required (T)/12 hours continuous flight operation is desired (O).	G						
187	B	Maintainability, Mean Time Between Failure (MTBF) - An MTBF of at least 1.4 hours is required (T)/at least 2.0 hours is desired (O).	R	R	G				PLAN AVAILABLE FOR REVIEW
188	C	Maintainability, Mean Repair Time-Operational Mission Failure (MRT/OMF) - An MRT/OMF of 7 hours or less is required (T)/5 hours or less is desired (O).	G						CV /OT&E
189	M	Maintainability, Mean Repair Time (Abort)(MRTa) - An MRTa of 4.8 hours or less is required (T).	Y						VALIDATE IN OT-IIIa (MAIN OPEVAL PROBLEM CORRECTED)
190	B	Maintainability, Integrated Diagnostics - A 100 percent integrated diagnostics capability using automated, semi-automated, and manual diagnostics resources is required.	Y						SOFTWARE UPGRADES WILL BE VALIDATED IN OT-IIIa
192	B	Maintainability, Integrated Diagnostics - The aircraft shall achieve a Built-in-Test (BIT) Fault Detection (FD) rate of 70% (T)/85% (O).	G						
193	B	Maintainability, Integrated Diagnostics - The aircraft shall achieve a Built-in-Test (BIT) Fault Isolation (FI) rate of 70% (T)/85% (O).	G						
194	B	Maintainability, Integrated Diagnostics - The aircraft shall achieve a Built-in-Test (BIT) Fault Alarm (FA) rate of 25% (T)/15% (O).	R	R	G				JASS 2.7 WILL CORRECT
195	B	Mobilization and Surge Requirements - The aircraft must be capable of arriving at a staging base within 72 hours of initial mobilization notification and landing within 12 hours of arrival at the staging base (T).	G						

CURRENT STATUS
 G Full Capability Exists or Threshold Met
 Y Limited Capability Exists
 R No Capability or Threshold Not Met

STATUS ARROW
 ← Ahead of Recovery Plan
 → Recovery Plan on Schedule or Not Required
 ⇄ Behind Recovery Plan

PROJECTION OF STATUS FOR LOT PRODUCTION
 G Complete or Meets Production Lot with Low Risk
 Y Current Plan Meets Production Lot with Low or Medium Risk
 R Current Plan Does Not Meet Production Lot
 N/A CV Specific Requirement to Be Tested in CV OT-III

JORD Requirements

Num	(M)/ (C)/ (B)/oth	Requirement	Current	Status Lot	Status Lot	Status Lot	Status Lot	Status Lot	Comments
			Status	5	6	7	8		
			G/Y/R	G/Y/R	G/Y/R	G/Y/R	G/Y/R	G/Y/R	

196 B Combat Support Requirements - The aircraft must provide ease of access for inspection and facilitate the rapid repair/replacement of aircraft components in the field.

197 B Combat Support Requirements - A rapid repair of minor battle damage capability by Organizational Maintenance Activity (OMA) personnel is required (T). Battle damage assessment and repair procedures will be incorporated into the Interactive Electronics Technical Manuals (IETMs).

198 B Combat Support Requirements - Rapid mission turn-around (refuel only) is required to be completed by no more than two qualified 15 minutes or less (T)/10 minutes or less (O).

199 B Service Life - A minimum aircraft service life of 20 years is required (T)/30 years is desired (O).

200 B Defensive Electronic Countermeasures (DECM) - An integrated DECM capability is required to support the detection, evasion, and/or countering of threat anti-air and air-to-air weapons systems. USSOCOM DECM requirements are detailed in a classified document.

201 B Defensive Electronic Countermeasures (DECM) - DECM capabilities will include passive IR suppression (T).

202 B Defensive Electronic Countermeasures (DECM) - DECM capabilities will include radar warning (T).

203 B Defensive Electronic Countermeasures (DECM) - DECM capabilities will include laser warning (T/P3)

UNREPAIRED DAMAGE LIMITS (UDL) FOR ALL CRITICAL COMPONENTS ARE FUNDED AND IN DEVELOPMENT. CONCURRENTLY, SPONSON DEPOT LEVEL REPAIR PROCEDURES ARE FUNDED AND IN DEVELOPMENT. FUNDING FOR DEVELOPMENT OF COMPOSITE DYNAMIC COMPONENT REPAIR PROCEDURES IS A PRO3 ISSUE AND EXPECTED TO BE COMPLETE IN FY07

CURRENT STATUS
 G Full Capability Exceeds Threshold Met
 Y Limited Capability Exists
 R No Capability or Threshold Not Met

STATUS ABBREVI
 ▲ Ahead of Recovery Plan
 → Recovery Plan Status or Not Required
 ▼ Behind Recovery Plan

PROJECTION OF STATUS FOR LOT PRODUCTION
 G Complete or Nearly Complete Production Lot with Low Risk
 Y Complete or Nearly Complete Production Lot with Medium Risk
 R Current Plan Does Not Meet Production Lot
 N/A CV Specific Requirement to Be Tested in CV OT-IH

MV IS GREEN. P3I FOR CV BLOCK 10 INCORPORATION.

JORD Requirements

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Current Status Lot Status Lot Status Lot Status Lot

8
G/Y/R G/Y/R G/Y/R G/Y/R

Num	(M/V) (C/V)	Req/Requirement	Current Status	Lot Status	Lot Status	Lot Status	Lot Status	Comments
204	B	Defensive Electronic Countermeasures (DECM) - DECM capabilities will include missile approach warnings (T).	G					(M/V and CV lots 5,6) AAR-47 operational and tests completed in EMD. DIRCM will replace AAR-47 in lot 7 for CV.
205	B	Defensive Electronic Countermeasures (DECM) - DECM capabilities will include state of the art countermeasures, to include automatic and manual dispensing of expendables (T).	G					(M/V) ALE-47 operational and tested in EMD. (C/V) Testing is ongoing.ECP IN WORK TO ADD A FORWARD BUCKET TO INCREASE NUMBER OF EXPENDABLES
206	B	Defensive Electronic Countermeasures (DECM) - DECM capabilities will include switches for chaff and flare expendables located on the flight controls and at the scanner/observer stations in the cargo compartment, crew door, and cargo ramp (T).	Y					MV Chaff and flare switches are only located on the flight controls. CV IS CURRENTLY GREEN
208	C	Defensive Electronic Countermeasures (DECM) - DECM capabilities will include radio frequency jamming (T).	G					CV IOT&E
210	C	Defensive Electronic Countermeasures (DECM) - DECM capabilities will include a follow-on infrared jamming capability (TFP3).	G					P31 BLOCK 10 INCORPORATION
212	B	Defensive Weapons - A mission configurable, selectable rate of fire, Night Vision Device (NVD) compatible weapon system is required (T). Space and power for USSOCOM requirements must be preserved (T).	R	R	R	R	G	Proposal received from Bell-Boeing and funded in FY-01
215	B	Nuclear, biological, and Chemical (NBC) Survivability - Electronic pulse hardening for survivability of flight critical components is required (T).	G					DEMONSTRATED WITH COMPONENT LEVEL TESTING
216	B	Nuclear, biological, and Chemical (NBC) Survivability - Fuselage and cockpit design must restrict the entry of contaminant agents into the aircraft's interior and must support the isolation/protection of the primary flight crew during ground operations (T).	Y					Overpressurization of aircraft not achievable, MOPP gear is required. PMA RECOMMENDS REVIEW OF REQUIREMENT

CURRENT STATUS
 G Full Capability Exists or Threshold Met
 Y Limited Capability Exists
 R No Capability or Threshold Not Met

STATUS ARROW
 ▲ Ahead of Recovery Plan
 → Recovery Plan on Schedule or Not Required
 ▼ Behind Recovery Plan

PROJECTION OF STATUS FOR LOT PRODUCTION
 G Complete or Meets Production Lot with Low Risk
 Y Current Plan Meets Production Lot with Low or Medium Risk
 R Current Plan Does Not Meet Production Lot
 NA CV Specific Requirement to BS Tested in CV OT-IH

JORD Requirements

(M/V)
(C/V)
CIV

Num (M/V)
217 B

Requirement

Nuclear, biological, and Chemical (NBC) Survivability - Aircraft external and internal surfaces must be resistant to the adherence or effects of contaminants and be designed to facilitate rapid post-mission decontamination (T).

Nuclear, biological, and Chemical (NBC) Survivability - All aircrew stations are required to be compatible with aircrew body armor and NBC protective garments and masks (T). All future modifications to the aircraft should be compatible with the Service's NBC ensemble (T).

Environmental Control Unit (ECU) - A self-contained ECU capable of maintaining a suitable crew and cabin occupant comfort level throughout the operating environment is required (T).

Oxygen System - An aircrew oxygen receptacle must be provided at each of the seven aircrew/scanner/observer stations (T).

Oxygen System - The oxygen system must be self-contained, must not rely on external support for liquid oxygen, and must support the oxygen requirements for a crew of four from any four of the seven oxygen receptacles throughout the altitude range of the aircraft (T).

Magnetic Heading Indicator - An easily readable, NVG compatible aircraft magnetic heading indicator in the troop/cargo compartment is required (T).

Personnel Hoist - A variable speed (0 to 225 feet per minute) personnel hoist with at least 235 feet of useable cable is required (T).

Current Status
G/Y/R

218 B

G

Y

G

Y

G

R

Status Lot 5
G/Y/R

Status Lot 6
G/Y/R

Status Lot 7
G/Y/R

Status Lot 8
G/Y/R

Comments

COST EFFECTIVE SOLUTION NOT ACHIEVABLE WITH CURRENT TECHNOLOGY

ECS UPGRADE CURRENTLY FUNDED

ABOVE 18,000 FT REQUIRES SUPPLEMENTAL OXYGEN

HOIST NOT INSTALLED. CURRENT HOIST REQUIRES ADDITION OF CLUTCH. CAN EITHER ADD CLUTCH OR INTEGRATE CLUTCHED COTS HOIST. INVESTIGATING ALTERNATE LOCATION FOR HOISTING (UNFUNDED)

CURRENT STATUS
G Full Capability Exits or Threshold Met
Y Limited Capability Exits
R No Capability or Threshold Not Met

STATUS ARROW
▲ Ahead of Recovery Plan
→ Recovery Plan on Schedule or Not Required
→ Behind Recovery Plan

PROJECTION OF STATUS FOR LOT PRODUCTION
G Complete or Meets Production Lot with Low Risk
Y Current Plan Meets Production Lot with Low or Medium Risk
R Current Plan Does Not Meet Production Lot
N/A CV Specific Requirement to Be Tested in CV OT-III

JORD Requirements

(M) V

(C) V

(B) Both

Requirement

Current Status Lot Status Lot Status Lot Status Lot Status Lot
 G/Y/R G/Y/R G/Y/R G/Y/R G/Y/R G/Y/R

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Comments

HOIST NOT INSTALLED. CURRENT HOIST REQUIRES ADDITION OF CLUTCH. CAN EITHER ADD CLUTCH OR INTEGRATE CLUTCHED COTS HOIST. INVESTIGATING ALTERNATE LOCATION FOR HOISTING (UNFUNDED)
 CONTROL PROVISIONS IN PLACE

P31 BLOCK 10 INCORPORATION

ALL AERIAL DELIVERY CAPABILITIES WILL BE VALIDATED IN LOT-III.A EXCEPT AIRDROPS FROM THE CABIN DOOR

Physical dimensions of ramp do not allow simultaneous six man sticks. Twelve jumpers serially can be accomplished.

Palletized equipment demonstrated. No vehicles.

No FASTROPE operations from cabin door. (PMA RECOMMENDS JORD CHANGE FOR ALTERNATE LOCATION)

PROJECTION OF STATUS FOR LOT PRODUCTION
 G Complete or Meets Production Lot with Low Risk
 Y Current Plan Meets Production Lot with Low or Medium Risk
 R Current Plan Does Not Meet Production Lot
 N/A CV Specific Requirement to Be Tested in CV OI-1H

Personnel Hoist - Hoist capacity must be at least 600 lb/272 kg up and down (T).

Personnel Hoist - The hoist must have the capability to be operated by a non-flying crewman from the cabin door/cabin area (T). Operation by either pilot from the cockpit is desired (O).

Personnel Hoist - The hoist must have the capability to be operated by a non-flying crewman from the cabin door/cabin area and simultaneously be controlled from the cockpit (T).

Aerial Delivery Provisions - Provisions for aerial delivery (airdrop) of personnel and various types of loads are required (T). Airdrops will be both static-line and free fall parachuting for personnel; static-line parachuting and free fall (no chute) for equipment. The cargo ramp will be the primary exit for airdrop, but the ability to airdrop personnel and equipment bundles from the cabin door is also desired (O).

Aerial Delivery Provisions - The ability to airdrop from the ramp two, simultaneous, six-man sticks of parachutists or jumpers.

Aerial Delivery Provisions - The ability to airdrop from the ramp up to four 500 lb/227 kg, sequentially-loaded, A-7 or A-21 containerized delivery system bundles.

Aerial Delivery Provisions - The ability to airdrop from the ramp small vehicles and palletized equipment.

Fast Rope - The aircraft must provide the capability to employ two Fast Ropes off the ramp and one out the cabin door to quickly deploy personnel in a hover (T).

CURRENT STATUS

G Full Capability Exists or Threshold Met
 Y Limited Capability Exists
 R No Capability or Threshold Not Met

STATUS ARROW

▲ Ahead of Recovery Plan
 → Recovery Plan on Schedule or Not Required
 → Behind Recovery Plan

JORD Requirements

Num	(M)Y (C)Y	Req/oth	Requirement	Status Lot								Comments
				Current G/YR	5 G/YR	6 G/YR	7 G/YR	8 G/YR	9 G/YR	10 G/YR		
233	C		Fast Rope/Rope Ladders - The requirement to employ the Fast Rope Insertion and Extraction System (FRIES) through both the ramp and cabin door is required (T).	Y								No FASTROPE ops from cabin door. (PMA RECOMMENDS JORD CHANGE FOR ALTERNATE LOCATION)
234	C		Fast Rope/Rope Ladders - The requirement to employ Stabilized Extraction Rigging (STABCO) through both the ramp and cabin door is required (T).	Y								STABCO operations conducted through cargo hook doors. (PMA RECOMMENDS JORD CHANGE FOR ALTERNATE LOCATION)
235	C		Fast Rope/Rope Ladders - The requirement to employ rope ladders through both the ramp and cabin door is required (T).	R								No certified rope ladder available or planned. (PMA RECOMMENDS JORD CHANGE)
237	B		Rough Terrain Operations - The aircraft must be capable of routine rough terrain VTOL operations without damage to the aircraft or components as a result of normal procedures.	G								
238	B		Safety - Airframe and component design and operation must be AW existing standards to ensure the safety and health of aircrews and maintenance personnel.	G								
239	B		Safety - Explosive devices incorporated into the weapon system design must be certified under the Hazards of Electro-magnetic Radiation to Ordnance (HERO) program (T).	G								
241	B		Combat Identification - The aircraft must provide an overall, general knowledge of the tactical battlespace, including the location of friendly, neutral, and enemy forces as well as the plan of action for battle	R								LACK OF HANDHOLDS IN CABIN AREA. JTIDS REQUIRED

CURRENT STATUS
 G Full Capability Exists - Threshold Met
 Y Limited Capability Exists
 R No Capability or Threshold Not Met

STATUS ARROW
 ▲ Ahead of Recovery Plan
 → Recovery Plan on Schedule or Not Required
 ▼ Behind Recovery Plan

PROJECTION OF STATUS FOR LOT PRODUCTION
 G Complete or Meets Production Lot with Low Risk
 Y Current Plan Meets Production Lot with Low or Medium Risk
 R Current Plan Does Not Meet Production Lot
 N/A CV Specific Requirement to be tested in CV OT-III

JORD Requirements

(MIV)
(CIV)
(B)with

Current Status Lot Status Lot Status Lot Status Lot
 Status 5 6 7 8
 G/Y/R G/Y/R G/Y/R G/Y/R

Nim	Requirement	Current Status	Lot 5	Lot 6	Lot 7	Lot 8	Comments
242	Combat Identification - The aircraft is interoperable with existing avionics systems, integrated with head-up display screen (O), interoperable with friendly and allied systems, highly jam resistant, and causes no degradation of other operating systems. Sensors are highly jam and spoof resistant, interoperable with existing weapons systems, compatible with planned/existing communications structure, highly accurate, stand-alone operations, interoperable with planned/existing position, location identification (PLI) systems, and interoperable with joint/allied systems.	Y					PR 03 FUNDING REQUEST FOR LOT 9 MW INCORPORATION, UPGRADED GPS RECEIVER
245	Support Equipment (SE) - Organizational and Intermediate level SE is required to be of modular design for two person maneuvering (without the aid of additional motorized material handling equipment) and transportable as internal cargo aboard the aircraft for strategic and tactical mobility (T).	G					REQUIRES POSE FOR VEHICLES (SHORING)
246	Support Equipment (SE) - SE must be operable and maintainable under all environmental conditions expected of the aircraft.	G					
247	Support Equipment (SE) - Automated test equipment (ATE) should be of modular design with each module weighing no more than 150 pounds (T)/120 pounds (O) and be operable and maintainable in all environmental conditions expected of the aircraft.	G					
248	Support Equipment (SE) - Peculiar SE must be kept to a minimum.	G					
249	Support Equipment (SE) - Organizational SE must be available prior to first aircraft delivery and must interface with the aircraft Built-In-Test/Built-In-Test Equipment (BIT/BIITE) to the maximum extent possible.	G					PMA RATING, DOT&E DID NOT EVALUATE

CURRENT STATUS
 G Full Capability Exists or Threshold Met
 Y Limited Capability Exists
 R No Capability or Threshold Not Met

STATUS ARROW
 ↑ Ahead of Recovery Plan
 → Recovery Plan on Schedule or Not Required
 ↓ Behind Recovery Plan

PROJECTION OF STATUS FOR LOT PRODUCTION
 G Complete or Meets Production Lot with Low Risk
 Y Current Plan Meets Production Lot with Low or Medium Risk
 R Current Plan Does Not Meet Production Lot
 N/A CV Specific Requirement to be Tested in CV OT-IH

JORD Requirements

Num	(M)/ (C)/ (B)/alt	Requirement	Current Status G/Y/R	Status Lot 5 G/Y/R	Status Lot 6 G/Y/R	Status Lot 7 G/Y/R	Status Lot 8 G/Y/R	Comments
250	B	Support Equipment (SE) - Intermediate level Automated Test Equipment (ATE) must be used to the maximum extent possible. ATE, test program sets, and adapters must be able to detect 100% of all supported Weapons Replaceable Assembly (WRA) faults.	G					PMA RATING, DOT&E DID NOT EVALUATE
251	B	Support Equipment (SE) - Intermediate level Automated Test Equipment (ATE), must be able to isolate 100% of all detected faults to three Shop Replaceable Assemblies (SRA), 95% to two SRAs, and 90% to one SRA (T).	G					PMA RATING, DOT&E DID NOT EVALUATE
252	B	Integrated Logistics Support (ILS) - Navy and Air Force policy on ILS shall be followed. An appropriately tailored MIL-STD-1388 ILSA shall be initiated and performed concurrently with DOT&E. Organic support at Initial Operational Capability (IOC) shall at a minimum, consist of a complete set of logistic resources required for organizational and shipboard maintenance of the system (T).	G					PMA RATING, DOT&E DID NOT EVALUATE
253	B	Manpower Constraints - The aircraft shall not require unique service skill levels.	G					
254	M	Manpower Constraints - The aircraft shall utilize integrated Military Occupational Specialty (MOS) codes.	G					
255	C	Manpower Constraints - The aircraft shall utilize Air Force Specialty Codes (AFSC).	G					
256	M	Manpower Constraints, USMC Aircrew - USMC pilot and enlisted aircrew (crewchiefs/aerial observers) manpower requirements and crew-to-seat ratios must not exceed those currently dedicated to CH-46E and CH-53D medium lift squadrons. A capability for full system flight operations with a minimum crew of two pilots and one crew chief is required (T).	G					

CURRENT STATUS
 G Full Capability Exists or Threshold Met
 Y Limited Capability Exists
 R No Capability or Threshold Not Met

STATUS ARROW
 ▲ Ahead of Recovery Plan
 → Recovery Plan on Schedule or Not Required
 ▼ Behind Recovery Plan

PROJECTION OF STATUS FOR LOT PRODUCTION
 G Complete or Meets Production Lot with Low Risk
 Y Current Plan Meets Production Lot with Low or Medium Risk
 R Current Plan Does Not Meet Production Lot
 NA CV Specific Requirement to Be Tested in CV OT-IH

JORD Requirements

Num	(M/Y) (C/Y) (B/oth)	Requirement	Current Status Lot				Status Lot				Comments	
			5	6	7	8	5	6	7	8		
257	C	Manpower Constraints, USSOCOM Aircrew - SOF pilot and enlisted aircrew manpower requirements must not exceed those currently dedicated to the MH-53J weapon system. A capability for full system flight operations with a crew of two pilots and two Flight Engineers (FE), one FE in the cockpit jump seat as an integral cockpit crew member and one FE in the cabin is required (T). A crew ratio of 1.5:1 at IOC and building to 2.0:1 at FOC is required (T).	G								CV IOT&E	
258	M	Manpower Constraints, USMC Maintenance Personnel - Direct Maintenance Spaces Per Aircraft (DMS/A) must not exceed current levels dedicated to CH-46E and CH-53D medium lift squadrons.										DOT&E VIEWS AS YELLOW, PMA VIEWS AS GREEN (COVERED IN RM&A POINT PAPER)
259	C	Manpower Constraints, USSOCOM Maintenance Personnel - Direct Maintenance Spaces Per Aircraft (DMS/A) must be <=20.5 people per aircraft (T) <=13.33 people per aircraft (O).	G									CV IOT&E
260	M	Training - The training concepts, devices, training agencies, and equipment requirements will be developed in concert with USSOCOM requirements and promulgated in the JTP- and TDRD. Appropriate computer courseware (hardware and software), flight trainers, instrument trainers, weapons systems trainers, maintenance trainers, and publications will be	G									VALIDATE IN FOT&E
261	C	Training - An integrated, ground based training system support aircrew and maintenance training, formal school curricula, and combat mission refresher training is required.	G									CV IOT&E

CURRENT STATUS
 G Full Capability Exists or Threshold Met
 Y Limited Capability Exists
 R No Capability or Threshold Not Met

STATUS ARROW
 ← Ahead of Recovery Plan
 → Recovery Plan on Schedule or Not Required
 ⇐ Behind Recovery Plan

PROJECTION OF STATUS FOR LOT PRODUCTION
 G Complete or Meets Production Lot with Low Risk
 Y Current Plan Meets Production Lot with Low or Medium Risk
 R Current Plan Does Not Meet Production Lot
 N/A CV Specific Requirement to Be Tested in CV OT-III

JORD Requirements

Num	(M) V (C) V (B) oth	Requirement	Current Status Lot Status Lot Status Lot Status Lot					Comments
			5	6	7	8		

262 C Training - A total training system that maximizes the integration of curriculum, training media, courseware, stand up instruction, facilities, management support, support equipment and the aircraft is required. Resources and provisions must be provided to accommodate training for all personnel who will operate, support, and maintain the aircraft throughout its life cycle (T).

263 C Training - Concurrency of training devices (TD) through the life cycle of the aircraft is required (T). All TDs should be reconfigurable in a simple, complete manner to rapidly accommodate engineering change proposals (ECP), operational flight programs (OFP), design enhancements, and aircraft modifications. Applicable ECPs and OFPs must be written to include TDs. This includes the capability to incorporate changes required to bring the CV-22 up to a full JORD compliant configuration (T).

264 B Logistics Considerations - A task oriented, Integrated Electronic Technical Manual (IETM) system (Level 4) is required at the Organizational and Intermediate maintenance levels (T).

265 B Logistics Considerations - Computer Aided Acquisition and Logistics Support (CAALS) for technical data is required as specified in OPNAVINST 3120.5, AF1 21-104, and DoD MIL-HDBK-59 (T).

266 B Command, Control, Communications, Computers, and Intelligence - Interoperability with existing (T) and planned (O/P3) DoD systems is required (T) and with allied service systems is desired (O).

267 B Command, Control, Communications, Computers, and Intelligence - A DoD approved High Order Language (HOL) must be used for all newly developed software (T).

CV IOT&E

CV IOT&E

SOFTWARE UPGRADES IN WORK. SYSTEM VALIDATION IN OT-IIIIB

PMA RATING, DOT&E DID NOT EVALUATE

A JOINT PMA-DOT&E POINT PAPER ADDRESSING INTEROPERABILITY/COMMUNICATION ISSUES

CURRENT STATUS
 G Full Capability Exists or Threshold Met
 Y Limited Capability Exists
 R No Capability or Threshold Not Met

STATUS ARROW
 ▲ Ahead of Recovery Plan
 → Recovery Plan on Schedule or Not Required
 ▼ Behind Recovery Plan

PROJECTION OF STATUS FOR LOT PRODUCTION
 G Complete or Meets Production Lot with Low Risk
 Y Current Plan Meets Production Lot with Low or Medium Risk
 R Current Plan Does Not Meet Production Lot
 N/A CV Specific Requirement to Be Tested in CV OT-III

JORD Requirements

Num	(M/V) (B/oth)	Requirement	Current Status Lot Status Lot Status Lot Status Lot								Comments	
			5	6	7	8	9	10	11	12		
268	B	Command, Control, Communications, Computers, and intelligence - interface with existing and planned information sources to receive and process intelligence, flight planning, and support data in near Command, Control, Communications, Computers, and intelligence - Provide an override function to allow incorporation of local updates (T).	R									CV IS CURRENTLY GREEN WITH "MATT". PR03 ISSUE REQUESTING DATA LINK FOR MV
269	B	Command, Control, Communications, Computers, and intelligence - Support entry, time stamping, access retrieval, modification, and deletion of data as well as frequency keying and zeroizing capability (T).	G									
270	B	Command, Control, Communications, Computers, and intelligence - Be able to input to a standard DSS or to interface directly with the aircraft avionics system.	G									
271	B	Transportation - The aircraft is required to be self-deployable to all theaters of operations.	G									
272	B	Transportation - For intra-theater movements, all required supplies and SE must be V-22 transportable.	G									
273	B	Transportation - For inter-theater movements, all required supplies and SE must be C-141/C-17/C-130 transportable (T).	G									
274	B	Transportation - The capability to transport required SE, supplies/spare parts, munitions (7 day supply), and support personnel with personal gear for 3 aircraft for a 30 days deployment in no more than 5 C-141 equivalent sorties is required (T) and no more than 3 C-141 equivalent sorties is desired (O).	G									
275	C	Racing - The aircraft will utilize existing bases and facilities in place at time of fielding. Additionally, the aircraft will be required to operate from air capable ships, fully supported forward main bases, and austere forward operating bases.	G									CV IOT&E
276	B	PROJECTION OF STATUS FOR LOT PRODUCTION G Complete or Meets Production Lot with Low Risk Y Current Plan Meets Production Lot with Low or Medium Risk R Current Plan Does Not Meet Production Lot N/A CV Specific Requirement to Be Tested in CV OT-IH										

JORD Requirements

Num	(M)/ (CV)	(B)/oth	Requirement	Current Status Lot		Status Lot		Status Lot		Comments
				G/Y/R	G/Y/R	G/Y/R	G/Y/R	G/Y/R		
277	B		Interoperability with Joint Service, and Allied Systems - The aircraft must comply with applicable provisions contained in the DoD Joint Technical Architecture (JTA) to include DII COE compliance.	G						JITC CERTIFICATION IN WORK
278	B		Energy Standardization and Efficiency Needs - The aircraft must operate with JP-5 and JP-8 fuel as well as their civilian and NATO equivalents (T).	G						
279	B		Geographical Information and Services (GIS) - The navigation system must support joint interoperability by allowing navigation with respect to all datum. Standard GIS products from the National Imagery and Mapping Agency (NIMA) should be used to support digitized moving map and navigational technologies (T). The navigation system must also have the capability to translate all ingested datums to the DoD standard WGS-84.	Y						VALIDATE IN OT-III
280	M		Key Performance Parameter (KPP) - Cruise Speed 240 kts (T)/270 kts (O).	G						
281	C		Key Performance Parameter (KPP) - Cruise Speed 230 kts (T)/250 kts (O).	G						CV IOT&E
282	C		Key Performance Parameter (KPP) - Mission Radius (Long Range Special Ops) 500 nm (T)/750 nm (O).	G						CV IOT&E
283	B		Key Performance Parameter (KPP) - Mission Radius (Pre Assault Raid) 200 nm X 1 (T)/(O)	G						
284	M		Key Performance Parameter (KPP) - Mission Radius (Sea Trooplift) 50 nm X 2 (T)/110 nm X 2 (O).	G						
285	M		Key Performance Parameter (KPP) - Mission Radius (Sea External) 50 nm X 1 (T)/110 nm X 1 (O).	G						
286	M		Key Performance Parameter (KPP) - Mission Radius (Land Trooplift) 200 nm X 1 (T)/(O).	G						
287	M		Key Performance Parameter (KPP) - Mission Radius (Land External) 50 nm X 1 (T)/110 nm X 1 (O).	G						

CURRENT STATUS
 G Full Capability Exists or Threshold Met
 Y Limited Capability Exists
 R No Capability or Threshold Met

STATUS ARROW
 ▲ Ahead of Recovery Plan
 → Recovery Plan on Schedule or Not Required
 ▼ Behind Recovery Plan

PROJECTION OF STATUS FOR LOT PRODUCTION
 G Complete or Meet Production Lot with Low Risk
 Y Meet Production Lot with Medium Risk
 R Current Plan Does Not Meet Production Lot or Medium Risk
 N/A CV Specific Requirement to Be Tested in CV OT-III

JORD Requirements

Num	(M)/ (C)/ (B)/oth	Requirement	Current Status Lot		Status Lot		Status Lot		Comments
			G/Y/R	G	G/Y/R	G/Y/R	G/Y/R		
288	B	Key Performance Parameter (KPP) - Self-Deployment range 2100 nm with 1 refuel (T)/2100 nm with 0 refuel (O).	G						
289	M	Key Performance Parameter (KPP) - Payload (troopseating) 24 (T)/(O).	G						
290	C	Key Performance Parameter (KPP) - Payload (Troop seating) 18 (T)/24 (O).	G						CV IOT&E
291	M	Key Performance Parameter (KPP) - Payload (External Lift) 10,000 lb (4536 kg) (T)/15,000 lb (6804 kg) (O).	G						
292	B	Key Performance Parameter (KPP) - VISTOL Capable (T)/(O).	G						
293	B	Key Performance Parameter (KPP) - Shipboard Compatible (T)/(O).	G						
294	B	Key Performance Parameter (KPP) - Aerial Refuel Capable (T)/(O).	G						
295	M	Key Performance Parameter (KPP) - Survivability 12.7 mm @ 90% VEL (T)/14.5 mm @ 90% VEL (O).	G						
296	C	Key Performance Parameter (KPP) - Operational Environment 300 ft TFFTA, Day/Night, VMC/IMC (T)/100 ft TF/1A, Day/Night, VMC/IMC (O).	G						CV IOT&E
297	C	Key Performance Parameter (KPP) - Precision Navigation - Locate LZ within 2X Rotor Diameter @ Max Combat Radius (T)/Locate LZ within 1X Rotor Diameter @ Max Combat Radius (O).	G						CV IOT&E
298	C	Key Performance Parameter (KPP) - Weapons System Reliability - >=0.77 (T)/>=0.84 (O).	G						CV IOT&E

CURRENT STATUS
 G Full Capability Exists or Threshold Met
 Y Limited Capability Exists
 R No Capability or Threshold Not Met

STATUS ARROW
 ▲ Ahead of Recovery Plan
 → Recovery Plan on Schedule or Not Required
 ▼ Behind Recovery Plan

PROJECTION OF STATUS FOR LOT PRODUCTION
 G Complete or Meets Production Lot with Low Risk
 Y Current Plan Meets Production Lot with Low or Medium Risk
 R Current Plan Does Not Meet Production Lot
 N/A CV Specific Requirement to Be Tested in CV O-I-III

JORD Requirements

(M)Y
(C)Y
(B)oth
298 M

Requirement

Amphibious Pre-Assault/Raid Operations - Execute a vertical takeoff with a minimum of 18 (T)/24 (O) combat equipped Marines or an internally carried vehicle with a crew of three combat equipped Marines, from an air capable ship and Hover Out of Ground Effect (HOGE) at sea level/103°F/39.44°C in no wind conditions at 95% engine Takeoff Rated Power (TRP). Transition to forward flight and transit at best cruise airspeed at or below 500 feet AGL for 200 nautical miles (nm) to a confined area landing zone at 3000 feet Mean Sea Level (MSL)/91.50p/33.05°C. Transition to and HOGE at 95% engine TRP. In no wind conditions, execute a vertical landing and discharge the payload. Then execute a vertical takeoff, transition to forward flight, clearing a 50 foot obstacle within 100 feet horizontally, and transit at best cruise airspeed at or below 500 feet AGL for 200nm to return to the ship and land. The flight profile must be completed without refueling, and must include sufficient fuel to loiter in the vicinity of the CAL for 30 minutes after delivery of the payload. The loiter fuel requirement is in addition to the OPNAVINST 3710.7 reserve fuel requirement.

Current Status Lot Status Lot Status Lot Status Lot
G 5 6 7 8
G/Y/R G/Y/R G/Y/R G/Y/R G/Y/R

Comments

CURRENT STATUS
G Full Capability Exceeds or Threshold Met
Y Limited Capability Exceeds
R No Capability or Threshold Not Met

STATUS ARROW
▲ Ahead of Recovery Plan
→ Recovery Plan on Schedule or Not Required
▼ Behind Recovery Plan

PROJECTION OF STATUS FOR LOT PRODUCTION
G Complete or Meets Production Lot with Low Risk
Y Limited Capability Exceeds Production Lot with Low or Medium Risk
R Current Plan Does Not Meet Production Lot
N/A CV Specific Requirement to Be Tested in CVOT-III

JORD Requirements

Num	(M)/ (C)/ (B)/with	Requirement	Current Status	Status Lot G/Y/R	Status Lot G/Y/R	Status Lot G/Y/R	Status Lot G/Y/R	Comments
300	M	Amphibious Troop Lift - Execute a vertical takeoff, with 24 combat equipped Marines or an internally carried vehicle with a crew of three combat equipped Marines, from an air capable ship and HOGGE at sea level/103oF/39.44°C in no wind conditions, at 95% engine TRP. Then transition to forward flight and climb to and loiter, at or below 1000 feet AGL for 40 minutes. Next, transit at best cruise airspeed at or below 500 feet AGL for 50nm (T)/110nm (O) to a confined area landing zone at 3000 feet MSL/91.5oF/33.05°C. Transition to and HOGGE at 95% engine TRP, in no wind conditions, and execute a vertical landing and discharge the payload. Then execute a vertical takeoff, transition to forward flight, clearing a 50 foot obstacle within 100 feet horizontally, climb to and transit at or below 500 feet AGL for 50nm (T)/110nm (O) to return to the ship, loiter 15 minutes, and then land. Repeat preceding mission flight profile, excepting the initial 40 minute loiter, without refueling.	G	5	6	7	8	
301	M	Amphibious External Lift - Execute a 10,000 lb/4536 kg external cargo payload pick-up from an air capable ship at sea level/103oF/39.44°C and HOGGE, in no wind conditions, at 95% engine TRP. Then transition to forward flight and transit at optimum airspeed at or below 500 feet AGL for 50nm (T)/110nm (O) to a confined area landing zone at 3000 feet MSL/91.5oF/33.05°C. Transition to and HOGGE at 95% engine TRP, in no wind conditions, for five minutes and release the payload. Then transition to forward flight, clearing a 50 foot obstacle within 100 feet horizontally, and transit at best cruise airspeed at or below 500 feet AGL for 50nm (T)/110nm (O) to return to the ship, loiter 15 minutes, and land prior to first refueling.	G					

PROJECTION OF STATUS FOR LOT PRODUCTION
 G Complete or Meets Production Lot with Low Risk
 Y Current Plan Meets Production Lot with Low or Medium Risk
 R Current Plan Does Not Meet Production Lot
 N/A CV Specific Requirement to Be Tested in CV-T-IH

STATUS ARROW
 ← Ahead of Recovery Plan
 → Recovery Plan on Schedule or Not Required
 ↔ Behind Recovery Plan

CURRENT STATUS
 G Full Capability Exists or Threshold Met
 Y Limited Capability Exists
 R No Capability or Threshold Not Met

JORD Requirements

M/N (C)Y 302	M	Requirement	Current Status		Status Lot 5		Status Lot 8		Comments
			G/YR	G/YR	G/YR	G/YR			

Land Assault Troop Lift. Execute a vertical takeoff, with 24 combat equipped Marines or an internally carried vehicle with a crew of three combat equipped Marines, from a confined area landing zone and HOGÉ at 3000 feet MSL/91.50F/33.05°C, in no wind conditions, at 95% engine TRP. Transition to forward flight, clearing a 50 foot vertical obstacle within 100 feet horizontally. Climb to and transit at or below 500 feet AGL at best cruise airspeed for 200nm to another confined area landing zone at 3000 feet MSL/91.50F/33.05°C. Transition to and HOGÉ at 95% engine TRP, in no wind conditions, and execute a vertical landing and discharge payload. Then execute a vertical takeoff, transition to forward flight, clearing a 50 foot vertical obstacle within 100 feet horizontally, climb to and transit at or below 500 feet AGL at best cruise airspeed for 200nm to the point of origin. Transition to a HOGÉ and execute a vertical landing. This mission flight profile must be done without refueling.

Land Assault External Lift. - Execute a 10,000 lb/4536 kg external cargo payload pick-up from a confined area landing zone at 3000 feet MSL/91.50F/33.05°C and HOGÉ, in no wind conditions, at 95% engine TRP. Transition to forward flight, clearing a 50 foot vertical obstacle within 100 feet horizontally. Climb to and transit at or below 500 feet AGL at optimum airspeed for 50nm (T)/110nm (O) to another confined area landing zone at 3000 feet MSL/91.50F/33.05°C. Transition to and HOGÉ at 95% engine TRP, in no wind conditions, for five minutes and release payload. Then transition to forward flight, clearing a 50 foot vertical obstacle within 100 feet horizontally, and transit at or below 500 feet AGL at best cruise airspeed for 50nm (T)/110nm (O) to point of origin. Transition to a HOGÉ and execute a vertical landing. This mission flight profile must be done without refueling.

PROJECTION OF STATUS FOR LOT PRODUCTION
 G Complete or Meets Production Lot with Low Risk
 Y Current Plan Meets Production Lot with Low or Medium Risk
 R Current Plan Does Not Meet Production Lot
 NA CV Specific Requirement to Be Tested in CV OT-III

STATUS ARROW
 ▲ Ahead of Recovery Plan
 → Recovery Plan on Schedule or Not Required
 ▼ Behind Recovery Plan

CURRENT STATUS
 G Full Capability Exists or Threshold Met
 Y Limited Capability Exists
 R No Capability or Threshold Not Met

JORD Requirements

(M)/
(C)
(B)/oth
C
Num
304

Requirement

Long Range Special Operations - The JMVX must be capable of transporting 18 mission equipped troops (4770 lb/2,272 kg) (Threshold)/24 troops (6,360 lb/2,885 kg) (Objective) 500 nm (Threshold)/750 nm (Objective), off-load the troops from a 70 foot HOGE in 1 minute, and return 500 nm (Threshold)/750 nm (Objective). The transition from HOGE to forward flight must clear a 50 foot obstacle within 100 feet horizontally. The aircraft must be capable of flying this mission under Tropical Day conditions except for the takeoff and landing which shall be performed at sea level, 88°F/32°C, and the mid-point hover which shall be at 3,900 feet, 82°F/28°C. Outbound cruise shall be restricted to no greater than 10,000 feet pressure altitude (PA). The final 250 nautical miles prior to the mid-point shall be flown in the terrain following/terrain avoidance mode starting at 300 feet PA and increasing 144 feet PA per 10 nautical miles flown. The first 250 nautical miles of the return flight shall also be flown in the terrain following/terrain avoidance mode starting at 3,900 feet and decreasing 144 feet per 10 nautical miles flown. Cruise portions of the mission shall be flown at constant airspeeds. Fuel capacity must permit arrival over destination with enough usable fuel to increase the total planned flight time between refueling points by 10 percent or 20 minutes at Best Endurance Velocity (VBE) at 10,000 feet MSL, whichever is greater.

Current Status Lot Status Lot Status Lot Status Lot Status Lot
G/Y/R G/Y/R G/Y/R G/Y/R G/Y/R G/Y/R

Comments

CV/OT&E

CURRENT STATUS
G Full Capability Exists or Threshold Met
Y Limited Capability Exists
R No Capability or Threshold Not Met

STATUS ARROW
▲ Ahead of Recovery Plan
→ Recovery Plan on Schedule or Not Required
▼ Behind Recovery Plan

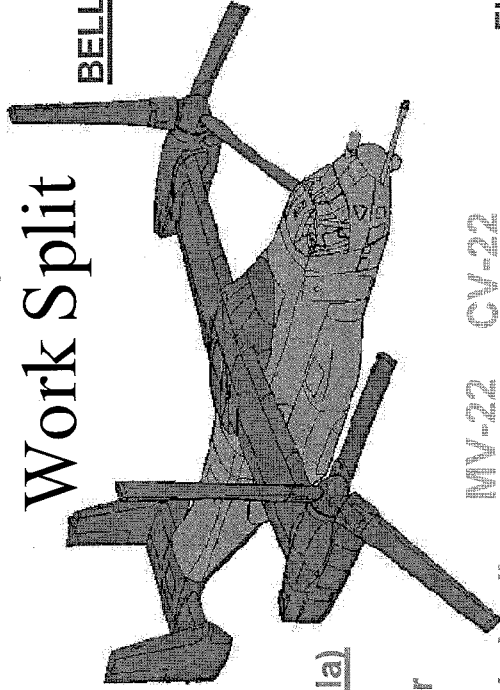
PROJECTION OF STATUS FOR LOT PRODUCTION
G Complete or Meets Production Lot with Low Risk
Y Current Plan Meets Production Lot with Low or Medium Risk
R Current Plan Does Not Meet Production Lot
N/A CV Specific Requirement to Be Tested in CV OT-IH

APPENDIX G

BELL-BOEING TEAM WORK SPLIT

Bell-Boeing Team

Work Split



BOEING (Phila)

Fuselage
Landing Gear
Avionics
Electrical & Hydraulic
Performance
Flying Qualities
Development Flight Test

BELL (Arlington, Tx)

Wing
Wing Fairing
Nacelles
Propulsion
Rotors
Dynamics
Empennage
Ramp
Final Assembly
Flight Operations
Delivery
Electronic Warfare Systems

MV-22 CV-22

Final Assembly BELL (Amarillo, Tx)

APPENDIX H

GLOSSARY

Acronym	Definition
A/C	Aircraft
ACM	Air Combat Maneuvering
AGL	Above Ground Level
AMEGS	Aviation Maintenance Event Ground Station
AoA	Angle of Attack
BFWS	Blade Fold/Wing Stow
BIT	Built-In-Test
CAI	Computer Aided Instruction
CAL	Confined Area Landing
CAS	Calibrated Air Speed
COEA	Cost & Operational Effectiveness Analysis
CPI	Cost Performance Index
DCMA	Defense Contracts Management Agency
DSS	Data Storage Set
DT	Development Testing
EI	Engineering Investigation
EMD	Engineering & Manufacturing Development
FA	False Alarm
FADEC	Full Authority Digital Engine Control
FCC	Flight Control Computer
FD	Fault Detection
FFS	Full Flight Simulator
FI	Fault Isolation
FLIR	Forward Looking Infra-Red
FLOT	Forward Line of Own Troops
FMC	Full Mission Capable
FOC	Full Operational Capability
FOD	Foreign Object Debris
FOT&E	Follow On Test & Evaluation

APPENDIX C – PANEL FACT FINDING ACTIVITIES

FPI	Fixed Price Incentive
FRS	Fleet Replacement Squadron
FSD	Full Scale Development
GSE	Ground Support Equipment
HAZREP	Hazard Report
HIGE	Hover In Ground Effect
HMD	Helmet Mounted Display
HMR	Hazardous Material Report
HOGE	Hover Out of Ground Effect
HROD	High Rate Of Decent
HUD	Head-Up Display
ICDS	Inter-Connected Drive Shaft
ICW	Interactive Courseware
IETM	Interactive Electronic Technical Manual
ILS	Integrated Logistics Support
ILSP	Integrated Logistics Support Plan
IMC	Instrument Meteorological Conditions
IMI	Interactive Multi-media Instruction
IOC	Initial Operational Capability
IOT&E	Initial Operational Test & Evaluation
IPT	Integrated Project Team
ITT	Integrated Test Team
JASS	JMVX Applications System Software
JORD	Joint Operational Requirements Document
KPP	Key Performance Parameter
LATT	Low Altitude Terrain Tactics
LFT&E	Live Fire Test & Evaluation
LHA	Amphibious Assault Ship, TARAWA Class
LHD	Amphibious Assault Ship, WASP class
LRIP	Low Rate Initial Production
LSA	Logistics Support Analysis
LSAR	Logistics Support Analysis Report
LZ	Landing Zone
MAF	Maintenance Action Form
MAGTF	Marine Air Ground Task Force
MC	Mission Capable
MCAS	Marine Corps Air Station

APPENDIX C – PANEL FACT FINDING ACTIVITIES

MEU(SOC)	Marine Expeditionary Unit (Special Operations Capable)
MFD	Multi-Functional Display
MFHBA	Mean Flight Hours Between Abort
MFHBF	Mean Flight Hours Between Failure
MFHBUM	Mean Flight Hours Between Unscheduled Maintenance
MMH/FH	Maintenance Man-Hours/Flight Hour
MOUT	Military Operations in Urban Terrain
MR	Mission Reliability
MRTa	Mean Repair Time after Abort
MTAT	Mean Turn Around Time
MTBF	Mean Time Between Failure
NALCOMIS	Naval Aviation Logistics Command Management Information System
NAMTS	Naval Aviation Maintenance Trainer Suite
NATOPS	Naval Air Training and Operating Procedures Standardization
NAWC	Naval Air Warfare Center
NBC	Nuclear, Biological & Chemical
NOE	Nap-Of-the-Earth
OEI	One Engine Inoperative
OFT	Operational Flight Trainer
OGE	Out of Ground Effect
OMF	Operational Mission Failure
OMFTS	Operational Maneuver From The Sea
OPEVAL	Operational Evaluation
ORD	Operational Requirements Document
PAA	Primary Aircraft Authorized
PEDD	Portable Electronic Display Device
PEO	Program Executive Officer
PIO	Pilot Induced Oscillation
PRGB	Prop-Rotor Gear Box
PTT	Part Task Trainer
QA	Quality Assurance
QMS	Quality Management System
RFI	Ready For Issue
RM&A	Reliability, Maintainability & Availability
S/A	Situational Awareness
SAR	Safety Action Records
SAR	Search And Rescue

APPENDIX C – PANEL FACT FINDING ACTIVITIES

SAR	Selected Acquisition Report
SME	Subject Matter Expert
SOF	Special Operations Force
SPI	Schedule Performance Index
SPIE	Special Personnel Insertion & Extraction
STO	Short Take Off
TACAN	Tactical Air Navigation
TAS	True Air Speed
TCL	Thrust Control Lever
TF/TA	Terrain Following/Terrain Avoidance
TOA	Total Obligation Authority
TOC	Total Ownership Cost
USSOCOM	US Special Operations Command
VLATT	V-22 Low Altitude Terrain Tactics
VMC	Visual Meteorological Conditions
VMS	Vehicle Management System
VRS	Vortex Ring State
VSLED	Vibration, Structural Life, and Engine Diagnostic system
VTOL	Vertical Take Off & Landing
WSR	Weapon System Reliability

General DAILEY. We recommended that the program be continued but restructured. We found no evidence of an inherent safety flaw in the V-22 tiltrotor concept, that the requirement is justified, and that the V-22 has demonstrated its ability to satisfy the requirement. However, we found that the V-22 lacks the maturity needed for full-rate production or operational use.

We recommended temporarily reducing production to a minimum sustaining level which will provide funds for the maturation program while keeping the number of aircraft requiring retrofit to a minimum. To recover program cost and schedule, we recommended that the program ultimately procure at a higher, more efficient rate with a firm, fixed-price, multiyear contract. We also recommended implementation of a phased approach to return to full-rate production and operation.

Mr. Chairman, this concludes my statement on behalf of the panel, and we are now ready for your questions.

[The prepared statement of General Dailey follows:]

PREPARED STATEMENT BY GEN. JOHN R. DAILEY, USMC (RET.)

Mr. Chairman and members of the committee, we are pleased to appear today to discuss the findings and recommendations of The Panel to Review the V-22 Program. The panel is composed of four members: Norman R. Augustine, Dr. Eugene E. Covert, Gen. James B. Davis, USAF (Ret.), and myself as the Chairman. Secretary of Defense Cohen determined that the accident history of the V-22 aircraft and other testing issues required an independent review of the program.

I would like briefly to review our activities. The panel was commissioned on December 15, 2000 and met with the Deputy Secretary of Defense on December 28, 2000. Fact-finding activities started on January 11, 2001. These consisted of briefings on the Marine Corps and Special Operations Command mission requirements, the ability of the V-22 aircraft to meet the requirements and the program status. We were briefed by the Program Manager, the Director of Operational Test and Evaluation, and the General Accounting Office. We spoke to the Naval Air Systems Command, test personnel, pilots, maintainers and contractors.

In March we conducted site visits. We visited the training squadron at Marine Corps Air Station, New River, North Carolina and Special Operations Command at MacDill Air Force Base, Florida. After a visit at Bell Helicopter in Fort Worth and Amarillo, Texas we concluded our visits at Boeing Helicopter in Philadelphia, Pennsylvania. During this time we toured the flight line, training facilities, maintenance spaces, factories and engineering laboratories and flew the V-22 simulator.

On March 9, we conducted an open meeting to provide the general public the opportunity to submit information to the panel about the V-22 program.

On April 18, we held an open meeting to conduct public deliberations in preparation for submitting our recommendations to the Secretary of Defense. Our purpose today is to present a summary of our findings, conclusions and recommendations and with your permission, submit a copy of our report for the record.

We recommended that the program be continued, but restructured. We found no evidence of an inherent safety flaw in the V-22 tiltrotor concept, that the requirement is justified, and that the V-22 has demonstrated its ability to satisfy the requirement. However, we found that the V-22 lacks the maturity needed for full-rate production or operational use.

We recommended temporarily reducing production to a minimum sustaining level, which will provide funds for the maturation program while keeping the number of aircraft requiring retrofit to a minimum. To recover program cost and schedule, we recommended the program ultimately procure at a higher, more efficient rate with a firm, fixed-price multiyear contract. We also recommended implementation of a phased approach to return to full-rate production and operation.

Mr. Chairman, this concludes my statement on behalf of the panel and we are now ready for your questions.

Chairman WARNER. Thank you very much.

Many people are following this hearing who do not have the benefit of all of the background and documents that we have before us

to draw a conclusion. In just your own simple expression of terms, is it the judgment of yourself and the panel that this technology can, at some point in time, be made safe and that an operational fleet of these aircraft can be manufactured?

General DAILEY. It is the opinion of the panel that this is so.

Chairman WARNER. Do you have a period of time in which you would hope that this technology will be established as ready to go into full production?

General DAILEY. We recommended that the production be reduced at this point until the deficiencies in the current design are corrected.

I think it is important to point out here, sir, that we are not talking about technology. These are not technological barriers that are being faced. These are production issues that have arisen as a result of the dense packing of the nacelle primarily with hydraulic lines, wire bundles, and fasteners that hold them in place. So, this is not a rewinging or technology issue of that magnitude. However, there is significant indication that work needs to be done in these areas.

This is a 5,000 pound hydraulic system which is the wave of the future. The F-18E/F and the F-22 are using this pressure also, as opposed to the 3,000 pounds that we had in previous aircraft. It provides you the opportunity to use smaller actuators so you can get a more compact packing or density of the nacelle and the advantages it provides.

But there are still things to be learned. They are using titanium lines, which are very strong and light, but they are also more brittle than stainless steel and more subject to chafing. Therefore, when the fasteners do not hold the parts in the proper position, they rub against each other, which is what happened in one of the accidents.

We recommend reengineering the nacelle. We suggest going back in and taking a look at all of these systems that are in the nacelle to see how they interoperate and how they are placed, and to determine the operational environment in terms of temperature, vibration, and acoustics. This has been done, but perhaps more is required.

Chairman WARNER. You used the term very carefully, and it is clearly understandable—there were deficiencies in design—that is a finding by this panel.

Mr. Augustine, you have spent a lifetime with firms that do design, research and development, test and evaluation, and production. The panel has determined that these deficiencies existed, and I would like to get a clear understanding as to why they were not detected beforehand. To enlighten the committee and all those following this hearing, why were they not discovered by others and remedied before this aircraft was utilized in such a way as to put at severe risk those operating it?

Mr. AUGUSTINE. Mr. Chairman, that is a question that we have all thought about a good deal these past 4 months. I think the first thing I need to observe is that this is a very complex machine. It is very complex aerodynamically and it is very complex mechanically.

There were certain things that were not done that in retrospect, I am sure the designers wish they had done. One of those things was to do more analysis, of what we in the trade call "single-point failures"—in other words, where one single failure can have a catastrophic result. In most cases aircraft are designed to have two; in the case of this aircraft, often three failures are required before you can lose the aircraft. Had a more thorough single-point failure analysis been done, I think that we could have had a better status today.

A second thing that I believe was not done was to evaluate off-nominal conditions in the software. The software is complicated—that is true of many systems today. I would submit that one can look at code by the hour and not find the subtleties that contributed to one of the accidents. I think one has to test over and over and over, but particularly in off-nominal conditions where something has gone wrong and you are in a mode you had not expected to be in.

The third thing I would submit would be that, over the years, the test program for defense systems has turned into one where it is more a case of filling out a report card—and if you do not fill in this square properly, your program will be canceled. Whereas, in the past, test programs focused more on what can we break, how can we break it, and can we fix it, and can we break it safely and test. I think today, testing is much more cautious and less exhaustive, less probing than it used to be.

Those would be the three principal things that come to my mind.

Chairman WARNER. The findings of this panel can be utilized throughout our whole military procurement program in terms of testing.

Mr. AUGUSTINE. I think even more broadly than that, Mr. Chairman. We put together a list of 17 characteristics where we see problems in the acquisition program as a whole, and we compared the V-22 with that list. In most cases, the V-22 was not particularly dissimilar from other aircraft. In fact, even the accident rate at this point for the V-22 is not that much greater than other aircraft.

I think the big difference is, in my own case where I am more familiar, for example, with the F-16, when you lose an early F-16, which is a tragedy, usually there is only one person on board. It is a pilot and often a test pilot. In this case, you had a large number of marines riding in the back.

Chairman WARNER. My last question, General Dailey. As I am sure you are aware, there is an ongoing investigation by the Department of Defense Inspector General concerning an allegation of falsification of maintenance records for the V-22. Did your panel also look into this allegation, and if so, is there any potential that this maintenance record falsification, if the allegation proves to be true, could have contributed to the V-22 tragic accidents of April or December?

General DAILEY. We did not look specifically into this allegation, sir. It is being covered by the Inspector General, and we do not have the report. However, they had our report and they reviewed it. We have a letter from the Inspector General saying there are no inconsistencies with our findings and theirs.

Chairman WARNER. Thank you very much.

Due to the large number of Senators, we will adhere to a 6-minute rule very carefully.

Senator LEVIN.

Senator LEVIN. Has the Inspector General concluded his report?

General DAILEY. I don't believe so.

Senator LEVIN. How could they then say that there are no inconsistencies between their conclusions and yours if they have not yet finished their report?

General DAILEY. I believe that they have proceeded to the point where they are writing their report and have not completed it, but they have the findings and were able to determine that we are consistent with what they found.

Senator LEVIN. I would like to ask some questions about the acquisition system itself. Since there were so many problems with significant safety issues that you identified, such as those with the hydraulic systems on the aircraft, how did the V-22 ever graduate to engineering and manufacturing development and begin flying troops in training missions, given that state of affairs? How could it have gotten to that point?

General DAILEY. I think that it is important to point out that in testing there were 13 key performance parameters that are required for the airplane to meet. It met all 13 of those. There are 241 additional thresholds that must either be met or modified by the customer as not being necessary. Out of those 241, 230, or 90 percent, were met, and there are 11 remaining that have either not been tested—for example, icing was not tested because it was in the summertime and there was no ice available. That was scheduled for later this fall. The maneuvering envelope for defensive aircraft maneuvering has not been tested but is scheduled.

Of those 11, none of those were issues that would keep the airplane from actually being fielded at this point because they were going to be tested prior or they could be determined to be unnecessary. Those were things that were not absolute requirements in order for the aircraft to proceed.

The maintenance problems that have been identified on the hydraulic system, which is the most talked about, have been in work, in one case, since 1999 they have been working on fixes for this. But they have been learning, as they have been going, in terms of the problems and how they are being manifested.

One of the things that has been found—and I think it is important to point out—we did not uncover any issue that was not identified to us by the program manager when we started this process. When we had our open meeting for the public, we gave everyone an opportunity to come in, and anything that wanted to be said about this program could be said. Our goal was to get every issue that we had heard or could find in writing or that had been stated in one way or another, and then run it to ground to find out what the facts are. That is what we have done in our report. We have taken every issue that we know of and we have taken it to a conclusion and a recommendation.

We concentrated on those things that have been identified as deficiencies, not those things that have been identified as being actually best in class in terms of the program. An example would be

the risk management program—interestingly enough, it is of such quality we have recommended that it be incorporated into the Defense Management College course for program management at Fort Belvoir.

So, there were things that were being done on this program that have been underway for quite some time. But there were things that were learned also that perhaps should have been learned earlier in a test program than they were.

Senator LEVIN. Secretary Cohen, as I understand it, did not ask you to look into the question of falsification of maintenance data in the operational squadron. Is that correct?

General DAILEY. That is correct, sir.

Senator LEVIN. Did you get any information from the Inspector General's investigation about the alleged attempts to falsify maintenance data?

General DAILEY. No, sir. We have no information from the IG.

Senator LEVIN. Now, if you do not have that information, what confidence do you have that the maintenance data that you used in arriving at your conclusions was honest?

General DAILEY. The maintenance data itself was not critical to our findings. It was the maintenance support system, including the technical publications, the device by which this information is displayed—which is essentially a laptop computer—and the training devices being utilized for maintenance training, which are all in great need of improvement before this system can be fielded. As a matter of fact, probably the major deficiency in terms of the reliability and supportability is the inability of the maintenance people to use the system that was put in place to support this aircraft.

It is interesting to note that a new airplane was being introduced at the same time a new maintenance support system was being introduced to support that aircraft. The electronic display system is also new.

So, I guess it was a case of not having any constants in the program. Everything was a variable. Therefore, the difficulty in working the system on a new aircraft where there was very low experience level has been the primary cause of problems that we have seen.

We did not address the data itself as being critical to our findings.

Senator LEVIN. During your review, did you come across any attempt to suppress or modify data to the Navy acquisition chain or to Congress on specific problems, such as the fact that the V-22 had been experiencing hydraulic system problems well before that crash in December 2000?

General DAILEY. No, sir, we did not. We were given all of the information by the program office, both contractors, and the training squadron. All of this information was made available to us.

Senator LEVIN. You came across no efforts to suppress, change, or modify any information that was provided either to Congress or to the acquisition chain?

General DAILEY. We have no information of that type, no, sir.

Senator LEVIN. Finally, why should we go ahead with any production of the V-22, including minimum sustaining rate produc-

tion, until we can be assured that any new design will be safe enough to carry troops?

General DAILEY. I think that the most important point here is that they have made significant progress in their learning curve and production. In our review we found that the initial aircraft that were delivered had about 35 discrepancies upon the acceptance check by the receiving unit. The last aircraft that was presented had four discrepancies. The people who are doing this work have come along significantly in terms of their ability to produce these airplanes.

This is a workforce that we feel is important to keep in place. Now, they do not have to work three shifts a day, but a one-shift, 5-day-a-week operation to keep that workforce in place and to keep the benefits of the learning curve that have already been developed are probably our principal reason for recommending that the line be kept open rather than shut down. Mr. Augustine may want to elaborate on that.

Mr. AUGUSTINE. Well, I think that the General has really stated what there is to be said.

Senator LEVIN. Thank you. Thank you, Mr. Chairman.

Chairman WARNER. Thank you, Senator Levin.

Just from a procedural standpoint General Dailey, I suppose many of the questions will come to you, but if other members of the panel wish to enter the colloquy with a Senator propounding a question, just indicate that to the Senator, and I am certain that you will be recognized either by the chair or by that Senator because we value the contribution of all of you. Thank you very much.

Senator Santorum.

Senator SANTORUM. Thank you, Mr. Chairman.

Thank you, members of the panel, for your service.

I am chairman of the Subcommittee on Airland. One of the things that I and my colleague, Senator Lieberman, have expressed concern about was mentioned just very briefly in one of your comments, the F-22, and the deferral of testing—I believe the concern about the use of simulation, modeling, and all the other things, as opposed to the actual testing. It is in a somewhat earlier stage of development than the V-22. That raises some concern from my perspective, given what we saw with V-22, deferral of testing, maybe too much use of simulation and modeling, that we may be getting into the same problem.

You made a comment that the hydraulic system used on the V-22 is similar to the one that is being used on the F-22?

General DAILEY. The pressure of the system.

Senator SANTORUM. The pressure—and that is new?

General DAILEY. Yes, it is.

Senator SANTORUM. I just wanted to make sure that I understood that correctly and raised that concern.

Could you tell me what areas of testing were deferred to potentially get us into this current problem and whether there are some lessons to be learned from other programs with respect to that subject?

General DAILEY. Yes, sir. I think that the testing that was deferred was that portion that was not considered necessary to go to

the next step in whatever the program was. An example of this would be in the vortex ring state, which is an issue with one of the mishaps. The envelope was expanded to 40 knots of air speed or less and 800 feet per minute rate of descent. That was the envelope that was cleared to go to the next phase of operations. We are recommending that that be taken much farther and that the characteristics of this vortex ring state be fully investigated before proceeding with operational pilots flying the airplane again.

Usually in these cases, where we are trying to get from one point to the next in terms of a schedule, the testing is taken to the point where it is considered adequate to certify an envelope of operations. That requires agreement from everyone involved before they proceed. I think that was probably the case here.

By the way, one of the things that we have also recommended is more simulation than was done with this airplane because there are high fidelity simulators now that are available at the contractor facility.

Senator SANTORUM. But not in lieu of actual testing.

General DAILEY. No. It would be a combination. But this is a place where you can do some of the more hazardous testing to make sure that you understand it completely before you actually go to the flight testing.

Senator SANTORUM. Any other deferments or any other waivers of testing that we should be aware of and learn from?

General DAILEY. I think it is the process.

Senator SANTORUM. You are suggesting that the process of meeting these particular benchmarks is actually driving a short-cutting of testing, just so you can reach that benchmark so you can go to the next stage?

General DAILEY. It can. I would say that it certainly could happen because testing costs money. It depends on the funding for the program. It depends on the schedule and what is enough to get you to the next step. I think that is one of the things that Mr. Augustine covered in the recommendations in terms of the entire acquisition system that we—

Senator SANTORUM. So, it is a minimalist approach. In other words, let us get to the next stage and then we will worry about those other tests. We are not looking at it from a more comprehensive point of view? Mr. Augustine, you seem to want to jump in here.

Mr. AUGUSTINE. Yes. I was just going to say that there are really two very critical decision points in an acquisition program. The first is to begin engineering development, and the second is to begin production. There has been a tendency, I believe, to focus on performance, meaning how far does it go, how high, how fast, and so on, at the expense of paying attention to its reliability—can it be maintained? Particularly at the second of those two milestones, it is every bit as important to be sure that the system is reliable, that it is safe, that it is maintainable. I think we placed too much focus on the more traditional performance parameters. I believe that has been one of the problems that this program has suffered, and it is certainly not the first program that has suffered in that regard.

Senator SANTORUM. General Davis.

General DAVIS. Senator, in the past I was with the F-16 program, and we not only tested the envelope that we had to get to operational evaluation (OPEVAL), but we actually worked the edges. That is where a great deal of learning comes, especially in the flight testing.

In the software testing, they had a good test setup, but there was not a man in the loop originally, at least as much as there should have been. Boeing has changed that. I think that if they had had a man in the loop, they might have predicted this difficulty they had in December, but it was a test that just was not done. It has been done and will continue to be done, and I think that is very important. If you have a lot of software where it goes fail/operate, fail/safe, you need to, as the chairman of the panel said, work the off-nominal testing to make sure that airplane is ready to go.

Senator SANTORUM. Dr. Covert.

Dr. COVERT. Sir, if I may. You made a reference to a comparison of the V-22 and the F-22. I think it is important to realize as advanced as the F-22 is, it still falls within a lot of experience we have had with other airplanes. I think it is important to realize the V-22 is an entirely new kind of machine. It can take off like a helicopter. It can cruise like an ordinary propeller-driven airplane. As such, I think that the testing requirements are larger for something new because we do not always know what to expect. So, I think there is a tendency to look at this as just another airplane, and I think that is a bad thing to do and it probably has resulted in some of the decisions that have been made, sir.

Senator SANTORUM. My time has expired. Thank you, Mr. Chairman.

Chairman WARNER. Thank you very much, Senator.

Senator REED.

Senator REED. Thank you very much, Mr. Chairman.

Gentlemen, thank you for your report. I think we all recognize that we have to get this right. This is an important potential asset to the Marine Corps, and it is something we have to do for the 23 marines and their families to make sure we have all the answers and go forward with that information.

Let me try to put it in context and ask General Dailey or Mr. Augustine or anyone else—in your experience, have we seen comparable problems in other systems that have successfully gone on to full production? I do not want to infer that this is routine, but is this within the scope of previous experience? Mr. Augustine.

Mr. AUGUSTINE. In my experience, I would say it is within the general range. There are some things here that are more extreme probably for the reason that we have a more complex system and a new concept. But if I look back at any number of programs that I have observed, accident rates in this general range have not been uncommon early, unfortunately. If one goes back 20 or 30 years, the accident rates were much, much higher than we are experiencing here. If I looked at a lot of programs that have been very successful—the Polaris, the overhead programs, the Sidewinder—I could list a number that had long streaks of failures that today I think would have guaranteed cancellation—once they had wrung the problems out, they turned out to be very good.

I think the key point is whether the problems are due to engineering implementation or whether they are conceptual, and that is the tough issue to address.

Senator REED. I presume from your report that you feel it is more an engineering than a conceptual problem. Is that correct?

Mr. AUGUSTINE. That was, of course, one of the fundamental questions that we had to address. There have been four accidents, with the V-22 and one with the XV-15 that was a precursor prototype. Of those five accidents, four quite clearly were not connected with the concept. One arguably was or was not.

Given that, I think the strongest thing I could say is that there is no evidence of a conceptual flaw. That does not guarantee there is not one, but there is certainly no evidence that there is a conceptual flaw with the V-22.

Senator REED. When you talk about conceptual flaw, another way is a design defect rather than some type of engineering defect.

Mr. AUGUSTINE. Is it something that good engineering should be able to solve or are you trying to fight the laws of nature?

Senator REED. In that concept, as you looked at your review of the design of the aircraft, did you measure against the full range of operational tests or operational environments that this aircraft would operate in? General Dailey, perhaps you could respond.

General DAILEY. The testing that has been conducted does do that, with the exception of the icing test, as I mentioned, they are waiting for the cold weather to get the environment. But the performance parameters that are required as the primary requirements for the airplane have been met and thoroughly tested.

Senator REED. Mr. Augustine alluded to this. One of the real tragedies is that unlike some other programs, where the nature of the aircraft was a single-seater and there was an experienced test pilot, we lost 19 young marines in the incident in Arizona in a more operational test. That is what I am getting at in terms of the operational arena that this aircraft might be employed in.

You are confident that, given all the missions posited for this—bringing marines over the beach, inserting special operations troops by various means—that there is not a design flaw with respect to those operations.

General DAILEY. Yes. As a matter of fact, it is the design that is going to probably make them more successful in those types of operations than they would be with the current systems because of the speed, range, and payload. The survivability of this airplane is significant. The testing that has been done there with live-fire tests have indicated that the survivability is going to be greatly enhanced over the existing systems.

Senator REED. Just a final point and maybe a conclusory point. You all seem to be saying that this is now an engineering challenge, well within the capability and capacity of our technology and our expertise in building aircraft to master. Is that fair? I do not want to put words in your mouth, but is that a fair assessment? Dr. Covert, you are the aeronautical engineer.

Dr. COVERT. I think that I would answer your question by saying that the problems that we have encountered so far have been problems primarily related to several aspects. One is that you want to build this machine as light as possible in order to make recovering

practical, and this causes you to want to go to a 5,000 psi hydraulic system.

One of the things that is almost impossible to calculate is the environment in the nacelle. What is the noise level? What is the vibration level? What is the acoustic level? What is the temperature? This is a little bit at odds with the idea of how do we make it as dense and compact as possible.

The sort of problems that have been surfaced are those due to the fact that the noise and vibration levels are higher than anticipated, that the manufacturing process that they use called "click studs" to hold the little bits of fasteners there so you keep the wire where you want it or you keep the hydraulic tube where you want it. This process probably could be refined or perhaps a new procedure used. But it is that level of detailed engineering that we are talking about. It is not the grand level of—Mr. Chairman, may I say let the record show I was waving my arm at this point?

Chairman WARNER. Yes, very clearly.

Dr. COVERT. Thank you, sir.

It is not the grand concept that is important or where the shortcomings are. It is this detail that is not uncommon to encounter in other airplanes as well.

Senator REED. Just a final point. As you reviewed the information and looked carefully at this system, did you discover any other areas that should be looked at as potential problems in the future in terms of a very complicated platform?

Dr. COVERT. I do not think we encountered any areas that had not been previously reported in flight testing and OT&E or otherwise. It is just that the chafing of the titanium tube called itself dramatically to our attention as a result of the last December incident.

Senator REED. Mr. Augustine.

Mr. AUGUSTINE. I would agree with the professor and his comments. I would add that our understanding of that slip stream and downwash is somewhat limited. It is extremely complex, and there is more attention that needs to be paid in determining the exact consequences that it has.

Senator REED. General Davis.

General DAVIS. Senator Reed, the one thing that stands out in this program is the abilities, the maintainability and reliability. They put three complex systems on top of each other, and that in itself does not produce a safety hazard. But it is something that you ought to look into with other programs to try to make sure we do not end up in that sort of square corner. You have a completely electronic manual that has only been 15 percent manually validated and 85 percent simulated that plugs into a machine that we have very difficult codes to translate. Then on top of it, we have a force reporting system that is so brand new that the Marine Corps does not even have the manuals to properly interpret it. It is a very difficult situation.

There is a real problem in trying to predict what the minority member basically said. How do you know that data is right and how can you analyze it and properly fix it? If you take anything away, it is let us not do that again.

Senator REED. Gentlemen, thank you very much.

Chairman WARNER. Thank you very much, Senator.

Senator Roberts.

Senator ROBERTS. Thank you, Mr. Chairman, and I want to thank you for holding this hearing.

My fear is that with the full and the justified attention paid to the tragedies and the mistakes that are associated with the Osprey, that without a full understanding of the viability and the soundness of this program, that minds are understandably closing to the concept and the technology that the V-22 represents. I think you have done a good job here this morning trying to set the record straight. No one wants to sign on to this program if the technology is not sound, if the aircraft is not flyable by the men and women of the military services, nor if it does not really represent a capability not really resident in other aircraft.

I hope that there can be an assurance to the public, to the members of this committee, and to the military that the V-22 can be made safe and technologically sound and will give the military capabilities not yet found in aircraft of today.

Now, Mr. Chairman, April 25, 1980. American armed forces attempted to rescue 53 citizens being held hostage by terrorists at the U.S. Embassy in Teheran. After the mission had moved to a staging area at a deserted airstrip in the Iranian desert—Desert One—it was terminated because of equipment failure. In the process of withdrawal, two aircraft collided, a massive blaze erupted, eight servicemen died, and one was permanently disabled.

When the Air Force operators, Army operators and marines at Desert One returned to their home bases, they commemorated the sacrifice of their colleagues and created the Bull Simons Scholarship Fund for the 17 surviving children. Now there is a Warrior Foundation offering scholarship assistance to 83 children of the special operators that were killed. That is a tragedy just as severe and just as tragic as the 19 losses in Arizona.

The President of the United States in 1995 said to those assembled, we are all here to thank our men and women in uniform for the rescue of Captain Scott O'Grady. He went into it in considerable detail. An F-16 pilot in Captain O'Grady's Triple Nickel Squadron picks up a faint radio signal and relays it to an AWACS plane. Within minutes the AWACS operators positively identified Captain O'Grady, and hours later 40 airplanes and helicopters are airborne, led by a combat search/rescue team from the 24th Marine Expeditionary Unit commanded by Colonel Martin Burnt. The AWACS aircraft, a marvel of our technology—emphasize the word "technology"—guides two Super Stallion helicopters within 50 yards of Captain O'Grady. At the end of it, Captain O'Grady said, "Mr. President, I want to say one thing: The United States is the greatest country in the world, and God bless America."

These are the kinds of missions that the Marine Corps tells me that this aircraft is uniquely qualified for. These are the kinds of missions that were described to me when the Commandant of the Marine Corps and I took a test flight or a demonstration flight over by the Pentagon. That flight really knocked my socks off in terms of its capabilities.

You have indicated that we recommended that the program be continued but be restructured. We found no evidence of an inherent

safety flaw in the V-22 tiltrotor concept, that the V-22 has demonstrated its ability to satisfy the requirement. Then you also say, however, that we found that the V-22 lacks the maturity needed for the full-rate production or operational use. You have a list of suggestions.

This is the same question asked by Senator Reed and others on the committee. It is repetitive. I think, Dr. Covert, you have already answered it. Is this technology such that we should continue this program for the missions that I have described?

General DAILEY. Yes, sir, we believe it is.

Senator ROBERTS. The bottom line, in terms of your paragraph here, number seven in your report, basically is the bottom line despite the stain that we have on the program. Stains are a hard thing to wipe out—you can scrub and scrub. No one knows that better than the Commandant of the Marine Corps, but I think it is a stain that must be removed. We need a new fabric not only for the Marine Corps but for the military, and I commend you for your work and your conclusions.

I would be happy to let you respond.

General DAVIS. Sir, one comment needs to be made. If it was going to take 3 days to do the Desert One operation, this aircraft could have done it in one period of darkness. That, in itself, is a major step forward.

Senator ROBERTS. Well, that is my fault for not really pointing that out. I thought that was self-evident. Also, with Scott O'Grady. You could do the same thing in regards to what? The NEO evacuation such as we have seen in Africa or the recovery of downed pilots, not to mention a host of other positive things. Those are the kinds of dramatic incidents in which we can see a lot of personal tragedies if we do not have this kind of capability in the future.

I thank the chairman.

Chairman WARNER. Thank you very much, Senator Roberts.

Senator Nelson.

Senator BEN NELSON. Thank you, Mr. Chairman. I would like to thank the members of the panel for your diligent efforts to review the V-22 program, and I want to thank the Marine Corps leadership for coming here today to focus on these briefings and their findings.

Obviously, our thoughts are with the families, certainly with all of the marines who have lost their lives during these mechanical accidents.

There are two major issues here that are important. Number one is a question of safety, obviously, and reliability. In many respects they go together. Clearly, when the reliability factor is in doubt, the safety issue is there as well.

In terms of the downwash question, when the V-22 is in helicopter mode, is that a technological issue such as the one that you have raised that is now being worked on that may have positive implications when it is worked through to other craft as well—by having technology that will transfer from one craft to another in terms of hydraulics? That appears to be manageable and can be engineered, hopefully. What about the downwash? Is that a factor that can be dealt with in a similar fashion?

Dr. COVERT. Yes, sir. I believe so. But I think in making that answer, we have to make clear that the downwash is related to the size and load on the rotors, and because of the shipboard requirements to store the rotors, these rotors have been optimized to be somewhat smaller than you might use if it was not to be used in shipboard.

Senator BEN NELSON. You get a concentration as a result of that. Dr. COVERT. That is right.

But the downwash is the price you pay for sustentation. That is lift. I guess I should have used a one-syllable word instead of several. But anyway, the downwash is the reaction to carrying the load. I think that is well understood under normal flight circumstances.

Do you want to add anything, Mr. Augustine?

Mr. AUGUSTINE. Yes. I would just say that the particular downwash characteristics of this aircraft are quite fundamental to the aircraft. It is unlikely they will be changed significantly.

You mentioned hydraulics.

Chairman WARNER. Excuse me. I am going to have to make an administrative announcement. We now have a vote. I am going to quickly go over and come back. Senator Levin will recognize Senators in my absence, but we are going to keep the hearing going straight through the vote.

Mr. AUGUSTINE. With regard to the hydraulics that you mentioned, there probably is nothing that is terribly unique about this aircraft other than the density in those nacelles.

Senator BEN NELSON. But the density factor and the technology that it represents does have application to other craft for the future. Hopefully we can engineer around the density issue for safety and reliability purposes. I have just been concerned that we get that behind us because of the unique characteristics of the craft for downwash purposes, that it does not create other reliability and safety issues as well.

Mr. AUGUSTINE. I think the most important thing we could say is there is no evidence of any fundamental flaw in the tiltrotor concept, and second, make no mistake. This is an aircraft that, in terms of reliability and maintainability, is not ready for operational use or for production.

Senator BEN NELSON. Thank you.

General DAVIS. Senator, if I might add, the downwash may very well be an offensive capability because when you put troops on the ground, you create confusion with that downwash. But it is manageable. The Marine Corps has tested that, and they are able to do those things they need to do.

Senator BEN NELSON. Thank you.

Senator LEVIN [presiding]. Thank you, Senator Nelson.

Senator Allard.

Senator ALLARD. First of all, before I ask a question, I just want to associate my remarks with many members of this committee, and so I will not repeat what they have already stated.

I do think that we have a certain responsibility to make sure to make the V-22 as safe as possible. It is a little difficult sometimes to know where the acceptable risk might be.

You have listed a number of things that you think should be improved. When I was reading the summary report, I did not get the idea that they were particularly prioritized. Do you have a priority as to how they should move forward?

General DAILEY. Actually, they all need to be corrected. I think it is an either/or type thing. You cannot fix just the hydraulic system. It has to be an integrated redesign of that nacelle so that everything works together and accommodates the concerns that have been expressed by some of the panel members in terms of the operating environment within the nacelle.

Beyond that, in the flight control system and the software that goes with that, that needs to be completely revalidated.

They have the ability to do this. The good news is they have a good handle on what the problems are, and because of the fidelity of the simulators they have, they can run these programs very extensively so they understand, before the contractor test pilots actually get into the flight testing mode again, what they are going to anticipate with some of these situations. This has not been the case in the past.

We intentionally did not prioritize our recommendations because it is a package that we believe has to be accomplished and in a phased approach. We laid out what needs to be done before the test pilots start flying it again, and then what needs to be done before the operational pilots start to fly it, and then what needs to be done before it is fielded operationally with a squadron deploying.

Senator ALLARD. Does anybody else want to comment on that? [No response.]

Also, one of the panel members—I think it was you, General Dailey—had commented that the crash rate was not much more than other aircraft. I wonder if perhaps you would elaborate on that specifically, in relation to new types of aircraft, not just their variations.

General DAILEY. Yes, sir. Actually I believe it was Mr. Augustine who said this, so he may want to elaborate.

Senator ALLARD. I apologize.

General DAILEY. We tried to run a comparison of similar and dissimilar type aircraft to show at this stage of development where the V-22 fit. It is difficult because the recordkeeping is different today, for example, with the CH-46, which is the airplane this V-22 will replace. They did not keep track of accidents back before it actually became a production aircraft. All the development accidents were not listed. The CH-46 had 44 accidents, but the entire aft pylon had to be completely reengineered and replaced, similar to a rewinging of an airplane. Now, this was back in 1965. We have made great strides since then.

If you took a more modern aircraft like the UH-60, for example, which is a very fine helicopter, its accident rate was much less. It approaches zero, but again we do not have apples-to-apples comparisons here in terms of what happened. Since then, there have been operational accidents with loss of Army personnel.

It is very difficult to get any kind of a comparison where there is no exception to what you are trying to say. We have laid out a table within the report. The F-14 is a complex airplane, in terms of the way it operates, with a swing-wing design. There was some

concern about that—the F-14 is the only aircraft that we have found that at this stage of development actually had a worse accident rate than the V-22 in terms of accidents per flying hour.

It is because this airplane only has 3,500 flying hours. If you take all of the tiltrotor flights of about 5,000 hours, it makes it a little better, but still it is the low flight time and with four accidents total, counting two while it was still in development with the contractor and then two operational accidents.

I know I have wandered around with this, but this is not one where we can give you a quantitative “this is it” in where it fits. But we believe—and I believe Mr. Augustine said—that this is not unlike what we have experienced in our past with other aircraft being introduced into the inventory.

Senator ALLARD. Mr. Augustine, do you want to elaborate on that?

Mr. AUGUSTINE. I might just quote some of the numbers briefly that we did gather. We gathered data that are included in our report on three other aircraft, and we have data on aircraft beyond that. The number of mishaps per 100,000 flight hours are, I would say, within statistical significance of being quite comparable with being the same range. For example, the three other aircraft are fixed wing fighters. They have accidents per 100,000 flying hours of 79, 50, and 61, and the V-22 is 77.

Now, as the General said, one has to be careful because there are some definitional issues one could question. But based on my own experience, I really do not see anything that is totally out of family. I think the big difference here is when you have a lot of people flying in the back of an airplane that is very immature, the consequences of accidents are just escalated enormously.

Senator ALLARD. Mr. Chairman, I see my time is expired.

Senator LEVIN. Thank you, Senator Allard.

Senator Collins, you are now chairing.

Senator COLLINS [presiding]. A frightening thought. [Laughter.] Thank you, Senator Levin.

I will be brief because we do have a vote in progress with very little time remaining.

First, gentlemen, I want to thank you for your very important and valuable service as members of The Blue Ribbon Panel.

Your report makes clear that you found no evidence that the V-22 concept is fundamentally flawed, but it seems to me that there is considerable evidence that the development and testing process was fundamentally flawed. In particular, Mr. Augustine, I was struck by your comments this morning that there was not enough focus on reliability, maintainability, and safety and that instead, the focus was on the capability of the aircraft. That leads me to two questions.

First, did you find specific flaws in the process that caused this flawed development?

Second, and perhaps more troubling, is it likely that these flaws in the acquisition process are not just characteristic of the V-22 development, but rather indicative of more systemic flaws that may be affecting the development of other new concept weapons systems? General or Mr. Augustine, either of you may respond.

Mr. AUGUSTINE. With regard to your last question, I think there are systemic difficulties in the acquisition process that the V-22 suffered from that are not terribly unique to the V-22. One of them does have to do with the issue of reliability and the emphasis placed on it, as well as maintainability.

There was a good deal of testing done—and we should make that clear—on reliability and maintainability. We were given a good deal of data about it. I think the issue is the extent to which that data is used in making decisions, and I think the decisions tend to focus perhaps too much on classical performance parameters—I use that term reluctantly—but speed, payload, range, and so on, at the expense of reliability, maintainability, and safety. Those would be the principal concerns that I would cite.

Senator COLLINS. Did you find evidence, as some press reports have suggested, that data suggesting these problems existed were not taken seriously enough, or were discounted in the effort to get this aircraft operational?

Mr. AUGUSTINE. No, I would not say that. One does observe—and again, I do not think it is unique to this program—a trend over the years that testing is becoming a matter of whether you are permitted to continue with the program, are you permitted to go to the next phase, does the program live; whereas, earlier in my career, the purpose of testing was to find out what was wrong and fix it.

Senator COLLINS. To work out those problems?

Mr. AUGUSTINE. You intentionally tried to break things in a safe fashion. Today, in my judgment, there is not enough of that done. I think the V-22, as I said, did not do anything terribly different from what most programs do.

Senator COLLINS. Doctor, did you have something you wanted to add to that?

Dr. COVERT. Well, I want to second everything that Mr. Augustine said.

I want to also remind everyone of something that we found that I believe General Dailey remarked on, and that is that not only was a new type of airplane being put into service, but at the same time, people were trying to take advantage of advances in information technology. So, instead of a paper handbook, they had something that was on a computer, and instead of what we used to call a yellow sheet—the pilot comes off the airplane and he writes down his complaint—this is information that is being read directly from a diagnostic system within the airplane. No attempt as yet seemed to have been made—and I emphasize “seemed to have been made”—to make these things integral with each other. The new code, for example, in the diagnostic system is not consistent with the maintenance system.

The maintenance system does not seem to be organized to favor the people trying to maintain it. We watched a sergeant try to get a drawing and a part number, and after 60 steps, he was defeated by the system.

I am not arguing that the maintenance and reliability system of the V-22 is what it should be, but I think at the same time, the people who are trying to maintain the V-22 have done a magnificent job working with what I would consider to be a frightfully immature system itself.

Senator COLLINS. But that is exactly my concern. It sounds like we are rushing the process rather than taking the time that is needed to resolve these problems, and that part of the impetus for rushing the process is the fear that we in Congress or DOD will cancel the project if it is not moving along at a very rapid pace.

Dr. COVERT. Well, if I may, ma'am, I think that it is always hard for me to judge some of these issues.

But I do think that it is not always wisest to introduce two or three new things all at once on a new program. I think that whether that was an act in haste or an act of optimism on the part of what the new system was going to do or what it was, I cannot say, but I think it is imprudent to introduce all these things at once.

Senator COLLINS. Thank you. Do any of you have further comments you would like to add? Yes, General Davis.

General DAVIS. Again, I think Mr. Augustine covered it, but the process has changed. When we brought the F-16 on, we lost nine aircraft. Those were engineering problems and consequently were fixed, and it turned out to be a wonderful airplane not only in the United States but everywhere else. The process has changed because we have become more critical of the process, and one of the reasons we are more critical is because the process costs more money. Consequently, as Mr. Augustine said, you test it, you try to break it, and then you try to fix it. There is a tendency, possibly, to avoid those regimes.

Now, for instance, the flight envelope was not fully tested, as you have heard. It was not required to be tested to get an operational evaluation (OPEVAL), but it would have been smart in hindsight that we did fully test all the regimes of flight. We should do the vortex ring state (VRS) or the high rate of descent testing long before we get an OPEVAL.

Senator COLLINS. Thank you, Mr. Chairman.

Chairman WARNER [presiding]. Thank you very much, Senator. They are holding the vote for you. Worry not. In the opening comment, General Dailey, I copied down the note that this panel isolated deficiencies in design. Am I not correct in that?

Now, were the accidents in your judgment attributed to these deficiencies in design? I will let each member of the panel answer that question because it is key.

General DAILEY. Well, I will start then. The deficiencies in design—it is important for us to point out those are routing of cables, wire bundles, and this sort of thing, not deficiency in the design of the wing elasticity or—

Chairman WARNER. I understand that. You isolated certain deficiencies in the design of this aircraft.

General DAILEY. Yes, sir. They were identified to us. We did not actually determine anything that had not already been discovered.

Chairman WARNER. That is the second part of this question. Again, the question is were the accidents in any way, in your collective judgment, attributed to those deficiencies?

General DAILEY. The failures of the hydraulic system and the software anomaly were contributing factors to one of the mishaps.

Chairman WARNER. Now, I will go over to Dr. Covert, then across. Do you concur with that observation?

Dr. COVERT. Sir, I concur with that observation.

Mr. AUGUSTINE. One of the things I have learned in my career is there is no such thing as a random failure. So, yes, there had to be design problems.

General DAVIS. I agree, sir.

Chairman WARNER. Now, you said that those deficiencies were brought to your attention by the program manager. Your exact language was you "did not uncover any issue not covered by the program manager." That is what I understood you to say, and Dr. Covert, I listened very carefully. You used the words "they were previously reported."

Dr. COVERT. Yes, sir.

Chairman WARNER. Well, we have present here today the program manager, as I understand it, Admiral Enewold. The program manager is the one who briefed you, identified the deficiencies. The Admiral is, so to speak, the next up in the chain of command having oversight of this program, together with other programs. Am I not correct on that, Admiral?

Admiral ENEWOLD. Correct.

Chairman WARNER. This leads to an inference, maybe a deduction that if this knowledge were in the possession of the program manager, it was in the possession of the Admiral. It was known, presumably, all the way up the chain of command of the Marine Corps and the chain of command the Admiral reports to. I just make that observation, having been here for 23 years and having spent 5 years and 4 months in the Navy Department myself.

This leads to this observation, which I will give the program manager and the Admiral an opportunity at the stand to respond to, if they knew about it and dutifully reported it up the chain, why did somebody not take corrective actions before the accidents which you, General Dailey, said were the causal result of these deficiencies? Does anybody have any observation about that? Yes.

Mr. AUGUSTINE. Yes, I started to make this comment before to lend balance to my earlier remarks. I am glad to have the opportunity to respond.

One of the great advantages that you are so well aware of is that our military has is a technological lead, and it is a very perishable lead. Semiconductor integrated circuits are kind of the heart of today's technology. One generation is 30 months. So, there is a great pressure to get technology into the field, and I am sure on those commanders, and I felt this when I was in the Pentagon. If there is another Desert One, you would probably like to have a V-22. So, there is obviously a pressure to go ahead with the program.

Chairman WARNER. I understand that but we have, of course, to examine the balance between that pressure, the balance between military necessity, and the risks that we subject all those involving the operation of the aircraft to. That is the fundamental question.

Mr. AUGUSTINE. Absolutely.

Chairman WARNER. Does anyone else wish to comment on that?

General DAILEY. Sir, may I?

Chairman WARNER. Yes.

General DAILEY. I think it is important that we say that these things were known. The software anomaly was not known. That became known after the mishaps.

Chairman WARNER. I judged that.

General DAILEY. In the case of, for example, the hydraulic system, there are engineering change proposals that have been under development for quite some time, and work was being done. Funding was an issue as being able to fund these to get them incorporated, to get them moving through the process by which they had to be reviewed. But it was not a case of inactivity that we have detected. Also perhaps the severity was not recognized at that point.

As Mr. Augustine pointed out, this aircraft has triple redundancy in its hydraulic system. That is unusual for any aircraft. There was a level of confidence that the aircraft could survive some fairly significant combat damage or failures of systems.

We did not find a lack of activity or intent in terms of correcting these, but it was just the fact that they had not been incorporated and were deemed to be appropriate to proceed. There were no incidents that we know of where these systems failed and caused near misses or that sort of thing.

Chairman WARNER. I understand, but there is still the inference out there that a decision was made to continue the test program and, indeed, go beyond that and have some operational at the time the passengers were killed. Operational is a part of the overall OPEVAL.

The point is, do we still go ahead when there is a convergence of knowledge that we have deficiencies, which you have acknowledged were the cause of at least one accident? Those are judgments. We are sitting here with the benefit of hindsight. But that judgment obviously was made at various levels from the program manager up.

General DAILEY. Yes, sir. In fact, you have hit upon a very important point here, sir. The aircraft involved in that accident where we lost the marines was a production aircraft. It was not a test aircraft. The decision had been made that the aircraft had reached an adequate design state where it was ready to proceed to production. That is a very important point.

Chairman WARNER. I have gone back and I will provide for the record a detailed analysis of the various congressional actions taken with respect to the funding. At least since 1997, Congress has authorized, this committee, and I presume the House, and has appropriated funds for the V-22 program at or above the President's request.

[The information referred to follows:]

Analysis of Authorizations and Appropriations
for MV-22 Osprey Aircraft Program from fiscal year 1997 through fiscal year 2001

		Budg Req	HASC	SASC	HAC	SAC	Auth Conf	App Conf
FY-97	Procurement	500.1	732.9	730.9	732.9	730.9	620.9	620.9
	RDT&E	576.8	613.8	596.8	613.8	596.8	576.8	576.8
FY-98	Procurement	472.0	786.4	155.0	661.3	627.0	626.3	627.0
	RDT&E	529.5	529.5	529.5	529.5	529.5	529.5	529.5
FY-99	Procurement	610.8	675.8	610.8	696.8	610.8	688.8	610.8
	RDT&E	355.1	355.1	355.1	355.1	355.1	355.1	355.1
FY-00	Procurement	796.4	856.4	919.4	856.4	919.4	919.4	856.4
	RDT&E	182.9	182.9	182.9	182.9	182.9	182.9	182.9
FY-01	Procurement	1128.6	1128.6	1128.6	1128.6	1128.6	1128.6	1128.6
	RDT&E	148.2	148.2	148.2	148.2	148.2	148.2	148.2

All numbers in millions of dollars

Chairman WARNER. Did you develop any reviews regarding the adequacy or the inadequacy of the funding levels for this program as contributing causes to these accidents?

General DAILEY. We did, sir. We feel that there are several indicators that this program has been underfunded throughout the years. The most significant indicator is the fact that they have been trading aircraft to stay within their funding constraints to operate the program. They have decided to use actual aircraft as maintenance trainers as opposed to buying maintenance training devices. There are good and bad points to that. We are not saying that is necessarily bad, but it is unusual, and we think it is an indication of a funding problem.

[The witness provided the following information to supplement the record.]

The panel found no direct correlation between the mishaps and the lack of funding. However, inadequate funding is the predominant reason why design maturity was deferred to production. No reserves in development and inadequate reserves for engineering changes in low-rate production delayed design maturity. Problems were identified and in many cases the fixes were deferred due to lack of funding.

Chairman WARNER. That was also tied to spare parts. I have read through all of these records and found where they had to cannibalize and had to ground aircraft, one of them I think for 72 hours, for the want of a screw no bigger than this.

General DAILEY. That is correct.

We actually based our recommendations on the Navy Center for Cost Analysis estimates that have the spares on the Navy side, the marine side, underfunded. In fact, the Air Force was properly funded by their estimate. Now, the Air Force operates on a different concept. They use detachments which go out with 100 percent packup, so they have a higher level of sparing normally.

But we think that spares are definitely an area that require attention. Now, this is a difficult problem too because, when you have a brand new airplane, you do not know what is going to break on it. You have an analysis that says certain things are going to break, but until you develop some experience, you may be buying

parts that you are never going to use. That has happened in the past. So, we have gone to a system of getting experience and then properly sparing, and that still could take place.

Chairman WARNER. Let me ask you to readdress the question of broken parts. Very often in the case of spares, there is a determined life span in which they are operable and then are replaced prior to a breakage. I think what you are saying is that in an orderly course of the spares program, there were deficiencies either in the adequacy of the procurement or the distribution or the like.

But my question was really directed at the money needed for design, the money needed for research and development, for OPEVAL, and so forth. Did you see any severe funding deficiencies that could have in any way contributed to these accidents?

General DAILEY. That is difficult.

Chairman WARNER. You can take that for the record and study it because this hearing is not trying to determine culpability or fault in any final way. But we have to look into whether or not Congress did not fund this program adequately and if that was brought to the attention of Congress by the executive branch which has the initial responsibility to recommend to Congress a level of funding.

My records show that since 1997 Congress met the requests—and this is not a political question in any sense—of the administration. We have, as the Secretary of Defense during a period of that time, Mr. Cohen, who is well-known to this committee and whose integrity I would not question for a second. Knowing of his long-standing working relationship with the Commandant, I am confident that there was a review of the funding level either by him personally or his senior staff to determine the adequacy of the level of funding.

Does anybody else wish to question on the funding?

General DAVIS. Sir, nothing that contributes to the accidents, but the program is estimated to be \$600 million short of spares over the lifetime of the program. There was no reserve fund to take care of small engineering things, and the Department of the Navy and the Department of Defense obviously were trying to live within the program but with some cost growth, which always occurs with your long experience, Mr. Chairman. The Navy tried very hard not to bust the budget, and that is why they deferred some airplanes to later buy. But it was a constrained funding.

Chairman WARNER. I think that is a fair observation, General, and you are certainly one who is eminently qualified to make that observation and we accept it.

Mr. Augustine, did you indicate you wanted to contribute?

Mr. AUGUSTINE. I would like to follow your suggestion and provide for the record a statement on this. But I would go ahead to say that it is clear that the lack of funds and particularly the lack of reserves caused cost increases and caused schedule delays. But knowing what I know today, I would have a hard time directly coupling the lack of funding to the accidents.

Chairman WARNER. I appreciate that.

Senator Inhofe, are you ready to proceed?

Senator INHOFE. Yes, Mr. Chairman.

I became interested in this issue, Mr. Chairman, back in 1987 when they were talking about it. I happen to have over 40 years experience in aviation, so I look at these new technologies when they come up, and I look at the needs that are out there. In looking at this, I can remember, Mr. Chairman—at that time I was in the House. We talked about the commercial application of this, having nothing to do with military, the fact that we have more and more airports, we have more and more people to serve, more and more people are flying, noise requirements and everything else. This capability is a totally new technology in terms of application.

We looked at it and felt at that time some other countries—and I do not remember which ones were talking about getting in on the initial funding. At that time the big issue was, at least over in the House in our Transportation Committee, that we wanted to keep control of this. That was one of the motivations in the very beginning.

In 1991 I had occasion to emulate Wiley Post's around-the-world flight. I remember coming back from across the Bering Strait into Alaska. I went up to Juneau and went into our Coast Guard group there, and the Commandant there said, if we can get the V-22 in the Coast Guard, virtually every function that we perform, oil spill containment, search and rescue, it would replace every vehicle that we have.

I do not know if someone has talked about some of these other applications or not because I know you were more confined to just the military application, what the marines are going to be doing with it.

If I remember correctly, even going back to the F-117, there were about four or five accidents at that time, and yet we know what happened later on, how it performed in the Persian Gulf. I can remember when the same questions were being asked about the C-17 and the B-2.

Did you cover in this report anything really dramatically different, when you are researching a new platform, a new technology, about this than many of the other rather dramatic changes?

Second, do you not agree that there are going to be accidents in any type of a radical change in a technology?

Number three, if we do not do this, some of the other countries who would be doing this might get this technology and put us in a disadvantageous position? Any of the above?

General DAILEY. Well, yes, sir. We did not specifically address the requirements for other countries or other programs. Actually we looked at the program and its status from the performance of the stated requirements of the military, and we found that it will meet them and it has demonstrated that capability. We did not find any inherent flaw in the design of the tiltrotor concept, but that there were engineering changes that needed to be incorporated to make the aircraft reliable and maintainable for operational use.

Senator INHOFE. But you have been involved in developing or working with the development of other platforms prior to this as well. I guess the question is—it is awfully difficult to go through this period of time without something like this happening. The one that comes to my mind is the 117 because we had several accidents that almost killed the program.

General DAILEY. Yes, sir. We had a fairly lengthy discussion on this particular issue. We have laid it out to the best of our ability in the report, but it is difficult to compare aircraft, particularly one that is a hybrid like this one where it is neither an airplane nor a helicopter, but both. We found it to not be inconsistent with what we have experienced in other aircraft in this development stage.

Senator INHOFE. Yes, General Davis.

General DAVIS. Sir, knowing you are a pilot, you would understand it, but if there is no CV-22, if the program is canceled, then this Congress, this Department of Defense is going to be faced with aging aircraft and trying to find more aircraft to do the mission.

But as the chairman pointed out, this thing is a national asset to general aviation, because it is quieter than most of the aircraft that we have to fly in. It does not need a runway, if you will, and that is probably our biggest problem in aviation today. We do not have enough runways. The packing of those runways is just atrocious. There is no known country that is playing with the same technology.

Clearly it is a national asset, but more importantly, it is a national asset that can do things with better survivability, like Desert One, like Somalia, if necessary, that it can do in one period of darkness, and we just do not have that capability. Plus, you do not have the visibility of lots of tankers, C-5s, taking airplanes apart to do this mission. This mission can self-deploy, retrieve whatever you want to retrieve, and get back out in one period of darkness.

Senator INHOFE. I can remember taking the time to fly down to Fort Worth in the very early stages of this program. At that time, the Japanese had expressed a lot of interest. Is this something that is not happening now?

General DAVIS. No, sir. They are using a different approach. They have not gone to this system at all.

Senator INHOFE. Lastly, Mr. Chairman, we get around in a lot of these CH-46s, and they are getting pretty old. Did you cover specifically in there—

Chairman WARNER. Excuse me, Senator. You might state for the record, because this is a very important question, just what are the aging periods for that class of aircraft. The Commandant can add further information, but I think you ought to put this in this question.

Senator INHOFE. Yes. Well, it has been around for 30 years, and we know now there are parts problems. Of course, the technology is not anything. At the time that we were developing this, though, I remember this, Mr. Chairman. I was not here at that time, but there were several accidents, quite a few, and quite a few since then in the CH-46 that were pretty serious.

I guess you have stated what we would do in the absence of this. What is the alternative to this platform? Keep using the 46s?

General DAILEY. Yes, sir. The Program Analysis and Evaluation group in DOD is doing a cost evaluation at this time. We provided them with our recommendations and they say that the recommendations we have come up with are consistent with what they are finding in terms of alternatives, which there are none that will actually do the mission. There is a combination of aircraft that

could do parts of it, but there is no single aircraft that could meet the entire requirement.

Senator INHOFE. Thank you very much. Thank you, Mr. Chairman.

Chairman WARNER. Thank you very much.

Senator LEVIN.

Senator LEVIN. Thank you very much, Mr. Chairman.

I would like to ask you to compare some of your findings with the findings of the Director of Operational Testing and Evaluation, who until recently was Phil Coyle. It seems to me he has come to some different conclusions than you did. I am wondering whether you have assessed those conclusions and can explain why you differ with him, where there are differences in your report.

I have not had a chance to see that side-by-side yet. Did you do that in your report?

General DAILEY. Yes, sir. We met with him very early in our process because we were very interested in what their findings had been so that we could pursue them.

First of all, when they conduct a test, they have very stringent requirements as to how they report things and the criteria by which they make their judgments, and it is set.

One of the things that comes out of that is a figure on mean time between failure, which is the term that is used. This is the flying hours between the time something actually fails.

The thing is that there is no differentiation between a light bulb or an engine failing. So, if you have a single failure, it could have been a light bulb that was not required for a daytime flight or an engine that failed, but you get the same mark for both. We do not believe that those are the most important numbers to concentrate on. We think that—and we specifically recommend this—that the focus be on mean time between mission abort, in other words, how often does the airplane fly when you need it and then how long does it take to fix it when it breaks? That was part of our recommendation.

In going back and evaluating the fixes that go into this airplane, we think those are the important criteria to use as opposed to some of the standard or traditional numbers. I think that Mr. Coyle agreed with us in terms of what we were saying as to our approach and our recommendations.

Senator LEVIN. Let me just explore with you for a few minutes some of what I understand to be the differences, and perhaps you can clarify them.

One relates to the downwash problem. Many of the missions that this plane is designed to handle depend on landing in unimproved areas, carrying external cargo, conducting so-called “fast rope operations.” Based on the DOT&E’s evaluation, some of those operations could be precluded by the current levels of downwash. Would you agree with that?

General DAILEY. “Could be” I think is the operative term there. The downwash is a factor.

Senator LEVIN. Do you agree that they could be?

General DAILEY. Under some circumstances, yes.

Senator LEVIN. Is that something we should live with? I think Mr. Augustine said there is a downwash problem. I think it was

your testimony. He said it was something we just have to live with. Should we live with that “could be,” that we may not be able carry out some of the missions intended?

General DAILEY. I think that the other half of that answer is there are also capabilities on this airplane that would enable you to do things you cannot do with current airplanes in terms of carrying out the mission. There are situations right now where the 46 cannot do it.

But this is a different downwash and it is a different situation. In the case of the fast rope, which is one of the examples I believe the Senator used, the requirement is to do fast rope on three ropes simultaneously. It was found during the testing that coming out of the cabin door directly under the rotors was not a good idea, and so it was decided not to do it.

Whether they could put a deflector above the door—whether it would be necessary—so, one of the things that we recommended is that the users validate these requirements before they start spending money to make sure that we can meet them. That is an example. They were able to go simultaneously off the back ramp with two. So, is two good enough to do this, or do you want to spend more money and get three? That is what we meant by the revalidation of the requirements.

Now, the landing in unimproved surfaces, a “brownout” as they call it, when you land in the sand or a whiteout in the snow, exists for any helicopter. It is different for each one because of the downwash pattern. This airplane has references for the pilot that do not exist in other helicopters in terms of forward-looking infrareds and heads-up displays on his windshield that give him actually a better capability or potential to carry this off.

But in any case, when you get into a downwash where you are blowing the snow or sand up, you are along for the ride for the last few feet, and that is the way you do it. You set it up. You know what you are going to do, and then you put it down. There is risk because there could be a hole in the ground or a crevice or something, and this happens to helicopters. But that is what I meant when I said it “could be” a situation where you would have a problem.

Senator LEVIN. I think it is important that we make an assessment as to what missions could be affected by things that we now believe cannot be corrected so that we can make a judgment on the overall plane. It seems to me that the aircraft was designed to carry out certain missions, which our current helicopters cannot. They are very important missions. I have supported this aircraft. On the other hand, if all of the missions that it is designed to achieve cannot be or might not be achieved—I agree with you that the emphasis should be on what “might not be achievable”—I think we should know that so we can make an overall assessment of this aircraft.

I think General Davis wants to speak.

General DAVIS. Yes, sir. For instance, they did not do the rope ladder insertion because they could not find a ladder that was safe to use. They could not use the hoist because a hoist has not been designed to use out of the aircraft. So, they have not really failed. It is just they have not been tested yet.

Senator LEVIN. But that is not a downwash problem.

General DAVIS. Yes, sir.

Senator LEVIN. It is a downwash problem if they do not have the ladder?

General DAVIS. The ladder may go up in the rotors.

Senator LEVIN. So, that could be cured by a different ladder.

General DAVIS. Yes, sir.

Senator LEVIN. Just two other quick questions. The urgency to reach the full-scale production level was apparently the reason why false reports were filed. I am just wondering if you could tell us what shortcuts were made in testing because of that same rush to a decision point on full-scale production. What tests should have been accomplished that were not, for the same reason that apparently the false reports were filed, which is that pressure to get to full-scale production.

General DAILEY. I am not sure that is the reason why the testing was deferred, by the way. It could have been a combination of things, affordability, but time certainly was a factor, and also what is good enough at this point to take the aircraft to the next step because there are follow-on test opportunities.

I believe that the expansion of the flight envelope—in hindsight everyone recognizes that that should have been expanded further, and we have specifically recommended that, with a step-by-step approach as to how that should be accomplished.

Senator LEVIN. What other steps were possibly omitted or shortcut because of that time pressure?

Mr. AUGUSTINE. Well, I would just add that this comes in the category the chairman cited as a judgment issue. There are things in retrospect that are very obvious that one would wish—and I am sure the program wishes—

Senator LEVIN. That is not what I am asking. I am saying where time pressure could have been the reason that there was a shortcut taken, not just in retrospect, but actually during the events as they unfolded.

Mr. AUGUSTINE. It is hard for us to cite that because we were not there at the time, but things that one clearly should have done was more testing of the vortex ring state, more testing of the operational issues you just raised about downwash, dust, fast roping, and also just getting more hours of flight for reliability. But at the time that the decisions were made, I would have a hard time faulting any cutting in testing because of time pressure.

Senator LEVIN. Thank you.

Chairman WARNER. Senator Nelson has not had his first opportunity to ask questions.

Senator BILL NELSON. Thank you, Mr. Chairman. I will just ask a couple of questions and continue to listen to your line of inquiry and the answers.

I would like to ask Mr. Augustine, what was the technological reason for why a system like the Harrier was not utilized for this kind of aircraft and its mission?

Mr. AUGUSTINE. I would think that probably the driving reason would be with the sort of payload that one wanted to carry here, to use a Harrier concept would be pressing the state of the art.

Senator BILL NELSON. In other words, you would have too large of a load for the thrust of the engines on a Harrier. You needed a greater lift capability. Is that what you mean?

Mr. AUGUSTINE. I believe that to be true in the Harrier, in the JSF, where you have a much smaller payload to be carried. It is a lot more feasible to do that with a pure jet. It would just be terribly inefficient, I think, to try to do that with today's kinds of jet engines.

Senator BILL NELSON. Now, given what you know about the development of systems where we have come to this point with the Osprey, what would you have changed in the development of it so that we would have a full-up operating system at this point?

Mr. AUGUSTINE. Well, that is a very good and a very difficult question. I think the first thing I would have done is, at the beginning of the program, include enough funding reserves so that we could have dealt promptly with problems as they appeared.

I think probably the second thing I would have done is a lot more engineering testing before I got into operational tests.

It is so easy to say this in retrospect, but I think one has to be awfully careful, in general, before one puts a system in production, to be sure that the reliability is there. I have seen this many times where everything else looks like it is okay, and we will get it in production. Then we will fix the reliability problems.

Another thing that in retrospect one certainly should probably not have done is flown that many people in the airplane at the time that they were conducting the flights. Again, it was a judgment.

Senator BILL NELSON. What kind of developments of systems in the past, in your experience, could you point to where we made those mistakes and learned from them and corrected them that we should have done in the development of this system?

Mr. AUGUSTINE. Well, every development program tends to be rather unique in terms of its problems, but there are certain patterns that prevail. I was citing earlier systems that have proven to be successful, going all the way back to the Sidewinder and through the Polaris, through the overhead reconnaissance systems, to the Apollo precursor missions to the moon and many others you could name, F-117, that had a lot of problems early on, many of them for exactly the same kind of reasons we have seen here. I do not think we have discovered any new causes of problems, particularly. Those systems tended to prove to be successful.

I think the number one lesson I have learned, in trying to manage development projects, is that even the best managed projects do get into trouble as they go along. You are pushing the state of the art. You are trying to defy the law of gravity.

I think the biggest mistake we make, assuming the system is needed and assuming that it is conceptually feasible, is stopping and then starting over with something new, believing that the new thing will not have any problems. I think what we have done in the past is we have traded problems that we did not know about for problems we did know about. My two caveats here are very important, though.

Senator BILL NELSON. In each one of those systems that you just cited, they went on to be successful. Do you think that this one will as well?

Mr. AUGUSTINE. That, of course, is a judgment question. I believe that if the things we have recommended are done, there is a very high probability that this will go on to be a successful system, which is not to say that there, sadly, will not be more crashes. Again, when one tries to defy the law of gravity, as I have throughout my career, unfortunately you lose airplanes.

Senator BILL NELSON. Thank you, Mr. Chairman.

Chairman WARNER. I thank you, Senator.

Just one or two wrap-up questions, gentlemen. I am going to ask the same question to each of you and see whether or not we can obtain some perspective and some judgment on the timeline beginning here today and when you think we will have enabled all who will be involved, from the principal two contractors to others, to resolve these problems and, once again, we should resume production.

Now, I note that part of your report is that we should continue a limited production. Now, that is in the face of the time needed to fully analyze the deficiencies and make the corrections.

We will start with you, Dr. Covert. What is your judgment as to that timeline in terms of a year, 2 years, 3, whatever it may be? Why do you feel that we should continue the production even though we have recognized deficiencies existing at this time?

Dr. COVERT. I think we should continue the production for the reasons that General Dailey stated. In terms of a timeline, there is no single timeline to look at the individual elements. For example, I suspect the software anomaly—

Chairman WARNER. I beg your pardon. I missed a few words. I just did not hear them.

Dr. COVERT. I think what I was saying was that different things require different periods of time to be corrected. I think the software anomaly probably can be corrected by the fall of this year. I think that some of the details, like the wiring harness and what kind of tubing to use, probably depends to a certain extent on the length of time required to get the engineering change orders developed and then to contract the work and to get it done.

I suppose that optimistically I think it can be done in the neighborhood of a year and pessimistically I think it could be done in perhaps 2 years, depending on how the pieces of the puzzle fall.

Chairman WARNER. General Dailey.

General DAILEY. I agree, sir. I think a very important point, though, is at the reduced production rate, that the funding associated with those aircraft that are not being produced be devoted to the development of the engineering change proposals and the incorporation. Funding is going to be a key feature as to how long it takes, but I think it could be done in a year, 2 years at the outside.

Chairman WARNER. You recommend specifically that production continue. I presume that is to keep the subcontractor and the contractors in place, occupied to the best extent we can with a limited production.

General DAILEY. That is correct, sir. Because of the demonstrated learning curve that they have in place now from the discrepancies

found on production aircraft, that is something that would take a long time to redevelop. It would take probably a year or so, if we were to shut it down and start over again, and you may introduce problems we do not even know about now. We think that keeping the current workforce is very important.

Chairman WARNER. Your timeline?

General DAILEY. I believe it can be done in a year, with 2 years being the outside limit.

Chairman WARNER. Mr. Augustine. May I say I will always remember your statement—I think it is so important in this hearing—that in your judgment and that of the other panel members, nothing to date indicates that this concept of aviation defies the laws of nature or the laws of physics and that it is achievable and in a safe way at some point in time.

Mr. AUGUSTINE. I believe that to be true.

Chairman WARNER. Fine.

Now, as to the question on the timeline?

Mr. AUGUSTINE. This again is purely judgment. But I would say, given adequate funding, 2 years would probably be about a nominal time. It might do it a little faster; it might take longer, but that would be my nominal estimate.

With regard to stopping production—we considered stopping production, but breaking a production line is something that one should try awfully hard not to do. Not only does it increase cost, but more importantly, I suspect breaking this production line would do more to contribute to unreliability than all the things we are trying to do to make the machine reliable.

Chairman WARNER. I think that is a very important observation because you lose all the skilled workers and their training cycle and the like.

I am making this observation, but if anybody disagrees, do so. The deficiencies, assuming they can be technically corrected, can be either retrofitted or put in these aircraft at the appropriate time, without a disruption to production. Am I correct on that?

Mr. AUGUSTINE. I think that is true. I think also we believe we know generally where the deficiencies are and it is probably possible to delay those parts of the aircraft and work on other parts.

Chairman WARNER. General Davis, as to the timeline.

General DAVIS. Mr. Chairman, it is going to sound like we rehearsed this answer, but we did not. I agree with all the comments, especially shutting the production line down. You lose that expertise. You raise your costs and you are going to rebuild in reliability problems that this program does not need.

Chairman WARNER. General Jones in his testimony will be touching on the benefits of this type of aeronautical breakthrough, far beyond our military deployment. Do each of you concur with the thought that our Nation could be on the very cutting edge of new types of civilian aircraft if this thing proves out and becomes safe? Does anybody want to comment on that? I think it is an important part of this record and the decision that has to be made on a go or no-go on this program.

General DAVIS. Sir, if I might, in answer to Senator Inhofe's question, clearly I think we are ahead on this, and secondarily, I see this as not only a great benefit to complete our national mis-

sions, but as you stated in your opening statement, it is sort of a national asset. Its ability to go into airports without having to use a runway will be very beneficial because building runways takes 7 to 9 years and a lot of money. Consequently, this airplane could actually bring in passengers to the terminal and you could actually cut down the commuter use of the runways.

Chairman WARNER. Does anyone else wish to comment on that question?

General DAILEY. I would like to say, sir, I believe this is breakthrough technology that is important to this country and our future.

Chairman WARNER. Not only the military, but the civilian applications.

General DAILEY. Very much so.

Chairman WARNER. With our presumably owning the technology, we could have an export item here of significant impact on our balance of payments and trade.

General DAILEY. Yes, sir. Particularly when you look at the origin of commuter aircraft today, not being produced in this country, this is an opportunity for us to provide a capability there.

Chairman WARNER. Dr. Covert.

Dr. COVERT. I concur.

Senator BILL NELSON. Mr. Chairman?

Chairman WARNER. Yes.

Senator BILL NELSON. May I follow up with a question on that? Help this new member to understand a concept. Is the technology such that if this system is successful you could even make larger systems for commuter aircraft? Is that what you are saying?

Chairman WARNER. I remember this program throughout my many years on this committee, and that was one of the fundamental issues when this program was first brought to our attention. I say to my colleague that there is a long history in our country of the initial costs of aircraft development being borne by the United States military and very quickly the civilian community transitions with that aircraft to civilian uses. I know that was the case with our transport aircraft at the end of World War II, and I am sure that these gentlemen could give you other clear examples of how we have transitioned from the military adaptation, operational and proven technology, right into the civilian use of this aircraft. That is correct. I remember—I am sure you also do, colleague, how we were told in the beginning, a decade or so ago, that it could extrapolate this technology to accommodate a civilian aircraft and a number of passengers, larger than the military load.

Senator LEVIN.

Senator LEVIN. Just one more question, Mr. Chairman, regarding this timeline. That will depend on how extensive the changes need to be and how extensive the testing is I assume. Is that correct?

General DAILEY. Yes, sir.

Senator LEVIN. Again, the Director of Operational Test and Evaluation, until recently Phil Coyle, said this relative to the vortex ring state condition: The problem "cannot be remedied by minor design changes." Do you disagree with that?

General DAILEY. No, sir. I think that is correct.

Senator LEVIN. Even with changes which are not minor, you still believe that kind of a timeline can be met?

General DAILEY. Yes, because you will avoid the vortex ring state parameters.

Senator LEVIN. You believe the hydraulics failures can be corrected in such a way that we are not going to get back into an unacceptable weight condition within that same time frame?

Dr. COVERT. Mr. Senator, I think that is correct.

But I would like to make one other comment, if I may, on the vortex ring state. Every airplane has a flight envelope in which it is possible to have safe flight and that you can fly outside the envelope, you are inviting disaster. I think as the flight testing proceeds and the vortex ring state borders are well defined, we will find that we can operate this airplane safely within an envelope and accomplish the missions as desired in a much more favorable way.

Senator LEVIN. I just have one other request. If this is not already in your report, if you could give us a side-by-side comparison of any findings of the OT&E Director that are different from yours, if you could pull them out of your report, pull them out of his findings, and then give us your assessment of the differences, that would be helpful. It may already be in your report. I have not had a chance to read it.

General DAILEY. It is not specifically, no, sir.

Senator LEVIN. I think that would be useful, just in one place, to have those differences.

[The information follows:]

The Panel to Review the V-22 Program recommendations are consistent with the findings of the Director, Operational Test and Evaluation (DOT&E) report and briefing to us. In fact, the Acting Director stated that position in the House Armed Services Committee hearing. DOT&E is in substantial agreement with the findings and conclusions of the panel. DOT&E places somewhat greater significance on the difficulties related to reliability failure and autorotation than does the panel report.

The appendix for the Joint Operational Requirements document includes the differing respective positions of the Program Manager and DOT&E on downwash and reliability and maintainability. Additionally, one of our recommendations was to have the Navy Operational Test and Evaluation Force and DOT&E consider the use of standard risk indices (similar to those used by the Naval Air Systems Command) to aid decisionmakers in assessing risk.

Senator LEVIN. I would just ask to go off the record just for one second. [Pause.]

Chairman WARNER. Gentlemen, is there any other testimony regarding the entirety of our proceeding today about which you wish to make some comment before we go to our next panel?

General DAILEY. If I could, sir, just say that we were very much impressed with the openness with which everyone provided information to us throughout this review and genuine interest in identifying the problems and getting on with solving them.

I would also, if I may, publicly thank the members of this panel. This has been one of the finest groups I have ever had the privilege to be associated with.

Chairman WARNER. I certainly join in that. I had intended to express my heartfelt appreciation just as a citizen of this country and most specifically as a Senator for your public service. It has been tremendous, and I think it has been extremely helpful to all parties involved in this. So, I thank you.

Senator Inhofe.

Senator INHOFE. One question for the record. There has been legislation introduced, and I was gone for a little while. I do not know if they addressed that or not, but for the record, if you would respond to your feelings as to what it would cost and your recommendation in terms of the Feingold legislation that has been introduced.

[The information follows:]

The panel's recommendation is to reduce production to a minimum level to provide funds for the Design Maturation Phase and to keep the number of aircraft requiring retrofit to a minimum. The Design Maturation Phase will address deficiencies identified by the panel. The minimum level is required to maintain the existing learning of the labor force and avoid more problems with starting up again. The panel does not support the Feingold proposal because it does not free-up sufficient resources to conduct the Design Maturation Phase efforts in fiscal year 2001. The panel can not determine the cost impact of the Feingold proposal because the Department is still considering the panel's recommendation.

Chairman WARNER. Thank you, Senator.

We will now excuse you and I will make a statement before the next witnesses appear.

Gentlemen, before you take the witness stand, the chair indicated that he would give the Program Manager, Col. Nolan Schmidt, and Adm. Steven Enewold the opportunity to make any comments they wish. You may, however, decide that you prefer to have the benefit of the Inspector General's report because it is the intention of this committee, shortly after the issuance of that report, to go into that report with the Inspector General and the timing of that sequence may facilitate your testimony. Eventually you will have the opportunity to appear before this committee. If you desire to do so now, the chair will give you the opportunity; if you desire to wait, without any inference to be drawn between your election to do it now or later.

Colonel SCHMIDT. I would like to speak now, sir.

Chairman WARNER. All right. We will now have Adm. Steven Enewold and Col. Nolan Schmidt appear before the committee. Obviously, you were not aware that this opportunity would be given, but I felt, in eliciting certain testimony, that it would be important to you, both personally and professionally, to be given this opportunity promptly, so the chair elected to do so. You do not have statements prepared, but we will proceed and we will proceed in the order that perhaps the two of you wish agree on.

Admiral ENEWOLD. I guess rank has its privileges, sir.

Chairman WARNER. It has, indeed.

I fully understand your position, but I think the record should show exactly what your position is and your area of responsibilities.

STATEMENT OF ADM. STEVEN L. ENEWOLD, USN, NAVAL AIR SYSTEM COMMAND PROGRAM EXECUTIVE OFFICER FOR ASSAULT AND SPECIAL MISSIONS

Admiral ENEWOLD. Absolutely. I thank the rest of the Senators for having us.

My name is Steve Enewold. I am the Program Executive Officer for Air Antisubmarine Warfare (ASW), Assault and Special Mission Aircraft Programs, and the V-22 fits into the portfolio that I oversee.

I want to, for the record, make it clear that I took over this position 2 days after the December mishap.

Chairman WARNER. December tragic accident.

Admiral ENEWOLD. Yes, sir, the tragic accident.

Chairman WARNER. That is December of?

Admiral ENEWOLD. 2000, last December. I have been in the position now about 4 months. As such, during the full-rate production decision, I was not in my current position, but I did have the opportunity to observe the proceedings, if you will, of the Program Executive Office and the preparations that went forward to the milestone for the full-rate production decision meeting.

I can state for the record that I saw no undue pressure—or any pressure, for that matter—on the program to rush to judgment, if you will, on the testing or that kind of thing. In fact, I would say that the deferral of testing and the waivers that we have talked about happened many, many months before the full-rate production decision meeting or anything like that was scheduled. It happened, I think, before operational testing started. So, the discussion of waivers happened long before the milestone decision.

During the milestone decision brief, I sat along the wall. I was not at the table in the decision process. But there was a lengthy discussion of the R&M issues that were associated with the V-22.

Chairman WARNER. Identify the acronym “R&M.”

Admiral ENEWOLD. I am sorry, sir. The reliability and maintainability (R&M) issues that were identified.

At the time we had the Operational Test and Evaluation report, which classified the aircraft as effective and suitable beyond Low Rate Initial Production (LRIP), and the report from the Office of the Secretary of Defense Director of Operational Test and Evaluation, Mr. Coyle, that said it was operationally effective and not suitable as tested. The “as tested” piece is a key point for the discussion here because the test airplanes had not incorporated some of the fixes that had already been designed and were, in fact, being incorporated in the production aircraft.

At that same meeting, we also discussed what I will call the reliability growth plan, and that is the effort that the program office had gone through to identify the engineering changes that had to be made to the aircraft and then also talked about when those changes would be incorporated on the production line. Colonel Schmidt went through that in great detail on how many fixes had been identified, completely engineered, and in which lot of aircraft they would be incorporated. I will let Colonel Schmidt talk to that.

Then the last thing I would like to address is the question of why we should go forward. I think it really comes down to four areas.

The complexity of the design fixes that we have seen so far are not of the magnitude that they would prohibit retrofit. We do not see a great deal of dollar expense incurred by retrofitting the existing aircraft that we already have.

As Dr. Covert said, we have a fair amount of testing and revalidation to accomplish, and we think, in order to get back into the air, we will have to do that. So, the software will obviously be retrofittable, with any changes we make to that.

Production line preservation is a key issue because we have learned a great deal on the production line, and we do not want

to lose that. The subvendor base that is supporting the line we believe will depart and go somewhere else and support other programs if we do not maintain a reliable line to help produce the airplane.

Last, we do have follow-on testing that is planned to look at both the incorporation of the reliability/maintainability fixes, and in the development world, to look at the vortex ring state, icing, and some of the other issues that were deferred well before the operational testing started.

Those I think are my key points, and I am going to pass it over to Colonel Schmidt.

Chairman WARNER. That is very helpful testimony. Thank you, Admiral.

Colonel.

**STATEMENT OF COL. NOLAN SCHMIDT, USMC, V-22 PROGRAM
MANAGER**

Colonel SCHMIDT. Yes, sir.

I wrote down one quote from Mr. Augustine as he was speaking. He said, "Well-run and managed programs have problems."

I would like to speak specifically to the timing of when I knew things and decisions that resulted after having known things.

Chairman WARNER. You might tell us exactly when you joined the program, maybe something of your background.

Colonel SCHMIDT. Yes, sir. I joined the program in the summer of 1997, and scheduled removal from the program and the Corps would be this summer. June 14th is the scheduled change of command.

I came from out of the Marine Corps' EA-6B program. I was a navigator in the EA-6B program, so I have an electronic warfare (EW) background. It was happenstance, in reality, that I ended up in this program. I was managing EW programs for naval aviation in the 1997 time frame when my predecessor was getting ready to depart. Because of the fact that the Marine Corps sometimes has somewhat of a dearth of program managers, we looked across the board where we could get a program manager for the program at that time, and that is how I ended up in the program.

I do not have a rotary background, and I have had to rely upon a number of folks from around the Marine Corps and the Navy and the Air Force to give me that expertise which I did not have. I did have a number of years in program management experience.

Last week I went to VMMT-204 Squadron, which is the training squadron down in New River. The Commandant was there earlier in the month. I went last week to basically tell them exactly what I knew when.

If you go back to the two questions, sir, that you asked of the committee, if you were told those things, then how come the chain did not know? I reported to the committee in late January of this year, of 2001. I reported to The Blue Ribbon Panel, and we spent 8 hours in one day basically running through the program. We gave them 8 hours of information in late January of 2001.

That was a month-and-a-half, if not 2 months, after the accident. Certainly I did not have an accident report. However, given what had happened in that accident, we had specifics. We basically knew

the primary things that had caused that accident, one of which was the flight software program problem, and one of which was hydraulics. Of course, we reported to the committee those problems. However, I did not know those specific problems until after the accident.

Flight control software—I do not think anybody has any question that we did not know that issue until after the accident. We are going in and we are doing some real in-depth analysis. We are bringing folks in from the Massachusetts Institute of Technology (MIT). We are bringing folks in from the National Aeronautics and Space Administration (NASA) to help us, Boeing, British Aerospace (BAE), to work through those software problems and do a much stronger flesh-out of those anomalies that were spoken to by The Blue Ribbon Panel, partly under their direction. That is an effort that will take on the order of 6 months and continue flesh-out over the life of the program. Any flight control software—we do not stop fleshing it out at the end of development. We continue to mature that flight control software over time. That will continue.

The other one is the hydraulics. The hydraulics is somewhat more, I would say, problematic. What did you know when? When do you have enough information to make a decision to stop everything? That is the question that is really being asked.

We knew we had quality problems. There are several people who have spoken to production quality issues, why we need to keep the production line going, because folks on that line do certain things. They learn them over time. They do them better when they learn a problem and it gets identified, and then they do it better the next time. We knew we had quality problems.

In March of 2000, prior to the first accident, but completely unrelated to the first accident, I might say, I went to the companies, Bell and Boeing, and I said, we are identifying too many problems coming out of the production line going forward in these airplanes. We need to get our hands around those quality issues. I said, I can do it from the Government's viewpoint or you can do it. Which do you want to do? They said, we would like to take that one on. So, in March they started that effort between Bell and Boeing.

By the time we got to July of 2000, we had to down an airplane. It was about the third airplane that we had to hold down for a time period, and it was specifically related to the interconnect drive shaft. It goes from one engine to the other engine, so that if you have a problem in one engine, this is the drive shaft that drives the rotor on the other side. There are a number of fixtures, interconnections, on that drive shaft that we had to remove from aircraft, redo them, and reinstall them. It caused some huge problems to the marines down in the VMMA-204 Squadron. It had to be done across the test force. At that point, myself and Admiral Enewold's predecessor said we now need to do a total Government quality audit of the two contractors.

But, realize, at that point it is still quality in general. What is the specific problem that you are referring to? There were a number of different issues. You heard to 35 different inspection things on one aircraft, the first aircraft that did not pass as that aircraft was accepted. Reduced to four today. A number of issues, some of

them hydraulic, some of them electrical, different things that we were trying to get our hands around.

We go forward with the quality audit starting in the July-August time frame of 2000. It was basically finished by around November. It came out with 50 findings that we said, these are things that had to be done to improve the quality of the airplane on the production line. Those were things that we then put in a plan to address each one of those items. We had a metric system put in place to start reducing those problems. That was all put in place.

After the accident, in January, I went to my Assistant Program Manager for Logistics.

Chairman WARNER. For a time frame, accident in December 2000, and now this is January 2001.

Colonel SCHMIDT. Yes, sir. Thank you very much.

In January 2001, I went to my Assistant Program Manager for Logistics, now Colonel Loren Eck, then Lieutenant Colonel Loren Eck. He was the guy that was looking at, from our point of view, airplanes and how well they were being kept up down at New River. I said, Loren, go back over your data and show me if you could correlate any problems to this specific hydraulic tube. Do you see a problem where we had any correlation to this hydraulic tube or two hydraulic tubes or three hydraulic tubes? Was there any correlation, something that we should have found that we did not see prior to the accident?

Loren went back through the data. He said there was no correlation. The problem was we were finding a little nick here, a little nick there, going across the board. It was related in our minds to quality overall in the airplane rather than to one specific engineering design change.

So, when we talk about engineering design, we are looking—I am jumping now to the future—in a nacelle area, do we need more room overall? Do we need to clamp more lines overall? Do we need to clamp them in a different way? All those kinds of questions. It is a nitroid engineering not a grand global scale engineering problem that we have.

We were perceiving that as quality. We were not perceiving that as a specific hydraulic issue one place or the other. That is the reason in my mind that I was not clairvoyant enough to cause a stop here that would have restrained this terrible tragedy from happening.

Chairman WARNER. I thank you. That is very valuable testimony.

I want to put in the record—and correct me if for any reason this information is inaccurate—the four accidents associated with this aircraft. In 1991, a crash due to wires crossed on the computer, no fatalities. 1992, crash due to fire, landing at Quantico, seven fatalities. All that was under the jurisdiction of the contractor. Am I correct in that?

Colonel SCHMIDT. To the best of my knowledge, yes, sir.

Chairman WARNER. April of 2000, 19 fatalities, the vortex ring state problem. December 2000, New River, North Carolina, hydraulic leaks and software, four fatalities.

Colonel SCHMIDT. Yes, sir.

Chairman WARNER. Now, this is an interesting point that I hope you can clarify for me, Colonel Schmidt. What other catastrophic hydraulic failures did the V-22 have and were you made aware of them?

Colonel SCHMIDT. In fact, just in the last 2 weeks, I have been made aware of one that occurred during operational evaluation (OPEVAL). There may have been another one, but this is one that I have been made aware of during OPEVAL. It was a similar failure, not the same failure. It did not get reported into any chain that went to either the manufacturer or ourselves in the program office.

Chairman WARNER. That is what has been brought to my attention, that there was another one, and it was not brought to your attention. I simply, at this point in time, want to be very careful. We are going to go back and construct our understanding of the facts as to why that was not brought to your attention, and we will give you an opportunity to insert for the record, as we insert our findings in the record, any amplification that you have.

Colonel SCHMIDT. Yes, sir.

Chairman WARNER. I thank both of you.

Senator Levin.

Senator LEVIN. I think it is important that we give the witnesses an opportunity after our Inspector General report to comment on it and to come back.

Chairman WARNER. That will be done.

Senator LEVIN. On this last point, how is it possible that there could be one and possibly two hydraulic failures during that operational testing of the V-22 that would not be reported to you? How is that possible?

Colonel SCHMIDT. This is something I believe that The Blue Ribbon Panel is speaking about. But during OPEVAL, we have put together an independent test structure for evaluation. To ensure that we have independence, from the point of time that we hand those airplanes over to OPEVAL, my communications with that group get very limited. Any communication that comes to me at that point has to go through Commander, Operational Test and Evaluation Force (COMOPTEVFOR) and is labeled specifically—I forget the label, but it is a message of deviation off the operational evaluation. Therefore, any communicate to me is a deviation from the norm.

Engineering is involved during operational evaluation. But any engineer that is involved in support, for instance, doing an engineering investigation, et cetera, is required to sign a document that says that, under penalty of jail, he will not divulge that information to me, to the program office. We have a series of engineers that may be supporting in some fashion, but they cannot open up that information back to the program office.

A specific area that we had of constraint during this operational evaluation was R&M, reliability and maintainability. We had, I thought, an agreement that reliability problems that came up during operational evaluation would be reported back to us so we could start our engineering fixes to those problems earlier. Those were not reported to us during operational evaluation for the specific reason that we cannot report those issues to the program manager.

Senator LEVIN. Again, when did you first learn of them?

Colonel SCHMIDT. OK, let me take the question right there. Two years prior to operational evaluation, I predicted that we would not pass our threshold for the 1.4 hours mean time between failure. I predicted that; our office predicted that 2 years early.

Going into the OTRR—that is operational test readiness review—we predicted that we thought we would have around 1.0 hours mean time between failure. The threshold was 1.4. We said we are not going to pass this area. That was one of the areas of waiver. It was a specific waiver where we asked that it be tested during operational evaluation, that we evaluate the reliability of the airplane because we knew that was an issue that we were not going to pass. But we also knew that there were other areas in the reliability area that the airplane would pass, and we felt, therefore, overall the airplane would be effective and suitable. It would be suitable overall.

But we knew that mean time between failure was not going to pass. We knew that 2 years prior to operational evaluation. Just looking at the growth curve that we had at that time for the things that we were installing into the airplane to improve reliability, they were not going to make that 1.4 threshold.

That 1.4 threshold, by the way, is rather what I would call sporty. The standard today in the CH-46 is around .80 hours. In the CH-53 community, it is a little bit lower than that, about .7, .6 hours. I do not know those numbers exactly, but they are well under the 1.4 threshold that we have on the V-22 program. It was something that we were really having to stretch.

We now have a plan in place to reach that 1.4 hours, and the definition of it now is not mean time between failure. It is mean flight hours between failure, which is a tougher threshold than mean time between failure. We have a plan in place. We have already incorporated nearly 100 fixes in this airplane to improve reliability. We have approximately another 60 or so to go to get to that 1.4 hours, but a plan is in place to get there—delivered aircraft—in late fall of 2003.

Chairman WARNER. Let me interject just one fact.

Senator LEVIN. The answer to my question.

Chairman WARNER. You go ahead.

Colonel SCHMIDT. I thought I had, but give me the question again, sir. I missed it.

Senator LEVIN. The question is when did you first learn about those two hydraulic failures?

Colonel SCHMIDT. The two hydraulic failures from which ones?

Senator LEVIN. The operational test and evaluation folks. You said there were one or two failures that were not reported to you during that time. You gave us the reason why. They are not allowed to communicate with you except with a specific waiver. My question was, when did you first learn about it?

Colonel SCHMIDT. I am sorry. Approximately a week and a half ago, sir.

Senator LEVIN. This is important information, is it not? It relates to safety. You are the program manager. You are in the position to fix a problem, and you are saying that those one or two failures were not reported to you until a few weeks ago?

Colonel SCHMIDT. Yes, sir.

Senator LEVIN. Well, there is something wrong there.

Colonel SCHMIDT. I would agree, sir.

Senator LEVIN. I have to tell you something. I do not know how program decisions can be made without the program manager knowing about these kinds of problems. I would say that the wall that was supposed to be there between the operational testing and evaluation folks and our program manager, it seems to me, is a wall that is aimed at keeping them independent from you. But that is no reason why information that they obtain that relates to safety should not be transmitted to you. There is a mechanism by which to do that. You say they have to get a sign-off by somebody, but it seems to me clearly that should have happened. Do you agree with that?

Colonel SCHMIDT. Yes, sir.

Senator LEVIN. One other point.

Chairman WARNER. I was reluctant to bring this point up, but I felt it important, since I had you here, I just wanted to put in the record, which will be helpful for the discussion, that this malfunction occurred in February of 2000. So, it was months before the two accidents. Am I not correct in that? That is what our document shows.

Colonel SCHMIDT. I can figure this out. It was on the flight from ferrying the last aircraft from Patuxent River to the west coast to start the second phase of OPEVAL. It would have been late January/early February time frame. I do not know exactly the date.

Chairman WARNER. Our records show that. That is why I am very cautious to put our findings into the record. We will give the other side, who are not present today, the opportunity to contribute to this committee and to this record what they knew about it. We will clarify, the best we can, the position of one side of the Marine Corps not talking to the other because, as Senator Levin and I point out, this is a serious problem in our judgment. But there may be an answer to it. In fairness to many, we must hear both sides before we render any final judgments.

Senator LEVIN. My last question. The time pressure to get to full production. Would you agree that early in this program, as long as you were there, there was pressure to get to full-scale production in this program?

Colonel SCHMIDT. No more than is normal for any program.

Senator LEVIN. Just a normal amount of time pressure in your judgment.

Colonel SCHMIDT. Yes, sir.

Chairman WARNER. Thank you, Senator.

You have joined us, Senator Reed. We had not anticipated we would put these two gentlemen up, and I made the judgment it would be helpful to the hearing. Do you have any questions at this point?

Senator REED. Mr. Chairman, no.

Chairman WARNER. If not, we will go to the Commandant.

Senator REED. I think that is appropriate.

Chairman WARNER. We thank both of you. We will soon be communicating with you with regard to our understanding of that 2000 incident. Thank you very much. That was very helpful testimony.

We will now receive testimony from the Commandant of the Marine Corps, General Jones, and General Holland.

General Jones, we are ready when you are, sir, and we thank you for your patience. But I think it was very important that we thoroughly and carefully review the testimony of the previous panel, and I am sure you agree with me.

Any statement that either of you have in writing will be admitted in its entirety into the record. Proceed as you wish.

STATEMENT OF GEN. JAMES L. JONES, JR., USMC, COMMANDANT, U.S. MARINE CORPS; ACCOMPANIED BY MAJOR KARSTAN HECKL, ASSISTANT OPERATIONS OFFICER, VMMT-204; AND STAFF SERGEANT THOMAS FOWLER, CREW CHIEF, VMMT-204

General JONES. Thank you, Mr. Chairman. With the chair's indulgence, I would like to proceed with just a very brief opening statement by way of summary.

Mr. Chairman and members of the committee, I deeply appreciate the opportunity to appear before you today to present testimony concerning the V-22 Osprey.

You have received testimony from the independent panel convened by the former Secretary of Defense, William Cohen, and we are all grateful for the diligent efforts by these distinguished experts.

I might pause and introduce two people to you whose opinion and expertise is also to the point. I would like to ask Major Karstan Heckl and Staff Sergeant Thomas Fowler, seated behind me, to just stand up to be acknowledged. Major Heckl is the Assistant Operations Officer of the VMMT-204 Squadron, an experienced Osprey pilot, and Staff Sergeant Thomas Fowler is a crew chief. In addition to the observations of the distinguished panel of experts, I think it was also very useful to have two people who actually fly and work on these machines to be here to take in this testimony. If the chair would like to call them for any questions, they are certainly available and free to provide—

Chairman WARNER. General, I thank you for bringing these two outstanding individuals here so that they can report back firsthand to their colleagues their understanding of the testimony given not only by this panel, but our distinguished commandant.

General JONES. Thank you, sir.

All these findings and recommendations help us all to understand both the promise of tiltrotor technology, as well as the prudent path we must now follow in order to be able to fully harvest its potential both for the future of our joint military capability, as well as that of our industrial base.

As the report has only just recently been obtained, we are still in the process of evaluating the best way to implement its many fine recommendations. As we complete this task, we will recommend to the Secretary of Defense a revised plan for the future of the program, and we will keep you and members of this committee fully informed as to the proposed corrective plan.

Our new direction should be event driven vice timeline driven in order to ensure that the necessary remedies are fully implemented one step at a time.

Chairman WARNER. General, I think we should also put in at this point in your testimony that we anticipate the Inspector General's report. Estimates I have received are approximately 2 weeks. Thereafter, I presume you will be making your recommendations to the Secretary of Defense.

General JONES. Correct, sir.

The history of the V-22 program is particularly well known to this committee. A summary of it is contained in my prepared remarks. In the interest of brevity, I would like to just make the following observations.

This has been an extremely difficult period of time for those of us privileged to wear the marine uniform. The two most recent accidents of the V-22 have caused enormous grief for the marines and their families. Daily we mourn the tragic loss of our comrades and we reach out to their loved ones in any way we can. We will continue to do so forever.

Oftentimes from such tragedies, though, comes learning. It is in such lessons that we can and must find the solutions that will enable our future warriors to discharge their important responsibilities to the Nation as safely as possible and with the finest equipment we can place in their hands.

But we should never hesitate to walk away from any technology, the V-22 included, if it were to be found to be either unsuitable, unsafe, or operationally too fragile for it to be placed in the hands of our most precious assets, our marines. We love our people, not our machines. But we use our machines in order that we might safely prevail in our important and frequently dangerous missions. It is, therefore, of paramount importance that we should never be reluctant to simply do what is right.

Similarly, no marine would knowingly place any other marine at risk in any technology, particularly aviation technology, without the full confidence of the many experts, civilian and military alike, who have worked so diligently to develop it for our Nation's warriors to use. This has always been a distinguishing characteristic of our Nation in developing technologies on land, at sea, in the air, and even in space. This applies to the V-22 Osprey program especially.

With regard to aviation, we know that despite the most modern development in production techniques anywhere in the world, risks are still omnipresent. Examples of this reality abound. I would just like to cite but one that has been previously referred to.

For years during the development of the F-117 stealth fighter, the program was "protected" by an understandable veil of secrecy. This aircraft made its maiden flight nearly 20 years ago on June 18, 1981. Before the program was declassified in 1988, three of these aircraft had crashed. An additional three more crashed before 1997. Had the program not been invisible to the public eye, it is not difficult to imagine the criticism that could have been directed its way in the aftermath of such accidents—cost, odd shape, risky technology, not ready—the same types of comments that have been attributed to the V-22, a very visible program by contrast. Yet, what a wonderful and still unique capability the F-117 has given the Nation.

The V-22 has similar promise within its own operational mission envelope. It is truly the first step away from the limits of the physics of rotary wing technology.

The work of the panel has answered the three most pressing questions with regard to this program. Those questions are: one, is tiltrotor technology mature? Specifically, do the laws of physics, as we understand them, allow a single airframe to perform the flight functions of both the helicopter and a fixed wing aircraft? The panel has answered in the affirmative on this issue, at the same time eliminating any lingering thoughts that the technology might have been a causal factor in any of the four V-22 accidents, which I briefly summarize in my prepared testimony.

Question number two. Is the V-22 program operationally robust enough to meet our needs? Associated with this question are issues relating to maintenance and reliability, parts availability, program funding, and mean time between failures. The panel has found that more work needs to be done in this area, and we agree with this important finding. In fact, the central question is the focus of the panel's effort.

Question number three. What is the most efficient and economical way to bring this capability into the inventory so that we can retire our aging airframes that have reached the end of their service life? This includes the challenge of restructuring the program in order to implement the panel's recommendations.

As you referred to just a minute ago, Mr. Chairman, we are also awaiting the results of the Department of Defense IG with regard to possible malfeasance concerning the reporting of V-22 readiness data. That report should be forthcoming in the near future.

Mr. Chairman, I brought with me a variety of letters written by representatives of both commercial and military interests, foreign and domestic alike, expressing their collective belief in the viability of tiltrotor technology and urging our perseverance in this regard. I ask that these letters be made a part of the record.

In addition to their extraordinary military potential, tiltrotors of all sizes could play an important role in the transformation of our military forces for the 21st century. History shows that our Nation has long enjoyed a pioneering role in aviation development, a position of global leadership we want to preserve in this technologically oriented 21st century.

Mr. Chairman, I am very pleased that General Charles Holland, our distinguished Commander in Chief (CINC) from the Special Operations Command, is here today to offer his views on this issue as well. I look forward to responding to your questions.

[The prepared statement of General Jones follows:]

PREPARED STATEMENT BY GEN. JAMES L. JONES, JR., USMC

INTRODUCTION

Chairman Warner, Senator Levin, and distinguished members of this committee, thank you for the opportunity to appear before you today to discuss the future of the MV-22. The crashes of two Ospreys and loss of 23 marines in the past year have painfully illustrated the stark reality that military service and aircraft development, even in our modern era of improved technology, are still inherently dangerous pursuits. Marines and their families are our most valued treasures and we are deeply saddened by these accidents and the unimaginable grief they have caused.

As a result of the most recent mishap on December 11, 2000, we have conducted comprehensive external and internal reviews of the program. The Marine Corps should pursue the MV-22 only if it proves to be technologically mature, operationally reliable, and affordable. Safety undergirds each of these areas and transcends the entire program. As I have stated on many occasions: in the Corps, we do not love machines, we love the people who use machines. That is why when machines fail and cause loss of life, it is so very painful for the entire marine family.

It was over 20 years ago that the Marine Corps began to consider replacement options for its aging CH-46E Sea Knight and CH-53D Sea Stallion helicopters. Following a rigorous evaluation of future mission requirements, tiltrotor technology was selected as the best option to achieve future needs for its promise to revolutionize our expeditionary capabilities. Since the early 1980s, various government agencies and contractors have conducted seven major Cost and Operational Effectiveness Analyses. Each analysis validated the merit of tiltrotor technology and concluded that the Osprey was potentially more cost and operationally effective than any existing alternative.

Over time, it became apparent that the enormous potential of tiltrotor technology would allow the Marine Corps to greatly expand the scope of its combat operations. The Osprey would allow the Marine Corps, for the first time, to move away from traditional amphibious operations to more advanced, sea-based, expeditionary operations. At twice the speed, three times the payload, and five times the range, this aircraft significantly improves our operational reach and tactical flexibility. Furthermore, the Osprey dramatically increases our strategic agility with its capacity to self-deploy over 2,100 nautical miles with but one aerial refueling. Finally, tiltrotor technology also has great potential for civilian application.

In requesting that the Secretary of Defense appoint an independent review panel to conduct a comprehensive examination of the program, following the 11 December mishap, we hoped to obtain the answers to three basic questions: Is tiltrotor technology sufficiently mature to meet near-term requirements? Is it robust enough to satisfy our rigorous operational standards, including the safety of our personnel? Finally, what is the most efficient and economical way to bring the aircraft into our inventory? We are grateful to the review panel for its hard work, thoroughness, and diligence, and we are pleased that its answer to the three important questions is "yes," with some important caveats. We can now objectively assess the program in its entirety and determine the best way ahead.

THE IMPERATIVE TO REPLACE LEGACY SYSTEMS

The Marine Corps' fleet of CH-46E and CH-53D helicopters began their service in the mid-1960s. At the end of their 20-year initial projected service life, both began experiencing escalating maintenance costs; reduced reliability, availability, and maintainability; and significant performance degradation. These challenges are even more pronounced today, as the average age of our CH-46E and CH-53D helicopters is over 30 years. These helicopters are old, their production lines are closed, parts are scarce, and their maintenance requirements exceed the bounds of reasonableness. They are truly "legacy systems" with numerous current and projected deficiencies: inadequate payload, range, and speed; and, no self-deployment or aerial refueling capability. Clearly, a capable replacement aircraft is required and long overdue.

The tiltrotor, vertical/short takeoff and landing (V/STOL) Osprey is designed to replace our aging fleet of medium lift helicopters and remedy their deficiencies while expanding our mission envelope. The MV-22 incorporates myriad advanced technologies: composite materials; fly-by-wire flight controls; digital cockpit; and, a sophisticated airfoil design. The MV-22 can carry 24 combat-equipped marines or an 11,700 pound single point external load. Its two 38-foot rotor systems and engine/transmission nacelles mounted on each wing tip allow it to operate like a helicopter for takeoff and landing. Once airborne, the nacelles rotate forward 90 degrees, converting the MV-22 into a high speed, high altitude, and fuel-efficient turbo-prop aircraft.

The multi-mission Osprey will join the Advanced Amphibious Assault Vehicle and the Landing Craft, Air Cushion as an integral part of the mobility "triad," and will enable the Corps to conduct operations from over-the-horizon and the sea-base. Missions for the aircraft include amphibious assault, raid operations, medium cargo lift, tactical recovery of aircraft and personnel, fleet logistic support, and special warfare. Possessing the attributes needed to fight and win on tomorrow's battlefields, the MV-22 will be the cornerstone of Marine Corps assault support for the first half of the 21st century. Most importantly, it will save lives in future conflicts as it al-

lows for the movement of troops and supplies farther and faster than ever before and with far less vulnerability to opposing forces.

The Marine Corps is not the only service that will benefit from tiltrotor aircraft. The U.S. Special Operations Command has embraced the Osprey as the best solution to remedy its own current and projected aircraft deficiencies. Their current inventory includes a variety of fixed and rotary wing aircraft that lack the self-deployment and other high performance capabilities required for special operations. Consequently, they are developing their own version of the MV-22, the CV-22, which is specifically designed to conduct long-range, night and all weather special operations. The U.S. Air Force and U.S. Special Operations Command plan to acquire 50 Ospreys. The U.S. Navy is interested in the Osprey as well, and intends to acquire 48 of the HV-22 model tailored for combat search and rescue missions, special warfare, and fleet logistical support. Finally, some of our allies, notably Great Britain, Australia, and Japan, have shown interest in the Osprey. I have provided the committee copies of letters I have received from dignitaries of foreign countries expressing their interest in utilizing tiltrotor technology in the future.

The potential of tiltrotor technology transcends the military community. Commercial aviation has recognized that the civilian use of tiltrotor aircraft has enormous potential. Tiltrotor technology could redefine regional air travel and commuting, particularly in congested areas of the country like the northeastern seaboard. A larger quad-tiltrotor aircraft that carries up to 100 passengers could help reduce air traffic delays, congestion, and noise pollution near airports while increasing the capacity of existing airports without adding more runways. Clearly, civil tiltrotor applications could potentially bring a new dimension to commercial aviation while greatly benefiting our industrial base.

THE DEVELOPMENT OF THE MV-22

Tiltrotor technology is not new. The MV-22 traces its origins back to 1954, with Bell Helicopter's tiltrotor prototype, the XV-3. In 1956, Boeing developed a tilt-wing aircraft, the VZ-2. During the 1960s, Bell and Boeing continued their development of tiltrotor technology. In 1973, Bell was awarded a NASA-U.S. Army contract to develop two tiltrotors. The result of this contract was the XV-15, first flown in 1977, with full conversion¹ occurring 2 years later. In fact, one of the XV-15s is still in service.

The success of the XV-15 led to the Joint Services Advanced Vertical Lift Aircraft Program (JVX) in December of 1981. The goal of the program was to meet the needs of all four services for a vertical takeoff and landing (VTOL), medium lift, tactical transport aircraft. Soon thereafter, the Joint Services Technical Assessment confirmed that tiltrotor technology was the optimal choice to achieve service needs.

In April 1982, the Bell-Boeing team was formed in order to combine the companies' resources and draw upon their collective strengths. One year later, the Bell-Boeing team was selected by the U.S. Navy to be the prime contractor for the JVX. The JVX later became the V-22, which was first flown in 1989. Since then, pre-production versions of the MV-22 have flown 3,324 hours. In the past 2 years alone, production model MV-22s have flown 1,869 hours.

It is a well known fact that military aviation is an oftentimes hazardous undertaking. In 1954, the Department of Defense had its highest number of aviation accidents: 775. In the 1990s, thanks in part to technological advances, the Department averaged about 20 aircraft accidents per year. However, the development of new aircraft retains inherent risk and, despite our best efforts, the MV-22 is not exempt from such risk. In the last 10 years, there have been four Class A mishaps² involving the MV-22.

The first mishap occurred on June 11, 1991, when the Bell-Boeing Full Scale Development ship #5 crashed as a result of two out of three roll gyros³ being wired incorrectly. Essentially, the aircraft lost control due to reversed roll channel wiring. The second mishap occurred on July 20, 1992, as a result of an engine fire that spread through one of the nacelles and subjected the pylon-mounted drive shaft⁴ to high temperature exposure, causing it to fail. Consequently, the remaining good engine was unable to drive both proprotors and the resulting crash claimed seven lives. Tragically, there were 19 fatalities in the third mishap that occurred on April

¹ Full conversion refers to the ability to transition between airplane and helicopter modes during flight.

² A Class A mishap is categorized by a loss of life or property damage in excess of one million dollars.

³ A gyroscopic instrument that helps the pilot to control the left and right roll of the aircraft.

⁴ This drive shaft allows either of the aircraft's two engines to drive both proprotors in the event that either engine fails.

8, 2000. The cause of this accident has been primarily attributed to flying outside the flight envelope established for the MV-22 (250 percent above the Naval Air Training Operating Procedures Standardization limit). The most recent mishap occurred December 11, 2000, near New River, North Carolina. A flight control hydraulic system failure was compounded by a flight control software anomaly, resulting in a crash and four fatalities. While acknowledging the tragic consequences of these mishaps, it is also important to recognize that they were not the result of any failure of tiltrotor technology.

Following the first three mishaps, problems in design and engineering were identified and remedied. After the December mishap, the decision to proceed to full-rate production of the aircraft was postponed and three separate investigations, in addition to the customary Aircraft Mishap Board Investigation, were conducted to ascertain the cause of the crash and to determine the future of the MV-22.

First, at my request, then-Secretary of Defense Cohen appointed a review panel to conduct a comprehensive examination of the program emphasizing training, engineering and design, production and quality control, suitability to satisfy operational requirements, performance and safety of flight. I declared at that time that I would recommend that the Corps not pursue the MV-22 program, if it became apparent that this was not the right thing to do.

Second, a Judge Advocate General's Manual (JAGMAN) investigation was convened to ascertain the facts surrounding the latest mishap. The results of the JAGMAN investigation were announced on April 5, 2001. The investigation revealed that a main hydraulic line ruptured due to chafing caused by an electrical wire bundle. As a result, there was an uneven distribution of hydraulic power to the left and right swashplate actuators.⁵ As noted earlier, this problem was compounded by a software anomaly, causing the aircraft to depart controlled flight and crash.

The final inquiry was requested in January of this year, after a member of the Osprey training squadron, Marine Medium Tiltrotor Training Squadron-204 (VMMT-204), alleged in an anonymous letter that the squadron's commander had encouraged his marines to falsify maintenance records. Upon receipt of that letter and the audiotape that accompanied it, I directed the Marine Corps Inspector General to conduct a comprehensive initial inquiry. Subsequent to that action, based on my belief that the gravity of the accusations might invite undue perceptions of command influence, and that a full and impartial accounting was essential, I asked that the Department of Defense Inspector General assume responsibility for the investigation. That investigation is ongoing.

THE FINDINGS OF THE REVIEW PANEL

The Marine Corps is grateful for the review panel's thoroughness and objectivity and concurs with its conclusions and recommendations. First and foremost, the review panel concluded that tiltrotor technology is sound and mature. This finding mirrors our own and is consistent with the fact that tiltrotor technology was not found to be a factor in any of the four mishaps described earlier. The review panel also concluded that the aircraft's reliability and maintainability must be improved through additional engineering, testing, and evaluation. We have also come to this conclusion.

The review panel recommends development of a restructured program that uses a phased approach to achieve a return to flight and tactical introduction. Specific recommendations cover: minimal sustainable production rate in the near-term; adequate and stable funding; requirements validation; safety (hardware, software, and operations); reliability and maintainability; quality, training, and technical publications; and, communications across the program (among operators, contractors, engineers, etc.). Described later is our plan to implement these recommendations. Finally, the review panel concluded that the MV-22 is cost-effective and provides the Marine Corps capabilities that cannot be provided by any single helicopter or conventional aircraft. We agree.

Although I am pleased with the findings of the review panel and remain fully confident in the viability of the aircraft, I am deeply concerned by the as yet unresolved allegations of malfeasance and suggestions of program instability. The Marine Corps will seize upon this opportunity to ensure that we do not compromise our integrity, lower our standards, or jeopardize the safety of our marines for any program. The resolution of the question of malfeasance, despite its grave importance, cannot occur until the Department of Defense Inspector General's investigation is completed. We look forward to a full examination of the investigation's results, which will aid our

⁵A swashplate actuator is a hydro-mechanical device that helps the pilot control the aircraft.

efforts to appropriately address these issues. We are also determined to embrace this opportunity to thoroughly evaluate the role we play in program management.

THE WAY AHEAD

A detailed plan is in place that will expeditiously implement the review panel's recommendations. The Deputy of the Program Executive Office for Tactical Aviation at the Naval Air Systems Command is leading a V-22 Acquisition Working Group to develop a restructured MV-22 and CV-22 program that complies with the review panel guidance, acquisition policies, and service needs. The goal of the V-22 Acquisition Working Group is to deliver to the military services a safe, reliable, and operationally effective V-22.

The options being developed will consider both the time and the funding required to efficiently achieve operational capability. This entails completion of both planned and additional developmental testing, correction of deficiencies and suitability issues, and verification through follow-on operational testing and evaluation. Restructuring of the program will be necessary to accommodate these actions. Participants in this process include members from the Program Management Activity; the Program Executive Officer for Air, Antisubmarine Warfare, Assault and Special Mission Programs of Naval Aviation; Assistant Secretary of the Navy (Research, Development, and Acquisition); U.S. Special Operations Command; the U.S. Air Force; Headquarters Marine Corps; the Commander, Naval Air Systems Command; and, representatives from Bell and Boeing. The group will produce program restructuring options for consideration by acquisition officials and will make recommendations on how to fund the revised program.

It will take time to incorporate critical design improvements and we will proceed methodically. The current road map to full operations is a five-phased approach with specified entrance and exit criteria for each phase.

- Phase 0: Commence technical assessment and complete thorough flight readiness review.
- Phase 1: Resume testing with Engineering and Manufacturing Development aircraft (both the MV and CV models) and augment with Low Rate Initial Production aircraft as necessary.
- Phase 2: Resume Marine Medium Tiltrotor Training Squadron-204 (VMMT-204) training operations and production acceptance flights.
- Phase 3: Stand up a MV-22 operational squadron at New River, North Carolina and a CV-22 training squadron at Kirtland Air Force Base in New Mexico.
- Phase 4: Operational deployment/employment of the MV-22 and CV-22.

The immediate steps include: confirmation of industry willingness to support the restructured program; ensuring acquisition road map compatibility with technical assessment (development of entrance and exit criteria); finalizing a deficiency matrix (including reliability and maintainability issues); developing timelines for correction; providing cost estimates for correction; developing cost, schedule, and production adjustments; and, finally, obtaining consensus among developmental and operational testers. We must also ensure that our training is deliberate and thorough and that quality assurance is maintained.

A WISE INVESTMENT

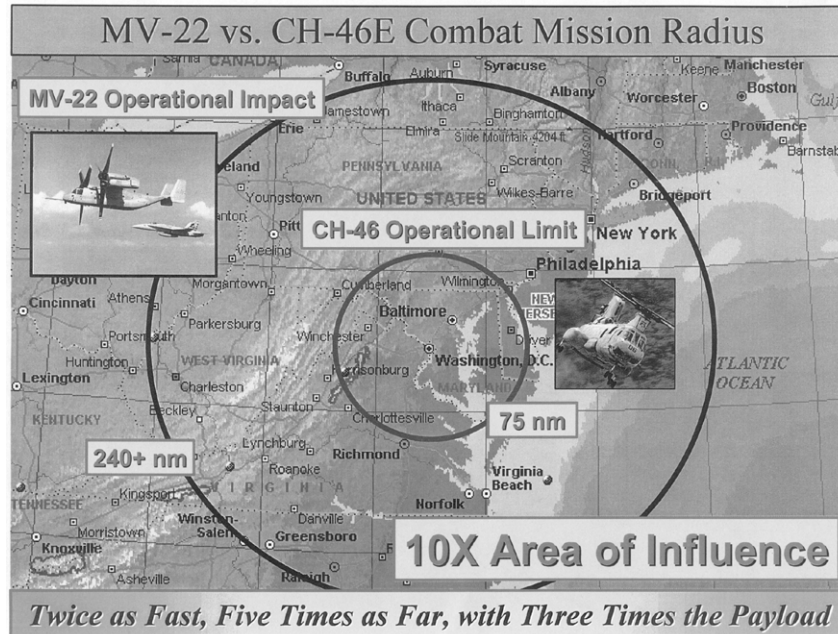
The MV-22 has been described, by some, as an unsafe aircraft—a flawed hybrid, neither a good fixed wing aircraft nor a good helicopter. However, the facts show that the MV-22's safety record compares favorably with the safety records of most tactical aircraft in the Department of Defense at a similar time in their program life. The principal aircraft the MV-22 will replace, the CH-46 Sea Knight, had 44 mishaps during its first 5 years of service four decades ago. In the face of such enormous difficulties, we adjusted our training methods, flight procedures, and maintenance. We also improved our airframes and avionics. As a result, the CH-46 has been in service for 38 years—well beyond its expected service life.

The MV-22 has weathered nearly two decades of scrutiny. Seven major Cost and Operational Effectiveness Analysis studies have confirmed its viability and concluded that it is more cost-effective than any helicopter or any mix of conventional helicopter types. It is, in fact, the only practical alternative that meets the tri-service requirements of the Marine Corps, Air Force, and Navy. Other options offer no real advantages in cost savings/avoidance, given the requirement. In fact, other options are accurately described as a “step back.” A comparison of the capabilities of the MV-22 with those of the aircraft it will replace is illustrative.

The CH-46E has a crew of three, a payload of 12 combat troops or 4,000 pounds (external), a cruise speed of 100 knots, and a combat radius of 75 nautical miles.

By comparison, the MV-22 has a crew of three, a payload of 24 combat troops or 11,700 pounds (single point external), a cruise speed of 250 knots, and a combat radius of over 240 nautical miles. Additionally, it is capable of aerial refueling, “high speed” externals (10,000 pounds @ 227 knots), and, as figure (1) illustrates, it has an exceptionally large area of influence.

FIGURE 1



A thoughtful consideration of current and future threats, as well as the multitude of other demands for limited resources, leads me to the conclusion that the capabilities of the MV-22, which will enhance our national security, continue to justify the investment. We must understand that our armed forces help to protect and promote our national security through military forward presence operations that enable our Nation to project power and influence, and by maintaining the ability to conduct operations across the spectrum of conflict. Our men and women in uniform will always be the foundation for success in these endeavors. However, they will need superior equipment and weapons systems to prevail on the complex battlefields of the future. This reality requires the Nation to leverage technology to not just do things better, but to do things differently. Maintaining our technological edge over future adversaries is fundamental to our success—the MV-22 significantly contributes to this requirement.

CONCLUSION

In the early 1960s, the Apollo program was given the task of landing a man on the moon and returning him safely, before the end of that decade. This required aeronautical innovations in multi-stage rocketry and a multitude of other technological advances. Tragically, three astronauts of Apollo-1 died when a flash fire occurred in the command module during a launch pad test. Despite that tragedy, and with the knowledge that progress is often accompanied by risk, the Apollo program steadfastly continued and eventually achieved historic successes that made all Americans proud.

We are all acutely aware of the challenges associated with the MV-22. In the near future, we will embrace the recommendations of the review panel and make corrections where we must to improve both the aircraft and the management of the program. We will ensure that the MV-22 is reliable, operationally suitable, and afford-

able—just as we did 40 years ago with each of the aircraft the Osprey is intended to replace. With time, diligence, the close cooperation of our partners in industry, and with the support of Congress, we can work through the present challenges confronting us and achieve the tremendous operational capabilities offered by this remarkable aircraft.

As has always been the case, our actions will be guided by an unyielding commitment to do what is right for our marines, their families, and our Nation.

Chairman WARNER. Thank you, General. Without objection, those letters will be admitted.

[The letters referred to follow:]

V-22 Support Letters

Japan – Mitsui Bussan Aerospace (SAR and replacement for CH-47, UH-60)

Brazil – Lider Taxi Aero (Support BA 609, SAR, Air Medical, corporate transport)

Pakistan – Aerotron Limited (Supports long range capability, strategic impact) writes may ALLAH grant you the fortitude to succeed in this noble goal

Bulgaria – Rotas Intl LTD (Air Medical, suitable for mountainous terrain and limited airport infrastructure)

Turkey – Altay (Air Medical, awaiting BA 609, long range and speed of V-22)

Mexico – Sacsa (Air Medical, SAR, saves on infrastructure)

Rumania – O.V. Aviation (have option for 1 BA 609, saves on infrastructure)

Argentina – La Macarena S.A. (Air Medical, SAR, off shore support to oil platforms, speed, range, special operations)

Greece – Kostas Karayannis S.A. (business and military potential and could possibly change the mobility of the world as we know it)

USA

Ron M. Aryel, MD MBA (Air Medical, SAR, off shore, disaster relief, scientific support to arctic stations)

National Guard Association – (strong support for ANG units getting V-22 for both military and civil support missions)

M International Inc. – (future potential of tilt rotor technology)

John Kelly Consulting Inc. Former Ambassador – (states increased mobility V-22 offers will offset deployments bound by fixed and vulnerable airfields)

Dennis Eckenrod, Chief Pilot American Airlines – (FLEW the XV-15) a VTOL, VSTOL aircraft would greatly reduce the need for runways and provide needed relief to overcrowded hubs, also a goal of civil aviation to operate as quietly as possible, the XV – 15 was surprisingly quiet)

D.J. Canty Chairman, Pres, CEO of American Airlines – (V-22 and 609 may have potential use with American as well as regional carriers that serve as feeders to major airline hubs. It could be one of the solutions to crowded airports, airways and delays.

ES MAR REC'D

Mitsui Bussan Aerospace Co., Ltd.

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February 26, 2001

General James L. Jones
Commandant
Headquarters, U.S. Marine Corps
Pentagon, Room 4E714
Washington, DC 20380-1775

Dear General Jones:

Subject: V-22 for Japanese programs

I am writing to you to express our serious interest in and support to the V-22 program.

We, Mitsui Bussan Aerospace Co., Ltd., are a wholly owned subsidiary of Mitsui & Co., Ltd. that was established in 1876 and is the largest general trading company in the world. Since 1952, Mitsui has been a sales representative and a licensee of Bell Helicopter in Japan; we have been very successful in sales and co-production programs for both military and civil arena. We think very much of what tiltrotor technology can bring to the future of our customers and us.

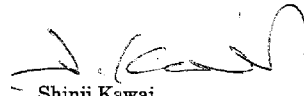
Japan Maritime Self Defense Force (JMSDF) has shown keen interest in the V-22. Because of its VTOL capability and its ability to transport people and equipment for long distance at high speeds, JMSDF has been studying to apply it to SAR mission. In addition, its replenishment role would be another key point in their consideration. New 13,500-ton class DDH, two of which have been authorized for JFY01-05 Middle Term Defense Program, should be a perfect platform that can enjoy a great capability of the V-22. In fact, JMSDF has incorporated to procure two aircraft of "New Mine Hunting and Transport Helicopter" into the MTDP. The V-22 is one of the candidates.

Japan Ground Self Defense Force (JGSDF) and Japan Air Self Defense Force (JASDF) are also our potential customers. JGSDF will reform its 12th Division to Air Mobile Brigade in this March. Current plan is to use CH-47JA for heavy lift mission and UH-60JA for medium lift mission because of inventory. The V-22 is a good fit as a replacement for the future. Also, the V-22 should be able to share roles of CH-47J and UH-60J fleets in JASDF's inventory.

Other potential government customers include Japan Coast Guard who keeps asking us to update information of programs and products regarding tiltrotor aircraft such as the V-22, BA609 and even Eagle Eye UAV. Needless to say, our success on business for BA609 and Eagle Eye is dependent on the success of the V-22 program. Tiltrotor technology is really the need of Japan because of its geographical features and having wide oceanic territory.

In conclusion, I would like to emphasize that your further commitment to the V-22 is so important for Japan. All at Mitsui are wishing for the V-22 to overcome the tough situation caused after mishaps of last year and fly again soon.

Very truly yours,



Shinji Kawai
President



172 MAR REC'D

EDUARDO DE PEREIRA VAZ
CHIEF EXECUTIVE OFFICER

LÍDER TÁXI AÉREO S.A.
AV. SANTA ROSA, 123 - BELO HORIZONTE
MINAS GERAIS - 31270-750 - BRAZIL
PHONE: (031) 490-4550 - FAX: (031) 490-4554
E-mail: evaz@lidertaxiaereo.com.br

March 2nd, 2001.

General James L. Jones
Commandant
Headquarters, U.S. Marine Corps
Pentagon, Room, 4E714
Washington, DC 20380-1775

Ref.: Tiltrotor Technology

Dear General Jones:

In light of the recent developments that call into question the continuity of the V-22 program, we would like to share our testimony regarding the potential of the tiltrotor technology in the Brazilian aviation market.

Líder Táxi Aéreo S/A is a leader in the executive aviation industry in Brazil with forty three years of an impeccable reputation that marks our activities in the civil and military segments. In such capacity we have represented Bell Helicopter Textron, Inc. since 1984 and Raytheon Aircraft Company since 1995. In the last five years we have commanded a sales record in excess of one hundred and twenty helicopters and seventy airplanes in Brazil. Our deep knowledge of the Brazilian aeronautical market has led us to follow with great expectation the development of the V-22 program and the tiltrotor technology.

The unique capabilities of the tiltrotor technology with its vertical takeoff and landing ability that makes it possible to transport people at high speeds without the use of major airports is set to revolutionize several segments of the aviation industry in Brazil. Given their flexibility and exceptional performance, the V-22 and the BA609 have tremendous sales potential in the civil and military market for



L I D E R

EDUARDO DE PEREIRA VAZ
CHIEF EXECUTIVE OFFICER

LÍDER TÁXI AÉREO S.A.
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E-mail: evaz@lidertaxiaereo.com.br

application in the off-shore segment, search and rescue missions, air-medical and corporate transportation. As an evidence of our firm belief in this technology we have placed three purchase orders for the BA 609 with Bell Helicopter three years ago. Furthermore, we are working with Brazilian aeronautical authorities in order to make the necessary infrastructure adjustments to make the VTOL technology fully operational in Brazil in the near future.

Whereas your commitment to the V-22 program is crucial to the future evolution of the tiltrotor technology, we support the strategy chosen by the U.S. Marine Corps, hoping that the V-22 program will proceed and make its contribution to the mobility needs of people worldwide.

Sincerely,

AEROTRON (Private) LIMITED

APARTMENT NO. 804, PARK TOWERS, F - 10 MARKAZ, ISLAMABAD, PAKISTAN
TEL: 92-51-2298371/2/3, FAX: 92-51-2298374, Email: aero@comsats.net.pk



APL-213/2001

February 22, 2001

General James L. Jones
Commandant
Headquarters, U.S. Marine Corps
Pentagon, Room 4E714
Washington, DC 20380-1775
U. S. A.

Dear General Jones,

I have been the Independent Representative of Bell Helicopter Textron Inc., USA, for Pakistan since 1973 and have been selling and servicing the helicopters in Pakistan during this period. I have also been the President of the Regional Advisory Board of Europe, Africa and Middle East as well as a member of the World Advisory Board and the Chairman of the Technical Operations Committee from 1990 to 1995.

Since the last three-(3) decades of my career, a large part has been spent with Military customers such as the Pakistan Army and I am familiar with the military needs and realities of the region. After the attack helicopter concept was pioneered by the U.S. Army Aviation and refined by the U.S. Marine Corps in the AH-1 and AH-64 Attack helicopter vehicles which changed the way Armies perform their tasks, the new tilt rotor technology with its vertical take off and landing capability and its ability to transport people and equipment over long distances (at 2-1/2 times that of helicopters) at high speeds (at 2-1/2 times that of helicopters) without the use of major airports will be a major strategic advantage and force multiplier for the U.S. and coalition forces which will make that strategic critical difference for these forces against future adversaries in the region.

Tilt Rotor technology will not only have a tremendous strategic impact on any future air sea land battle scenario but has a wide ranging potential for civil applications and has a great growth potential as a short and medium range air vehicle in the civil market. I foresee 100 - 200 passenger quad tilt rotors operating from major city centers to city center providing safe routine cost effective airline type transportation thus saving hundreds of millions of man hours thereby increasing productivity by quantum leaps.

Presently the Pakistan Army has a battalion lift capability to move 600 combat troops based on 30 SA-330L Pumas and 12 Mil MI-17 (HIP). It is limited to a radius of

AEROTRON (Private) LIMITED

operation of 125 nautical miles (n.m.) lifting 600 combat equipped troops every 2 hours at this combat radius. 15 V-22's could transport 1,500 combat equipped troops to a radius of operation of 125 n.m. every 2 hours or could lift 600 combat equipped troops to a radius of operation of 400 n.m. without refueling thus increasing short range strategic lift by 2-1/2 times.

I am surprised there is an even a controversy and question about the V-22's future has arisen. The United States will be doing a dis-service to itself and to the coalition forces by denying this vital and critical development of technology which has immense strategic implications and is the only piece of hardware in the 21st century which would give that critical edge to U.S. and coalition force commanders which could mean the difference between victory and defeat.

It is like telling our soldiers and generals that after having developed the breech loading rifle that they are to go back using bows and arrows.

The U.S. Aerospace Industry has come a long way in developing the tilt rotor. General, I beseech you to use every thing in your power and ability to convince the American people, the U.S. Government, Congress and Senate to support this vital piece of hardware which has revolutionized warfare.

Please do not equip the U.S. Armed Forces and other coalition forces with obsolete equipment and then expect them to fight a modern war with minimum casualties. The successful development of the U.S. Armed Forces was evident from the results of second Gulf war i.e. Desert Shield and Desert Storm, where the U.S. Armed Forces emerged from the dark night of the Vietnam War with flying colours.

It was men like you who drafted and crafted the hardware and the software against the opposition of lesser men and women to achieve the result of the U.S. Armed Forces and particularly the U.S. Marine Corps in becoming the most effective military arm of the United States and the free world in maintaining peace in a dangerous world.

May I Allah grant you fortitude to succeed in this noble goal and our prayers and thoughts are with you in this endeavor.

With best regards,



AZHAR WALI MOHAMMAD

Director

Aerotron (Private) Limited

ROTSAS INTERNATIONAL LTD

28 February 2001

General James L. Jones
Commandant
Headquarters, U.S. Marine Corps
Pentagon, Room 4E714
Washington, DC 20380 - 1775

Sir,

Subject: V-22 Future

Our company, Rotsas International Ltd is the independent representative of Bell Helicopter TEXTRON for the Republic of Bulgaria. With sales of six (6) Bell 206 B-3 and one Bell 430 to the Bulgarian Army and the Bulgarian Government respectively we are a leader in this market. No other western helicopters were sold so far in the country. The people here trust American products, technology and innovation.

After the first conversion from helicopter to airplane made by XV-3 on December 17, 1958, the dream of a new generation of aviation specialists came true and the Tiltrotor was borne.

Every step however from the aviation history was written by the blood of the pioneers.

Speed, service ceiling, capacity and the ability to take off and land without runways anywhere make the tiltrotor practical for all types of missions. Surveillance, command and control, search and rescue, transport of personnel and cargo for long distances. Within these broad tasks are dozens of specific applications the tiltrotor can perform better than a fixed-wing aircraft or a helicopter. Perhaps none more beneficial than the tiltrotor as an EMS transport.

1606 Sofia, Bulgaria, 30A Pencho Slaveikov Blvd, fl. 1, ap. 2,
tel. (+359 2) 9531303, tel. & fax. (+359 2) 9532608
E-mail: rotsas@rtsonline.net

ROTSAS INTERNATIONAL LTD

We truly believe that the tiltrotor has both military and civil applications and great growth potential in our urban world.

With these applications, tiltrotor is extremely suitable for countries such as ours. The Balkan Peninsula with its high mountains and lack of modern airport infrastructure is ideally served by the tiltrotor technology. There is a big interest here in the V22 among the Air Force, Navy, Special Forces, Ministry of Health and private operators.

To this end we appreciate your help to keep the V - 22 project alive and bring to mankind a truly needed product.



Christos Rotsas
Chairman

1606 Sofia, Bulgaria, 30A Pencho Slaveikov Blvd, fl. 1, ap. 2,
tel. (+359 2) 9531303, tel. & fax. (+359 2) 9532608
E-mail: rotsas@rtsonline.net



Ankara, February 23 2001

General James L. Jones
Commandant
Headquarters, U.S. Marine Corps
Pentagon, Room 4E714
Washington, DC 20380-1775

Dear General Jones,

Our Company, Altay, as the representative of some major U.S. Aviation companies such as; Lockheed Martin, Bell Helicopter Textron Inc, Raytheon Aircraft Company, has been actively involved in Military and Civilian aviation matters.

We very closely monitor every development in this dynamic field and also disseminate this information in the Military and Civilian aviation community here in Turkey.

The tiltrotor technology is not only our but also the number one area of interest of whole community. We have already provided detailed information to some military prospects like Turkish Navy, Gendarmerie, Turkish Army about V-22. It is a kind of general consensus among the military environment in Turkey that the tiltrotor technology with its vertical take of and landing capability and its ability to transport people and equipment for long distances at high speeds, without the use of major airports will cause considerable changes in military operational concepts.

It has got vast area of civil applications from EMS to transport of people in our country when the long distances taken into consideration. All our present operators anxiously waiting for the certification of model 609 which is the derivative of V-22.

General Jones, we have also heard about the unfortunate accidents that V-22's were involved and extend our condolences. However, as you would appreciate this type of accidents may always happens in the aviation area and should not constitute a reason to stop this kind of an important project. At this part of the world we believe that this project which is carried out under your leadership is not only important for USMC but also to the world. If I may, I like to state that your further commitment to the V-22 is to the future of this very important technology evolution.

Sincerely Yours


Murad Dural
President



March 12, 2001

General James I. Jones
Commandant
Headquarters, U. S. Marine Corps
Pentagon, Room 4E714
Washington, D.C. 20380-1775

Dear General Jones,

INFOMIN/SACSA has been a major player in the Mexican industry in the last 30 years providing aeronautical services to the Government as well as the Private market.

INFOMIN/SACSA, through its subsidiary SACSA, has several international alliances with worldwide leaders such as:

Bell Helicopter Textron
Pratt & Whitney
Honeywell
Fairchild Dornier
Offshore Logistics

With these partnerships we are able to offer a wide range of aircraft and products to fulfill the requirements of the Mexican market with Top Notch technology, such is the case of the tilt rotor aircraft Bell/Agusta 609 and the Bell/Boeing V22.

For Mexico, these products have specific attractiveness considering the geographical conditions of the country and the operational capabilities of the aircraft, which do not require an airport or other major infrastructure to perform.

We strongly believe these aircraft can revolutionize the way to perform missions like EMS and search & rescue. As well as many other applications for the commercial and military markets.

We have been following the media reviews on the V22 technology. And, we consider his project of enormous importance for the future of the Aerospace Industry.

Therefore, we consider that the U.S. Marine Corps support and Commitment to the project are a key factor to its success.

Respectfully,


Eduardo Méndez
Director Global Alliances

SERVICIOS AEREOS DEL CENTRO, S.A. DE C.V.

Calle 3 Hangar 22, Aeropuerto Internacional de Toluca, 50500 Estado de México, México Tel. (72) 79 28 00

O.V. AVIATION Ltd.

23 FEB REC9

To
General James L. Jones
Commandant
Headquarters, U.S. Marine Corps
Pentagon, Room 4E714
Washington, DC 20380-1775

Bucharest, February 15, 2001

Dear Sir,

On behalf of everyone at OV Aviation, a Romanian company with the longest credentials in international aviation field, representing US and European specialized manufacturers for more than 10 years, please accept this letter of support to the V-22 Program.

The amazing VTOL capabilities of V-22 make it most suitable for transporting people and equipment farther and faster, using little or not at all runway. We truly believe that this technology will change the way the world is flying today.

Of course, we are following with great interest the development of both military and commercial applications, and we are excited by the recent information related to future models.


As Romania has few major airports and under-developed general infrastructure, V 22 and its commercial versions have a great future, once the models are released for export. In fact, we are proud one of the Romanian companies providing transport services in Romania has taken an option for one BA 609, as recognition of the future potential of VTOL aircraft produced by Bell.

We are aware of your positive attitude towards V 22 program and we fully support your further commitment to this program, as a vital step to the future tilt rotor technology evolution.

Yours faithfully,

O.V. AVIATION Ltd.

Bucharest Office


George POPESCU
Executive Director

BUCHAREST OFFICE:
Splaiul Independentei 7
Bl. 791, Sc. 2, Ap. 33.
Bucharest, ROMANIA

Phone: +401-338-0597/338-1941
Fax: +401-338-1989
e-mail: ovav@kappa.ro

23 FEB REC

25 de Mayo 489 6° Piso (C1002ABI)
Buenos Aires - República Argentina

International Tel : (54-11) 4312 5671
International Fax : (54-11) 4311 5742
E-Mail macarena@inea.com.ar

LA MACARENA S.A.

Buenos Aires, February 20th, 2001

General James L. Jones
Commandant
U.S. Marine Corps

Dear General Jones:

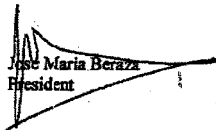
Our company has more than 40 years of experience in the aviation business during which we provided more than 1,650 fixed and rotary wing aircraft, components and maintenance services to the military and civil markets of Argentina. We have been proud members of the Bell family for more than 30 years.

We think that the V-22 is a revolutionary piece of equipment, the first step toward a world of new tiltrotor technology. We are very excited about its future, not only because of its unique capabilities, but also because we feel it will become an indispensable tool in both military and civil applications. This point of view is also shared by Argentina's military and civil authorities and by our customer base in general. We have no doubt that tiltrotor technology will change the aviation picture worldwide in both the military and civil sectors. It will allow missions to be performed outside the range and speed of normal helicopters and thereby ensure that many more lives are saved than are possible with current technology.

In our country, the military and civil government mission applications of tiltrotor aircraft will include among other things search and rescue, interdiction, surveillance, medical supply and equipment distribution, food distribution, fire fighting, the identification and evacuation of disaster areas, personnel and cargo transport, emergency medical services and special operations. In the commercial world Argentine applications of tiltrotor aircraft will include offshore oil support, as well as passenger and cargo transportation, to name a few.

We very much appreciate your continued support of the V-22 and your attention to this matter. As has been stated, the V-22 is very important to the future of tiltrotor aviation which will have positive impacts in areas far outside of the traditional aviation field. So much is riding on this current situation.

Please receive our best personal regards,


Jose Maria Beraza
President

**KOSTAS
KARAYANNIS S.A.**

58, Kasodistriou Ave.
GR 142 95, Nea Ionia
Athens - Greece
Tel: 66 00 460 - 4
Fax: 66 93 322

General James L. Jones
Commandant
Headquarters, U.S. Marine Corps
Pentagon, Room 4E714
Washington, DC 20380-1775

March 6, 2001

General James L. Jones,

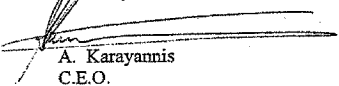
Our company Kostas Karayannis S.A. has been involved in aviation in Greece for over 30 years. We represent in Greece, Boeing, Lockheed Martin and Bell Helicopter Textron among other businesses. I have followed closely the V22 program as it has considerable implications to changing the mobility of the world as we know it. Although I have read recently of the detractors comments on this technology I must say that our company fully supports it. This technology has been worked on for over 20 years by Bell Helicopter Textron and Boeing and is at a stage where it has become a practical and potent force.

Being intimately involved in both military transport and passenger transport in Greece I can say that tiltrotor technology will change the way business is done in the future. It will place the United States in a vastly more capable position to move people and equipment farther and faster with less ground set-up required. Greece presently is looking to replace their transport helicopter needs and would very much look at this technology should it be fielded with the US military.

Our company and I personally feel that the United States Marine Corp. must stay committed to the V-22 and tiltrotor technology to stay on the cutting edge of advances. As you know the European Union is currently looking to begin fielding their own version of a tiltrotor aircraft. Without the support and commitment of the United States Marine Corp. to this program America will lose a great chance at a technological lead in a new field of vertical flight.

I hope that you also can see the potential of such a great technology and continue to support the development of this technology within the US Marine Corp.

Sincerely,



A. Karayannis
C.E.O.

15 APR REC'D

DMCS/AM

Ron M. Aryel MD MBA
112 Grape Street
Philadelphia PA 19127-1420
215-508-2466

March 29, 2001

General James L. Jones, Commandant
United States Marine Corps
Headquarters
Washington, D. C. 20380-1775

Dear General Jones,

I read with interest your press release, dated March 7, 2001, regarding the MV-22 Osprey.

I am a physician with experience serving on Disaster Medical Assistance Teams, as well as an amateur aviation historian of sorts. I see the MV-22 as the most significant breakthrough in general aviation technology since the hovercraft. Like any other technology, it has demonstrated a need for thorough testing, evaluation and "debugging."

I believe the Osprey has tremendous potential for not only military services, but for ambulance transport, disaster relief and evacuation, urban air transport and industrial applications (such as off-shore oil rigs and remote duty or scientific stations of the type currently served by ski-equipped Hercules aircraft).

I have the greatest respect for the Marines who are involved in flying this aircraft, and for the courage of the members of service who died as a consequence of accidents. I believe the best way to honor them and to serve our country's interests is to do as you have advocated. I applaud your decision to support the program as well as your support of prudent and responsible management.

I sincerely hope that the technical challenges posed by the Osprey are overcome and your new training squadron is visited by the success its members have worked and sacrificed hard to deserve.

Sincerely,



Ron M. Aryel, MD MBA



JUL 28 REC 7

 NATIONAL GUARD ASSOCIATION OF THE UNITED STATES

ONE MASSACHUSETTS AVENUE, NORTHWEST • WASHINGTON, D.C. 20001 • (202) 789-0031 • FAX (202) 682-9358

To: General James Jones
 Commandant
 U. S. Marine Corps
 HQMC
 Washington, D. C.

26 July 2000

Subj: USMC Participation in NGAUS Annual Conference and Exhibition

Dear General Jones,


This letter is to extend an invitation to Marine Corps Aviation to participate in our 122nd Annual Conference and Exhibition. The basis for this invitation is the emergence of significant interest in the V-22 platform on the part of various state Adjutant Generals for the Air National Guard (ANG) units. There is currently a four state Coalition consisting of Alaska, California, Minnesota and New York formed with the objective of securing CV-22 capability for both military and civil support missions. There is interest in the platform in other states and this Coalition may expand over the coming months and years.

Of particular interest to the present and future members of the ANG V-22 Coalition would be information on how the Marine Corps plans to use the V-22 in Combat, Rescue, Special Operations, Disaster Relief, Civil Support and (in particular) with its CBIRF Unit in WMD response missions. A Marine sponsored exhibit at the Conference might highlight some of these applications. In addition, we would assist where ever possible to promote break-out sessions during the Conference that would enable Marine Aviators to brief interested Guardsman on these topics and the Marine V-22 Program status generally.

We hope that you will consider this invitation favorably and look forward to your participation. The appropriate point of contact here at NGAUS for coordination of USMC participation would be Mr. Glenn Ross (tel. 202-408-5888).

Thank you for your consideration.

Best regards,


 Richard C. Alexander
 Major General, USA, (Ret.)
 Executive Director



M INTERNATIONAL, INC.

2 MAR REC'D

Avn

General James L. Jones
Commander
Headquarter, U.S. Marines Corp.
Pentagon, Room 42714
Washington DC 20380-1775

February 23, 2001

Dear General Jones:

This letter is written in support of the MV-22 Tiltrotor aircraft. As the CEO of a long established aviation company, I realize the importance of this aircraft and its advanced technology to the future mobility of our forces and the defense of our nation.

We have come too far to abandon this important system. The Tiltrotor future is tremendous, utilizing both military and commercial applications.

The Marines Corp is known and appreciated for its loyalty to its men and equipment. I speak for our entire company when I encourage you to stick with the MV-22 and assure you of our full support of this position.

Sincerely

Richard McConn
President and CEO
M International

John Kelly Consulting, Inc.
International Services

21 FEB 2001



1808 Overlake Drive, Suite D Conyers, Georgia 30013

(770) 918-9937 Fax (770) 483-3090
E-mail: jkellycon@aol.com

February 13, 2001

General James L. Jones, USMC
Commandant
Headquarters USMC
Pentagon, Room 4E714
Washington DC 20380-1775

Dear General Jones:

I write in support of the V-22 tiltrotor aircraft.

As a consultant in the international aerospace arena for the past seven years, I am acutely aware of the advanced technology and mobility that the tiltrotor offers. As a thirty-year member of the U. S. Foreign Service with the Department of State in combat situations, I am aware of the critical need for USMC mobility.

I was the keynote speaker at a 1999 Air Mobility Symposium at Robins Air Force Base, which drew attendees at the flag level from all four services, industry, and government. In my remarks I spoke of the great potential for tiltrotor aircraft in moving people and cargo around the globe.

The V-22 has attracted justifiable attention as it looses the deployments from fixed and vulnerable airfields. The USMC decision to procure the aircraft is a prudent action.

I urge your continued support and commitment to the V-22.

Sincerely,

A handwritten signature in cursive script that reads "John H. Kelly".

John H. Kelly
Ambassador, retired.

American Airlines®

Date: February 14, 2001

115 FEB REC'D

General James L. Jones Jr.
Commandant
Headquarters Marine Corps
Washington, D.C.

Dear General Jones:


The purpose of this letter is to add my voice in support of the V-22 program. I recently had the opportunity to fly the XV - 15 Tilt-rotor aircraft, and I must say that it was most impressive. When I agreed to fly the aircraft, it was my intent to really put it through its paces and I did just that. Even with a somewhat limited helicopter background I found the Tilt-rotor easy to fly, particularly in the hover mode, and the handling was very intuitive from the perspective of a fixed-wing pilot. This combination of speed, maneuverability and quietness make the Tilt-rotor the obvious choice for both civil and military use. I have never felt as comfortable in a new aircraft as I felt in this one.

From a civil perspective, this technology promises to be an answer to a capacity constrained industry desperately in need of assistance. A VTOL/STOL aircraft would greatly reduce the need for runways and provide much needed relief to our overcrowded hubs. For example, today it takes approximately 15 minutes to taxi from the gate to the departure end of a runway on a standard fair weather day. The Tilt-rotor would be able to operate without using these crowded taxiways and depart immediately. The resultant savings in time would enable this aircraft to deliver better point-to-point performance on medium stage lengths than its runway-impaired competitors.

One aspect of the aircraft that surprised me greatly was how quiet it was in the airplane mode. It is a goal of civil aviation to operate as quiet an aircraft as possible. The same Tilt-rotor technology that allows the V-22 to silently deploy troops would provide an operator with the ability to operate in noise sensitive areas with little or no environmental impact.

This aircraft must not be allowed to fall by the wayside. Please consider me an ally in what I believe is a fight for the lives of those individuals who will be served by this technology.

Yours truly,


Captain Dennis B. Eckenrod
Chief Pilot - DFW

American Airlines

21 FEB REC'D

D. J. Carty
Chairman, President, and CEO

February 13, 2001

General James L. Jones
Commandant
Headquarters, U.S. Marines Corps
Pentagon, Room 4E714
Washington, DC 20380-1775

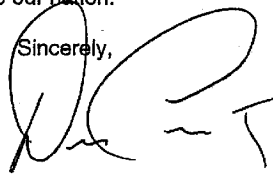
Dear General Jones:

I have been following with some interest the stories on the V-22 TiltRotor. I wish to send my regrets to you and your Marines on the V-22 aircraft accidents this past year. While these are indeed tragic events, they are not unique in aviation, especially during introduction of new military aircraft. Hopefully, there will not be a rush to judgement on the program until all the facts are known and understood.

As TiltRotor technology of the V-22 and Bell's 609 gains acceptance with military and commercial operators, it also may have potential use with American, as well as regional carriers that serve as feeders to the major airline hubs. It could be one of the solutions to crowded airports, crowded airways, and delays travelers face today.

I wish you the best on this program and your mission. I am grateful for the service you and your Marines deliver to our nation.

Sincerely,



ke

Chairman WARNER. You point out the pioneering history of the United States. I know you are here for testimony regarding these tragic losses and the future of this program. But in discussing these letters with you in our conversations recently, it is the expression by the leaders of the American industrial base that this technology is safely achievable and that it will have wide applications in the civilian community, frankly, after the armed services of the United States prove its capability and safety record. Am I correct in my summary of these letters?

General JONES. That is correct, sir.

Chairman WARNER. Fine. I thank you, General.

General Holland.

STATEMENT OF GEN. CHARLES R. HOLLAND, USAF, COMMANDER IN CHIEF, UNITED STATES SPECIAL OPERATIONS COMMAND

General HOLLAND. Mr. Chairman, Senator Levin, distinguished members of the committee, I have some brief comments, but I also have a written statement for the record, which will be provided.

I appreciate the opportunity to appear before the committee today and provide the special operations perspective on one of our future capabilities, the CV-22 tiltrotor aircraft.

Chairman WARNER. I urge you to take a minute, because many are following this hearing, to explain in detail the Special Operations Command in our overall structure of the military and the range of missions that it is capable of performing.

General HOLLAND. Yes, sir. Probably the best example is the example Senator Roberts alluded to earlier when he talked about what happened on 25 April 1980. When we talk about that particular mission, it was scheduled for 35 hours from the time that we started the execution until it was completed. All of you know what happened once we arrived to Desert One.

Chairman WARNER. You may want to describe it. We talked about it in our office, and Senator Levin and I worked on the report of that—it was the rescue operation. Go ahead. You give the details.

General HOLLAND. Yes, sir. It was the rescue operation in Teheran of our American hostages.

Chairman WARNER. The diplomatic personnel.

General HOLLAND. Yes, sir. We were called upon to put together a team of people. At that time we did not have a team that had trained together, but they were brought together with the best expertise that we had at the time. As we started the mission, we found that we had some shortcomings, and those shortcomings obviously led to the point when Col. Charlie Beckwith, who, by the way, will get the Bull Simon's award at Special Operations Command this summer in June—

Chairman WARNER. A very extraordinary officer with whom I had a great deal of opportunity to visit and interrogate in writing the report for this committee. I think he is well deserving of this commendation.

General HOLLAND. Yes, sir.

As a result of the low level flying, which was at night over water, through sandstorms, we did not have the minimum capability that

we needed with helicopters at the Desert One site. That is when Colonel Beckwith decided to abort the mission. During the abort was when we refueled the helicopters to extract from that location that the accident occurred.

I would remind the committee that this entire operation was designed for 35 hours, which meant that after we refueled the helicopters, if the plan was allowed to proceed, that we would proceed to a hide site and then the next night, spending that day in enemy territory, we were to go into the embassy. If we had the technology available in the CV-22, we could have performed that entire mission in 8 hours, which is equivalent to the one period of darkness, which would allow us to have the element of surprise. I also think it would have been of great significance in our ability to accomplish the mission. So, I think that one scenario best portrays what this technology can provide.

As we look into the 21st century and the increased opportunities that we have with adversaries around the world, whether it be terrorism or whether it be weapons of mass destruction, we need increased technology for our operators to be able to go out and proceed with the mission.

I appreciated the opportunity to hear from The Blue Ribbon Panel because, as General Jones and I said, we had only seen the draft. I had seen some of the summaries, but to hear them come forward with what their concerns were, because for us, to be able to accomplish that mission, we are going to have to have a safe aircraft. It is going to have to be reliable. It is going to have to be maintainable in an austere location where SOF operates around the world.

What I heard from The Blue Ribbon Panel today, I am encouraged that we have an aircraft that, given time to do the testing and the training for our pilots in a tested environment, we can get to that point where we will have this leading edge technology available for our air crews so they can perform their special operations missions around the world.

[The prepared statement of General Holland follows:]

PREPARED STATEMENT BY GEN. CHARLES R. HOLLAND, USAF

INTRODUCTION

Mr. Chairman, distinguished members of the committee, I am pleased to appear before you as the Commander of the United States Special Operations Command (USSOCOM). I look forward to discussing USSOCOM's need for and the benefits of the CV-22, a key future aviation platform for USSOCOM. The CV-22 represents an advanced vertical lift aircraft this Nation can count on to successfully employ special operations forces (SOF) when and where needed.

Since the Desert One tragedy two decades ago, military and civilian leaders have consistently advocated two goals: (1) develop a closely integrated joint team of special operators and (2) provide them the best equipment. The CV-22 represents one of those "best technological means." The CV-22 will expand our ability to conduct our primary, mandated missions for the Nation—counter-terrorism and counter-proliferation. It will ensure our ability to perform strategic reconnaissance, direct action, and unconventional warfare operations for the theater CINCs. Finally, it will enhance our ability to perform coalition support, humanitarian assistance, and other operations around the world.

REQUIREMENT

Special operations forces (SOF) have long recognized the need for a high-speed, long-range, vertical lift aircraft to conduct precise, low-visibility, penetration mis-

sions transporting men and materiel deep into hostile or denied territory during a single period of darkness. The new aircraft must be self-deployable, sustainable, and capable of operating from any airfield or sea-based platform. The most demanding SOF missions require the speed necessary to conduct operations over long distances, all terrain, at night, and in adverse weather. Such an aircraft requires a robust and upgradeable defensive avionics suite for greater survivability in the face of advanced anti-aircraft defenses. This need has been consistently expressed in several documents, such as the original Air Force Statement of Need and the subsequent Joint Operational Requirements Document.

The current SOF aircraft inventory consists of modified C-130s and a variety of Army and Air Force helicopters which provide tremendous combat capability to the warfighting CINCs. However, none of these combine the speed, range, survivability, and vertical lift capabilities required to conduct SOF missions. The current C-130 fleet has the required speed and range, but lacks the ability to land on unprepared airfields and landing zones used routinely by helicopters.

SOF's existing helicopter fleet is among the most technologically advanced in the world, but lacks the speed and unrefueled range necessary to conduct sensitive missions deep in enemy territory within one period of darkness, or without the requirement of refueling in hostile or denied areas.

The CV-22 alone combines combat capabilities needed on the modern battlefield with speed and range of fixed-wing aircraft and vertical performance of a helicopter. This combination will enable it to fill a niche no other aircraft can approach. Increased SOF mobility in terms of range, speed, survivability, and rapid responsiveness is more critical than ever for meeting difficult operational environments, both current and projected.

Future operations are certain to be more challenging. Forecasts generally indicate that the information agility of any potential adversary will require improved denial and deception efforts on our part. Potential adversaries may also deny us access to operating facilities near their area of operation. These forecasted trends indicate the substantial and growing need for an aircraft with a smaller logistics footprint, higher speed, and longer range. A platform that combines these characteristics greatly enhances success in tactical surprise against an adversary. In short, we need an aircraft that can operate inside an opponent's decision loop. In a world of high-speed, digital communications, the CV-22 can act as a bridge to that future. The 1993 Cost and Operational Effectiveness Analysis (COEA) of the Advanced Multi-Mission Lift Aircraft (MV-X) said, "the force mix of USSOCOM aircraft that includes the CV-22 is the preferred alternative."

PROGRAM

The clear, strong, and compelling need for a new capability led to the current acquisition program, the SOF variant of the V-22 Osprey. Because of the unique nature and relatively small budget of USSOCOM, normal aircraft procurement concepts either leverage other service development efforts or modify an existing platform provided by that service.

A joint V-22 program that would meet SOF's unique requirements was a natural evolution with the United States Marine Corps plan to procure tiltrotor technology as a replacement for their aging helicopters. The opportunity to "get in on the ground floor" of the V-22 development allowed USSOCOM to help shape and craft a vehicle central and critical to future capabilities.

The V-22 program has had technical and operational difficulties inherent in any complex engineering effort. Particularly regrettable are the incidents where lives have been lost. We all feel a profound sense of loss and deep sympathy for the family members and close friends of those who have directly experienced such tragedy.

As such, we consider the actions of the Commandant asking the Secretary of Defense to convene an independent review panel—The Blue Ribbon Panel—a thoroughly appropriate action. USSOCOM hosted the panel in our headquarters at MacDill Air Force Base, Florida, and has cooperated with their deliberations via briefings and technical presentations to ensure their efforts are complete.

We fully support the Department of the Navy's "Way Forward" proposal to develop a revised acquisition strategy addressing all the current major concerns of this program.

I recently had discussions with some of the test pilots presently stationed at Edwards Air Force Base, California, where the CV-22 developmental testing is ongoing. While every pilot I spoke to would get back into a V-22 and fly it again, each is primarily concerned about sufficient flight-testing and flight-control software maturity. These issues need to be addressed, and I understand an extensive flight test

program and recertification of the software are two major areas of work planned for this program.

CV-22 ENHANCEMENTS

To meet SOF's unique mission needs, the CV-22 will have improved navigation, communication, mission management, and defensive electronic warfare avionics coupled with increased fuel capacity and terrain following and terrain avoidance radar. Improved navigation will facilitate both the worldwide self-deployability and the independent penetration capability of the CV-22. Enhanced communication capacity will enable dynamic coordination of operations both across a formation and around the globe. Comprehensive mission management equipment will allow instant in-cockpit updates to the tactical situational awareness of special operations aircrews. Advanced CV-unique defensive avionics, coupled with the MVs ballistic tolerance and other capabilities, will be crucial to the survivability required to operate in denied territory. A layered defensive capability, consisting of reduced probability of detection, active and passive infrared and radar-guided countermeasures systems, and a high ballistic tolerance provides improved survivability. Finally, the CV-22 will carry a greater fuel load providing greater range without refueling.

The CV-22 variant of the V-22 will be specifically tailored to bring the battle to an adversary's back yard. Employing speed, range, and agility, special operators will use the CV-22 to strike quickly and effectively when and where least expected. The CV-22 enhancements are designed to ensure access, survivability, and mission accomplishment even in the face of hostile opposition, aided in part by a revolutionary reduction in acoustic signature while in the fixed-wing mode.

OPERATIONAL POTENTIAL

We must keep firmly in mind that the CV-22 will provide future SOF operators an entirely new weapon system with different capabilities and capacities. This will generate new tactics, techniques, and procedures as well as innovative operational and strategic concepts.

This new technology, and its concurrent and innovative tactics and procedures, will transform the current special operations employment paradigm.

As an example, one of the most frequently made comparisons of the CV-22 is to measure its potential for impacting the execution of Operation EAGLE CLAW, the American hostage rescue mission into Iran in 1980. As originally planned, Operation EAGLE CLAW required 35 hours to execute. The low speed and limited range of available helicopters drove this lengthy mission duration and necessitated forward landings by C-130 refuelers and H-53 helicopters at unprepared locations.

In contrast, had CV-22s been available, they could have accomplished the Operation EAGLE CLAW mission in 8 hours with a considerably smaller overall force. The reduction in exposure time, coupled with a smaller footprint, would have provided a higher probability of success.

A more recent mission comparison that highlights the capability of the CV-22 is the Non-Combatant Evacuation (NEO) of U.S. citizens from Liberia in 1996. If nine CV-22s rather than nine SOF helicopters were used, the aviation required to conduct the mission would have arrived at the crisis site in 1 day instead of 2, and 2,000 U.S. citizens would have been evacuated in 4 days rather than the 10 actually required.

Because of its enhanced speed and range, the CV-22 also requires fewer supporting aircraft. CV-22s conducting the Liberia NEO would require only five support/cargo sorties and three tankers, while the helicopters that actually conducted the NEO required 14 support/cargo sorties and two MC-130Ps for refueling.

In summary, using CV-22s for the NEO in Liberia would have resulted in faster response times to the crisis area, an overall quicker evacuation of Americans, required less supporting aviation, and expended significantly less fuel. Improved performance in these critical areas results in increased capability for SOF aviation.

Comparisons to past operations are enlightening and provide interesting data points, but future CV-22 operations are what make development and fielding vital to special operations. No one can say for certain what specific missions will be required, but we have projected numerous approximate scenarios.

For example, we can reasonably expect there will be some natural and man-made disasters requiring rapid delivery and distribution of relief supplies. CV-22s could launch rapidly after notification and head toward the stricken area, proceeding to a secure, stable staging base (or ship) in the disaster region. Fresh CV-22 crews, transported on KC-10s, could launch relief missions as soon as supplies were transloaded from the KC-10 to the CV-22 and the location for delivery determined. A CV-22 could easily carry enough Meals Ready-to-Eat (MRE) or Humanitarian

Daily Rations (HDR), some 6,270 pounds of food, 500 nautical miles to feed about 4,000 people.

There are two driving reasons to use CV-22s in this scenario instead of another aircraft or helicopter. The first is the response time afforded by the CV-22. The CV-22's self-deployability not only gets it to the operation more quickly, but also frees up other airlift assets to transport supplies rather than aircraft. This increases national responsiveness and reduces mission cost.

The second is the enhanced survivability of the CV-22. Those who object to U.S. humanitarian efforts quickly detect our response to a disaster. Then, even the most benign mission can become dangerous to our personnel. The CV-22 will have the defensive countermeasures suite necessary to operate in an uncertain environment with an acceptable margin of safety. There are no survival guarantees, but CV-22 defenses are planned for some of the toughest challenges.

Additional future missions supporting our national military strategy may include key operations during a large-scale conventional conflict. These missions could range from strategic reconnaissance providing "eyes on target for ground truth" to direct action against a weapon of mass destruction buried deep in a hardened bunker. To get the forces into position for these, or any number of other scenarios, a clandestine infiltration may need to be executed.

Once launched, the CV-22s would fly at low altitude, blacked out for night operations, and avoid populated areas to evade radar/visual detection. Using the best planning methods and available intelligence information would also reduce exposure to enemy radar. Other potential tactics would include launching from multiple locations with each location having only a very small force. The ultimate objective is to avoid detection completely or to achieve tactical surprise and generate uncertainty for our adversaries.

CV-22s can physically perform all of the several hundred potential missions evaluated and enjoy a significantly higher mission survival probability due to information denial, detection avoidance, and self-defense capability.

AIRCRAFT STATIONING

USSOCOM plans to place CV-22s in four locations around the globe. Training will be based in New Mexico at Kirtland Air Force Base. Kirtland has the support infrastructure and a rich history of training superb aviators for special operations.

Operational CV-22 units will be centered at Hurlburt Field, Florida as part of the 16th Special Operations Wing and will also join existing SOF units in the Pacific and European theaters overseas. These units will become key strategic and asymmetric assets available to our Theater CINCs. Linking this total force structure with the global strategic airlift/refueling capabilities of U.S. Transportation Command will allow special operations to respond within 1 day virtually anywhere in the world.

CONCLUSION

We look forward to the day when CV-22s are fielded and ready. USSOCOM anticipates the time when the tiltrotor is in the hands of special operators and maintainers alike, all performing the tasks for which they have trained.

In the past 20 years, SOF's requirement for a long-range insertion and extraction vertical takeoff and landing (VTOL) aircraft that can operate in hostile or denied territory during one period of darkness has not wavered. We support the efforts of the Commandant to ensure that these aircraft are safe and reliable. There are inherent risks to any new developing weapon system. Our job is to mitigate and manage that risk each and every day. Daily, we send America's sons and daughters into many situations around the world where we simply cannot guarantee that they will be without risk; never does this undermine our moral and professional obligation to try, however. In the short- and long-term, the CV-22 represents more than just our ability to increase mission capability. Inherently the cornerstone of that improvement is the increased survivability and probability of success for a special operations mission that would employ tiltrotor technology. As the world has changed, so must we. The CV-22 is a capability we need in order to stay on the leading edge of change.

Thank you.

Chairman WARNER. Thank you very much.

Now, colleagues, we will do a round of questions of 6 minutes for those of us present.

General Jones, you have an opportunity to review the conclusions and recommendations of this panel. We give you now an opportunity to express your views and any different perspectives, or disagreements you may have. Are there any conclusions particularly with which you have a question in your own professional judgment?

General JONES. Mr. Chairman, I have had an opportunity to not only read the panel's recommendation but assist in the debriefing at the departmental level. I have spoken with each member of the panel individually. I think that their contribution to resolving the issues surrounding this program has been—I do not think we could assemble a better panel that is more qualified and more expert in their opinions. We accept the findings of the panel in its totality.

Chairman WARNER. Now, General, we isolated as best we could the time within which these corrections can be made, and we can then proceed, hopefully, if it is the judgment of the President and Congress, to continue the program. But given the time of a year to 2 years before we go to full production—and then that fills in that much of a delay in terms of the final delivery of the aircraft the Marine Corps needs, and indeed, General Holland, that you require. What will you do in the interim period? What equipment will you extend the life service, of course, of what you have in inventory today? Will you seek any new equipment as a fill-in for that period? What are your proposals?

General JONES. Sir, we will continue to maintain our systems, principally the older version of the CH-53 and the CH-46.

Chairman WARNER. It is important to give the ages because the American public does not have the opportunities that we do to deal with these facts daily, but I think they would be astonished to know how old some of these aircraft are, rotary aircraft in particular. I do not know what the average person does, but we turn in our cars periodically and get new ones. But we are asking the men and women of the United States military, both the Marine Corps and the Army and the Air Force and others—indeed, the Coast Guard uses this particular aircraft. This is an old, old aircraft.

General JONES. Yes. As a matter of fact, it predates my service in uniform.

Chairman WARNER. Let us give some dates here so they have a full appreciation of the need to modernize and to proceed with the procurement of new equipment in this area for our military.

General JONES. The CH-46 aircraft is 31.8 years old today. That is one of the aircraft it will replace. The CH-53 Delta is 30.3 years old. Within the Marine Corps inventory, and General Holland, of course, has a similar problem.

Chairman WARNER. Now, to that age baseline of 30, you have to add 5, 6, 7 years, maybe up to a 2 year delay before production is resumed at full scale, plus the delivery time in that production cycle. That production cycle is spread over a number of years. We are looking at pressing 40 years of age by the time this inventory is replaced by the V-22, assuming this program goes forward.

General JONES. Yes, sir. We have had a lot of experience, obviously, with maintaining old systems. To get to these years, you develop some skill. We have made improvements on these aircraft. We have re-engined them. We have given them longer range. We

have redone the avionics, but essentially the frame is over 30 years old.

Chairman WARNER. There are significant costs associated with maintaining the older equipment. I want the public to understand that. They know how difficult it is to maintain an old automobile. Well, this is an example of the military equipment.

General JONES. We not only have that difficulty, but we also have the difficulty with finding parts. The production lines have shut down. The parts are harder to find, and many times they have to be created at great expense because of such limited demand. But we generally have a cost growth of about 8 percent per year with maintaining legacy aviation systems.

Obviously, we would like to get to the replacement that we have in mind, but we will continue to do this prudently. If it is within the range that the distinguished panel that preceded us postulated, we will find the work-arounds to continue to fly our legacy systems safely and carefully. It will cost more money. It will be more difficult, but within that time frame, Mr. Chairman, I think we can get there.

Chairman WARNER. Thank you.

General Holland, same question to you.

General HOLLAND. Yes, sir, Mr. Chairman. It is a similar case for what we do in Special Operations Command. We have currently transferred all of our MH-60Gs, which are the Pave Hawk helicopters, from the Air Force Special Operations Command to the Air Force to pick up combat search and rescue missions. We have started the drawdown of our MH-53J Pave Low helicopters. However, given this decision and given the decision that our Secretary of Defense will make, then we will level off at this point and continue our MH-53Js.

The good thing about our Pave Low helicopters is that we had already accomplished a major service life extension not too many years ago. The next time that I would have to do a major service life extension program would be starting in 2008. We do have some time between now and then to work through this issue to ensure that we have a safe and reliable airplane to support our special operations air crews and the teams that we put into the airplane.

Chairman WARNER. Just as a footnote, the same aircraft that Colonel Beckwith had 21 years ago this month, you have some upgraded models, but it is still the same old chassis. Am I not correct?

General HOLLAND. Yes, sir.

Chairman WARNER. Learning from the experience of our tragic intervention of our aircraft by Chinese aircraft and the resulting inspection—I use that word lightly—by the Chinese of our assets, this committee will address that in due course. But it seems to me that is a lesson learned that this same aircraft that you will be operating, in some instances in some missions, far into territory that could be unfriendly, are you watching carefully the built-in mechanisms of this aircraft to do what destruction may be necessary should one of them fall into the hands of people or a nation that is antithetical in interest to ours?

General HOLLAND. Yes, sir. I think that is definitely something that we will take on. I think there are a lot of lessons learned that will come out of this.

Chairman WARNER. Take a very hard look at that, General, because as you said, in the case of Colonel Beckwith, he was deep into Iran at some point.

Senator Levin.

Senator LEVIN. Thank you, Mr. Chairman.

It seems to me we have at least three issues in front of us. The first is the specific questions about the V-22—its future—what is going to be necessary to get it flying right, safely, maintainably, and specific questions relating to that, including the cost.

Second are the process questions about the acquisition system—what changes need to be made in the acquisition system, if any, to avoid some of the problems which we have already seen?

The third issue is the accountability question relative to this particular acquisition. There may be other questions as well. The accountability questions, it seems to me, are the ones that are not really before us this morning because we will have to wait for other reports in order to get into those.

On the first series of questions, there are a whole host of specific questions about the problems with this particular aircraft: what it will cost time-wise and dollar-wise to fix them; whether or not it is capable of fully carrying out the missions for which it was designed; or whether there has been some diminution in that as the operational test and evaluation people feel.

We have operational test and evaluation folks saying that some of the proposed missions could be either precluded or possibly diminished by the downwash problem. They are not sure how difficult it will be to fix the hydraulic system problem. We had an acknowledgment from our first panel that those changes are not minor design changes, either there or with the vortex ring state problem.

We have a number of fixes that are required. We are going to have to have some delays, perhaps a year or 2 to carry out those repairs. We are going to have the added cost of going to a low-rate production or minimum sustaining rate of production, instead of full-rate production. There are some significant costs involved here as well.

I think it would be helpful for us for the record, because I do not think you could do that in a comprehensive way here now, given the time problem, if you could examine the operational test and evaluation assessments, go through our panel's review, tell us what you believe the additional costs are going to be through these delays or through the fixes, and where you agree or disagree with any of the OT&E folks' points. I am going to leave all of that for the record because it is a comprehensive question that I am asking you.

[The information follows:]

General JONES. First question—what is the status of V-22 and the restructure plan?

Answer: The developmental flight test program is scheduled to resume in April 2002. The SECDEF will submit a report to Congress 30 days before the before the resumption of flight testing. Safety modifications to the aircraft are underway at Pax River to support flight tests.

The V-22 Block A flight testing program will consist of roughly 1,000 flight test hours completed from April 2002 through approximately September 2003. Roughly 1,500 additional flight test hours are projected in the future for Blocks B and C.

V-22 has a block upgrade approach for incorporating improvements for safety/reliability and accessibility.

Block A - Safety and maintenance mods to the nacelle (enhanced clearance, improved access, hydraulic line coatings, clamp redesign, etc.) as well as structural fastener changes will begin with the last two aircraft of Lot 5 (fiscal year 2001 procurement).

Block B - Redesigned nacelle and avionics improvements mods begins with Lot 8 (fiscal year 2004 procurement).

Block C - Mission enhancement mods (cabin redesign, hoist alterations, ground collision warning, integrated INS/GPS) begins with Lot 10 (fiscal year 2006 procurement).

\$1.32 billion is budgeted to procure 11 MV-22 aircraft, the minimum sustaining production rate.

\$600 million is budgeted for engineering development efforts on the MV-22 and the CV-22 Block 0 aircraft.

The program office will focus on MV-22 and CV-22 Block 0 through 2003 to ensure the program's priorities are safely returning to flight and finalizing V-22 design changes.

The second question concerns the process with regards to the acquisition system, as to what changes need to be made in the acquisition system, if any, to avoid some of the problems which we have already seen.

Answer: In accordance with the recommendation of the Blue Ribbon Panel to Review the V-22 Program, the program will establish maximum economic production rates and seek multi-year procurements after deficiencies are addressed and a stable configuration is reached in order to recover total program cost and schedule.

The third question concerns accountability relative to this particular acquisition.

Answer: Following the second of two fatal MV-22 mishaps in 2000, the Defense Department suspended all flight activities, including VMMT-204 operations and on-going MV-22 and CV-22 development testing. The Department also postponed a pending decision on full-rate production until the results of the mishap investigation could be developed and understood. The Secretary of Defense, citing the mishaps as well as issues that had arisen from the recent operational evaluation (OPEVAL Phase I), established an independent review of the program which was designated The Panel to Review the V-22 Program (Blue Ribbon Panel). He appointed Gen. John R. Dailey, USMC, (Retired), Mr. Norman R. Augustine, Gen. James B. Davis, USAF, (Retired), and Dr. Eugene E. Covert to the panel. Their report, submitted in April 2001, recommended that the Department proceed with the V-22 Program, but that it temporarily reduce production to a minimum sustaining level to provide funds and time for a "Development Maturity Phase." The panel further recommended 71 specific and 14 summary changes, improvements and other actions to address known safety and programmatic risks, as well as issues dealing with aircraft reliability, maintainability, and logistics supportability.

As a follow-up to the panel report, the Naval Air Systems Command asked the National Aeronautics and Space Administration (NASA) to convene a panel of rotorcraft aerodynamics and flight control experts to review the aeromechanical aspects of the V-22 design as manifested in flight tests and mishap investigation results. Dr. Harry McDonald, the Director of NASA's Ames Research Center, Moffett Field, California, chaired the Tiltrotor Aeromechanical Phenomena Assessment Panel. The panel concluded that there are no known aeromechanical phenomena that would stop the safe and orderly development and deployment of the V-22. They made 17 "high priority" and 11 "vehicle enhancement" recommendations to address vortex ring state, power-off and autorotation issues, and shipboard compatibility deficiencies, as well as several other flight control and performance matters.

Concurrent with the two external panel reviews, the V-22 Program conducted comprehensive reviews of all system safety and reliability analyses, all program risk issues, and deficiencies and commissioned several assessments (including expert independent product and process audits of the Flight Control System (FCS) software and hydraulic system). Additionally, an engine nacelle "tiger team" (which included developers and operators) examined the nacelle to improve overall component layout.

Senator LEVIN. Then there is another issue which has to do with the acquisition process. Would you agree, from all you know, that

there was just routine time pressure to get this aircraft to full-rate production?

General JONES. From all I know, Senator, and with due deference to the reality that this aircraft has been flying for 11 years, we were certainly anxious to be able to provide the replacement aircraft for our aging aircraft. But I would draw the line that we would either knowingly or intentionally or recklessly accelerate the development of a program, thereby placing passengers at risk or crews at risk.

This is a question that I have explored in some depth with the chain of command inside the Marine Corps, right down to the squadron that our two marines represent here today, to make sure that that was not done or not done intentionally or by inference. I am satisfied that we tried to bring this program along as safely as possible on the timelines and within the funding lines that were provided and requested.

Senator LEVIN. So from all that you know, you do not believe that the amount of pressure to get this program to full-scale production was unusual or inappropriate.

General JONES. From all I know, but I would also say that I represent a force that is used to accomplishing its mission, and people are very proud of that record. But I think leaders draw the line at crossing over to where the results in doing things put people at risk unnecessarily, and I think that line is fairly solid.

Senator LEVIN. There is, I think, an unnamed marine officer in today's *Washington Post* who said, "The problem is we fielded the aircraft before it should have been." Do you agree with that?

General JONES. I think there are a lot of things, in hindsight with the work of the panel, that had we known certain things, we probably would have done things differently. But I think the central question relates to the question that you were getting at, Senator Warner, and you, Senator Levin, and that is the obvious care that we must give to whether our actions contributed to causing an accident that resulted in fatalities. I think that is a central question that we should consider. So far, I have not seen that connection, but we are looking for it.

Senator LEVIN. Last question. Apparently there were two major hydraulic failures during the operational testing and evaluation never reported to the program manager, apparently even until a few weeks ago. This is incredible to me. Is there not something fundamentally flawed about an acquisition system where major hydraulic failures occur and are not reported to the program manager until months later after a catastrophic loss, even though those failures occurred during the operational test and evaluation stage?

General JONES. I completely agree with you. For the record, I would like to say that I found out about it yesterday afternoon at about 1600.

I have said publicly and privately that I think we should relook at our acquisition systems, not just for aircraft, but our systems in general and the modalities that govern those systems. The existence of firewalls between very important functions that effectively deny the transmission of relative information that would be important in the development of a program across those different organizations has to be looked at.

I believe as a service chief that the construct of the laws regarding acquisitions keeps me outside of the loop too much. I am involved in the requirements process, but by law there is not a whole lot I can do in terms of the acquisition process. It is a very closed loop and it has very, very stringent regulations. I feel a little external to the process.

I have made that known and my colleagues, other service chiefs, have made that known to the new administration, Secretary Rumsfeld and his staff, and they have taken that on, not only that but our business reforms and business practices that we are taking a look at to make sure that we use the taxpayers' dollars very wisely. But the acquisition system I think should be opened up and relooked at.

Senator LEVIN. Just for the record, apparently there is a way that an operational testing and evaluation office can make those failures known to a program manager.

General JONES. Exactly.

Senator LEVIN. It is not a wall which is impenetrable. It is a wall which has to be climbed and, at times, must be climbed if you have failures in tests which could affect lives.

General JONES. Exactly.

Senator LEVIN. There is a way that information could go to a program manager. It just has to be signed off on. The wall is there, but it is there to be climbed at times and to be penetrated at times. I think we have to look into that.

As our chairman pointed out, I think we have to get all the sides of that before we reach any conclusion. I have to tell you, at first glance, I find it extraordinary that that could have happened without the information being passed along to the program manager so that the repair could have been made or some steps could have been taken to avoid any catastrophic losses.

Thank you.

General JONES. If I may just add. What I really am concerned about is just the overall ability to communicate across the many different factions involved in the acquisition process or the inability of some people to be completely—or the process that excludes people that probably should be included in the process.

Chairman WARNER. I was reluctant to bring it up, but I felt that it had to be brought out. I join my distinguished colleague, Senator Levin, in observing that at this point with this state of facts known to us, this is a very serious anomaly in the system. But before we render any final judgment, we must give both sides the opportunity to come forward. As I stated earlier, Senator Levin's and my staff, working jointly, will be placing into the record eventually our understanding of this situation. We will submit it to you for comment, and I hope that you will put in the comment and give the other side the opportunity to comment on it. Then we will reach judgment.

I commend the program manager for his forthrightness in this testimony.

General, anything further you would like to add regarding that point, before we go to our distinguished colleague?

General HOLLAND. No, sir.

Chairman WARNER. Then we go to Senator Roberts.

Senator ROBERTS. Well, thank you, Mr. Chairman.

I think Senator Levin has referred to something that I think is exceedingly important, and that is the article in the *Washington Post* as of today and many other articles that were on the front page, and rightly so. I am sure we have all seen and read them. This is a tough story because if the actions of some marines that were outlined in the article are accurately portrayed, then there is an additional dimension to this story that must be addressed.

To all marines in uniform—and I wrote this out so I could say it very clearly—the phrase “semper fi” has very special meaning and sets the Corps apart from her sister services. So, for the sake of the Corps, the action of marines that would put a system above the trust and lives of other marines must be dealt with fairly and swiftly.

It was with a great deal of pride that I read page 9 of the Commandant’s statement where he said, “I am deeply concerned by the as yet unresolved allegations of malfeasance and suggestions of program instability.” More to the point, he said, “The Marine Corps will seize”—and I emphasize the word “seize”—“upon this opportunity to ensure that we do not compromise our integrity, lower our standards, or jeopardize the safety of our marines for any program.” He went on to say, “The resolution of the question of malfeasance, despite its grave importance, cannot occur until the Department of Defense Inspector General’s investigation is completed.” That is certainly true.

Stains are hard things to deal with, to get rid of, as I indicated in my earlier statement. But with the leadership of the Commandant, the United States Marine Corps is dedicated to removing this stain and replacing it with a new fabric of trust and capability that is commensurate with our past and our institutional history.

I want to thank the Commandant for his leadership and his concern in this regard and I think enough said.

Mr. Chairman, I want to thank you for pointing out the real problem we face with the CH-46 and the CH-53D helicopters. The statement by the Commandant indicated these helicopters are old. Their production lines are closed. The parts are scarce. Their maintenance requirements, and probably the understatement of the morning, exceed the bounds of reasonableness. They are truly legacy systems. I will go a little farther. They are buckets of bolts, and they do perform a function. But we have to move.

I would like for both Generals to indicate—we have talked about the situation in Teheran or the situation in regards to Desert One that I brought up earlier and Scott O’Grady. I have here a map that indicates the mission radius: twice as fast, five times as far, with three times the payload. Unfortunately, it looks like, by this map, we are going to leave from Quantico and go on a mission toward Wheeling. We better inform Senator Byrd from West Virginia in that regard if that is the case. [Laughter.]

But can you come up with a specific example in the unsafe world today why this aircraft is so necessary? I want it event oriented. I want it mission oriented. I want it in straightforward language.

Let me tell you what we are going to do this afternoon. At 2:30 this afternoon, we are going to have a hearing on an investigation on the CST teams. Those are the RAID teams by the National

Guard. If you have an event of any kind of terrorism, these folks are supposed to be there within 4 hours, and with the helicopters they are flying specially equipped, what a marvelous opportunity for this aircraft in regards to that mission.

Can you give me just a couple of examples? Tell us again why this is so important from an actual event in an unsafe world.

General JONES. Well, range, speed, and payload is obviously very important. It allows for the projection of forces in a hostile environment to occur, if it is a sea-based force, from well over the horizon, as one who cut his teeth on ground combat in Vietnam and hailed helicopters, the CH-46 being one of them, once we got the problem solved.

But on a tactical level, helicopters have a very noisy signature. I have verified this personally down at Camp Lejeune. The V-22 is by you before you even hear it. It is so quiet that there is no comparison. From enhancing the survivability of our forces on the ground and the tactical survivability of the crew and people in a V-22, that is very important.

It has an NBC capability that helicopters do not have; in other words, it is survivable in a chemical and biological environment.

We will want to put a weapons system on the V-22. We have foregone temporarily because of cost.

But it will give situational awareness to the embarked crews before they even offload. One of the big problems in helicopters, in just the lack of technology, is not really knowing which way you are facing when you run out of the helicopter and trying to get some sort of spatial orientation on the ground. Now with GPS technology, the squad leader in the back of the V-22 will be able to know exactly where he is, exactly where the V-22 is pointing when they land, and the egress and the security of the force at that very, very difficult moment when you get out of the helicopter and you do not know exactly where you are. Those few seconds can make the difference between life and death.

The sheer potential power of the V-22 in terms of what it can lift will remove forever the dependence on the calculations that we have to make with all helicopters that are much more susceptible to lift restrictions, depending on the temperature gradient and the weather conditions.

This is a step away from the limits of physics imposed on rotary wing technology.

I have spoken about this with the Chief of Staff of the Army and the CNO and the Chief of Staff of the Air Force, and all services are very interested in even a larger version of this tiltrotor, the C-130 type of configuration. Once we get over these initial difficulties, it is not hard to see that tiltrotors, large and small, could play a very, very important role in our future transformation of the Armed Forces.

Senator ROBERTS. General Holland.

General HOLLAND. Yes, sir. I would like to add one other aspect which is very compelling. It is the deployability of the CV-22 compared to the way we deploy today. Probably the best example would be what happened during the Liberian Non-Combatant Evacuation Operation (NEO) in 1996. At that time, we had to tear down our helicopters, and that is important. For us to be able to

go over long distances, both in the Pacific and in Europe going into Africa, we have to take the rotor heads off (it takes a crane to be able to do this) and put it on board a C-5 airlifter and then forward deploy it.

So, number one, it takes time, to tear down and prepare for shipment either the MH-53 or a MH-47 helicopter that we have in special operations. Then you have to get the C-5 to come in to do the upload, fly, and then you have to rebuild it, which, once again, when you arrive, you have to have a crane in place. You have to have your maintainers then put the helicopter back together and do a functional check flight before you start the operation.

With the CV-22, once the deployment order comes in, you could self-deploy over 2,100 miles with one in-flight refueling, thereby getting there quicker and then join the forces and other equipment, thereby reducing the amount of time to the deployed location, say, from 72 hours down to a day. The deployment opportunities that this provides, not only in the savings from aircraft but also in dollars, is also a very key aspect.

From USSOCOM perspective, what it means is that we can stay inside the decision cycle of the enemy. We can get there quicker. We have found that if you can get to a crisis quicker, then you have an opportunity to then take care of the situation. Then it is more favorable for what we need to do.

Senator ROBERTS. Mr. Chairman, my time is expired, but I had one other question I would like to ask.

Chairman WARNER. You take such time as you need.

I wish to state that I associate myself with your remarks, certainly with regard to the manner in which our distinguished Commandant has worked his way, on behalf of the Corps, through this difficult problem. We have a long way to go in terms of personal accountability and otherwise. We have to be very careful to protect the interests of those under the Uniform Code of Military Justice. But you have done a commendable performance, General Jones, a very commendable performance in the finest traditions of the Marine Corps.

Senator Roberts and I were privileged to wear the green ourselves many years ago. My service is very modest compared to the others.

Senator ROBERTS. The next question I have is in part in relation to that. Part of the challenge, it seems to me, in regards to this system is that our future crews may not think that the V-22 is safe or somehow may feel the system is being pushed on them before it is ready. This is to both Generals. I would like to know your assessment of the confidence of the air crews and the mechanics in operating and maintaining the MV-22. This is in relation to some of the comments that have been in the Nation's press.

General JONES. Sir, if I may, I would be happy to give you my personal opinion, but one of the reasons that I asked Major Heckl and Staff Sergeant Fowler to be here today is so that if you wanted to address that question directly to them, that they could give you their answer. I would be very happy to ask either one of them to come up here and answer that question.

Chairman WARNER. General, I think it would be helpful. I think it is important not only for the record and for the Senate, but for

all those following this hearing to see these brave and courageous young persons who are working their way through the evaluation of this aircraft. We will invite them to the witness stand.

General JONES. With your permission, sir, I will step aside and let them—

Chairman WARNER. Why do you not remain and just pull up a second chair here.

Major, if you will give your full rank and serial number.

Major HECKL. Sir, my name is Major Karstan Heckl and I am the Assistant Operations Officer at Marine Medium Tiltrotor Training Squadron-204 in New River, North Carolina, a former CH-46 pilot and now V-22.

Chairman WARNER. How many hours have you had in the 22?

Major HECKL. I am a little nervous, sir. I have never done this before, so forgive me. I would rather be flying airplanes. [Laughter.]

I was a newly designated aircraft commander, sir. I had a flight of approximately 6 hours on the Friday before the mishap, December 8.

Chairman WARNER. You mean the accident.

Major HECKL. Yes, sir, the accident on December 11th.

Just for everybody's knowledge, I was personal and close friends of all four aviators and the air crew that died in both accidents. So, it certainly means a lot to me.

That December 8th before, I had flown the aircraft for about 6 hours and had gone everywhere from Charleston, South Carolina, up to Norfolk, Virginia, in the airplane, which is a far reach from my former airframe.

Chairman WARNER. What do you think the total number of hours would be?

Major HECKL. I am a little over 80 probably, sir, with about 200 in the simulator, which is an important issue that has not been addressed here. The simulator device that the Marine Corps and the NAVAIR system bought for us is something we have never seen before. It is phenomenal and it is a leap in technology itself.

Chairman WARNER. Thank you very much, Major.

Would you identify yourself? I know exactly what a crew chief is, but you are an integral part of the crew and you fly with this plane.

Sergeant FOWLER. Yes, sir. Staff Sergeant Fowler, also a VMMT-204 Crew Chief and maintainer in the Flight Line Division, formerly CH-46. I have about 20-25 hours.

Chairman WARNER. Now, Senator Roberts, would you care to continue?

Senator ROBERTS. I would just like to ask the basic question that has been referred to in the press, and it is an obvious question in regards to future crews may not think that this aircraft is safe or that somehow it is being pushed on you before it is ready. What is your assessment of the confidence of the air crews and the mechanics?

Major HECKL. Sir, I had the fortune to talk with the Commandant yesterday when I got into town. This may have been an issue that perhaps we were being shielded from, but at my level, sir, I am an operator and I am a pilot. I fly airplanes, and Staff

Sergeant Fowler fixes and flies them with me. We just were flying, sir, and training. We never felt that we were being forced to cut corners or anything else. As the Assistant Operations Officer, one of the guys that is an integral part of the training of the rest of the aviators, I never felt that at all.

The press can say what they want. I do not necessarily agree with it, and that is not an issue.

But I have never felt any pressure, and I think I speak for all my colleagues down at the squadron, to include my CO, that we never felt any pressure. We were flying airplanes and we were fixing airplanes, and we would like to get back to doing that.

Senator ROBERTS. I appreciate that.

Sergeant, any comments?

Sergeant FOWLER. No, sir. I would concur with that.

The only perceived pressure that might have been felt is just what was being printed in the newspapers, that VMMT-204 was under pressure to get the program going. Like the Major alluded to, we have been taking a lot of shots on the chin and unjustly in many cases. If there was any pressure, that is where it would come from.

Senator ROBERTS. This is the aircraft of the future, as far you are concerned.

Sergeant FOWLER. Sir, I have complete confidence in the aircraft. Like the Major said, we are both from CH-46s, and I do not hesitate to tell anyone that my first flight in the V-22, I kind of had a chip on my shoulder. I was partial to the CH-46. We both still love the airframe a great deal. The minute that aircraft took off and I spent my first couple of minutes flying, I was like you, sir, astonished, amazed at the power and the capabilities of the platform.

I've done in-country and split Yugoslavia where we really did not have that much information on what to expect. We pulled 46s in Haiti after they were taking fire in a small town in the mountains, and in both instances the V-22 would definitely have served its purpose much better than the 46 did.

Chairman WARNER. Much better. You mean less risk to the operators and the passengers that you have on board.

Sergeant FOWLER. Yes, sir. A prime example is the amount of time that it would take that aircraft to exit the zone. A V-22 can get out of there just like that, decrease in small arms fire, and the time that it would take in the split instance took us probably an hour to fly from ship to split would be, I'm guessing, in a quarter of the time in a V-22.

Senator ROBERTS. Major, would you like to add anything to that?

Major HECKL. Sir, he and I both have a great deal of deployed time, and quite frankly, I wish I were there again, but with this airplane. The bottom line is, the last decade is replete with examples of where the country has called us to go into harm's way to rescue American civilians, et cetera. I have been involved with a couple of them. There was one case in 1990 when Liberia fell apart the first time with Charles Taylor, and the MEU, the Marine Expeditionary Unit, was not within striking distance, and it took us days to get there. With this aircraft, it would have been about a 4½/5-hour flight, and we would not have been inserting squads.

We would have been inserting a company reinforced with marines that could control any situation virtually.

Sir, I have no doubt. Those non-combatant evacuation operations that you hear referred to so often that we do so often—this machine is going to be the ticket. The long-range payload capability is phenomenal. I have flown the airplane. I have been there and I have done it in every single flight environment this aircraft can operate in. I have about 25 hours on NVGs in this thing. It is a good machine.

Senator ROBERTS. Mr. Chairman, I wish our other colleagues could have been present for what I think is some very dramatic testimony. It is the response that I think was important to have on the record. I thank you, Major. I thank you, Sergeant.

I have one other question.

Chairman WARNER. You go right ahead, Senator.

Senator ROBERTS. Senator Levin has concern. I have concern. I thank Senator Levin for bringing this up. This is the downwash syndrome with this aircraft. I guess I would ask both Generals. Does the downwash make the aircraft operationally limited or ineffective in regards to the specific missions of the Marine Corps or Special Operations?

General JONES. I think it is something that we have to deal with. We are used to downwash, whether it is from a CH-53 Echo, which is arguably very similar to the V-22—

Chairman WARNER. I think we need a definition. I understand it. I have been in it. All of us have. Explain exactly the downwash phenomenon, and then, General Holland, you add, of course, your response to this important question.

General JONES. Well, downwash in the V-22 occurs when the nacelles are in the helicopter mode. Obviously, when you power up the engines, you force the air through the blades and you get a tremendous amount of downward thrust which allows the V-22 to lift up, the same as any helicopter.

The 53 Echo is our largest helicopter, and it creates a very significant downwash. It is not the sine qua non of the V-22. It is an aspect of its operational mission envelope.

We had hoped to have three different exit points on the V-22, but these are things that we are going to work with as the program develops. There is a question of the right ladder to make sure that when you drop a rope ladder down, that it is robust enough that it does not get sucked back up into the blades.

Those are things where the work-arounds will be found. But it certainly is not going to make or break this particular program. They are work-arounds. You may be able to get two exit points off the aft section of the aircraft, but we will need to get the aircraft back in the air to continue that kind of development. But it was not something that was a show-stopper in the development and testing phase.

Chairman WARNER. Let me just clarify. You are talking about an operation where it comes in, descends to a level of 20 or 30 feet, or whatever the case may be, above the ground, decides not to go down fully, but to remain in the hovering mode, and then passengers exit down ladders.

General JONES. Yes, sir, for a tactical insert.

Chairman WARNER. That is correct.

In your judgment, while there are problems, these can be worked out and resolved.

General JONES. I am of the opinion they can be. This is a technique that we have developed with all helicopters. This is just a different variation of it, and it takes some understanding. The downwash now is on the horizontal axis instead of the vertical axis.

Chairman WARNER. General Holland.

General HOLLAND. Yes, sir. I agree with General Jones. I think this is one area that is a concern, but we are going to continue to work with the Navy, the Marine Corps, and Special Operations Command. At this time, we are reviewing our requirements. The good thing to note is that we can exit the airplane safely, according to The Blue Ribbon Panel, from the ramp. It is not that we cannot fast rope. It is more or less whether or not we would have three areas to fast rope. That is the part we all need to keep in consideration.

We are also going to look at designs. We are going to look at our tactics and techniques and what is smart. I am encouraged by what The Blue Ribbon Panel stated today, and I am also encouraged that we are going to be able to find some solutions.

General JONES. If I could just come back on that one briefly. There was a very good question I think that Senator Roberts asked about this downwash, and the answer that came from the panel had to do with what we call brownout or whiteout, where you land and kick up so much dust and dirt that you lose visibility, and the same thing in snow. I thought the panel's answer was very thoughtful on that. The navigational aids and the visibility from the cockpit in the V-22 is dramatically different than from anything we have seen in a helicopter. Those phenomena will actually be, I think, in the long term less of a problem for the V-22 than it is, let us say, in a 46.

Senator ROBERTS. Mr. Chairman, the only final comment I would have is that I truly appreciate your leadership in trying to figure out how we can by law do some fixing on the acquisition process. I did not know this. I did not know by law that the service chief of a particular service could not have input in regards to acquisition and testing to determine whether whatever the platform being developed was safe for the specific mission. That service chief probably knows more about that than any other single individual.

It seems to me if they are locked out of the system, that we have some real legislative work ahead of us to consider in regards to input by people who are now representing their views on the panel. I know that the Commandant certainly feels that way and has a sense of personal frustration that he could not, by law, take part. Somehow or other in the law of unintended consequences or be careful what we ask for, it seems to me we need to take a hard look at that. I really want to thank you for mentioning that and saying the committee will take a hard look at that.

Chairman WARNER. We thank you, Senator. I have been sitting on this committee for almost a quarter of a century, and we learn every day where we have to get down in our system and find solutions to problems which apparently have been there.

Senator Roberts, before you leave, I would just like to ask our two operational marines here a tough question, but it needs to be answered. As I mentioned with deepest humility, both Senator Roberts and I served in uniform. My service was very modest.

I know the Corps considers itself one big family and that is true of the other services. As such, the spouses, the loved ones are very much a part of that family. I opened, as did the Commandant, with our compassion for that family, which is probably the most valuable support that any of us have while we are in the Corps.

I think you better see if you can put into the record—maybe you want to submit it later, but if you want to articulate it. It is important that you are ready to step up as the operators, but the families also have a voice in this decision and maybe you would prefer to put that in writing and send it to us, unless you want to comment today.

Major HECKL. Sir, I can speak without a doubt on that issue. As a husband and father of two, my wife, my family is totally in support of my decision to do this, and there are no safety concerns at all, sir.

I think that aviation is inherently a risky business, and marines are doers. We do not like to be told to stop. We want to accomplish the mission. That is why a lot of times people turn to us to get the job done. If we want a zero mishap rate, let us park the airplanes. I will certainly not agree with that, and we can start shooting bows and arrows again. But sir, it is a risky business. I have buried a lot of my friends, some now in the V-22, a lot in other airframes. A lot. My family is not concerned. They know the risk exists, be it in a V-22 or in my venerable CH-46 Echo. It is not a concern on my part, sir.

Chairman WARNER. Sergeant.

Sergeant FOWLER. Sir, I feel compelled to say this for the marines at 204 who would not let me live it down. We have a squadron of marines and airmen down at 204 that are committed to showing the Nation basically that this is a viable asset, that we need the V-22. I talked to Mrs. Nelson who is here. Mrs. Gruber is here I know. I knew Mrs. Nelson's husband very well. Although it is a tragic accident, I also know that if I were in the same position, they would want us to carry on, and that is what we are going to do, sir. I just wanted to let you know we are committed to bringing the V-22 to the American public and showing them it is definitely the best option.

Chairman WARNER. Fellow marines, I thank you very much.

The hearing is concluded. I think this committee has, if I may say, in a very forthright and careful manner, discharged our responsibility of the initial hearings on this. The hearing is recessed.

[Questions for the record with answers supplied follow:]

QUESTIONS SUBMITTED BY SENATOR STROM THURMOND

1. Senator THURMOND. General Dailey, I want to congratulate the panel on the excellent report. Although the report provides a comprehensive list of issues that must be resolved before the V-22 goes to full production, you did not address the V-22 test program.

Does the panel have any views of the adequacy of the V-22 flight test program?

General DAILEY. Developmental testing was conducted with the intent of demonstrating specification compliance clearing the envelope for the operational testers to demonstrate Joint Operational Requirement Document requirements. The vortex

ring state (VRS) testing was adequate for its purpose (OPEVAL flight clearance). Poor crew coordination and violation of a flight manual warning caused the Mirana mishap, neither of which would necessarily have been prevented by more developmental flight testing. On the other hand, had the developers thoroughly assessed VRS, the community would have been more aware of its characteristics and hazards than were the pilots involved in the Mirana mishap. Formation flight and desert landings were partially tested, again to clear an OPEVAL envelope. More testing is needed in all of these areas to thoroughly define flight characteristics and develop procedures, techniques and limitations.

The panel does not see this tendency to limit developmental testing as a V-22 unique trend. There are other cases in recent years where test programs were limited to demonstrating the requirements, with little or no attention given to exploring the actual limits of the aircraft's capabilities. This "scorecard" approach to testing, usually motivated by the desire not to fail and the fear of cancellation, can have the effect of putting off important lessons until later in operations. This may be acceptable for aircraft with crew escape systems, but should not be tolerated for transport aircraft, or aircraft with limited crew escape capability.

2. Senator THURMOND. Mr. Augustine, based on your distinguished career both in government and the corporate world, how would you compare the scope of the V-22 problems with other major weapon development programs?

Mr. AUGUSTINE. I would say, Senator Thurmond, that with one possible exception the problems of which we are aware on the V-22 are not at all atypical of the sort of problems encountered in most major system development undertakings. Because of the flowfield complexity associated with the VRS problem, we still, I believe, have more to learn about that particular phenomenon. On the other hand, as I look at the overall technical challenges posed by the V-22 as compared with other systems that have ultimately proven successful, it is hard to say that the former are any more formidable.

Unfortunately, if the V-22 program is continued there will be future aircraft losses. This is a tragic aspect of all challenging aviation undertakings. On the other hand, it should be possible to manage these undertakings including the V-22, so as to minimize the likelihood of occurrence and consequences of such events.

3. Senator THURMOND. General Davis, although the number of crashes associated with the V-22 program are not out of the ordinary when compared to other major aircraft development, the significant loss of life associated with these crashes has made the V-22 program more visible.

In your judgment, was it a requirement to carry the large number of passengers at this point in the V-22 development?

General DAVIS. The test/training objectives for the Mirana flight apparently called for a number of combat marines to be carried in the troop compartment. In retrospect, it is fair to challenge any such requirements when a new aircraft is still relatively unproven. Just because the aircraft has been cleared by the development testers for operational testing, it does not mean that the risks (including uncertainties) are at a reasonable level. OPEVAL uses very experienced aircrews, and after OPEVAL, the first squadron is staffed by experienced personnel and operated in a highly structured environment (training). These staffing and operating approaches are appropriate for a new aircraft. The same risk-based approach should be applied to passenger missions. We recommend in the report that passenger flying be restricted to "mission essential" personnel until the V-22 is ready for operational deployment. By then, the aircraft should have accumulated enough flight time to reduce the uncertainties to an acceptable level for routine passenger operations.

4. Senator THURMOND. General Davis, the panel's report reflects that a major flight safety issue with the V-22 is the vortex ring state. Before the tragic mishap in Mirana, were there any indicators the vortex ring of the V-22 differed significantly from that associated with large helicopters? If so, what precautions did the Marine Corps incorporate in the test program? Do you believe these precautions were appropriate?

General DAVIS. The engineering community apparently anticipated VRS in the V-22, but not the asymmetric roll response that characterized the Mirana mishap. Because there was no research into VRS for the V-22, the only real precautions taken for it were:

- (a) Handpicked, most helicopter experienced pilots for OPEVAL
- (b) A flight handbook warning to avoid high sink rates at low forward speed (although it was inadvertently placed in the wrong part of the manual)

- (c) Enough developmental flight test to ensure that the warning limit (800 feet per minute sink rate at or below 40 knots forward speed) was safe.

In retrospect, the precautions taken by the program for VRS were inadequate. The testing was inadequate to determine the exact nature of V-22 VRS. Because of this, they had no direct knowledge of onset conditions, natural warning characteristics, handling qualities (longitudinal or lateral directional), or recovery procedures. The flight manual warning was inadequate to provide proper V-22 unique training in that it was poorly worded and improperly placed. After the mishap, more testing was initiated, and the flight manual was corrected. The panel endorsed these actions, and believes that they, along with emphasis on a cockpit warning system, and ground school and simulator training for the pilots, will go a long way towards reducing the chance of VRS mishaps in the future.

5. Senator THURMOND. General Jones, The Panel to Review the V-22 Program indicated that the V-22 test program was underfunded for the scope of the program. Do you agree with this assertion? If not, why not?

General JONES. Spares, support, and procurement ramp have been the primary funding concerns in the V-22 program. During the program restructure, the focus is the correction of noted deficiencies. The intent is to provide full funding for the critical spares and support areas. Following the complete correction of deficiencies, the intent is to ramp the procurement up to the most efficient level. The Marine Corps will work with OSD, the Navy, and industry to ensure the funding is maintained at appropriate levels. The continued support of Congress is critical to the success of this effort.

6. Senator THURMOND. General Holland, in the development testing of the CV-22, did your pilots experience similar problems as those associated with the Marine Corps test program? If so, what was the coordination between the two programs?

General HOLLAND. The CV-22 effort is embedded in the overall V-22 program being executed by the Department of the Navy. As such, there are not truly two separate programs, but two facets of the same program. This is equally true of the test effort which uses an integrated developmental and operational testing approach for both the MV-22 and CV-22.

As part of this integrated testing, Air Force pilots and maintainers have for years been, and are still, working side-by-side with their Marine Corps and contractor test counterparts. Air Force personnel also participated in the MV-22 Operational Evaluation and provided inputs into the final report that also assessed the operational effectiveness and suitability of the V-22 for special operations missions. Thus, coordination between the two services is a continuous and ongoing process. Our test pilots, aircrew members and maintainers have experienced the V-22 alongside the marines every step of the way.

Specific testing of CV-22 variant started only very recently, late in 2000. This effort includes Marine Corps participation and is located at Edwards Air Force Base, California. Only a handful of flights were conducted there before the current operational pause was put in effect.

Independent Air Force testing will occur during the CV-22 dedicated Initial Operational Test and Evaluation (IOT&E) currently scheduled to be conducted in 2003 at Kirtland Air Force Base, New Mexico.

QUESTIONS SUBMITTED BY SENATOR BOB SMITH

7. Senator SMITH. Why shouldn't we cancel the V-22 program right now?

General HOLLAND. The V-22 program should not be canceled because it is the best solution available (now or over the next decade) to special operations forces' (SOF) indisputably valid and high priority military need. The \$13 billion invested to date has developed an innovative airframe that will meet SOF's requirements for a high-speed, long-range penetrating aircraft. While the V-22 hardware and software are not completely ready for full-rate production, their closeness to completion is evidenced by the number of hours the V-22 has flown and the amount of testing that has been accomplished thus far. We must continue the remaining testing and redesign that will allow the V-22 to meet SOF's real and pressing needs.

General JONES. Our legacy medium lift helicopter platforms have served our Nation very well but have exceeded their initial projected service life. They continue to become more unreliable, more expensive to maintain and are less capable with each passing year. Tiltrotor technology is sound and provides a true leap-ahead in capability. The review panel's hard work bears this out. The Osprey is arguably the most studied weapon system in the history of our American military. Each succes-

sive study has validated that the V-22 was the most cost and operationally effective alternative. Cancellation would delay the beginning of replacement of our legacy platforms by at least 5 to 7 additional years. The safety of our personnel who fly and ride on these legacy platforms must be considered. Our plan for the future of the program will ensure that we can move forward with an aircraft that is safe, highly capable and affordable. That aircraft is the V-22.

8. Senator SMITH. Is the requirement for the V-22 still valid?

General HOLLAND. Absolutely! The United States Special Operations Command's (USSOCOM) requirement for the CV-22 is not only still valid, it is more acute today than when it was first articulated as an Air Force Statement of Need nearly two decades ago. USSOCOM continues to operate in a turbulent and uncertain world where the threat to aircraft intensifies and modernizes every day. In peacetime, crisis and in wartime, USSOCOM's missions (such as counterproliferation, combating terrorism, direct action, and special reconnaissance) demand the ability to penetrate hostile and denied territory with a force of highly trained operators. The political uncertainty in many regions around the globe continues to demonstrate many situations where special operations forces (SOF) could be called upon to intervene. Each year, anti-aircraft weapons continue to become more widely distributed and technically sophisticated. Computerization in the fields of radar, communication and analysis makes penetrating a defended area more risky as time progresses.

While our missions remain imperative, the operating environment makes those missions more difficult to accomplish with our current assets, particularly with those assets aging. Many USSOCOM aircraft are wearing down, particularly the MH-53s that we have flown heavily and with great success for the past 30 years. We need something to replace the capability we will lose over time and it should be something truly fit for the rigors of the 21st century. The CV-22 is fit for the future and will be ready to meet our real missions needs.

General JONES. Yes. It was over 20 years ago that the Marine Corps began to consider replacement options for its aging CH-46E Sea Knight and CH-53D Sea Stallion helicopters. Following a rigorous evaluation of future mission requirements, tiltrotor technology was selected as the best option to achieve future needs for its promise to revolutionize our expeditionary capabilities. The Marine Corps' fleet of CH-46E and CH-53D helicopters began their service in the mid-1960s. At the end of their 20-year initial projected service life, both began experiencing escalating maintenance costs; reduced reliability, availability, and maintainability; and significant performance degradation. These challenges are even more pronounced today, as the average age of our CH-46E and CH-53D helicopters is over 30 years. These helicopters are old, their production lines are closed, parts are scarce, and their maintenance requirements exceed the bounds of reasonableness. They are truly "legacy systems" with numerous current and projected deficiencies: inadequate payload, range, and speed; and, no self-deployment or aerial refueling capability. Clearly, a capable replacement aircraft is required and long overdue. The V-22 remains the most capable platform to provide us the capability we need to meet the missions of the 21st century.

9. Senator SMITH. What are you doing to improve R&M?

General JONES. Safety and reliability is the focus of our road ahead for the V-22. Increased focus and commitment by industry and the government to this issue will ensure a safe and reliable aircraft is delivered to the fleet. An aggressive plan to improve the reliability and maintainability of the V-22 has been in place since the conclusion of OPEVAL. We have expanded this plan by incorporating a deficiency matrix, which now identifies every known deficiency. Additionally, we have developed a phased implementation plan that corrects these deficiencies.

QUESTIONS SUBMITTED BY SENATOR RICK SANTORUM

10. Senator SANTORUM. General Jones and General Holland, as the customers for the MV-22 and CV-22, what are the operational ramifications to your respective missions if the V-22 is canceled?

General JONES. Canceling the program would directly impact four areas.

First, the cost (in terms of equipment, parts, and manpower) to maintain our legacy aircraft will continue to increase. The requirement to replace our medium lift inventory is valid. The legacy medium lift aircraft are over 30 years old; they need to be replaced. Additionally, the V-22 is the most suitable solution to meet 21st century battlespace requirements. Our legacy medium lift helicopter platforms have served our Nation very well but have exceeded their initial projected 20 year service

life. They continue to become more unreliable, more expensive to maintain and are less capable with each passing year.

Second, first operational deployment of a replacement alternative would not occur for 7 to 10 years. Cancellation would delay the beginning of replacement of our legacy platforms by at least 5 to 7 additional years. The safety of the personnel who fly and ride on these legacy platforms must be considered. The plan for the future of the program will ensure that the program can move forward with an airplane that is safe, highly capable and affordable. That aircraft is the V-22.

The third impact would be felt at VMPT-204, the Osprey training squadron. We have over 300 marines, sailors, and airmen and eight aircraft currently assigned. A disposition plan would have to be worked with dramatic impacts on personnel and funding.

The fourth impact—the Marine Corps will experience further delays in implementing our capstone concept of Expeditionary Maneuver Warfare (EMW). The V-22 is the only aircraft capable of fulfilling the medium lift assault support needs required to execute EMW. Seven Cost and Operational Effectiveness Analyses (COEAs) or Analysis of Alternatives (AoAs) all state that for equivalent lift, the V-22 is the most cost effective. Platforms considered included the H-60, H-53, CH-47, EH-101, S-92, and combinations thereof. Also, “equivalent lift” to a V-22 12-plane squadron does not necessarily fit aboard an L-class ship because it takes more aircraft for the equivalent lift and more manpower to support it.

General HOLLAND. If the CV-22 were canceled, the ramifications to special operations forces (SOF) might not be immediately felt, but rather would result in the continual erosion of our capability to successfully perform our missions in the future. Operationally, SOF rely on maintaining an edge in both technology and training for success. In aviation, that technological edge has consistently exhibited itself in the ability to reliably fly faster, further and in ways that are less vulnerable. The CV-22, with its unique capabilities, is the next logical step to keep SOF ahead.

As the world in which SOF operates evolves in terms of the technology, techniques and training aimed at detecting and preventing our penetration into the area of our enemy, SOF needs to maintain its pace of progress to keep that needed edge. As our current inventory of modified helicopters ages, they become more expensive to maintain and less capable of hosting modifications needed to cope with the evolving world. Without the CV-22, conduct of special operations will become more complex and expensive and potentially, less likely to succeed.

11. Senator SANTORUM. General Jones and General Holland, if the V-22 were not to be procured, what other platforms would you consider to meet your stated requirements?

General JONES. Seven major Cost and Operational Effectiveness Analysis studies have concluded that the V-22 is more cost-effective than any helicopter or any mix of conventional helicopter types. In fact, the V-22 is the only practical alternative that meets the tri-service requirements of the Marine Corps, Air Force, and Navy. Other options offer no real advantages in cost savings/avoidance, given the requirement. In fact, other options are accurately described as a “step back.” The V-22 is the only platform that can fulfill the stated requirements.

General HOLLAND. There are no other current platforms that will meet the United States Special Operations Command’s (USSOCOM) requirement for the capabilities offered by the CV-22. Tiltrotor technology will allow special operations forces (SOF) deep access into denied areas where the current helicopter fleet cannot go. Only the CV-22 has the range, speed, and survivability to carry out critical missions deep in denied territory within a single period of darkness, negating the need to seize and hold forward staging bases and friendly forces on the ground. This 100 percent increase in combat radius over current SOF helicopters would allow the CV-22 to operate over an area four times as large as the helicopters, with a similar or smaller logistics footprint.

Having said that, if the CV-22 program is canceled, USSOCOM will have to extend our aging MH-53 PAVE LOW fleet to maintain our current level of risk. This will include a costly service life extension program (SLEP). Additionally, USSOCOM will be forced to begin a new acquisition program for a next-generation platform meeting the same requirements as the CV-22, but now 15 years late to need. We have no budget for such an effort, the cost of which would likely be more than the CV-22. It would have to be a joint program between USSOCOM and other services to be affordable to USSOCOM.

12. Senator SANTORUM. General Jones and General Holland, what are the estimated costs associated with substituting or sustaining other platforms?

General JONES. Cost is relative. The Selected Acquisition Report (SAR) methodology asks for the entire R&D program, aircraft acquisition, all spares, logistics and support equipment to be spread over the total procurement quantity and calculated in inflated then-year dollars. Reporting the total planned buy in constant year dollars for the fully outfitted flyaway aircraft is more accurate and results in a better defined value (\$47.3M in 2001 dollars for the V-22).

Consider the performance leap. The V-22 is twice as fast as the helicopters it replaces and has 4 to 5 times the range. This is a much larger performance premium than that enjoyed by the newest generation of fighters over their predecessors.

Consider cost effectiveness. Seven Cost and Operational Effectiveness Analyses (COEAs) or Analysis of Alternatives (AoAs) all state that for equivalent lift, the V-22 is the most cost effective. Platforms considered included the H-60, H-53, CH-47, EH-101, S-92, and combinations thereof. Also, "equivalent lift" to a 12 plane V-22 squadron does not necessarily fit aboard an L-class ship because it takes more aircraft for the equivalent lift and more manpower to support it.

In each of seven COEAs conducted by a diverse series of trusted institutions, the V-22 was a very consistent first choice with no clear second choice among the widest possible variety of potential alternatives. Each analysis showed that the MV-22 Osprey is the most operationally effective choice and also, the most cost effective (affordable) choice for the Marine Corps. The analyses concluded that:

- The total life cycle cost for the V-22 proved to be \$3 billion less than an equal lift CH-60/CH-53 force.
- The V-22 force exhibited much greater survivability—over a 7 to 1 advantage in troop transport. Thus, resulting in a much greater level of protection than other assault support aircraft could provide to our most precious asset . . . our marines.
- An MV-22/CH-53E force will deliver three times the combat power of an equal lift CH-60/CH-53E force in the critical first hour of an amphibious assault.
- An additional \$3 billion cost avoidance was attributed to a decreased need for shipping and airlift assets due to the self-deployability of the V-22.
- The V-22 option is fully supportable within the Marine Corps' current force structure. An equally capable CH-60/CH-53E alternative would demand a force structure increase of 3,000-4,000 personnel. This represents several billion dollars of cost avoidance over a 20-year period.

The V-22 Osprey provides the Nation an affordable balance of flexibility, responsiveness, and survivability that is required for 21st century military operations. Such balance cannot be achieved with any other combination of platform options. Other alternatives including mixes or 'silver bullets' offer no real advantage in cost savings or avoidance given the requirement. The bottom line is the V-22 may be more expensive on a unit cost basis, but it is significantly more capable and cost effective than any alternative. The V-22 is the only alternative that meets the requirement.

General HOLLAND. If the CV-22 program were canceled, there would be severe funding impacts in both the short and long term. The near term cost to extend the MH-53 PAVE LOW fleet, including a service life extension program (SLEP), would be close to \$820 million through fiscal year 2007. The long term costs we estimate at \$2.2 billion through fiscal year 2012. This, in effect, would divert a great portion of our budget from modernization to sustainment of a legacy system.

Furthermore, the United States Special Operations Command (USSOCOM) would have to begin an acquisition program for a new platform meeting the same CV-22 capabilities. We expect that the cost would be greater than that of the CV-22 program, which has already gone through development and is very close to production. Again, USSOCOM has no current budget for such an effort and would have to seek overguidance.

13. Senator SANTORUM. General Dailey, how confident are you in Bell/Boeing's commitment and ability to fix the problems associated with the V-22?

General DAILEY. The panel talked to senior leadership at Bell and Boeing about their commitment to a safe and capable aircraft for the services. We are confident that they will take our recommendations to heart, and work hard to correct program and design deficiencies. We recommended that until the program completes its maturation phase, the CEOs of the two companies meet monthly with the Joint Program Office Director and the Navy Program Manager to stay abreast of progress and to put management emphasis on any problems that might arise.

14. Senator SANTORUM. General Jones and General Holland, we have heard from The Blue Ribbon Panel that this program has been underfunded from the beginning. How do we prevent this from happening in the future?

General JONES. Spares, support, and procurement ramp have been the primary funding concerns in the V-22 program. During the program restructure, the focus is the correction of noted deficiencies. The intent is to provide full funding for the critical spares and support areas. Following the complete correction of deficiencies, the intent is to ramp the procurement up to the most efficient level. The Marine Corps will work with OSD, the Navy, and industry to ensure the funding is maintained at appropriate levels. Additionally, the Office of the Assistant Secretary of the Navy for Research, Development, and Acquisition established the V-22 Program Executive Committee (EXCOM) to review the program on a continuing basis with a focus on:

- Government/Contractor approach
- Critical technical, testing, programmatic, and supportability issues
- Areas of technical risk
- Details of the program restructure
- Cost and schedule performance
- Manufacturing quality
- Program communication

The continued support of Congress is critical to the success of this program.

General HOLLAND. The CV-22 offers a leap-ahead technology and capability for the United States Special Operations Command (USSOCOM). It represents a critical modernization effort for special operations forces (SOF). Because USSOCOM has a limited budget, we must leverage procurement efforts by the services, modifying those aircraft for SOF use. For the CV-22, the Navy pays for development, Air Force pays to procure the basic CV-22 airframes, and USSOCOM funds the SOF-unique content such as terrain following/terrain avoidance radars and an upgraded electronic warfare suite designed to increase aircraft survivability against advanced threats.

Because of the complex nature of funding, both the Air Force and USSOCOM must rely on accurate joint cost modeling estimates. USSOCOM has consistently fully funded the Major Force Program 11 (MFP-11) portion to those estimates. The best way to ensure adequate funding is to have accurate cost models. USSOCOM, the Air Force, and the Navy must work together to ensure the joint program office is fully staffed and both MV-22 and CV-22 costs are accurately and completely modelled. Additionally, as The Blue Ribbon Panel pointed out, the V-22 program suffers from funding decrements common to all acquisition programs. However, because the V-22 is a new technology, subject to higher technical risk, it may need protection from "customary decrements" (taxes) and require a robust management reserve.

QUESTIONS SUBMITTED BY SENATOR CARL LEVIN

15. Senator LEVIN. Colonel Schmidt, can you expand on your testimony on restrictions placed on personnel involved in the operational test and evaluation of the V-22 Osprey? Specifically, do you have any explanation for why the team participating in the operational test and evaluation of the V-22 did not pass any important safety or reliability information to you or other responsible officials within the V-22 program office?

Colonel SCHMIDT. To my understanding, the Commander, Operational Test and Evaluation Force (COMOPTEVFOR) generally discloses Operational Evaluation (OPEVAL) information during the course of OPEVAL via anomaly reports, Naval Safety Reporting and the Naval Aviation Maintenance Discrepancy Reporting Program (NAMDRP) reports. Some reports that fell into those categories were issued during V-22 OPEVAL. I do not have insight into whether all events that should have been reported were in fact reported; this is a matter that COMOPTEVFOR would need to address. On July 5, 1999, before the November 1999 OPEVAL start, I coordinated with Captain Evans of COMOPTEVFOR to receive, via the anomaly report vehicle, continual reliability data during the course of OPEVAL, primarily because of our prediction of a lower than threshold Mean Flight Hours Before Failure (MFHBF) number. The data was to be open data, meaning that the Naval Air System Command (NAVAIR) or Program Manager (PMA) could use it as needed, to include release to Bell-Boeing. My intent was to get a head start on planning for corrections of reliability issues found on production aircraft, rather than to wait until completion of OPEVAL to identify problems. When the first set of OPEVAL reliability data was provided in February of 2000 (covering the period of October/November,

1999) to the receiving NAVAIR reliability engineer, he acted upon it by providing information of interest to selected government and contractor personnel for problem investigation. The engineer was told by the Multi-Service Operational Test Team (MOTT) that his actions conflicted with his "trust agent" agreement. This was inconsistent with the open data agreement with COMOPTEVFOR, and the result was that all further deliveries of reliability data during OPEVAL were withheld from that time. Unfortunately, I was not personally informed of this situation until OPEVAL was essentially completed which was in July 2000. NAVAIR was provided the OPEVAL reliability data in August 2000 as a single block delivery.

It is my understanding that Secretary of the Navy Instruction (SECNAVINST) 5000.2B directs anomaly reports to be utilized to provide information back to the program office. In Para. 6.3.1.2.1 of the instruction it states: "An anomaly report shall be originated by COMOPTEVFOR when minor failures or anomalies are discovered during operational testing that impact testing, but are not so severe that testing should be stopped." During OPEVAL, 13 anomaly reports were issued. I believe this is the appropriate vehicle for relaying information back to the program office to ensure all potential issues are addressed.

16. Senator LEVIN. Colonel Schmidt, do you believe that there were any statutory or regulatory restrictions that should have prevented the operational testers from informing you or other responsible officials within the V-22 program office of such information?

Colonel SCHMIDT. I am not aware of any statutory or regulatory restrictions that preclude the operational testers from providing the program office with important safety and reliability information.

17. Senator LEVIN. Colonel Schmidt, can you describe in greater detail what important safety or reliability information has become known to you since the end of operational test and evaluation? In your opinion, which of these pieces of information would have warranted contemporaneous action by the program office had the program office been made aware of the information?

Colonel SCHMIDT. Several data items were made available after the end of operational evaluation (OPEVAL), which would have been more useful if provided in a more timely fashion. The Maintenance Action Form (MAF) database was provided in August 2000. This data describes maintenance actions taken and the failures that occurred. It could have provided the basis for corrective actions to commence 10 months earlier if provided during the OPEVAL, as agreed to by the Commander, Operational Test and Evaluation Force and the Program Officer for V-22 on July 5, 1999, prior to the start of OPEVAL. The corrective actions would have resulted in earlier reliability (and maintainability) improvements.

During my testimony, I discussed information about the February 24, 2000 abort due to a similar hydraulic failure to that experienced in the December 11, 2000 accident. How important this knowledge would have been, if received at an earlier date, cannot be ascertained after the fact. This information was obtained verbally by The Blue Ribbon Panel (Bryan O'Connor), but its usefulness would not have precluded the December accident in that the failure did not include pilot interaction with the primary flight control system button and related software, as occurred in the December accident.

18. Senator LEVIN. Colonel Schmidt, some of our problems in the hydraulics system apparently result from the fact that the early test aircraft were too heavy and were redesigned to make the V-22 lighter. This led to packing things more tightly into the nacelles, and moving to the higher pressure hydraulics systems. Both of these changes, at least indirectly, contributed to the hydraulics failure in the December crash.

How extensive a redesign do we need to make to ensure that we won't experience the hydraulic line chafing problem?

Colonel SCHMIDT. The V-22, both in Full Scale Development (FSD) and Engineering and Manufacturing Development (EMD), used a 5000 psi hydraulic system. The nacelle was not reduced in volume and the hydraulic system was not changed from FSD to EMD. However, the changes that did occur within the nacelle in going from FSD to EMD were made to reduce weight, improve maintainability, and to improve component cooling, while maintaining adequate line clearances. Nevertheless, present status indicates that the product being delivered to the fleet has unacceptable line chafing. This issue is being addressed.

At this time we do not know how extensive the redesign needs to be. A review of the current design is underway to determine what changes will be necessary to preclude chafing.

19. Senator LEVIN. Colonel Schmidt, can we be assured that required safety changes won't put us back into an unacceptable weight condition again?

Colonel SCHMIDT. I believe that safety changes will not put us back into an unacceptable weight condition.

20. Senator LEVIN. Colonel Schmidt, the vortex ring state condition in certain parts of the flight envelope was the cause of the April 2000 crash. Phil Coyle, the Director, Operational Test and Evaluation (DOT&E), came to the conclusion that fixing the vortex ring state problem in a side-by-side rotor system "cannot be remedied by minor design changes." (Page 70 of DOT&E briefing charts to The Panel to Review the V-22 Program).

Do you agree with the conclusion by DOT&E?

Colonel SCHMIDT. I disagree with the DOT&E briefing charts. First, the vortex ring state (VRS) condition does not occur within any part of the authorized flight envelope. The April 2000 Mirana, Arizona accident occurred well outside (2½ times) the authorized rate of descent limit for low airspeeds. Additionally, dedicated VRS flight testing, completed to date at altitude, shows VRS is predictable. Test data will be used to create VRS responses in the simulator for pilot training. Additionally, an audible warning will be provided in the aircraft to alert pilots who fly outside the approved envelope to an approaching VRS condition. To provide aerodynamic design correction to remove VRS is probably not possible given that it is an inherent characteristic for rotorcraft and would certainly be unnecessary given the above discussion. No other rotorcraft development project has attempted to eliminate VRS through aerodynamic design.

21. Senator LEVIN. Colonel Schmidt, what is your assessment of how extensive the fixes may be for the vortex ring state problem?

Colonel SCHMIDT. No changes are expected to be incorporated for VRS. However, we do intend to incorporate within the simulators the aircraft VRS response to permit training for avoidance, recognition and recovery if the limitations are exceeded. In addition, we will provide a cockpit warning to notify the pilot of exceeding the approved envelope and approaches to the region of possible VRS. It should be noted, to my knowledge, the V-22 will be the only rotorcraft to implement such a cockpit warning, even though VRS is an inherent characteristic of all rotorcraft.

22. Senator LEVIN. Phil Coyle, the Director, Operational Test and Evaluation (DOT&E), highlighted a number of areas for The Panel to Review the V-22 Program wherein he felt the V-22 did not perform well during operational testing, or was granted a waiver from testing so no data was taken during operational testing.

We all understand that waivers sometimes may be necessary, and that there is a formal process in the acquisition system for deciding on such waivers. However, some of these situations could have broad implications for operating the aircraft and having it perform its missions.

For example, *situations not tested* included operations under icing conditions, integrated operations with other aircraft, and flying under instrumented flight rules for shipboard operations at night.

Poor testing results included inability of the aircraft to execute shipboard short take-off and landing (STOL) operations at full mission weight (implying reduced combat radius), and the avionics systems producing faulty altimeter readings when the aircraft is carrying external cargo loads.

Colonel Schmidt, were you aware of all waivers that were granted for the program during the operational testing periods?

Colonel SCHMIDT. Yes, I was aware of all waivers granted, as was the leadership at the time, including Rear Admiral Newsome, USN, former Program Executive Officer for Air Antisubmarine Warfare, Assault, and Special Mission aircraft (PEO(A)) and Rear Admiral Nathman, USN, Director, Air Warfare Division, who signed out the waiver letter. The 21 waivers granted were fewer than those on any other recent Department of the Navy (DON) Aviation Operational Evaluation waiver list.

23. Senator LEVIN. Colonel Schmidt, why do you believe that the testing that was conducted derived sufficient testing data upon which to base decisions on the program?

Colonel SCHMIDT. The testing was adequate as substantiated by the Operational Evaluation Report, which stated "The V-22 is effective and suitable".

24. Senator LEVIN. Colonel Schmidt, do you believe that the operational testing data indicates that we may need to make modifications to the aircraft design to enable it to meet its requirements?

Colonel SCHMIDT. Yes, in order for the aircraft to meet all 243 requirements in the Joint Operational Requirements Document (JORD), modifications will have to be made. A review of the JORD is underway to validate the need of each of the requirements. However, it is clear at this point that modifications to improve reliability/maintainability (R&M) and the hoist are needed. Prior to the December 5, 2000 Milestone III meeting and the December 11, 2000 mishap, there were correction plans in place for improvement of R&M and the hoist (i.e., design, developmental testing, and follow-on operational test & evaluation). The intensive Blue Ribbon Panel review and technical assessment resulting from the December 11, 2000, accident has made clear the necessity for further changes and flight testing. Except for the faulty flight control software identified by the rare combination of events which led to the mishap, the aircraft was considered flight worthy. The software fault is being corrected and, when verified, the aircraft will be flight worthy again. The earlier than planned maturing of the V-22 system that these reviews are bringing to bear (to include the Interactive Electronic Technical Manuals (IETMs), optimized Naval Aviation Logistics Command Management Information System (NALCOMIS), training, and mission planning as well as the aircraft) will provide the confidence to Congress, the American people, decisionmakers, and warfighters to proceed with this revolutionary aircraft that will save thousands of American lives.

25. Senator LEVIN. In expeditionary environments, the forces that would be operating the V-22, both within the Marine Corps and with the special operations forces, would be required to operate with as small a ground "footprint" (people, hardware, spares, etc.) as possible.

General Jones and General Holland, what gives you confidence that the V-22 program will have sufficient reliability, availability, and maintainability to allow your forces to operate in these expeditionary environments without having to rely on too large a ground support footprint?

General JONES. The reliability growth plan developed prior to operational evaluation (OPEVAL) and since updated shows the V-22 is on track to meet or exceed all reliability, availability, and maintainability (RAM) Operational Requirements Document (ORD) requirements by the fall of calendar year 2003. This is ahead of the projected first operational deployment of the aircraft. The documented growth of reliability from the Engineering Manufacturing and Development (EMD) phase through OPEVAL and VMMT-204 operations supports the projected growth of the V-22 Program Office RAM plan.

Component reliability is the main driver to the RAM metrics that were not met during and following OPEVAL. With improved component reliability, Mean Flight Hour Between Failure (MFHBF) will increase, Maintenance Man Hours per Flight Hour (MMH/FH) will decrease and the Mean Flight Hour Between Unscheduled Maintenance (MFHBUM) will increase. The reduction of MMH/FH will reduce maintainer workload and allow the manpower requirement to be satisfied whether working from home base or in an expeditionary environment. Additionally, experienced maintainers with improved technical publications (i.e. Integrated Electronic Technical Manual System) and refined maintenance procedures will decrease the Mean Repair Time-Abort (MRTa). As the aircraft matures, reliability improves, and squadron maintainers become familiar with the aircraft; the aircraft's RAM will allow for full spectrum operations throughout the expeditionary environment without a requirement for a large logistical footprint.

General HOLLAND. One of the most critical aspects of measuring the reliability and availability for mission operations is the aircraft's operational reliability or Mean Time Between Failures (MTBF). Currently, the MTBF of the V-22 is about 0.78 hours, approximately 55 percent of the Operational Requirements Document threshold of 1.4 hours. Much attention has been placed on this number, but it needs to be kept in perspective. This threshold is one of the most stringent ever placed on a new aircraft and is 61 percent higher than the current MH-53 MTBF of 0.55 hours.

The Program Office's attention on increased quality during production, incorporation of projected design changes, and implementation of their reliability Corrective Action Plan (CAP) highlight the commitment to increased reliability and aircraft availability. If the proposed CAP is fully implemented the MTBF should meet the ORD requirement of 1.4 hours by the third quarter 2003, and exceed it by 34 percent by the fourth quarter 2003.

In regards to "too large a ground support footprint," the V-22 inherently reduces the ground support footprint necessary to support the warfighter. Current projections show 28 maintenance personnel per aircraft for the CV-22 compared to 39.7 maintenance personnel for the MH-53J, a 29 percent reduction in personnel.

During a simulated scenario employing 8 MH-53s, 4 C-5s, and 12 C-17s were required to load and transport the MH-53s, personnel, and equipment—compared to only 5 C-17s for the deployment of 8 CV-22s. The inherent capability of the V-22 allowed self-deployment, and allowed mission execution in one period of darkness compared to 35 hours for the MH-53. This also preserved operational security by eliminating buildup and flight test. The V-22 provides an estimated 77 percent reduction in execution timeline, reduces overall mission complexity, and increases probability of success. Even with the V-22 MTBF rate, the ground support footprint would be approximately one third of the MH-53 because of increased speed, range, and flexibility.

Regarding maintainability, projected design changes will not only impact reliability, but will also significantly provide a positive impact on the maintainability of the V-22. Redesign of the engine nacelles to include increased clearances between hydraulic lines and electrical wiring, new curing methods for attaching hardware (click studs), and the addition of multiple maintenance access panels will reduce system failures through contact. These actions will also give the maintainer more room to work, aid in inspection of critical areas, and as a result reduce unscheduled maintenance downtime.

26. Senator LEVIN. It is clear that the V-22 program will have to be delayed even if Secretary Rumsfeld decides to continue the program. Such a delay could involve waiting 2 or 3 years to start full production.

General JONES, what steps will be necessary in the Marine Corps to keep the CH-46 flying while we make any necessary fixes to the V-22 design?

General JONES. Based on current utilization rates, the service life of the CH-46E does not need to be extended to compensate for the delay of the MV-22. However, the cost of ownership of the CH-46E will likely continue to rise. Over the past 7 years, flight hour costs and maintenance man hours per flight hour have increased by approximately 30 percent (in constant \$FY00). Additionally, over the past decade, Marine Aviation has paid over \$600M in upgrades to keep the airframe viable. The most current improvement, the Engine Reliability and Improvement Program (ERIP), will ensure the reliability and health of the CH-46E engine and will cost an additional \$200M. This program is fully funded, and thanks to Congressional support, we were able to start it 1 year early (in this fiscal year). However, ERIP was procured based on a projected retirement schedule. As the delay of the MV-22 becomes more definitive, Marine Aviation will have to examine how many more ERIP kits the Marine Corps will need to procure. The current ERIP cost estimates are \$1.3M per aircraft (then year dollars).

27. Senator LEVIN. General Jones, how long can the CH-46 fleet be kept in safe flying condition?

General JONES. The CH-46E fleet can be kept in a safe flying condition indefinitely, but the cost of ownership of the CH-46E will continue to rise and will eventually become intolerable. Over the past 7 years, flight hour costs and maintenance man hours per flight hour have increased by approximately 30 percent (in constant \$FY00). Additionally, over the past decade, the Marine Corps has paid over \$600M dollars in upgrades to keep the airframe viable. The most current improvement, the Engine Reliability and Improvement Program (ERIP), ensures the reliability and health of the CH-46E engine and is fully funded at \$200M. Thanks to Congressional support, we were able to start it 1 year early (in this fiscal year). However, ERIP was procured based on a projected CH-46E retirement schedule. As the delay of the MV-22 becomes more definitive, Marine Aviation will have to examine how many more ERIP kits the Marine Corps will need to procure. The current ERIP cost estimates are \$1.3M per aircraft (then year dollars).

28. Senator LEVIN. I am informed that the Special Operations Command (SOCOM) may have clearer options with regard to a delay in CV-22 initial operational capability (IOC). I understand that, with additional funds, SOCOM could extend the use of the MH-53 helicopters that the CV-22 is scheduled to replace.

General Holland, is this an accurate reflection of your position?

General HOLLAND. The CV-22 Osprey will fulfill a mission need that SOF cannot meet with any existing helicopter. Tiltrotor technology will allow SOF access into denied areas where the current helicopter fleet cannot go. Only the CV-22 has the range, speed, and survivability to carry out critical missions deep in denied territory within a single period of darkness, negating the need to seize and hold forward staging bases and friendly forces on the ground. The 100 percent increase in combat radius over current SOF helicopters would allow the CV-22 to operate over an area four times as large as the helicopters, with a similar or smaller logistics footprint.

Any delay in fielding of the CV-22 will force USSOCOM to extend the aging MH-53 PAVE LOW fleet. The cost across the Future Years Defense Program (FYDP) to extend this legacy system would be at least \$330 million to include the additional costs of deferred sustainment efforts. The additional costs outside the FYDP could exceed \$290 million. Any slip of IOC greater than 2 or 3 years will require an expensive MH-53 service life extension program (SLEP) in addition to the costs just stated. As you point out, any effort to extend the MH-53 PAVE LOW is unresourced at this time, and completely beyond USSOCOM's ability to resource internally.

29. Senator LEVIN. General Holland, can you tell the committee what steps would be required to absorb a 2- or 3-year delay in CV-22 IOC?

General HOLLAND. Given expected reduced procurement profiles, a 2- or 3-year delay in CV-22 initial operating capability (IOC) would cause the United States Special Operations Command (USSOCOM) to delay the MH-53 drawdown outside the current Future Years Defense Program (FYDP). The new profile would generate the requirement to fund approximately \$40 million in previously deferred upgrades. Our initial estimate of the cost of the extension is at least \$330 million in the current FYDP, with the additional cost approaching \$290 million outside the FYDP. These funds would be required to upgrade, operate, sustain, and man the current MH-53 fleet.

In the event our current strategy for drawdown of the MH-53s is delayed, we would have to seek overguidance to resource the additional cost. This plan would only extend the current level of risk without addressing the additional required capabilities provided by the CV-22.

QUESTIONS SUBMITTED BY SENATOR EDWARD M. KENNEDY

30. Senator KENNEDY. The panel was established by Secretary of Defense Cohen to look into MV-22 safety and combat effectiveness, suitability to satisfy operational requirements, training, engineering and design, production and quality control, performance and safety of flight. After your review you feel that the program "should be continued, but restructured," and that there is no inherent safety flaw in the V-22 tiltrotor concept, although it lacks the "maturity needed for full-rate production or operational use."

What is the timeline that the panel feels is necessary to achieve the required maturity before the V-22 is ready for full-rate production or operational use?

PANEL I. The panel recommended a phased, event-driven approach to return to operations including flight readiness reviews for each phase. As discussed by each of the panel members during the testimony, given adequate funding, the estimated timeline to fully analyze the deficiencies and make corrections range from a minimum of 1 year to 2 years.

31. Senator KENNEDY. Mr. Augustine, one panel recommendation is to keep the production lines open by producing MV-22s at the minimum sustaining level. Currently eight aircraft have already been produced, and are now awaiting retrofits.

What do you believe the Marine Corps can do, or should do, with these aircraft?

Mr. AUGUSTINE. Additional aircraft for testing will be required for the Design Maturation Phase the panel recommends. It is my understanding that the program manager plans to use some of those fielded aircraft to conduct these tests. Eventually all the aircraft should be retrofit with the changes developed and returned to the fleet for operational use.

32. Senator KENNEDY. General Jones, the JAG manual report and the mishap investigation report stated that the emergency procedure for the hydraulic failure encountered by the MV-22 crew on December 11, 2000 called for the pilots to push the illuminated Primary Flight Control System (PFCS) button. When the pilots reset the PFCS button, it started an unanticipated chain of events that likely resulted in the deadly crash of a potentially air worthy aircraft due to a software anomaly. This emergency procedure was in the NATOPS manual but was never tested and verified in the simulators or anywhere else.

How does an emergency procedure become part of the NATOPS manual without first being tested?

General JONES. The Naval Air Training and Operating Procedures Standardization (NATOPS) Flight Manual, Navy Model MV-22B Tiltrotor, Change 3 dated 1 June 2000 is a preliminary manual. Test pilots and engineers from Naval Air Systems Command (NAVAIR) and industry tested and validated all procedures, including emergency procedures for the V-22.

Test pilots and engineers from both NAVAIR and industry test all emergency procedures before incorporating them into a NATOPS flight manual. The Chief of Naval Operations directs the Commander, NAVAIR to issue and maintain the NATOPS manuals as part of the complete NATOPS program. The manual contains information on all aircraft systems, performance data, and operating procedures required for safe and effective operation of the aircraft. These manuals are living documents that are continually subject to revision and modification of procedures throughout the life of the aircraft. As an aircraft program matures, it continues in a cycle of identifying a problem, researching a solution, testing the solution, implementing the solution, and monitoring the solution. There are two acceptable ways to test a solution and incorporate it into an emergency procedure, through acquiring actual test data and through simulation supported by actual test data. The determination of how a specific emergency procedure is validated depends on the risk associated with validating that procedure. Even mature aircraft, such as the CH-46E, require continuous procedure modification and validation.

33. Senator KENNEDY. General Jones, are all emergency procedures and aircraft flight limitations included in the NATOPS manual being reviewed and verified as a result of this tragedy?

General JONES. All emergency procedures for the MV-22 are currently in the process of review and re-validation. Pilots from the Integrated Test Team and VMMT-204 are validating the procedures utilizing the Flight Control Software Integration Rig (FCSIR), Flight Simulation Lab (FSL) and the Software Integration Lab (SIL) in Philadelphia, the Full Flight Simulator at MCAS New River, and the Manned Flight Simulator (MFS) at Patuxent River. The emergency procedures are being flown using the aforementioned facilities following any changes in the aircraft flight control software to ensure there are no anomalies. Any emergency procedures that can be safely evaluated in actual flight test will be included with the continued development testing following the return to flight. Continued development flight testing will further evaluate and define the flight envelope for the aircraft. Included in this testing will be the completion of the high rate of descent testing and the multi-plane formation interface testing. As the simulation and flight validation progresses, changes will be incorporated into the NATOPS manual and promulgated to all V-22 activities.

34. Senator KENNEDY. General Jones, in your written testimony you state, "The review panel also concluded that the aircraft's reliability and maintainability must be improved through additional engineering, testing, and evaluation. We have also come to this conclusion."

Why did the Marine Corps come to this conclusion only after the second mishap in 2000 and not as a result of the reports produced by operational testing and the April 2000 mishap in Arizona?

General JONES. The MV-22 did not meet all reliability, availability, and maintainability (RAM) requirements during operational evaluation (OPEVAL), as was expected and documented in the Operational Test and Readiness Review prior to the start of OPEVAL. The reliability growth plan was developed prior to OPEVAL and has since been updated showing the MV-22 is on track to meet or exceed all RAM Operational Requirements Document (ORD) requirements by the fall of calendar year 2003. The documented growth of reliability from the Engineering Manufacturing and Development (EMD) phase through post-OPEVAL supports projected growth of the V-22 Program Office plan.

Component reliability is the main driver to the RAM metrics that were not met during and following OPEVAL. With improved component reliability, Mean Flight Hours Between Failure (MFHBF) will increase, Maintenance Man Hours per Flight Hour (MMH/FH) will decrease and the Mean Flight Hours Between Unscheduled Maintenance (MFHBUM) will increase to meet the requirement. The reduction of MMH/FH will reduce maintainer workload and allow the manpower requirement to be satisfied. Additionally, experienced maintainers with improved technical publications (i.e. Integrated Electronic Technical Manual System) and refined maintenance procedures will decrease the Mean Repair Time-Abort (MRTa).

The program office RAM plan is based on projections of component reliability fixes that are being incorporated into each production lot. A calculation of the individual contribution for each component reliability improvement is evaluated with a confidence factor before the increase in overall system reliability is projected. The improvement projections are conservative estimates, and the plan includes fixes to take the overall system reliability to 1.53 MFHBF vice 1.4, to account for impacts of future reliability degraders. Retrofit will be accomplished by preferred sparing or through the use of retrofit funding (APN-5) as available. As a point of comparison,

it should be noted that the MFHBF for the CH-46 and CH-53D are 0.89 and 0.82. The readiness rates (based on the same ground rules), Full Mission Capable (FMC) rating and Mission Capable (MC) rating will improve as a result of the reliability plan. Additionally, the logistic support for the V-22 was immature and supply delays were a major degrader for FMC/MC ratings, as mentioned in the OPEVAL report. Immaturity of some systems, such as subsequently corrected Blade Fold Wing Stow (BFWS), resulted in extremely low FMC ratings. It is expected that the next Operational Test (OT) period will see improvements in the factors that severely impacted OPEVAL FMC/MC. As the aircraft matures, reliability improves and squadron maintainers become familiar with the aircraft; the aircraft's RAM will be well within the ORD requirements.

35. Senator KENNEDY. It is my understanding that considerable planning and reorganization went into the training and support of MV-22 training squadrons and future operational units. These steps included reassignment of pilots, mechanics, administrative and supply support personnel from other units, particularly CH-46E helicopter units, to the MV-22 program.

General Jones, if the panel's recommendations are accepted and MV-22 production is slowed to a minimum sustaining level, what impact will that have on force structure within the Marine Corps aviation community?

General JONES. The slowing of MV-22 production and procurement will have no impact on the force structure of Marine Corps aviation communities. The force structure associated with the MV-22 is designed to be a one-for-one replacement for the force structure of the CH-46E and CH-53D. Delays in transitioning from the CH-46E or CH-53D to the MV-22 will merely delay personnel transitions to the MV-22. As the MV-22 program experiences delays, we will manage the force structure and personnel accordingly.

36. Senator KENNEDY. General Jones, you mentioned at the hearing that the CH-46E can be relied upon to meet Marine Corps operational requirements in the interim. Could you please provide, in detail, how you think this can be done and at what cost?

General JONES. Based on current utilization rates, the service life of the CH-46E does not need to be extended to compensate for the delay of the MV-22. However, the cost of ownership of the CH-46E will likely continue to rise. Over the past 7 years, flight hour costs and maintenance man hours per flight hour have increased by approximately 30 percent (in constant \$FY00). Additionally, over the past decade, Marine Aviation has paid over \$600M in upgrades to keep the airframe viable. The most current improvement, the Engine Reliability and Improvement Program (ERIP), will ensure the reliability and health of the CH-46E engine and will cost an additional \$200M. This program is fully funded, and thanks to Congressional support, we were able to start it 1 year early (in this fiscal year). However, ERIP was procured based on a projected CH-46E retirement schedule. As the delay of the MV-22 becomes more definitive, Marine Aviation will have to examine how many more ERIP kits the Marine Corps will need to procure. The current ERIP cost estimates are \$1.3M per aircraft (then year dollars).

37. Senator KENNEDY. General Jones, while the Marine Corps awaits the MV-22, are changes being considered to minimize the operational and logistical shortcomings of continuing to deploy the CH-46E?

General JONES. The Marine Corps will continue to monitor the health of the CH-46E. Based on current utilization rates, the service life of the CH-46E does not need to be extended to compensate for the delay of the MV-22. We will continue with the most current improvement, the Engine Reliability and Improvement Program (ERIP), to ensure the reliability and health of the CH-46E engine. Thanks to Congressional support, this program is fully funded, and we were able to start it 1 year early (in this fiscal year). However, ERIP was procured based on a projected retirement schedule of the CH-46E. As the delay of the MV-22 becomes more definitive, Marine Aviation will have to examine how many more ERIP kits the Marine Corps will need to procure in order to ensure the CH-46 remains operationally deployable. The current cost estimates are \$1.3M per aircraft (then year dollars) for ERIP modification.

38. Senator KENNEDY. Recently, reports in the *Washington Post* included statements from officers involved in the V-22 JAG and mishap investigations. These officers stated that the software anomaly was a design flaw that was known for months by both the aircraft developers and marine officials, but went "largely uncorrected." We have learned through past programs that "whistleblowers" can provide impor-

tant information on program safety, and laws have been put in place to protect such whistleblowers and prevent retribution.

General Jones, can you assure us that the Marine Corps won't take adverse action against individuals who raised concerns about the program or the program's management?

General JONES. No adverse action has or will be taken against the individuals who raised concerns about the program or the program's management. However, action may be taken on individuals involved in the program that are determined to be guilty of wrongdoing by the DODIG's investigation.

QUESTIONS SUBMITTED BY SENATOR JOSEPH I. LIEBERMAN

39. Senator LIEBERMAN. The panel discovered several problems with the V-22 program and even called this a "troubled program," yet they recommend limited production. The program has been ongoing for almost two decades at an investment of \$12 billion. There have been several deaths and the program appears to be fraught with multiple complications. The panel has stated that the program is "nowhere close to being ready for use in day-to-day operations" and that "I wouldn't let time be the driver. . . . However long it takes, it will take." Further, their recommendations will produce significant delays and additional costs.

What was the basis of your recommendation to continue limited production of the program?

PANEL I. The panel recommended continuation of limited production because it found no inherent flaw in the V-22 tiltrotor concept, that the requirement is justified and the V-22 has demonstrated its ability to meet it.

40. Senator LIEBERMAN. Given the need for a marine requirement to deliver troops quickly and safely from offshore ships to inland sites, did you consider alternatives?

PANEL I. The panel worked with the Office of the Secretary of Defense Program Analysis and Evaluation Division on alternatives being considered to meet stated V-22 mission. The panel also reviewed the V-22 mission requirements. The panel felt that the V-22 mission was justified because of its capability to deploy rapidly over long distances, engage in surprise operations and carry out missions in a single period of darkness. As an example, the Desert One mission in Iran, involved 2 days of hiding in the desert . . . a mission that could have been carried out by a V-22-like aircraft in a single period of darkness. The high political stakes involved in such missions make it imperative that they be carried out successfully when undertaken. Given that, the panel felt that the V-22 mission was justified and that it was the only aircraft that could meet the stated mission. Although, there are aircraft, or combinations of aircraft, that can carry out lesser missions or execute the V-22 missions with more time and higher risk.

41. Senator LIEBERMAN. Since program launch in 1981 it has been wrangled with challenges-budget cuts, rising costs, technical problems, competing Navy programs, and short on performance goals. Did you consider, and if so, can you discuss the pros and cons you considered against program cancellation?

PANEL I. Program cancellation was discussed. The V-22 is more expensive than helicopter alternatives, although it provides more capability. V-22 cancellation may save some funds over helicopter alternatives but additional risk of successfully completing missions would have to be accepted. We also reviewed an assessment of the impact on the industrial base although this was not a major consideration in our decision to proceed with a restructured program.

42. Senator LIEBERMAN. Are you concerned about the implications of falsified maintenance records on the conclusions in your report and your testimony? Do you intend to release an addendum following the investigation into the recent falsification charges?

General DAILEY. As discussed in the hearing, the maintenance data itself was not critical to our findings. We found deficiencies in the systems to support this aircraft that must be fixed. The Department of Defense Inspector General (DODIG) reviewed our draft report and concluded that none of the information gathered by the panel contradicts the information gathered by the DODIG in its ongoing investigation (appendix D of the panel's report). Therefore, the panel does not intend to release an addendum following the investigation into the recent falsification charges.

43. Senator LIEBERMAN. In your testimony, you have indicated that the tiltrotor concept is not fundamentally flawed, but rather that the problems have been associated with engineering details. In order to perform its mission, the V-22 must be a highly robust system, namely a system that can function reliably in extremely adverse conditions, and one which does not become unsafe upon small departures from optimized operational requirements. I am concerned both about the ability to overcome the detailed engineering design flaws, and the long-term consequences of the limitations on the flight envelope required for safe operation (e.g. to avoid the vortex ring state). Can you, with confidence, recommend that the flight envelope will not be so sensitive and constrained as to limit the operational utility of the aircraft?

PANEL I. The safe flight envelope for the V-22 aircraft, that has been established based on flight tests, will permit safe and operationally effective utilization of the aircraft. It is the intent of the V-22 program office to investigate the controllability of the aircraft inside the currently restructured flight regime, consisting of low air-speed and high descent rate, as soon as the aircraft is returned to flight status. One of the objectives of the flight test program is to prove out the effectiveness of recovery maneuvers from the restructured flight regime.

44. Senator LIEBERMAN. Can you, with confidence, recommend that the "engineering details" can be resolved such that the aircraft will have an acceptable level of maintainability and reliability?

PANEL I. The maintainability and reliability of the V-22 aircraft have been adversely impacted by lack of adequate spares, incomplete training aids, and design and workmanship deficiencies. The V-22 program office is engaged in structuring an ongoing program to correct the design deficiencies and establish a responsive and effective maintenance support system. The problems that need to be fixed have been identified based on the developmental and operational testing to date and provide a firm basis for corrective actions.

45. Senator LIEBERMAN. "Regrettably, when we pioneer aviation, we seem to go through difficult periods. . . . We did it with the CH-46 helicopter 34 or 35 years ago and actually with the stealth fighter as well," General Jones has said. "If you were to take that program (F-117) out of the protection of its security, and after about two or three crashes the American public had looked at that aircraft, you would have seen the same kind of hue and cry," Jones said. "If you stick with it and it's the right thing to do and the right technology, and you invest correctly and do all the right things, you can do something that will save lives in the long run. . . . That's where I think tiltrotors will take us." he said.

What changes do you propose to improve the safety and testing of the V-22?

General JONES. The V-22 review panel recommended development of a restructured program that uses a phased approach to achieve a return to flight and tactical introduction of the V-22. The Marine Corps concurs with the panel's recommendation and has developed a detailed plan that will expeditiously implement the review panel's recommendation.

The Deputy of the Program Executive Office for Tactical Aviation at the Naval Air Systems Command led the V-22 Acquisition Working Group to develop a restructured MV-22 and CV-22 program that complies with the review panel guidance, acquisition policies, and service needs. The goal of the V-22 Acquisition Working Group is to deliver to the military services a safe, reliable, and operationally effective V-22. The options being developed will consider both the time and the funding required to efficiently achieve operational capability. This entails completion of both planned and additional developmental testing, correction of deficiencies and suitability issues, and verification through follow-on operational testing and evaluation. Restructuring of the program will be necessary to accommodate these actions. Participants in this process include members from the Program Management Activity; the Program Executive Officer for Air, Antisubmarine Warfare, Assault and Special Mission Programs of Naval Aviation; Assistant Secretary of the Navy (Research, Development, and Acquisition); U.S. Special Operations Command; the U.S. Air Force; Headquarters Marine Corps; the Commander, Naval Air Systems Command; and representatives from Bell and Boeing. The group will produce program restructuring options for consideration by acquisition officials and will make recommendations on how to fund the revised program. It will take some time to incorporate critical design improvements, and we will proceed methodically. The current road map to full operations is a five-phased approach with specified entrance and exit criteria for each phase.

Phase 0: Commence technical assessment and complete thorough flight readiness review. We have already begun this phase.

Phase 1: Resume testing with Engineering and Manufacturing Development aircraft (both the MV and CV models) and augment with Low Rate Initial Production aircraft as necessary.

Phase 2: Resume Marine Medium Tiltrotor Training Squadron-204 (VMMT-204) training operations and production acceptance flights.

Phase 3: Stand up a MV-22 operational squadron at New River, North Carolina and a CV-22 training squadron at Kirtland Air Force Base in New Mexico.

Phase 4: Operational deployment/employment of the MV-22 and CV-22.

The immediate steps include: confirming industry's willingness to support the restructured program; ensuring acquisition road map compatibility with technical assessment (development of entrance and exit criteria); finalizing a deficiency matrix (including reliability and maintainability issues); developing timelines for correction; providing cost estimates for correction; developing cost, schedule, and production adjustments; and finally, obtaining consensus among developmental and operational testers.

46. Senator LIEBERMAN. The JAG Manual investigation confirmed that the marines and private defense contractors were aware of serious problems with the hydraulic system more than a year before the December 2000 crash. Can you explain what was being done to correct the problems with the hydraulic system over that year?

General JONES. In April 2000, a service bulletin was issued by Bell-Boeing that identified problems with chafing of hydraulic lines. At that time, VMMT-204 at Marine Corps Air Station, New River, North Carolina, started to inspect those lines. Unfortunately, the affected line involved in the December 11, 2000 mishap was not identified for special inspection in that Airframes Bulletin.

Further analysis of the hydraulic systems is clearly warranted, and currently underway by Naval Air Systems Command (NAVAIR) in coordination with Bell-Boeing and VMMT-204. The government and contractor team is conducting a complete hydraulics audit of the aircraft. Recommended changes to the hydraulic system as a result of this audit are currently being evaluated and are planned for installation later this year. Recent inspections at New River and Amarillo will contribute to other corrective actions.

Further, as a result of developmental testing, a number of hydraulic component improvements have been incorporated into the delivered aircraft. Beyond those changes already made, others planned for incorporation include a new swashplate actuator with an improved seal design to reduce leakage. Production aircraft will incorporate the new swashplate actuator during the fall of 2001.

47. Senator LIEBERMAN. The V-22 program crashes have been compared with the F-117. Can you discuss that comparison, given the differences in the number of aircrew involved?

General JONES. The comparison between the V-22 and the F-117 is made to demonstrate that aircraft with troubled beginnings can mature into highly regarded aircraft. The F-117 had seven mishaps during its test and evaluation period. As a classified program, these mishaps were not made public and therefore did not draw the same media attention as the V-22. Even with this number of mishaps, almost twice as many as the V-22, the F-117 is considered a great aircraft. In fact, some of our most highly regarded aircraft suffered mishap rates much greater than the V-22. The CH-46 suffered 44 non-combat related aircraft losses in the first 5 years of acceptance. The F-8 suffered 288 non-combat losses, the F-4 suffered 112, and the F-14 suffered 27 losses also within the first 5 years of acceptance. All these proven and highly regarded aircraft suffered much higher losses than the V-22 and were considered successful aircraft. Unfortunately, assault support aircraft like the V-22 and transport helicopters have the potential for more personnel loss even with excellent mishap rates.

48. Senator LIEBERMAN. A former V-22 program manager blames some of the Osprey's problems on the fact that once Congress gave Navy officials control of the program's funds, "they shifted money out that could have gone to early development and testing." Do you agree with this?

General JONES. Proper funding is critical to successful program execution. Austere budgets and limited modernization dollars have made successful program execution very challenging in nearly every acquisition program. Spares and support are primary funding concerns in the V-22 program. During the program restructure, it is my intent, to the extent response permit, to ensure that these critical areas are fully funded. I welcome your continued support in this effort.

49. Senator LIEBERMAN. What recommendations do you have regarding program management?

General JONES. A service chief's oversight ability within a program is limited by current acquisition regulations. One of the aspects of acquisition that is difficult is that I am viewed as responsible for execution and program decisions but am legally constrained from all but cursory involvement. Bearing that in mind, one of the things we could do to assist the V-22 program manager would be to properly fund the Engineering Change Order (ECO) line in the budget. As budgets have gotten more austere, this funding has been reduced. Full funding of the ECO line would give the program manager flexibility to meet unforeseen circumstances or to quickly implement engineering change proposals, flexibility he does not currently have.

50. Senator LIEBERMAN. The OSD V-22 review panel presents a program lacking in thorough and meaningful testing and evaluation. They present a long list of problems that must be addressed and fixed before the program can move forward.

What is the cost estimate for making the changes recommended by the panel?

General JONES. The current estimate to incorporate all recommended corrective changes proposed by the V-22 review panel is \$480 million over the next 6 years. The review panel recommends development of a restructured program that uses a phased approach to achieve a return to flight and tactical introduction. Specific recommendations cover: minimal sustainable production rate in the near-term; adequate and stable funding; requirements validation; safety (hardware, software, and operations); reliability and maintainability; quality, training, and technical publications; and, communications across the program (among operators, contractors, engineers, etc.). We have a detailed plan in place that will expeditiously implement the review panel's recommendations. The Deputy of the Program Executive Office for Tactical Aviation at the Naval Air Systems Command (NAVAIR) lead the V-22 Acquisition Working Group to develop a restructured MV-22 and CV-22 program that complies with the review panel guidance, acquisition policies, and service needs. The goal of the V-22 Acquisition Working Group is to deliver to the military services a safe, reliable, and operationally effective V-22. The options being developed will consider both the time and the funding required to efficiently achieve operational capability. This entails completion of both planned and additional developmental testing, correction of deficiencies and suitability issues, and verification through follow-on operational testing and evaluation. Restructuring of the program will be necessary to accommodate these actions. Participants in this process include members from the Program Management Activity; the Program Executive Officer for Air, Antisubmarine Warfare, Assault and Special Mission Programs of Naval Aviation; Assistant Secretary of the Navy (Research, Development, and Acquisition); U.S. Special Operations Command; the U.S. Air Force; Headquarters Marine Corps; the Commander, Naval Air Systems Command; and, representatives from Bell and Boeing. The group will produce program restructuring options for consideration by acquisition officials and will make recommendations on how to fund the revised program. It will take time to incorporate critical design improvements and we will proceed methodically.

51. Senator LIEBERMAN. What is the lead time necessary to implement the changes?

General JONES. Current estimates anticipate 18-24 months to fully implement the changes recommended by the V-22 review panel.

The review panel recommends development of a restructured program that uses a phased approach to achieve a return to flight and tactical introduction. Specific recommendations cover: minimal sustainable production rate in the near-term; adequate and stable funding; requirements validation; safety (hardware, software, and operations); reliability and maintainability; quality, training, and technical publications; and, communications across the program (among operators, contractors, engineers, etc.).

We have a detailed plan in place that will expeditiously implement the review panel's recommendations. The Deputy of the Program Executive Office for Tactical Aviation at the Naval Air Systems Command (NAVAIR) led the V-22 Acquisition Working Group to develop a restructured MV-22 and CV-22 program that complies with the review panel guidance, acquisition policies, and service needs. The goal of the V-22 Acquisition Working Group is to deliver to the military services a safe, reliable, and operationally effective V-22. The options being developed will consider both the time and the funding required to efficiently achieve operational capability. This entails completion of both planned and additional developmental testing, correction of deficiencies and suitability issues, and verification through follow-on operational testing and evaluation. Restructuring of the program will be necessary to ac-

commodate these actions. Participants in this process include members from the Program Management Activity; the Program Executive Officer for Air, Antisubmarine Warfare, Assault and Special Mission Programs of Naval Aviation; Assistant Secretary of the Navy (Research, Development, and Acquisition); U.S. Special Operations Command; the U.S. Air Force; Headquarters Marine Corps; the Commander, Naval Air Systems Command; and, representatives from Bell and Boeing. The group will produce program restructuring options for consideration by acquisition officials and will make recommendations on how to fund the revised program. It will take time to incorporate critical design improvements and we will proceed methodically.

52. Senator LIEBERMAN. Can the marines and the “requirement” await such massive overhauls?

General JONES. Yes, the Marine Corps can manage without the increased capability during the restructuring and fielding of the MV-22. Current estimates anticipate 18–24 months to fully implement the changes recommended by the V-22 review panel. The Marine Corps will continue to monitor the health of the CH-46. Based on current utilization rates, the service life of the CH-46E will not need to be extended to compensate for the delay and restructuring of the MV-22 program. We will continue with the most current improvement, the Engine Reliability and Improvement Program (ERIP), to ensure the reliability and health of the CH-46E engine. Thanks to Congressional support, this program is fully funded, and we were able to start it 1 year early (in this fiscal year). However, ERIP was procured based on a projected retirement schedule of the CH-46E. As the delay of the MV-22 becomes more definitive, we will have to examine how many more ERIP kits the Marine Corps will need to procure to ensure the CH-46 remains operationally effective until replaced by the MV-22.

53. Senator LIEBERMAN. Given the uncertainty about the accuracy of the data in light of the possibility that the records were falsified, do you go back to the beginning of the program OPEVAL to ensure accurate data and to rebuild trust in the aircraft?

General JONES. The accusations of data falsification only pertained to the mission capable readiness rates, not safety of flight aircraft maintenance data at VMMT-204.

54. Senator LIEBERMAN. If so, what is the cost and schedule of such a re-work?

General JONES. We do not intend to go back to the beginning of OPEVAL due to accusations of falsification of readiness data at VMMT-204, as the accusations only question readiness reporting of the aircraft.

55. Senator LIEBERMAN. If not, are you willing to risk further crashes by not ferreting out all the details associated with the problems—known and unknown?

General JONES. Based on the findings of the review panel, JAG investigation, Aircraft Mishap Board, and pending the results of the DODIG, I feel comfortable implementing and executing our plan to restructure and field the MV-22 without jeopardizing the safety of our marines. We remain confident that the additional developmental testing, correction of deficiencies and suitability issues, and verification through follow-on operational testing and evaluation will ferret out all known and unknown problems and allow the aircraft to mature into the national asset it is destined to become.

56. Senator LIEBERMAN. If the details and problems cannot be fixed, what are the alternatives, the cost to execute, and timeline to implement?

General JONES. The Osprey is arguably the most studied weapon system in the history of our American military. Each successive study has validated that the V-22 was the most cost and operationally effective alternative. It is, in fact, the only practical alternative that meets the tri-service requirements of the Marine Corps, Air Force, and Navy. Other options offer no real advantages in cost savings/avoidance, given the requirement. In fact, other options are accurately described as a step back from V-22 capabilities. Cancellation would delay the beginning of replacement of our legacy platforms by at least 5–7 years and would require several billion dollars (at a minimum) of additional developmental funding, regardless of what alternative platform was selected. This would be in addition to the \$12 billion already invested to date in the V-22 program. Increased costs associated with operating legacy aircraft years longer than originally anticipated would also be incurred while pursuing other alternatives. The V-22 remains the most cost and operationally effective medium lift replacement alternative.

QUESTIONS SUBMITTED BY SENATOR JACK REED

57. Senator REED. General Jones, your testimony highlights the need to improve communications between industry and the marines. Would you discuss this issue in more detail?

General JONES. Improved communication is essential to successfully putting the V-22 program back on track and to restoring the confidence of the operating forces. We are continuing to develop a detailed plan and implementation has already begun. Recently, maintenance personnel and pilots from VMMT-204 visited V-22 production facilities in Pennsylvania and Texas. The frank dialogue and exchange of views was beneficial to all concerned. Additionally, the Office of the Assistant Secretary of the Navy for Research, Development, and Acquisition established the V-22 Program Executive Committee (EXCOM) to review the program on a continuing basis with a focus on:

- Government/Contractor approach
- Critical technical, testing, programmatic, and supportability issues
- Areas of technical risk
- Details of the program restructure
- Cost and schedule performance
- Manufacturing quality
- Program communication

We will continue and enhance these efforts in the future. The Marine Corps, Air Force, Navy, and our industry partners are committed to ensuring that all concerned have an ability to articulate their concerns and receive timely feedback.

58. Senator REED. General Jones, what confidence do you have that the MV-22 program can be fixed?

General JONES. First and foremost, the review panel concluded that tiltrotor technology is sound and mature. The review panel also concluded that the aircraft's reliability and maintainability must be improved through additional engineering, testing, and evaluation. We fully concur. The review panel recommends development of a restructured program that uses a phased approach to achieve a return to flight and tactical introduction. Finally, the review panel concluded that the MV-22 provides the Marine Corps with capabilities that cannot be provided by any single helicopter or conventional aircraft. We agree. It will take time to incorporate critical design improvements, and we will proceed methodically. I am confident the current road map to full operations will enable us to safely and successfully address all issues facing the V-22.

59. Senator REED. What number of MV-22s is the optimal number to produce over the next 3 years?

General JONES. The optimal number of MV-22s to produce over the next 3 years is 54 aircraft. The optimal procurement of those aircraft would be 12 in fiscal year 2002, 18 in fiscal year 2003, and 24 in fiscal year 2004.

[Whereupon, at 1:37 p.m., the committee was adjourned.]

