Statement by
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AirLand Forces Subcommittee

Tactical Aviation

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Operational testing within the Department of Defense focuses on the determination of a weapons system's capability in accomplishing a mission. I mention this at the outset because it's easy to get sidetracked by specific performance details without looking at the overall mission accomplishment of a system. The operational testing that is conducted on tactical aircraft, as well as other weapons systems, places those aircraft in combat realistic scenarios to determine how well they carry out their missions. Because mission measures are sometimes difficult to characterize or quantify, we often compare a new system to an existing system as a baseline for comparison. We are doing this for the F/A-18E/F by comparing it to the F/A-18C/D for both air-to-air and air-to-ground missions. Similarly for the F-22 we will compare its air-to-air mission against the F-15C. While specific performance parameters are important and are often used for comparison, they are best viewed in a mission context.

Some of the tactical aircraft currently in development are undergoing early testing as a part of the development process and the operational test community is taking advantage of this to influence or conduct some of the early testing so it is done in realistic operational conditions. This enables more of the early decision making on these aircraft to be supported by assessments of demonstrated performance. We appreciate this Committee's emphasis on demonstrated performance, including demonstrated flight test results as a basis for commitments to acquisition.

The Office of the Director, Operational Test and Evaluation and the Navy and Air Force Operational Test Agencies (OTAs) have been significantly involved in the early testing of the F/A-18E/F, F-22 and V-22. We have found that early operational assessments of the potential effectiveness and suitability of these aircraft have helped identify problems early, focusing management attention on their correction, and achieving a better system at the time of initial operational capability. We recommend that the Joint Strike Fighter (JSF) also involve the Navy and Air Force OTAs to identify issues early and help control costs.

Today I will address what we have learned about the F/A-18E/F, F-22, and V-22 with a focus on recent testing and current performance status. I will also identify our concerns and actions we feel need to be taken with regard to those concerns. Both the F/A-18E/F and the V-22 have undergone substantial testing and early assessments and therefore we have learned more about these aircraft. Accordingly, we have fewer unexplored areas for these two aircraft and fewer uncertainties, and we feel those programs present less risk. I also discuss the status of the F-22 and the JSF. As I discuss each aircraft, please keep this in mind since the more thoroughly tested aircraft will have dealt with a longer list of issues and will have demonstrated overall performance more completely.

F/A-18E/F PROGRAM

The F/A-18E/F program is a large, visible, and mature program. The Navy is being very open with us in addressing issues promptly as they arise. The Program Manager is supporting the findings of the independent Operational Test Agency, and working hard to address issues from the early operational test, called OT-IIB, which was conducted at China Lake, CA, last August. Early operational tests, such as OT-IIB, are designed to demonstrate readiness to proceed into the more formal and extensive Initial Operational Test and Evaluation (IOT&E). This evaluation will begin in May 1999 and will extend over the subsequent six-month time frame. Testing often reveals new problems, but we do not expect a major surprise from the IOT&E, given the extensive testing to date. In this comprehensive test effort, the F/A-18E/F has accumulated about 4,300 hours of developmental and operational flight test to date. This testing identified numerous deficiencies, consistent with the Department's experience with previous aircraft development programs. We applaud the open and balanced approach the Navy has taken in recognizing these deficiencies so that they can be corrected or mitigated by the program.

In order to keep the Secretary of Defense informed, on January 19, 1999, my office provided him an in-depth assessment of operational testing to date and our opinion of aircraft performance prior to the Navy Program Review that supported the most recent funding decision. In addition, since the completion of OT-IIB in 1998, we have provided program updates to the Under Secretary of Defense for Acquisition and Technology concerning the demonstrated performance and progress of aircraft testing.

The Department of Defense embarked upon the F/A-18E/F program primarily to increase the Navy's capability to attack ground targets at longer ranges. In order to attain this objective, the principal improved characteristics sought for the F/A-18E/F were: increased range and payload; increased capability to bring back unused weapons to a carrier; improved survivability; and growth capacity to incorporate future advanced subsystems, particularly avionics. Based upon the testing to date, particularly the recent OT-IIB, I believe that these primary objectives are being met. However, not surprisingly, there are also a number of concerns. I'll address both the strengths and the concerns revealed by testing.

F/A-18 E/F Strengths

Testing to date indicates that the F/A-18E/F is meeting its key objectives of increased range and payload. (In one prescribed configuration and flight profile of 390 nautical miles, the two-seater F-model is short of its established range by 2 nautical miles, a tactically insignificant amount.) The F/A-18E/F will bring to the Battle Group Commander increased tactical capability due to its two additional weapons stations and capacity to provide enroute strike package air-to-air refueling. In meeting challenges from enemy aircraft and surface threats, these additional weapons stations will give the aircraft a much greater measure of self-protection. The test data from OT-IIB also shows that the F/A-18E/F has air combat enhancing features of departure resistance, cockpit field of view, and the capability to rapidly and positively point the nose of the aircraft at will while engaged in close combat.

With regard to the F/A-18E/F's principal objective as a longer-range, attack aircraft, this aircraft has demonstrated superb weapons delivery accuracy, possibly the best in the fleet. Defense suppression and, in particular, night interdiction have also been rated very favorably by the operational test pilots. The aircraft's fuel efficiency and capacity to loiter for extended periods and then execute the Forward Air Control and Close Air Support missions is excellent.

The F/A-18E/F is also well suited for cyclic carrier operations with increased endurance and capability to provide mission or recovery airborne refueling to other aircraft. Also beneficial is the ability to bring back and land heavy ordnance on the ship. This feature, increasingly important as the Navy continues to use increased numbers of relatively expensive precision-guided weapons, provides Air Wings many more options either in training or during real-world operations.

F/A-18E/F Concerns

There are several concerns ranging from important to minor. The most important concerns are buffet and acceleration. These are certainly not all of the issues, but the ones we believe bear closest scrutiny.

Buffet is a holdover issue with a history in the wing drop fix, and two forms of buffet continue to be manifest. The first is experienced in 1g transonic flight and is analogous to driving on a gravel road. The other occurs at a variety of altitudes and configurations and is associated with angle of attack in a turn. The onset of this buffet occurs at lower angles of attack than is desired. While neither of these buffets were assessed by the OT-IIB pilots as interfering with task accomplishment, they are clearly bothersome. Therefore, the Program Manager is continuing a pragmatic test program of various engineering configurations to alleviate buffet, including flight testing of thickened trailing edge flaps and improved flight control software.

A high frequency buffet also was experienced on the F/A-18C/D aircraft and can be a concern relative to wing fatigue life. Knowing this, Boeing strengthened portions of the E/F wing in the original design. In-flight measurements of this higher-frequency spectrum buffet on the E/F have been completed and will be incorporated into the fatigue test program.

Upgrading the F/A-18 to provide the improvements in range, payload, and the capability to bring back unexpended ordnance to the carrier and land, necessarily implies a larger, heavier airframe and stiffer wing. Consequently, it is not surprising that such a design must trade off acceleration. Acceleration of the aircraft is comparable to its predecessor, the C/D, with either the basic F-404 or the F-404 Enhanced Performance Engine in subsonic and negative-g regimes. However, it is slower to accelerate to supersonic speeds in 1g flight, compared to the F/A-18C/D with the enhanced engines. Closely tied to this is the aircraft climb performance. Above 30,000 feet, climb performance is not equivalent to C/D performance. This may require additional use of the afterburner, or development of new tactics. A tiger team is still investigating ways to clean up the aircraft aerodynamically to address these issues, and the tactical implications will be assessed during IOT&E.

Also, several concerns from just a few months ago now have been corrected. For example "wing drop" has been largely eliminated. What remains is what is being termed lateral activity or a "twitch," which occurs briefly in some dynamic flight regimes. It was experienced prior to, and during OT-IIB, and was regarded by operational test pilots as a minor deficiency having no impact on tactical employment. This included air-to-air and air-to-ground tracking maneuvers that demand precise control. While there are some drag and turn rate penalties associated with correcting wing drop, which are continuing to be analyzed, the operational testers stated that these penalties are unlikely to change the operational effectiveness of the aircraft.

The testing and analysis of the survivability of the F/A-18E/F will not be completed until IOT&E. Two key contributing subsystems incorporated into the F/A-18E/F are the ALE-50 towed decoy and ALR-67 (V3) Radar Warning Receiver. Previous testing has shown the ALE-50 to be effective against an important class of threat missiles, and recent testing of the ALR-67 (V3) indicates that it will improve the pilot's situation awareness. However, each of these subsystems also has its own unique issues, so the full assessment of overall F/A-18E/F survivability must await completion of IOT&E where such system capabilities and pilot tactics will be more fully explored.

While the aircraft is experiencing some other technical challenges, I believe these to be normal for this stage of aircraft development and mitigation plans are underway which will be tested. These challenges include:

a. ALE-50 Towed Decoy. Line burn-off and electrical failures have been the issue. An improved line with greater integrity has been demonstrated in technical tests. Also, the full system maneuvering envelope has been achieved at military rated thrust. Work continues to expand the operating envelope, as well as solving remaining technical issues.

b. Pylon Post Loads. The 4 degree outward cant of the pylons, required for weapons separation, results in higher-than-expected air loads on the inboard wing pylons with certain external stores. Options for design modification of pylon post/wing attachment are in development. The plan is to incorporate modifications in LRIP 3 aircraft and retrofit earlier aircraft.

c. Under-Wing Noise and Vibration. Under-wing noise and vibration environment is more severe than for the F/A-18C/D. Although no limits on weapons carriage are foreseen, redesign of some fatigue-life-limited parts on individual stores is in development. A similar redesign was required for the F-15/AMRAAM interface.

d. Engine Issues. Blade Disk (Blisk) cracks and engine stalls were observed during last year’s catapult testing. Hot gas reingestion on the 58-foot catapult positions causes self-clearing pop compressor stalls in full afterburner after 12-15 seconds. The stalls do not occur on the longer catapult positions or in half afterburner setting. The redesign of the number 3 bearing, as well as a redesign of the “w” seal between compressor and hot section components, and refurbishment of the Engineering and Manufacturing Development (EMD) engine compressor blades is expected to correct this problem. As a backup, software changes have been incorporated to limit the engines to half afterburner while stationary on the catapult. During the catapult firing, full afterburner will be automatically selected.

e. F/A-18E/F Electronic Protection Suite. The status of the F/A-18 E/F electronic protection suite warrants concern because technical immaturity has plagued developmental efforts for the Integrated Defensive Electronics Counter Measures (IDECM) system. These issues have delayed IDECM EMD efforts to the point that the F/A-18E/F will not have the IDECM electronic protection suite for operational use for at least the first two deployments. The Navy is currently looking at other electronic protection systems as an interim capability to bridge the gap until IDECM technology matures, but has yet to completely resolve those details. The IDECM suite is one of the cornerstones of the overall F/A-18E/F survivability assessment and, until it is deployed, less capable electronic protection systems will have to suffice.

A lack of high angle of attack agility was observed during the OT-IIB. Based upon recent developmental testing, the program believes that this issue has been largely resolved with new flight control software currently being flown in the aircraft. Of course, this will be another area that will be examined for confirmation during IOT&E. Other items which have been corrected include: weak brakes; Instrument Carrier Landing System display jitter; improvements in BIT false alarm rates; aileron buzz; brake and Auxiliary Power Unit accumulator life; blinking and blanking displays, design and installation of a new hydraulic , and ALE-50 cockpit mechanization.

The F/A-18E/F program and Boeing are working hard on all these issues with the intent of improving performance in as many areas as possible prior to IOT&E next May. Of course, there is not a lot of time and some items may not be resolved until after IOT&E. Such items will be evaluated for their overall mission impact in IOT&E and after correction will be evaluated in subsequent tests.

The F/A-18E/F Live Fire Test program is both thorough and aggressive. It is based on Joint Live Fire Program testing of the F/A-18A/C; ballistic testing of components and major subassemblies, and ballistic tests of the nearly full-up survivability test article. It will be followed by integration of the test results in an F/A-18E/F system-level vulnerability analysis. The Joint Live Fire program resulted in five major vulnerability design changes of the F/A-18E/F: the fuel system, flight controls, engines, inlet ducts, and stabilator designs were improved. This is the first time a drop test and barricade article has been converted to support live fire testing. The test article is sufficiently sophisticated to allow live fire testing that ballistically challenges both the aircraft and a running engine. This is a good example of a prudent use of expensive assets.

As part of the effort to reduce vulnerability of the aircraft upon being hit by enemy fire, fuselage dry bay fire suppression has been improved to the point that Halon is no longer required in this application. Inert gasses generated from devices similar to those that power the airbags in your cars have been substituted as the fire suppressant.

Recent testing has focused on system components and subassemblies. Live Fire testing of the F-414 engine indicated that when a fan blade became separated from a turbine wheel, the blade would penetrate the engine casing and cause damage to other components of the aircraft. The engine casing was redesigned and subsequent tests indicate separated blades will be contained. Fuel ingestion and ballistic tolerance testing have also been conducted on the F-414 with encouraging results in comparison to similar tests of the F-404. Fuel cell qualification testing was conducted on the airframe and indicated that design goals were met. Ballistic testing is ongoing and has included testing of the horizontal stabilator and the wing leading edge dry bay. Various engine vulnerability tests, and various fire suppression tests--some of which will include testing with a running engine--remain to be conducted. The LFT&E program is adequate to resolve all critical operational issues by Milestone III in 2000. We are closely involved in ongoing LFT&E activities, and will provide an independent assessment of the final results at Milestone III.

In less than a month and a half, the F/A-18E/F will begin formal IOT&E. During this evaluation, the aircraft will undergo a rigorous and operationally realistic test regimen to determine both operational effectiveness and suitability. It will also be tested to demonstrate how well it performs as compared to its predecessor and the threat. My office will approve the operational test plan, closely monitor the tests, and conduct an independent assessment, reporting to the Secretary of Defense and Congress on the adequacy of testing and on our judgment of operational effectiveness, suitability and survivability for combat.

In summary, testing to date indicates that the F/A-18E/F program is progressing towards the aircraft the Department has sought: a more survivable aircraft that provides increased capabilities to meet Navy requirements; a credible force multiplier for the battle group with the capability to air-to-air refuel all air wing tactical assets; a platform that possesses excellent capabilities in medium and long-range aerial combat; and an aircraft with substantial built-in growth. Although OT-IIB did identify some areas of concern, it substantially reduced the uncertainties with regard to expected combat performance and, in that sense, contributed to the reduction of risks associated with F/A-18E/F acquisition. I look forward with confidence to continued openness on the part of the Navy as this important program moves into IOT&E, and I will carefully examine and report to you the results from that testing.

F-22 PROGRAM

The F-22 Raptor is an air superiority fighter designed to dominate the air environment in the 21st century. It will use advanced technologies in stealth, supercruise, and integrated avionics to employ air-to-air and air-to-ground weapons. The F-22 is being developed to be ready for operational use in December 2005 to replace the F-15.

The F-22 is an ambitious program. Its design and most of its subsystems are new. There are two engineering and manufacturing development aircraft at Edwards AFB, CA, currently in development flight test. Operational test personnel are involved early in the program through integrated product teams and the combined test force. This process was used to develop the test and evaluation master plan to ensure the operational requirements are addressed early in the program.

In accordance with the test and evaluation master plan, the test program will assess the degree of mission accomplishment and the synergistic effect of the desired F-22 characteristics of stealth, speed, maneuverability, and integrated avionics. The engineering and manufacturing development phase employs operationally realistic ground and flight test scenarios to identify system performance deficiencies early before they become more difficult and costly to resolve. This strategy is built on demonstrations that measure program progress. Six major areas of performance are being investigated: 1) flight envelope, which relates to speed and altitude; 2) maneuver capability, which relates to gravity force and angle of attack; 3) supercruise; 4) low observability, both radar and infrared; 5) weapons, both air-to air and air-to-ground; and 6) avionics, including navigation.

The flight test program is designed to expand the flight envelope incrementally through critical flight test data points, examining both flying qualities and propulsion test results. So far, the F-22 flight test program is progressing well and about as we had predicted. The F-22 Combined Test Force at Edwards AFB, CA, has flown 96 sorties and accumulated 203.8 flight hours to date. On November 23, 1998, the F-22 completed the congressionally mandated first 183 hours of flight testing. During this period, 62 percent more test points than planned were accomplished giving increased confidence in the results to date in various flight regimes. The flight testing to date has emphasized evaluation of airframe/engine integration and performance, and aircraft handling qualities. This testing expanded the allowable flight envelope as planned. The F-22 demonstrated performance to date is flight to a maximum altitude of 50,000 feet, and a maximum speed of 1.4 times the speed of sound, maneuverability at angles of attack from a minus 10 degrees to a plus 26 degrees, gravity forces from a minus 1 to a plus 6, aerial refueling, and weapons bay door operations.

Early flight testing revealed airframe structural and engine mount stresses that required redesign. The two flight test aircraft are in lay-up at Edwards AFB, CA, to incorporate structural modifications to provide the capability to continue the next phase of envelope expansion. Modifications of this sort are normal for this stage of aircraft development and include:

- Modifying the vertical fins to correct a localized strength deficiency
- Replacing the horizontal stabilators to correct composite material delamination
- Installing stronger engine mount torsion links to handle extreme operating conditions during envelope expansion
- Repairing some delaminations of mid-fuselage longerons (longitudinal fuselage frames) that were discovered during lay-up

Additional modifications resulting from flight testing include:

- Redesigned fuel system components to correct reliability problems
- Installing modified brakes and brake control software to correct persistent problems during early flight tests
- Software changes to correct gravel road buffeting
- Correction of canopy fogging and environmental control system problems

The modifications are almost complete, and the effort is now shifting to ground vibration testing to verify that the structural improvements are adequate, and weapon bay door strength measurements on the first test aircraft. It should be noted that only about five percent of the planned flight test program has been completed and only about 10 percent of the envelope expansion testing. The remaining work on the second test aircraft involves installation of instrumentation to measure possible problems with the distribution of the inlet air reaching the engine, and an emergency spin chute to allow expansion of the high angle-of-attack envelope. Flight testing is planned to resume on one aircraft later this month and the other in May of this year. The third flight test aircraft delivery to Edwards AFB, CA, will not occur until January 2000 or later. This aircraft will assist with the envelope expansion efforts.

The F-119 engines powering the F-22 have performed exceptionally well in ground test cells and in early flight test operations. However, a low pressure turbine blade failed in the first production-configured flight test engine after only 10 hours of ground testing. This failure has forced a redesign that will delay delivery of production representative test engines until January 2000. However, flight testing can continue without interruption using existing flight test engines containing an earlier turbine blade design.

Delivery of the first four avionics test aircraft has slipped due to titanium casting problems with the wing attachment fittings and welding problems in the aft fuselage. The fourth flight test aircraft, which will be the first test aircraft equipped with the initial mission avionics suite, will not enter the test force until at least February 2000. The schedule slip is 5.5 months for the first mission avionics test aircraft and lesser slips for the next three aircraft. These delivery slips will compress the flight schedule for mission avionics development if the Milestone III decision date (August 2003) at the end of EMD does not change. The largest development risk is in the integrated avionics area that will be tested from 2000 through 2002.

The F-22 program’s Flying Test Bed (FTB) has provided valuable early radar test data in an airborne operating environment. The modified Boeing 757 FTB completed 18 test flights (94.4 flight hours) from November 1997 through August 1998 with a prototype radar installed in an F-22 integrated forebody spliced to the FTB’s nose. The FTB resumed testing on February 15 with a simulated F-22 fighter wing (containing many of the antennas that will be installed in the wing) installed above the 757 cockpit and with the associated avionics hardware and software installed in the cabin. This modification will allow the FTB to test some of the F-22’s integrated avionics controlled from a simulated F-22 cockpit in the FTB. This should provide early results on the F-22 Block 2 avionics/radar integration in an airborne test environment prior to flight testing in the fourth through ninth F-22 flight test aircraft. Block 1.0 software, containing the first mission avionics functions is undergoing ground testing and is scheduled for delivery to the FTB and flight test checkout this month. The next operational flight program software intended for flight test, Block2/3S, is scheduled to be completed in July of this year.

Avionics ground test and simulation activities are also key contributors to reducing development risk and providing capable integrated avionics. The Joint Cost Estimating Team (JET), which reviewed the F-22 EMD program in 1996, made a number of recommendations to reduce testing by enhancing simulations. One of the major changes to the JET recommendations this year was the merger of the Integrated Hardware-in-the-Loop Avionics Test (IHAT) facility to be constructed in Marietta, GA, with the Electronic Combat Integrated Test (ECIT) at Edwards AFB, CA. Although this compromises the original intent of the IHAT, separate IHAT and ECIT test facilities were not affordable within the F-22 EMD budget. The capability of another critical system test facility, the Air Combat Simulator (ACS), was also reduced by 1998 budget cuts. This reduction essentially forced a change to hosting the aircraft operational flight program on a commercial computer instead of on the same central integrated processor (CIP) computer that will be installed in the F-22. However, in addition to reducing ACS development and operating costs, this change will permit earlier ACS use in avionics software testing. Hopefully, the earlier ACS contribution to this important risk reduction task will offset the disadvantage of not testing the aircraft computer hardware in the ACS loop. However, we are still concerned that potential further reductions in the quality of simulators will significantly degrade testing adequacy, and ultimately may require additional testing.

A key development effort that had fallen behind schedule is the logistics test effort. This test effort is especially important because of the many materials and processes that need to be developed to improve maintainability of the F-22’s low observable (LO) airframe, based on F-117 and B-2 operational support problems. The logistics testing tasks were delayed by the maximum flying effort to achieve the 183-hour requirement last year. A recovery of the logistics testing schedule has occurred during the ongoing lay-up period, but most of the LO maintainability demonstration tasks are still to be accomplished. A contractor team will brief the DOT&E staff next week on the LO maintainability processes development status.

The GAO report "F-22 Aircraft Issues in Achieving Engineering and Manufacturing Development Goals" expressed a primary concern with the ability of the F-22 program to be completed within the EMD cost limitation established by the National Defense Authorization Act for Fiscal Year 1998. This is also a concern to DOT&E. Since the only major source of unspent or uncommitted EMD funds is the testing budget, much of the flight test planning effort involves reducing test costs. After several replanning cycles, test program deletions generally are not improving efficiency but, rather, are causing test reductions that lead directly to increased development risks. Although some changes do result in improved test efficiency, such as an improved climatic test program, the general trend is to reduce the highest-risk avionics development testing well below the Joint Cost Estimating Team recommendations. Of particular concern is a potential reduction of mission avionics flight testing. It should be noted that the December 1999 production commitment for six aircraft will be made without any mission avionics testing in flight test aircraft.

In August 1997, I approved the alternative live fire test and evaluation plan contained in the approved test and evaluation master plan. The National Defense Authorization Act of 1997 waived full-up, system-level live fire testing of the F-22 aircraft. The associated alternative plan includes hydrodynamic ram, dry bay fire and critical component tests as well as demonstration of active fire suppression systems. Cluttered, unprotected dry bay fire and component blast/fragment vulnerability tests were conducted in 1997. Test results showed that some of these bays are more susceptible to ballistically induced fire than desirable. One bay, in particular, is the bay that resides between the engines. There is currently no redesign planned to protect this bay. Another area of concern is the fire suppression system in the main landing gear bay. This area was tested and the design would not be adequate to extinguish fires. The Air Force program has decided to eliminate the initially planned suppression system from the production design; this significantly reduces the F-22 survivability.

One result from the live fire testing program which significantly increased survivability was the substantial redesign of the wing in 1993-94. The original wing design for the F-22 contained 17 all-composite sine wave spars in the substructure. Small-scale live fire testing showed that the all-composite substructure could not withstand the hydrodynamic ram pressure due to threat impact into the wing. The wing was redesigned such that portions of six of the sine wave composite spars were replaced with titanium spars. Small-scale live fire testing indicated that the redesigned wing would withstand the expected hydrodynamic ram pressure. Full-scale testing of the wing is planned for 2001. A flight test aircraft will be flown to the Naval Air Warfare Center, China Lake, CA, to undergo a full-scale live fire hydrodynamic ram test. If successfully demonstrated, the wing redesign will have significantly decreased F-22 vulnerability, by possibly as much as 50 percent.

V-22 PROGRAM

The V-22 weapon system is a multi-service, multi-mission vertical/short takeoff and landing aircraft being developed for operational use for the year 2000 and beyond. The V-22 is required to conduct worldwide operations during contingencies and conventional, unconventional, and tactical nuclear, biological, or chemical (NBC) warfare. There are two variants of the V-22: the MV-22 is the USMC version, and the CV-22 is the USAF version. The primary mission of the MV-22 is amphibious assault. The primary mission of the CV-22 is long-range infiltration, exfiltration, and resupply of Special Operations Forces (SOF). Secondary missions are land assault, medevac, fleet logistics support, and special warfare. The MV-22 will replace the CH-46E and CH-53A/D in the USMC. The CV-22 will replace the MH-53J, MH-60G, and supplement the MC-130 in the USAF.

Three early operational assessments have been conducted since 1994. OT-IIA, a combined developmental/operational test (DT/OT), was conducted from May to July 1994 to support the Milestone II+ and the EMD critical design review. OT-IIB, also a combined DT/OT, was conducted from June to October 1995 to continue the assessment of the V-22's potential operational effectiveness and suitability and to support an advanced acquisition contract for Low Rate Initial Production Lot 1 (LRIP-1). OT-IIC, a combined DT/OT, was conducted from October 1996 to May 1997 to assess the potential operational effectiveness and suitability of the EMD design and to support LRIP-1 and AAC for LRIP-2 decisions. A major concern from these early tests was the strength of the proprotor downwash and its impact on fast-rope exits from the aircraft and operations on the ground beneath a hovering V-22. This issue was extensively examined to find work-arounds that would safely permit these operations.

As a result of OT-IID, conducted during September and October 1998, we now have considerably greater understanding of the V-22's inherent capabilities and limitations in its intended operating environment. Because the three previous Early Operational Assessments involved only limited flights of the prototype aircraft from the Full-Scale Development program of the early 1990s, the most recent test took advantage of an expanded flight envelope with the current EMD program aircraft to assess the operational effectiveness of the V-22 in a variety of mission tasks. OT-IID consisted of 63 flights lasting a total of 143 hours, operating from Patuxent River, MD; Eglin AFB, FL; and New River MCAS, NC. The test results mitigated some earlier concerns, demonstrated some remarkable performance capabilities, and raised some new concerns regarding reliability which must be addressed in the formal IOT&E later this year.

The V-22's combined speed, payload, and range far exceed the capabilities of current medium-lift helicopters. These parameters are a strong factor in the advantage the V-22 has shown over competing helicopters in numerous comparative analyses performed over the last decade, and the test results indicate that the MV-22 will support the Navy/Marine Corps concept of amphibious operations from over the horizon. During the recent testing, operational pilots were able to begin to combine the performance capabilities inherent in the V-22 with realistic new tactics. Some of the results indicate that the V-22 will provide impressive new capabilities. For example, the speed with which the V-22 can lift off from a landing site and accelerate away from the threat area far exceed the comparable capabilities of existing medium-lift rotary-wing aircraft. The V-22 also performed very well in rugged terrain takeoffs and landings, and predictions for self-deployment range and speed exceeded operational requirements.

Relative to Vietnam-era helicopters it replaces, the V-22 exhibits far greater survivability when hit by hostile small-arms and anti-aircraft fire; estimates range as high as a factor of 10 reduction in the probability of kill given a hit. This results not only from a reduction in vulnerable area, but from considerable survivability engineering features designed into the aircraft from the outset of development. One area of concern remains from recent live fire testing--the sponson fuel tank, when subjected to direct hits from medium-caliber fire, exhibits vulnerability to hydraulic ram damage, potentially exposing troops in the cabin to fire/explosion hazards and requiring extensive battle damage repair. A more robust fuel bladder that reduces the fire/explosion hazards has been successfully tested, but because of weight concerns, the decision to install these bladders is still pending. Engineering study continues on this problem.

Because the V-22 is still in development, numerous limitations to the realism of the test were imposed for reasons of safety or logistics. The more significant of these limitations included:

- Mixed contractor/military maintenance workforce, which restricted our ability to draw conclusions about reliability and maintainability. This will be corrected in IOT&E this autumn.
- Production-representative diagnostic hardware and software were not installed, limiting the ability to assess maintainability. This will be corrected during IOT&E.
- Production-representative internal cargo-handling and auxiliary fuel systems were not installed, limiting the ability to perform self-deployment and rapid on-load/off-load of palletized cargo.

- The attachment devices for alternate insertion/extraction devices were not the ones planned for the production aircraft, thereby limiting the evaluation of such tasks as fast-rope, rope ladder, and rappelling from the V-22.

Some concerns from earlier operational assessments remain. The damaging effects of the strong proprotor downwash in certain areas beneath the hovering V-22 have been cited since the OT-IIA in 1994 as a potential problem for embarking and debarking troops by means of rope ladder, fast-rope, or rappelling, external load pickup, landing in confined spaces and on rooftops, and performing rescue hoist operations. Although some of these operations were successfully completed during OT-IID, the full range of performance remains to be demonstrated.

The lack of a defensive gun system for the V-22 may necessitate keeping the V-22 out of defended hostile landing zones until any threat forces there are neutralized. This would place additional sortie requirements on operational forces to provide armed escort aircraft. The program is currently conducting trade studies of various options for a defensive weapon, but early incorporation is not planned.

The defensive countermeasures suite lacks the capability to manually deploy chaff and flares from the aft cabin crew stations. From their rear-hemisphere lookout, the crewmembers in the back would be likely to spot a SAM or AAA fire, but unable to counter such fire.

Although the reliability, availability, and maintainability data generated during OT-IID were more extensive than in previous tests, it was not possible to draw final conclusions regarding those suitability parameters. But while the statistical uncertainty in the data is very large, the data do suggest that several aspects of reliability and maintainability are problematic and deserve close attention in the IOT&E testing later this year. It is likely that the V-22 will not meet its reliability and maintainability requirements until nearly two years after IOT&E. That will decrease the flying rate and increase the logistics burden on the first training and operational V-22 squadrons.

The aircraft provides no protection for the engines and environmental control system from the effects of sand, dust, and salt-laden air. Following operations involving low-altitude hover over salt water, the V-22 required a fresh-water washdown of both engines to remove salt deposits immediately after every flight. This was a time-consuming and labor-intensive operation, involving ladders or work stands and a fresh-water hose; the program plans to incorporate a single-point fresh-water fitting under the wing in future production lots.

During at-sea developmental testing of the V-22's compatibility with helicopter carriers in January of this year, the V-22 successfully completed over 325 landings on USS Saipan under a variety of wind-over-deck and deck motion conditions. During one such landing attempted under relatively benign conditions, the pilot initiated a waveoff after encountering what he thought might be a control problem. In the interest of safety, the carrier testing was concluded early while an engineering investigation was conducted. After examination of the flight test data, the program concluded that a minor change to the automatic flight control system software was in order, and that effort is underway now. After land-based verification of the fix, shipboard testing will resume later this summer when a ship is available. Complete interoperability with a variety of ships is planned for IOT&E later this year.

In summary, I believe that the V-22 test program is progressing satisfactorily, although about two months behind schedule. OT-IID, just completed, afforded us considerable insight into the capabilities of this unique aircraft, and uncovered no apparent showstoppers. Continued management attention is needed to improve the reliability and maintainability of the aircraft as early as possible to minimize impact on the first training and operational squadrons. A considerable challenge for the program remains the successful integration of avionics systems and other equipment unique to the CV-22 version for the Special Operations Forces.

My office will closely monitor the final planning for and conduct of IOT&E. We expect that IOT&E will provide opportunity for the operational testers to fully examine the effectiveness and suitability of the V-22, including numerous subsystems, equipment, and operational environments which have not yet been fully tested. I will forward my assessment to Congress as to the adequacy of testing and the meaning of the results following completion of IOT&E.

JSF PROGRAM

The Joint Strike Fighter Program is intended to develop and deploy a family of strike aircraft addressing the needs of the Air Force, Navy, Marine Corps, and Royal Navy. This family of strike aircraft will consist of three variants: Conventional Takeoff and Landing (CTOL), Aircraft Carrier Suitable (CV), and Short Takeoff and Vertical Landing (STOVL). The focus of the program is affordability; reducing the development, production, and ownership costs of the JSF family of aircraft. The JSF will be a single-seat, single-engine aircraft capable of performing and surviving lethal strike warfare missions using an affordable blend of key technologies developed by other aircraft programs. CV and STOVL variants require an option for a two-seat version.

The Joint Strike Fighter program was placed under oversight for OT&E and LFT&E in June 1995 as the Joint Advanced Strike Technology (JAST) program. Representatives from DOT&E and from the Navy and Air Force Operational Test Agencies participated in several of the Integrated Program Teams (IPT) established by the JSF program.

In support of its commitment to an affordable, highly-common family of next-generation multi-role strike fighter aircraft, the JSF program has adopted an iterative approach toward development of fully validated, affordable operational requirements. This approach emphasizes the early and extensive use of cost-performance trades. To assess military utility in support of these trades, the JSF program is continuing development of its Virtual Strike Warfare Environment (VSWE), a Modeling and Simulation (M&S) environment to ensure consistent models and databases.

Representatives of the Service OTAs, AFOTEC and COMPOTEVFOR, are actively participating as “players” in several simulations that the Program Manager has established to provide insights to determine the final operational requirements. This active participation by the OTAs at the early requirements-formulation stage is both unusual and commendable. As a result, we are hopeful that the operational testers will have a good understanding of the trades and reasoning underlying the final requirements. Not only does this open process for requirements development and the availability of the VSWE improve the linkage between the test and requirements processes, the models used in conjunction with the VSWE may prove useful in the test and evaluation process, although experience has shown that even the best available models do not always predict realistic combat performance.

A multi-year $2.2 billion JSF Program Definition and Risk Reduction effort commenced in November 1996 with competitive contract awards to Boeing and Lockheed Martin for the Program Definition and risk Reduction Program. These competing contractors will build and fly concept demonstrator aircraft, conduct concept unique ground demonstrations, and continue refinement of their ultimate delivered weapon system concepts.

During the ongoing JSF Program Definition and Risk Reduction phase, each team will build, qualify, and fly two Concept Demonstrator Aircraft, designated the X-32 and X-35. Rather than being prototypes with full-up systems, these demonstrators incorporate the engine and outer mold lines of the contractor’s preferred JSF design, but they will largely use off-the-shelf systems and avionics. These demonstrators are intended to demonstrate the viability of each contractor's design concept, including the capability to accomplish short takeoff, hover and transition to flight, up-and-away performance, and low-speed handling consistent with landing aboard a carrier. During this phase, each contractor is responsible for planning and executing the ground and flight tests and demonstrations. Flight testing of these demonstrator aircraft is planned during FY 2000. Government personnel will actively participate in test planning and execution at the discretion of the respective competing contractors. The principal purpose of this demonstration program is to assist the contractors in design and risk reduction for their Preferred Weapon System Concepts that they will propose for Engineering and Manufacturing Development.

The Program Definition and Risk Reduction phase will allow early test insights into the viability of the basic aircraft designs. More challenging to assess during this phase will be the contractors' progress in developing the integrated avionics suite that will be essential to the final JSF design, as well as validating the needed improvements in operational supportability and the cost of ownership. Improved insights into integrated avionics risks may be available prior to the planned JSF Milestone II decision (FY01) from the ongoing F-22 program, which is leading the way in facing such challenges. Since both of the competing JSF contractors are key members of the F-22 team, the lessons learned from that program should reduce the risks in similar areas of the JSF.

As a result of acquisition reform initiatives such as performance-based specifications, normal live fire test activities have not been required of the two competing contractor teams during the Program Definition and Risk Reduction Phase. The option of whether or not to conduct vulnerability reduction design refinement, risk reduction and live fire testing has been left to the competitors to choose in attempting to meet performance-based specifications. The test and evaluation master plan states that the program intends to balance vulnerability and susceptibility, but the program has yet to identify what values of vulnerability they are using to balance against susceptibility. The program has clearly defined susceptibility (i.e., RCS/IR levels), but they have yet to identify the desired vulnerability levels.

None of the major components of the F-119 engine were live fire tested under the F-22 program. Lessons learned from the F-18E/F LFT&E tests (F-414 engine) show that engine vulnerabilities uncovered early may be reduced by redesign of either the engine components, the engine bay, and/or the surrounding aircraft. From information available to us, it appears that major design trades are now being investigated without explicit vulnerability considerations. In this regard, the F-119 engine should undergo live fire testing now.

The Service OTAs plan to conduct an Early Operational Assessment during the JSF Program Definition and Risk Reduction Phase to support the FY01 Milestone II decision.   In structuring the participation of the OTAs in this phase the OTAs will carry out thorough assessments while preserving the legitimate proprietary information in this competitive environment. I plan to personally meet with the JSF Program Director within the upcoming weeks to work out the details of this early involvement of the operational testers in this important program.

As I look further down the road, the planning for EMD provides ample opportunities for the conduct of operational assessments leading up to Dedicated OT&E/OPEVAL. As the program matures, we will work with the program to define specific accomplishments or characteristics that each of these operational test periods must confirm, consistent with the event-driven acquisition strategy required by DoD Regulations and adopted by JSF. The initial planning for Dedicated IOT&E included 12 production test articles. While this quantity of aircraft appears adequate for the conduct of a thorough operational test, it is none too many since three different aircraft configurations must be tested in the accomplishment of a variety of missions. In addition, revised planning as a result of the Quadrennial Defense Review has staggered the delivery of the three versions of JSF, so that the first proposed Low-Rate Initial Production lot consists of only four aircraft, all in the Conventional Takeoff and Landing configuration. With deliveries of the three variants staggered over multiple years, it will be difficult to structure a test program that capitalizes on the similarities of the three variants and supports a full-rate production decision for all three variants at a single Milestone III event.

At this relatively early stage of the JSF program, the integration of program planning and test and evaluation planning appears to be on a sound foundation. A program as complex as the JSF (multiple aircraft configurations for multiple users) especially needs to employ fully the Integrated Program and Process Development concept to develop operational requirements and formulate integrated test and evaluation strategies. Operational Test Agencies must participate fully and continuously in relevant program activities. Despite the near-term concerns of the competitive environment, I am confident that we will establish a thorough program of operational assessments during Program Definition and Risk Reduction to support progress of the JSF program and--later, during EMD--with thorough operational testing of the JSF.