

## F/A-22 Raptor

The Air Force is developing the F/A-22 Raptor as its next-generation air dominance fighter. It is intended to replace the current fleet of F-15C Eagle fighters and will also have an air-to-surface attack capability. Planned Raptor missions include air superiority (both counter-air and destruction of enemy air defenses), strategic target attack, and close air support in high threat environments. Key features of the F/A-22 include low radar observability (with internal weapons carriage) and supersonic cruise capability in non-afterburning power, combined with superior maneuverability and excellent handling qualities. Other features critical to the F/A-22 are an integrated avionics suite incorporating offensive and defensive sensors; an electronically scanned, active element radar array; and an advanced electronic warfare system with a variety of identification and countermeasures capabilities. Enhanced logistics features include an integrated maintenance information system and advanced Diagnostics and Health Management (DHM) to achieve reduced maintenance manpower and improved deployability. Armament consists of six AIM-120C radar-guided air-to-air missiles, two AIM-9 infrared guided missiles, and a 20 mm M-61 cannon. Alternatively, two 1,000 pound Joint Direct Attack Munitions (JDAMs) are intended to be carried internally along with two AIM-120s and two AIM-9s.

### TEST & EVALUATION ACTIVITY

Performance of the F119 engine has generally been excellent. Full-scale airframe static testing and the first of three (originally four) planned fatigue lifetimes of testing have been completed and the second fatigue life testing is nearly complete. The program now plans to complete three fatigue lifetimes prior to the completion of the ongoing engineering and manufacturing development phase in November 2005. Expansion of flight test into the high-speed, high-G load regions of the performance envelope is ongoing. Radar testing continues in conjunction with the communications, navigation, and identification and electronic warfare subsystems that provide the other components of integrated closed-loop tracking. However, software instabilities and problems with the communications, navigation, and identification and electronic warfare subsystems have seriously hampered progress of the avionics flight test program. Resolution of these avionics instabilities and performance problems are essential to continued progress and this issue has received significant attention. An independent OSD avionics working group, which includes national-level software experts and DOT&E participation, is working with the contractor and the Air Force to help address efforts to correct software deficiencies.

Safe separation unguided missile launches have been conducted at high angles of attack, under supersonic conditions, and at high roll rates. Guided missile launches, essential to validate the F/A-22's combat capability, are continuing in accordance with DOT&E-approved operational scenarios. Stealth testing has included measurements of radar and infrared signatures, evaluations of signature stability over time, and low observable maintenance testing. Measured radar signatures have been consistent between test aircraft and are generally meeting system specifications. The Air Force plans to validate the processes and procedures for the maintenance and restoration of RCS that are in development.

Wing leading edge dry bay LFT&E ballistic testing was conducted during October 2002. The test article was an actual F/A-22 aircraft with vertical tails, engines, and electronic components removed.

Due to continuing technical and schedule risk, OSD maintained an extremely high level of scrutiny on the program including convening



*AFOTEC plans employ the F/A-22 in air-to-air roles in several realistic Offensive Counter Air and Defensive Counter Air scenarios.*

# AIR FORCE PROGRAMS

Quarterly Defense Acquisition Board (DAB) reviews chaired by the Defense Acquisition Executive (DAE). DOT&E participates in regular Air Force Readiness to Test meetings in order to track progress and understand issues. At the July 2003 DAB, the DAE directed that a preliminary phase of operational testing and evaluation (OT&E Phase I) be conducted to establish a performance baseline prior to the start of IOT&E. If demonstrated performance during OT&E Phase I is successful and the F/A-22 weapons system, as tested, does not require substantial modification prior to the start of IOT&E, the results from OT&E Phase I could be used to reduce the scope of the subsequent IOT&E. The intent is for the Air Force Operational Test and Evaluation Center (AFOTEC) to determine what works, what does not, and what needs to be fixed before entering IOT&E. DOT&E approved the Air Force test plan for OT&E Phase I and IOT&E, including a comparison test using the F-15C, on September 10, 2003. AFOTEC will conduct OT&E Phase I and the IOT&E, which are both mission-oriented operational tests. AFOTEC plans employ the F/A-22 in air-to-air roles in several realistic Offensive Counter Air and Defensive Counter Air scenarios.

## TEST & EVALUATION ASSESSMENT

DOT&E has focused attention on determining whether or not the Air Force is providing a production representative weapons system for the upcoming operational testing. To this end, the program continues to identify modifications to be implemented on production representative test aircraft. Differences between the aircraft planned for operational testing and production aircraft exist, particularly in the avionics hardware, aircraft canopies, and maintenance information systems. DOT&E continues to review and assess the impact of differences on performance with the Air Force to ensure an adequate evaluation.

Only one flight test aircraft incorporates the structural modifications and special instrumentation needed to enable the flight envelope to be fully cleared to its airspeed, altitude, and G-load design limits. This situation poses a schedule risk in clearing the required flight envelope prior to IOT&E. Additionally, all operational test aircraft currently have multiple operating limitations, including the aircraft intended to be production representative and available for operational testing. Successful conduct of IOT&E requires an adequate flight envelope and unmonitored flight clearance (without control room support to monitor loads/stresses during maneuvers typical of visual "close-in" air combat).

Avionics software instabilities have resulted in an inefficient avionics test program, delays in integrating required functionality, and delays in fixing system deficiencies. Resolving avionics system instabilities and functionality issues has required dedication of an F/A-22 test aircraft to stability testing, development of numerous software fixes, and extensive regression testing. Additional software problems were sometimes created during incorporation of planned functionality and the software stability resolution process, further complicating efforts to achieve the planned software integration schedule. Additional time may be required to incorporate and validate all necessary stability and functionality-related avionics modifications prior to an event-driven start of IOT&E. While significant progress has been made by the program in reducing the root causes of software instabilities, several remain as well as numerous deficiencies in functionality that will potentially affect mission performance.

Maintainability and sortie generation require adequate integrated diagnostics. This capability will not be available until after planned software is implemented that allows maintenance personnel to operate the interface between planned support equipment and aircraft systems. Integrated diagnostics is required for an adequate IOT&E suitability evaluation. Maintaining the operational test aircraft during the IOT&E will require some contractor-operated special test equipment; consequently, the user has modified the maintenance concept for units that will operate initial production lots. In addition to sufficiently mature DHM, flight-line maintenance lacks the functionality in the integrated maintenance information system necessary to troubleshoot and track aircraft maintenance as well as adequate, useable technical order data for performing the required routine maintenance tasks. Recently, the Air Force determined that an F/A-22 unit will not need to deploy with as many personnel or materiel to repair low observable defects as was originally envisioned. However, maintaining the aircraft's low observable features depends on validation of maintenance procedures, signature assessment system software and databases through adequate flight test.

The maintainability dilemma is exacerbated by lower than predicted reliability in aircraft systems and the cockpit canopy has fallen far short of its service life requirement, resulting in the need to procure additional spare canopies to support

# AIR FORCE PROGRAMS

the IOT&E. Low aircraft systems reliability, in concert with the other suitability factors mentioned here, has resulted in very low sortie generation rates despite a significant amount of maintenance performed on aircraft used for operational test pilot and maintainer training. This has caused the operational test unit to re-plan the training program required prior to IOT&E. The suitability deficiencies must be corrected and adequate spare parts provided to be able to fully train the operational test force and subsequently succeed in IOT&E.

End-to-end weapons integration missile shots have had mixed results. Four shots have demonstrated the capability to engage and destroy enemy aircraft in specific, discreet combat representative scenarios. However, three other shots indicated fire control deficiencies exist that need to be resolved in development. Some F/A-22 weapons separation, fully integrated guided missile test launches, and JDAM testing are planned to be done concurrently with IOT&E. JDAM employment is planned for follow-on test and evaluation, to be conducted after IOT&E. DOT&E believes that a large F/A-22 development risk, from both a technical and schedule perspective, lies in the integration of the avionics suite with realistic air-to-air and, eventually, air-to-surface weapons employment.

The F/A-22 Air Combat Simulator (ACS), an integral part of the planned IOT&E, is intended to model the dense surface-to-air and air-to-air threat and electronic signal environment that is impractical or too costly to generate in open-air trails. Development of the ACS (consisting of four actual F/A-22 cockpits installed in visual scene domes and ten other manned interactive cockpit stations) continues, but delays in integrated avionics flight test and threat model-related development have affected ACS verification, validation, and accreditation activities. The contractor has taken steps to improve ACS realism and has a plan to provide a dense track environment in which to model F/A-22 performance. There is a risk that ACS cannot be accredited and contingency plans for additional open air testing are called for in the IOT&E test plan.

The ballistic vulnerability LFT&E program surfaced several vulnerabilities that the Program Office is working to resolve.

Significant F/A-22 operational capability is being deferred until after the start of IOT&E. Deferred testing includes the ferry configuration, external stores and JDAM carriage and release, full missile and gun employment envelope, and numerous system specification compliance test points. Deferred mission avionics capabilities include JDAM employment, AIM-9X integration, helmet mounted cueing system integration, Joint Tactical Information Data System transmit capability, and transition to the planned production version of the F/A-22 Common Integrated Processor, with attendant changes to avionics core processing. An updated Test and Evaluation Master Plan is required for DOT&E approval that details the test strategy for an adequate follow-on test and evaluation for the deferred capability, as well as deficiencies identified in IOT&E.

DOT&E assesses technical and schedule risk in providing an effective and suitable production representative weapons system for a successful IOT&E by the planned March 2004 start date as high. In particular, a sufficient amount of time must be allowed to incorporate fixes to test aircraft prior to the start of IOT&E, based on the assessment of performance in the preceding OT&E Phase I.

