

F-35 Lightning II Joint Strike Fighter (JSF)

Executive Summary

- The F-35 Lightning II program continues to make progress on the first System Design and Development aircraft. First flight is expected to occur in mid-December 2006.
- Work on a Test and Evaluation Master Plan revision continues. The revised document needs to incorporate more detail on test content and adequate resources for operational test and evaluation.
- The Air Force and Navy FY08 Program Objective Memoranda do not support an adequate full-scale aerial target replacement necessary for F-35 weapons integration testing. The operational test planning for the F-35 is not adequate without a credible full-scale aerial target.
- The Air Force and Navy operational test agencies completed an operational assessment of F-35 development in late 2005. Issues raised in the assessment are under review by the program office and require follow-up.
- Live Fire ballistic vulnerability testing:
 - Evaluated candidate dry bay fire extinguisher designs
 - Determined the extent of fire migration from the roll duct to the engine

System

- The F-35 Lightning II program is a joint, multi-national, single-seat, single-engine family of strike aircraft consisting of three variants:
 - F-35A Conventional takeoff and landing (CTOL)
 - F-35B Short takeoff and vertical landing (STOVL)
 - F-35C Aircraft carrier takeoff and landing (CV)
- It is designed to survive in an advanced threat (year 2010 and beyond) environment using a blend of advanced technologies with improved lethality compared to legacy multi-role aircraft.
- Using an Active Electronically Scanned Array radar and other sensors, the F-35 is intended to employ precision-guided



bombs such as the Joint Direct Attack Munition and Joint Standoff Weapon, AIM-120C radar air-to-air missiles, and AIM-9 infrared air-to-air missiles.

- The F-35 is under development by a partnership of countries: the United States, Great Britain, Italy, the Netherlands, Turkey, Canada, Australia, Denmark, and Norway.

Mission

- A force equipped with F-35 units should permit the combatant commander to attack targets day or night, in all weather, in highly-defended threat areas at the strategic, operational, and tactical levels of warfare.
- Targets include: fixed and mobile land targets, enemy surface units at sea, and air threats, including cruise missiles.

Activity

- The program began using the F-35 ground lab system, which contains actual aircraft systems. The lab connects missions systems with air vehicle systems to operate as an aircraft allowing test and trouble shooting on the ground.
- Using the initial software as checked out in the ground lab system, the first System Design and Development aircraft completed engine operations from idle power to full afterburner and pre-mission power-on checks. First flight is expected to occur in mid-December 2006.
- Engine ground tests accumulated approximately 6,100 hours on 11 F135 engines and 240 hours on 2 F136 engines.
- Development of the Cooperative Avionics Test Bed continues; it is a structurally modified Boeing 737 commercial airline aircraft fitted with an F-35 simulator cockpit, mission systems sensors, and avionics. It includes 20 engineering workstations to assess mission systems performance. Flight testing with F-35 mission systems avionics is planned to begin in 2007.
- The operational test agencies completed an operational assessment in November 2005 and reported results to the program office and the Defense Acquisition Board in May 2006.

AIR FORCE PROGRAMS

- DOT&E is reviewing the Test and Evaluation Master Plan revision completed by the program office. It has not been formally submitted to DOT&E for approval.
- Negotiations have begun with interested partner nations to define involvement in combined operational test and evaluation.
- Live Fire ballistic vulnerability testing and analyses included:
 - Dry bay fire suppression system tests to evaluate the fire suppression systems' performance against high explosive incendiary rounds
 - Roll duct fire migration testing to evaluate the extent of fire migration from the roll duct to the engine
- The Joint Strike Fighter program office made the decision to remove five of the six dry-bay fire suppression systems.

Assessment

- The Test and Evaluation Master Plan revision lacks details on test content, measures for performance, and does not establish specific resource requirements for adequate opposing forces and targets in open air and modeled test events.
- The Air Force and Navy FY08 Program Objective Memoranda do not support an adequate full-scale aerial target replacement necessary for F-35 weapons integration testing. The operational test planning for the F-35 is not adequate without a credible full-scale aerial target.
- The issues cited by the operational test agencies in the operational assessment warrant continued follow-up and further assessment. The program office is studying resolution of the helmet mounted display integration, thermal management issues, flight test schedule executability, instrumentation for operational testing, and maintainability issues.
- Given the high degree of concurrency in F-35 development, a commitment to event-driven decisions and ensuring readiness to begin operational test and evaluation is critical.
- Live Fire testing and evaluation revealed:
 - The fire suppression system successfully suppresses dry bay fires in the protected bays and successfully reduces fire migration into surrounding bays
 - Threat induced fires in the roll duct bay can migrate into the engine bay generating high temperatures
- The Joint Strike Fighter program office's recent decision to remove five of the six dry bay fire suppression systems from each variant will significantly increase the vulnerability of the aircraft to ballistic threat induced fires. It will also adversely affect the safety of the aircraft from non-ballistic induced fires.

Recommendations

- Status of Previous Recommendations. The joint program office and Services have made satisfactory progress on FY05 recommendations, with the exception of:
 - FY05 #2: DOT&E recommended that the program identify all test resource shortfalls in opposing force/threats and present a solution that mitigates these. No progress has been made on this recommendation. The Test and Evaluation Master Plan revision should establish these test resource needs before being submitted for approval by DOT&E.
 - FY05 #4: DOT&E recommended that the program develop a predictive model to determine how test data on engine performance following "quick dump" fuel ingestion at the sea level test site could be extrapolated to predictions for higher operating altitudes. No action has been taken.
- FY06 Recommendations. The program should:
 1. Ensure follow-up on the issues cited by the operational test agencies in the recent operational assessment.
 2. Consider opportunities to conduct IOT&E at an earlier point in initial production with operationally representative weapons systems.
 3. Follow the framework for partner operational test planning outlined by the Defense Acquisition Board in May 2006.
 4. Fund an adequate full-scale aerial target replacement in order to ensure the resources will exist to confirm F-35 operational effectiveness.
 5. Conduct additional full-up, system-level Live Fire ballistic tests to determine the vulnerability of the F-35 with only one dry bay fire suppression system.