

F-22A Advanced Tactical Fighter

Executive Summary

- F-22A Update 5 combines an aircraft Operational Flight Program (OFP) software suite upgrade providing radar enhancements and Ground Collision Avoidance System software with the integration of limited AIM-9X Block 1 air-to-air missile capabilities. The Air Force Air Combat Command completed a Force Development Evaluation (FDE) of these capabilities in 1QFY16, and the operationally effective system was fielded to F-22A units. Full AIM-9X Block 1 and Block 2 integration will be completed in F-22A Increment 3.2B.
- F-22A Increment 3.2B is a separate Major Defense Acquisition Program modernization effort intended to integrate AIM-120D and AIM-9X missile systems; an Enhanced Stores Management System (ESMS) for weapons integration and employment improvements; Intra-Flight Data Link (IFDL) improvements and electronic protection enhancements; improved emitter geolocation capability; and a Common Weapon Employment Zone for air-to-air missile employment.
 - Increment 3.2B developmental testing experienced delays in FY15 due to additional unplanned regression testing for earlier Increment 3.2A and Update 5 OFP software development efforts and related competition for limited developmental test resources.
 - Increment 3.2B developmental testing continued throughout FY16 but experienced delays due to software stability and performance shortfalls.
 - In-flight cockpit display blanking and ESMS functionality deficiencies resulted in flight safety operating restrictions, and required additional unanticipated OFP software releases and regression testing. Consequently, the planned Air Force Milestone C decision slipped from March to August 2016.
 - At Milestone C, the Air Force authorized the procurement of 35 of 71 planned hardware kits through low-rate initial production (LRIP). The Air Force does not plan to procure the remaining LRIP kits until it confirms progress in resolving the deficiencies noted in FY16.
 - Flight testing through September 2016 showed improvement with cockpit display stability; however, ESMS deficiencies persisted in the software OFP. As of the end of FY16, investigative efforts had not fully ruled out the possible need for system hardware design changes.
 - Given the limited development progress in FY16, it is unlikely that Increment 3.2B developmental testing will complete as planned at the end of April 2017, or that IOT&E will begin as planned in August 2017.



System

- The F-22A is an air-superiority fighter that combines low observability to threat radars, sustained high speed, and integrated avionics sensors.
- Low observability reduces threat capability to engage F-22As with current adversary weapons.
- The aircraft maintains supersonic speeds without the use of an afterburner.
- Avionics that fuse information from the Active Electronically Scanned Array radar, other sensors, and data linked information for the pilot enable employment of medium- and short-range air-to-air missiles, guns, and air-to-ground munitions.
- The Air Force intended the F-22A to be more reliable and easier to maintain than legacy fighter aircraft.
- F-22A air-to-air weapons are the AIM-120C/D radar-guided missile, the AIM-9M/X infrared-guided missile, and the M61A1 20 mm gun.
- F-22A air-to-ground precision strike capability consists of the 1,000-pound Joint Direct Attack Munition and the 250-pound Small Diameter Bomb Increment 1.
- The F-22A program delivers capability in increments. Incremental Enhanced Global Strike modernization efforts include the following current and near-term modernization efforts:
 - Increment 3.1 provides enhanced air-to-ground mission capability, to include geolocation of selected emitters, electronic attack, air-to-ground synthetic aperture radar mapping and designation of surface targets, and Small

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Diameter Bomb integration. Increment 3.1 is currently fielded in operational F-22A units.

- Increment 3.2A is a software-only upgrade providing improved electronic protection, Link 16 Receive, and combat identification capabilities. Increment 3.2A is a modernization effort within the scope of the F-22A Advanced Tactical Fighter baseline acquisition program of record and is currently fielded in operational F 22A units.
- Update 5 combines an OFP upgrade providing software driven radar enhancements, Ground Collision Avoidance System software, and the incorporation of limited AIM-9X capabilities. Update 5 OFP FDE testing completed in 1QFY16. The Update 5 OFP is currently fielded in operational F-22A units.
- Increment 3.2B is a separate Major Defense Acquisition Program modernization effort intended to integrate AIM-120D and AIM-9X missile systems; an ESMS for weapons integration and employment improvements; IFDL and electronic protection enhancements; improved emitter

geolocation capability; and integration of a Common Weapon Employment Zone for air-to-air missiles employed by the F-22A. The Increment 3.2B IOT&E is currently planned for 4QFY17.

Mission

Commanders will use units equipped with the F-22A to:

- Provide air superiority over friendly and non-permissive, contested enemy territory
- Defend friendly forces against fighter, bomber, or cruise missile attack
- Escort friendly air forces into enemy territory
- Provide air-to-ground capability for counter-air, strategic attack, counter-land, and enemy air defense suppression missions

Major Contractor

Lockheed Martin Aeronautics Company – Fort Worth, Texas

Activity

- The Air Force conducted all testing in accordance with the DOT&E-approved Test and Evaluation Master Plan and Update 5 FDE plan.
- Air Force Air Combat Command completed an FDE of the Update 5 OFP software suite in 1QFY16. Operational flight testing was executed in three phases: assessments of new capabilities and tactics, techniques, and procedures (TTP) development; missionized scenarios to evaluate Update 5 capabilities and assess/refine derived TTPs in a tactical environment; and live fire weapons employment of the AIM-9X. Update 5 capabilities were fielded to operational F-22A units in FY16.
- Increment 3.2B developmental testing continued throughout FY16 but experienced delays due to software stability and performance shortfalls. The Air Force-planned Milestone C decision slipped from March to August 2016. At Milestone C, the Air Force authorized the procurement of 35 of 71 planned hardware kits through LRIP.

Assessment

- The F-22 Update 5 OFP software suite enhancements and limited AIM-9X Block 1 integration are operationally effective. Full AIM-9X Block 1 and 2 missile integration remains to be tested in Increment 3.2B IOT&E. Update 5 further corrected some of the software deficiencies noted in FY15 Increment 3.2A operational testing.
- F-22 Increment 3.2B developmental testing revealed flight safety and system performance shortfalls and experienced delays due to software stability in FY16.
 - The program experienced in-flight cockpit display blanking occurrences for which root cause fault analysis is still ongoing. Flight testing through September 2016 showed improvement with cockpit display stability.

- The Increment 3.2B ESMS functionality as tested through the end of FY16 did not ensure proper weapons bay door and missile launcher positions, resulting in uncommanded and uncontrollable weapons bay door positions and cycling in flight. As with the display blanking problem, ESMS door shortfalls led to additional flight safety restrictions.
 - ESMS deficiencies persisted in the software OFP version flown through the end of September 2016. At the end of FY16, investigative efforts had not yet ruled out the possible need for system hardware design changes. Due to these problems, modification of the remaining three operational test aircraft was delayed until 1QFY17.
 - Delayed modification of the entire nine-aircraft test fleet hinders the program's ability to conduct four-ship test missions, which are needed to vet key Increment 3.2B capabilities and complete developmental testing within the scope of the Air Force's schedule.
- Although the program has demonstrated some elements of each of the combat capability candidates in laboratory and flight testing, as of the end of September 2016 numerous performance shortfalls exist across the scope of the intended enhancements, and a substantial volume of developmental testing remains to be accomplished.
- The DOT&E November 2015 FOT&E report highlighted F-22A software reliability and performance problems realized in the F-22A Increment 3.2A software suite. In that report, DOT&E cautioned that F-22 modernization efforts risked potentially unacceptable software reliability and associated performance shortfalls unless the Air Force focused concerted efforts on software reliability improvements. Thus far, Increment 3.2B performance and reliability had not shown such improvements.

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- F-22A modernization increments and development schedules remain tightly coupled, with little margin for unanticipated regression testing and correction of critical deficiencies when discovered in operational testing. To date, Increment 3.2B developmental testing has experienced several delays due to additional unplanned regression testing for Increment 3.2A and Update 5 OFP efforts in 2015, competition for limited test resources, and problems with Increment 3.2B display blanking and ESMS. These factors contributed to a delayed Increment 3.2B Milestone C decision. Given the limited development progress in FY16, it is unlikely that associated developmental testing will complete as planned at the end of April 2017, or that IOT&E will begin as planned in August 2017.
- In FY15, DOT&E highlighted that integration of the AIM-120D weapon model into the Advanced Combat Simulator (ACS) presented a risk to the Increment 3.2B program's ability to begin scheduled FY17 IOT&E on time. In FY16, delivery of the Raytheon AIM-120D model to Lockheed Martin for incorporation into the ACS remained a risk to the currently planned IOT&E schedule.
- In FY16, the Air Force initiated action to establish a comprehensive strategy for evaluating the cybersecurity vulnerabilities of the F-22 weapon system across the span of projected modernization efforts. Specific strategy

details remain to be incorporated into forthcoming F-22 modernization efforts.

Recommendations

- Status of Previous Recommendations. The Air Force continues to address previous recommendations; avionics stability shortfalls remain to be evaluated in the scope of Increment 3.2B IOT&E.
- FY16 Recommendations. The Air Force should:
 1. Correct performance deficiencies and software anomalies associated with Increment 3.2B before proceeding to IOT&E.
 2. Reassess the Increment 3.2B development schedule based on the risks of successful completion due to performance shortfalls realized to date, and ensure the program has adequate resources to complete and deliver the capabilities required by the Air Force with the avionics stability necessary for these capabilities to be operationally effective and suitable.
 3. Continue to improve F-22A avionics software stability to support operational mission execution needs.
 4. Ensure the adequacy of the force structure and schedule margins necessary to support F-22A modernization efforts.

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