

F-22A – RAPTOR Modernization

Executive Summary

- F-22A Increment 3.2B is a 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. IOT&E began August 21, 2017, and completed April 6, 2018, with the Air Force Full-Rate Production decision on August 10, 2018.
- Update 6 is a software-only Operational Flight Program (OFP) effort to update the aircraft cryptographic module with an F-22A cryptographic architecture change to accommodate multiple, simultaneous algorithms for Link 16 datalink interoperability and secure ultrahigh frequency radio communications. Update 6 also is intended to incorporate deferred software corrections carried over from Increment 3.2B developmental testing. Developmental testing began November 13, 2017, with an expected completion of January 7, 2019. The Air Force intends to field Update 6 in 2019.

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 fuse information from the Active Electronically Scanned Array radar, other sensors, and datalink information for the pilot to 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 provided 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 Diameter Bomb integration.
- Increment 3.2A was 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 combined an OFP upgrade providing software driven radar enhancements, Ground Collision Avoidance System software, and the incorporation of limited AIM-9X capabilities. The Update 5 OFP is currently fielded in operational F-22A units.
- Increment 3.2B is a separate Major Defense Acquisition Program modernization effort that integrates 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. IOT&E of the 3.2B capability concluded in April 2018 and is currently projected to begin fielding mid-2019 with a compatible version of Update 6 software.
- Update 6 is a software-only OFP effort to update the aircraft KOV-20 cryptographic module with an F-22A cryptographic architecture change to accommodate multiple, simultaneous algorithms for Link 16 datalink interoperability and secure ultrahigh frequency radio communications. Update 6 is also intended to incorporate

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deferred software corrections carried over from Increment 3.2B developmental testing. The software-only effort may be loaded into aircraft that are receiving Increment 3.2B capability as well as those that are not. The Air Force intends to field Update 6 in 2019.

- F-22A Tactical Link 16 (TACLink) and Tactical Mandates (TACMAN) are separate pre-Milestone B hardware and software modernization programs intended to provide Link 16 transmit capability through the Multifunctional Information Distribution System/Joint Tactical Radio System and replace the legacy Mark XVII Mode 4 Identification Friend or Foe (IFF) system with the Mode 5 IFF system. The Air Force expects to field TACLink and TACMAN capabilities in FY21 and FY22, respectively.

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 Increment Update 5 testing in accordance with the DOT&E-approved Test and Evaluation Master Plan in 2017, which tasked the 53rd Wing to accomplish a sufficiency of test report (SOTR) following completion of developmental test.
- The Air Force completed Increment 3.2B developmental testing in August 2017. Some of the deficiencies identified in developmental testing were carried over into IOT&E, and the Air Force deferred corrective action to a future OFP effort.
- AFOTEC conducted Increment 3.2B IOT&E from August 21, 2017, through April 6, 2018. AFOTEC designed the F-22 Increment 3.2B IOT&E to determine how well the F-22A could conduct its air-to-air and air-to-ground missions. The mission-level portion of the test consisted of 18 open-air test events at the Nevada Test and Training Range (NTTR) and 49 Pilot-in-the-Loop modeling and simulation test events at the Air Combat Simulator. The Program Office intends to fix deficiencies found during 3.2B IOT&E and re-test to validate completion of corrective actions.
- The Air Force approved the Increment 3.2B Full-Rate Production decision on July 31, 2018, with projected initial fielding in mid-2019.
- DOT&E published a classified F-22 Increment 3.2B IOT&E report in August 2018. The evaluation included results from both developmental and operational testing.

Assessment

- F-22A Increment 3.2B developmental testing experienced performance shortfalls across some of the enhancement capabilities, which led to multiple unplanned OFP revisions.

The Air Force deferred corrective action for some deficiencies to future software modernization efforts.

- Increment 3.2B test of the operational effectiveness and suitability was limited by the open-air test venue types and density of ground threats; lack of real time battle shaping because the Air-to-Air Range Infrastructure (AARI) instrumentation was not accredited; and lack of surrogate adversaries that adequately emulate the modern air and ground threat.
- The capabilities introduced with Increment 3.2B were integrated effectively on the F-22A and demonstrated the reliability, availability, and maintainability to be comparable to that of the F-22A operational fleet.
- The Increment 3.2B IOT&E revealed classified cyber deficiencies. Details are in the August 2018 DOT&E IOT&E report.

Recommendations

The Air Force should:

1. Provide the test infrastructure, instrumentation, and surrogate threats to conduct F-22A operational testing against an operationally realistic array of threats to fully vet F-22A and fifth generation capabilities on an appropriate open-air test range.
2. Resolve AARI sustainment, test readiness, and modernization shortfalls to support simultaneous advanced aircraft open-air mission testing on an appropriate open-air test range.
3. Accomplish additional testing and follow up as provided in the DOT&E Increment 3.2B IOT&E report.