

## 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.
- The Air Force identified ESMS deficiencies during Increment 3.2B developmental testing, completed in August 2017. Some of these were carried over into IOT&E, and the Air Force deferred corrective action to a future Operational Flight Program (OFP) effort.
- The Air Force Operational Test and Evaluation Center (AFOTEC) began Increment 3.2B IOT&E in September 2017 and will complete in April 2018. The Increment 3.2B Full-Rate Production decision is currently scheduled to occur in July 2018. F-22A Increment 3.2B IOT&E adequacy requires the ability to conduct mission-level, open-air flight testing against specific adversary air capabilities. As of the start of IOT&E, the Air Force was not able to provide the means to conduct open-air testing on the Nevada Test and Training Range (NTTR) using all of the appropriate air assets required by the IOT&E test plan.
- The NTTR Air-to-Air Range Infrastructure (AARI) instrumentation system provides an automated means for real-time battle shaping crucial to complex F-22A open-air operational flight testing through shooter-to-target accredited weapons fly-out simulations. As of September 2017, the Air Force had not demonstrated AARI readiness to support FY17-18 Increment 3.2B IOT&E and will not be able to accredit the system due to lack of end-to-end verification of all functions and detailed validation of weapons fly-out models.
- Without an accredited AARI system, the Air Force lacks the means of resolving operational mission-level measures for F-22A Increment 3.2B IOT&E in open-air flight testing, and places pending FY18 F-35 IOT&E open-air NTTR testing in jeopardy since a fully functional AARI is required for F-35 IOT&E.

### 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 datalinked 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 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 intended to integrate AIM-120D and AIM-9X missile systems; an ESMS for weapons integration and employment improvements;

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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.

- 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 ultra-high frequency radio communications. Update 6 is also intended to incorporate deferred software corrections carried over from Increment 3.2B developmental testing. The Air Force intends to field Update 6 in CY19.
- 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

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## Activity

- The Air Force conducted Increment 3.2B testing in accordance with the DOT&E-approved Test and Evaluation Master Plan.
- 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 began Increment 3.2B IOT&E in September 2017 and will complete in April 2018. The Increment 3.2B Full-Rate Production decision is currently scheduled to occur in July 2018.
- The NTTR AARI instrumentation system provides an automated means for real-time battle shaping crucial to complex F-22A open-air operational flight testing through shooter-to-target accredited weapons fly-out simulations. As of September 2017, the Air Force had not demonstrated AARI readiness to support FY17-18 Increment 3.2B IOT&E.

## Assessment

- F-22A Increment 3.2B developmental testing experienced performance shortfalls across some of the enhancement capabilities that led to multiple unplanned OFP revisions. Accordingly, IOT&E did not begin until early September. ESMS functionality shortfalls identified in FY16-17 flight testing were not fully resolved. The Air Force deferred corrective action to future Update 6 OFP software modernization efforts.
- F-22A Increment 3.2B IOT&E adequacy requires the ability to conduct mission-level, open-air flight testing against specific adversary air capabilities in order to vet the full capabilities of the Increment 3.2B hardware and software enhancements. As of the start of IOT&E in September 2017, the Air Force was

not able to provide the means to conduct open-air testing on the NTTR using all of the appropriate air assets required by the IOT&E plan. IOT&E open-air flight test execution will be inadequate unless the Air Force can provide the required assets for testing.

- NTTR AARI development was late to need for Increment 3.2B IOT&E, and as of September 2017 had not successfully completed network tests necessary for AARI utilization in IOT&E. AARI accreditation using current standards for test resource modeling and simulation is unlikely due to the lack of end-to-end verification of all functions and detailed validation of weapons fly-out models against valid reference sources such as live fire data and high-fidelity vendor models.
  - Without accreditation, AARI weapon fly-outs cannot be used to complete operational testing, and human intervention utilizing Range Training Officers (RTOs) will be required to accomplish missions.
  - Reliance on RTO interventions increases the risk of incorrect "kill" decisions due to estimates of weapons performance coupled with the dynamic nature of F-22A flight missions. This increases the likelihood that IOT&E missions may have to be reflown, creating the need for resources that would have been unnecessary with a working, accredited AARI system.
  - Without an accredited AARI system, it will be more difficult for the Air Force to resolve highly complex operational mission-level measures for F-22A Increment 3.2B IOT&E in open-air flight testing, and places pending FY18 F-35 IOT&E open-air NTTR testing in jeopardy since a fully functional AARI is required for F-35 IOT&E.

## Recommendations

- Status of Previous Recommendations.
  1. The Air Force partially addressed FY16 recommendations regarding Increment 3.2B performance deficiencies and software anomalies, and deferred some corrective actions to future aircraft OFP efforts.
  2. In FY14, DOT&E recommended the Air Force resolve AARI sustainment, test readiness, and modernization shortfalls in order to support Increment 3.2B IOT&E test adequacy; however, the system did not demonstrate readiness for FY17 testing.
- FY17 Recommendations. The Air Force should:
  1. Provide the means to conduct F-22A operational testing against the adversary threat composition needed to fully vet F-22A and similar (i.e. F-35) capabilities in open-air flight testing on the NTTR.
  2. Resolve AARI sustainment, test readiness, and modernization shortfalls to support advanced aircraft open-air mission testing on the NTTR.

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