

Patriot Advanced Capability-3 (PAC-3)

Executive Summary

- The Army conducted the Patriot Post Deployment Build-8 (PDB-8) IOT&E throughout FY/CY17, concluding in November 2017. Data from the IOT&E will support the PDB-8 fielding and Patriot Advanced Capability-3 (PAC-3) Missile Segment Enhancement (MSE) Full-Rate Production decisions in 2018.
- The Army conducted five Patriot flight test engagements using Patriot interceptors in FY/CY17, achieving intercepts of all targets: three short-range ballistic missile (SRBM) targets, one medium-range ballistic missile (MRBM) target, and one cruise missile target.
- As part of the IOT&E, the Army conducted Sustained Operations, Mobile Flight Mission Simulator, Interoperability, and Regression Phases, as well as a Cooperative Vulnerability and Penetration Assessment (CVPA) and a partial Adversarial Assessment (AA).

System

- Patriot is a mobile air and missile defense system that counters missile and aircraft threats. The newest version of Patriot hardware and software under development is PDB-8, which consists of improvements required to:
 - Counter the evolving threat
 - Improve combat identification and the Air Defense Interrogator Mode 5 Identification, Friend or Foe capability
 - Mitigate false tracks
 - Improve electronic protection
 - Integrate further the MSE interceptor/ground system capabilities
- The system includes the following:
 - C-band, multi-function, phased-array radars for detecting, tracking, classifying, identifying, and discriminating targets and supporting the guidance functions
 - Battalion and battery battle management elements
 - Communications Relay Groups and Antenna Mast Groups for communicating between battery and battalion assets
 - A mix of PAC-3 hit-to-kill interceptors and PAC-2 blast fragmentation warhead interceptors for negating missile and aircraft threats
- The newest version of the PAC-3 interceptor, the MSE, is in the production and fielding phase. The PAC-3 MSE provides



- increased battlespace defense capabilities and improved lethality over prior configuration Patriot interceptors.
- Earlier versions of Patriot interceptors include the Patriot Standard interceptor, the PAC-2 Anti-Tactical Missile, the Guidance Enhanced Missile (GEM) family (includes the GEM-T and GEM-C interceptor variants intended to counter tactical ballistic missiles (TBMs) and cruise missiles), the PAC-3 (baseline), and the PAC-3 Cost Reduction Initiative (CRI) variant.

Mission

Combatant Commanders use the Patriot system to defend deployed forces and critical assets from missile and aircraft attack and to defeat enemy surveillance air assets in all weather conditions and in natural and induced environments.

Major Contractors

- Prime: Raytheon Company, Integrated Defense Systems – Tewksbury, Massachusetts (ground system and PAC-2 and prior generation interceptors)
- PAC-3, PAC-3 CRI, and PAC-3 MSE Missiles: Lockheed Martin Corporation, Missile and Fire Control – Grand Prairie, Texas

Activity

- The Army conducted most testing in accordance with the DOT&E-approved Test and Evaluation Master Plan and test plans. The Army postponed one of the Missile Flight Test-A (MFT-A) intercepts against a fixed-wing aircraft target employing countermeasures until PDB-8.1 flight testing in

2021. The Army did not conduct the Patriot AA according to the DOT&E-approved test plan, resulting in some gaps in understanding PDB-8 cybersecurity. To address these gaps, the Army plans to conduct a second Patriot AA in October 2018.

FY17 ARMY PROGRAMS

- The Army conducted the PDB-8 IOT&E throughout FY/CY17 to support the PDB-8 fielding and PAC-3 MSE Full-Rate Production decisions. The IOT&E included the following events:
 - Sustained Operations phase in October 2016
 - CVPA in January 2017
 - Mobile Flight Mission Simulator missions in February to April 2017
 - A partial AA in May 2017
 - Interoperability testing in June 2017
 - MFT-A1 in June 2017 at White Sands Missile Range (WSMR), New Mexico. During this test, Patriot engaged a TBM target with a PAC-3 MSE interceptor and a GEM-T interceptor, and then engaged a cruise missile target with a PAC-3 MSE interceptor.
 - MFT-B in September 2017 at the Reagan Test Site, Kwajalein Atoll, Marshall Islands. During this test, Patriot engaged an MRBM target using a ripple method of fire (discharge of missiles in quick succession) and three PAC-3 MSE interceptors.
 - Regression Testing in July to August 2017 and in October to November 2017.
 - MFT-A2 in November 2017 at WSMR. During this test, Patriot simultaneously engaged and intercepted two TBM targets using two mixed ripples of interceptors (PAC-3 MSE/PAC-3 CRI and PAC-3 CRI/PAC-2 GEM-T).
- The Patriot CVPA revealed some cybersecurity shortfalls. The partial AA was not adequate to support a full assessment of cybersecurity.

Recommendations

- Status of Previous Recommendations. The Army satisfactorily addressed 15 of the previous 25 recommendations. The Army should continue to address the following recommendations:
 1. Conduct Patriot air and missile defense testing during joint and coalition exercises that include large numbers of different aircraft types, sensors, battle management elements, and weapons systems. Additionally, the Army should conduct Red Team AAs during joint exercises to test Patriot cybersecurity.
 2. Conduct a Patriot flight test against an anti-radiation missile target to validate models and simulations.
 3. Improve Patriot training to ensure that Patriot operators are prepared to use the system in combat.
 4. Have Patriot participate with live interceptors in Terminal High-Altitude Area Defense (THAAD) flight testing to determine Patriot-to-THAAD interoperability and the capability for Patriot to intercept tactical ballistic missile targets that THAAD does not intercept. (The FY16 National Defense Authorization Act requires at least one intercept or flight test each year that demonstrates interoperability and integration among Patriot, THAAD, and/or Aegis BMD.)
 5. Collect operational reliability data on Patriot systems in the field in order to calculate the Mean Time Between Critical Mission Failures.
 6. Use test units for future Patriot operational tests that have operationally representative distributions in soldier proficiency.
 7. Conduct future operational flight tests with unannounced target launches within extended launch windows.
 8. Improve Patriot radar reliability.
 9. Conduct a simultaneous engagement of a cruise missile target with a PAC-2 GEM-T interceptor and a maneuvering full-scale, fixed-wing aircraft target employing electronic countermeasures with a PAC-3 MSE interceptor.
 10. Have Patriot participate with live interceptors in Aegis BMD flight testing to determine Patriot-to-Aegis BMD interoperability and the capability for Patriot to intercept ballistic missile targets that Aegis BMD does not intercept.
- FY17 Recommendations. The Army should:
 1. Fix the cybersecurity vulnerabilities identified during the CVPA and limited AA and verify these fixes through subsequent cybersecurity testing.
 2. Conduct future TBM flight tests with targets having threat-representative payloads to adequately assess Patriot lethality against TBMs.
 3. Conduct an adequate AA that assesses insider, nearsider, and outsider attack vectors using representative trained soldier-operators in all manned stations.

Assessment

- Patriot successfully engaged all five targets during the PDB-8 IOT&E. Patriot also demonstrated some problems, including the following:
 - Patriot training remained inadequate to prepare operators for complex Patriot engagements. This was true during the PDB-7, PDB 6.5, and PDB-6 Limited User Tests (LUTs) as well.
 - Patriot had some classified effectiveness shortfalls.
 - Preliminary data suggest that Patriot ground system reliability did not meet the threshold requirement.
 - Patriot had some classified survivability and cybersecurity shortfalls.
- During the MFT-A1 flight test, Patriot demonstrated the capability to detect, track, engage, and intercept a TBM target with a mixed ripple engagement using PAC-3 MSE and PAC-2 GEM-T interceptors, and the capability to detect, track, engage, and intercept a cruise missile target with a PAC-3 MSE interceptor. During the MFT-A2 flight test, Patriot demonstrated the capability to detect, track, engage, and intercept two TBM targets using two ripples of interceptors (PAC-3 MSE/PAC-3 CRI and PAC-3 CRI/PAC-2 GEM-T). The PAC-3 MSE intercepted the Sabre target in its extended battlespace.
- During the MFT-B flight test, Patriot demonstrated the capability to detect, track, engage, and intercept an MRBM target in the PAC-3 MSE extended battlespace.
- Patriot has not had a flight test against a TBM target with a threat-representative payload since 2000, which limits the ability to assess Patriot lethality against TBMs.