

## Patriot / Medium Extended Air Defense System (MEADS)

### Executive Summary

- The Army conducted five major developmental Patriot flight test missions and a Post-Deployment Build (PDB)-6.5 Limited User Test (LUT) operational test in FY10.
- The second guided flight of the Patriot Advanced Capability-3 (PAC-3) Missile Segment Enhancement (MSE) interceptor achieved a successful intercept of a ballistic missile target with the second of two interceptors ordered to launch.
- PDB-6.5 flight tests with PAC-2 missiles conducted in December 2009 and March 2010 were successful.
- A PAC-2 missile flight test in October 2009 and a PAC-3 missile flight test in December 2009 were successful.

### System

- The Patriot is a mobile air and missile defense system that counters missile and aircraft threats. The system includes the following:
  - C-band phased-array radars for detecting, tracking, classifying, identifying, and discriminating targets
  - 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 missiles and PAC-2 blast fragmentation warhead missiles for negating missile and aircraft threats
    - The newest version of the PAC-3 interceptor is the Cost Reduction Initiative (CRI) missile. In addition, the Army is developing the PAC-3 MSE missile with increased battlespace defense capabilities and an improved lethality enhancer.
    - Earlier versions of Patriot interceptors include the Patriot Standard missile, the PAC-2 Anti-Tactical Missile (ATM), and the Guidance Enhanced Missile (GEM) family (includes the GEM-T and GEM-C missile variants).
- The Medium Extended Air Defense System (MEADS) is intended to be a more deployable, mobile, and capable air and missile defense system than Patriot. Planned MEADS developments include the following:
  - Battle management, command, control, communications, computers, and intelligence elements; Ultra High



- Frequency-band 360-degree surveillance radars; X-band 360-degree multi-function fire control radars; and missile launchers and reloaders
- MSE missiles developed under the Patriot program

### Mission

Combatant Commanders using Patriot have the capability to defend deployed forces and critical assets from missile and aircraft attack and to defeat enemy surveillance air assets (such as unmanned aerial vehicles) in all weather conditions, clutter, and electronic countermeasure environments. Combatant Commanders will use MEADS to provide maneuver forces with continuous 360-degree protection against missile and aircraft threats.

### Major Contractors

- Lockheed Martin Missile and Fire Control – Dallas, Texas
- MEADS International, Inc. – Orlando, Florida
- Raytheon Integrated Defense Systems – Tewksbury, Massachusetts

### Activity

- The Army conducted the PDB-6.5 LUT at White Sands Missile Range (WSMR), New Mexico, from November 2009 to July 2010. DOT&E approved deviations from the 2004 Patriot Test and Evaluation Master Plan (TEMP) because the software changes between PDB-6 and PDB-6.5 were less extensive than had been anticipated in 2004. The

PDB-6.5 LUT did not include a sustained operations phase or an interoperability phase and the PDB-6.5 testing included four developmental/operational test flight tests instead of four developmental test flight tests and three operational test flight tests. These deviations were documented in a 2009 Memorandum of Understanding.

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- During the ATM-48 flight test at WSMR in October 2009, Patriot fired two GEM-T interceptors and killed a high-speed tactical ballistic missile with the second interceptor.
- During production configuration flight test PC-08 at WSMR in December 2009, Patriot fired two PAC-3 CRI missiles and intercepted a short-range ballistic missile target with the first interceptor.
- During PDB-6.5 flight test P6.5-3A at WSMR in December 2009, Patriot fired a Standard missile and two PAC-2 missiles against a low-altitude cruise missile target using miss bias and maximum fuze delay to prevent the interceptors from killing the target.
- During the second intercept attempt for the MSE missile (Flight Test 7-2A) at WSMR in February 2010, Patriot attempted to fire two MSE interceptors at a ballistic missile target. The second MSE intercepted the target; the first interceptor failed to launch.
- During PDB-6.5 flight test P6.5-2 at WSMR in March 2010, Patriot fired a GEM and a PAC-2 missile at one ballistic missile target and then fired a GEM-C and PAC-2 missile at a second ballistic missile target, intercepting and killing the first target with a GEM and killing the second target with a PAC-2 missile.
- The next Patriot operational test, the PDB-7 LUT, is scheduled to begin in 4QFY11.

## Assessment

- The PDB-6.5 LUT was the first operational test to use two synchronized hardware-in-the-loop systems, which allowed the integrated air picture from two batteries to be presented to the battalion. The Patriot PDB-6.5 system showed improvements in performance against some threat types but degradations in performance against other threat types.
  - The total Patriot system performance against anti-radiation missiles and air-to-surface missiles could not be determined because Patriot interceptor lethality data does not yet exist for these threats.
  - The total Patriot system performance against cruise missiles, fixed-wing aircraft, or unmanned aerial vehicles could not be determined because the Lower Tier Project Office has not performed the simulation runs necessary to characterize Patriot interceptor lethality against these threats.
  - Patriot failed to meet the firing battery reliability requirement and PDB-6.5 testing was not adequate to determine Patriot maintainability or operational availability.
  - Patriot system complexity has exceeded the current operator capabilities and training.
  - Information assurance testing revealed some improvements, but the crew had pre-knowledge of the penetration test. Testing, therefore, provided biased data with regard to operator responses to cyber attacks.
- During the ATM-48 missile flight test, a transmitter arc experienced in the Patriot ground radar during the engagement of the ATM-48 target with the first GEM-T interceptor led

- to a larger miss distance than had been expected for the first interceptor. However, while the fuze exhibited anomalous behavior, the first GEM-T still intercepted the ATM-48 target. The second GEM-T interceptor killed the target, achieving a successful miss distance and exhibiting the expected fuze geometry.
- During flight test PC-08, both PAC-3 CRI missiles performed in good agreement with preflight predictions. The first CRI missile intercepted and destroyed the target.
- During PDB-6.5 flight test P6.5-3A, the Army was not able to address the objective of fully exercising post-intercept engagement decision and weapons assignment logic because the Patriot system dropped track on the target just after the first planned intercept event. Aside from this problem, all three engagements were successfully accomplished as planned.
- During flight test 7-2A, Patriot demonstrated the capability to kill a tactical ballistic missile target with an MSE interceptor in the extended MSE battlespace. The in-flight interceptor performance was consistent with preflight predictions and body-to-body impact was achieved, resulting in the destruction of the target. Patriot was to have fired two MSE missiles during this flight test, but the first MSE suffered a seeker reset and failed to launch. The cause of this seeker reset is still under investigation.
- During PDB-6.5 flight test P6.5-2, Patriot demonstrated the capability to kill a tactical ballistic missile target with a GEM interceptor and then engage and kill a second tactical ballistic missile target in the presence of the debris cloud from the first intercept. Three of the four interceptors behaved nominally, but the GEM-C fired against the second target exhibited a fuze anomaly that resulted in a missile self-destruct prior to target intercept. The PAC-2 missile fired against the second tactical ballistic missile target did successfully destroy the target.
- The Missile Defense Agency (MDA) plans to conduct the first Ballistic Missile Defense System operational flight test (FTO-01) in FY12. FTO-01 will include Aegis, Terminal High-Altitude Area Defense (THAAD), and Patriot intercept attempts against three ballistic missiles. Although Patriot and THAAD can together provide a robust defense if Patriot is able to intercept threats that THAAD does not kill, MDA and the Army are not currently planning to demonstrate this capability in FTO-01.

## Recommendations

- Status of Previous Recommendations. The Army satisfactorily addressed two of the previous ten open recommendations. Recommendations concerning conducting Patriot testing during Joint and coalition exercises; upgrading the Patriot hardware-in-the-loop systems to model electronic countermeasures and identification, friend or foe systems; updating the Patriot Test and Evaluation Master Plan; conducting a Patriot flight test against an anti-radiation missile target; providing probability of kill tables for all required threats prior to the start of operational tests; reviewing the risks of not conducting all flight tests against ballistic missiles using two interceptors; planning to conduct an IOT&E prior to

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- the MSE full-rate production decision; and conducting a robust Force Development Experiment prior to PDB-7 operational testing still remain.
- FY10 Recommendations. In addition to addressing the above recommendations, the Army should:
    1. Improve Patriot training to provide the level of expertise required for PDB-6.5 operations.
    2. Conduct future Patriot information assurance testing as an integrated part of operational testing rather than as a dedicated information assurance test so the crews will not know when to expect cyber attacks.
    3. Have Patriot participate with live interceptors in THAAD flight testing to demonstrate that Patriot can intercept targets not killed by THAAD.

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