

Patriot / Medium Extended Air Defense System Combined Aggregate Program (PATRIOT/MEADS CAP)

Executive Summary

- The Army conducted five major developmental Patriot flight tests from October 2006 to July 2007 (three operational flight tests and two Evolutionary Development Program flight tests) and achieved four successes.
- The Army conducted a major Patriot operational test, the Post-Deployment Build-6 (PDB-6) Limited User Test (LUT), from 4QFY06 through 2QFY07.

System

- The Patriot/Medium Extended Air Defense System (MEADS) Combined Aggregate Program (CAP) is based on incrementally inserting MEADS major end items into the current Patriot system. The approach allows for earlier modernization and fielding of enhanced capabilities prior to fielding of the full MEADS system capability.
- The Patriot system includes:
 - C-band phased-array radars for detecting, tracking, classifying, identifying, and discriminating targets
 - Battalion Information and Coordination Centrals, Battery Command Posts, and Engagement Control Stations for battle management
 - Communications Relay Groups and Antenna Mast Groups for communicating with battery and battalion assets
 - A mix of Patriot Advanced Capability-3 (PAC-3) hit-to-kill missiles and PAC-2 blast-fragmentation warhead missiles for negating air and missile 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 Missile Segment Enhancement (MSE) missile with increased range and altitude capabilities.
 - PAC-2 interceptors include the Guidance Enhanced Missile (GEM), the newest version of which is the GEM-T. The GEM-T is designed primarily to counter



aircraft, including low radar cross-section cruise missiles, but also has improved capability against short-range ballistic missiles.

- Planned MEADS developments include:
 - Battle management, command, control, communications, computers, and intelligence elements; Ultra High Frequency-band 360-degree surveillance radars; X-band 360-degree multifunction 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.

Activity

- The Army fired a salvo of two Patriot GEM missiles at a short-range ballistic missile target during the PDB-6 LUT flight test P6L-2 in October 2006. The first GEM intercepted and killed the target at the expected ground range and altitude.
- The Army fired a salvo of two Patriot PAC-3 CRI missiles at a short-range aerodynamic ballistic missile target during the PDB-6 LUT flight test P6L-3 in October 2006. The first CRI intercepted and killed the target at the expected ground range and altitude. The second CRI missile self-destructed as planned.
- During PDB-6 LUT flight test P6L-1 in November 2006, Patriot intercepted a low radar cross section cruise missile target with a GEM-T.
- The Army conducted sustained operations testing during the PDB-6 LUT in November 2006.
- In January and February 2007, the Army conducted PDB-6 LUT mobile flight mission simulator hardware-in-the-loop regression testing.

ARMY PROGRAMS

- In May 2007, during the first flight test of the MSE missile (Flight Test 7-1), Patriot fired an MSE control test missile at a simulated target.
- Patriot fired a PAC-3 CRI missile at a subscale aircraft target equipped with electronic countermeasures during Flight Test 14-1 in July 2007. The CRI intercepted and killed the target.
- The Army conducted penetration characterization testing for the MSE missile lethality enhancer titanium fragments in July 2007.
- The Army Research Laboratory conducted information assurance insider penetration testing during the PDB-6 LUT.
- Limited information assurance insider penetration testing during the PDB-6 LUT revealed shortcomings that could contribute to Patriot system vulnerability to information operation attacks. The test was limited because it was conducted at a time when the system was unmanned. Although the test provided data to address information assurance protection metrics, it was not adequate to address DOT&E metrics on information assurance detection, reaction, recovery, or restoration or to fully assess Patriot survivability from information operations attacks.
- The PDB-6 LUT included a Joint Interoperability Demonstration that addressed interoperability between Patriot and other air and missile defense elements using both live and virtual participants. The results indicate a marked improvement in Patriot joint interoperability since the last demonstration conducted in 2002, although some issues remain unresolved.
- The penetration characterization lethality testing provided data that should lead to improved estimations of PAC-3 missile lethality.

Assessment

- The four FY07 major developmental Patriot flight tests conducted against targets were successful.
- During Flight Test 7-1, a loss of actuator battery voltage at MSE control test missile launch led to lateral accelerations exceeding design limits. This caused missile structural failure approximately three seconds after launch.
- Only one mobile flight mission simulator hardware-in-the-loop system was available for the PDB-6 LUT, preventing the Army from testing more than one Patriot battery at a time. Patriot met the PAC-3 Operational Requirements Document system effectiveness and defended area Key Performance Parameter requirements for some tactical ballistic missiles, but failed to meet these requirements for other tactical ballistic missile threats. Patriot demonstrated mixed performance against cruise missiles and aircraft. Performance against anti-radiation missiles, air-to-surface missiles, and unmanned aerial vehicles is uncertain due to insufficient data on Patriot interceptor lethality against these three classes of threats.
- The Army has acquired a second hardware-in-the-loop system that will support the PDB-6.5 LUT (scheduled for 2009) enabling a robust battalion-level evaluation of Patriot performance. This will allow the Army to use two flight mission simulators simultaneously to load two Patriot batteries with tactically-representative types and numbers of simulated targets and live friendly and threat aircraft with electronic countermeasures. The Army will also use these simulators for training, verifying fixes, and minimizing the possibility of encountering unexpected problems.
- The sustained operations phase of the PDB-6 LUT demonstrated that the Patriot test unit had good reliability and operational availability but did not meet mean time to repair, emplacement time, or march order time requirements. PDB-6 increased the workload of some Patriot operators and required a level of expertise that exceeded the current Army training standard for some Patriot operations.

Recommendations

- Status of Previous Recommendations. The Army has resolved all but the following DOT&E recommendations, which require further attention: Air and missile defense testing should occur during joint and coalition exercises that include large numbers of different aircraft types; sensors; battle management, command, control, communications, computers, and intelligence; and weapon systems (FY05). The Army should upgrade the existing and new hardware-in-the-loop systems to model electronic countermeasures and identification friend or foe systems (FY06). The Army should update the Test and Evaluation Master Plan to address changes in the acquisition and supporting test strategies for the MSE missile and MEADS (FY06).
- FY07 Recommendations. The Army should:
 1. Conduct the Test and Evaluation Master Plan-required Patriot flight test against a threat-representative anti-radiation missile target. A test to address this recommendation is scheduled for December 2007.
 2. Conduct Red Team penetration testing during mobile flight mission simulator hardware-in-the-loop operational testing to evaluate the effects of information operations attacks on mission performance and to determine the ability of Patriot soldiers to detect, react, recover, and restore following information operations attacks.