

M109 Family of Vehicles (FoV) Paladin Integrated Management (PIM)

Executive Summary

- The Army began the M109 Family of Vehicles (FoV) Paladin Integrated Management (PIM) IOT&E 1 in October 2016 at Fort Hood, Texas. IOT&E 1 was suspended after the first record test vignette because 28 soldiers were affected by toxic fumes released into the M109A7 Self-Propelled Howitzer (SPH) cab.
- Feedback from the root cause analysis indicates that the toxic fumes are related to breech reliability, training on the M109A7, and technical manuals.
- IOT&E 1 was adequate to conclude the M109A7 SPH is not operationally effective and not operationally suitable.
- Cannon artillery units equipped with PIM SPH cannot execute delivery of cannon field artillery munitions using the M232A1 Modular Artillery Charge System (MACS 5H) charge increment, which is needed to reach beyond 18 kilometers of range.
- The M109A7 SPH did not meet reliability, availability, and maintainability requirements.
- The primary M109A7 SPH failure modes are associated with the breech and its sub-components. Demand for repair parts associated with the breech exceeded the supply inventory of operational units. The breech has not changed as part of the M109A7 PIM program.
- In January 2017, DOT&E submitted an Operational Assessment to Congress for the suspended IOT&E. A second IOT&E is scheduled for March 2018 following the Army's implementation of corrective actions from the IOT&E 1.
- The Army continued multiple phases of the M109A7 FoV PIM weapons firing and automotive performance, and reliability developmental testing at Yuma Proving Ground, Arizona.

System

- The M109 FoV PIM consists of two vehicles: the SPH and Carrier Ammunition Tracked (CAT) resupply vehicle.
 - The M109A7 SPH is a tracked, self-propelled 155 mm howitzer designed to improve sustainability over the legacy M109A6 howitzer. The production howitzers have a modified M109A6 turret with a high-voltage electrical system and a modified Bradley Fighting Vehicle chassis, power train, and suspension. The Army is updating the breech based on results from testing in IOT&E 1. A crew of four soldiers operates the SPH and use it to engage targets at ranges of 22 km using standard projectiles and 30 km using rocket-assisted projectiles.
 - The M992A3 CAT supplies the SPH with ammunition. The ammunition carriers have a chassis similar to the SPH. The ammunition carriers are designed to carry



- 12,000 pounds or 98 rounds of ammunition in various configurations. A crew of four soldiers operates the CAT.
- The Army will equip the SPH and CAT with two armor configurations to meet two threshold requirements for force protection and survivability – Threshold 1 (T1) and Threshold 2 (T2).
 - The base T1 armor configuration is integral to the SPH and CAT. The Army intends the T2 configuration to meet protection requirements beyond the T1 threshold with add-on armor kits.
 - The Army plans to employ PIM vehicles in the T1 configuration during normal operations and will equip the SPH and CAT with T2 add-on armor kits during combat operations.
- The Army designed an underbody kit to determine the potential protection an SPH and CAT could provide against IEDs similar to those encountered in Iraq and Afghanistan. The Army purchased five underbelly kits for test purposes. The Army does not intend to equip the SPH or CAT with the underbody kit at this time.
- The Army intends to employ the M109 FoV as part of a Fires Battalion in the Armored Brigade Combat Team and Artillery Fires Brigades.
- The Army plans to field up to 574 sets of the M109 FoV with full-rate production planned for FY18.

Mission

Commanders employ field artillery units equipped with the M109 FoV to destroy, defeat, or disrupt the enemy by providing integrated, massed, and precision indirect fire effects in support of maneuver units conducting unified land operations.

Major Contractor

BAE Systems – York, Pennsylvania

Activity

- The Army began the M109 FoV PIM IOT&E 1 in October 2016 at Fort Hood, Texas. IOT&E 1 was suspended after the first record test vignette because 28 soldiers were affected by toxic fumes released into the M109A7 SPH cab.
- DOT&E submitted an Operational Assessment to Congress for the suspended IOT&E in January 2017.
- A second IOT&E is scheduled for March 2018 at Fort Riley, Kansas.
- The Army continues to conduct Production Qualification Testing (PQT) at Yuma Proving Ground, Arizona.
- The Army is developing concepts for design and production of an extended range cannon and breech assembly.
- In FY18, the Army plans to conduct additional exploitation testing on the SPH to complete validation of modifications to the T1 and T2 armor systems. These modifications are to address vulnerable areas identified in earlier testing.

Assessment

- Although the Army suspended the IOT&E 1, the test was adequate to conclude the M109A7 SPH is not operationally effective and not operationally suitable.
 - In the suspended IOT&E, both the CAT and the SPH showed significant improvement over the speed and maneuverability demonstrated by the legacy ammunition carrier and howitzer.
 - In the suspended IOT&E, breech failures were the most common failure. Eleven of the 16 failures were related to the breech components requiring parts replacement (firing mechanism, plunger pins, firing pin retainers, split rings, obturator pads, etc.) and or field-level repair. The breech is a legacy component from the fielded M109A6 SPH and was not changed as part of the M109A7 PIM program in order to fire propellant charges necessary to attain extended range in combat. Cannon artillery units equipped with the M109A7 SPH cannot execute delivery of cannon field artillery munitions using the M232A1 MACS 5H charge increment, which is needed to reach beyond 18 km of range.
 - During IOT&E 1, a field artillery unit equipped with M109A7 SPH was not able to provide the volume of fire needed to support an Armor Brigade Combat Team due to breech failures.
 - During the test, cannon artillery units equipped with the M109A7 SPH generated a high demand for repair parts associated with the breech in order to correct the frequent failures.
- Since IOT&E 1, the Army developed a phased approach to its breech reliability failures that addresses subcomponents of the legacy breech in phase one, with more comprehensive

- design changes in phase two. Neither phase will change the basic breech design. The phase one changes may reflect a modest increase in reliability over what was seen in IOT&E 1. Although phase one could reflect an increase in reliability, phase two will not be executed until FY19, after IOT&E 2 in FY18.
- In addition to the phase one breech subcomponent improvements, the Army updated technical manuals to address methods to mitigate toxic fumes, maintenance requirements, and breech subcomponent related failures.
- The M109A7 SPH did not meet reliability, availability, and maintainability requirements. The CAT did very well in the suspended IOT&E and shows promise to meet its requirements in IOT&E 2.
- Non-breech reliability problems found on both the CAT and the SPH have been addressed in a comprehensive test-fix-test cycle throughout PQT. Engine component failures in both the CAT and the SPH have been initially traced to transmission oil cooler design discrepancies. An interim design change has mitigated further failures.
- During IOT&E 1, the M1068/A3 Fire Direction Center tracked vehicle could not execute a mix of missions a self-propelled field artillery would be expected to complete. The M1068/A3 Fire Direction Center tracked vehicle cannot keep pace with the PIM FoV, and lacks necessary mobility and reliability.
- The Program Office has taken considerable action to correct deficiencies identified in early testing and to validate associated fixes over the course of the Developmental Performance, Automotive, and LFT&E program.
 - During armor exploitation testing, most of the modified armored areas demonstrated that they provide protection against Key Performance Parameter threats.
 - Changes to the CAT's crew compartment Automatic Fire Extinguisher System (AFES) mitigate the deficiency identified in early testing and reduce its vulnerability to fires.
- The crew compartment AFES in the SPH was designed to protect a small, localized area in the crew compartment. Live fire testing demonstrated that the system is deficient in providing adequate fire survivability. The Program Office is redesigning this system to improve SPH survivability to fires. While not yet optimized, the M109A7 provides improved crew fire safety compared to the currently fielded M109A6 because:
 - The M109A7 has crew compartment AFES capability while the M109A6 has none.
 - The M109A7 has reduced fire hazards compared to the M109A6 because of the replacement of hydraulic systems, found on the M109A6, with electric drives.

FY17 ARMY PROGRAMS

Recommendations

- Status of Previous Recommendations. The Army addressed seven of the previous recommendations. The following recommendations remain valid:
 1. Continue developmental breech component upgrades and verify corrections for the breech deficiencies.
 2. Consider replacing the M1068/A3 Fire Direction Center tracked vehicle with an alternative vehicle until the Armored Multi-Purpose Protection Vehicle is fielded.
 3. Examine suspension component wear associated with road wheels and track pads, and determine whether there is an inconsistency with Bradley in comparable weight configuration.
 4. Correct the deficiencies in the SPH crew compartment AFES and validate those fixes in test.
- FY17 Recommendations. The Army should:
 1. Leverage lessons learned from the suspended IOT&E and develop, implement, and test requisite hardware, software, training, and maintenance actions in comprehensive, operationally realistic IOT&E.
 2. Continue pursuit of final design, development, and testing of new cannon and breech assembly to address legacy breech and cannon reliability and to mitigate range and rate of fire shortcomings of the M109A7 as contrasted with allied and threat cannon artillery systems.

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