

## M109A7 Family of Vehicles (FoV) Paladin Integrated Management (PIM)

### Executive Summary

- The Army began the second M109 Family of Vehicles (FoV) Paladin Integrated Management (PIM) IOT&E on February 26, 2018, at Fort Riley, Kansas.
- The results from the second IOT&E indicate that the system is operationally effective. The Self-Propelled Howitzer (SPH) demonstrated accurate artillery fires, and both the SPH and the Carrier Ammunition Tracked (CAT) conducted movement and maneuver sufficient to keep pace with an Armored Brigade Combat Team.
- The SPH is operationally suitable in environments that require the SPH to fire Modular Artillery Charges 1-4. The SPH is not operationally suitable in environments that require the highest propelling charge, Modular Artillery Charge 5H.
- The CAT resupply vehicle is operationally suitable. The CAT exceeded its reliability and availability requirement.
- The M109A7 SPH met operational availability and maintainability requirements. The Army may need to stockpile spare breech- and cannon-related parts to support operations in a high-intensity environment.
- In the second IOT&E, the Army updated technical manuals to address methods to mitigate toxic fumes, to amplify system maintenance requirements, and to prescribe recurring breech subcomponent preventive and corrective maintenance tasks.
- In July 2018, DOT&E submitted a report to Congress for the second IOT&E.
- The Army plans to continue developmental testing of the M109A7 FoV PIM weapons firing to address planned improvements to the breech and increased reliability. The Army will conduct missions with soldier crews as part of the breech reliability testing to address those missions not completed during the IOT&E.

### System

- The M109 FoV PIM program consists of two vehicles: the SPH and CAT resupply vehicle.
  - The M109A7 SPH is a tracked, self-propelled 155 mm howitzer designed to improve sustainability over the legacy M109A6 howitzer. The Army is updating the breech based on results from testing in the second IOT&E.
  - 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 requirement 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 underbody 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 689 sets of the M109 FoV with full-rate production planned for FY19.

### 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

# FY18 ARMY PROGRAMS

## Activity

- The Army began the final unit training for the second IOT&E in January 2018. The IOT&E began with the pilot test on February 26; record test vignettes began on March 8; and the operational test ended on March 21. The Army conducted testing in accordance with a DOT&E-approved Test and Evaluation Master Plan (TEMP) and test plan.
- The Army conducted a second cybersecurity test in accordance with a DOT&E-approved test plan.
- DOT&E submitted a report to Congress for the second IOT&E in July 2018 and the LFT&E report in June 2018.
- The Army will continue to conduct developmental testing to address breech reliability fixes and will address missions not fired during the IOT&E, such as firing the Modular Artillery Charge System 5H at high quadrant elevation, in an excursion event with soldier crews as part of the breech reliability testing.
- The Army is developing concepts for design and production of an extended range cannon and breech assembly.
- The Army updated technical manuals and training to address methods to mitigate toxic fumes, to amplify system maintenance requirements, and to prescribe recurring breech subcomponent preventive and corrective maintenance tasks.
- The M109A7 SPH met the Army's availability and maintainability requirements. It did not meet reliability requirements. The CAT did very well and met both its reliability and availability requirements.
- The Program Office made progress in correcting deficiencies identified in previous cyber testing. The results of the second cyber test can be found in the classified annex to the July 2018 DOT&E report.
- The Program Office has taken 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 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 and is deficient in providing adequate fire survivability. The Program Office is developing courses of action to redesign this system and improve SPH crew survivability to fires. While not yet optimized, the M109A7 provides improved crew fire safety compared to the currently fielded M109A6 because:
  - The M109A7 has limited AFES capability in the crew compartment 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.

## Assessment

- The M109A7 FoV PIM system is operationally effective. A field artillery unit equipped with the SPH provided accurate artillery fires. Both the CAT and SPH showed significant improvement over the speed and maneuverability demonstrated by the legacy ammunition carrier and howitzer; movement and maneuver was sufficient to keep pace with an Armored Brigade Combat Team.
- The SPH is operationally suitable in environments that require firing Modular Artillery Charges 1-4. In environments that require Modular Artillery Charge 5 with high rates of fire, volumes of fire, and range, such as those envisioned by the Army Operational Mode Summary/Mission Profile (OMS/MP), breech- and cannon-related subcomponent failures frequently prevented achievement of Army reliability and responsiveness standards.
  - In the IOT&E, breech- and cannon-related sub-component failures were the most common failure. The breech is a legacy component from the fielded M109A6 SPH and was not changed as part of the M109A7 PIM program. During the IOT&E, the cannon artillery unit equipped with the M1097A7 SPH generated a high demand for repair parts to correct the frequent failures and maintain operational availability consistent with Army requirements.
  - Since the first IOT&E, the Army began implementing a two-phased approach to correct legacy breech reliability failures. Phase one addresses subcomponents of the legacy breech; phase two comprises more comprehensive design changes for the gun mount and cradle. Neither phase changes the basic breech design. The Army implemented the phase one changes during the second IOT&E. The Army plans to implement and test the phase two breech changes in FY19 and 20. DOT&E will observe the firings.

## Recommendations

The Army should:

1. Continue to pursue the final design, development, and integrated testing of a new cannon and breech assembly to address legacy breech and cannon reliability to mitigate range and rate of fire shortcomings in the M109A7 SPH.
2. Consider stockpiling breech parts with deployed artillery units or prepositioned fleets.
3. Resolve the identified cybersecurity vulnerabilities; refine tactics, techniques, and procedures relating to the identification of cybersecurity threat activity and responses.
4. Correct the deficiencies in the SPH's crew compartment AFES and validate those fixes in test.