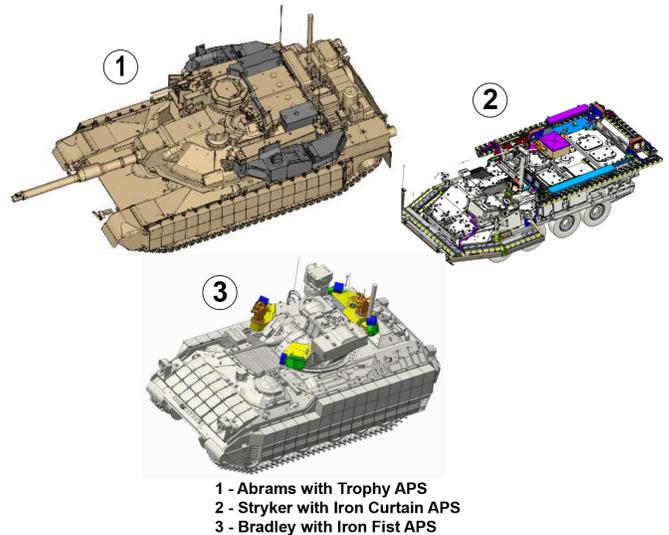


Active Protection Systems (APS) Program

Executive Summary

- On October 12, 2016, in support of the European Deterrence Initiative, the Army G-8 issued a Directed Requirement to procure and rapidly field (by FY20) Non-Developmental Item (NDI) Active Protection Systems (APS) to one Armored Brigade Combat Team (Abrams and Bradley vehicles) of pre-positioned stocks and to one Stryker battalion task force.
- The Army intends for APS to improve the survivability of combat vehicles against anti-tank guided missile, rocket-propelled grenade, and recoilless rifle threats by using kinetic “hard kill” options to intercept and disrupt/defeat the incoming threat warhead.
- On February 18, 2017, the Army Acquisition Executive approved an Acquisition Decision Memorandum authorizing expedited installation and characterization of three NDI “hard kill” APS to assess maturity, performance, and integration risk. The following systems were selected: Rafael Trophy APS for the Army Abrams M1A2 and Marine Corps M1A1 tanks, the IMI Systems Iron Fist APS for the Bradley vehicles, and the Artis Iron Curtain for the Stryker vehicles.
- The Army divided APS testing into three phases: Phase 1 is the characterization phase, Phase 2 is the urgent material release (UMR) phase, and Phase 3 is the program of record phase.
- The Army completed Phase 1 Trophy testing in September 2017; Phase 1 Iron Curtain and Iron Fist testing is ongoing.
- Phase 1 Trophy live fire testing demonstrated the ability of the APS to successfully intercept two of the three class threats tested and the potential to provide improved protection against these threats when compared to the existing systems without APS. This capability was demonstrated under benign range conditions and simple threat scenarios inhibiting an assessment of the APS performance with confidence.
 - The Army performed the majority of the tests on a ballistic hull and turret asset that did not independently power the APS, nor have any internal operational features as they would in a fielded configuration.
 - The level of involvement and control of the foreign contractor, Rafael, was high. In many cases, the Army allowed Rafael to adjust the test events to be conducted, provide exclusion zones, and precondition systems with software fixes.
 - Expected software and potential hardware changes in Phase 2 may limit the applicability of Phase 1 results towards overall system evaluation.
- Phase 1 Trophy user testing identified a degradation in turret traverse performance resulting from an imbalance of the turret due to the additional weight of the Trophy system. Subsequent user testing identified several mitigations that



- reduce the effect of the imbalance enough for crews to conduct combat operations with the additional weight.
- Given the Phase 1 testing limitations, a more operationally realistic testing effort will be required in Phase 2 to support the UMR.

System

- The APS solutions consist of multiple components and subsystems that enable the system to detect and declare a threat, deploy countermunitions, and disrupt/defeat the threat. A successful APS intercept of a threat does not imply the absence of residual damage.
- The Army selected Rafael Trophy APS to be installed and characterized on the Army Abrams M1A2 and Marine Corps M1A1 tanks. The Trophy system engages incoming threats with a kinetic projectile intended to destroy the threat or cause early initiation. The Abrams base armor is expected to be able to absorb threat residuals. The Trophy APS adds approximately 5,000 pounds to the platform. In addition to the installation of the Trophy system onto the tank, the Army has incorporated limited integration of the Trophy system into the tank’s situational awareness system.
- The Army selected the IMI Systems Iron Fist to be installed and characterized on the Bradley. The Iron Fist engages incoming threats with an explosive projectile intended to destroy or divert the threat, and adds approximately 450 pounds to the platform. The fielded Bradley A3 does not generate sufficient power to operate the APS. The Bradley A4, which is currently under development, does generate sufficient power, so power components from the Bradley A4 must be integrated into the APS test asset.

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- The Army selected the Artis Iron Curtain to be installed and characterized on the Stryker. The Iron Curtain engages incoming threats with a kinetic projectile intended to prevent function of the warhead. The Iron Curtain adds approximately 5,700 pounds to the Stryker vehicle.

Mission

- Army and Marine units intend to use Abrams main battle tanks equipped with the Trophy APS to close with and destroy the enemy by fire and maneuver across the full range of military operations.
- Army units use Bradley vehicles equipped with the Iron Fist APS to provide protected transport of soldiers; provide

overwatching fires to support dismounted infantry and suppress an enemy; and to disrupt or destroy enemy military forces and control land areas.

- Army commanders use Stryker vehicles equipped with the Iron Curtain APS to disrupt or destroy enemy military forces, to control land areas including populations and resources, and to conduct combat operations to protect U.S. national interests.

Major Contractors

- Rafael Advanced Defense Systems Ltd. – Haifa, Israel
- IMI Systems – Ramat HaSharon, Israel
- Artis, LLC – Reston, Virginia

Activity

- The Army divided APS testing into three phases:
 - Phase 1 (characterization phase) consists of limited characterization testing of threat interaction on the APS system. It is intended to determine fundamental performance and limitations of the system and to provide initial insight into the potential effects of installation of APS systems on the host platforms.
 - Phase 2 (UMR phase) should consist of testing the production-representative APS installed on operationally representative systems under realistic combat conditions to adequately assess the true capabilities and limitations of the systems, as intended to be used in combat, prior to fielding.
 - Phase 3 (program of record phase) should assess the effectiveness, suitability, and survivability of the system equipped with production-representative APS under realistic combat conditions against the spectrum of operationally relevant threats.
- The Army is currently executing Phase 1. Phase 2 is anticipated to begin in January 2018. The start of Phase 3 has not yet been determined.
- The Army conducted Phase 1 Trophy live fire testing at Redstone Arsenal, Alabama, from April through July 2017. Live fire testing included a total of 46 test events.
 - Twenty-nine performance characterization tests on Abrams to demonstrate basic, vendor-claimed APS capabilities. If the APS vendor did not project a successful engagement then the program manager either modified or eliminated the engagement. These tests included seven collateral damage collection events (in conjunction with live threat-counter munition interaction) to assess the potential injury to dismounted soldiers from fragmentation produced during an APS engagement.
 - Eight tests to demonstrate APS performance in operationally relevant and stressing conditions to include three simultaneous (dual) threat engagement tests, two defilade tests, one elevated foliage test, and two tests with metallic clutter on the ground to assess potential radar interference. The program manager deferred testing of one

threat class, tests in urban environments and tests in rainy conditions, originally planned for Phase 1 to Phase 2.

- Nine additional characterization tests on a Marine Corps M1A1 tank using inert rounds to determine APS system performance on a moving (vehicle and/or turret) platform.
- The Army conducted two Phase 1 Trophy user events at Yuma Test Center, Arizona, in June and September 2017.
- Phase 1 testing of the Iron Fist APS implementation on Bradley has been hampered by vehicle power requirements and some component software problems. Consequently, Phase 1 testing of Iron Fist APS on Bradley is 4 months behind schedule.
- Phase 1 testing of Iron Curtain APS on Stryker has been hampered by the replacement of some of the APS components to include the radar. Consequently, Phase 1 testing of Iron Curtain APS on Stryker is 6 months behind schedule.
- Phase 2 test planning is ongoing. The Army has not yet delivered a plan for DOT&E review.
- Contingent upon successful installation and characterization for all three platforms (Phase 1) and guidance from the Army Requirements Oversight Council (AROC), the Army is expected to complete the necessary design and tailored testing (Phase 2) to procure and rapidly field APS to one Armored Brigade Combat Team (Abrams and Bradley vehicles) of pre-positioned stocks, and to one Stryker battalion task force, under a UMR basis. Direction from the AROC may include additional sets to be fielded.

Assessment

- Phase 1 Trophy live fire testing demonstrated the capability of the Trophy APS system to counter two of the three class threats tested. However, the additional protection afforded to the crew and system by the APS and the tradeoff between APS performance and known performance of reactive armor tiles (which APS replaces on certain parts of the vehicle) should be further verified in Phase 2 testing. Phase 1 testing included several limitations that inhibit an assessment of the APS performance with confidence.

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- The Army conducted testing on assets that were not configured for combat, and often lacked critical components such as a functional engine. This inhibited the ability to assess any adverse effects of the APS on vehicle power generation capability.
- Tests were severely limited in realism by unexpected system corrections, calibrations, and limitations imposed by the contractors. Some contractors also communicated several unexpected performance limitations of their APS systems, requiring extensive modification of planned test events. Because of these and other limitations, it is reasonable to assume that any performance reporting from Phase 1 is optimistic and needs to be confirmed in more operationally realistic conditions in Phase 2.
- The test design did not incorporate suitable means for quantifying residual vehicle penetration because rolled homogeneous armor plates were used as witness material in lieu of the complex armors present on the Abrams.
- Phase 1 Trophy user testing in June identified a turret weight imbalance problem caused by the addition of Trophy. The September event demonstrated that mitigations can minimize the effect of the weight imbalance.
 - The June 2017 user assessment event identified a degradation in turret traverse performance resulting from an imbalance of the turret due to the additional weight of the Trophy system. The crew could not traverse the turret manually on slopes greater than 5 degrees and power traverse capability was degraded on slopes greater than 8 degrees. Technical analysis indicated a high likelihood of delays between pulling the trigger and the main gun round actually firing.
 - The subsequent user testing in September 2017 identified several mitigations that reduced the degradation in turret traverse performance enough for crews to conduct combat operations with the additional weight, and the potential trigger delay problems were not observed during the event. The Army has not made a final decision on the final configuration for mitigations.
- The UMR Phase 2 effort should inform the Army's decision to field any of the APS systems on these vehicles. This decision should be made not only on the basis of threat defeat criteria and comparison to vehicles that are not APS-enabled, but also with the risks associated with operating in all battlefield and operational conditions. Unit combat effectiveness and risks associated with collateral effects, maintenance, and user-based tactics, techniques, and procedures should also be kept firmly in mind.

Recommendations

- Status of Previous Recommendations. This is the first annual report for this program.
- FY17 Recommendations. The Army should:
 1. Ensure that Phase 2 test assets are fully functional and configured for combat to determine the true performance of the APS in an operationally realistic configuration and environment.
 2. Focus Phase 2 testing more on the combat vehicle and crew/occupant instead of solely on threat/countermunition interaction from the APS engagement; this is the only way true unit-level survivability can be assessed to inform decisions regarding risks in an operational context.
 3. Minimize contractor involvement in Phase 2 testing to the extent possible.
 4. Design Phase 2 testing to enable an assessment of any residual damage effects even given a successful intercept of the threat.
 5. Include an adequate user assessment to ensure turret imbalance does not further degrade system performance.
 6. Include logistical considerations for installation, maintenance, countermunition resupply, and transportation in future test design.

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