

Assault Amphibious Vehicle Survivability Upgrade (AAV-SU)

Executive Summary

- The Assault Amphibious Vehicle Survivability Upgrade (AAV-SU) program conducted LFT&E from April 2016 to June 2017 and an operational assessment (OA) from April to June 2017.
- The Engineering and Manufacturing Development (EMD) Phase LFT&E focused on a limited number of specification compliance shots and demonstrated that AAV-SU meets its force protection requirements.
- The AAV-SU-equipped test unit successfully completed seven of eight mission profiles during the OA, demonstrating adequate capability in both desert and littoral environments to include entering and exiting the USS *San Diego* (LPD 22), an amphibious transport dock ship. In some cases, vehicle failures and transmission problems reduced combat power and caused delays during mission execution. In the unsuccessful mission profile, a sufficient number of vehicles could not be repaired in time to start the mission.
- Data from the OA indicate that reliability remains a problem for the AAV-SU. The AAV-SU's Mean Time Between Operational Mission Failures (MTBOMF) was 10.7 hours during the OA, as compared to the 14.2 hours demonstrated in developmental testing and the 25-hour user requirement.

System

- The AAV family of vehicles is the U.S. Marine Corps' principal amphibious lift system and armored personnel carrier. It is designed to provide combat support, armor protected firepower, and mobility for a reinforced rifle squad and associated combat equipment for operations on land or at sea.
- After-action reports from Operation Iraqi Freedom highlighted AAV shortfalls in survivability against explosive threats such as landmines and IEDs. These shortfalls limited the employment of AAVs in Iraq after 2007 and precluded employment in Afghanistan.
- The marines intend for the AAV-SU program to improve force protection against ballistic and underbelly explosive threats and maintain land and water mobility performance.
 - The survivability upgrades include new external armor, an added spall liner, underbelly protection, lower sidewall protection, integrated blast-mitigating seats, and improved fuel tanks.
 - The performance upgrades account for the added weight due to survivability upgrades and include improvements



to the powertrain and suspension in order to maintain or increase the vehicle's land and water mobility performance compared to the current vehicle, the AAV Reliability, Availability, Maintainability/Rebuild to Standard (AAV RAM/RS).

- Initial Operational Capability for the AAV-SU is planned for FY19. The Marine Corps intends the AAV-SU to reach Full Operational Capability in FY23 and it must be sustained until at least 2035. The Marine Corps will field AAV-SU vehicles to each of its two active-component Assault Amphibian Battalions, the Combat Assault Battalion, 3rd Marine Division, and the Combat Assault Company, 3rd Marine Regiment. Additional vehicles will be utilized for training, testing, and supporting the maintenance cycle.

Mission

- Commanders employ Assault Amphibian Battalions to provide task-organized forces to transport assault elements, equipment, and supplies ashore; execute ship-to-shore, shore-to-shore, and riverine operations; support breaching of barriers and obstacles; and provide embarked infantry with armor protected firepower, communication assets, and mobility.
- AAV-SU-equipped units support surface power projection and forcible entry against a defended littoral region.

Major Contractor

SAIC – McLean, Virginia

Activity

- The U.S. Army Aberdeen Test Center conducted EMD Phase LFT&E for the AAV-SU from April 2016 to June 2017 at Aberdeen Proving Ground, Maryland, in accordance with DOT&E-approved test plans. LFT&E was adequate to support an evaluation of the AAV-SU force protection requirements:
 - System-level live fire testing characterized the AAV-SU force protection against two underbody mines, one undertrack mine, and one side IED event.
 - Ballistic exploitation testing of the AAV-SU characterized the abilities of unique features on the AAV-SU (e.g., gaps, seams, and unique geometries) to provide protection against ballistic threats.
- The Marine Corps Operational Test and Evaluation Activity (MCOTEA) conducted a pre-Milestone C OA from April 12 through June 14, 2017, and a Cooperative Vulnerability and Penetration Assessment (CVPA) at the Marine Corps Air Ground Combat Center, Twentynine Palms, California, and Marine Corps Base Camp Pendleton, California, in accordance with the DOT&E-approved test plan. The OA was adequate to support an evaluation of the AAV-SU.
 - The transmission has a hydraulic braking system that is used to slow or stop the vehicle. This transmission braking system has a safety feature that automatically brakes the vehicle in the event of certain automotive problems. If the driver manually applies the brakes after the system brakes itself automatically, all hydraulic pressure will be lost, and the brakes will lock. This results in a time-consuming and difficult process to unlock the brakes and requires one of the crew to be exposed outside the hull of the vehicle to gain access to a lever that is pumped in order to restore pressure to the system.
 - The AAV-SU accommodated 17 marines in cramped conditions despite some omitted equipment and supplies. The effects were:
 - The embarked troop commander could not egress through the AAV-SU troop compartment, as is done with the AAV RAM/RS, because of reduced clearance between his position and the troop compartment. Instead, he had to exit through the top-side hatch and climb down from the top of the vehicle on an exposed, narrow ladder, which caused him to lose contact with his personnel at a critical point.
 - Egress time, or the amount of time needed for the embarked infantry to exit the vehicle tactically, is prescribed by the user to be 18 seconds for the reinforced rifle squad loads. The AAV-SU combined (day and night) median egress time was 29 seconds, which exceeded the user requirement and was 11 seconds slower than the median value demonstrated for the AAV RAM/RS during the OA.
 - The CVPA investigated the ability to disrupt communications and exploit the controller area network (CAN) bus and the vendor's maintenance laptop. The CVPA verified that the CAN bus was isolated from the network, thereby preventing an outsider from exploiting this vehicle component network. The cyber test team found no outsider vulnerabilities. Details of cybersecurity vulnerabilities are discussed in the classified appendix to DOT&E's October 2017 OA report.

Assessment

- The AAV-SU-equipped test unit successfully completed seven of eight mission profiles during the OA and was able to shoot, move, and communicate in order to close with and destroy the enemy in both desert and littoral environments.
 - The test unit demonstrated sufficient cross-country mobility and was able to operate with an M1A1 tank section during a desert mission profile.
 - During littoral operations, the AAV-SU-equipped test unit was able to enter and exit LPD 22 (an amphibious transport dock ship), operate in the ocean, and cross the surf zone.
 - Data from the OA indicate that reliability remains a problem for the AAV-SU. The AAV-SU entered the OA with less-than-required reliability observed during developmental testing. AAV-SU's MTBOMF was 10.7 hours in the OA, as compared to the 14.2 hours demonstrated in developmental testing, the 25-hour growth curve prediction, and the 25-hour user requirement. The revised reliability growth strategy is optimistic and does not reach the required MTBOMF by the IOT&E scheduled for 2QFY19.
 - The vehicle transmission was the source of three move-related problems:
 - When the AAV-SU's tracks are used for water propulsion, the crew can operate in this mode for just a short time before the transmission overheats – a problem that manifested itself when the water jets malfunctioned.
 - When coming ashore, AAV crews engage tracks prior to entering the surf zone providing both water jets and tracks for propulsion. The AAV-SU transmission requires the driver to slow the engine speed to idle before shifting, causing a pause during a critical sea-to-shore transition and creating a period of vulnerability during a contested beach landing.
 - LFT&E characterized vulnerabilities to operationally realistic direct and indirect fire threats that the AAV-SU is expected to encounter in combat. This included a number of specification compliance shots that demonstrated that AAV-SU meets its force protection requirements.
 - The AAV-SU meets its force protection requirements for underbody threats.
 - A vulnerability in the initial AAV-SU design was discovered during the first underbody mine event. The contractor implemented fixes to correct this vulnerability. The test of the design modifications demonstrated adequate protection.
 - A vulnerability was discovered during the side IED event. The program addressed this vulnerability, and the AAV-SU will be

retested against this threat during Full-Up System-Level live fire testing in the Production and Deployment (PD) phase.

- The bow armor will require additional testing in the PD phase to characterize its level of protection.

Recommendations

- Status of Previous Recommendations. The Marine Corps is working to ensure that enough test assets (e.g., armor coupons) are allocated for the appropriate phases of test for both the AAV-SU and Amphibious Combat Vehicle 1.1 programs.
- FY17 Recommendations. The following is a summary of key recommendations. A complete list of recommendations is contained in DOT&E's OA report dated October 2017.
 1. Reduce the troop capacity threshold and modify the vehicle troop compartment to allow a combat-configured marine to

egress through the vehicle's troop compartment; allow more space for embarked marines; store required crew-served weapons, supplies, ammunition, and equipment; and improve egress times.

2. Revise the reliability growth strategy to reflect the lower than projected reliability during EMD phase developmental and operational testing.
3. Modify the vehicle or develop operational procedures to allow the crew to transition from water jets to track operations when coming ashore without a delay; prevent automatic locking of brakes when the driver inadvertently presses the brake pedal after the vehicle automatically brakes itself; allow the crew to restore brake/transmission pressure from within the vehicle; and support water track operations without the transmission overheating.

FY17 NAVY PROGRAMS