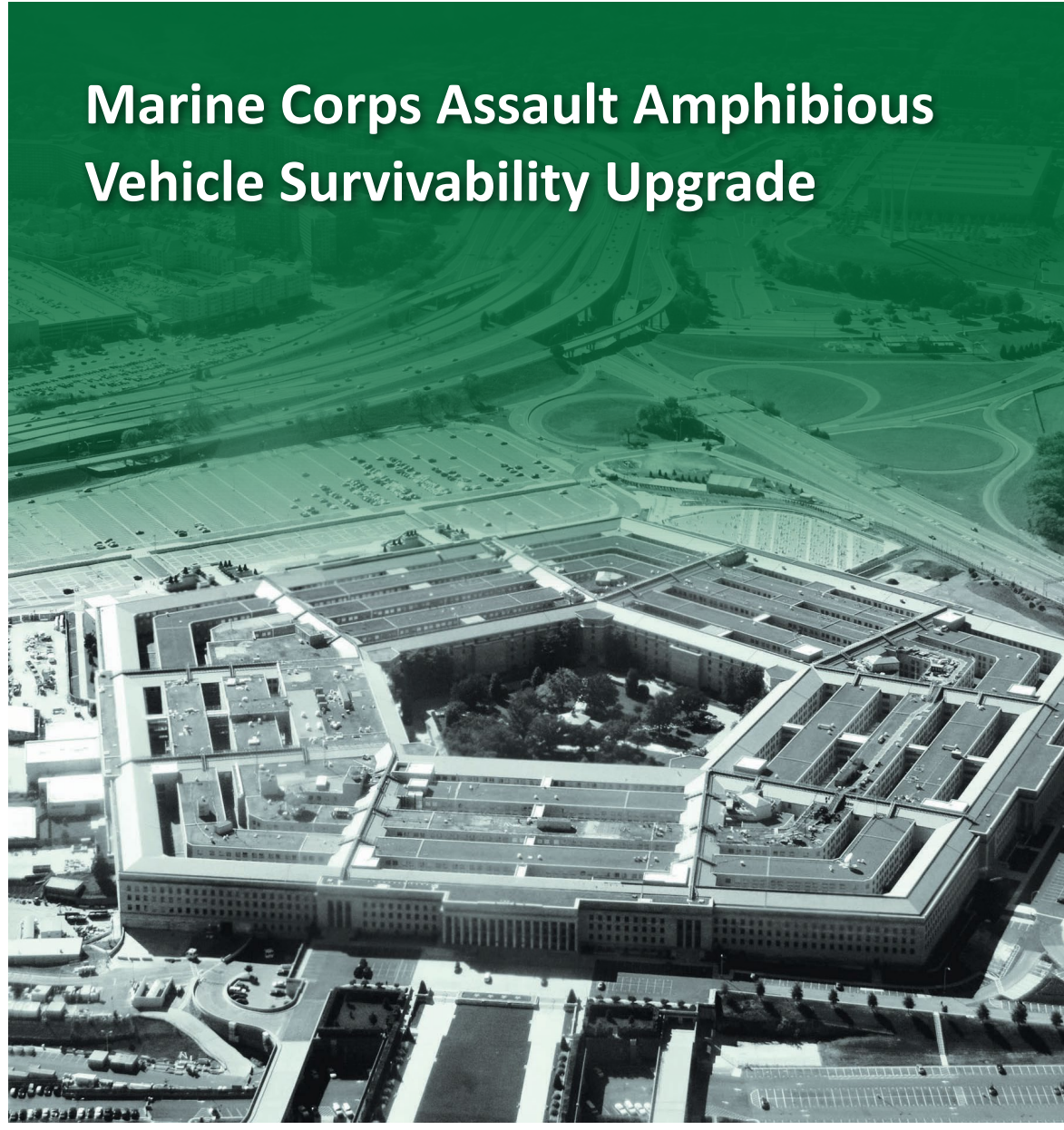


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INSPECTOR GENERAL

U.S. Department of Defense

JANUARY 4, 2018



Marine Corps Assault Amphibious Vehicle Survivability Upgrade

INTEGRITY ★ EFFICIENCY ★ ACCOUNTABILITY ★ EXCELLENCE

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Results in Brief

Marine Corps Assault Amphibious Vehicle Survivability Upgrade

January 4, 2018

Objective

We determined whether the Marine Corps effectively managed the Assault Amphibious Vehicle (AAV) survivability upgrade. Specifically, we determined whether the Program Manager, Advanced Amphibious Assault (program office) increased the AAV's force protection and whether the survivability upgrade met all program requirements.

Background

The AAV is a tracked combat vehicle that can immediately transition from water to land operations. The purpose of the survivability upgrade is to increase the AAV's force protection and provide the Marine Corps an amphibious assault capability until the fielding of the new Amphibious Combat Vehicle. The program office plans to upgrade 405 AAVs by FY 2023 for an estimated procurement cost of \$835 million. The Program Executive Officer Land Systems, as the milestone decision authority, approved the initial production of 18 upgraded vehicles in August 2017.

Finding

The program office achieved its primary requirement to improve the AAV's force protection. However, the program office did not achieve all program requirements, including cost control, tactical egress, and reliability, before beginning initial production. This occurred because vehicle updates and design changes:

- increased costs above the average procurement unit cost objective of \$1.65 million per vehicle,

Finding (cont'd)

- prevented a troop commander wearing full personal protective equipment from exiting the rear of the vehicle, and
- reduced the vehicle's reliability. The AAV survivability upgrade also experienced failures of its legacy parts affecting its reliability performance.

As a result, program officials began initial production on vehicles that did not meet all program requirements. The AAV survivability upgrade may require future modifications and additional funds if the troop commander cannot safely exit the rear of the vehicle and the program office cannot improve the AAV's reliability and functionality. In addition, reduced vehicle reliability could decrease the number of operational vehicles, increase the number of upgraded vehicles and spare parts, or increase maintenance time.

Recommendations

We recommend that the Program Executive Officer Land Systems reestablish a cost control to minimize procurement costs. In addition, the Program Executive Officer Land Systems should test and verify that a troop commander wearing full personal protective equipment can exit the rear of the vehicle. The Program Executive Officer Land Systems should also develop a solution, in coordination with Headquarters Marine Corps, Combat Development and Integration, for the AAV survivability upgrade to demonstrate the required level of reliability before procuring additional low-rate initial production vehicles.

Management Comments and Our Response

The Program Executive Officer Land Systems did not address the recommendation to reestablish a cost control to minimize procurement costs; therefore, the recommendation is unresolved and remains open. The Program Executive Officer stated that cost controls are necessary and are



Results in Brief

Marine Corps Assault Amphibious Vehicle Survivability Upgrade

Management Comments (cont'd)

in place as established by the acquisition program baseline. In addition, the program office is required to report costs quarterly to the Program Executive Officer Land Systems and the Assistant Secretary of the Navy (Research, Development, and Acquisition). We request that the Program Executive Officer Land Systems provide additional comments regarding how the acquisition program baseline will minimize procurement costs.

The Program Executive Officer Land Systems addressed all specifics of the recommendation to verify that the troop commander can exit the rear of the vehicle before procuring additional low-rate initial production vehicles. Therefore, this recommendation is resolved, but will remain open. We will close this recommendation once we verify that the program office demonstrated the troop commander wearing full personal protective equipment can exit the rear of the vehicle.

The Program Executive Officer Land Systems partially addressed the recommendation to develop a solution, in coordination with Headquarters Marine Corps, Combat Development and Integration, for the AAV survivability upgrade to demonstrate the required level of reliability before procuring additional low-rate initial production vehicles. Therefore, this recommendation is unresolved and remains open. The Program Executive Officer stated that the AAV survivability upgrade Milestone C Acquisition Decision Memorandum established criteria for the AAV survivability upgrade to demonstrate reliability acceptable to the Director, Capabilities Development Directorate before the full-rate production decision. However, the memorandum also states that the Marine Corps should withhold award of additional low-rate initial production vehicles until the AAV survivability upgrade demonstrates reliability acceptable to Headquarters Marine Corps, Combat Development and Integration. We request that the Program Executive Officer Land Systems provide comments on the final report regarding the solution to improve the AAV survivability upgrade's reliability before procuring additional low-rate initial production vehicles.

Please see the Recommendations Table on the next page for the status of the recommendations.

Recommendations Table

Management	Recommendations Unresolved	Recommendations Resolved	Recommendations Closed
Program Executive Officer Land Systems	1.a and 1.c	1.b	None

Note: The following categories are used to describe agency management’s comments to individual recommendations.

- **Unresolved** – Management has not agreed to implement the recommendation or has not proposed actions that will address the recommendation.
- **Resolved** – Management agreed to implement the recommendation or has proposed actions that will address the underlying finding that generated the recommendation.
- **Closed** – OIG verified that the agreed upon corrective actions were implemented.





**INSPECTOR GENERAL
DEPARTMENT OF DEFENSE
4800 MARK CENTER DRIVE
ALEXANDRIA, VIRGINIA 22350-1500**

January 4, 2018

MEMORANDUM FOR UNDER SECRETARY OF DEFENSE FOR ACQUISITION, TECHNOLOGY,
AND LOGISTICS
DIRECTOR, OPERATIONAL TEST AND EVALUATION
NAVAL INSPECTOR GENERAL

SUBJECT: Marine Corps Assault Amphibious Vehicle Survivability Upgrade
(Report No. DODIG-2018-060)

We are providing this report for review and comment. The Program Manager, Advanced Amphibious Assault, increased the Assault Amphibious Vehicle's force protection; however, the survivability upgrade did not meet all program requirements, including cost, tactical egress, and reliability, before beginning initial production. We conducted this audit in accordance with generally accepted government auditing standards.

We considered management comments on a draft of this report when preparing the final report. DoD Instruction 7650.03 requires that recommendations be resolved promptly. The Program Executive Officer Land Systems agreed with the recommendations, but did not address the specifics of Recommendation 1.a and 1.c. We request that the Program Executive Officer Land Systems provide additional comments to the final report on Recommendations 1.a and 1.c by February 5, 2018. Comments provided to the final report must be marked and portion-marked, as appropriate, in accordance with DoD Manual 5200.01.

Please send a PDF file containing your comments to audclev@dodig.mil. Copies of your comments must have the actual signature of the authorizing official for your organization. We cannot accept the /Signed/ symbol in place of the actual signature. If you arrange to send classified comments electronically, you must send them over the SECRET Internet Protocol Router Network (SIPRNET).

We appreciate the courtesies extended to the staff. Please direct questions to Mr. Kenneth VanHove at (216) 535-3777 (DSN 499-9946).

A handwritten signature in black ink that reads "Troy M. Meyer".

Troy M. Meyer
Principal Assistant Inspector
General for Audit

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Introduction

Objective

We determined whether the Marine Corps effectively managed the Assault Amphibious Vehicle Survivability Upgrade (AAV SU). Specifically, we determined whether the program office increased the AAV's force protection and whether the survivability upgrade met all program requirements. See Appendix A for a discussion of the scope and methodology related to the audit objective.

Background

The AAV is a tracked combat vehicle that can immediately transition from water to land operations. The AAV has been in the Marine Corps inventory since 1972 and has undergone four modernization efforts. The most recent effort was the Reliability, Availability, Maintainability/Rebuild to Standard (RAM/RS), which occurred in 1998 to upgrade the AAV engine, transmission, and suspension. The Marine Corps removed the RAM/RS from combat in Iraq in 2007, and the vehicle was not used in Afghanistan because it could not protect personnel against explosive threats, including improvised explosive devices. The Marine Corps originally intended to replace the RAM/RS with the Expeditionary Fighting Vehicle; however, the Marine Corps canceled the program in 2011 due to cost and schedule delays. The purpose of the survivability upgrade is to improve force protection of the RAM/RS and provide the Marine Corps an amphibious assault capability until the fielding of the new Amphibious Combat Vehicle. Figure 1 shows an AAV SU.



Figure 1. AAV SU

Source: Director, Operational Test and Evaluation FY 2016 Annual Report.

The Marine Corps plans to upgrade 466 of its 964 RAM/RS vehicles in two increments and sustain them through FY 2035. The first increment will upgrade 405 personnel and command and control vehicles by FY 2023 for an estimated procurement cost of \$835 million. The second increment will partially upgrade 61 recovery and mine countermeasure vehicles by FY 2026. The Marine Corps has not identified the requirements and associated costs for these partially upgraded vehicles because the second increment is a future program requirement. Table 1 details the number of planned upgrades by AAV variant.

Table 1. Number of Upgraded AAV SU Variant

Variant	Quantity	
	Increment 1	Increment 2
Personnel	361	0
Command and Control	44	0
Recovery	0	39
Mine Countermeasure	0	22
Total	405	61

Source: Headquarters Marine Corps, Combat Development and Integration.

Program Management

The Program Executive Officer Land Systems reports to the Assistant Secretary of the Navy (Research, Development, and Acquisition) and approves program decisions as the milestone decision authority for the AAV SU program.

The Program Manager, Advanced Amphibious Assault, (program office) reports to the Program Executive Officer Land Systems and oversees life cycle management, including day-to-day implementation of cost, schedule, and performance objectives. In addition, the program office develops tests to ensure the AAV SU meets program requirements established in the capability documents.

Headquarters Marine Corps, Combat Development and Integration

Headquarters Marine Corps, Combat Development and Integration (CD&I) officials develop future operation concepts and determine how to organize, train, and equip the Marine Corps. CD&I coordinated with Marine Corps officials to validate the AAV SU performance requirements and developed the capability documents.

Marine Corps Operational Test and Evaluation Activity

The Marine Corps Operational Test and Evaluation Activity provides operational testing and evaluation for the Marine Corps and coordinates with CD&I to resolve problems with performance requirements. The Marine Corps Operational Test and Evaluation Activity provided input on the AAV SU live-fire test and evaluation strategy and test and evaluation master plan. In addition, the Marine Corps Operational Test and Evaluation Activity planned and conducted the AAV SU operational test and evaluation from April through June 2017.

Director, Operational Test and Evaluation

The Director, Operational Test and Evaluation (DOT&E), oversees operational and live-fire test and evaluation for designated DoD systems, including the AAV SU. The DOT&E provides independent assessments of the system to the Secretary of Defense; Under Secretary of Defense for Acquisition, Technology, and Logistics; and Congress. The DOT&E ensured operational and live-fire test and evaluation was adequate to confirm the operational effectiveness, suitability, and survivability of the AAV SU in combat.

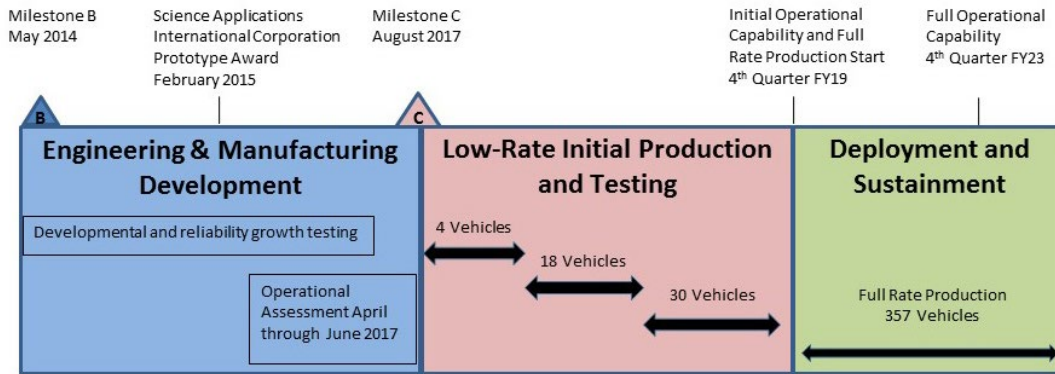
Acquisition Milestones

The Defense Acquisition System uses three milestones to manage major defense acquisition programs.

- Milestone A initiates technology development and risk reduction.
- Milestone B initiates engineering and manufacturing development.
- Milestone C initiates initial production and deployment.

On October 29, 2013, the Marine Corps awarded two contracts, one to British Aerospace Engineering, and one to Science Applications International Corporation to demonstrate a design solution and provide test support for the AAV SU. The AAV SU entered Milestone B in May 2014. During the engineering and manufacturing development phase, the program office conducted the preliminary and critical design reviews. During these reviews, the program office assessed whether the vehicle design could meet performance requirements and selected Science Applications International Corporation to build the prototype vehicles. The contract included additional initial production options that could increase the contract's value to \$193.80 million. The Program Executive Officer Land Systems approved the program to enter Milestone C and begin the initial production of 18 upgraded vehicles in August 2017. The program office plans to use these vehicles for additional reliability testing, giving them the opportunity to meet performance requirements before full-rate production. Figure 2 illustrates the three AAV SU program milestones.

Figure 2. Acquisition Milestones for the AAV SU Vehicle



Source: The DoD OIG.

Vehicle Performance Requirements

The AAV SU capability documents identified key performance parameters (primary), key system attributes (secondary), and additional system attributes (third-level) requirements to perform amphibious assault missions in various terrains and environments. Primary requirements are critical to developing effective military capability. Secondary requirements are necessary to achieve a balanced-system solution, but not critical enough to be primary requirements. Third-level requirements are not as critical as primary or secondary requirements, but still determine the vehicle's operational effectiveness. The AAV SU program had two primary requirements before Milestone C:

- Force Protection—Prevent the incapacitation of crew and occupants against under-vehicle attacks, and
- Cost—Average procurement unit cost must not exceed \$1.65 million.

The AAV SU program also had secondary and third-level requirements to meet the categories of vehicle performance including tactical egress for all infantry members to exit the rear of the vehicle and achieve reliability of 25 hours between operational mission failures (failures).¹

¹ Operational mission failures stop missions by interfering with essential functions, such as move, shoot, communicate, carry, and protect.

Review of Internal Controls

DoD Instruction 5010.40 requires DoD organizations to implement a comprehensive system of internal controls that provides reasonable assurance that programs are operating as intended and to evaluate the effectiveness of the controls.²

We determined that the Marine Corps' internal controls for the AAV SU acquisition program were effective as they applied to the audit objective. However, program office officials could experience increased costs and decreased reliability resulting from unresolved vehicle performance problems before Milestone C.

² DoD Instruction 5010.40, "Managers' Internal Control Program Procedures," May 30, 2013.

Finding

Program Officials Should Continue to Address AAV SU Program Requirements

The program office achieved its primary requirement to improve the AAV's force protection. However, the program office did not achieve all program requirements, including cost control, tactical egress, and reliability, before beginning initial production. This occurred because vehicle updates and design changes:

- increased costs over the average procurement unit cost objective of \$1.65 million per vehicle,³
- prevented a troop commander wearing full personal protective equipment from exiting the rear of the vehicle, and
- reduced the vehicle's reliability. The AAV SU also experienced failures of its legacy parts affecting its reliability performance.⁴

As a result, program officials began initial production on a vehicle that did not meet all program requirements. The AAV SU may require future modifications and additional funds if the troop commander cannot safely exit the rear of the vehicle and the program office cannot improve the AAV's reliability and functionality. In addition, reduced vehicle reliability could decrease the number of operational vehicles, increase the number of upgraded vehicles and spare parts, or increase maintenance time.

Force Protection Requirement Met

The program office achieved the primary requirement to protect personnel by improving the AAV's force protection. The AAV SU added improved armor, blast-absorbing seats, and protected fuel tanks to protect crew and occupants from roadside improvised explosive devices, mines, small arms, and grenades. The live-fire test results demonstrated the AAV SU met the force protection requirement before the Milestone C decision.⁵

However, the force protection upgrades affected the AAV SU's ability to meet program requirements, such as cost control, tactical egress, and reliability. DoD Instruction 5000.02 requires the program to maintain cost within the

³ Average procurement unit cost is calculated by dividing total program procurement cost by the number of items being procured.

⁴ Legacy parts are the RAM/RS parts that were not replaced as part of the vehicle's survivability upgrade package.

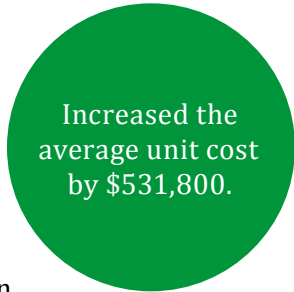
⁵ Live-fire testing included the AAV SU's force protection against mines, improvised explosive devices, and other operational threats.

affordability constraints, demonstrate that the production design is stable, and demonstrate performance requirements through testing in order to meet Milestone C entrance criteria.⁶ A design is stable when demonstrations show that the system is capable of meeting the performance requirements. The program office has an opportunity to test and correct performance problems before full-rate production; however, the AAV SU did not meet all performance requirements before Milestone C.

AAV SU Exceeded the Affordability Requirement

The program office did not achieve the cost control requirement because vehicle updates and design changes increased costs above the average procurement unit cost objective of \$1.65 million. DoD Instruction 5000.02 requires affordability to be a program requirement and compliance with affordability goals for production and sustainment during Milestone B. CD&I established the procurement cost as a primary program requirement in December 2014 based on what the Marine Corps could afford. According to program documents, performance requirements were less important than the \$1.65 million average procurement unit cost requirement and if the Marine Corps did not meet the cost requirement, it would not procure the AAV SU.

The estimated average procurement unit cost at Milestone B was \$1.53 million. The Milestone C average procurement unit cost increased to \$2.06 million, which included contractor quality and design improvements necessary to meet performance requirements of the contract, such as modifying seats and addressing fuel leaks. After Milestone B, CD&I added two requirement changes—the electrical system upgrade and the command and control variant—that were not included as part of the original AAV SU contract. These additional requirements increased the unit cost by \$263,200 (17.2 percent). However, the program office also encountered another \$268,600 (17.6 percent) increase in the cost per vehicle due to other program changes, including the hull and transmission updates. This increased the average unit cost by \$531,800, or 35 percent more than the Milestone B estimate. Table 2 identifies the updates and design changes and the associated cost growth per vehicle.



Increased the average unit cost by \$531,800.

⁶ DoD Instruction 5000.02, "Operation of the Defense Acquisition System," January 7, 2015.

Table 2. Vehicle Cost Growth

Updates and Design Changes	Cost Growth Per Vehicle
Electrical System	\$186,000
Hull Modification	81,800
Transmission	72,500
Command and Control Variant	77,200
Other*	114,300
Total	\$531,800

*This includes eight updates and design changes.

Source: Program Manager, Advanced Amphibious Assault.

In July 2017, CD&I officials removed the \$1.65 million average procurement unit cost requirement from the capability document and are using the program baseline as the cost control method. The program baseline is an agreement between the milestone decision authority and the program manager used to track and report costs for the life of the program. According to a CD&I official, the average procurement unit cost requirement controlled costs for the engineering and manufacturing development phase. However, the average procurement unit cost increased by 35 percent during this phase.

(FOUO) CD&I officials stated that the program baseline, which established the amount of money available in the budget, will determine affordability after Milestone C. Program officials identified a 3-percent decrease in the program baseline cost since Milestone B, despite the average procurement unit cost increase associated with vehicle reliability, updates, and design changes. CD&I officials stated there was an [REDACTED]-percent decrease in the number of vehicles to be fielded to operational units and program officials stated the decrease kept the program within its program baseline cost. However, the Marine Corps reallocated these vehicles to [REDACTED] without adequate documentation to justify the need for the [REDACTED].⁷ Table 3 shows the AAV SU allocation at Milestone B and Milestone C.

⁷ (FOUO) [REDACTED]

Table 3. AAV SU Allocation

(FOUO)	Milestone B	Milestone C
Operational Units	█	█
Depot Maintenance Float Allowance	█	█
Prepositioned Stock	█	█
Total AAVs Fielded	392	405
Percentage to Operational Units	█%	█% (FOUO)

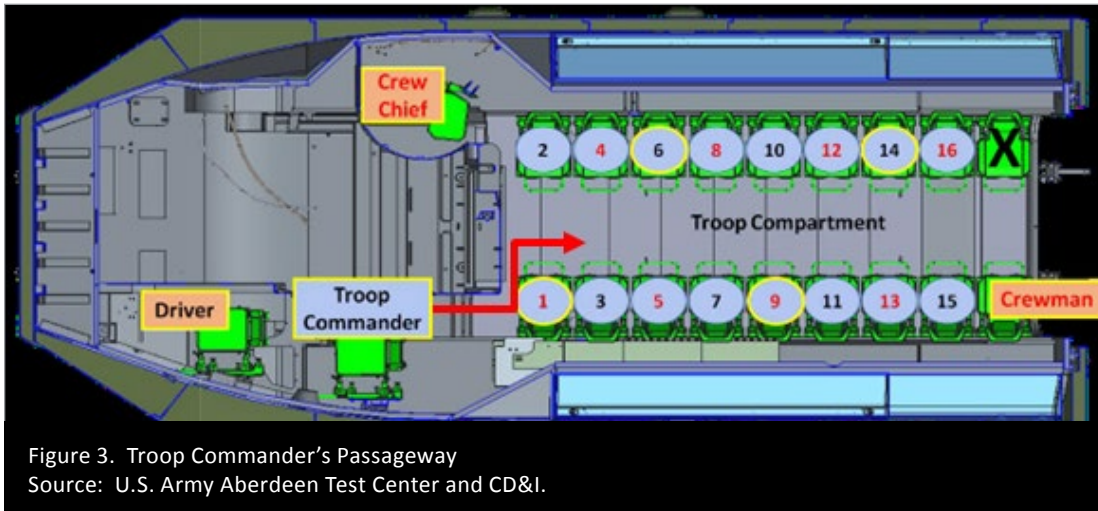
Source: CD&I.

The Marine Corps has fewer incentives to minimize procurement costs without a unit cost requirement. According to program officials, the reduction in vehicles fielded to operational units decreased the estimated costs for maintenance and sustainment, but did not affect the increase in the average procurement unit cost.⁸ In April 2017, Marine Corps officials identified concerns to the contractor about the contractor’s ability to track costs, specifically incomplete or missing information about the average procurement unit cost. Because the average procurement unit cost increased, and there are concerns about the contractor’s ability to identify costs accurately, the Program Executive Officer Land Systems should reestablish a cost control to minimize procurement costs, focusing on mission needs instead of available funding.

Design Changes Necessary to Achieve Tactical Egress

The program office did not achieve the tactical egress performance requirement because vehicle updates and design changes made to meet the force protection requirement prevented a troop commander wearing full personal protective equipment from exiting the rear of the vehicle. DoD Instruction 5000.02 states that the Marine Corps should develop, build, and test a product to verify that all requirements are met and demonstrate that the production design is stable before Milestone C. The AAV SU program has a third-level requirement for all infantry members to exit the rear of the vehicle. However, the troop commander was not able to exit the rear of the vehicle during developmental and operational testing. Figure 3 shows the passageway from the troop commander’s station.

⁸ Sustainment includes costs to operate, maintain, and support a fielded system until the end of system operations.



During developmental testing in September 2016, the program office learned that the passageway was too narrow and a design change was necessary to allow a troop commander wearing full personal protective equipment to exit the rear of the vehicle. Program officials considered several possible solutions and suggested that the troop commander could exit through the top of the vehicle. However, CD&I officials stated that exiting through the top was not an acceptable solution because the troop commander would be exposed to enemy fire.

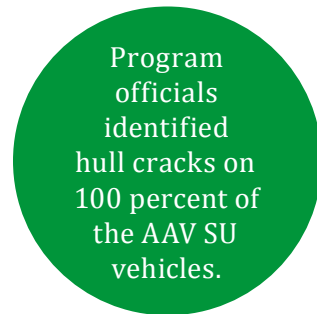
It was not until after operational testing in July 2017 that program officials proposed seven design modifications that may help the troop commander exit the rear of the vehicle. Program officials stated that the proposed design modifications will not increase the average procurement unit cost. The program office plans to implement these modifications on all AAV SU vehicles. The four initial production vehicles scheduled for delivery in March 2018 will be used to test the effectiveness of the modifications from April through June 2018.

On August 17, 2017, the Program Executive Officer Land Systems approved the procurement of an additional 18 initial production vehicles before implementing and testing these modifications. The Program Executive Officer Land Systems prohibited the program office from procuring any other vehicles until it provides a plan to the Program Executive Officer Land Systems to address the egress problem. In addition to the program office providing the plan, the Program Executive Officer Land Systems should verify that a troop commander wearing full personal protective equipment can exit the rear of the vehicle before procuring additional initial production vehicles. This would indicate that the design is stable and the modifications meet program performance requirements.

Reliability Needs Improvement

The program office did not achieve the reliability performance requirement because upgrades and design changes made to meet the force protection requirement reduced the vehicle's reliability. The AAV SU also experienced failures of its legacy parts affecting its reliability performance. DoD Instruction 5000.02 requires the vehicle to meet its requirements before Milestone C and achieve acceptable performance and reliability before full-rate production. The AAV SU has a third-level reliability performance requirement to achieve 25 hours between failures. CD&I officials based this requirement on the RAM/RS reliability demonstrated in 2012. The program office used corrective action periods and Defense Contract Management Agency oversight at the contractor's facility to improve reliability and performance.⁹ However, the AAV SU did not demonstrate an acceptable level of reliability before Milestone C. According to program officials, the AAV SU's reliability was only 14.2 hours between failures versus the required 25 hours.

The AAV SU program force protection upgrades and design changes resulted in an 11,645-pound increase to the vehicle's weight and contributed to the reliability failures. A CD&I official stated that the additional weight caused the hulls to crack more frequently requiring additional maintenance, but did not affect the AAV SU's ability to meet force protection requirements. For example, program officials identified hull cracks on 100 percent of the AAV SU vehicles. According to CD&I officials, hull cracks occurred on only 30 percent of the RAM/RS vehicles before the upgrade. The program office plans to monitor the cracks, and CD&I officials stated that a change in material where the cracks occur may be necessary. The added weight also increased failures in suspension system parts.



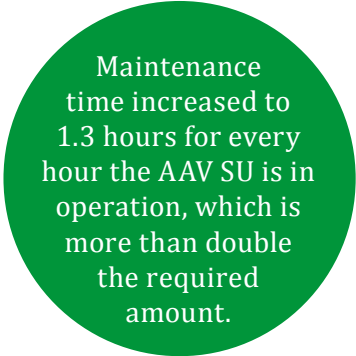
Program officials identified hull cracks on 100 percent of the AAV SU vehicles.

The AAV SU program force protection upgrades and design changes contributed to reliability failures during developmental and operational testing. For example, program officials identified that the sensors in the new transmission are too sensitive for military use and cause the transmission to shut down during land and water testing. The program officials asked the contractor to adjust the sensors to prevent the transmission from shutting down. According to DOT&E officials, the new transmission caused eight failures, increased vehicle maintenance, and affected the functionality of the AAV SU.

⁹ Corrective action periods are planned timeframes for the system to undergo changes to correct identified problems.

The AAV SU also experienced failures with legacy parts. According to the Marine Corps Operational Test and Evaluation Activity operational assessment, the AAV SU experienced an additional eight failures caused by legacy parts. For example, legacy parts used in the hydraulics system failed during 2012 and 2013 testing and continued to fail during the AAV SU operational testing, resulting in schedule delays. Program officials stated that the Marine Corps did not provide funding to increase the vehicle's reliability beyond the RAM/RS and, consequently, legacy parts failures will continue in the AAV SU.

The added weight and parts failures also increased maintenance time and decreased the vehicle's availability. The maintenance time increased to 1.3 hours for every hour the AAV SU is in operation, which is more than double the required amount of 0.6 hours.



Maintenance time increased to 1.3 hours for every hour the AAV SU is in operation, which is more than double the required amount.

The program office plans to continue improving reliability after testing the four initial production vehicles and implementing corrective actions. This is consistent with the milestone decision authority's requirement to demonstrate progress that is acceptable to CD&I. Program officials stated that they will not know whether the AAV SU's reliability will meet the 25-hour requirement until June 2018. According to a CD&I official, the Marine Corps may have to accept reliability less than 25 hours and consider this a trade-off for the increased force protection. However, in August 2017, CD&I officials revalidated 25 hours as the reliability requirement. The Program Executive Officer Land Systems should coordinate with CD&I to develop a solution for the AAV SU to demonstrate the required level of reliability before procuring additional initial production vehicles.

Program Could Experience Increased Costs and Decreased Availability

The program officials began initial production on a vehicle that did not meet all program requirements. If the proposed design changes do not allow the troop commander to safely exit the rear of the vehicle, additional changes may not be affordable because the average procurement unit cost has already increased by 35 percent. In addition to the increased procurement cost, the Marine Corps will also experience increased sustainment costs as a result of the decreased reliability, increased maintenance, and decreased vehicle availability throughout the AAV SU life cycle.

If low reliability rates continue, the Marine Corps will need to determine whether to continue to decrease the number of operational vehicles, spend additional funds to upgrade more vehicles, or provide additional maintenance to ensure AAVs are available to perform missions. Until the vehicle's ability to meet program requirements is demonstrated through testing, the Marine Corps should not procure additional initial production vehicles.

Management Comments on the Finding and Our Response

Although not required to comment, the Deputy Director, Land and Expeditionary Warfare, on behalf of the DOT&E, provided comments on the draft report and finding. Summaries of management comments on the report and our response are in Appendix B.

Recommendations, Management Comments, and Our Response

Recommendation 1

We recommend that the Program Executive Officer Land Systems:

- a. **Reestablish a cost control to minimize procurement costs, focusing on mission needs instead of available funding.**

Program Executive Officer Land Systems Comments

The Program Executive Officer Land Systems partially agreed with our recommendation, stating that the program office agrees that cost controls are necessary and are in place as established by the acquisition program baseline. DoD Instruction 5000.02 requires all acquisition category III programs to have an acquisition program baseline that includes cost controls. The program office is required to report cost quarterly to the Assistant Secretary of the Navy (Research, Development, and Acquisition) and the Program Executive Officer Land Systems. The AAV SU's mission focused acquisition program baseline was established at Milestone B and updated at Milestone C.

Our Response

Comments from the Program Executive Officer Land Systems did not address the specifics of the recommendation; therefore, the recommendation is unresolved and remains open. The Program Executive Officer did not explain how the program office plans to use the acquisition program baseline to minimize procurement costs. The acquisition program baseline at Milestone B contained a \$1.65 million

average procurement unit cost requirement, which was also a primary requirement in the capability document. However, the AAV SU exceeded the maximum unit cost constraint by 35 percent at Milestone C. The program office removed the \$1.65 million average procurement unit cost requirement from the capability document and are now using the acquisition program baseline to control costs. The Milestone B acquisition program baseline did not minimize procurement costs and the Milestone C procurement unit cost within the acquisition program baseline could be exceeded if action is not taken to control future cost growth of the program.

Program officials are aware that the reliability and functionality of the AAV SU needs to improve, which could cause the average procurement unit cost to continue to increase above \$2.06 million. The Marine Corps needs to monitor the cost of the necessary improvements and ensure the maximum unit cost constraint is not exceeded. By controlling procurement costs, the Marine Corps can ensure the future procurement of 387 additional AAV SUs will be affordable. We request that the Program Executive Officer Land Systems provide comments on the final report regarding how the acquisition program baseline will minimize procurement costs.

- b. Verify that a troop commander wearing full personal protective equipment can exit the rear of the vehicle before procuring additional low-rate initial production vehicles.**

Program Executive Officer Land Systems Comments

The Program Executive Officer Land Systems agreed with our recommendation, stating that the program office established an action plan that identified seven areas for modification to improve the ability for the troop commander to exit through the vehicle. Production control model vehicles include all modifications to support improved troop commander exit.

Our Response

Comments from the Program Executive Officer Land Systems addressed all specifics of the recommendations; therefore, the recommendation is resolved, but will remain open. We will close this recommendation once we verify that the program office demonstrated that the troop commander wearing full personal protective equipment can exit the rear of the vehicle.

- c. **Develop a solution, in coordination with Headquarters Marine Corps, Combat Development and Integration, for the Assault Amphibious Vehicle Survivability Upgrade to demonstrate the required level of reliability before procuring additional low-rate initial production vehicles.**

Program Executive Officer Land Systems Comments

The Program Executive Officer Land Systems partially agreed with our recommendation, stating that the Milestone C Acquisition Decision Memorandum established criteria for the AAV SU to demonstrate reliability acceptable to the Director, Capabilities Development Directorate, before the full-rate production decision. Reliability will be demonstrated on the production control model vehicles currently in production.

Our Response

Comments from the Program Executive Officer Land Systems only partially addressed the recommendation; therefore, the recommendation is unresolved and remains open. The Milestone C Acquisition Decision Memorandum states that the AAV SU must demonstrate acceptable reliability before the full-rate production decision. However, the memorandum also states that the Marine Corps should withhold award of additional low-rate initial production vehicles until the AAV SU demonstrates reliability acceptable to CD&I. We request that the Program Executive Officer Land Systems provide comments on the final report regarding the solution to improve the AAV SU's reliability before procuring additional low-rate initial production vehicles.

Appendix A

Scope and Methodology

We conducted this performance audit from March 2017 through November 2017 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

To determine whether the Marine Corps effectively managed the AAV SU program, we interviewed AAV SU program stakeholders and reviewed program documentation. Specifically, we compared developmental and operational test results to the requirements in the capability documents to determine whether the AAV SU met performance requirements. We identified that the program office did not achieve some performance requirements including two third-level requirements. In addition, we compared program estimates and acquisition program baselines to the capability documents to determine whether the AAV SU met the affordability requirement.

We interviewed AAV SU program stakeholders from the following organizations.

- DOT&E
- Program Executive Officer Land Systems
- Program Manager, Advanced Amphibious Assault
- Marine Corps Operational Test and Evaluation Activity
- CD&I
- Marine Corps Logistics Command
- Defense Contract Management Agency

We also reviewed the following regulations and guidance related to contractor performance, performance requirements, program cost, and testing.

- Federal Acquisition Regulation, Subpart 42.15, “Contractor Performance and Information,” January 19, 2017
- DoD Instruction 5000.02, “Operation of the Defense Acquisition System,” January 7, 2015
- “Defense Acquisition Guidebook,” September 16, 2013
- Marine Corps Operational Test and Evaluation Activity, “Operational Test and Evaluation Manual,” February 22, 2013

Use of Computer-Processed Data

We did not use computer-processed data to perform this audit.

Use of Technical Assistance

We used assistance from the DoD Office of Inspector General Technical Assessments Directorate to review the test results and capability documents to determine whether the AAV SU meets the performance requirements.

Prior Coverage

No prior coverage was conducted on the AAV SU during the last 5 years.

Appendix B

Management Comments on the Report and Our Response

Our detailed response to the comments from the Deputy Director, Land and Expeditionary Warfare, on behalf of the DOT&E, on statements in the draft report follow. The complete text of those comments is in Management Comments section of this report.

1. Introduction: Acquisition Management and Finding Paragraph

Management Comments: The Deputy Director, Land and Expeditionary Warfare, stated that the Initial Operational Test and Evaluation and Full-Up System Level Live Fire Test and Evaluation provides information for the full-rate production decision review, which occurs after Milestone C. This gives the program office the opportunity for corrective action and testing between Milestone C and the full-rate production decision. The report's conclusion that the AAV SU did not meet all requirements at Milestone C is true, but it does not explain that the program office has time and opportunity to address the reliability, tactical egress, and cracked hull performance problems discovered in testing. The Deputy Director also stated the report does not mention the program office's efforts to mitigate this risk through the acquisition and testing of four vehicles that will receive all corrective actions identified to date.

Audit Response: We agree with the Deputy Director that the program office has the opportunity to address performance problems prior to full-rate production. The report states that the program office plans to test the four initial production vehicles, but adds that if the problems are not corrected it could affect the affordability and reliability of the program. However, we revised the report to add that the program office has the opportunity to meet performance requirements before full-rate production and implement corrective actions (pages 4 and 12).

2. Introduction: Program Management

Management Comments: The Deputy Director, Land and Expeditionary Warfare, stated that it is not accurate to state that the program office is required to develop tests.

Audit Response: According to the AAV SU Test and Evaluation Master Plan, the program office's responsibilities include developing tests to ensure achievement of thresholds established in the AAV SU capabilities documents. Therefore, we revised the final report to state the program office is developing tests as part of their responsibilities (page 2).

3. Finding and Reliability Needs Improvement

Management Comments: The Deputy Director, Land and Expeditionary Warfare, stated that vehicle upgrades affected reliability as well as functionality. The issues with the transmission affected reliability and a third-level performance requirement, Transition, which is the vehicle's ability to transition between water and land. However, the report does not include an effect on the transition requirement. The Program Executive Officer Land Systems and program office are working with the contractor to correct the transmission problems prior to full-rate production.

Audit Response: We agree with the Deputy Director that the vehicle upgrades, including the new transmission, affected the AAV SU's functionality and transition requirement. While the transmission affected the transition requirement, all program stakeholders expressed significant concern about the reliability of the vehicle. As identified in the report, the program office did not meet all program requirements and the report discussed three requirements that were impacted by vehicle updates, which included a new transmission. The report also states that program office officials asked the contractor to address the transmission problems. As reported by the Marine Corps Operational Test and Evaluation Activity and DOT&E, the transmission directly impacted the mission failures and reliability of the AAV SU. However, we revised the final report's finding paragraph to state that the AAV SU may require future modifications and funds if the program office cannot improve the AAV's functionality (page 6).

4. Finding: Force Protection Requirement Met

Management Comments: The Deputy Director, Land and Expeditionary Warfare, stated that the DOT&E does not pass or fail system performance and recommended the report be revised to state that the Live Fire Test and Evaluation conducted before the Milestone C decision demonstrated that the AAV SU met its force protection requirements.

Audit Response: We agree that Live Fire Test and Evaluation demonstrated that the AAV SU met the force protection requirement before Milestone C. As a result of management comments, we revised the report to delete "passed" live-fire testing (page 6).

5. Finding: Reliability Needs Improvement

Management Comments: The Deputy Director, Land and Expeditionary Warfare, stated that reliability performance is not improved through testing, just measured.

Audit Response: The report stated that the program office plans to continue improving reliability by testing the four initial production vehicles. This was based on statements from program office officials about their plans to improve reliability. However, as a result of management comments, we revised the report to clarify that the program office planned to improve reliability after testing and implementing corrective actions (page 12).

6. Finding: Program Could Experience Increased Costs and Decreased Availability

Management Comments: The Deputy Director, Land and Expeditionary Warfare, stated that the Program Executive Officer Land Systems and the program office are already taking actions to meet performance requirements in accordance with the Milestone Decision Authority's Milestone C Acquisition Decision Memorandum. The Deputy Director recommended the report be revised to state that the Marine Corps should withhold award of low-rate initial production lot 2 until the AAV SU demonstrates progress toward reliability that meets a point estimate for mean time between operational mission failure that is acceptable to CD&I.

Audit Response: We believe the Marine Corps should withhold award of additional initial production vehicles as required by the Acquisition Decision Memorandum. However, withholding award of these vehicles should not be dependent on merely making progress, but achieving the required level of reliability. Because CD&I officials revalidated 25 hours as the requirement, the Program Executive Officer Land Systems should develop a solution in coordination with CD&I that will demonstrate the required level of reliability, as recommended in the report.

Management Comments

Director, Operational Test and Evaluation



OPERATIONAL TEST
AND EVALUATION

OFFICE OF THE SECRETARY OF DEFENSE
1700 DEFENSE PENTAGON
WASHINGTON, DC 20301-1700

MEMORANDUM FOR PROGRAM DIRECTOR, ACQUISITION AND SUSTAINMENT
MANAGEMENT, DEPARTMENT OF DEFENSE INSPECTOR
GENERAL

SUBJECT: Marine Corps Assault Amphibious Vehicle Survivability Upgrade
(Project No. D2017-D000AT-0119.000)

Thank you for the opportunity to review and comment on your report on the Marine Corps Assault Amphibious Vehicle Survivability Upgrade. I do not concur with several points in the report.

Page 3, Acquisition Management (Critical)

Item: The Acquisition Management paragraph omits mention of the Full Rate Production Decision Review (FRP DR) that follows Milestone C and that the FRP DR is informed by Initial Operational Test and Evaluation (IOT&E) and Full-Up System Level Live Fire Test and Evaluation (LFT&E). This fails to account for the opportunity that the program office has for corrective action and testing between Milestone C and the full rate production decision. The report's conclusion that the AAV-SU did not meet all requirements at Milestone C is true, but it does not explain that the program has time and opportunity to address the reliability, tactical egress, and cracked hull performance problems discovered in testing.

Recommendations:

- Change "three milestones" to "four milestones" and add FRP DR as a bullet under Milestone C.
- Change the last sentence on page 3 as follows: The Program Executive Office (PEO) and program office plan to use these vehicles for additional reliability testing which should allow the opportunity for identification and implementation of corrective actions prior to the IOT&E and FRP DR.
- Add IOT&E and FRP DR to Figure 2 at the top of page 4.

Page 6, Finding (Critical)

Item: Vehicle upgrades affected reliability as well as functionality. This effect on functionality is mentioned on page 11 when discussing the transmission but is omitted here. The issues with the transmission affected reliability and a tertiary performance requirement, Transition.

Recommendation: Change bullet #3 in the Finding callout box to read: "reduced the vehicle's reliability and affected transition functionality. The AAV-SU experienced failures of its legacy parts affecting its reliability performance."



Director, Operational Test and Evaluation (cont'd)

Page 6, Finding (Critical)

Item: The Finding callout box states that “program officials began initial production on a vehicle that did not meet all program requirements” and the vehicle “may require future modifications.” While this is correct, the report omits that there is opportunity to address any problems or failures prior to IOT&E and full rate production. As a result, readers may conclude that any future modifications would have to be made after full rate production which is not the case. The period between Milestone C and FRP DR allows the program office to review and test the vehicle’s performance and address failure modes before a full rate production decision. The report does not mention PEO and program office efforts to mitigate this risk through the acquisition and testing of 4 vehicles that will receive all corrective actions identified to date.

Recommendation: Add the following sentence to the end of the last paragraph in the Finding call out box: “The PEO intends to use these initial production vehicles to implement corrective actions identified prior to Milestone C and will test these vehicles to identify any additional problems prior to IOT&E and making a full rate production decision.”

Page 6, Force Protection Requirement Met (Critical)

Item: DOT&E does not “pass” or “fail” system performance.

Recommendation: Reword sentence #3 as follows: “Live Fire Test and Evaluation conducted prior to the Milestone C decision demonstrated that the AAV-SU meets its force protection requirements.”

Page 11, Reliability Needs Improvement (Critical)

Item: The report discusses secondary and tertiary requirements, listing troop egress and reliability. On page 11, it notes that the new transmission has affected the functionality of the AAV-SU, but does not specify its effect on a tertiary requirement (Transition).

Recommendation: Add the following sentences to paragraph 3 on page 9: This degradation in functionality has affected the vehicle’s ability to transition between water and land, a tertiary attribute for the AAV-SU. The PEO and program manager are working with the vendor to correct transmission issues and have plans to address performance shortfalls prior to FRP.

Page 12, Reliability Needs Improvement (Critical)

Item: The first sentence of paragraph 2 on page 12 is not correct, as reliability performance is not improved through testing, just measured.

Recommendation: Change the first sentence of paragraph 2 as follows: The program office plans to use the time between Milestone C and FRP DR to implement corrective actions that are designed to improve reliability of the AAV-SU. Testing of the initial production vehicles will validate if planned reliability growth benchmarks have been met.

Page 13, paragraph 1 (Critical)

Item: The final sentence of paragraph 1 seems to contradict recommendation 1.c and does not mention that the PEO and PM are already taking these actions in accordance with the Milestone Decision Authority’s Milestone C Acquisition Decision Memorandum.

Director, Operational Test and Evaluation (cont'd)

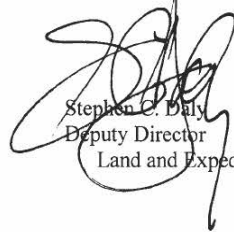
Recommendation: Delete the last sentence of paragraph 1, page 13 and replace with the following: The Marine Corps should withhold award of low rate initial production lot 2 until the AAV-SU demonstrates progress toward reliability that meets a point estimate for mean time between operational mission failure that is acceptable to Headquarters Marine Corps, Combat Development and Integration.

Page 2, Program Management (Administrative)

Item: The program management paragraph asserts that the program office is “required to develop tests” which is not an accurate description of a program office’s responsibility.

Recommendation: Change the sentence as follows: “In addition, the program office develops a Test and Evaluation Master Plan (TEMP) under the auspices of the Test and Evaluation Working level Integrated Product Team to reflect the user’s requirements and describe how these capability needs will be tested during developmental and operational test and evaluation.

My point of contact in this matter is [REDACTED]. He may be reached at [REDACTED] or [REDACTED].


Stephen C. Daly
Deputy Director
Land and Expeditionary Warfare
5 Dec 17

Program Executive Officer Land Systems



DEPARTMENT OF THE NAVY
HEADQUARTERS, UNITED STATES MARINE CORPS
3000 MARINE CORPS PENTAGON
WASHINGTON, DC 20350-3000

IN REPLY REFER TO:
7500
DMCS-A
11 Dec 17

From: Head, Audit Coordination, Office of the Staff Director
To: Program Director, Acquisition and Sustainment Management,
Office of the Inspector General, Department of Defense

Subj: MARINE CORPS ASSAULT AMPHIBIOUS VEHICLE SURVIVABILITY
UPGRADE (PROJECT NO. D2017-D000AT-0119.000)

Ref: (a) DODIG PD (ASM) Memo to USD (AT&L), DOTE, and
NAVINGEN dated November 13, 2017

Encl: (1) U.S. Marine Corps Official Responses

1. Reference (a) requested management comments to the subject draft audit report.
2. Enclosure (1) provides our official responses.
3. We appreciate the opportunity to respond to the report.
4. I am yo
reached at [REDACTED].

A handwritten signature in black ink, appearing to be "C. S. [REDACTED]", with a black rectangular redaction box below it.

Copy to:
OSD (DOTE)
ASN (RD&A)
NAVINGEN (N14)
IGMC
CL
DC, P&R (MCMICP)
DC, CD&I
CMDR, MCSC

Program Executive Officer Land Systems (cont'd)



UNITED STATES MARINE CORPS
PROGRAM EXECUTIVE OFFICER
LAND SYSTEMS MARINE CORPS
2200 LESTER STREET
QUANTICO, VA 22134-6050

IN PEOPLE REFER TO:
5000
PEO LS
DEC 01 2017

From: Program Executive Officer Land Systems Marine Corps
To: Office of the Director, Marine Corps Staff

Subj: DEPARTMENT OF DEFENSE INSPECTOR GENERAL DRAFT REPORT,
PROJECT NUMBER D2017-D000AT-0119.000 FINAL PROGRAM
MANAGER, ADVANCED AMPHIBIOUS ASSAULT COMMENTS FOR THE
AMPHIBIOUS VEHICLE SURVIVABILITY UPGRADE

Encl: (1) PM AAA Response to DoD IG Draft Report for the USMC
AAV SU Project D2017-D000AT-0119.000 of 30 Nov 17

1. The Program Executive Officer Land Systems concurs with the input provided by the Program Manager, Advanced Amphibious Assault (PM AAA) in the enclosure, addressing the recommendations of the Department of Defense Inspector General (DOD IG) draft report D2017-D000AT-0119.000.

2. My point of contact for this matter is [REDACTED], Marine Corps Systems Command Audit Liaison, at [REDACTED].

John M. Garner
JOHN M. GARNER

Copy:
PEO LS (PM AAA)

Program Executive Officer Land Systems (cont'd)

PM AAA RESPONSE TO DoD IG DRAFT U.S. MARINE CORPS
ASSAULT AMPHIBIOUS VEHICLE SURVIVABILITY UPGRADE
PROJECT D2017-D000AT-0119.000

DoD IG Recommendations:

1.a. Reestablish a cost control to minimize procurement costs, focusing on mission needs instead of available funding.

PM AAA Response:

Partially Concur - PM AAA agrees that cost controls are necessary and are currently in place as established by the Acquisition Program Baseline (APB). DoD 5000.02 Change 2 requires all ACAT III Programs to have an APB that includes cost controls. Additionally, quarterly cost reporting to Assistant Secretary of the Navy (Research, Development, and Acquisition) (ASN (RD&A)) and Program Executive Office Land Systems (PEO LS) is required through Research, Development, and Acquisition Information System (RDAIS). AAV SU's mission focused APB was established at Milestone B and updated at Milestone C.

1.b. Verify that a troop commander wearing full personal protective equipment can exit the rear of the vehicle before procuring additional low-rate initial production vehicles.

PM AAA Response:

Concur - Memo for the Record "Program Manager, Advanced Amphibious Assault Strategy For Troop Commander (TC) Egress on AAVP7A2" signed on 25 July 17 established an action plan and identified seven areas for modification to improve the ability for the TC to egress through the vehicle. Production Control Model (PCM) vehicles being manufactured at this time include all modifications to support improved TC egress.

1.c. Develop a solution, in coordination with Headquarters, U.S. Marine Corps, Combat Development and Integration, for the AAV SU to demonstrate the required level of reliability before procuring additional low rate initial production vehicles.

PM AAA Response:

Partially Concur - AAV SU Milestone C Acquisition Decision Memorandum (ADM) signed 17 August 17 established an Entrance Criteria for the AAV P7A2 Full Rate Production (FRP) Decision to demonstrate reliability acceptable to the Director, Capabilities Development Directorate (CDD). Reliability will be demonstrated on the PCM vehicles currently in production.

Enclosure (1)

Acronyms and Abbreviations

AAV SU Assault Amphibious Vehicle Survivability Upgrade

CD&I Headquarters Marine Corps, Combat Development and Integration

DOT&E Director, Operational Test and Evaluation

RAM/RS Reliability, Availability, Maintainability/Rebuild to Standard



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