



April 2017

AMPHIBIOUS COMBAT VEHICLE ACQUISITION

Cost Estimate Meets
Best Practices, but
Concurrency between
Testing and
Production Increases
Risk

Accessible Version

GAO Highlights

Highlights of [GAO-17-402](#), a report to congressional committees

Why GAO Did This Study

In 2011, the Marine Corps began the acquisition process for the ACV as a potential replacement for all or a portion of the AAV fleet, the primary way to transport marines from ship to shore under hostile and hazardous conditions. The ACV fleet is to have improved protected land mobility.

The National Defense Authorization Act for Fiscal Year 2014 included a provision that GAO annually review and report on the ACV program until 2018. This report, GAO's fifth, assesses the extent to which (1) the cost estimate for the ACV program's first increment aligns with best practices and operations and support costs are accurately reported; and (2) the program's schedule changes affect risk. GAO assessed the cost estimate for the program against best practices in GAO's Cost Estimating Guide. GAO also compared the program's previous and current schedule and test plans, and interviewed program officials.

What GAO Recommends

GAO recommends that DOD (1) adjust the key assumption used to calculate the estimated AAV operations and support costs presented in the ACV SARs; and (2) postpone the ACV 1.1 production decision until early fiscal year 2019. DOD concurred with the first recommendation and non-concurred with the second, stating that delaying the decision could affect the ACV fielding schedule and other efforts. As discussed in the report, GAO stands by its recommendation because the approved ACV acquisition program baseline indicates it is acceptable for the production decision to occur as late as December 2018 (which is in fiscal year 2019).

View [GAO-17-402](#). For more information, contact Marie A. Mak at (202) 512-4841 or makm@gao.gov.

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Cost Estimate Meets Best Practices, but Concurrency between Testing and Production Increases Risk

What GAO Found

GAO assessed the cost estimate for the first increment of the Amphibious Combat Vehicle (ACV) program—ACV 1.1—and found that it was developed in accordance with best practices. The cost estimate, (approximately \$2.0 billion for development and procurement and \$4.2 billion for operations and support), which included both the Department of Defense (DOD) Office of Cost Assessment and Program Evaluation's (CAPE) and program cost estimates, fully or substantially met the criteria for the four characteristics of a high-quality, reliable cost estimate. Specifically, GAO found that the estimate:

- fully met the characteristic of being comprehensive,
- substantially met the characteristic of being well-documented,
- fully met the characteristic of being accurate, and
- substantially met the characteristic of being credible.

However, GAO also found that a comparison of Assault Amphibious Vehicle (AAV) to ACV 1.1 operations and support costs reported by DOD to Congress—through Selective Acquisition Reports (SARs)—may be overstating comparison AAV costs as a result of an underlying assumption relating to troop carrying capacity. The ACV SAR provides comparison costs for 204 ACVs and 204 AAVs, implying a one-for-one replacement of AAVs by ACVs, when in fact comparatively more ACVs may be required because they are expected to carry fewer marines. Specifically, the AAV can transport 17 marines, while the ACV 1.1 will carry a minimum of 10 marines or up to 13. Further, program officials informed GAO that only 180 AAVs would likely be replaced by the incoming 204 ACV 1.1s. Internal control standards call for communication of quality information—including externally—to achieve an entity's objectives. SARs provide useful information to Congress that can be used in decision making. Without revising the assumption, DOD may overstate the operations and support costs savings that may be realized through acquisition of the ACV 1.1.

Despite a December 2015 bid protest (that was denied), the Marine Corps is maintaining an aggressive schedule to achieve initial operational capability—the point at which it will receive vehicles and have the ability to employ them—while increasing program risk. The bid protest delayed multiple program events ranging from testing to the start of production. For example, developmental testing, initially planned for February 2017, will not begin until April 2017—around the same time that Congress typically decides whether to fund program activities for the following fiscal year. The program's current schedule increases the level of concurrency, or overlap, between testing and production—placing the program at an increased risk of discovering deficiencies after some vehicles have been built, potentially requiring costly modifications. Further, the current schedule for the production decision could weaken Congressional oversight as Congress will likely be deciding whether to provide funds for ACV production before results from developmental testing are available. Internal control standards call for management's use of quality information to make informed decisions. Postponing the program's production decision until early fiscal year 2019 would reduce concurrency and enable Congress to obtain sufficient knowledge prior to making a procurement funding decision.

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Abbreviations

AAV	Assault Amphibious Vehicle
ACV	Amphibious Combat Vehicle
BAE	BAE Systems Land & Armaments, L.P.
CAPE	Office of Cost Assessment and Program Evaluation
DOD	Department of Defense
EVM	Earned Value Management
EFV	Expeditionary Fighting Vehicle
FOC	Full Operational Capability
FRP	Full-Rate Production
IOC	Initial Operational Capability
LRIP	Low-Rate Initial Production
SAIC	Science Applications International Corporation
SAR	Selected Acquisition Report

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April 18, 2017

Congressional Committees

In 2011, the Marine Corps began the acquisition process for the Amphibious Combat Vehicle (ACV), which has a currently projected life cycle cost of \$6.2 billion, as a potential replacement for all or a portion of the Assault Amphibious Vehicle (AAV) fleet—the primary platform for transporting marines from ship to shore under hostile and hazardous conditions. The AAV vehicles are viewed as having limitations in water speed, land mobility, lethality, protection, and network capability. The ACV fleet is similarly intended to transport marines from ship to shore, but with improved protected land mobility, and its acquisition approach calls for development in three increments with distinctive variants, each with potentially increased amphibious capability. Development of the first increment is currently underway, and development of the second is scheduled to start in fiscal year 2018.

The National Defense Authorization Act for Fiscal Year 2014 included a provision that we annually review and report to the congressional defense committees on the ACV program until 2018.¹ This report, our fifth, assesses the extent to which (1) the first increment of the ACV program's life cycle cost estimate aligns with best practices and operations and support costs are accurately reported; and (2) the program's schedule changes, if any, affect risk. We also reviewed the ACV program's approach to overseeing contractor cost and schedule performance; see appendix I for details.

To conduct this work, we reviewed program documentation such as cost estimates, schedules and test plans that became available since we reported on the program in October 2015, the ACV acquisition strategy, and documents detailing the Marine Corps' process for overseeing ACV contractor performance.² Overall, we assessed the program's reporting of

¹Pub. L. No. 113-66, § 251 (2013).

²GAO, *Amphibious Combat Vehicle: Some Acquisition Activities Demonstrate Best Practices; Attainment of Amphibious Capability to be Determined*, [GAO-16-22](#) (Washington, D.C.: Oct. 28, 2015).

information to be used in decision making to standards for internal controls in the federal government.³

To assess the ACV program's life cycle cost estimate—including research, development, test and evaluation; procurement; military construction; and operations and support—from fiscal years 2020 through 2045, we compared the independent cost estimate prepared by the Department of Defense's (DOD) Office of Cost Assessment and Program Evaluation (CAPE) for the ACV acquisition along with the cost estimate developed by the ACV program office against best practices identified in the GAO Cost Estimating and Assessment Guide.⁴ Specifically, we compared the methodologies used by the Marine Corps and CAPE to develop their estimates against the best practices associated with the four characteristics identified in the cost estimating guide that underpin a sound cost estimate. Our analysis for that comparison scored the extent to which the ACV cost estimates met four characteristics as follows:

- A score of “fully met” means that the agency provided data and documentation that satisfies the entire best practice criterion.
- A score of “substantially met” means that the agency provided data and documentation that satisfies a large portion of the best practice criterion.
- A score of “partially met” means that the agency provided data and documentation that satisfies about half of the best practice criterion.
- A score of “minimally met” means that the agency provided data and documentation that satisfies a small portion of the best practice criterion.
- A score of “not met” means that the agency provided data and documentation that does not satisfy any portion of the best practice criterion.

In addition, we compared the funding for ACV 1.1 activities in the 2017 President's Budget to the funding levels suggested in the cost estimate to determine if the Marine Corps implemented the decision made by the

³GAO, *Standards for Internal Control in the Federal Government*, [GAO-14-704G](#), (Washington, D.C.: September 2014).

⁴GAO, *GAO Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs*, [GAO-09-3SP](#) (Washington, D.C.: March 2009).

Under Secretary of Defense for Acquisition, Technology and Logistics in November 2015 to align the program's budget with the cost estimate.

To assess the ACV program's schedule, we compared the previous schedule outlined in the program's Test and Evaluation Master Plan at its last major milestone—Milestone B (November 2015)—against updated versions of the program's schedule and test plans. Finally, we interviewed knowledgeable program and agency officials from the Marine Corps' Advanced Amphibious Assault program office; the CAPE; and the Marine Corps Systems Command regarding the program's documentation and processes.

We conducted this performance audit from September 2016 to April 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.

Background

In 2011, the Marine Corps completed initial acquisition documentation providing the performance requirements for the ACV, and over the following 3 years it adopted an acquisition strategy to develop the ACV in three increments: ACV 1.1, 1.2, and 2.0.

- ACV 1.1 is to be a wheeled vehicle that provides improved protected land mobility but limited amphibious capability. In operations, it is expected to be part of an amphibious assault through the use of a surface connector craft to travel from ship to shore.⁵
- ACV 1.2 is anticipated to be a vehicle with improved amphibious capability, including the ability to self-deploy and swim to shore.
- ACV 2.0 is expected to focus on exploring technologies to attain higher water speed capability.

⁵Surface connectors are vessels that enable the transportation of military assets, including personnel, material, and equipment, from the sea to the shore.

Prior to the ACV acquisition in 2011, the Marine Corps canceled an earlier replacement amphibious vehicle program after more than a decade of effort and the expenditure of \$3.7 billion because of concerns about the program's affordability.⁶ As we previously reported, program difficulties occurred in part because not enough time was allowed to demonstrate maturity of the vehicle's design early enough in the acquisition process to incorporate the results of tests into design changes, which resulted in schedule slippages.⁷ Specifically, we also found that more time was needed for reliability testing after early developmental tests revealed major problems with the design. Our prior work on best practices found that successful acquisition programs take steps to gather knowledge that confirms that technologies are mature, designs are stable, and production processes are responsibly managed.⁸ A knowledge-based acquisition framework involves achieving the right knowledge at the right time, and enabling leadership to make informed decisions about when and how best to advance through the acquisition process. Moreover, successful product developers ensure that a high level of knowledge is achieved at key junctures in development.

In our 2014 and 2015 reports, we described the efforts to initiate the ACV program, how the ACV program's incremental acquisition approach compares to acquisition management best practices, and how the ACV increments are to achieve greater amphibious capability.⁹ For example, in October 2015, we reported that most of the program's acquisition activities to that point reflected best practices, including an incremental approach for achieving full capability. We also found that while the ACV acquisition strategy minimized program risk by using mature technology, competition, and fixed-price contracts when possible, some elements of

⁶The Marine Corps' Expeditionary Fighting Vehicle (EFV) was considered a potential replacement for the AAV prior to acquisition of the ACV. The Marine Corps began development of the EFV in 2000; however, following a 2007 breach of a statutory cost threshold, the program was restructured and subsequently canceled by DOD in 2011.

⁷GAO, *Defense Acquisitions: The Expeditionary Fighting Vehicle Encountered Difficulties in Design Demonstration and Faces Future Risks*, [GAO-06-349](#), (Washington, D.C.: May 1, 2006).

⁸For example, see GAO, *Defense Acquisitions: Assessments of Selected Weapon Programs*, [GAO-16-329SP](#), (Washington, D.C.: Mar. 31, 2016).

⁹GAO, *Status of Efforts to Initiate an Amphibious Combat Vehicle Program*, [GAO-14-359R](#), (Washington, D.C.: Apr. 10, 2014); *Amphibious Combat Vehicle Acquisition: Marine Corps Adopts an Incremental Approach*, [GAO-15-385](#), (Washington, D.C.: Apr. 15, 2015); and [GAO-16-22](#).

the acquisition approach such as the program’s plan to hold a preliminary design review—a technical review assessing the system design—after beginning development did not align with best practices and could increase program risk. In commenting on a draft of our 2015 report, DOD stated that it believed that its efforts on this program are aligned with our best practices. We noted that while some aspects of the acquisition suggested lower levels of risk, the deviations to best practices observed could potentially increase risk.

In line with the program’s March 2015 acquisition strategy, which has not changed since our last review, the Marine Corps subsequently selected two contractors—BAE Systems Land & Armaments, L.P. (BAE) and Science Applications International Corporation (SAIC)—and awarded them contracts to design and produce 16 ACV prototype vehicles each. In October 2016, the program completed a combined preliminary and critical design review, and program officials reported that the two contractors both successfully met all of the requirements for those reviews.¹⁰ Figure 1 depicts the BAE and SAIC prototype vehicles.

Figure 1: ACV 1.1 Prototype Vehicles



Source: (left to right) ACV 1.1 produced by BAE Systems Land & Armaments, L.P., © BAE Systems, Inc. and ACV 1.1 produced by Science Applications International Corporation, © SAIC (images). Images provided by Marine Corps Systems Command. | GAO-17-402

ACV Life Cycle Cost Estimate Aligned with Best Practices, but Comparison of AAV and ACV

¹⁰The Preliminary Design Review is a technical assessment that establishes the baseline of a system to ensure that the system is ready to proceed into detailed design with acceptable risk. A Critical Design Review is a multi-disciplined technical review to ensure that a system can proceed into fabrication, demonstration, and test, and can meet stated performance requirements within cost, schedule, and risk.

Costs in Report to Congress May Overstate Comparison Costs

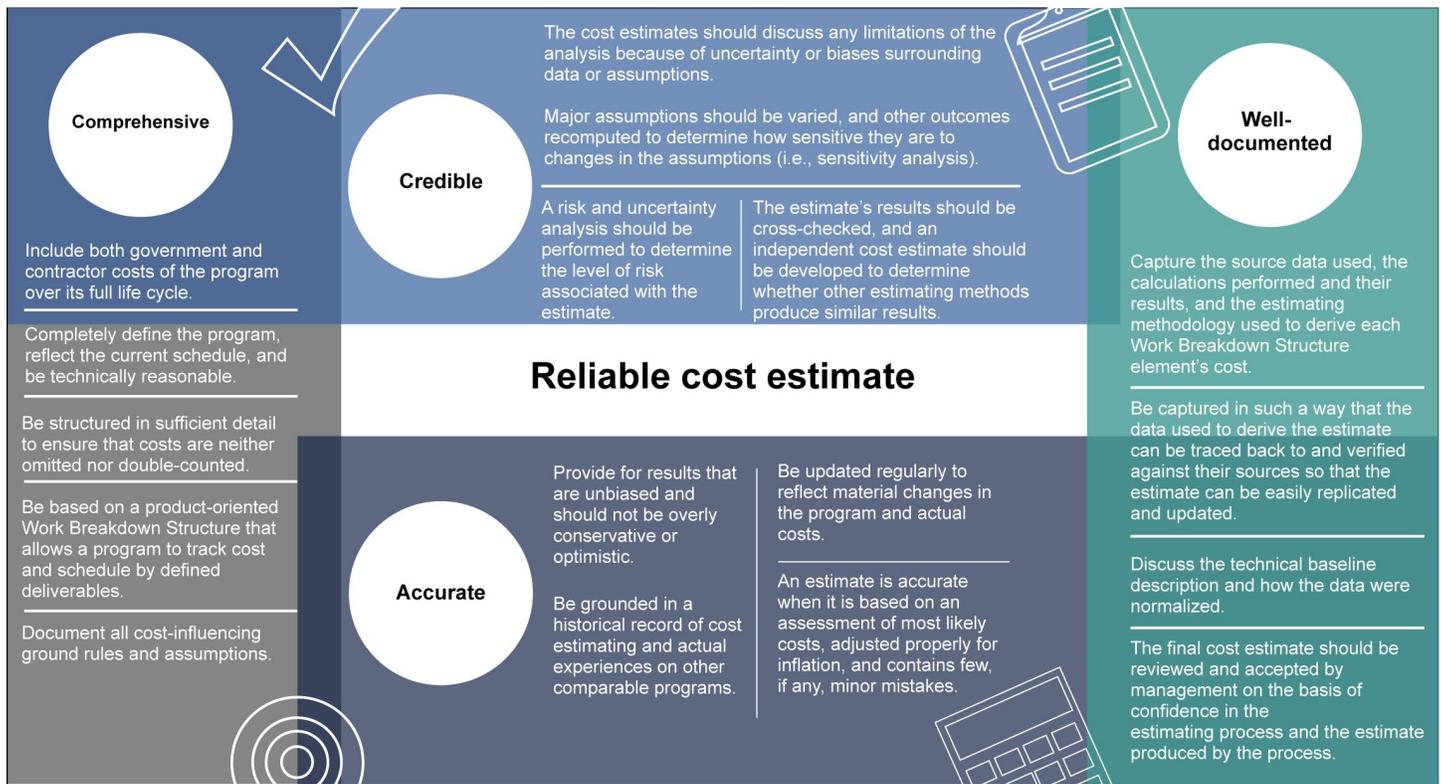
We found that the life cycle cost estimate for the first ACV increment—ACV 1.1—was developed in accordance with best practices, and that ACV 1.1 development and procurement efforts are budgeted to the levels indicated by that estimate. We also found that using a comparison of the AAV and ACV 1.1 operations and support costs—provided in a report to Congress—may be misleading as the costs were calculated assuming a one-for-one replacement of AAVs by ACVs, when comparatively more ACVs may be required because they carry fewer marines. For many programs, the operations and support costs are the largest of the four cost categories (development, procurement, military construction, and operations and support).

Cost Estimate for ACV's First Increment Aligned with Best Practices

CAPE estimated the life cycle costs for ACV 1.1 vehicles to be just under \$6.2 billion (then-year dollars)—\$811 million for development, \$1.168 billion for procurement, and nearly \$4.2 billion for operations and support. We found that the methodologies used by CAPE and program office for developing the estimate was consistent with best practices identified in GAO's cost estimating guide.¹¹ Based on our analysis, we determined that the estimate either fully or substantially met the criteria for the four characteristics of a high-quality, reliable cost estimate identified in the cost estimating guide: comprehensive, credible, accurate, and well-documented. Those four characteristics with some of their selected best practices are detailed in figure 2.

¹¹[GAO-09-3SP](#).

Figure 2: Four Characteristics of a High-Quality, Reliable Cost Estimate



Source: GAO. | GAO-17-402

Note: Information in table taken from *GAO Cost Estimating and Assessment Guide*.

Specifically, in reviewing the ACV cost estimate against the best practices associated with each of those characteristics, we found the following:

- The estimate fully met the characteristic of being comprehensive as it accounted for all life cycle costs associated with the ACV program and covered the program in its entirety. It was also structured with sufficient detail to ensure that costs were neither omitted nor double-counted, based on an appropriate work breakdown structure and documented the cost-influencing ground rules and assumptions.¹² For

¹²A work breakdown structure is a method of deconstructing a program's end product into successive levels (of detail) with smaller specific elements until the work is subdivided to a level suitable for management control. Work breakdown structures provide a basic framework for a variety of activities such as cost estimating and developing schedules. Within the ACV cost estimate, cost elements capture the discrete costs of a particular activity of work, such as labor, material, and fringe benefits.

example, we found that the program fully developed a Cost Analysis Requirements Description, which documents the assumptions and ground rules used by both the program office and CAPE in developing their estimates. Additionally, CAPE included ground rules and assumptions specific to its estimate in its summary memo to highlight where it differed from the program office.

- The estimate substantially met the characteristic of being credible. The CAPE cost estimators did not apply cost risk to their estimates but reviewed the ACV program office's data—which included a quantifiable risk assessment—and proposed contract information for risks accordingly. The program office also modeled the risk for each phase of the estimate. Program officials told us that in doing so, they interviewed subject matter experts to develop risk inputs and then added a 30 percent contingency to those figures because a DOD risk and uncertainty handbook suggests that subject matter experts typically capture only 70 percent of risk due to optimism.¹³ Additionally, both CAPE and the program office performed crosschecks to ensure that the estimating results were consistent with observable historical trends for comparable programs.
- The estimate fully met the characteristic of being accurate. While CAPE did not perform a quantifiable risk analysis to ensure that the estimate was unbiased, the program office estimate did. Furthermore, both estimates were heavily based on historical data that were examined for accuracy and applicability to the ACV program and that information was included and documented in both estimates.
- The estimate substantially met the characteristic of being well-documented. CAPE documented some costs in its estimate at a high level, whereas the program office provided detailed documentation that included definitions, assumptions, and an estimating methodology for each cost element included in its estimate. The Cost Analysis Requirements Description also defined the technical assumptions used in both the development and procurement estimates.

ACV 1.1 Acquisition Costs from the Estimate Are Reflected in the Budget

Following DOD's decision to fund the ACV program to the levels specified in the cost estimate, the Marine Corps aligned the program budget with

¹³Department of Defense and National Aeronautics and Space Administration, *Joint Agency Cost Schedule Risk and Uncertainty Handbook*, Mar. 12, 2014.

the ACV cost estimate. In a November 2015 Acquisition Decision Memorandum approving the ACV program entering development, the Under Secretary of Defense for Acquisition, Technology and Logistics decided that the program should be fully funded to the CAPE estimates for development, procurement, military construction, and operations and maintenance in the fiscal year 2017 President’s Budget. Based on our analysis, we found that the ACV acquisition costs—development and procurement—detailed in the cost estimate generally equaled, and in some cases were exceeded by, the program’s funding levels in the 2017 President’s Budget. The Under Secretary also set a 20-year operations and support cost¹⁴ affordability cap of \$3.1 billion (base year 2014 constant dollars) for the 204 first increment vehicles to be procured.¹⁵ Table 1 provides a summary of CAPE’s \$6.2 billion estimate for those funding categories.

Table 1: Amphibious Combat Vehicle (ACV) 1.1 Independent Life Cycle Cost Estimate (Then-year dollars, in millions)

	Prior to fiscal year 2015	Fiscal year 2015	Fiscal year 2016	Fiscal year 2017	Fiscal year 2018	Fiscal year 2019	Fiscal year 2020	Fiscal year 2021	To complete	Total
Development	85.6	28.1	298.0	143.0	170.0	48.8	32.2	4.8	—	810.5
Procurement	—	—	—	—	154.8	184.4	194.3	634.9	—	1,168.4
Military construction	—	—	—	—	—	4.8	11.0	6.3	2.8	24.9
Operations and support	6.7	3.1	1.4	1.5	2.1	2.8	5.2	7.6	4,148.6	4,179.0
Total	92.3	31.2	299.4	144.5	326.9	240.8	242.7	653.6	4,151.4	6,182.8

Source: GAO analysis of Department of Defense data. | GAO-17-402

Note: Data in table are from the Office of the Secretary of Defense’s Office of Cost Assessment and Program Evaluation independent cost estimate for Milestone B. The life cycle cost estimate is divided into several categories: (1) development costs for the research and development and test and evaluation of the system; (2) procurement costs for production of the system and costs necessary to deliver a useful end product; (3) military construction costs for construction of base and other facilities related to the fielding of the system; and (4) operations and support costs for the fielded system. The operations and support costs above reflect the sustainment of 204 ACVs through fiscal year 2045 (a 20-year service life). This estimate reflects the first increment of the ACV program—ACV 1.1—only.

¹⁴Operations and maintenance costs are only one portion of operations and support costs. Operations and support costs consist of sustainment costs incurred from the initial system deployment through the end of system operations and include all costs for operating, maintaining, and supporting a fielded system.

¹⁵An affordability cap is a threshold that a program must remain under for the program to be affordable. It is the functional equivalent of a key performance parameter for establishing the program baseline and monitoring program performance.

In our review of the 2017 President’s Budget, we identified ACV 1.1 development and procurement efforts and found that both were funded in excess of the CAPE estimate, see table 2. We were unable to identify the military construction funding because it begins in fiscal year 2019, and therefore is not included in the 2017 budget submission. However, program officials stated that \$19 million is currently available for the roughly \$25 million military construction requirement, and they expect the remaining \$6 million to be available as ACV is considered a high-priority program.

Table 2: Amphibious Combat Vehicle (ACV) 1.1 Independent Cost Estimate Compared to President’s Fiscal Year 2017 Budget (Then-year dollars, in millions)

	Cost estimate	President’s Budget 2017	Difference
Development	810.5	951.8	141.3
Procurement	1,168.4	1,173.3	4.9

Source: DOD. | GAO-17-402

Note: Data are taken from the Office of the Secretary of Defense’s Office of Cost Assessment and Program Evaluation (CAPE) independent cost estimate for Milestone B and the department’s fiscal year 2017 President’s Budget submission for Navy Research Development Test and Evaluation. The President’s Budget figures include resources for planned corrective actions and funding for ACV 1.2 and ACV 2.0; the CAPE’s independent cost estimate reflects ACV 1.1 only.

Similarly, ACV 1.1’s operations and support costs were not in the 2017 budget as those costs will be budgeted in future years and principally outside of the program through other accounts—such as the military personnel budget—in which costs are not readily or uniquely associated with specific programs. However, CAPE estimated operations and support costs for ACV 1.1 are \$4.2 billion (then-year dollars) for 204 vehicles over a 20-year life cycle (fiscal years 2020 to 2045).

Comparison of AAV to ACV 1.1 Operations and Support Costs in Report to Congress May Overstate AAV Costs

We also reviewed DOD’s initial ACV 1.1 Selected Acquisition Report (SAR) from June 30, 2016, and found that it included operations and support costs for ACV 1.1 that matched the independent cost estimate, but may provide a misleading comparison between AAV and ACV

operations and support costs.¹⁶ While the comparison suggests that the ACV 1.1 may be more affordable to sustain, the comparative AAV quantities—and costs—are overstated. Specifically, the SAR estimated operations and support costs using the same number of AAVs and ACVs, which implies that the number of AAVs being replaced is the same as the number of ACV 1.1s joining the fleet. The SAR reported that 20 years of operations and support costs for 204 ACV 1.1s would total \$2.9 billion compared to nearly \$3.5 billion for the same number of AAVs, indicating that the operations and support costs for ACVs would be less than what the Marine Corps could expect to spend on AAVs.¹⁷ However, the ACV will likely carry fewer marines than the AAV it is replacing. Whereas the AAV can transport 17 marines, the minimum troop capacity requirement for ACV 1.1 is 10 marines with a goal of 13. As a result, the number of AAVs needed to match the troop carrying capacity of 204 ACVs would actually be fewer than the 204 reported in the SAR. Table 3 compares the number of AAV vehicles needed to match the troop-carrying capacity of the 204 ACV 1.1 vehicles being procured.

¹⁶A new major defense acquisition program is generally required to establish a baseline that includes initial estimates for key cost, schedule, and performance metrics before entry into system development, low-rate initial production, and full-rate production. Information about these baselines is reported to Congress in a standardized format through SARs. On a periodic basis, programs update the information in these reports by comparing the latest cost, schedule, and performance estimates against the initial estimates and providing explanations for any major deviations. Requirements for submitting SARs to Congress, including the timing of these reports and the types of information to be included, are established in statute, under 10 U.S.C. § 2432.

¹⁷Operations and support costs in the SAR were calculated using base year 2014 dollars.

Table 3: Troop Carrying Capacity Comparison for Amphibious Combat Vehicle (ACV) 1.1 and Assault Amphibious Vehicle (AAV)

Vehicle type	Vehicle quantity	Troop-carrying capacity (per vehicle)	Total carrying capacity
ACV (minimum)	204	10	2,040
ACV (goal)	204	13	2,652
AAV	204	17	3,468

Estimated AAV replacement based on ACV minimum and goal total carrying capacities

Vehicle type	Vehicle quantity	Troop-carrying capacity (per vehicle)	Total carrying capacity
AAV (minimum above)	120	17	2,040
AAV (goal above)	156	17	2,652

Source: GAO analysis of ACV program documentation. | GAO-17-402

In discussing this issue with ACV program officials, they informed us that only 180 AAVs would be replaced by the incoming 204 ACV 1.1s. Consequently, we calculated the AAV operations and support costs, considering troop capacities and the program-provided number of AAVs to be retired, and found that the operations and support costs for ACV 1.1 may not represent the savings suggested by the SAR comparison. The SAR comparison currently suggests that the ACV 1.1's operations and support costs may represent a savings of nearly \$585 million over the operations and support costs for existing AAVs, but the comparative cost advantage could be significantly less—approximately \$179 million—when the replacement assumption is revised. Table 4 provides our calculations.

Table 4: Operations and Support Costs Based on Troop Capacity Assumptions for Amphibious Combat Vehicle (ACV) and Assault Amphibious Vehicle (AAV) (Base year 2014 dollars, in millions)

	ACV		AAV
	As reported in Selected Acquisition Report	As reported in Selected Acquisition Report	Revised replacement assumption
Assumed number of vehicles	204	204	180
Estimated operations and support costs	2,867.8	3,452.7	3,046.5
Comparative advantage, ACV to AAV	—	-584.9	-178.7

Source: GAO analysis of ACV 1.1 Selected Acquisition Report (June 2016) | GAO-17-402

Standards for internal control in the federal government call for the communication—including externally—of quality information that is to achieve the entity’s objectives. Quality information is information from relevant and reliable data and is appropriate, current, complete, accurate, accessible, provided on a timely basis, and meets identified information requirements. Given that SARs provide useful information to the Congress that can inform decision making, it is imperative that they contain quality information, especially regarding operations and support costs, which for many programs can account for about 70 percent of total life cycle costs. Without revising the assumptions used in the SAR to accurately account for troop capacity, the comparison of operations and support costs reported by DOD may be overstating the savings that may be gained from the ACV 1.1 acquisition.

The ACV Program Maintains an Aggressive Schedule to Achieve Operational Capabilities, but Concurrency between Testing and Production Increases Risk

The Marine Corps is maintaining an aggressive schedule to achieve initial operational capability. Initial operational capability is the point at which the Marine Corps will receive the new ACVs, and have the ability to employ and maintain them. The Marine Corps still plans to meet its original August 2020 initial operational capability date, even though some testing and the start of production have slipped by several months. In December 2015, a vendor that was not selected to continue competing for the opportunity to produce the ACV fleet filed a bid protest—subsequently denied—that resulted in a series of delays for a number of ACV program acquisition events ranging from testing to production.¹⁸ For example, instead of reaching its production decision—also known as Milestone C—in February 2018 as originally envisioned, the Marine Corps now plans to make that decision 4 months later in June 2018, at which point it plans to select a single contractor from the two contractors developing ACV 1.1

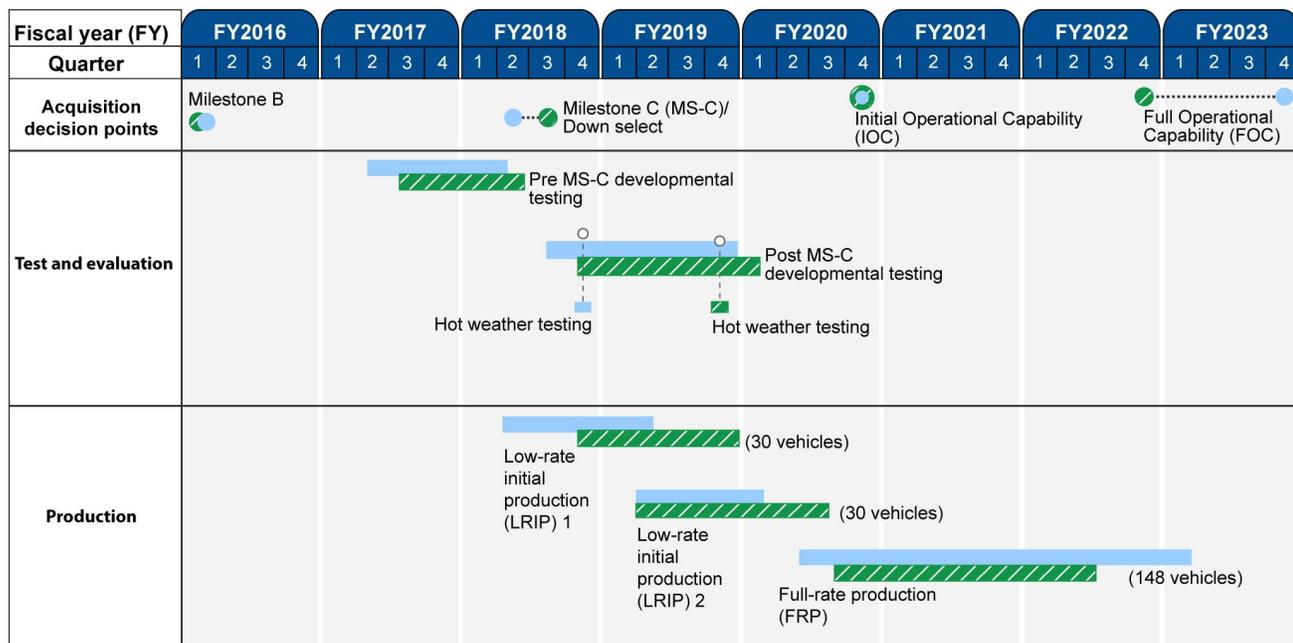
¹⁸On December 7, 2015 a bid protest was filed with GAO, resulting in the program issuing a stop work order to the two contractors selected to develop ACV 1.1 prototype vehicles. On March 15, 2016, GAO denied the bid protest and the stop work orders were lifted.

prototype vehicles and award a contract and begin production of 30 ACV 1.1s in a first round of low-rate initial production.¹⁹

Similarly, rather than starting in February 2017, developmental testing will not begin until April 2017—around the time in the budget process that Congress begins deliberating whether to fund the first year of ACV production—because the delivery of prototype vehicles was postponed as well. Program officials explained that both ACV contractors were issued stop work orders during the bid protest which, in turn, delayed the delivery of the ACV prototypes and, therefore, the start of developmental testing. Nearly all subsequent test events had to be adjusted accordingly—from 2 to 12 months—thereby increasing concurrency, or the overlap of testing and production. Figure 3 highlights the changes in the program’s schedule since the start of development (Milestone B) in November 2015 through the present.

¹⁹Low-rate initial production establishes the initial production base for the system or capability increment, provides an efficient ramp-up to full-rate production, and maintains continuity in production pending operational test and evaluation completion. The ACV program is planning on 2 years of low-rate initial production through two contract options of 30 ACV 1.1 vehicles each, for a total of 60 ACV 1.1s. Four of the 60 are to be used for testing and will not be fielded. The remaining 56 vehicles along with 148 subsequent full-rate production vehicles are to be fielded—for a total of 204 fielded ACV 1.1 vehicles.

Figure 3: Amphibious Combat Vehicle's (ACV) Milestone B Baseline Schedule Compared to Schedule as of January 2017



■ Schedule at Milestone B
▨ Updated schedule

Source: GAO analysis of DOD data. | GAO-17-402

Note: Data in graphic are from ACV schedules provided by DOD. Milestone B is the decision to enter the engineering and manufacturing development phase of the federal acquisition cycle; and Milestone C is the decision to enter the production and deployment phase.

Despite delays, the Marine Corps plans to maintain its schedule for a second round of 30 low-rate initial production units in order to provide a platoon of 21 ACV 1.1 vehicles to reach its original initial operational capability date, and collapse 3 years of production into 2—accelerating the ACV’s full operational capability milestone by 1 year. Full operational capability is when a system is delivered to users—in this case, the marines who will operate the ACVs in the field—and they have the ability to fully employ and maintain it to meet an operational need. Program officials told us that they were able to condense 3 years of full-rate production into 2 as funding was available in the planned budgets.

In October 2015, we reported that the ACV 1.1 acquisition strategy minimizes program risk by using mature technology, competition, and fixed-price type contracts when possible.²⁰ We also reported that as a

²⁰GAO-16-22.

result of its aggressive acquisition schedule, the program planned on a higher level of concurrency between developmental testing and production than would take place under a more typical acquisition schedule. Typically, it is considered a best practice to complete most developmental testing before production begins in order to update the design with all necessary fixes, as design flaws discovered after production starts can result in costly retrofits and schedule delays.

The delays in the program testing schedule experienced as a result of the bid protest have further increased the program's overlap—or concurrency—between testing and production with a number of tests slipping 3 months and one slipping a year. Specifically, the updated ACV schedule shows that hot weather testing, one of the many test events scheduled to take place during developmental testing, has been delayed by an entire year, at which point the program will have committed to production of nearly 30 percent of the 204 vehicles to be fielded. Hot weather testing was initially scheduled to be completed before a planned second low-rate initial production award was to be made for procurement of an additional 30 ACV 1.1 vehicles. However, it will now start after that second round of low-rate production has begun.

While program officials estimated that the testing delays should only increase the number of additional vehicles that may have to be subsequently retrofitted by 8 to 10, we estimate that as many as 60 ACVs—potentially all of the first and some or all of second low-rate initial production vehicles—could require retrofitting. Specifically, given the 1-year delay in the completion of hot weather testing, the second round of low-rate initial production will have been under way for 6 months. Additional time will be needed if any problems discovered during hot weather testing require design changes, which would need to be developed—and further tested—during the remaining months of low-rate production. If the subsequent design changes are not finalized until the second round of low-rate production is complete, all 60 vehicles from the first and second rounds of low-rate production may need to be retrofitted at that time.

Because of schedule delays, Congress will likely be deciding whether to fund the fiscal year 2018 start of ACV production just as developmental testing begins. Standards for internal control in the federal government call for management to use quality information to make informed decisions to achieve key objectives and address risks. In this case, sufficient knowledge is important for Congress to make key decisions in its oversight responsibilities, including appropriating funds. The ACV 1.1's

current schedule for making a production decision in June 2018 would require Congress to consider the procurement funding request in early 2017—when it typically would make funding decisions for fiscal year 2018—before the results from developmental testing are available. Further, as we have previously reported, once funding starts for a program other tools of oversight are relatively weak.²¹ If, however, the decision to enter production occurs at the start of fiscal year 2019, Congress would be better positioned to decide whether to provide funding for ACV production with insights from developmental testing.

Conclusions

Given that SARs are a valuable means of providing Congress information by which it can judge program performance and affordability, it is critical that SARs provide reliable information, including realistic comparison data on operations and support costs that Congress can use in making informed decisions. Taking steps to ensure that the data reported in the SAR are based on realistic assumptions may help ensure that the Marine Corps is providing the most accurate information possible to Congress to inform funding decisions.

Authorizing programs and appropriating funds are some of the most powerful oversight tools Congress has, but once funding starts other tools of oversight are somewhat limited. While it is understandable that DOD would want to put new vehicles in the hands of marines quickly, doing so should not put Congress in the position of funding production before significant developmental testing is done. Furthermore, while the Marine Corps is optimistic about its approach and believes risk is minimized by the ACV's relatively stable design, we see parallels between the risks facing the ACV program—given the concurrency between testing and production—and those that faced the previously canceled amphibious vehicle program. Reducing that concurrency may not only reduce program risk, but may also allow Congress to consider the results of developmental testing in its decision to fund the start of ACV production.

²¹GAO, *Defense Acquisitions: Joint Action Needed by DOD and Congress to Improve Outcomes*, [GAO-16-187T](#) (Washington, D.C.: Oct. 27, 2015).

Recommendations for Executive Action

We recommend that the Secretary of Defense direct the Secretary of the Navy to take the following two actions:

1. Adjust the number of AAVs used in calculating AAV operations and support costs in the SAR to reflect a more realistic comparison to the 204 ACV 1.1s being procured.
2. Postpone the ACV 1.1 program's production decision until early fiscal year 2019 to reduce concurrency between testing and production.

Agency Comments and Our Evaluation

We provided a draft of our report to DOD. The agency's comments are summarized below and reprinted in appendix II. We also received technical comments, which we incorporated, as appropriate. DOD concurred with our recommendation to adjust the number of AAVs used to calculate AAV operations and support costs in the SAR to reflect a more realistic comparison to the ACVs being procured, and did not concur with our recommendation to postpone the ACV 1.1 production decision until early fiscal year 2019 to reduce concurrency between testing and production.

In its written comments, DOD stated that postponing the program's production decision—Milestone C—until fiscal year 2019 could delay the ACV fielding schedule and impact the affordability and sequencing of future modernization efforts across the Marine Corps' overarching Ground Combat Tactical Vehicle Replacement Strategy. In addition, DOD suggested that a significant slip in reaching initial operational capability could potentially impact other programs and extend reliance on AAVs. However, we disagree that our recommendation to postpone the ACV production decision by 4 months—from June 2018 to October 2018, into early fiscal year 2019—would have the negative impacts DOD described based on the schedule parameters already established in the approved ACV acquisition program baseline. These baselines are agreements between the program managers and the Milestone Decision Authority—which is the Secretary of the Navy for the ACV program—that reflects the approved schedule, performance, and cost parameters that are the basis for satisfying an identified mission needs. At minimum, an acquisition program baseline contains the objective and threshold values for major milestones and significant schedule events, key performance parameters

from the approved requirements document, and the life cycle cost estimate approved for the program. ACV's approved baseline clearly indicates that it would be acceptable for the Milestone C production decision to occur as late as December 2018—at the end of the first quarter of fiscal year 2019 and 2 months beyond what we suggest—while still satisfying DOD's amphibious vehicle mission needs. Further, if, as DOD suggests, postponing the program's production decision by 4 months were to result in a comparable delay in reaching initial operational capability, the ACV baseline also indicates that it would be acceptable for the program to reach that capability up to 6 months later than the currently scheduled date of August 2020.

In its written comments, DOD also stated that Marine Corps leadership considered the level of risk posed by the concurrency between testing and production minimal and acceptable. Further, Marine Corps leadership has prioritized reaching initial operational capability over several key aspects of performance in order to field the new ACVs as soon as possible. As discussed in this report and our previous work, we disagree with the Marine Corps' assessment of the schedule risk facing the program. We previously reported that the ACV program has a higher degree of concurrency between testing and production than would take place under a more typical acquisition schedule, and that level of concurrency has increased as a result of program delays stemming from the bid protest. Further, we see parallels between the risks facing the ACV program and those faced by the previous amphibious vehicle replacement program—the Expeditionary Fighting Vehicle—that was canceled after more than a decade of effort and the expenditure of \$3.7 billion. That program encountered difficulties in part because not enough time was allowed to incorporate the results of testing into design changes, which resulted in schedule slippages and expensive retrofitting. As we have indicated in this report, based on the program's current schedule, Congress will need to decide whether to fund the start of production before developmental tests have demonstrated ACV's design maturity. Therefore, we stand by our recommendation to delay the program's production decision by 4 months, into early fiscal year 2019, to reduce concurrency between testing and production and, more importantly, enable Congress to make a funding decision based on the results of developmental testing. Although it is understandable that DOD would want to put new ACVs in the hands of marines as quickly as possible, doing so should not put Congress in the position of funding ACV production before the results of developmental testing are available to inform their decision.

We are sending copies of this report to interested congressional committees; the Secretary of Defense; the Under Secretary of Defense for Acquisition, Technology and Logistics; the Secretary of the Navy; and the Commandant of the Marine Corps. This report also is available at no charge on GAO's website at <http://www.gao.gov>.

If you or your staff have any questions on this report, please contact me at (202) 512-4841 or makm@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. Key contributors to this report are provided in appendix III.



Marie A. Mak
Director, Acquisition and Sourcing Management

List of Committees

The Honorable John McCain
Chairman
The Honorable Jack Reed
Ranking Member
Committee on Armed Services
United States Senate

The Honorable Thad Cochran
Chairman
The Honorable Richard Durbin
Ranking Member
Subcommittee on Defense
Committee on Appropriations
United States Senate

The Honorable Mac Thornberry
Chairman
The Honorable Adam Smith
Ranking Member
Committee on Armed Services
House of Representatives

The Honorable Kay Granger
Chairwoman
The Honorable Peter J. Visclosky
Ranking Member
Subcommittee on Defense
Committee on Appropriations
House of Representatives

Appendix I: Comparison of Marine Corps' Process for Overseeing Contractor Performance against GAO Best Practices

We assessed the Marine Corps' approach to overseeing ACV contractor cost and schedule performance and found it reasonable. Typically, to do this, we would assess a program's Earned Value Management (EVM) system's monthly reports, which include cost, schedule, and performance data. However, in March 2015, the Marine Corps received a waiver to forgo establishing a certified EVM system because, according to program officials, the cost of adding the system was greater than the benefit. Therefore, in the absence of an EVM system, we reviewed how the ACV program's alternative approach for overseeing contractor performance aligned with relevant best practices identified in the *GAO Cost Estimating and Assessment Guide*.¹ Specifically, the cost estimating guide identifies three characteristics that underpin a sound approach to overseeing contractor performance: (1) establishment of a comprehensive system, (2) ensuring performance data are reliable, and (3) utilizing performance data in making decisions. In assessing the ACV program office's approach to overseeing contractor performance associated with each of those characteristics, we found the following:

- The program office's approach generally established a comprehensive system for monitoring progress. For example, it is a best practice for a program's schedule to reflect the program's work breakdown structure—which is the logical sequencing of program activities—and the necessary resources for completing that work.² Through our review of ACV program documents and through discussions with program officials, we found that the ACV program's

¹GAO, *GAO Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs*, [GAO-09-3SP](#) (Washington, D.C.: March 2009).

²A work breakdown structure is the cornerstone of every program because it defines in detail the work necessary to accomplish a program's objectives. It provides a basis for identifying resources and activities necessary to produce deliverables and is a valuable communication tool between systems engineering, program management, and other functional organizations because it provides a clear picture of what has to be accomplished by decomposing the project scope into finite deliverables.

approach substantively met this best practice. Specifically, the program office followed a standard work breakdown structure that the contractors use in reporting their actual costs and a specified level of that structure will be approved by the Office of the Secretary of Defense, Office of Cost Assessment and Program Evaluation to ensure that it is consistently applied for each contractor.

- The program's process generally ensured that performance data are reliable because the program's planned approach includes steps to eliminate anomalies and guarantee that data are consistent among various reports. For example, the ACV program reported using a schedule assessment to ensure that schedule data received from its contractors do not contain errors and we found through our review of schedule documents that the program reviewed contractor-provided schedule data to ensure reliability. The program's assessment of schedule information includes, for example, identifying the number of tasks in progress and tasks missing baseline dates or facing constraints. Regarding future cost reports, program officials stated that they plan to compare multiple internal cost reports against one another to validate contractor-provided cost data, and they expect provisions within the contracts to incentivize their contractors to report accurately.
- The program is using performance data from contractors to make decisions. Program management reported that the data provided by the contractors are reviewed regularly and are used to develop corrective action plans and update the program baselines. For example, according to a program official, the ACV contractors are providing monthly integrated program management reports with schedule and performance data, which the program office is reviewing each month. Program officials also stated that with each submission, the ACV team identifies major variances based on data from that contractor's variance assessments for each work breakdown structure element. They stated that the ACV program office tracks the schedule for those elements each month to see how the baseline should be updated. In addition, the program plans to use ACV performance data to develop corrective actions by integrating the data into the program's ongoing risk analysis.

Appendix II: Comments from the Department of Defense



ACQUISITION

OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE
3015 DEFENSE PENTAGON
WASHINGTON, DC 20301-3015

MAR 28 2017

Ms. Marie A. Mak
Director, Acquisition and Sourcing Management
U.S. Government Accountability Office
441 G Street, N.W.
Washington, DC 20548

Dear Ms. Mak:

This is the Department of Defense response to the Government Accountability Office (GAO) Draft Report, GA0-17-402, "AMPHIBIOUS COMBAT VEHICLE ACQUISITION: Cost Estimate Meets Best Practices but Concurrency between Testing and Production Increases Risk," dated February 28, 2017 (GAO Code 101137). The Department appreciates the effort of the GAO and the opportunity to comment on the draft report.

The Department concurs with your first recommendation but does not agree with your second recommendation. Delaying the Amphibious Combat Vehicle Increment 1 Phase 1 Milestone C decision will have a negative effect on the Marine modernization and affordability of Marine Corps' Ground Combat Tactical Vehicle Replacement Strategy. Enclosed are recommended clarifications and supporting rationale for your report.

My point of contact for this effort is Mr. John McGough, 703-695-3043,
John.T.McGough.civ@mail.mil.

A handwritten signature in black ink, appearing to read "Dyke D. Weatherington".

Dyke D. Weatherington
Performing the Duties of the
Assistant Secretary of Defense
for Acquisition

Enclosure:
As stated

GAO DRAFT REPORT DATED FEBRUARY 28, 2017
GAO-17-402 (GAO CODE 101137)

**“AMPHIBIOUS COMBAT VEHICLE ACQUISITION: COST ESTIMATE MEETS BEST
PRACTICES BUT CONCURRENCY BETWEEN TESTING AND PRODUCTION
INCREASES RISK”**

**DEPARTMENT OF DEFENSE COMMENTS
TO GAO RECOMMENDATIONS**

RECOMMENDATION 1: Adjust the number of Amphibious Assault Vehicles (AAV) used in calculating AAV operations and support cost in the Selected Acquisition Report to reflect a more realistic comparison to the 204 Amphibious Combat Vehicle Increment 1, Phase 1 (ACV 1.1) being procured.

DoD RESPONSE: Concur.

RECOMMENDATION 2: Postpone the ACV 1.1 program’s production decision until early Fiscal Year (FY) 2019 in order to reduce concurrency between testing and production.

DoD RESPONSE: Non-concur

- Postponing the Milestone (MS) C decision until FY 2019 will add risk to the ACV Program and overall Marine Corps Ground Combat Tactical Vehicle Replacement Strategy (GCTVS) based on the following rationale:
 - The concurrence of testing and production cited in the draft Report are consistent with the approved Acquisition Strategy and Test and Evaluation Master Plan (TEMP).
 - This concurrency is considered low risk. The Program Life Cycle Cost Estimate and budget include funding to conduct corrective actions on the low number of Low-Rate Initial Production vehicles if required. Based on the technical maturation of these systems, corrective actions are not anticipated to be major vehicle changes.
 - All testing required by the TEMP and MS B Acquisition Decision Memorandum to be conducted prior to MS C will be conducted as directed. Ninety-six percent of the ACV’s 425 total requirements will be tested during the scheduled Developmental Tests (DT)/Operational Assessment, to include all critical requirements to support MS C. As part of DT, land mobility and hot weather testing will be accomplished at Yuma, Arizona during the Summer months. Additionally, chamber testing for high temperature will also be conducted prior to MS C. Of the remaining seventeen requirements, eleven are objective requirements and the remaining six requirements are low risk due to the design of the vehicle. Finally, the ACV test schedule was adjusted as part of the approved Acquisition Program Baseline to take into account the protest period.

- The significant risks to the Marine Corps fielding schedule and impact to the overall Marine Corps GCTVS that would result from delaying the ACV fielding decision, will impact the Marine Corps sequential modernization and affordability across the Future Years Defense Plan.
- Marine Corps leadership prioritized achieving ACV 1.1 operational capability over several key aspects of performance in order to field a modern personnel carrier at first opportunity. Additional desired capability, to include enhanced lethality, active protection, and improved water mobility performance were deliberately deferred to future increments as part of the first increment risk reduction approach. This approach is codified in the ACV 1.1 Capability Development Document which was approved by the Marine Corps Requirements Oversight Council and validated by the Joint Requirements Oversight Council.
 - Marine Corps leadership direction to the Program Office and its supervising Program Executive Office was to begin replacing legacy AAVs with ACVs at the first opportunity. The impetus for rapid replacement is force protection and system survivability performance. This approach and the risk it engenders were reviewed, assessed, and approved via Department of the Navy and Department of Defense Acquisition channels per Acquisition Category I program procedures.
 - Additionally, ACV 1.1 is part of a portfolio of ground combat and tactical vehicle modernization and sustainment programs. A significant slip in ACV 1.1 initial operational capability has the potential to negatively impact other programs, extends legacy system employment, and is not consistent with the planned acquisition and resourcing strategy for ACV 1.1
- Director, Operational Test and Evaluation operational assessment of the ACV 1.1 is scheduled for the second quarter of FY 2018 and will support the MS C decision scheduled for the third quarter of FY 2018. Delaying the ACV 1.1 MS C decision may have a negative effect on the Marine modernization and affordability of Ground Combat Vehicle Strategy.

REPORT CLARIFICATION: Page 7, Bullet 2 of the report states, "...the program office estimate - which the CAPE estimate was largely predicated on - did." The Director, Cost Assessment and Program Evaluation (CAPE) conducted an Independent Cost Estimate in support of the MS B decision. As such, recommend "- which the CAPE estimate was largely predicated on -" be removed from the paragraph.

Appendix III: GAO Contact and Staff Acknowledgments

GAO Contact

Marie A. Mak, (202) 512-4841 or makm@gao.gov

Staff Acknowledgments

In addition to the contact named above, Bruce H. Thomas (Assistant Director), Holly Williams (Analyst-in-Charge), Marie Ahearn, Alissa Czyz, Stephanie Gustafson, Jennifer Leotta, Bonita Oden, Karen Richey, Zachary Sivo, and Robin Wilson made key contributions to this report.

Appendix IV: Accessible Data

Data Table

Figure 3: Amphibious Combat Vehicle’s (ACV) Milestone B Baseline Schedule Compared to Schedule as of January 2017

Acquisition Decision Points

Schedule Event	Schedule at Milestone B	Updated Schedule
Milestone B	Dec 2016	Nov 2016
Milestone C (MS-C) / Down-Select	Feb 2018	June 2018
Initial Operational Capability (IOC)	Sep 2020	Sep 2020
Full Operational Capability (FOC)	Sep 2023	Sep 2022

Test and Evaluation

Schedule Event	Schedule at Milestone B	Updated Schedule
Pre MS-C Developmental Testing	January 2017 – Feb 2018	April 2017 – March 2018
Post MS-C Developmental Testing	April 2018 – Sept 2019	Aug 2018 – Oct 2019
Hot Weather Testing	Jul & Aug 2018	Jul & Aug 2019
Live Fire Test & Evaluation (LFT&E)	Jan-Sep 2019	April – Dec 2019
IOT&E	Oct –Dec 2019	Jan-Mar 2020

Production

Schedule Event	Schedule at Milestone B	Updated Schedule
Low Rate Initial Production (LRIP) 1	Feb 2018 – Jan 2019	Aug 2018 – Sep 2019
Low Rate Initial Production (LRIP) 2	Jan 2019 - Dec 2019	Jan 2019 – June 2020
Full Rate Production (FRP)	March 2020 – Dec 2022	May 2020 - April 2022

Agency Comment Letter

Text of Appendix II: Comments from the Department of Defense

Page 1

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Dyke D. Weatherington

Performing the duties of the assistant secretary of defense for acquisition

Enclosure

as stated

Page 2

GAO DRAFT REPORT DATED FEBRUARY 28, 2017 GA0-17-402 (GAO CODE 101137)

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Page 3

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