



April 2015

AMPHIBIOUS COMBAT VEHICLE ACQUISITION

Marine Corps Adopts an Incremental Approach

Report Documentation Page

Form Approved
OMB No. 0704-0188

Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

1. REPORT DATE APR 2015	2. REPORT TYPE	3. DATES COVERED 00-00-2015 to 00-00-2015			
4. TITLE AND SUBTITLE Amphibious Combat Vehicle Acquisition: Marine Corps Adopts an Incremental Approach		5a. CONTRACT NUMBER			
		5b. GRANT NUMBER			
		5c. PROGRAM ELEMENT NUMBER			
6. AUTHOR(S)		5d. PROJECT NUMBER			
		5e. TASK NUMBER			
		5f. WORK UNIT NUMBER			
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) U.S. Government Accountability Office, 441 G Street NW, Washington, DC, 20548		8. PERFORMING ORGANIZATION REPORT NUMBER			
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		10. SPONSOR/MONITOR'S ACRONYM(S)			
		11. SPONSOR/MONITOR'S REPORT NUMBER(S)			
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified	Same as Report (SAR)	25	

Why GAO Did This Study

The National Defense Authorization Act for Fiscal Year 2014 mandated GAO to review and report annually to the congressional defense committees on the ACV program until 2018. In April 2014 GAO produced the first of the mandated reports describing the status of the Marine Corps' efforts to initiate an ACV program. This second mandated report discusses (1) the current ACV acquisition approach and (2) how the ACV acquisition approach compares to acquisition management best practices.

To conduct this work, GAO reviewed program documentation and other materials for the ACV acquisition, including Acquisition Decision Memorandums, relevant analyses of alternatives, and a briefing on the most recent analysis of alternatives update. GAO also reviewed documentation and budget information for the AAV Survivability Upgrade Program and the Marine Personnel Carrier program. GAO identified acquisition best practices based on its prior body of work in that area and DOD guidance. GAO also interviewed program and agency officials.

What GAO Recommends

GAO is not making recommendations in this report. In commenting on a draft of this report, DOD stated that it believes its efforts on this program are aligned with GAO's best practices and it will continue to monitor the program and ensure that mitigations are in place to address potential risk areas. In GAO's upcoming review, additional analysis will assess how well the program is aligned with best practices.

View [GAO-15-385](#). For more information, contact Marie A. Mak at (202) 512-4841 or makm@gao.gov.

AMPHIBIOUS COMBAT VEHICLE ACQUISITION

Marine Corps Adopts an Incremental Approach

What GAO Found

Since GAO reported on the Amphibious Combat Vehicle (ACV) acquisition in 2014, the Marine Corps has adopted a new ACV acquisition approach consisting of three concurrent efforts that emphasize the requirement for improved protection from threats such as improvised explosive devices in the near term with improved amphibious capabilities over time. The first of the three efforts, the Assault Amphibious Vehicle (AAV) Survivability Upgrade Program, plans to upgrade legacy AAV protection and mobility. The second effort subdivides into two increments, ACV 1.1 and ACV 1.2. ACV 1.1 is a continuation of a previously suspended Marine Personnel Carrier program that intends to provide enhanced protected land mobility and limited amphibious capability. Testing on the ACV 1.1 will inform the development of the ACV 1.2, with the intent that the ACV 1.2 will demonstrate improved amphibious capability and at a minimum, achieve parity with the legacy AAV. The third effort, referred to as ACV 2.0, focuses on technology exploration to attain high water speed capability. Results of this high water speed research are intended to further inform the development of a replacement for the AAV fleet.

GAO's analysis of the ACV 1.1 planned acquisition approach has demonstrated the Marine Corps' use of, and deviation from, best practices; however, ACV 1.1 is still in the initial stages of the acquisition process, limiting our ability to determine how fully this approach will adopt a best practices knowledge-based framework. GAO's prior work on best practices has found that successful programs take steps to gather knowledge that confirms that their technologies are mature, their designs stable, and their production processes are in control. The knowledge-based acquisition framework involves achieving the right knowledge at the right time, enabling leadership to make informed decisions about when and how best to move into various acquisition phases. Specifically, the Marine Corps' incremental approach for the ACV acquisition is consistent with best practices and can increase the likelihood of success. The adoption of an incremental approach has helped the program progress towards achieving the balance—that is sought in accordance with best practices—between customer needs and resources (e.g., technologies, cost, and schedule). In addition, the ACV acquisition's pursuit of high water speed capabilities via technology exploration is also aligned with best practices. In previous reports, GAO has found that DOD should separate technology development from product development, and fully develop technologies before introducing them into the design of a system. In contrast, the program plans to hold the ACV 1.1 preliminary design review after Milestone B—the decision point allowing entry into system development—which is a deviation from best practices that can increase technical risk. According to DOD officials, this approach was selected because no contracts will have been awarded prior to Milestone B and the use of non-developmental technology will reduce acquisition risks and result in a high level of knowledge prior to the Milestone B decision. The recent completion of key documents—including an updated analysis of alternatives—will permit a more robust analysis and assessment of the ACV program's use of additional acquisition best practices.

Contents

Letter		1
	Results in Brief	2
	Background	4
	ACV Acquisition Approach Prioritizes Protected Land Mobility over Amphibious Capabilities	6
	Upcoming Activities Will Permit Further Analysis to Determine Use of Best Practices	12
	Agency Comments and Our Evaluation	16
Appendix I	Comments from the Department of Defense	19
Appendix II	GAO Contact and Staff Acknowledgments	20
Table		
	Table 1: Comparison of Selected Assault Amphibious Vehicle and Amphibious Combat Vehicle Capabilities	8
Figures		
	Figure 1: United States Marine Corps' Amphibious Combat Vehicle Acquisition Approach	6
	Figure 2: Navy's Ship to Shore Connector Amphibious Craft	9
	Figure 3: Notional Drawing of Amphibious Combat Vehicle 1.1	11
	Figure 4: Alignment of DOD's Acquisition Process and Best Practices	13

Abbreviations

AAV	Assault Amphibious Vehicle
ACV	Amphibious Combat Vehicle
APUC	average procurement unit cost
CDR	critical design review
DOD	Department of Defense
EFV	Expeditionary Fighting Vehicle
IOC	initial operational capability
PDR	preliminary design review
USMC	United States Marine Corps

This is a work of the U.S. government and is not subject to copyright protection in the United States. The published product may be reproduced and distributed in its entirety without further permission from GAO. However, because this work may contain copyrighted images or other material, permission from the copyright holder may be necessary if you wish to reproduce this material separately.



April 15, 2015

Congressional Committees

Since 1972, the primary platform for transporting Marines from ship to shore under hostile conditions has been the Assault Amphibious Vehicle (AAV). In 2011, acquisition of a proposed replacement vehicle—the United States Marine Corps’ (USMC) Expeditionary Fighting Vehicle (EFV)—was canceled due to concerns regarding the program’s affordability. In the same year, the USMC began an analysis of alternatives for the Amphibious Combat Vehicle (ACV), a potential replacement vehicle for all or a portion of the AAV fleet.¹ The ACV is intended to transport Marines from ship to shore and provide armored protection once on land.

The National Defense Authorization Act for Fiscal Year 2014 mandated us to review and report annually to the congressional defense committees on the ACV program until 2018.² In April 2014, we produced the first of the mandated reports describing the status of the USMC’s efforts to initiate an ACV program.³ This second mandated report discusses (1) the current ACV acquisition approach and (2) how the ACV acquisition approach compares to acquisition management best practices.

To conduct this work, we reviewed program documentation and other materials for the ACV acquisition, including Acquisition Decision Memorandums, relevant analyses of alternatives, and a briefing on the most recent analysis of alternatives update. We also reviewed documentation and budget information for the AAV Survivability Upgrade Program and the Marine Personnel Carrier program. We identified

¹An analysis of alternatives is a key first step in the acquisition process intended to assess alternative weapon system solutions for addressing a validated need.

²Pub. L. No. 113-66 § 251 (2013). The ACV program is still relatively early in the acquisition process. As a result, we were unable to review all of the elements in the mandate since the ACV program has not yet progressed to those stages in the acquisition process.

³GAO, *National Defense: Status of Efforts to Initiate an Amphibious Combat Vehicle Program*, [GAO-14-359R](#) (Washington, D.C.: Apr. 10, 2014).

acquisition best practices based on our extensive body of work in that area and Department of Defense (DOD) guidance, and used this information to analyze the proposed ACV acquisition approach and acquisition activities to date. We also reviewed our previous work on the ACV and EFV programs. In addition, we interviewed program and agency officials from the USMC's Advanced Amphibious Assault program office and Combat Development Command, the Office of the Deputy Assistant Secretary of the Navy for Expeditionary Programs and Logistics Management, and the Office of the Secretary of Defense, Cost Assessment and Program Evaluation.

We conducted this performance audit from August 2014 to April 2015 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.

Results in Brief

Since we reported on the ACV acquisition in 2014, the USMC has adopted a new ACV acquisition approach consisting of three concurrent efforts that emphasize the requirement for protected land mobility—improved protection from threats such as improvised explosive devices—in the near term with improved amphibious capabilities over time. The first of the three efforts is the AAV Survivability Upgrade Program that expects to upgrade legacy AAV protection and mobility. The second effort subdivides into two increments, ACV 1.1 and 1.2. ACV 1.1 is a continuation of a previously suspended Marine Personnel Carrier program that intends to provide enhanced protected land mobility and limited amphibious capability.⁴ Previous USMC analysis done in support of the ACV acquisition in 2012 found that a vehicle based on the Marine Personnel Carrier performed well in land-based scenarios, but as a non-amphibious armored personnel carrier, did not perform as well in

⁴The Marine Personnel Carrier program was suspended in 2013. According to USMC officials, budget uncertainty led the USMC to determine that it could not afford to have three simultaneous development and procurement programs for armored vehicles, specifically the ACV, the Marine Personnel Carrier, and the Joint Light Tactical Vehicle. After considering strategic priorities, the USMC decided to suspend the Marine Personnel Carrier program and continue with the ACV and Joint Light Tactical Vehicle.

amphibious assault scenarios. Testing on the ACV 1.1 will inform the development of the ACV 1.2, with the intent that the ACV 1.2 will demonstrate improved amphibious capability, at minimum achieving parity with the legacy AAV. The third effort, referred to as ACV 2.0, focuses on technology exploration to attain high water speed capability. Results of this high water speed research are intended to further inform the development of a replacement for the AAV fleet. According to USMC officials, high water speed capability (which had been a key requirement for EFV) may ultimately be achieved through an amphibious vehicle or a connector—a craft that transports personnel, weapon systems, equipment, and cargo from amphibious vessels to shore in assault and non-assault operations—that will provide high water speed for vehicles without that capability.

ACV 1.1 is still in the initial stages of the acquisition process, limiting our ability to determine how fully the ACV acquisition will adopt a best practices knowledge-based framework; however, analysis of the ACV 1.1 planned acquisition approach has demonstrated both use of, and deviation from, best practices. Our prior work on best practices has found that successful programs take steps to gather knowledge that confirms that their technologies are mature, their designs stable, and their production processes are in control. The knowledge-based acquisition framework involves achieving the right knowledge at the right time, enabling leadership to make informed decisions about when and how best to move into various acquisition phases. Specifically, the program office has adopted an incremental approach for the ACV acquisition that is consistent with best practices and can increase the likelihood of success. The adoption of an incremental approach has helped the program progress towards achieving the balance between customer needs and resources (e.g., technologies, cost and schedule) that is sought in accordance with best practices. In addition, the ACV acquisition's pursuit of high water speed capabilities via technology exploration is also aligned with best practices. In prior work we have found that DOD should separate technology development from product development, and fully develop technologies before introducing them into the design of a system. However, the program plans to hold the ACV 1.1 preliminary design review after Milestone B—the decision point allowing entry into system development—which is a deviation from best practices that can increase technical risk.⁵ According to DOD officials, this

⁵The preliminary design review is a technical review assessing the system design.

approach was selected because no contracts will have been awarded prior to Milestone B and the use of non-developmental technology will reduce acquisition risks and result in a high level of knowledge prior to the Milestone B decision. The recent completion of key documents—including an updated analysis of alternatives—will permit a more robust analysis and assessment of the ACV program’s use of additional acquisition best practices. We have identified a number of best practices for the development of analyses of alternatives that will inform this analysis.

Background

According to USMC officials, the AAV has become increasingly difficult to operate, maintain, and sustain. As weapons technology and threat capabilities have evolved over the past four decades, the AAV is viewed as having capability limitations in the areas of water speed and land mobility, lethality, protection, and network capability. The AAV is a self-deployed tracked (non-wheeled) vehicle with three variants, each describing its intended function—Personnel, Command, and Recovery. The AAV has a water speed of approximately six knots, and needs to be deployed from within 7.4 nautical miles of the shore. This factor may represent a significant survivability issue not only for the vehicle’s occupants, but also for naval amphibious forces that must move closer to potential threats on shore to support the vehicle. Over time, emerging threats—such as next generation improvised explosive devices—have changed the performance requirements for a vehicle that moves from ship to shore.

According to DOD, the need to modernize USMC’s capability of transitioning from ship to shore is essential. In response to the need for new and better capabilities, the USMC began development of the EFV in 2000. We reported on the EFV program in 2006 and 2010.⁶ The EFV was to travel at higher water speeds—around 20 knots—which would have allowed transporting ships to launch the EFV further from shore than the AAVs it was to replace. However, following the expenditure of \$3.7 billion between fiscal years 1995 and 2011 and a 2007 breach of a statutory

⁶GAO, *Defense Acquisitions: The Expeditionary Fighting Vehicle Encountered Difficulties in Design Demonstration and Faces Future Risks*, [GAO-06-349](#) (Washington, D.C.: May 1, 2006); and *Government Operations: Expeditionary Fighting Vehicle (EFV) Program Faces Cost, Schedule and Performance Risks*, [GAO-10-758R](#) (Washington, D.C.: July 2, 2010).

cost threshold⁷ that program was restructured and subsequently, in 2011, canceled by DOD due to affordability concerns. DOD authorized the USMC to seek a new solution, emphasizing the need for cost-effectiveness and requiring the establishment of cost targets. The USMC was granted flexibility in tailoring its acquisition approach to achieve those goals.

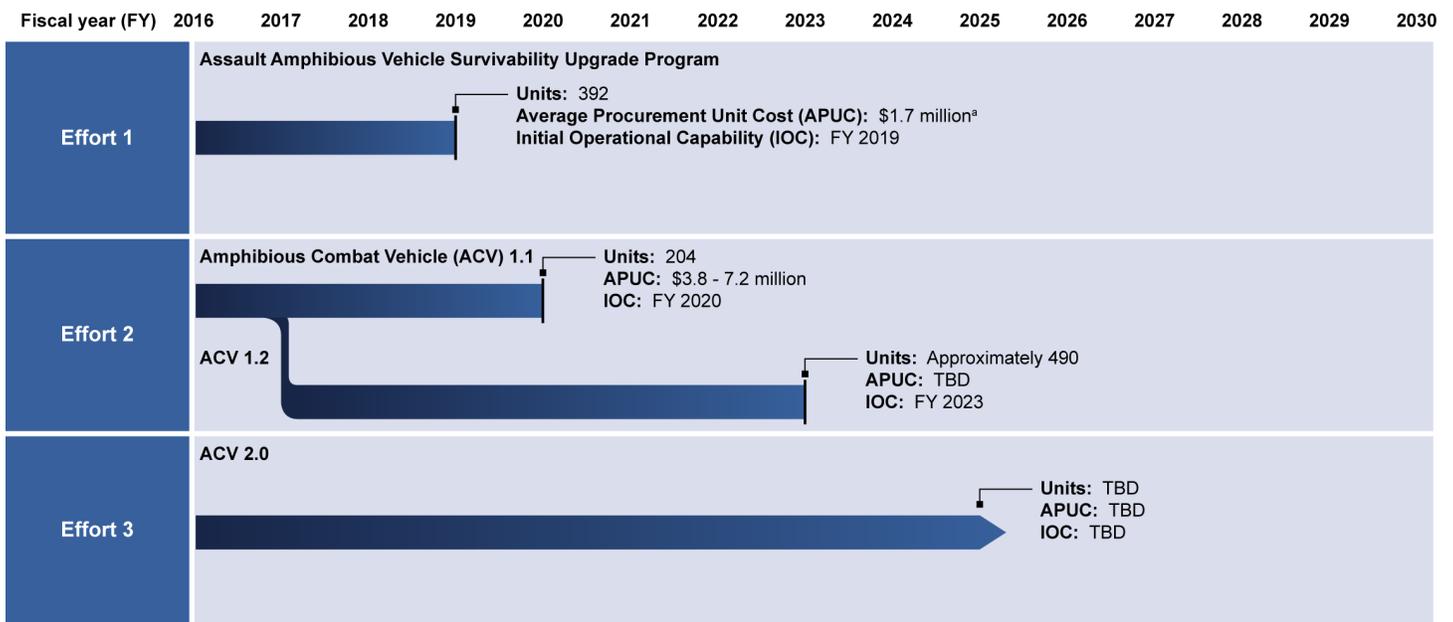
In 2011, the USMC completed initial acquisition documentation providing the performance requirements of a new replacement amphibious vehicle called the ACV. The ACV would be self-deploying with a water speed of 8 to 12 knots—permitting deployment beyond visual range of the shore—and would provide for sustained operations on shore with improved troop protection. The ACV would not, however, be required to achieve high water speed. An analysis of alternatives was completed for the ACV in the summer of 2012. This analysis identified two potential solutions for the ACV performance requirements. However, USMC leadership then requested that an affordability analysis be completed to explore the technical feasibility of integrating high water speed into the development of the ACV. According to DOD officials, the analysis indicated that achieving high water speed was technically possible but required unacceptable tradeoffs as the program attempted to balance vehicle weight, capabilities, and cost. Meanwhile, the USMC retained a requirement to provide protected land mobility in response to the threat of improvised explosive devices—a requirement the AAV could not meet due to its underbody design. In 2014 we reported that, according to program officials, the program office was in the process of revising its ACV acquisition approach based on this affordability analysis. In addition, DOD officials reported that the 2012 ACV analysis of alternatives might need to be updated or replaced based on potential changes to required capabilities.

⁷Section 2433 of title 10 of the United States Code, commonly referred to as Nunn-McCurdy, requires DOD to notify Congress whenever a major defense acquisition program's unit cost experiences cost growth that exceeds certain thresholds. This is commonly referred to as a Nunn-McCurdy breach. Significant breaches occur when the program acquisition unit cost or procurement unit cost increases by at least 15 percent over the current baseline estimate or at least 30 percent over the original estimate. For critical breaches, when these unit costs increase at least 25 percent over the current baseline estimate or at least 50 percent over the original, DOD is required to take additional steps, including conducting an in-depth review of the program. Programs with critical breaches must be terminated unless the Secretary of Defense certifies to certain facts related to the program and takes other actions, including restructuring the program. 10 U.S.C. § 2433a.

ACV Acquisition Approach Prioritizes Protected Land Mobility over Amphibious Capabilities

Since we reported on the ACV acquisition in 2014, the USMC has adopted a new ACV acquisition approach consisting of three concurrent efforts that emphasize the requirement for protected land mobility in the near term and seek improved amphibious capabilities over time. This approach is a significant change from the more advanced amphibious capabilities sought for the ACV in 2011. According to USMC officials, the first effort is the AAV Survivability Upgrade Program that plans to upgrade legacy AAV protection and mobility. The second effort subdivides into two increments, ACV 1.1 and 1.2. The third effort, referred to as ACV 2.0, focuses on technology exploration to attain high water speed capability. According to USMC officials, this acquisition approach was selected based on several factors, including (1) recognition that the ACV would spend much of its operating time on land, (2) shortfalls in the AAV's ability to meet protected land mobility requirements once on shore, and (3) technical and affordability challenges that preclude the development of a high water speed vehicle in the near term. Figure 1 provides information on these three concurrent efforts.

Figure 1: United States Marine Corps' Amphibious Combat Vehicle Acquisition Approach



Source: GAO presentation of DOD-provided data. | GAO-15-385

^aAPUC dollar amounts are presented in fiscal year 2014 dollars.

AAV Survivability Upgrade Program Intends to Mitigate Current AAV Fleet Shortfalls in Force Protection

The AAV Survivability Upgrade Program expects to upgrade survivability and mobility capabilities for a portion of the existing AAV fleet, thereby providing increased protection against threats such as improvised explosive devices. The AAV is expected to remain in operation until 2035.⁸ According to DOD officials, planned upgrades include the addition of underbelly armor, blast resistant seats, external fuel tanks and other modifications, such as suspension upgrades, intended to maintain mobility given the weight of extra armor. The upgraded AAVs expect to retain the six knot water speed of the legacy AAV. The AAV Survivability Upgrade Program plans to upgrade 392 of the fleet's 1058 AAVs. The upgrades will be made to the AAV Personnel variant—the version of the AAV used to transport infantry. The estimated average procurement unit cost for the upgrades—the total procurement cost divided by the number of units to be procured—is \$1.7 million (fiscal year 2014 dollars). The program has passed Milestone B with anticipated initial operational capability—generally attained when some units in the force structure have received the upgraded vehicles and have the ability to employ and maintain it—in fiscal year 2019.

ACV Acquisition Emphasizes Protected Land Mobility in the Near Term and Improved Amphibious Capabilities in the Second Iteration

The first increment of ACV development—ACV 1.1—is a wheeled vehicle that is intended to provide enhanced protected land mobility and limited amphibious capability. ACV 1.1 is a continuation of the previously suspended Marine Personnel Carrier program.⁹ At an expected water speed of five knots, ACV 1.1 intends to offer swim speeds comparable to the AAV and is expected to swim from shore to shore, crossing obstacles such as rivers, rather than from ship to shore. The ACV 1.1 is not planning to have a self-deployment capability and as a result, will rely on the assistance of connectors to move from ship to shore. The vehicle expects to feature a troop-carrying capacity of 10 infantry, with the objective of expanding this capacity to 13 infantry. According to program officials, the ACV acquisition will be informed by both a 2008 analysis of alternatives done for the Marine Personnel Carrier program as well as the 2012 ACV analysis of alternatives. USMC has recently completed an

⁸Prior to the cancellation of the EFV program, the AAV was scheduled to be removed from service in fiscal year 2018.

⁹According to DOD officials, Marine Personnel Carrier and ACV 1.1 are different names for combat vehicles with similar capabilities. In developing ACV 1.1, the USMC utilized prototypes, demonstration testing, and study results from the Marine Personnel Carrier program.

update to these two analyses—the 2014 ACV analysis of alternatives—with a focus on cost and affordability that, according to DOD officials, needed to be updated to reflect the current approach. The ACV 1.1 will likely be used concurrently with upgraded AAVs that are expected to provide amphibious capabilities that complement the enhanced protected land mobility sought by ACV 1.1. Table 1 provides a summary of selected capabilities of the legacy AAV, upgraded AAV and ACV 1.1.

Table 1: Comparison of Selected Assault Amphibious Vehicle and Amphibious Combat Vehicle Capabilities

Capability	Assault Amphibious Vehicle (AAV)	Upgraded AAV	Amphibious Combat Vehicle (ACV) 1.1
Improvised Explosive Device Protection (Underbelly)	Baseline Protection	Increased Protection	Increased Protection
Lethality (Armament)	.50 caliber machine gun and 40 mm grenade launcher Directly Manned Unstabilized ^a	.50 caliber machine gun and 40 mm grenade launcher Directly Manned Unstabilized ^a	.50 caliber machine gun or 40 mm grenade launcher Remotely Manned Stabilized ^a
Troop Capacity	21	17	10
Weight Growth Margin	0 lbs	No requirement	Gross Vehicle Weight + 15%
Water Speed	6 knots	6 knots	5 knots
Operating Sea State ^b	3	3	2
Self-Deployed	Yes	Yes	No

Source: GAO presentation of USMC data. | GAO-15-385

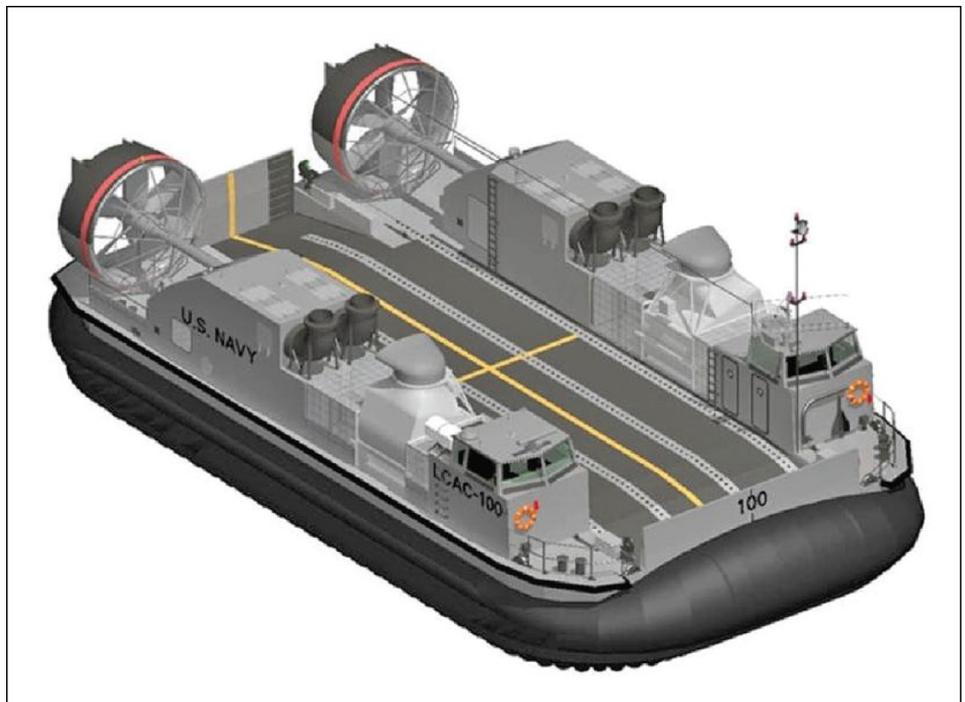
^aAccording to United States Marine Corps requirements documentation, unstabilized weapons are less accurate than stabilized when the vehicle is in motion.

^bThe Navy classifies sea states on a scale of 0 to 9 depending on the roughness of the water as caused by wind or other disturbances. Sea states 0 to 3 represent calm to slight seas of 4 feet or less. Sea state 4 is characterized by moderate seas of 4 to 8 feet. Sea states 5 to 6 range from rough to very rough seas between 8 to 20 feet. Sea states 7 to 9—the most challenging marine conditions—reflect high to extremely rough seas, including seas above 20 feet.

The 2012 analysis of alternatives done to support the ACV acquisition considered a vehicle based on the Marine Personnel Carrier, with capabilities similar to the ACV 1.1, and concluded that the vehicle was not an effective alternative to fill the identified ACV water mobility capability gaps. The analysis found that the vehicle performed well in land-based scenarios, but as a non-amphibious armored personnel carrier, did not perform as well in amphibious assault scenarios. In addition, the vehicle's reliance on a connector craft to travel from ship to shore would extend the time necessary to complete force landings and achieve objectives in amphibious scenarios. Since a connector craft, such as the ship to shore connector currently being developed by the Navy (see figure 2), would

have to transport these vehicles as well as personnel and other vehicles and equipment, it would also increase the number of connector loads and connector crew time. The analysis found that the increased use of connectors would result in a significant delay relative to self-deploying alternatives. Finally, the vehicle had less capacity than the other vehicles assessed in the analysis. The vehicle held nine infantry—similar to ACV 1.1’s threshold capacity of 10—while the other assessed vehicles held 17. According to the analysis, reduced capacity would require a higher number of vehicles to transport an infantry battalion. The larger number of vehicles would then require additional space on transportation vessels, potentially displacing other cargo and impacting logistical support and manning, as well as increasing the number of these vehicles required in the field. However, according to the analysis, the resulting vehicle dispersion would reduce infantry exposure to improvised explosive devices and increase the number of vehicles available to support a counterattack.

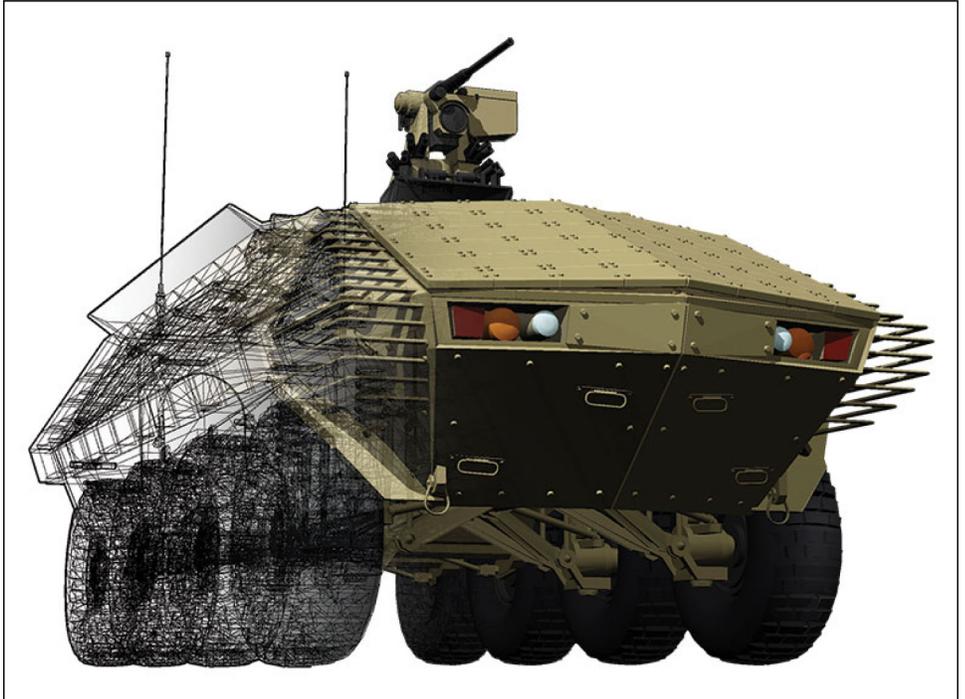
Figure 2: Navy’s Ship to Shore Connector Amphibious Craft



Source: U.S. Navy. | GAO-15-385

The USMC plans to acquire 204 ACV 1.1s and anticipates achieving initial operational capability in fiscal year 2020. According to program officials, the current estimated average procurement unit cost is between \$3.8 million and \$7.2 million (fiscal year 2014 dollars). The ACV 1.1 effort will enter the acquisition process at Milestone B, currently scheduled for the first quarter of fiscal year 2016. According to DOD officials, the planned use of existing, non-developmental technologies in ACV 1.1 reduces acquisition risk and facilitated the decision to enter the acquisition process at Milestone B with the goal of fielding a solution more quickly. The program office issued a Request for Proposal in the second quarter of fiscal year 2015 and plans to award contracts to two vendors at Milestone B and require each vendor to provide 16 prototype vehicles. DOD officials stated that the large number of prototypes will facilitate and expedite the testing process, allowing multiple tests to take place concurrently, and allowing testing to continue in the event of a prototype breakdown. They indicated that the USMC plans to begin testing the ACV 1.1's swim capability and other factors in fiscal year 2017. The two contracts are to run through the engineering and manufacturing development phase of the acquisition process, at which point USMC anticipates potentially down selecting to a single contractor. Figure 3 provides a notional drawing of the ACV 1.1.

Figure 3: Notional Drawing of Amphibious Combat Vehicle 1.1



Source: United States Marine Corps. | GAO-15-385

The second increment of ACV development—ACV 1.2—aims to improve amphibious capability. Program officials anticipate that ACV 1.2 will demonstrate amphibious capability that matches the legacy AAV, including the ability to self-deploy and swim to shore without the assistance of connector craft. According to DOD officials, ACV 1.2 will be based on ACV 1.1 testing and some 1.1s will be retrofitted with ACV 1.2 modifications. The USMC plans to acquire approximately 490 ACV 1.2s with initial operational capability scheduled for fiscal year 2023. In addition, the USMC plans to complete fielding of all ACV 1.1s and 1.2s, as well as the upgraded AAVs between the years 2026 and 2028.

According to DOD officials, the changes made for the ACV 1.2 increment may be done through improvements within the same program, or ACV 1.2 may be a separate program from ACV 1.1. This determination has not yet been made. In previous reports, we have found that managing weapon systems that are being developed in increments as separate acquisition programs with their own cost and schedule baselines facilitates

management and testing and helps avoid unrealistic cost estimates. This practice can result in more realistic long-range investment funding and more effective resource allocation.¹⁰

Technology Exploration Is Underway for High Water Speed Capability for Use in a Possible ACV 2.0

The third effort, referred to as ACV 2.0, focuses on technology exploration to attain high water speed capability. According to DOD, high water speed remains a critical capability. Technology exploration efforts are pursuing design options that may enable high water speed capability without accruing unacceptable trade-offs in other capabilities, cost or schedule. According to USMC officials, vehicle weight is the key barrier to achieving high water speed. Current technology exploration efforts include some technology from the canceled EFV program and focus primarily on various approaches addressing this weight challenge, including improving the technology that lifts the vehicle body onto plane and reducing the vehicle weight. According to DOD officials, the results of this high water speed research, knowledge gained from fielding the ACV 1.1 and 1.2, and information from the naval surface connector strategy are expected to inform the development of a replacement for the AAV fleet. According to officials, ACV 2.0 is a conceptual placeholder for that future replacement decision, which is expected to occur in the mid-2020s. High water speed capability may ultimately be achieved through an amphibious vehicle or a connector craft that will provide high water speed for vehicles without that capability.

Upcoming Activities Will Permit Further Analysis to Determine Use of Best Practices

Our prior work on best practices has found that successful programs take steps to gather knowledge that confirms that their technologies are mature, their designs stable, and their production processes are in control.¹¹ The knowledge-based acquisition framework involves achieving the right knowledge at the right time, enabling leadership to make informed decisions about when and how best to move into various acquisition phases. Successful product developers ensure a high level of knowledge is achieved at key junctures in development, characterized as

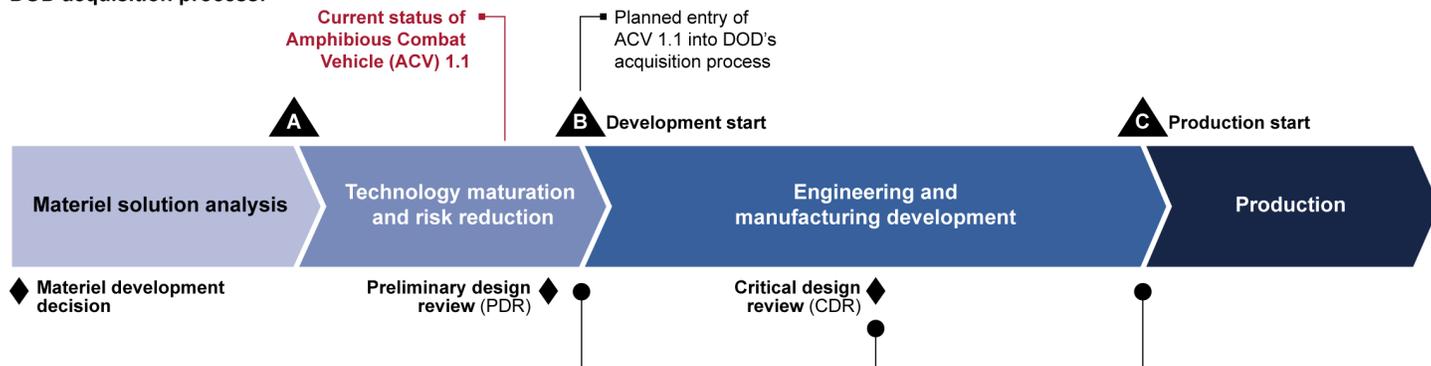
¹⁰GAO, *NASA: Actions Needed to Improve Transparency and Assess Long-Term Affordability of Human Exploration Programs*, [GAO-14-385](#) (Washington D.C.: May 8, 2014); and *Tactical Aircraft: F-22A Modernization Program Faces Cost, Technical, and Sustainment Risks*, [GAO-12-447](#) (Washington D.C.: May 2, 2012).

¹¹For example, see GAO, *Defense Acquisitions: Assessments of Selected Weapon Programs*, [GAO-14-340SP](#) (Washington, D.C.: Mar. 31, 2014).

knowledge points. During the initial stages of an acquisition process, referred to as Knowledge Point 1, best practices recommend ensuring a match between resources and requirements. Achieving a high level of technology maturity and preliminary system design backed by robust systems engineering is an important indicator of whether this match has been made. This means that the technologies needed to meet essential product requirements have been demonstrated to work in their intended environment. In addition, the developer has completed a preliminary design of the product that shows the design is feasible. Figure 4 further describes the three knowledge points and identifies the ACV 1.1 acquisition's status within the DOD acquisition process.

Figure 4: Alignment of DOD's Acquisition Process and Best Practices

DOD acquisition process:



Best practices knowledge-based acquisition model:

- Knowledge Point 1**

Technologies, time, funding and other resources match customer needs.

Decisions to invest in product development.

Key steps:

 - PDR completed
 - Technologies demonstrated to high levels
 - Incremental acquisition strategy in place
 - Knowledge-based cost estimate
- Knowledge Point 2**

Design is stable and performs as expected.

Decisions to start building and testing production representative prototypes.

Key steps:

 - Subsystems and system level CDRs completed
 - Ninety percent of engineering drawings released
 - Early integrated system prototype demonstrated
 - Critical manufacturing process identified
- Knowledge Point 3**

Production meets cost, schedule, and quality target.

Decisions to produce first units for customer.

Key steps:

 - Fully integrated, capable prototype demonstrated in intended environment.
 - Manufacturing processes in control
 - Product reliability demonstrated

Source: GAO analysis of DOD-provided data, DOD Instruction 5000.02, "Operation of the Defense Acquisition System" (January 7, 2015) and GAO's best practices. | GAO-15-385

The ACV 1.1 acquisition has yet to reach the first knowledge point, limiting our ability to determine how fully the acquisition will adopt the best practices knowledge-based framework. However, our review of the planned acquisition approach for ACV 1.1 has identified both the use of—and a deviation from—best practices.

- The ACV acquisition’s incremental approach to development is consistent with best practices. We have previously reported that adopting a more evolutionary, incremental strategy that delivers proven and operationally suitable capabilities when available—but acknowledges that more time is needed to deliver the full capabilities—can enable the capture of design and manufacturing knowledge as well as increase the likelihood of success in providing timely and affordable capability.¹² The ACV acquisition demonstrates this evolutionary approach, seeking smaller increases in capability with improvements planned over time. In contrast, the canceled EFV program sought significant increases in capability in a single development process. The adoption of an incremental approach has helped the program progress towards striking the balance between customer needs and resources (e.g., technologies, cost and schedule) that is sought at Knowledge Point 1. The ACV program has demonstrated a willingness to trade customer needs—such as high water speed in the near term—and utilize mature technologies in order to identify an affordable solution that is available in the necessary time frames.
- The ACV acquisition’s pursuit of high water speed capabilities via technology exploration is also aligned with best practices. In previous reports, we have found that DOD should separate technology development from product development, and fully develop technologies before introducing them into the design of a system.¹³ A science and technology environment is more conducive to the ups and downs normally associated with the discovery process. This affords the opportunity to gain significant knowledge before

¹²For example, see GAO, *Best Practices: Better matching of Needs and Resources Will Lead to Better Weapon System Outcomes*, [GAO-01-288](#) (Washington, D.C.: Mar. 8, 2001); and *Joint Strike Fighter: Additional Costs and Delays Risk Not Meeting Warfighter Requirements on Time*, [GAO-10-382](#) (Washington, D.C.: Mar. 19, 2010).

¹³See GAO, *Best Practices: Better Management of Technology Development Can Improve Weapon System Outcomes*, [GAO/NSIAD-99-162](#) (Washington, D.C.: July 30, 1999); and *Defense Acquisitions: Addressing Incentives is Key to Further Reform Efforts*, [GAO-14-563T](#) (Washington, D.C.: Apr. 30, 2014).

committing to product development and has helped companies reduce costs and time from product launch to fielding.

- The ACV 1.1 acquisition is planning to hold its preliminary design review 90 days after the Milestone B decision. According to program officials, the program office is seeking a waiver to permit this approach.¹⁴ Best practices recommend that the preliminary design review is held prior to Milestone B to increase the knowledge available to the agency at development start. In 2012, we reported that beginning product development and setting the acquisition baseline before completing this review increases technical risks and the possibility of cost growth by committing to product development with less technical knowledge than recommended by acquisition best practices and without ensuring that requirements are defined, feasible, and achievable within cost and schedule constraints.¹⁵ According to DOD officials, the review will be held after Milestone B because no contracts will have been awarded prior to that time. In addition, they stated that the use of non-developmental technology will reduce acquisition risks and result in a high level of knowledge prior to the Milestone B decision. However, it is the program office's intent that the engineering and manufacturing development phase be contracted under a hybrid contract that includes cost-plus-fixed-fee elements.¹⁶ Cost-plus-fixed-fee contracts are appropriate when uncertainties in requirements or contract performance do not permit the use of fixed-price contract types. These contracts are considered high risk for the government because of the potential for cost escalation. The selection of this contract type may denote some program risk; however, we will not be able to determine the extent of

¹⁴Unless waived by the Milestone Decision Authority, a preliminary design review is to be conducted before Milestone B for major defense acquisition programs, such as here. 10 U.S.C. § 2366b; DODI 5000.02. Major defense acquisition programs are those designated by DOD or estimated by DOD to require an eventual total expenditure for research, development, test and evaluation of more than \$480 million, or, for procurement, of more than \$2.79 billion, in fiscal year 2014 constant dollars. [DODI 5000.02, Encl. 1, Table 1]

¹⁵GAO, *Missile Defense: Opportunity Exists to Strengthen Acquisitions by Reducing Concurrency*, [GAO-12-486](#) (Washington, D.C.: Apr. 20, 2012).

¹⁶A cost-plus-fixed-fee contract is a type of cost reimbursement contract. When using this contract type the government pays for allowable incurred costs to the extent prescribed in the contract. These contracts establish an estimate of total cost for the purpose of obligating funds and establishing a ceiling that the contractor may not exceed without the approval of the contracting officer.

the risk and its potential impacts to the acquisition process until further information is available.

As the acquisition moves forward, we will continue to monitor the ACV effort by assessing its use of acquisition best practices.

According to program officials, a number of program documents, including a final report on the recent ACV 2014 analysis of alternatives update, were finalized to support a key program meeting that took place in March 2015. We have identified a number of best practices for the development of analyses of alternatives. These analyses can vary in quality, which can affect how they help position a program for success. In September 2009, we concluded that many analyses of alternatives do not effectively consider a broad range of alternatives for addressing a need or assess technical and other risks associated with each alternative.¹⁷ We have begun preliminary analysis on the existing 2008 Marine Personnel Carrier and 2012 ACV analyses of alternatives, including assessment of the analyses against our previously identified best practices and cost estimation criteria.¹⁸ We have recently received the final report, the 2014 ACV analysis of alternatives, reflecting how the prior analyses have been updated. Other documents completed recently include an acquisition strategy, results of a system requirements review, and the finalized document providing key acquisition requirements. These documents will permit us to conduct a more robust analysis and assessment of the ACV acquisition's use of best practices.

Agency Comments and Our Evaluation

DOD provided written comments on a draft of this report. The comments are reprinted in appendix I.

In commenting on a draft of this report, DOD stated that it believes its efforts on this program are aligned with our best practices and it will continue to monitor the program and ensure that mitigations are in place to address potential risk areas. Given that we have not been able to

¹⁷GAO, *Defense Acquisitions: Many Analyses of Alternatives Have Not Provided a Robust Assessment of Weapon System Options*, [GAO-09-665](#) (Washington, D.C.: Sept. 24, 2009).

¹⁸GAO, *GAO Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs*, [GAO-09-3SP](#) (Washington, D.C.: Mar. 2, 2009); and *DOE and NNSA Project Management: Analysis of Alternatives Could Be Improved by Incorporating Best Practices*, [GAO-15-37](#) (Washington, D.C.: Dec. 11, 2014).

conduct a robust analysis of key documents, including the analysis of alternatives, we cannot yet assess how well the program is aligned with best practices. DOD also provided technical comments that were incorporated, where appropriate.

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>.

Should you or your staff have any questions on the matters covered in 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 listed in appendix II.



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 J. 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 Rodney Frelinghuysen
Chairman
The Honorable Pete Visclosky
Ranking Member
Subcommittee on Defense
Committee on Appropriations
House of Representatives

Appendix I: Comments from the Department of Defense



ACQUISITION,
TECHNOLOGY
AND LOGISTICS

PRINCIPAL DEPUTY UNDER SECRETARY OF DEFENSE
3015 DEFENSE PENTAGON
WASHINGTON, DC 20301-3015

APR 2 2015

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, GAO-15-385, "AMPHIBIOUS COMBAT VEHICLE ACQUISITION: Marine Corps Program Adopts an Incremental Approach," dated February 26, 2015 (GAO Code 121246). The Department appreciates the effort of the GAO and the opportunity to comment on the draft report.

We believe our efforts on this program are aligned with GAO's best practices and will continue to monitor the program and ensure that mitigations are in place to address potential risk areas.

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


Alan F. Estevez

Appendix II: GAO Contact and Staff Acknowledgments

GAO Contact

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

Staff Acknowledgements

Key contributors to this report were Bruce H. Thomas, Assistant Director; Betsy Gregory-Hosler, analyst-in-charge; David Richards; Marie Ahearn; Brian Bothwell; Susan Ditto; Jennifer Echard; Dani Greene; Jennifer Leotta; Kenneth Patton; Karen Richey; and Ozzy Trevino.

GAO's Mission

The Government Accountability Office, the audit, evaluation, and investigative arm of Congress, exists to support Congress in meeting its constitutional responsibilities and to help improve the performance and accountability of the federal government for the American people. GAO examines the use of public funds; evaluates federal programs and policies; and provides analyses, recommendations, and other assistance to help Congress make informed oversight, policy, and funding decisions. GAO's commitment to good government is reflected in its core values of accountability, integrity, and reliability.

Obtaining Copies of GAO Reports and Testimony

The fastest and easiest way to obtain copies of GAO documents at no cost is through GAO's website (<http://www.gao.gov>). Each weekday afternoon, GAO posts on its website newly released reports, testimony, and correspondence. To have GAO e-mail you a list of newly posted products, go to <http://www.gao.gov> and select "E-mail Updates."

Order by Phone

The price of each GAO publication reflects GAO's actual cost of production and distribution and depends on the number of pages in the publication and whether the publication is printed in color or black and white. Pricing and ordering information is posted on GAO's website, <http://www.gao.gov/ordering.htm>.

Place orders by calling (202) 512-6000, toll free (866) 801-7077, or TDD (202) 512-2537.

Orders may be paid for using American Express, Discover Card, MasterCard, Visa, check, or money order. Call for additional information.

Connect with GAO

Connect with GAO on [Facebook](#), [Flickr](#), [Twitter](#), and [YouTube](#).
Subscribe to our [RSS Feeds](#) or [E-mail Updates](#). Listen to our [Podcasts](#).
Visit GAO on the web at www.gao.gov.

To Report Fraud, Waste, and Abuse in Federal Programs

Contact:

Website: <http://www.gao.gov/fraudnet/fraudnet.htm>

E-mail: fraudnet@gao.gov

Automated answering system: (800) 424-5454 or (202) 512-7470

Congressional Relations

Katherine Siggerud, Managing Director, siggerudk@gao.gov, (202) 512-4400, U.S. Government Accountability Office, 441 G Street NW, Room 7125, Washington, DC 20548

Public Affairs

Chuck Young, Managing Director, youngc1@gao.gov, (202) 512-4800
U.S. Government Accountability Office, 441 G Street NW, Room 7149
Washington, DC 20548

