



# The Marines' Expeditionary Fighting Vehicle (EFV): Background and Issues for Congress

**Andrew Feickert**  
Specialist in Military Ground Forces

April 2, 2009

Congressional Research Service

7-5700

[www.crs.gov](http://www.crs.gov)

RS22947

## Summary

The Expeditionary Fighting Vehicle (EFV) is an armored amphibious vehicle program that originated two decades ago to replace the 1970s-era Amphibious Assault Vehicle (AAV). The EFV has experienced a variety of developmental difficulties, resulting in significant program delays and cost growth. While the Marine Corps and Department of Defense remain optimistic about the future of the EFV program, there continue to be major concerns about the EFV's reliability, vulnerability to improvised explosive devices (IEDs), and escalating costs. This report will be updated as conditions warrant.

## **Contents**

Background .....	1
The EFV Program .....	1
What Is the EFV?.....	1
Program Structure .....	1
Program History .....	2
Critical Design Review and Additional Prototypes .....	4
Solutions for EFV IED Vulnerability.....	5
Program Cost and Funding .....	5
Potential Issues for Congress .....	6
Amphibious Fleet and EFV Vulnerabilities .....	6
What if the EFV Fails Its Second Systems Development and Demonstration (SDD) Phase Attempt?.....	7

## **Contacts**

Author Contact Information .....	7
----------------------------------	---

## Background

The Marine Corps is responsible for the conduct of amphibious operations in support of the full spectrum of U.S. national security objectives. If the Marines need armored fighting vehicles in the early stages of an amphibious landing, these vehicles must either be transported by landing craft with limited protection against enemy fire, or the armored vehicle must come ashore under its own power.<sup>1</sup> Like current AAVs, the EFV is designed to roll off a Navy amphibious assault ship, move under its own power to the beach, and cross the beach and operate inland. The EFV is to be designed to be able to be launched 25 miles off shore (the AAV can be launched only 2 miles from shore) permitting the fleet to operate “over the horizon,” where it theoretically would be less vulnerable to enemy fire. Some suggest that the 25-mile over the horizon operating capability may no longer provide the protection to the fleet that it once did, noting that the Hezbollah C-802 cruise missile, which successfully struck an Israeli ship in 2006, has a maximum range of 75 miles. Concerns also have been raised that, when ashore, the flat-bottomed EFV may be excessively vulnerable to improvised explosive devices (IEDs).

## The EFV Program

### What Is the EFV?<sup>2</sup>

The EFV is an armored, fully-tracked infantry combat vehicle operated by a three-person crew that can carry 17 combat-equipped Marines. It is to be a self-deploying, high-speed amphibious vehicle that will be able transport Marines from ships to objectives inland and will have the speed, maneuvering capabilities, fire power, and protection to operate with main battle tanks on land. It is intended to have a 20-knot speed in the water and a 345-mile range ashore with a 45-kilometer-per-hour speed on hard-surfaced roads. The EFV is to be designed to have modular armor and expanded mine blast protection and mount a 30mm high-velocity cannon in a stabilized turret. The EFV is also supposed to be able to communicate in joint networks and operate as part of a joint land force. There are to be two EFV variants. The EVF-P1 will carry a Marine rifle squad and its equipment and provide direct fire support during combat operations. The EFV-C1 variant provides command and control capabilities for commanders and their staffs.

### Program Structure

The EFV is described as the Marines' number one priority ground weapon system acquisition program and is the only Acquisition Category (ACAT) 1D program managed by the Marine Corps.<sup>3</sup> The Marine Corps EFV Program Office is collocated with the EFV's prime contractor—

---

<sup>1</sup> Unless otherwise noted, information in this section is taken from Sydney J. Freedberg, “Future Corps,” *National Journal*, May 10, 2008.

<sup>2</sup> Information in this section is from the 2008 United States Marine Corps Concepts & Programs Handbook, pp. 112-113; General Dynamics Land Systems Briefing: EFV Program, February 2008; and Marine Corps Tactical Systems Support Activity EFV Fact Sheet.

<sup>3</sup> Marine Corps Tactical Systems Support Activity EFV Fact Sheet. The 12<sup>th</sup> Edition of the *Defense Acquisition University Glossary*, July 2005, defines an ACAT 1D program as a Major Defense Acquisition Program (MDAP), which is estimated by the Under Secretary of Defense (Acquisition, Technology, and Logistics) (USD[AT&L]) to require the eventual expenditure for Research, Development, Test, and Evaluation (RDT&E) of more than \$365 million (FY2000 constant dollars) or the procurement of more than \$2.19 billion (FY2000 constant dollars).

General Dynamics—in Woodbridge, Virginia, and the Marines claim that collocation—the first of its kind for a major weapon system—has greatly reduced government contractor design costs and streamlined the program decision-making process.

## **Program History**<sup>4</sup>

In 1988, Acquisition and Program Decision Memorandums were signed by defense officials to initiate the Concept Exploration/Definition Phase (CE/D)<sup>5</sup> of what was then known as the Advanced Amphibious Assault Vehicle (AAAV) program. In 1995, the program entered into the Program Definition and Risk Reduction (PDRR) phase<sup>6</sup>, where it was considered by many to be a “model defense acquisition program,” winning two DOD awards for successful cost and technology management. In June 1996, a contract was awarded to General Dynamics Land Systems to begin full-scale engineering development of their design. Based on the aforementioned early success of the program, the Marine Corps awarded a cost-plus contract to General Dynamics in July 2001 for the Systems Development and Demonstration (SDD) phase of the program. General Dynamics and the Marines envisioned that the SDD phase would be completed by October 2003, a schedule that some say “proved too ambitious.”<sup>7</sup> In 2003, the Marines renamed the program the Expeditionary Fighting Vehicle (EFV) program.

## ***Problems During the SDD Phase***

The Government Accountability Office (GAO) alleges that:

The program did not allow enough time to demonstrate maturity of the EFV design during SDD. The original SDD schedule of about three years proved too short to conduct all necessary planning and to incorporate the results of tests into design changes. Specifically, the original schedule did not allow adequate time for testing, evaluating the results, fixing the problems, and retesting to make certain that problems are fixed before moving forward.<sup>8</sup>

---

<sup>4</sup> United States House of Representatives, Committee on Oversight and Government Reform, Majority Staff, “The Expeditionary Fighting Vehicle: Over Budget, Behind Schedule, and Unreliable,” April 29, 2008; “Military Vehicle Forecast: Expeditionary Fighting Vehicle,” Z Forecast International, June 2007, pp. 4-5; United States Government Accountability Office (GAO) Report to Congressional Committees, “Defense Acquisitions; The Expeditionary Fighting Vehicle Encountered Difficulties in Design Demonstration and Faces Future Risks,” GAO-06-349, May 2006, pp. 6-7.

<sup>5</sup> The Concept Exploration/Definition (CE/D) Phase of the Defense Systems Acquisition Process (now called the Concept Refinement [CR] Phase) is governed by Department of Defense (DOD) Directive 5000.1, “The Defense Acquisition System.” Activities during the CE/D phase, which normally lasts one to two years, include exploring material alternatives to satisfy mission needs; identification of high-risk areas; identifying most promising system concepts; developing a proposed acquisition strategy; and developing initial cost, schedule, and performance objectives.

<sup>6</sup> The Program Definition and Risk Reduction (PDRR) Phase normally lasts two to four years. Activities during this phase include defining key design characteristics and expected capabilities and demonstrating that technologies can be incorporated into systems designs. Prototype systems are developed during this phase.

<sup>7</sup> United States House of Representatives, Committee on Oversight and Government Reform, Majority Staff, “The Expeditionary Fighting Vehicle: Over Budget, Behind Schedule, and Unreliable,” April 29, 2008, p. 2.

<sup>8</sup> United States Government Accountability Office (GAO) Report to Congressional Committees, “Defense Acquisitions; The Expeditionary Fighting Vehicle Encountered Difficulties in Design Demonstration and Faces Future Risks,” GAO-06-349, May 2006, p. 13.

Because of these and other difficulties, the EFV program was “rebaselined” in November 2002, adding an additional year to the program schedule, and then rebaselined again in March 2003, also adding another year to the program schedule.<sup>9</sup> In December 2004, EFV prototypes experienced major failures of the hull electronics unit (HEU), the vehicle’s main computer system.<sup>10</sup> These failures caused the water-mode vehicle steering to freeze, making the vehicle non-responsive. The EFV also experienced significant problems in September and October 2004 with the bow flap—a folding panel extended forward to generate additional hydrodynamic lift as the EFV moves through the water.<sup>11</sup> The EFV experienced myriad hydraulics system failures, leaks, and pressure problems during testing that contributed to low reliability ratings. Because of reliability problems, the originally required 70-hour mean time between operational mission failure (MTBOMF) rate for the EFV was reduced by the Marines to 43.5 hours. Because of these demonstrated failures and related concerns about a lack of program management and oversight, the program was rebaselined for a third time in March 2005, this time adding an additional two years to the extra two years added during the previous rebaselining.

### ***2006 Operational Assessment<sup>12</sup>***

In 2006, the EFV was subject to an Operational Assessment—a series of tests to demonstrate that it could meet performance requirements—that if successfully completed, would permit the program to move into the production phase. During this assessment, the EFV experienced numerous critical failures and, because of repeated breakdowns, the EFV failed to meet reliability requirements and failed the assessment. For example, during the test, the vehicles were able to operate for only 4.5 hours between breakdowns and required about 3.4 hours of corrective maintenance for every 1 hour of operation—a maintenance burden that evaluators said would “wear out a unit under realistic combat operations.” Poor reliability also resulted in 117 Operational Mission Failures and 645 Unscheduled Maintenance Actions during testing. The EFV’s low reliability resulted in the EFV completing 2 out of 11 attempted amphibious tests, 1 out of 10 gunnery tests, and none of the 3 scheduled land mobility tests. The EFV prototypes tested were approximately 1,900 lb. too heavy to achieve the desired high water speed and, in some circumstances, could not accommodate equipment needed by Marines for special climatic conditions. Evaluators also noted significant problems in terms of limited visibility, excessive noise, and difficulty in reloading the EFV’s main gun.

---

<sup>9</sup> *Ibid.*, pp. 8-9. DOD has been known to rebase programs—change the program’s estimated cost and schedule so they are a more accurate reflection of how the program is progressing—in instances where a troubled program shows potential for improvement.

<sup>10</sup> United States House of Representatives, Committee on Oversight and Government Reform, Majority Staff, “The Expeditionary Fighting Vehicle: Over Budget, Behind Schedule, and Unreliable,” April 29, 2008, p. 4.

<sup>11</sup> Information in this section is from United States Government Accountability Office (GAO) Report to Congressional Committees, “Defense Acquisitions; The Expeditionary Fighting Vehicle Encountered Difficulties in Design Demonstration and Faces Future Risks,” GAO-06-349, May 2006, pp. 16-18.

<sup>12</sup> Information in this section is from United States House of Representatives, Committee on Oversight and Government Reform, Majority Staff, “The Expeditionary Fighting Vehicle: Over Budget, Behind Schedule, and Unreliable,” April 29, 2008, pp. 7-10.

## ***EFV Redesign***

In the aftermath of 2006 Operational Assessment, the Marines “went back to the drawing board.”<sup>13</sup> In February 2007, the EFV program office issued a “sources sought” notice, requesting information from industry leaders on “tracked combat vehicles that can provide an alternative design concept of the EFV”—a perceived vote of no confidence in General Dynamics by the Marines. Also that month, the Navy formally advised Congress that the EFV program would incur a cost breach, requiring program recertification under the Nunn-McCurdy Act (10 U.S.C. 2433).<sup>14</sup> Finally, in late February 2007, the Navy announced that it would have to relax EFV performance and reliability requirements in order for the program to continue. In March 2007, the Marines modified the original SDD contract and awarded General Dynamics an additional \$143.5 million to redesign the EFV.<sup>15</sup> In what has been termed “the largest program setback,” the Marines decided in June 2007 to repeat the entire SDD phase, meaning that instead of the original completion date of 2003, the SDD phase—if successful—will now be completed in 2011, eight years behind the original schedule.<sup>16</sup> In August 2008, the Marines and General Dynamics signed a SDD II contract, and work on seven new EFV prototypes is expected to begin in January 2009.<sup>17</sup> These new prototypes are expected to include rewired electronics to better protect against sea water, a rebuilt and strengthened gun turret that should improve ammunition feed to the main gun, and the addition of trim tabs to make the EFV more stable in the water. The new EFVs are scheduled to be built at the U.S. military’s joint tank production facility at Lima, Ohio, and are expected to be completed by early 2010.

## **Critical Design Review and Additional Prototypes<sup>18</sup>**

The General Accountability Office (GAO) notes that the EFV passed its December 2008 Critical Design Review (CDR) and, with 94% of the system’s design models releasable, that EFV’s critical technologies are mature and its design is stable. Because the EFV’s design has been stabilized, a number of critical manufacturing processes can be established. Because the EFV passed the CDR, the go-ahead was given for the production of the seven new prototypes. These new prototypes are expected to include almost 400 engineering design improvements to improve vehicle reliability.<sup>19</sup> It is likely that many of these engineering design improvements will add weight to the EFV. One potential change that could help reduce EFV weight could be

---

<sup>13</sup> Information in this section is from “Military Vehicle Forecast: Expeditionary Fighting Vehicle,” Z Forecast International, June 2007, p. 5.

<sup>14</sup> The Nunn-McCurdy Act (10 U.S.C. 2433) requires that Congress be notified when a major defense acquisition program incurs a cost increase of at least 15%. If the increase is 25% or greater, the Secretary of Defense must certify that the program is essential to national security and that new cost estimates are reasonable, that the program is properly managed, and that there are no feasible alternatives to the system in question.

<sup>15</sup> United States House of Representatives, Committee on Oversight and Government Reform, Majority Staff, “The Expeditionary Fighting Vehicle: Over Budget, Behind Schedule, and Unreliable,” April 29, 2008, p. 10.

<sup>16</sup> Ibid.

<sup>17</sup> Information in this section is from Kris Osborn, “USMC to Build 7 New EFV Prototypes,” *Defense News*, October 9, 2008.

<sup>18</sup> Information in this section is taken from Daniel Wasserbly, “USMC Receives EFV Prototype Boost,” *Jane’s Defence Weekly*, March 4, 2009, p. 10; Bettina H. Chavanne, “EFV Redesign Makes Tracks,” *Aviation Week*, March 6, 2009; and United States Government Accountability Office (GAO), *Defense Acquisitions: Assessments of Selected Weapons Programs*, GAO-09-326SP March 2009, pp. 77-78.

<sup>19</sup> Dan Lamothe, “U.S. Marine Corps Struggles to Redesign EFV,” *Defense News*, March 16, 2009.

incorporating a lighter-weight linked track that the Army is currently researching, which could reduce EFV weight by 800 pounds.<sup>20</sup>

## **Solutions for EFV IED Vulnerability**

As previously noted, there is a great deal of concern that the flat-bottomed EFV would be overly vulnerable to IEDs detonated under the vehicle. The lack of a V-shaped hull, which can mitigate underbelly IED explosions, is a long-standing concern of some in Congress, and the Marines contend that the EFV would have to be totally redesigned at great cost to incorporate a V-shaped hull.<sup>21</sup> The Marines suggest that installing an add-on underbelly armor appliqué after the EFV comes ashore will provide necessary protection. Marine officials also suggest that IEDs would not be a big concern during the initial stages of an operation and the EFV's mobility would provide protection from IEDs.<sup>22</sup> It can be argued, however, that the Marines are assuming away the EFV's vulnerabilities by suggesting that the enemy would not employ IEDs against Marine forces coming ashore and that the EFV could "out run" IEDs—something that has alluded smaller and faster combat vehicles in Iraq and Afghanistan.

## **Program Cost and Funding**<sup>23</sup>

The Marines originally planned to procure 1,025 EFVs at a total cost of \$8.5 billion. A December 2007 estimate by DOD predicts that the cost will increase by over 50% to \$13.2 billion—a 168% per-vehicle cost increase. The Marines currently plan to procure only 573 EFVs, giving the Marines the capacity to amphibiously transport eight infantry battalions (approximately 970 marines and sailors per battalion).<sup>24</sup> The President's FY2009 EFV Budget Request was \$ 316.1 million for Research, Development, Testing and Evaluation (RDT&E).<sup>25</sup> The House Armed Services Committee (HASC) "concerned that "plans to begin fabrication of new EFV prototypes in FY 2009 have not sufficiently addressed the need to enhance protection of the EFV from mines and improvised explosive devices" recommended a \$40.2 million reduction.<sup>26</sup> The Senate Armed Services Committee (SASC) in its version (S. 3001), recommended fully funding the President's \$316.1 million request.<sup>27</sup> The final version of the defense authorization bill agreed instead to a \$35 million cut.<sup>28</sup> House and Senate defense appropriators recommended \$256 million—a \$60

---

<sup>20</sup> Chavanne.

<sup>21</sup> Emelie Rutherford, "Murtha, Taylor Concerned About Expeditionary Fighting Vehicle Design," *Defense Daily* March 16, 2009.

<sup>22</sup> Bettina H. Chavanne, "EFV Redesign Makes Tracks," *Aviation Week*, March 6, 2009 and Emelie Rutherford, "Murtha, Taylor Concerned About Expeditionary Fighting Vehicle Design," *Defense Daily*, March 16, 2009.

<sup>23</sup> United States House of Representatives, Committee on Oversight and Government Reform, Majority Staff, "The Expeditionary Fighting Vehicle: Over Budget, Behind Schedule, and Unreliable," April 29, 2008, p. 11.

<sup>24</sup> Briefing slides, "Army and Marine Corps Tactical Wheeled Vehicle Strategy and Response to the Office of Management and Budget," Version 21.09, July 9, 2008, obtained from *InsideDefense.com*, August 20, 2008, and Norman Polmar, "18<sup>th</sup> Edition of the Naval Institute Guide to the Ships and Aircraft of the U.S. Fleet," U.S. Naval Institute, p. 44.

<sup>25</sup> DOD FY2009 Budget Request Summary Justification, February 2008, p. 187.

<sup>26</sup> Report 110-652, Duncan Hunter National Defense Authorization Act for Fiscal Year 2009, Report on the Committee on Armed Services House of Representatives on H.R. 5658, May 16, 2008, p. 198.

<sup>27</sup> Report 110-335, National Defense Authorization Act for Fiscal Year 2009, Report to Accompany S. 3001, Committee on Armed Services, United States Senate, May 12, 2008. p. 179.



million reduction to the President's EFV Budget Request.<sup>29</sup> According to GAO, as of March 2009, the EFV program will require \$1,043.6 million in research and development and \$9,778.4 million in procurement funding to complete the program and field 573 EFVs.<sup>30</sup>

## Potential Issues for Congress

### Amphibious Fleet and EFV Vulnerabilities

Some analysts contend that the operational environment has changed so significantly since the EFV's inception that both the fleet and the EFV face greater risks than anticipated.<sup>31</sup> The Navy and Marines envision that future conflicts will require a "persistent presence in littoral areas" characterized by land-based anti-ship cruise missiles, mines, and small, fast suicide boats. Twenty years ago when the EFV was conceived, some defense officials suggested that the fleet could operate 25 to 30 miles from shore, debarking EFVs for amphibious operations, but with the advent of these new enemy weapons and tactics, this is no longer possible. Instead, in order to sufficiently protect the large amphibious ships that transport Marines and EFVs, it has been suggested that the fleet might need to operate at least 100 miles from shore—beyond the EFV's range. If there are new developments in enemy weapons and tactics between now and 2025—when the EFV is scheduled to reach full operational capability—the vulnerability to the fleet could increase further. Another potential issue is the EFV's vulnerability to IEDs. Some in Congress are concerned that the flat-bottomed EFV, with a 16-inch ground clearance, would be highly vulnerable to IEDs that detonate under vehicles.<sup>32</sup> The Marines contend that a "V" shaped hull on the EFV to better protect it from IED blasts would force a total redesign of the EFV. Instead, the Marines propose that once ashore, armor could be applied to the underside of the EFV, a solution that has met with congressional skepticism.

A study by the Center for Strategic and Budgetary Assessment (CSBA) titled the *U.S. Marine Corps: Fleet Marine Forces for the 21<sup>st</sup> Century* advocates "cancelling the EFV in favor of an armored combat vehicle optimized for modern land warfare (with modest ability to traverse water obstacles) and combine it with a high-speed, shallow-draft, ship to shore 'connector' (e.g. high-speed lighterage, air-cushioned landing craft)."<sup>33</sup> The primary argument is that this solution would better address the "evolving anti-armor and precision-guided weapons regimes that will threaten naval forces at increasing distances at sea, and Marine Corps ground forces ashore."<sup>34</sup> This

---

(...continued)

<sup>28</sup> Duncan Hunter National Defense Authorization Act for FY 2009, HASC No. 10, Joint Explanatory Statement to Accompany S. 3001, September 2008, p. 521.

<sup>29</sup> Consolidated Security, Disaster Assistance, and Continuing Appropriations Act, 2009 (H.R. 2638: P.L. 110-329), Division c – Department of Defense Appropriations Act, 2009, October 2008, p. 352.

<sup>30</sup> United States Government Accountability Office (GAO), *Defense Acquisitions: Assessments of Selected Weapons Programs*, GAO-09-326SP, March 2009, pp. 77-78.

<sup>31</sup> Department of the Navy, "A Cooperative Strategy for 21<sup>st</sup> Century Seapower," October 2007, and Sydney J. Freedberg, "Future Corps," *National Journal*, May 10, 2008.

<sup>32</sup> Emelie Rutherford, "Lawmakers Cite Concerns With Marine Corps EFV Armor Solution," *InsideDefense.com*, January 14, 2008, and Emelie Rutherford, "Marine Corps Proceeds with Expeditionary Fighting Vehicle, Congressional Concern Remains," *Defense Daily*, April 11, 2008.

<sup>33</sup> Dakota L. Wood, "The U.S. Marine Corps: Fleet Marine Forces for the 21<sup>st</sup> Century," Center for Strategic and Budgetary Assessment, Washington, D.C., November 17, 2008, p. xv.

<sup>34</sup> *Ibid.*

approach may become an alternative if the EFV proves to be too unreliable or expensive to field, but any type of ship (such as the suggested Improved Navy Lighterage System) or ground combat vehicle (a modified Light Armored Vehicle [LAV] or the proposed Marine Personnel Carrier [MPC])<sup>35</sup> might also be equally as vulnerable to anti-armor and precision weapons. One proposal to address this vulnerability—an Active Protection System (APS) such as the one being developed for the Army's Future Combat System (FCS)—may be a potential solution, but it is not known if the APS can be readily adapted for maritime use.<sup>36</sup> The assertion that the MPC and a surface transport would have “the additional benefit of nearly doubling the intended purchase, thereby lowering the per-unit cost and simplifying related logistics issues within the Service” merits detailed examination, but any such examination should acknowledge that abandoning EFV altogether will result in a significant “sunk cost” that should be factored into any decisions related to the affordability of EFV alternatives.

### **What if the EFV Fails Its Second Systems Development and Demonstration (SDD) Phase Attempt?**

In order for the EFV to enter its planned Low Rate Initial Production (LRIP) phase in 2011, it must successfully complete its second attempt at SDD. While reports suggest that an earlier requirement for a prototype reliability demonstration has been dropped, there will likely be a series of operational tests similar to those conducted in 2006. Reports suggest that the new EFV prototypes will be subjected to a 500-hour reliability test.<sup>37</sup> The Marines have stated that the new EFV prototypes will achieve 61 hours mean time between operational mission failure (MTBOMF).<sup>38</sup> Despite claims that the second SDD phase is going well and that the design is both stable and mature, it is possible that the \$16 million per vehicle EFV may again perform unsatisfactorily in operational testing. If this is the case, it would likely be difficult to justify a third SDD phase, and it would probably not be operationally feasible to reduce the 573 EFV requirement any further to cut program costs. Given this potential scenario, it might be prudent to examine possible contingencies (such as the aforementioned CSBA proposal) should the EFV perform poorly on upcoming operational tests.

### **Author Contact Information**

Andrew Feickert  
Specialist in Military Ground Forces  
afeickert@crs.loc.gov, 7-7673

---

<sup>35</sup> Ibid., p. 64.

<sup>36</sup> Ibid.

<sup>37</sup> Chavanne.

<sup>38</sup> United States Government Accountability Office (GAO), *Defense Acquisitions: Assessments of Selected Weapons Programs*, GAO-09-326SP, March 2009, pp. 77-78.