United States Government Accountability Office

GAO

Report to Congressional Requesters

June 2006

COAST GUARD

Status of Deepwater Fast Response Cutter Design Efforts

GAO-06-764

June 2006

COAST GUARD

Status of Deepwater Fast Response Cutter Design Efforts

GAO Accountability · Integrity · Reliability

Highlights

Highlights of GAO-06-764, a report to congressional requesters.

Why GAO Did This Study

The Coast Guard has been pursing a replacement vessel for its aging and deteriorating patrol boats as part of the Integrated Deepwater System (or Deepwater) acquisition. Originally, all 49 of the Coast Guard's 110-foot patrol boats were to be converted into 123-foot patrol boats as a bridging strategy until a replacement vessel, the 140-foot Fast Response Cutter (FRC) came on line beginning in 2018. The initial conversions of the 110-foot patrol boats proved unsuccessful, though, and this prompted the Coast Guard to cancel further patrol boat conversions and accelerate the design and delivery of the FRC from 2018 to 2007. Early design efforts called for the FRC's hull, decks, and bulkheads to be made from composite materials rather than steel. Recently, design problems with the FRC's hull shape and weight have raised questions about the viability of the FRC design and use of composite materials.

This report examines (1) the factors that went into the decision to use composite materials for the FRC hull, (2) the types of composite materials that have been selected for the FRC hull, (3) the extent of contingency plans developed for use if the prototype hull fails to meet Coast Guard performance requirements, and (4) the status of design efforts for the FRC.

The Coast Guard concurred with the findings in this report.

www.gao.gov/cgi-bin/getrpt?GAO-06-764.

To view the full product, including the scope and methodology, click on the link above. For more information, contact Stephen Caldwell at (202) 512-9610 or caldwells@gao.gov.

What GAO Found

The Deepwater system integrator, Integrated Coast Guard Systems, decided to use composite materials for the FRC's hull because, according to contractor analyses, use of such materials instead of steel generally offers several advantages, including lower maintenance and life cycle costs, a longer service life, and reduced weight. Other potential advantages, according to the Office of Naval Research, include corrosion prevention and decreased damage from impacts.

The current FRC design calls for the use of two types of composite materials: (1) a solid laminate form to be used for the hull and (2) a "sandwich" form which is to be used on decks and bulkheads. Composite materials are not commonly used for vessels with comparable naval operations and have not been used on any prior Coast Guard vessels.

The Coast Guard does not have a formal, documented contingency plan should the FRC fail to meet performance requirements. However, Coast Guard officials said it plans to pursue certain mitigation strategies, such as repairing deteriorated hull structures and replacing obsolete or unsupportable equipment and systems, to keep the current patrol boats operating longer.

The Coast Guard suspended FRC design work in late February 2006 because of design risks, such as excessive weight and horsepower requirements. To address these and other risks, the Coast Guard is pursuing three strategies. The first strategy involves the system integrator purchasing design plans for and building an off-the-shelf patrol boat that could be adapted for Coast Guard use as a way to increase patrol hours until the FRC design is finalized. The first of these replacement patrol boats is to be operational in late 2009. The second strategy is to revise the necessary capabilities of the FRC in order to allow for modifications to the current FRC design. The third strategy is to have a third party reassess the analyses used in the decision to use composite materials for the FRC to determine if the use of composite materials will, in fact, reduce total ownership costs.

One of the Current Patrol Boats to Be Replaced by a Fast Response Cutter

Source: Courtesy of the U.S. Coast Guard.

Contents

Abbreviations

FRC	Fast Response Cutter
GAO	Government Accountability Office
ICGS	Integrated Coast Guard Systems
RFI	request for information

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United States Government Accountability Office
Washington, DC 20548

June 23, 2006

The Honorable Harold Rogers
Chairman
The Honorable Martin Olav Sabo
Ranking Member
Subcommittee on Homeland Security
Committee on Appropriations
House of Representatives

The Coast Guard has been pursuing a replacement vessel for its aging and deteriorating patrol boats as part of the Integrated Deepwater System (or Deepwater) acquisition. The Deepwater program utilizes a system of systems acquisition strategy that would replace its deteriorating Deepwater aircraft and vessels with a single, integrated package of new or modernized assets. This system of systems approach is designed to provide an improved, integrated system of aircraft, cutters, and unmanned aerial vehicles to be linked effectively through systems that provide command, control, communications, computer, intelligence, surveillance, reconnaissance, and supporting logistics. As of May 2006, the Coast Guard had spent approximately $26.7 million on design and test efforts for a replacement vessel for its patrol boats. Under the original 2002 Deepwater Implementation Plan, all 49 of the Coast Guard's 110-foot patrol boats were to be converted into 123-foot patrol boats, with increased capabilities, as a bridging strategy until a replacement vessel, the 140-foot Fast Response Cutter (FRC), came on line beginning in 2018. The initial conversions of the 110-foot patrol boats proved unsuccessful, though, prompting the Coast Guard to revise this part of the Deepwater program.[1] The 2005 Revised Deepwater Implementation Plan reflected the fact that the Coast Guard canceled further patrol boat conversions and accelerated design and delivery of the FRC, with the first FRC scheduled to come on line in 2007—11 years earlier than originally planned.

[1]The Coast Guard converted 8 of the 110-foot patrol boats to 123-foot boats, but discontinued further conversions because the patrol boats were experiencing technical difficulties, such as hull buckling on the *Matagorda*, and were not able to meet post-September 11, 2001 mission requirements.

During the early design efforts, the Deepwater program's system integrator[2] proposed building the FRC's hull, decks, and bulkheads out of composite materials rather than steel. Composite materials, as used in shipbuilding, are typically fiber-reinforced plastic laminates consisting of plies of various reinforcing fabrics laminated together. While design problems with the FRC's hull shape and weight have only recently been made public, Coast Guard engineering officials raised concerns about the viability of the FRC design beginning in January 2005.

In response to your request, we have been reviewing and analyzing the design efforts for the FRC. This is part of a large body of work GAO has undertaken since 1998 regarding the Deepwater program.[3] On April 12, 2006, we briefed your offices on four topics, as follows:

- the factors that went into the decision to use composite materials for the FRC hull,
- the types of composite materials that have been selected for the FRC hull,
- the extent of contingency plans developed for use if the prototype hull fails to meet Coast Guard performance requirements, and
- the status of design efforts on the FRC.

This report summarizes the findings we addressed at that briefing, as well as provides more current information on the Coast Guard's FRC design efforts to supplement the detailed briefing slides that we presented to your offices. Appendix I provides a copy of those slides.

In addressing the four topics, we reviewed and analyzed a variety of Coast Guard and contractor documents, briefings, and studies. We supplemented these document reviews by holding discussions with officials from the Coast Guard, the Office of Naval Research, and the Naval Surface Warfare Center. We conducted our work from February 2006 through May 2006 in accordance with generally accepted government auditing standards.

[2]Under the Deepwater program, the Coast Guard is relying on a prime contractor—called the system integrator—to identify and deliver the assets needed to meet Coast Guard mission requirements.

[3]Please see the Related Products section for a list of prior GAO products on the Deepwater program.

Results

The Deepwater system integrator, Integrated Coast Guard Systems (ICGS)[4] decided to use composite materials for the FRC's hull form after an analysis of alternatives found that the use of such materials instead of steel generally offers several advantages, such as lower maintenance and life cycle costs, a longer service life, and reduced weight. While these were the main reasons given for considering composites, the Coast Guard and ICGS have also leveraged information from research performed by the U.S. Navy's Office of Naval Research, which shows other potential advantages, such as corrosion prevention and decreased damage from impacts.

The current FRC design calls for the use of two types of composite materials: (1) a solid laminate form consisting of layers of glass-reinforced plastic and (2) a "sandwich" form consisting of two thinner layers of glass-reinforced plastic surrounding a core of either balsa wood or synthetic foam. The solid laminate form is to be used for the hull, which is to be constructed from a mold in a single process. The sandwich form, which weighs less than the solid form, is to be used on decks and bulkheads. Composite materials are not commonly used for vessels with comparable U.S. naval operations and have not been used on any prior Coast Guard vessels.

Even though composite materials are not commonly used in the construction of U.S. naval vessels used in military operations, the Coast Guard does not have a formal, documented contingency plan should the FRC fail to meet performance requirements. However, according to Coast Guard officials, the Coast Guard plans to pursue certain mitigation strategies to keep the current patrol boats operating longer, such as repairing deteriorated hull structures and replacing obsolete or unsupportable equipment and systems. Coast Guard officials also stated that they are pursuing the option of selecting design plans for a patrol boat that is already on the market that could be adapted for Coast Guard use as an interim measure until the FRC design is finalized. In addition, according to Coast Guard officials, the Coast Guard has taken steps designed to help ensure the FRC's reliability. First, because the FRC is to employ composite materials for the hull, the Coast Guard undertook a series of risk mitigation efforts, which are often part of a naval shipbuilding program, during the FRC's preliminary design phase. These efforts included fatigue

[4]In 2002, the Coast Guard awarded a contract to ICGS as the system integrator for the Deepwater program. ICGS is a joint venture between two contractors—Lockheed Martin and Northrop Grumman—that in turn contract with other subcontractors.

testing of composite material panels and joint configurations, as well as testing a scale model of the hull, and conducting a third-party design review. Second, the Coast Guard intends to conduct a 12-month performance evaluation when the first FRC is delivered, though there are currently no detailed plans as to what the evaluation will entail.

The Coast Guard suspended FRC design work in late February 2006 because of high technical risks associated with the emerging design. In particular, an independent design review by third-party consultants preliminarily demonstrated, among other things, that the FRC would be far heavier and less efficient than a typical patrol boat of similar length, in part, because it would need four engines to meet Coast Guard speed requirements. As a result, the Coast Guard is pursuing three strategies for moving forward with the FRC acquisition. The first strategy involves ICGS purchasing design plans for and building an "off-the-shelf" patrol boat as a way to increase patrol hours currently unmet by the patrol boat fleet. The first of these boats is projected to be ready for Coast Guard operations in 2009. However, according to Coast Guard officials, the off-the-shelf patrol boat may not meet Coast Guard performance requirements. The Coast Guard issued a request for information (RFI) in April 2006 to assess the off-the shelf options. According to Coast Guard Deepwater Program Officials, in response to the RFI, the Coast Guard received 26 distinct patrol boat design submissions from 17 vendors and is currently in the process of reviewing these submissions. They further stated that its senior leadership plans to make a decision regarding the off-the-shelf design in September 2006. According to the Coast Guard, a second strategy it is pursuing is to revise the necessary capabilities of the FRC in order to allow for modifications to the current FRC design. Concurrent with the first two strategies, the Coast Guard's third strategy is to have a third party reassess the analyses used in the decision to use composite materials for the FRC to determine if the use of composite materials will, in fact, reduce total ownership costs. The result of the Coast Guard pursuing these strategies is that the Coast Guard would end up with two classes of FRCs. The first class of FRCs to be built would be based on an adapted design from a patrol boat already on the market, to expedite delivery, and a follow-on class that would be based on revisions made to address the problems identified in the original FRC design plans.

Pursuant to these three strategies, Coast Guard officials now estimate that the first FRC will likely not be delivered until late fiscal year 2009, at the earliest, rather than 2007 as outlined in the 2005 Revised Deepwater Implementation Plan. Coast Guard officials have not yet determined how changes in the design and delivery date for the FRC will affect the overall

system of systems approach. However, because the delivery of Deepwater assets are interdependent within this acquisition approach, schedule slippages and uncertainties associated with potential changes in the design and capabilities of the new assets have increased the risks that the Coast Guard may not meet its expanded homeland security performance requirements within given budget parameters and milestone dates.

Concluding Observations

A number of factors are tied to the uncertainty surrounding the FRC program. First, the unanticipated problems associated with the 110-foot to 123-foot patrol boat conversion program prompted the Coast Guard to accelerate the FRC program by more than a decade. In addition, the system integrator has chosen to use a relatively new technology, namely composite materials, for the FRC hull form. As of May 2006, the Coast Guard has spent approximately $26.7 million for design and test efforts on the FRC, although it has yet to produce a viable design. Because of this, the first FRC will not be delivered until late fiscal year 2009, at the earliest, rather than in fiscal year 2007 as outlined in the 2005 Deepwater Revised Implementation Plan. This means the Coast Guard will have to continue to rely on its aging and deteriorating patrol boats. Moreover, because of the schedule slippage and uncertainties associated with potential changes in the design and capabilities of the FRC, the Coast Guard has increased the risks associated with the system-of-systems concept.

Agency Comments

We requested comments on a draft of this report from the Department of Homeland Security. The Department referred to the U.S. Coast Guard which generally concurred with the findings of the report and provided technical comments, which have been incorporated into the report as appropriate.

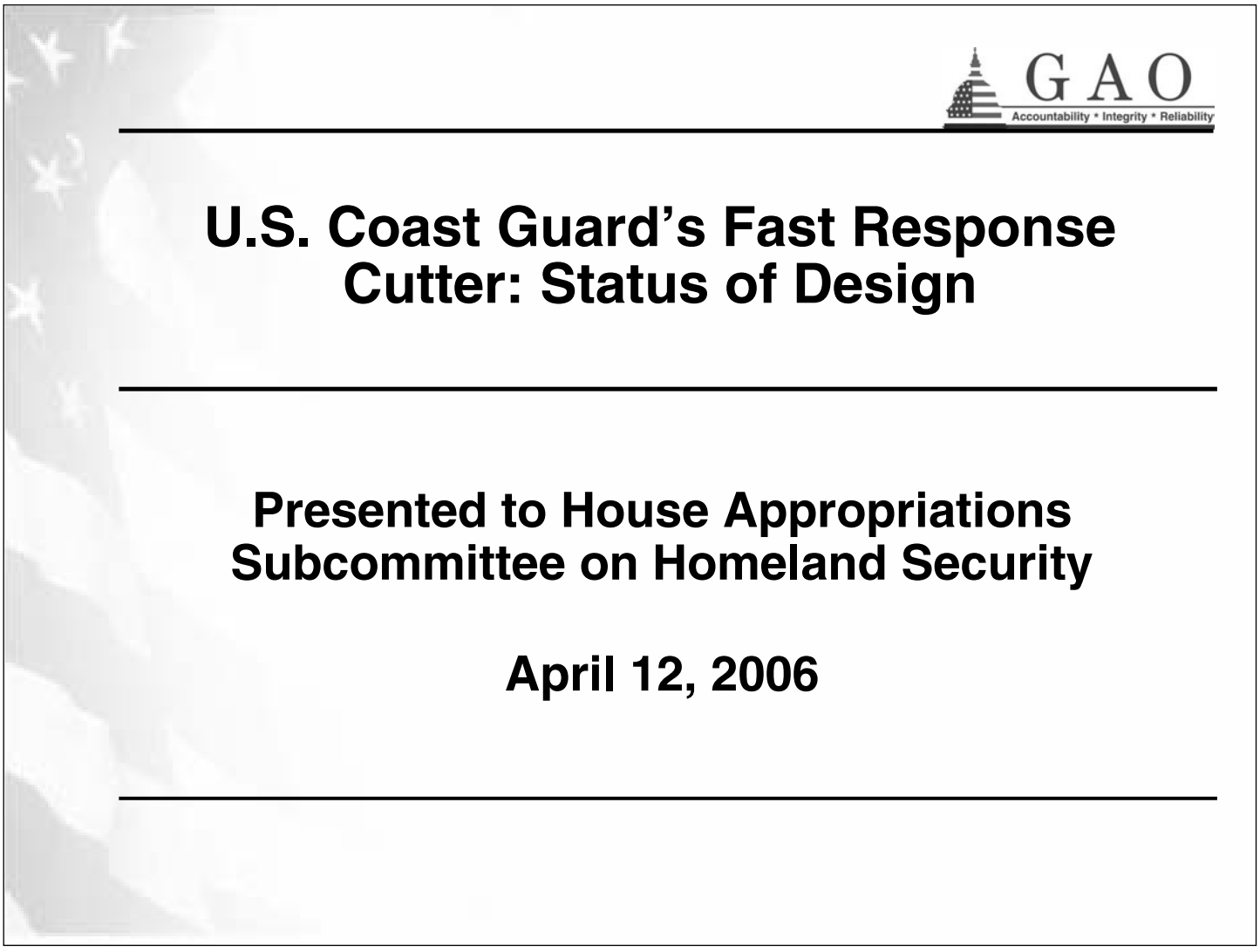
We are providing copies of this report to the Secretary of the Department of Homeland Security, the Commandant of the U.S. Coast Guard, and interested congressional committees. This report will also be made available to others upon request. In addition, the report will be made available at no charge on GAO's Web site at http://www.gao.gov.

For information about this report, please contact me at (202) 512-9610, or caldwells@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report.

Stephen L. Caldwell
Acting Director, Homeland Security
and Justice Issues

Appendix I: Briefing Section

This appendix contains the briefings slides presented to your staffs on April 12, 2006. While we have not modified the briefing slides, we have provided updated information in the accompanying letter regarding the Coast Guard's three strategies and cost information in an effort to provide the most current information. For example, slides 17 and 18 provide information on the Coast Guard's strategies to move forward with the FRC acquisition and associated program cost data but the letter provides updated information.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Accountability * Integrity * Reliability
U.S. Coast Guard's Fast Response Cutter: Status of Design
Presented to House Appropriations Subcommittee on Homeland Security
April 12, 2006

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Introduction

The Fast Response Cutter (FRC) is slated to replace the 110' and 123' patrol boats under the Deepwater system

The FRC is projected to provide greater speed, endurance, and operational hours than current patrol boats

As of the 2006 update submitted with the Administration's fiscal year 2007 budget request, the Coast Guard plans to acquire 58 FRCs

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Researchable Questions

- What factors went into the decision to use composite materials for the FRC hull form?
- What types of composite materials have been selected for the FRC hull form?
- What contingency plans have been formulated should the prototype hull form fail to meet Coast Guard performance requirements?
- What is the status of the FRC design?

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GAO's Approach

- Reviewed the decision to use composite materials for the FRC hull form, to include:
  - Relevant Coast Guard and contractor documents, trade studies, and briefings
  - Discussions with staff from the Coast Guard's Deepwater Program and the Engineering Logistics Center, the Office of Naval Research, and the Naval Surface Warfare Center
- Reviewed the decision regarding the types of composites to be used on the FRC hull form, to include:
  - Relevant Coast Guard and contractor documents and trade studies
  - Discussions with staff from the Coast Guard's Deepwater Program, as well as an Office of Naval Research official
- Discussed Coast Guard mitigation efforts and contingency plans with relevant Coast Guard Deepwater Program and test and evaluation officials

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GAO's Approach

- Reviewed the current status of the FRC design effort, to include:
  - Coast Guard documents, studies, briefings; contractor documents and briefings; and independent design review materials
  - Discussions with Coast Guard Deepwater Program and Engineering and Logistics Center officials
- We conducted our work between February and April 2006 in accordance with generally accepted governmental auditing standards

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Briefing Overview

- Decision to use composite materials for the FRC hull form
- Types of composite materials planned for use on the FRC hull form
- Risk mitigation and contingency plans should the first hull form fail to meet Coast Guard's performance requirements
- Recent history of FRC design concerns
- FRC re-design options
- FRC program costs to date

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Decision to use Composite Materials for the FRC

In July 2004, Integrated Coast Guard Systems (ICGS) decided to use composite materials for the FRC hull form

- ICGS's analysis of alternatives for the FRC found that the use of composite materials instead of steel offered advantages such as:
  - Reduced Total Ownership Costs
  - Increased operational availability (extended time between depot-level maintenance, decreased maintenance requirements)
  - Increased performance through weight savings (higher speed, extended range)

An official with the Office of Naval Research (ONR) also cited additional advantages such as:

- Corrosion prevention
- Impact damage – less likely than steel to result in a hole in the cutter

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Decision to use Composite Materials for the FRC

- According to ONR, some examples of successful use of composite material hulls include:
  - European naval vessels including British, Dutch, Swedish
  - U.S. Navy Minesweepers
- However, a Naval Surface Warfare Center official also cited the following disadvantages of using composite versus steel materials:
  - Far less stiff than a steel hull, thereby making it more likely to bend under weight
  - Level of confidence in performance and service experience less than that of steel

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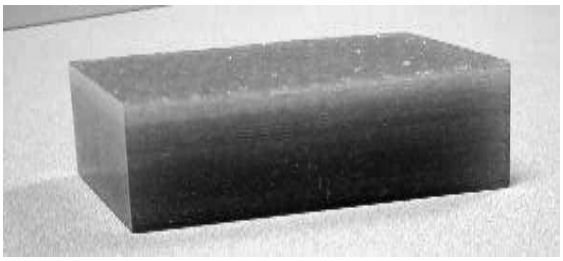
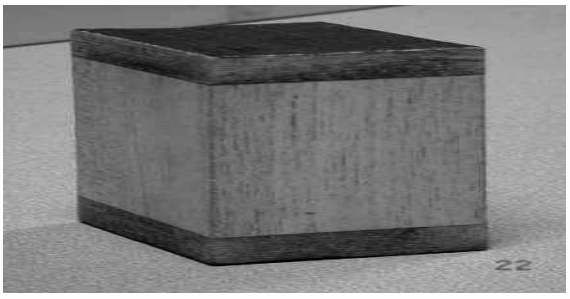
Planned Use of Composite Materials on the FRC

Two types of composite materials are to be used on the FRC:

- A **solid laminate** form consisting of layers of glass-reinforced plastic for the hull
- A "**sandwich**" form consisting of two thinner layers of glass-reinforced plastic surrounding a core of either balsa wood or synthetic foam for deck and bulkhead





Photos courtesy of the U.S. Coast Guard

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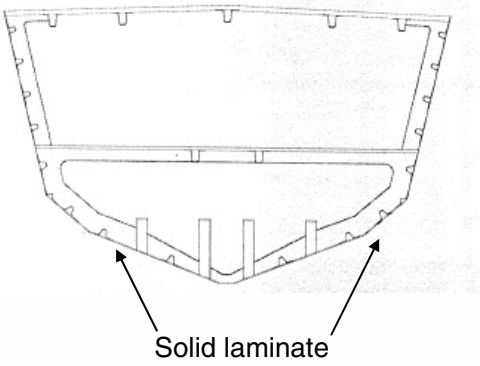
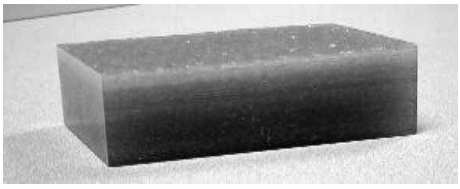
Planned Use of Composite Materials on the FRC

Solid laminate

- Solid, single-skin glass-reinforced plastic hull shell with attached stiffeners
- Entire hull would be molded into form in one process
- Low maintenance and life cycle costs, longer service life, lower weight than comparable steel hulls





Graphic & photo courtesy of the U.S. Coast Guard

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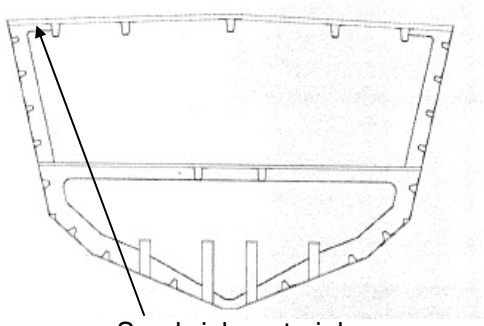
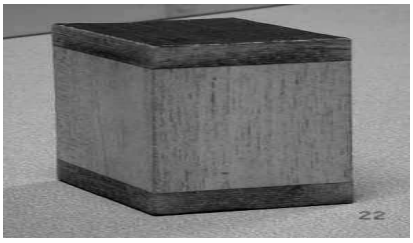
Planned Use of Composite Materials on the FRC

Sandwich form

- Thin glass-reinforced plastic "skins" separated by a core material
  - Core material will consist of either synthetic foam or balsa wood, depending on location
- Reduced structural weight with built-in insulation due to core material





Graphic & photo courtesy of the U.S. Coast Guard

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Risk Mitigation and Contingency Plans

Risk mitigation efforts during the Preliminary Design Phase (January 2005—February 2006) included:

- Model testing of the current design
- Independent Design Review (IDR) of the FRC design
- Testing of proposed composite material panels and joint configurations

Because of potential use of composite materials, Coast Guard intends to conduct a 12-month performance evaluation on the first FRC before ordering follow-on cutters

- Although the first FRC was to be delivered in 2007, per the revised 2005 Deepwater plan, there are currently no detailed plans as to what this evaluation will entail

While there is no documented contingency plan, according to a Coast Guard Deepwater Program official, should the first FRC fail to meet performance requirements, the Coast Guard would pursue further sustainment of the current 110-ft patrol boat fleet while reviewing other alternatives to reduce risk by exploring existing designs

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Recent History of FRC Design Concerns

Concerns about the FRC design have been raised since January 2005

- January 2005
  - Coast Guard Engineering Logistics Center (ELC) provided significant comments to ICGS's initial Concept Design Report, outlining concerns about the hull form, potential speed, and propulsion plant studies, among others
- April 2005
  - Coast Guard Deepwater Program Office and ICGS held a Systems Requirements Review
  - Coast Guard Deepwater Program Office focused on weight reduction strategies, with little to no attention on design concerns
- May 2005
  - Coast Guard ELC published a white paper formally outlining design concerns, such as the design process, estimated weight increases, hull form and propulsion
  - According to Deepwater Program officials, they acknowledged ELC's concerns and determined further testing was necessary to validate them

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Recent History of FRC Design Concerns

- August 2005
  - Due to its continued design concerns, Coast Guard Deepwater Program Office asked for an IDR
  - ICGS contracted with John J. McMullen & Associates to perform an IDR
- September 2005
  - Coast Guard Deepwater Program Office and ICGS held a Preliminary Design Review (PDR) and ICGS was authorized to award a contract for detailed design
  - PDR considered by Coast Guard Deepwater Program Office to be “successful” because ICGS met contractual requirements
- October 6, 2005
  - After PDR, Coast Guard Deepwater Program Office sent a letter to ICGS highlighting design concerns such as the hull design and inconsistent total ownership cost data, to be addressed prior to Critical Design Review

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Recent History of FRC Design Concerns

- January 2006
  - Due to preliminary model test observations ICGS identified cavitation (which can lead to engine inefficiencies and potential structural damage) as a concern with the FRC's hull form and presented an issue paper and briefing to Coast Guard officials
  - Coast Guard authorized additional testing to explore potential cavitation problems
- February 14, 2006
  - John J. McMullen & Associates provided a briefing on preliminary IDR results that, among other things, noted:
    - FRC preliminary design was unlike those typically found for patrol boats. For example, at 330 tons, FRC is 52% heavier than a standard patrol boat of similar length; thereby driving hull proportions, required power, structural design, fuel load and costs.
  - IDR preliminary results validated concerns raised in ELC's May 2005 white paper, as well as the initial concerns raised in early 2005

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Recent History of FRC Design Concerns

- February 28, 2006
  - According to Coast Guard Deepwater Program Office, FRC design work has been temporarily suspended because of high technical risks associated with current design
    - Risks include excessive weight, excessive horse power, and the likelihood of additional problems
  - According to the Coast Guard Deepwater Program Office, ICGS maintains that its FRC design has met contractual requirements and is withholding any judgment about the design until final IDR and model test results are available

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FRC Re-design Options

The Coast Guard is pursuing three strategies to mitigate FRC design technical risks

- Market survey
  - ICGS would purchase an "off-the-shelf" patrol boat design and if necessary, make modifications to meet Coast Guard requirements
  - The Coast Guard recently released a request for information to obtain data about the state of the market for proven patrol boat designs
- Modify current design
  - Coast Guard would revise planned FRC capabilities to allow for alterations to the FRC design
- Re-assessment of the composite versus metal business case analysis
  - Coast Guard would have a third party reassess the composite v. metal business case analysis to determine if the use of composite materials is still appropriate in terms of Total Ownership Cost

Estimated delivery date of first FRC: 4th quarter fiscal year 2009 or 4th quarter fiscal year 2010

* Please see pages 1 and 4 for updated information.

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FRC Program Costs To Date

- Costs of FRC design efforts to date

FRC design efforts	Total obligations	Total expenditures	Percent unexpended
Concept & preliminary design	$18,504,593	$17,250,000	7%
Proposal preparation for Long Lead Time Materials	$76,380	$67,065	12%
Contract & detail design	$14,520,000	$6,390,000	56%
Proposal preparation for contract & detail design	$1,441,036	$611,991	58%
Total	**$34,542,009**	**$24,319,056**	**30%**

- Costs of all FRC test efforts to date

FRC test efforts	Total obligations	Total expenditures	Percent unexpended
Composite material testing	$1,830,289	$455,000	75%
Hydrodynamic model testing	$1,989,782	$230,000	88%
Total	**$3,820,071**	**$685,000**	**82%**

- Fiscal Year 2007 budget request includes approximately $41.6 million for production of the first FRC

* Please see page 3 for updated cost information.

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Concluding Observations

- The Coast Guard has expended about $25 million and does not have a viable FRC design to date
- Because the first FRC may not be delivered until fiscal year 2009 or fiscal year 2010, the Coast Guard has lost time in acquiring the new capabilities it needs in a post 9/11 environment
- The longer it takes for the Coast Guard and ICGS to get an acceptable replacement for the 110-ft and 123-ft patrol boat fleets, the more the Coast Guard will have to rely on aging, deteriorating vessels
- The Coast Guard may have increased the risks associated with the "system of systems" concept due to schedule slippages and uncertainties associated with potential changes in the design and capabilities of the replacement assets

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Appendix II: GAO Contact and Staff Acknowledgments

GAO Contact

Steve Caldwell (202) 512-8777 or caldwells@gao.gov

Staff Acknowledgments

In addition to the contact named above, Steve Calvo, Assistant Director; Christopher Conrad, Adam Couvillion, Julie Leetch, and Stan Stenersen made key contributions to this report.

Related GAO Products

United States Coast Guard: Improvements Needed in Management & Oversight of Rescue System Acquisition, GAO-06-623 (Washington, D.C.: May 31, 2006).

Coast Guard: Changes to Deepwater Plan Appear Sound, and Program Management Has Improved, but Continued Monitoring is Warranted, GAO-06-546 (Washington, D.C.: April 28, 2006).

Coast Guard: Progress Being Made on Addressing Deepwater Legacy Asset Condition Issues and Program Management, but Acquisition Challenges Remain, GAO-05-757 (Washington, D.C.: July 22, 2005).

Coast Guard: Preliminary Observations on the Condition of Deepwater Legacy Assets and Acquisition Management Challenges, GAO-05-651T (Washington, D.C.: June 21, 2005).

Coast Guard: Preliminary Observations on the Condition of Deepwater Legacy Assets and Acquisition Management Challenges, GAO-05-307T (Washington, D.C.: April 20, 2005).

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