

GAO

Report to the Chairman, Committee on
Commerce, Science, and
Transportation, U.S. Senate

March 2004

COAST GUARD

Replacement of HH-65 Helicopter Engine





G A O

Accountability * Integrity * Reliability

United States General Accounting Office
Washington, DC 20548

March 24, 2004

The Honorable John McCain
Chairman, Committee on Commerce,
Science, and Transportation
United States Senate

Dear Mr. Chairman:

Over the last several years, the Coast Guard has experienced what it considers to be serious reliability and safety problems with its workhorse HH-65 helicopter used for key missions, such as search and rescue, migrant and drug interdiction, and homeland security.¹ Annually, the HH-65 contributes to saving 375 lives and assists on 2,065 drug interdiction cases, according to the Coast Guard. An increasing trend in the number and seriousness of safety-related HH-65 incidents in recent months, highlighted by some the Coast Guard deemed to be serious life-threatening incidents, prompted a Coast Guard decision in January 2004 to replace the existing engine and the associated engine control system² in this helicopter with a different engine, which it believes will improve safety and reliability and substantially reduce incidents.³

In light of the Coast Guard's decision to replace the existing engine, and as part of our already ongoing work on the safety and reliability of the HH-65 helicopter, you asked us to determine (1) whether the Coast Guard's decision to replace the existing HH-65 helicopter engine was fact- and risk-

¹The Coast Guard operates 84 HH-65 helicopters that are dispersed geographically across the United States to perform various missions. The HH-65 is the Coast Guard's only cutter deployable aircraft.

²"Engine," as used throughout the report, refers to the engine and engine control system. The function of the overall engine and engine control system is to maintain rotor speed and provide engine load-sharing under all normal flight conditions. Engine components include such parts as the fuel control unit, power turbine governor, and the airflow modulator. Engine control system components include the anticipator actuator, anticipator control box, and the dual collective potentiometer. The engine manufacturer (Honeywell) and the Coast Guard are each responsible for various separate engine and engine control system components.

³The Coast Guard decided on January 15, 2004, to replace the existing HH-65 engine within 24 months. The estimated investment for the replacement engine is \$150 million to \$250 million.

based; (2) the management and efficiency implications, if any, of the Coast Guard's approach for addressing the safety and reliability issues with the existing HH-65 engine and acquiring the replacement engine; and (3) the extent to which the replacement decision aligns with the Coast Guard's long-term helicopter needs under its Deepwater program.⁴ On March 12, 2004, we briefed your staff on the preliminary results of our work to date. Enclosure I contains the materials we presented at that time. Even though the results of our work are preliminary, we are reporting now to give the Coast Guard an opportunity to amply consider our findings as it proceeds with its HH-65 engine modification and replacement initiatives.

We conducted our work from June 2003 through March 2004 in accordance with generally accepted government auditing standards.

Results in Brief

The Coast Guard made a decision that was both fact- and risk-based for replacing the engine on the HH-65 helicopter. Recently, the number of reported in-flight power losses and incidents has grown dramatically. The Coast Guard reported 37 incidents in the first 3½ months of fiscal year 2004, when it made the engine replacement decision. That number had risen to 67 incidents as of March 1, 2004. In fiscal year 2003, pilots had reported a total of 32 incidents.⁵ We verified the data used to support the recent trends and incidents cited by the Coast Guard as a basis for making the engine replacement decision. Further, our interviews with pilots and our review of incident reports disclosed widespread Coast Guard concerns with the safety risks of flying the HH-65 helicopter because of the lack of reliability of its engine and engine control system. For example, some pilots and crew characterized flying the helicopter akin to “playing

⁴The Coast Guard's Deepwater program includes replacement and modernization of the agency's entire fleet of cutters and aircraft. The procurement is expected to cost over \$17 billion over 30 years. The Deepwater program's prime contractor acts as a system integrator with responsibility for identifying and delivering an integrated system of assets to meet the Coast Guard's missions. Apart from its HH-65 engine replacement decision in January 2004, the Coast Guard had already planned to modernize its HH-65 fleet and upgrade its capability as part of the Deepwater program. Planned HH-65 upgrades include a new engine and improved avionics for this helicopter. Under the Deepwater program timetable, delivery of the upgraded helicopters is scheduled to begin in fiscal years 2007 and be completed by 2013.

⁵To minimize continued safety risks associated with the HH-65 engine, the Coast Guard imposed operational restrictions on its use in October 2003. Operational restrictions included limiting helicopter landings on helipads and restricting cutter takeoffs and landings.

Russian roulette,” indicating that failures could occur at any time in flight. They also stated that they routinely employ atypical work-around solutions, such as dumping fuel and leaving a rescue swimmer behind, to accomplish missions when power failures and other engine-related problems occur. The Coast Guard also performed a risk analysis, using information on frequency of occurrence, severity of incidents, and assumptions about their relative importance that showed that the current situation warranted the highest possible risk category, sufficient to ground the fleet unless substantive steps were taken to improve safety and reliability. The Coast Guard’s determination of the need for immediate engine and engine control system replacement was also based on the belief that improvements being made to the existing engine by the manufacturer and the Coast Guard were not working fast enough. Similarly, HH-65 helicopter upgrades under the Coast Guard’s Deepwater program are not scheduled to begin until fiscal year 2006, and during the interim period, the Coast Guard did not want to further jeopardize the safety of its pilots and crew or those who depend on the Coast Guard during search and rescue operations.

The Coast Guard is using a two-track approach for dealing with safety and reliability problems with the HH-65 in the short term, and this approach has a number of notable management and efficiency implications. With regard to the first track, which involves installing a modified version of the existing engine, the Coast Guard has already bought 61 modified engines and plans to purchase 38 more for \$4 million before testing is completed on any of the modified engines.⁶ According to the Coast Guard, serious problems occurred with the modified engine during early testing, and further engine modifications were made.⁷ Moreover, installation of the first

⁶The modified engine, referred to as the LTS-101-850, is advertised to provide a 14 percent power increase over the LTS-101-750 engine, which currently powers the HH-65. The LTS-101-750 engine, manufactured by Honeywell, relies on a complex engine and engine control system. Since its introduction in 1984, the helicopter has experienced a variety of engine problems, initially with the core engine and in recent years with the control system. Further, the performance requirements (for weight) for the HH-65 have grown 17 percent over time without a corresponding growth in engine power.

⁷On November 5, 2003, an HH-65 that was being tested with the modified engines at the Coast Guard’s Aircraft Repair and Supply Center had an engine that would not start. Three days later, a similar event occurred on another modified engine. Subsequent investigations indicated that the clearance for engine-related blades was inadequate so that the blade tip was rubbing against the engine shroud. The material that rubbed away accumulated while the engine was running, and upon cool down, welded the blades to the shroud, causing the engine not to re-start.

61 modified engines is not scheduled to be completed on selected HH-65 helicopters until November 2004—at a time when installation of the replacement engines is scheduled to be underway on other HH-65 helicopters. Hence, the remaining 38 modified engines may not be needed until November 2004 at the earliest, depending on the results of the testing program. In light of these circumstances, we believe that proceeding with the 38-engine purchase is premature, at least until testing is completed in April 2004. Also, given that installation of the replacement engine likely will have already started by the time the 38 engines are ready for installation, a further Coast Guard review of the cost effectiveness of purchasing and installing these engines should be considered, in our opinion. The second track of the Coast Guard’s approach, which is to acquire a replacement engine, involves using a contractor to select and acquire the engine, rather than the Coast Guard managing the effort itself.⁸ The Coast Guard believes that this approach will both take advantage of the contractor’s acquisition expertise and reduce the Coast Guard’s legal risks by providing independence to the acquisition decision—thereby reducing potential disputes and protests over the engine replacement decision. However, as the Coast Guard recognizes, this approach most likely will cost more because of the contractor’s charges for profit and overhead, which could add 15 percent to total costs. Also, relying on the contractor adds another layer of administration and carries the risk of additional time to negotiate acquisition decisions, even after the initial contract award is made.

Whether the requirements for the replacement engine will be aligned with Deepwater requirements for this helicopter is unclear because the requirements for all Deepwater aircraft and vessels are still under review in light of the Coast Guard’s expanded homeland security responsibilities.⁹ If the two are not aligned, there are significant implications and risks related to the amount of money spent on engine replacements and the amount of time needed for replacement. For example, if the replacement engine does not meet power requirements for the Deepwater helicopter, a second new engine may have to be installed, largely negating the estimated

⁸This contractor, also the system integrator for the Coast Guard’s Deepwater program, is a business entity jointly owned by Northrop Grumman Ship Systems and Lockheed Martin Corporation.

⁹In general, the requirements refer to the engine’s capability with respect to the helicopter’s weight and weather conditions. For example, the requirements for the replacement engine call for an engine that must provide at least a 10 percent power margin during hover out of ground effect at 9,200 pounds on a 35 degree centigrade day at sea level.

\$150 million to \$250 million investment in the first replacement engine. Also, the Coast Guard would have to go through two replacement cycles—one for the first replacement engine and a second for the engine needed to meet Deepwater requirements. This could result in fewer helicopters being available to fulfill mission responsibilities.

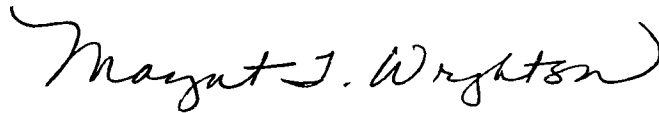
Scope and Methodology

Our work for this report involved reviewing and analyzing a variety of Coast Guard documents, decision papers, and data elements, as well as conducting site visits to Coast Guard air stations and other facilities. To assess the re-engine decision and replacement engine acquisition approach, we reviewed the Coast Guard decision memo and related documents, aircraft mishap data, and contractor data, and interviewed contractor and Coast Guard officials, including those in the offices of the Chief of Staff, Budget, Safety, HH-65, and Deepwater programs, Aircraft Repair and Supply Center, and Aviation Training Center. We also talked with pilots, crew, and other personnel who operate and maintain the HH-65. We verified the reported mishap data and conducted an assessment of the procedures and internal controls established for the database. To assess the management and efficiency implications, if any, of the Coast Guard's approach to acquiring the replacement engine, we reviewed Coast Guard documents and a legal analysis as well as interviewed Coast Guard officials from the Chief of Staff's office. To assess the alignment between the short- and long-term requirements, we reviewed Coast Guard planning documents, performance objectives, and information prepared for potential contractors, and interviewed Coast Guard and contractor officials.

Agency Comments

We provided a draft of this report to the Department of Homeland Security and the Coast Guard for review and comment. Generally, the Coast Guard agreed with the facts presented in the report. Coast Guard officials provided a number of technical comments and clarifications, which we incorporated to ensure the accuracy of our report. The Coast Guard agreed with our position regarding the timing of and need for purchasing the additional 38 modified (LTS-101-850) engines for the HH-65 helicopter. The Coast Guard agreed that purchasing the 38 additional modified engines before testing on them is completed would be premature, and the agency does not plan to do so, according to cognizant officials. In addition, Coast Guard officials said that based on these test results and the timetable for the HH-65 engine replacement effort, they plan to review the decision to purchase the 38 engines.

Copies of this report are being sent to the Secretary of the Department of Homeland Security, the Commandant of the Coast Guard, and other interested parties. The report is also available at no charge on GAO's Web site at <http://www.gao.gov>. If you have any questions about this report, please contact me at (415) 904-2200 or by e-mail at wrightsonm@gao.gov or Randall B. Williamson, Assistant Director at (206) 287-4860 or by e-mail at williamsonr@gao.gov. Other key contributors to this report were Odi Cuero, Marco Gomez, Bonnie Hall, Stan Kostyla, Julie Leetch, and Stan Stenersen.



Margaret T. Wrightson
Director, Homeland Security
and Justice

Enclosure I: Briefing Slides



U.S. Coast Guard HH-65 Helicopter Re-engine Decision

**Briefing to Senate Commerce, Science,
and Transportation Committee**



Objectives of Our Engagement

The Coast Guard decided in January 2004 that, for safety and reliability reasons, the existing engine on its HH-65 helicopters must be replaced (“re-engined”). The Coast Guard has also identified the HH-65 helicopter as the likely helicopter for upgrading as part of its Deepwater program

Our work for congressional requesters has focused on the following:

- Determining the extent to which the Coast Guard’s approach to assessing safety and reliability issues was
 - Fact-based: that is, stemming from evaluation of actual incidents
 - Risk-based: that is, incorporating an assessment of future risk
- Identifying the management and efficiency implications, if any, of the Coast Guard’s approach to acquiring the replacement engine
- Determining the extent to which the requirements for the replacement engine are aligned with engine requirements for the helicopter the Coast Guard will use as part of its Deepwater program



Scope and Methodology

- Sources used for assessing the re-engining decision and approach included Coast Guard decision memos and related documents; aircraft mishap data; interviews with pilots, crew, and other Coast Guard officials (Chief of Staff, Aviation, HH-65 program office, Safety, Budget, Deepwater, Aircraft Repair and Supply Center, Aviation Training Center); and information from contractors
- Sources used for assessing the alignment between re-engining and Deepwater requirements include Coast Guard planning documents, information prepared for potential contractors, and interviews with Coast Guard and contractor officials
- Because our engagement is ongoing, findings and observations presented in this briefing are preliminary
- Coast Guard continues to make decisions that could affect on our findings



Summary of Preliminary Findings

Objective 1

- The Coast Guard used a fact-based and risk-based approach for determining if the existing engine on the HH-65 needed to be replaced (See slides 7 – 11)

Objective 2

- The Coast Guard's interim approach to dealing with safety and reliability problems includes buying some engines that will marginally increase power, but the Coast Guard is planning to buy more of these engines than may be appropriate prior to the full replacement. By the time these engines would be scheduled to go on the helicopter, the re-engining would be underway. The approach to acquiring the replacement engine involves using the Deepwater program's contractor to make the engine selection based on Coast Guard requirements. Coast Guard officials said they used this approach to take advantage of the contractor's expertise and to lessen the Coast Guard's legal risk, for example, from bid protests. The Coast Guard recognizes this approach could add to cost and take more time than if it had managed the process itself (See slides 12 – 16)
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Summary of Preliminary Findings

Objective 3

- Whether the requirements for the replacement engine will be aligned with Deepwater requirements is unclear, because Deepwater requirements are being reviewed and developed in light of the Coast Guard's expanded homeland security missions. If the two are not aligned, there are significant implications and risks related to the amount of money spent on engine replacements and the amount of time needed for replacement (See slides 16 – 20)



Background

- **The helicopter:** The HH-65 is the Coast Guard's main helicopter, serving such missions as search and rescue, drug and migrant interdiction, and homeland security
- **Engine and related problems:** Problems with the current engine and related components have been occurring for a number of years, affecting the amount of power available for hovering, lifting, and other operations. The Coast Guard and Honeywell (the engine manufacturer) have been working to address these problems
- **Link to Deepwater:** While a final decision has not been made, the HH-65 is currently slated for retention and upgrade as part of the Deepwater program, a long-range program to improve the Coast Guard's at-sea assets (cutters, boats, aircraft, and related equipment). The current Deepwater schedule calls for upgrade requirements to be developed in 2006, with delivery of upgraded helicopters to occur in fiscal years 2007-2013
- **Deepwater contracting approach:** Development of Deepwater assets is being coordinated by a contractor or "systems integrator", Integrated Coast Guard Systems (ICGS). The systems integrator develops the performance specifications and selects which contractor will provide the assets. The Coast Guard provided the general performance requirements to the systems integrator in the statement of objectives



Preliminary Findings — Use of Fact-Based Approach to Re-engining Decision

- The Coast Guard based its decision in part on a rising number of in-flight loss-of-power incidents

Period	Number of reported in-flight loss-of-power incidents
Fiscal year 2000	9
Fiscal year 2001	12
Fiscal year 2002	11
Fiscal year 2003	32
Fiscal year 2004 (to point of decision on January 15, 2004)	37
Fiscal year 2004 (to 3/1/2004)	67

Source: U.S. Coast Guard

- In its January 2004 memorandum stating its basis for the re-engining decision, the Coast Guard also cited potentially life-threatening examples, including search and rescue, homeland security, and other missions, that pointed to an increasing severity in the loss-of-power failures



Preliminary Findings — Use of Fact-Based Approach to Re-engining Decision

- Our review of the Coast Guard’s mishap reports found no significant deficiencies
 - We verified the data existed to support the 37 FY 2004 mishaps cited in the Coast Guard’s January 2004 memo stating its basis for the re-engining decision. It was later determined that one of the incidents did not qualify as an engine mishap
 - Until fiscal year 2002 the Coast Guard did not have a way to capture potentially severe engine-related mishaps without extensive cost or injury



Preliminary Findings — Use of Fact-Based Approach to Re-engining Decision

- Our analysis of testimonial and documentary evidence from helicopter pilots and commanding officers (CO) of Coast Guard stations found **consistent** expressions of concerns about safety and reliability
 - In interviews, pilots and crew:
 - Characterized flying the HH-65 to playing 'Russian roulette'; failures could occur at any time in flight.
 - Said safety of both crew and clients are at risk
 - Said they routinely employ atypical work-arounds, such as dumping fuel, leaving rescue swimmer on scene, or overtorquing the engine, to accomplish missions
 - Examples of the most serious statements from mishap reports
 - 1/27/2003 – CO: “Do we have to kill an aircrew to get progress on replacing this antiquated and increasing unreliable engine control system?”
 - 8/14/2003 – CO: “We must make re-engining the HH-65 a priority and address whatever political and logistical hurdles stand in the way of reliable power for the backbone of the aviation fleet.”
 - 12/05/2003 – CO: “This was an early morning, night-time search and rescue case...we were fortunate that the condition of the patient did not deteriorate and a life lost associated with this malfunction.”



Preliminary Findings — Use of Fact-Based Approach to Re-engining Decision

- The Coast Guard's determination of the need for immediate engine replacement was also based on belief that improvements under way for safety and reliability were not working fast enough
 - In the Coast Guard's view, mitigation strategies undertaken as of January 2004 (such as more frequent overhauls of components and part replacements) had proven insufficient to address deficiencies in engine and related control components
 - A new control system, Full Authority Digital Electronic Control (FADEC) for the existing engine was under development but not scheduled to be prototyped and tested until fiscal year 2005 at the earliest. Coast Guard analysis indicated that no substantial improvements to safety could be made if the engine was not equipped with such a control system
 - The Deepwater solution was too far into the future. If the HH-65 were to become the Deepwater Multi-Mission Cutter Helicopter (MCH), upgrades to address these missions were not scheduled to begin until fiscal year 2006, with helicopters not scheduled to come on line until 2007-2013



Preliminary Findings — Use of Risk-Based Approach to Re-engining Decision

- The Coast Guard conducted a risk assessment prior to making its decision
- The Coast Guard considered Department of Defense, Federal Aviation Administration, and existing Coast Guard guidance for conducting risk assessments in determining criteria and a methodology for its analysis
- Using the above criteria and information about frequency of occurrence and severity of mishaps and assumptions about their relative importance, the Coast Guard determined that the current situation warranted the highest possible risk category
- The Coast Guard concluded that the result of this analysis provided a basis for grounding the fleet, but decided that meeting its mission required an approach that allowed the fleet to continue operating while taking steps to mitigate the risk



Preliminary Findings — Implications of the Coast Guard’s Re-engineing Approach

- The Coast Guard’s approach to re-engineing involves action on two parallel tracks

First track: until installment of a replacement engine is completed, continue efforts to improve existing engines and their control systems through such steps as the following:

- Upgrade existing engines to increase power by 14 percent
- Conduct more frequent component overhauls to prevent component failure
- Continue to restrict operations to minimize risk in such ways as:
 - Limiting helicopter landings on helipads at hospitals or other small landing areas
 - Restricting cutter takeoffs/landings
 - Minimizing rescue swimmer operations utilizing two swimmers

Second track: install a new engine in the entire HH-65 fleet within 24 months



Preliminary Findings — Implications of the Coast Guard's Re-engineing Approach

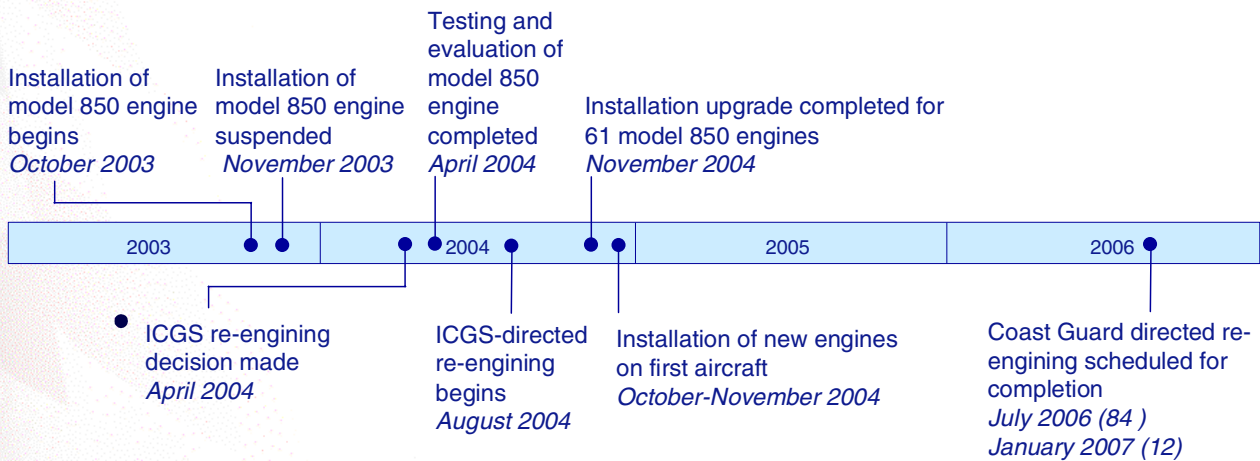
With regard to the first track of the Coast Guard's approach, decisions to buy **an additional** 38 LTS-101-850 engines (obligate \$4 million) before the system integrator makes a re-engine decision raises questions because

- The Coast Guard ordered 61 LTS-101-850 engines. The LTS-101-850 is a variant of the existing LTS-101-750, that is advertised with 14% power improvement over the existing engine. The Coast Guard plans to install 850 engines as a temporary upgrade until the replacement effort is complete in January 2007
- Installation of the first 61 850 engines is scheduled to be completed on November 1, 2004 when re-engineing would be underway
- Testing of delivered LTS-101-850 engines has revealed problems with engines seizing. Evaluation will not be completed until May 2004. Coast Guard stopped further operational use of the engines until issues resolved
 - Current operating restrictions with the 750 engine will likely continue with the LTS-101-850 engine, detracting from the value of the upgrade



Preliminary Findings — Implications of the Coast Guard’s Re-engining Approach

- Timeline for events on installation of LTS-101-850 engine upgrades and re-engining choice made by system integrator





Preliminary Findings — Implications of the Coast Guard’s Re-engining Approach

- The second track of the Coast Guard’s approach (acquiring the replacement engine) involves using the systems integrator for the Deepwater project to conduct the acquisition as opposed to the Coast Guard managing the effort. According to the Coast Guard, there are two primary advantages to this approach:
 - **Increased acquisition expertise.** The Deepwater contractor or systems integrator has a good overview because it is involved in acquiring many assets for the Coast Guard Deepwater program
 - **Reduced legal risk.** The approach provides independence to the acquisition decision. The system integrator’s decision to compete the re-engining contract further lessened the potential for legal challenges, such as avoiding contractor protests



Preliminary Findings — Implications of the Coast Guard’s Re-engineing Approach

- The Coast Guard’s re-engineing approach also carries two potentially negative consequences:
 - **Increased cost.** The systems integrator will include profit and overhead margins, which could add around 15 percent to the total cost of the acquisition
 - **Increased time for decisions.** According to the Coast Guard, relying on the systems integrator adds another layer of administration and carries the risk of additional time to negotiate acquisition decisions. Recent negotiations with the systems integrator have been exceptionally time consuming



Preliminary Findings — Alignment Between Re-engining and Deepwater Requirements

- Until Deepwater requirements are approved, the alignment between requirements for the replacement engine and requirements for the Deepwater engine cannot be determined. However, information to date suggests there is potential that the two will not be well aligned
 - Anticipated Deepwater requirements call for higher amounts of power than would be available under the requirements for the replacement engine
 - Documents suggest the Deepwater helicopter will be armed, adding to the weight. Coast Guard officials said they need a 20% power reserve at 9200 pounds due to aggressive tactics and maneuvering required for Airborne Use of Force profile. The Request for Information for the re-engining requires only a 10% power reserve
 - Documents also suggest additional engine power will be needed to allow the Deepwater helicopter to conduct “vertical insertion” (for law enforcement and homeland security purposes, allowing personnel to be roped up or down to vessels below)



Preliminary Findings — Alignment Between Re-engineing and Deepwater Requirements

- The Request for Information (RFI) requires commercial type certifications for the engine that could meet the re-engine requirements but not the anticipated Deepwater requirements
- An engine can be proposed and selected that meets both the re-engine and Deepwater requirements, minimizing alignment problems



Preliminary Findings — Alignment Between Re-engining and Deepwater Requirements

Coast Guard faces significant issues related to cost and schedule if requirements are not aligned

Cost issues

- If the engine installed under the HH-65 re-engining is not sufficient to meet requirements for the Deepwater helicopter, a second new engine will need to be installed. The cost of a second re-engining is unknown. If a second re-engining is needed, however, the estimated investment of \$150 million-\$250 million for equipping the HH-65 helicopter with the first engine would not represent best use of money
- Other adjustments to the helicopter, such as software upgrades for the helicopter's computer, adjustments to the engine cowlings and engine control systems and training simulator upgrades, may be necessary. The Coast Guard estimated that such costs could run to several millions of dollars for the fleet



Preliminary Findings — Alignment Between Re-engining and Deepwater Requirements

Coast Guard faces significant issues related to cost and schedule if requirements are not aligned

Schedule issues

- The Coast Guard would have to go through two replacement cycles—one for the first replacement engine, the second for the engine needed to meet Deepwater requirements. If the Coast Guard has to go through two replacement cycles, fewer HH-65 helicopters might be available to fulfill mission responsibilities
- The Coast Guard estimates that the time needed to equip the fleet with the replacement engine is 18 – 24 months; the potential length of time involved for conducting a second replacement is unknown

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