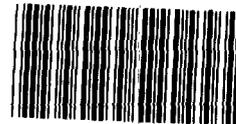


November 1992

# NAVY SHIPS

## Status of SSN-21 Design and Lead Ship Construction Program



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United States  
General Accounting Office  
Washington, D.C. 20548

**National Security and  
International Affairs Division**

B-236761

November 17, 1992

The Honorable Edward M. Kennedy  
Chairman, Subcommittee on Projection  
Forces and Regional Defense  
Committee on Armed Services  
United States Senate

The Honorable John Conyers, Jr.  
Chairman, Legislation and National  
Security Subcommittee  
Committee on Government Operations  
House of Representatives

This report is the unclassified version of the classified report we provided you in May 1992 on the results of our review of the Navy's Seawolf Nuclear Attack Submarine (SSN-21) construction program. This report discusses (1) the status of the Seawolf class submarine design; (2) the status of major subsystem development efforts and their potential impact on the Seawolf construction program; and (3) the cost, schedule, and performance status of the Seawolf construction program. Separate reports have been issued on the U.S. submarine shipbuilding industrial base and the Navy's nuclear-powered attack submarine force structure. This report is one in a series of reports responding to your requests that we review (1) the Seawolf class nuclear-powered attack submarine program, (2) its impact on the Navy's nuclear-powered attack submarine force structure, and (3) the U.S. submarine shipbuilding industrial base.

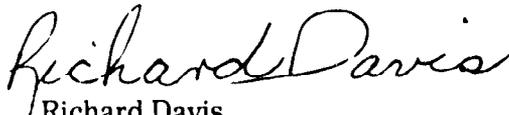
In January 1992, the Bush administration announced plans to terminate the Seawolf program after one submarine and, on March 20, 1992, proposed rescinding funds appropriated for the construction of follow-on Seawolfs. A partial rescission was approved by the House and Senate and signed by the President on June 4, 1992. According to the conference report, this action funded the second Seawolf and directed \$540.2 million to be used to provide advance procurement for a third Seawolf submarine, to restart the SSN-688 program, or for any other approach deemed beneficial to preserve the current submarine industrial base. Accordingly, the recommendation and matters for congressional consideration found in this report are no longer operative.

This report covers work we performed and comments we received from February 1991 through March 1992. The official Department of Defense response dated September 3, 1992, (see appendix II) notes that both the GAO findings and the prior Department of Defense response (see appendix I) must be viewed in the context of a much reduced Seawolf program. We are performing follow-on work which will address changes in the Seawolf program's status since March 1992 and expect to report to you in 1993.

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As agreed with your offices, we plan no further distribution of this report until 7 days from its issue date. At that time, we will send copies to the Chairmen, Senate Committee on Governmental Affairs, House Committee on Government Operations, Senate and House Committees on Appropriations, Senate and House Committees on Armed Services; the Director, Office of Management and Budget; and the Secretaries of Defense and the Navy.

If you or your staff have any questions on this report, please call me on (202) 275-6504. Major contributors to this report are listed in appendix III.

  
Richard Davis  
Director, Navy Issues



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# Executive Summary

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## Purpose

Detailed design of the Seawolf class nuclear-powered attack submarine (SSN-21) has been in progress for the past 5 years and is expected to be completed by June 1995. Construction of the first SSN-21 began in October 1989; it will cost the Navy more than \$2 billion (then-year dollars) when delivered in May 1996. Originally, the Navy planned to buy 29 SSN-21s through fiscal year 1999; however, that number was reduced to 12 submarines in January 1991, raising the average unit cost from \$1.5 billion to \$2.8 billion (then-year dollars).

Before the SSN-21 program was reduced from 29 to 12 submarines, the Chairmen, Subcommittee on Projection Forces and Regional Defense, Senate Committee on Armed Services, and Legislation and National Security Subcommittee, House Committee on Government Operations, asked GAO to (1) evaluate the status of the SSN-21 class design; (2) determine and evaluate the status of major subsystem development efforts and the potential impact of these systems on the SSN-21 construction program; and (3) assess the cost, schedule, and performance of the SSN-21 construction program.

Subsequently, in January 1992, after GAO completed its analysis, the Bush administration announced plans to terminate the SSN-21 program after one submarine. On March 20, 1992, President Bush submitted to the Congress two rescission proposals totaling more than \$2.9 billion. These proposed rescissions are for funds appropriated for construction of follow-on SSN-21s. However, these proposals must still go through the legislative review process and be accepted. Since this report primarily deals with the status of the SSN-21 class design and construction of the first submarine, the administration's rescission plans minimally affect the information contained in this report. But, if accepted, the plan will negate the report's recommendation and matters for congressional consideration sections.

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## Background

The SSN-21 will be the largest, quietest, most heavily armed nuclear-powered attack submarine (SSN) the United States has ever built. It will be capable of diving deeper, operating at faster tactical speeds, and carrying more weapons, while being less detectable than existing SSNs. The SSN-21 will be equipped with several new subsystems, including a more powerful propulsion system and a new combat system.

Detailed design of the SSN-21 began in April 1987. Newport News Shipbuilding and Dry Dock Company (Newport News Shipbuilding), Newport News, Virginia, is responsible for the overall design of the SSN-21

class and for the detailed design of the submarine's forward half. Under a subcontract to Newport News Shipbuilding, General Dynamics' Electric Boat Division (Electric Boat), Groton, Connecticut, is responsible for the detailed design of the submarine's rear half, including nonpropulsion plant items and other components in the engine room, such as the hydraulics, air conditioning, high pressure air system, and the aft nonpressurized hull area. Electric Boat began construction of the first SSN-21 in October 1989.

In May 1991, Electric Boat was awarded the construction contract for the second SSN-21, but the award was challenged in the U.S. District Court by Newport News Shipbuilding. On March 16, 1992, the 4th U.S. Circuit Court of Appeals in Richmond, Virginia, upheld the Navy's award of the contract to Electric Boat.

In December 1991, the Congress appropriated funds to construct the third SSN-21, with the Navy planning to issue a construction solicitation during the second quarter of fiscal year 1992. However, the administration's plan to terminate the program could make issues relating to construction of follow-on SSN-21s academic.

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## Results in Brief

The SSN-21 program is experiencing cost increases and schedule delays. As of December 31, 1991, design costs were estimated to more than double by the time the design contract is completed, and total construction costs were estimated to increase by about 45 percent over the original contract target costs. Welding cracks discovered during the lead ship's construction contributed to the increased construction costs and delayed its delivery from May 1995 to May 1996. As a result of this 1-year delay, the potential construction schedule impact of Newport News Shipbuilding's and Electric Boat's late delivery of design data has been reduced.

Two weapons systems that were planned for use on the SSN-21 experienced development and funding problems and were canceled. Because of this, the SSN-21 will be less capable than planned.

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## Principal Findings

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### Projected SSN-21 Cost Increases

On December 31, 1991, Newport News Shipbuilding estimated that the cost of completing the SSN-21 class design contract would increase by about \$352 million (current-year dollars), or about 116 percent over the original contract cost of \$303 million. Reasons given for the increased cost include the complexity of incorporating modular construction concepts into the SSN-21 class design and the cost of two shipyards concurrently designing the submarine. Under the provisions of the cost-plus-fixed-fee design contract, the government pays for all allowable costs and a negotiated fixed fee.

On December 21, 1991, Electric Boat estimated that the cost of building the SSN-21 would increase by about \$321 million (then-year dollars), or about 45 percent over the contract's original target cost of about \$718 million (then-year dollars). As of March 1991, Electric Boat had revised the original SSN-21 construction schedule three times, each time delaying and/or resequencing planned construction work. Both the cost growth and schedule revisions were primarily due to the late delivery of design data. In November 1991, the original construction schedule was revised a fourth time because of the welding problems. Construction contract provisions require the Navy and Electric Boat to share contract cost growth in excess of the contract's target cost, up to its ceiling cost. The sharing ratio depends on how much the cost growth exceeds the target cost.

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### Design Behind Schedule

Prior to discovery of the welding cracks, the SSN-21 design effort was behind schedule, causing the construction schedule to be revised three times. The design has continued to fall behind schedule. For example, as of December 31, 1991, design was more than 500,000 hours behind schedule. Further, of the 4,444 drawings required by November 27, 1991, 3,970 drawings were issued. It generally takes between 9 months and 18 months from start to finish of a drawing under the modular construction approach. Navy, Newport News Shipbuilding, and Electric Boat design officials characterized the drawing schedule as ambitious. Several reasons were given for issuing late drawings, including a congressional \$75-million reduction in SSN-21 class design funding during fiscal year 1990 and the complexity of incorporating modular construction concepts into the new SSN-21 class design. However, according to the Navy, the imbalance

between the design and construction efforts has been eliminated, primarily due to the 1-year delay caused by the welding cracks.

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### Welding Cracks Increase Cost and Delay Delivery

Welding cracks discovered in the SSN-21's hull, and subsequently in many of its components, increased the total cost of the submarine by about \$68.6 million (current-year dollars)—\$68.3 million for Electric Boat's construction and contractor-furnished equipment costs and \$0.3 million for government-furnished equipment—and delayed the submarine's delivery by 1 year. According to Navy and Electric Boat officials, although cracks were first found in January 1990 in the SSN-21's primary shield tank welds, they believed that corrective actions taken at that time solved the problem. Subsequent testing continued to indicate a potential welding problem; however, additional actions were not taken. In June 1991, construction weld cracks were again discovered, and by August 1991, the full magnitude of the problem became known and all welding was stopped. Navy and Electric Boat officials stated that the very small cracks were caused by using a high carbon content welding wire and allowing the welds to cool too quickly. The Navy and Electric Boat have assessed the problem and taken corrective action, and all welding was resumed in December 1991.

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### Reduced SSN-21 Performance

The SSN-21 will be less capable than planned because two weapon systems planned for use on the submarine have been canceled. First, the Navy had planned to equip SSN-21s with MK-48 torpedoes with propulsion system improvements and a quiet launch capability. However, development of the new propulsion system was canceled in September 1991 because it could not achieve its noise level goals. While the Navy plans to modify the existing MK-48 advanced capability torpedo's propulsion system to meet the SSN-21's needs, this alternative is not expected to achieve the noise reduction levels that were planned for the new propulsion system.

Second, the Navy planned to equip the SSN-21 with the submarine variant of the Sea Lance antisubmarine warfare standoff weapon system, a quick-reaction, conventional tactical weapon designed for long ranges. The Navy canceled the system in December 1989 because of high costs. As a result, the SSN-21 will be able to detect and localize enemy targets at long ranges, but will have to fire weapons at close ranges, thus increasing its vulnerability to counterattack. The Navy has no plans to develop an alternative to the submarine variant of the Sea Lance weapon system.

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## Recommendation

Should the Congress decide not to approve the administration's request to rescind funds appropriated for construction of follow-on SSN-21s, GAO recommends that the Secretary of Defense direct the Secretary of the Navy to provide the Congress an assessment of the extent to which problems in the lead ship design and construction, and in subsystem and weapons system development, will affect the cost, schedule, and performance of the follow-on SSN-21s.

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## Matters for Congressional Consideration

Should the Congress decide to continue with more than one SSN-21 class submarine, they may wish to consider restricting the use of funds already appropriated for the second and third submarines. Further, they may wish to delay funding additional submarines until the design has stabilized and planned modifications to the MK-48 advanced capability torpedo's propulsion system and the AN/BSY-2 combat system development efforts have matured.

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## Agency Comments

GAO provided a draft of this report to DOD on December 23, 1991, and asked for comments by January 22, 1992. On January 29, 1992, DOD requested a 3-week extension, until February 14, 1992, which GAO granted. DOD's official written comments were provided on March 27, 1992.

DOD generally agreed with GAO's findings on the status of the SSN-21 design and lead ship construction program and provided additional comments, which GAO has incorporated throughout the report (see app. I).

DOD disagreed with GAO's recommendation that the Congress be provided an assessment of the extent that problems in the lead ship design and construction, and in subsystem and weapon system development, affect cost, schedule, and performance of follow-on SSN-21 class submarines. It also partially concurred with GAO's matters for congressional consideration that the use of funds appropriated for construction of the third SSN-21 class submarine be restricted and funding for additional SSN-21 class submarines be delayed until the design has stabilized and planned weapon system modifications and combat system development efforts have matured. DOD's position is based on the Secretary of Defense's decision to build only one ship.

Our recommendation and the matters for congressional consideration are both contingent upon the construction of more than one SSN-21. On March 20, 1992, President Bush submitted to the Congress two rescission

proposals totaling more than \$2.9 billion. These rescission proposals relate to funds appropriated for the construction of the second and follow-on SSN-21s. However, if the Congress does not approve the rescission proposals within 45 days of continuous congressional session, the President must release the funds for the purposes appropriated. If the rescission proposals are not approved, GAO believes that an assessment of the potential effects problems in the SSN-21's design and construction could have on follow-on SSN-21 class submarines is needed. This assessment should be considered before the Navy authorizes SSN-22 construction and awards a contract for construction of SSN-23 and before the Congress considers funding further requests for follow-on SSN-21 class submarines.

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**Abbreviations**

|       |                                      |
|-------|--------------------------------------|
| CCAPS | Closed Cycle ADCAP Propulsion System |
| CFE   | Contractor-furnished equipment       |
| CIS   | Commonwealth of Independent States   |
| DOD   | Department of Defense                |
| GFE   | Government-furnished equipment       |
| SSN   | Nuclear Attack Submarine             |

# Introduction

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The Navy is concurrently designing and constructing the Seawolf class nuclear-powered attack submarine (SSN-21). The SSN-21 was to counter the former Soviet Union's new generation of quieter, more capable submarines, while maintaining an antisubmarine warfare qualitative advantage well into the next century. It will be the largest, quietest, most heavily armed nuclear-powered attack submarine (SSN) ever built by the United States. It will be capable of diving deeper, operating at faster tactical speeds, and carrying more weapons, while being less detectable than existing SSNs. In addition, the SSN-21 will have several new subsystems, including a more powerful propulsion system, weapons handling and control system, and combat system.

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## The Changing Submarine Threat

Extensive changes in the international environment has made prospects of global war less likely today than at anytime in the recent past. Regional conflicts involving other nations, however, have a greater potential for U.S. involvement; but currently, the submarines of those nations present only a limited threat to the Navy forces. However, as these nations acquire submarines and related technologies from the former Soviet Union's successor state, the Commonwealth of Independent States (C.I.S.)<sup>1</sup> and various western countries, they will present a greater threat to U.S. naval forces in the future.

The breakup of the Soviet Union has resulted in infrastructure disruptions, reduced defense budgets, and caused fiscal chaos in the C.I.S.

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## SSN-21 Procurement Rate Reduced

The number of SSN-21 class submarines the Navy planned to buy has been reduced. Original plans called for procurement of 29 SSN-21s through fiscal year 1999 at an estimated total cost of about \$44 billion (then-year dollars)—an estimated average unit cost of about \$1.5 billion. In August 1990, DOD, because of fiscal considerations and a reassessment of current and projected threats, reduced the total number of SSN-21s. In January 1991, the total number of SSN-21s to be built was reduced to 12 for a total estimated cost of about \$34 billion (then-year dollars), or an estimated average unit cost of about \$2.8 billion—an 87-percent increase. According to the SSN-21 program office, the increased unit cost was due to reducing annual SSN-21 procurement rates from three to one.

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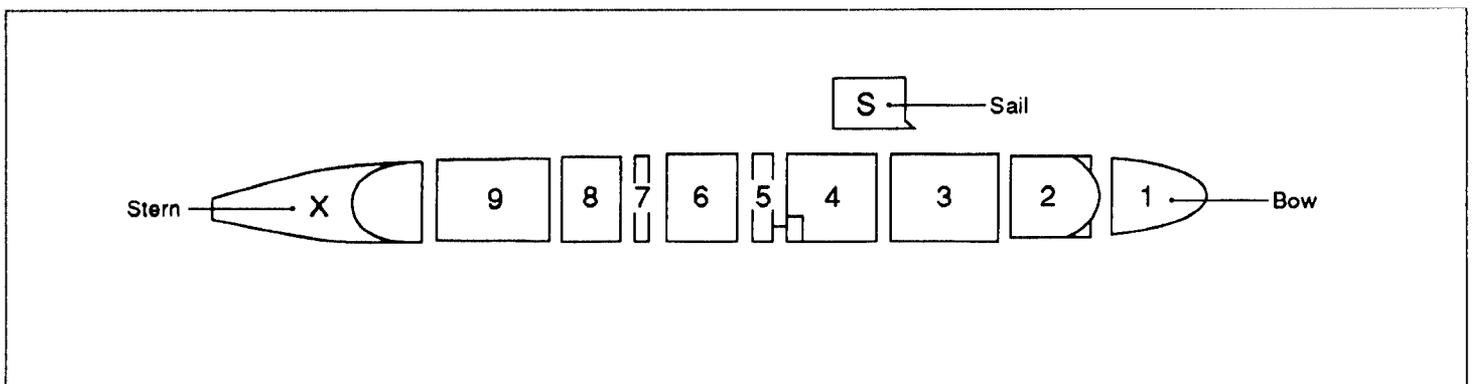
<sup>1</sup>The C.I.S. is a loose confederation of 11 of the former Soviet Union's 15 republics.

**SSN-21 Program Termination** The total number of SSN-21s to be built may be limited to one. In January 1992, the Bush administration announced plans to terminate the SSN-21 program after the first submarine. On March 20, 1992, President Bush submitted to the Congress two rescission proposals totaling more than \$2.9 billion. These two rescission proposals are for funds appropriated for construction of follow-on SSN-21s. Referring to the collapse of the Soviet Union, the administration stated that the United States no longer needed to proceed with the SSN-21 construction program. Instead, it stated that the Los Angeles class nuclear-powered attack submarines (SSN-688), among the most capable in the world, and a new lower cost submarine design will allow the Navy to modernize and maintain adequate SSN force levels in the coming years. The administration estimated that this submarine acquisition program change will save \$17.5 billion (then-year dollars) through 1997. The administration's rescission plans still must go through the legislative review process and be accepted.

## SSN-21 Construction Techniques

The SSN-21 is the first class of U.S. submarines designed to be built using modular construction techniques and processes. Under this construction process, SSN-21 class submarines will be built in 10 hull sections (see fig. 1.1), allowing for easier assembly and enabling the shipbuilder, in this case, General Dynamic's Electric Boat Division (Electric Boat), Groton, Connecticut, to complete numerous tasks, including placing major components and related systems into the hull sections prior to welding the sections together.

Figure 1.1: The SSN-21's 10 Modular Construction Hull Sections



However, to realize the full advantages of modular construction, a greater amount of preliminary and detailed planning must be accomplished before

construction starts. Multidiscipline product structure drawings must be issued to Electric Boat earlier and defined by hull section or area rather than by individual system or discipline. However, unlike previous submarine construction programs, designers provide sectional construction drawings in a format that Electric Boat can use without any further significant planning. Using the modular construction concept, designers generally require between 9 and 18 months from starting work on a system configuration drawing until a construction drawing is complete. During this period, the system configuration drawings are created, approved, and reformatted into sectional construction drawings. Construction drawings for the submarine's systems and related components are broken down into modules, submodules, items, and packages. They also define particular tasks performed by specific labor disciplines such as welders, machinists, or painters. Detailed construction drawings must be issued in a sequence and by established dates that support Electric Boat's modular construction, fabrication, and assembly plans.

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## SSN-21 Class Design and Construction Contracts

Newport News Shipbuilding and Dry Dock Company (Newport News Shipbuilding), Newport News, Virginia, and Electric Boat are designing the SSN-21 class. In April 1987, the Navy awarded Newport News Shipbuilding a \$303-million (fiscal year 1987 dollars) cost-plus-fixed-fee<sup>2</sup> contract for the submarine's overall design and for detailed design of its forward half, which includes the command and control center, the torpedo room, and the crew's living quarters. Under a \$48.8-million (fiscal year 1987 dollars) cost-plus-fixed-fee<sup>3</sup> subcontract to Newport News Shipbuilding, Electric Boat is responsible for the detailed design of the submarine's rear half, including nonpropulsion plant items and other components in the engine room, such as the hydraulics, air conditioning, high pressure air system, and the aft nonpressurized hull area. The SSN-21 class design contract continues until June 1995, with most design work scheduled for completion by November 1992.

In January 1989, the Navy awarded Electric Boat a \$718-million (fiscal year 1987 dollars) fixed-price-incentive-fee contract to build the first SSN-21. Construction began in October 1989, with delivery of the submarine originally scheduled for May 1995. As of January 31, 1992, the

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<sup>2</sup>An additional \$21.9 million is the fixed-fee portion of this contract. All amounts are expressed as fiscal year 1987 dollars unless otherwise indicated.

<sup>3</sup>An additional \$4.3 million represents the fixed-fee portion of this contract.

submarine was about 22 percent complete and all 10 hull sections were in various stages of construction.

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### **SSN-22 Contract Award Challenged**

On May 3, 1991, the Navy awarded Electric Boat a \$615-million (fiscal year 1987 dollars) fixed-price-incentive-fee contract to build the second Seawolf (SSN-22), which was challenged by Newport News Shipbuilding in the U.S. District Court. On July 31, 1991, the court overturned the contract award and ordered the Navy to submit a new bid solicitation for court approval, which was done on August 14, 1991. On September 6, 1991, the court delayed ruling on the Navy's proposed new bid solicitation and kept in effect all portions of prior court orders until all appeals by the Navy were concluded. The Navy, on September 6, 1991, appealed the court's July 31 and September 6, 1991, orders to the 4th U.S. Circuit Court of Appeals in Richmond, Virginia. The court heard the Navy's appeal on December 4, 1991, and on March 16, 1992, upheld the Navy's award of the contract to Electric Boat. According to a Navy program office official, since the court challenge was not resolved by the end of January 1992, the SSN-22's planned March 1997 delivery date will be delayed.

In late May 1991, the court allowed Electric Boat to perform preliminary planning and to order selected long-lead material and components for the SSN-22 but prohibited the shipyard from beginning construction of the submarine. On February 14, 1992, the Navy directed that work be stopped on selected SSN-22 and SSN-23 long-lead items ordered under the SSN-21 contract. Subsequently, that order was lifted for selected long-lead components.

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### **SSN-23 Contract**

In fiscal year 1991, Congress appropriated \$2.4 billion for construction of the third Seawolf (SSN-23) and for advanced procurement items for follow-on SSN-21s. Until the administration terminated the program, the Navy planned to issue a solicitation for construction of the SSN-23 in the second quarter of fiscal year 1992.

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### **Objectives, Scope, and Methodology**

The Chairman, Subcommittee on Projection Forces and Regional Defense, Senate Committee on Armed Forces; and the Chairman, Legislation and National Security Subcommittee, House Committee on Government Operations, asked us to (1) evaluate the SSN-21 class design status, (2) determine and evaluate the status of its major subsystem development efforts and the potential impact on the construction program, (3) assess

the cost, schedule, and performance status of the SSN-21 construction program, and (4) determine the potential effect budget reductions could have on the Navy's SSN force structure and what alternatives are being considered. A separate report<sup>4</sup> has been issued on the results of the fourth objective. In addition, a separate report<sup>5</sup> was also issued on the U.S. shipbuilding industrial base.

To accomplish our overall objectives, we reviewed and analyzed Navy and DOD documents, studies, assessments, and cost, schedule, and performance reports, and contractor cost reports. We also held discussions with Navy officials responsible for the SSN-21 class design, SSN-21 construction, and subsystems development in Washington, D.C., and at other locations discussed below.

To determine the SSN-21 class design status, we reviewed and analyzed contractor-developed documents and reports and held discussions with officials at Newport News Shipbuilding and Dry Dock Company, Newport News, Virginia; and General Dynamics' Electric Boat Division, Groton, Connecticut. We also discussed these matters with officials in the SSN-21 program office, Naval Sea Systems Command, Arlington, Virginia, and the Navy's Supervisor of Shipbuilding, Conversion, and Repair, Groton, Connecticut; and Newport News, Virginia.

To determine the status of the lead SSN-21 construction, we held discussions with officials from Electric Boat, the SSN-21 program office, and Supervisor of Shipbuilding, Conversion, and Repair, Groton, Connecticut. We selected a group of subsystems to review, based on discussions with the SSN-21 program office and shipyard officials. We also visited and discussed these systems with DOD and Navy officials, and the private business officials responsible for developing the AN/BSY-2 combat system, the propulsion system, the weapons stowage and handling system, torpedo tubes, torpedo ejection pumps, photonics mast periscope, and other subsystems. In addition, we obtained information on two weapon systems planned for use on the SSN-21—the Sea Lance Weapons System and the MK-48 advanced capability torpedo program.

To determine the status of the SSN-21 welding deficiencies, we held discussions with officials from the SSN-21 program office, Electric Boat and

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<sup>4</sup>Navy Ships: Alternatives For Sustaining SSN Force Levels (GAO/C-NSIAD-92-04, May 1992).

<sup>5</sup>Navy Shipbuilding: Effect of Reduced Submarine Procurement Rates on Industrial Base and Cost of SSN-21 Program (GAO/NSIAD-92-140, Apr. 1992).

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the Naval Inspector General's Office. We also reviewed and analyzed documents and reports from those offices.

Our review was conducted between February 1991 and March 1992 in accordance with generally accepted government auditing standards.

# SSN-21 Cost Increases

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SSN-21 class design<sup>1</sup> and lead submarine construction costs continue to increase. As of December 31, 1991, Newport News Shipbuilding estimated total design costs would more than double by the time the design is completed. On December 21, 1991, Electric Boat estimated total construction costs for the first SSN-21 will increase about 45 percent. Welding cracks discovered in the first SSN-21 contributed to the increased construction costs and caused a 1-year delay in the delivery of the submarine.

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## Design Costs Estimated to Double

On December 31, 1991, Newport News Shipbuilding estimated it would cost about \$655 million (current-year dollars) to design the SSN-21 class (see table 2.1), an increase of about \$352 million, or about 116 percent, over the original contract cost estimate.<sup>2</sup> The cost increase consists of about \$197 million for contract changes and \$154 million for cost growth. Included in Newport News Shipbuilding's revised estimate is Electric Boat's estimate of \$157.3 million (current-year dollars) to complete its design effort, which includes about \$109 million in cost growth over the cost of the original subcontract.<sup>3</sup>

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<sup>1</sup>In commenting on this report, DOD stated that the total estimated design cost for the SSN-21 class is about \$1.022 billion. In subsequent discussions with the SSN-21 program office, these costs are expressed in then-year dollars rather than current-year dollars as expressed in the report and are made up of about \$639 million for Newport News Shipbuilding, about \$162 million for Electric Boat, and \$221 for nuclear components.

<sup>2</sup>The April 1987 design contract was a \$303-million cost-plus-fixed-fee contract.

<sup>3</sup>Electric Boat was awarded a \$48.8-million cost-plus-fixed-fee SSN-21 design subcontract.

**Table 2.1: Newport News Shipbuilding's Estimated Cost to Complete SSN-21 Design Contract** (Current-year dollars)

| Dollars in thousands           |                                |
|--------------------------------|--------------------------------|
| <b>Contract quarter ending</b> | <b>Latest revised estimate</b> |
| March 1989                     | \$387,096                      |
| June 1989                      | 409,540                        |
| September 1989                 | 426,180                        |
| December 1989                  | 438,802                        |
| March 1990                     | 471,526                        |
| June 1990                      | 486,746                        |
| September 1990                 | 604,273                        |
| December 1990                  | 593,253                        |
| March 1991                     | 638,604                        |
| June 1991                      | 644,437                        |
| September 1991                 | 651,529                        |
| December 1991                  | 654,797                        |

According to DOD, the total \$351 million increase in design costs is due to original budget estimates that were established in 1983. These estimates were based on historical SSN-688 design cost information adjusted parametrically for differences between the SSN-688 and SSN-21. Subsequently, several factors contributed to the increased scope and cost of the SSN-21 class design, including the

- complexity of incorporating modular construction concepts into the new SSN-21 design,
- exclusion of production reviews from the budget,
- cost of two shipyards concurrently designing the SSN-21,
- cost of implementing advanced computer-aided design methods for modular construction, and
- cost of obtaining equipment to meet SSN-21 performance requirement.

A substantial portion of the \$351 million increase, about \$118 million, occurred between June 1990 and September 1990. According to the Navy, the design contract was changed in June 1990 to include an increase in the scope of work and additional staff hours. The changes resulted in a substantial increase in Newport News Shipbuilding's September 1990 estimated cost to complete the design. Under the cost-plus-fixed-fee contract provisions, the government pays for all allowable costs that Newport News Shipbuilding incurs in fulfilling the contract. In addition, Newport News Shipbuilding receives a negotiated fixed fee.

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Electric Boat's SSN-21 design director stated three reasons why its design subcontract's estimated cost has more than tripled:

- The contract has been underfunded by the Navy and Newport News Shipbuilding, which accounts for the largest portion of the cost growth.
- The actual design work was more expensive and developed slower than expected because of unanticipated difficulties in coordinating responsibilities, and obtaining information from Newport News Shipbuilding.
- The SSN-21 is the first U.S. submarine designed to be built in modules; therefore, preparation of drawings is more costly and requires more time to complete.

DOD, in commenting on this report, stated that the SSN-21 program office baselined the detail design contract on June 20, 1990, and consistently compares the latest revised contractor's estimate to the original contract. DOD further stated that comparisons in the report are not representative of the current contractual agreement with the lead design yard.

While we recognize that subsequent events often require that changes be made to contracts and related estimates, we believe that a comparison between current cost estimates with original cost estimates provides an insight into the events that are influencing the program and the trend of the program.

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## Construction Costs Estimated to Increase

SSN-21 construction costs have also increased (see table 2.2). By December 21, 1991, Electric Boat estimated total construction costs would total more than \$1 billion (then-year dollars), an increase of about \$321 million (or about 45 percent)<sup>4</sup> over the \$718 million (then-year dollars) contract target cost. The \$321 million increase includes<sup>5</sup> about \$144 million for direct labor, \$78 million for overhead costs, and \$99 million for materials. According to a SSN-21 program office official, the cost increase is primarily because Electric Boat's original target cost estimate did not totally reflect the SSN-21's construction costs. When the estimate was

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<sup>4</sup>The equivalent of about \$244 million in fiscal year 1987 dollars.

<sup>5</sup>Included in the \$321 million estimated cost increase is the \$68.3 million cost to correct construction and contractor-furnished equipment welding problems.

developed in 1988, SSN-21 cost estimates were based primarily on engineering estimates and historical cost data from Electric Boat's Trident<sup>6</sup> and SSN-688 submarine construction programs. As actual construction costs became available, however, it became clear that Electric Boat could not construct the SSN-21 as originally estimated.

**Table 2.2: Electric Boat's Estimated Cost to Complete SSN-21 Construction**  
 (Then-year dollars)

| Dollars in thousands           |                             |
|--------------------------------|-----------------------------|
| <b>Contract quarter ending</b> | <b>Estimate to complete</b> |
| June 1989                      | \$733,883                   |
| September 1989                 | 734,324                     |
| December 1989                  | 729,938                     |
| March 1990                     | 767,837                     |
| June 1990                      | 773,318                     |
| September 1990                 | 753,955                     |
| December 1990                  | 764,980                     |
| March 1991                     | 913,406                     |
| June 1991                      | 901,153                     |
| September 1991                 | 1,054,992                   |
| December 1991                  | 1,038,714                   |

According to an Electric Boat program official, cost increases are primarily due to SSN-21 construction schedule revisions, caused by late delivery of construction drawings. The largest quarterly cost estimate increase was about \$154 million—June 1991 to September 1991. This increase included \$61 million for direct labor, \$61 million for material, and about \$32 million for overhead. According to Electric Boat officials, the contract is experiencing cost increases largely because of late drawings, which has caused the SSN-21 construction schedule to be revised several times.

However, other factors have significantly contributed to contract cost increases. For example, the \$148 million estimated increase (between December 1990 and March 1991) was for an additional 2.4 million labor hours associated with SSN-21 construction. Of the 2.4 million hours, about 1.4 million was for (1) unanticipated costs associated with implementing the second phase of Electric Boat's manufacturing resource plan, (2) a

<sup>6</sup>Trident submarines are U.S. ballistic missile-firing submarines.

reassessment of trades labor during the SSN-22 estimating process, and (3) unanticipated review of specifications by its quality and engineering departments. The remaining 1 million hours was due to late delivery of design data to Electric Boat.

DOD commented that a lead ship historically encounters construction problems leading to schedule delays and cost increases. DOD further stated that termination of the SSN-21 program after the first ship will result in overhead at Electric Boat and its subcontractors being charged over fewer ships, and will likely result in higher costs for the lead SSN-21.

Contract provisions require the Navy and Electric Boat to share costs (in 1987 dollars) that exceed the target cost (\$718 million), up to the ceiling price (\$918 million—the maximum contract price the Navy will pay, including profit). For example, the contract has a two-step share ratio which specifies that the government will pay 80 percent and Electric Boat will pay 20 percent of costs (in 1987 dollars) above the contract's target cost, up to 130 percent of the target cost. Thereafter, the government and Electric Boat share costs based on a 50/50 ratio, up to the ceiling price. Electric Boat is to pay for all costs over the contract's ceiling price.

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## SSN-21 Welding Cracks

Cracks found in the HY-100<sup>7</sup> hull welds and subsequently in the HY-100 welds of many SSN-21 components increased the cost of the submarine by more than \$68.6 million (current-year dollars). Electric Boat's construction and contractor-furnished equipment portion of the cost increase is about \$68.3 million<sup>8</sup> and will delay the submarine's delivery by 1 year. The Navy's portion for government-furnished equipment will amount to about \$0.3 million. To correct the HY-100 welding problems and meet the May 1996 delivery date, Electric Boat estimated that, in selected critical path activities or items (such as the primary shield tank and the forward and aft reactor compartment bulkheads), it will need to work two or three shifts per day, 6 or 7 days per week, through May 1993. Although the cost and schedule impact on follow-on SSN-21s has not yet been determined, Electric Boat officials stated that the added cost for the SSN-22 will be significantly less because the SSN-22 construction contract had just been awarded when the welding problem occurred.

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<sup>7</sup>HY-100 steel is a high yield steel used in the construction of the SSN-21's pressure hull and selected components, allowing it to achieve deeper diving depths.

<sup>8</sup>Electric Boat's December 1991 settlement amounted to about \$58.8 million in 1987 dollars and is included in the December 1991 estimate to complete construction.

Construction of the lead submarine began in October 1989. In January 1990, Electric Boat notified the Navy that it had discovered cracks in the first welds (produced on the primary shield tank). The cracks, believed to be limited to welds created by the submerged arc welding process,<sup>9</sup> resulted from Electric Boat using a lower preheat temperature than authorized during initial construction welds, which caused hydrogen to remain entrapped in the metal. To correct these problems, the Navy and Electric Boat changed the welding procedures to include (1) placing additional controls to minimize moisture, (2) increasing the preheat temperatures, and (3) adding a post-weld soak<sup>10</sup> to prevent hydrogen damage. Because the gas metal arc welding process (the largest percentage of the welds were made using this process) does not use a flux material and thought less likely to cause hydrogen damage, those first welds were not examined at that time, even though the same welding wire was used.

Over the next 1-1/2 years, HY-100 welding tests continued to show that welds made in accordance with Navy specifications experienced hydrogen damage and were unacceptable. During this period, Electric Boat kept the Navy informed about their welding tests but incorrectly stated that the preheat temperatures had been increased for all welding processes. As a result, the Navy, believing the problem had been solved, did not take any formal corrective actions.

In June 1991, with construction approximately 15 percent completed, Electric Boat notified the Navy that it had discovered cracks in gas metal arc welds used to join two hull rings. This discovery resulted in the current weld replacement program. By July 1991, Electric Boat informed the Navy that the problem was more extensive than first estimated, and that the welding cracks also affected welds in at least 21 government- and contractor-furnished equipment (GFE/CFE) items/systems. In correspondence to the Navy, Electric Boat's engineering department concluded that the welding cracks were "...associated with the high strength levels of the weld deposit and that fabrication specification preheat levels are inadequate for the filler metal system when used at lower heat inputs."

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<sup>9</sup>Generally, three arc welding processes are being used to construct the SSN-21 and its components. These processes are (1) shielded, (2) gas metal, and (3) submerged.

<sup>10</sup>A post-weld soak is a heating process where the temperature of weld and the surrounding metal is maintained at a constant level for a set period of time.

Electric Boat recommended all hull welds be removed, the metal cleaned, and all joints rewelded.<sup>11</sup> For GFE/CFE components, where economically feasible, the material will be reused and where it is not, the component will be replaced. According to the SSN-21 program office, as the repair process continues, other affected components may be replaced. All welding of HY-100 steel was stopped in August 1991.

An analysis of the problem by a joint Electric Boat and Navy team determined that welding specifications, such as the minimum temperatures for preheating the HY-100 steel before welding, and the heat input allowed during welding were too low for the maximum carbon content specified for the welding wire. According to Navy and Electric Boat officials, both the welding procedures followed and the welding wire used were in accordance with Navy specifications. Some welding was resumed in September 1991, and all welding was resumed in December 1991.

DOD, in commenting on this report, stated that the HY-100 welding problem has been corrected. It stated that the resolution of the problem required (1) replacement of all HY-100 welds; (2) revision of welding procedures, weld material specifications, and fabrication specifications; and (3) institution of a weld product verification program. Finally, DOD stated that welding on the lead ship has resumed and is proceeding without difficulty.

The Navy also had a group of seven independent experts (in the area of welding, ship design, and fabrication) to individually review the circumstances and data that Navy collected related to the weld cracking. Written reports from each consultant were given to the Navy and generally agreed with Electric Boat's and the Navy's findings. The findings and recommendations will be the basis for future actions.

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## Naval Inspector General Report

In August 1991, the Assistant Secretary of the Navy for Research, Development and Acquisition asked the Office of the Naval Inspector General to investigate the cause of the welding problems and identify contributing factors in the decision-making process. A report was issued in November 1991.<sup>12</sup> The report showed, and the Navy and Electric Boat team found, that the logical and probable cause for the weld cracking was the

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<sup>11</sup>Within the SSN-21's hull, 8,451 weld joints were completed, using 180,000 pounds of weld wire.

<sup>12</sup>SSN-21 Welding Deficiencies, Department of the Navy's Office of the Naval Inspector General (Washington, D.C.: Nov. 1991).

combination of types of welding processes and materials used to produce the welds. Likewise, ineffective and untimely communications within the Navy was also a contributing factor. The report also faulted the Navy's Naval Sea Systems Command and Electric Boat in several areas, which included testing, welding, assumptions used to make decisions, and communications.

Specifically, the report identified the following factors as leading to the welding problems. Because HY-80 and HY-100 steels are almost the same, chemically, Navy officials originally assumed that the metals would behave similarly when welded. Early HY-100 weld tests, using the same welding wire used with HY-80 steel, tended to confirm these assumptions. Later, however, researchers in submarine design theory increased the strength of the HY-100 weld material to preclude failures at the weld, failing to consider the effect of these changes on the original assumptions. Subsequently, changes in military specifications, made in response to vendor and shipbuilder concerns, increased the possible use of inappropriate welding specifications and wire. Problems noted in production testing during the mid to late 1980s, an early warning of potential SSN-21 welding problems, went unnoticed because of the strength of the widely held assumption that HY-100 steel would behave like HY-80 steel and a shipbuilder's voluntary corrective action, caused cracking in the welds during construction. Finally, shortly after the start of SSN-21 construction, another early opportunity to avoid welding deficiencies was missed when cracking observed in January 1990 was incorrectly assumed to be related to the submerged arc welding process only. Corrective actions were limited to submerged arc welding.

In December 1991, responses to the Inspector General's report, the Commander, Naval Sea Systems Command and the SSN-21 program office stated that many of the proposed recommendations to correct the deficiencies were already being implemented. Specifically, a disciplined test and qualifications effort is being used to revalidate the materials and processes used for HY-100 welding. All of the welding processes have successfully completed the approved testing program. Additionally, using the results of the HY-100 test program as a basis, revisions were made to welding specifications to include new welding wire specifications (lower carbon content), and welding procedure cooling rates, a required post-soak of all welds to diffuse hydrogen, increased the testing of welds and imposed additional requirements for qualifying welders and inspectors. Statistical analyses are also required to ensure that an adequate

number of samples are used to determine the chemical makeup of the welding wire.

The Navy is developing a plan of action for the Assistant Secretary of the Navy's (Research, Development, and Acquisition) approval that responds to the problems noted in the Inspector General's report. Other actions also include a review group study by engineers from the Navy Strategic Systems Program Office. In April 1992, a draft of the study was submitted to the Office of the Commander, Naval Sea Systems Command for review.

Communications between the program office and other Naval Sea Systems Command offices were found to be sometimes ineffective and untimely. The SSN-21 program office recognized that this had been a problem in the past but was in the process of making the necessary corrections. For example, the program manager reported that the deputy program manager and department heads were directed to identify areas of actual or potential communication breakdowns and to provide appropriate recommendations for resolution of these problems. These managers agreed that several areas of communication needed improvement, including the need to operate in a more structured, institutional manner rather than on an issue-to-issue basis. They also found that the flow of information from and to the Naval Sea Systems Command technical support offices, such as finance and logistics, was untimely and often prevented the program office from receiving information in a timely and effective manner.

Communications between the program office and the Office of the Chief of Naval Operations were also found to be sometimes ineffective. Changes to this working relationship have been implemented and improvements noted. Finally, the program office agreed to formalize their written correspondence with contractors to avoid fiscal and legal implications if other problems should arise.

# Design and Construction Problems Will Delay SSN-21 Delivery

Even before discovery of the welding cracks, delivery of the SSN-21 in May 1995 was unlikely. The timely completion of required design data is critical to maintaining the SSN-21's modular construction schedule. However, the construction schedule was slipping because both Newport News Shipbuilding and Electric Boat were late in providing the required design data. As a result, the original construction schedule was revised several times and it appears that the submarine's delivery date would have slipped even without welding problems. However, according to the Navy, the imbalance between the design and construction efforts has been eliminated, primarily because of the 1-year delay caused by the welding problems.

## Slippage of Delivery Date Forecasted

In a March 1991 letter to the SSN-21 program manager, the Navy's Supervisor of Shipbuilding, Groton, wrote that "...the potential does exist that the [SSN-21's] scheduled delivery of May 1995 could slip." This assessment was based on Electric Boat not receiving design data in support of the SSN-21's construction schedules and the impact on construction if this trend continued, and the number of hours spent on construction being substantially less than required to support the schedule. In 1989, Electric Boat estimated that about 4 million hours would be spent on SSN-21 construction through March 1991, whereas only 2 million hours were actually spent. According to Supervisor of Shipbuilding Office officials, the primary reason for this difference was late delivery of design data.

## SSN-21 Design Behind Schedule

Although most design work (about 97 percent) was scheduled to be completed by November 1992, both Newport News Shipbuilding and Electric Boat, as of November 27, 1991, had collectively issued about 57 percent of all drawings<sup>1</sup> scheduled to be issued by that time. For example, Newport News Shipbuilding's cost performance reports showed that, since 1989, the design effort had continually been falling behind schedule. As of September 29, 1991, Newport News Shipbuilding's cost schedule report showed that about 7.8 million hours of design were scheduled for completion; however, only about 7.3 million hours had actually been accomplished.

<sup>1</sup>A total of more than 7,050 drawings will be needed to complete the SSN-21 class design, about twice the number originally planned. DOD, in commenting on this report, stated that the increase in the number of drawings resulted from a renumbering effort to streamline drawing preparation and continue to support modular construction. It stated that the effort to produce the configuration and construction drawings at Newport News Shipbuilding after the renumbering changed about one-half of 1 percent, from 2,607 thousand to 2,624 thousand manhours.

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According to Navy and Newport News Shipbuilding officials, the more than 500,000 hours that the SSN-21 class design was behind schedule was primarily due to the lack of early design information, which resulted in late delivery of construction design drawings.

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## Late Design Drawings

According to Electric Boat officials, the original SSN-21 construction schedule has been revised three times since 1989,<sup>2</sup> primarily because too many drawings were delivered late. Newport News Shipbuilding and Electric Boat, working under the revised March 1991 construction schedule, continued to issue drawings late. For example, they were scheduled to issue 4,444 drawings by November 27, 1991. At that time, however, they had issued 3,970 drawings (84 percent) or 474 less than needed to fully maintain the March 1991 construction schedule. In addition, they completed 60 other drawings ahead of schedule.

According to SSN-21 program office and Newport News Shipbuilding and Electric Boat design officials, considering that it takes from 9 months to 18 months from start to finish of a drawing, the drawing schedule is considered ambitious. Likewise, they stated that late design drawings were the result of the following:

- A \$75-million congressional reduction in design funding at the beginning of fiscal year 1991 resulted in reduced design staff, thus reduced drawing production.
- Electric Boat needed modular construction drawings earlier, with more detail than those issued to shipbuilders of prior submarine classes. (When drawing revisions are necessary, more time is required to incorporate revised data and issue them to Electric Boat.)

Newport News Shipbuilding's Vice President and its General Counsel stated that while there may have been some delay in its delivery of certain drawings, the principal cause was the drastic funding reduction at the beginning of fiscal year 1991. Also, they contend that Electric Boat has been consistently late in completing its drawings and has performed poorly, thereby contributing to this problem. An official from the Newport News Supervisor of Shipbuilding and Conversion office agreed with Newport News Shipbuilding's views on Electric Boat's performance and its effect on design cost increases and schedule slippage. However, this

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<sup>2</sup>In November 1991, the schedule was revised for a fourth time due to welding cracks.

official further stated that Electric Boat seemed to be working harder and faster to meet the design schedule.

Electric Boat disagreed that it has consistently issued drawings late and performed poorly, arguing instead that, from June 1989 through January 1991, it was generally on schedule. In February 1991, however, to meet the submarine's construction needs, it revised the sequence and accelerated the rate at which the drawings were to be issued. The Navy provided additional funding to Electric Boat and Newport News Shipbuilding to increase their design staffs.

In November 1991, SSN-21 program office officials stated that although Newport News Shipbuilding and Electric Boat delivered drawings late during 1990 and the first 6 months of 1991, the number of late deliveries has begun to decline in the last few months. The program officials believe that late drawings were caused by a fiscal year 1990 congressional funding reduction, and confusion between the two shipyards over the drawings' delivery schedule. DOD, in commenting on this report, stated that even though the current ship delivery date is May 1996, both design yards are working to deliver design products predicated on the May 1995 ship delivery date.

## Construction Behind Schedule

Before the welding cracks were discovered, by March 1991, the original SSN-21 construction schedule had been revised three times. Because each revision postponed and/or resequenced scheduled work, construction fell behind schedule. For example, Electric Boat estimated that about 4 million labor hours would be spent on SSN-21 construction through March 1991; however, only 2 million labor hours had been spent by that time. By June 29, 1991, construction was about 360,000 hours behind the March 1991 revised schedule. According to program office officials, the SSN-21's delivery date did not change, only the timing of interim events. Discovery of welding cracks, however, resulted in the revision of the original construction schedule a fourth time and delayed the SSN-21's delivery by 1 year, until May 1996. As of January 31, 1992, all 10 of the hull sections were under various stages of construction, and Electric Boat estimated that 22 percent of SSN-21 construction had been completed.

Construction of the various SSN-21 hull sections, subsections, and modules begins after receipt of design data. After receiving design data, Electric Boat prepares work packages (an estimated 98,000 work packages will be needed to build the SSN-21), each of which contains instructions for

performing specific construction work, and identifies the required materials and equipment needed to perform the work. The March 1991 revision of the construction schedule postponed and/or resequenced planned SSN-21 construction work, with the effect of increasing the number of work packages needed to be completed between June 1991 and the end of 1992 in order to stay on schedule. By the end of June 1991, Electric Boat had completed 5,197 (about 58 percent) of the 9,034 work packages scheduled for completion at that time. Delinquent work packages were usually the result of late or revised design drawings, according to an Electric Boat official. This official could not estimate the effect that late drawings might have had on the SSN-21's May 1995 delivery date. In addition, Electric Boat completed 1,673 work packages ahead of schedule because design data was available. We did not determine what effect completing work packages ahead of schedule might have had on the SSN-21's construction schedule because of the delay caused by the welding problems.

According to Electric Boat officials, its manufacturing resource planning control system does not allow construction work to begin until a completed work package is available. Although this control system may delay the start of some work, they believe that it helps eliminate unnecessary rework and inefficiencies experienced on lead ships of a class due to inaccurate or untimely design.

To minimize the effects of late work packages on SSN-21 construction, Electric Boat postponed and/or resequenced planned construction work. For example, Electric Boat has postponed and/or resequenced work on two auxiliary tanks and deck fabrication. We did not attempt to determine what effect, if any, delaying construction work on these components may have on the SSN-21's original delivery schedule because of the delay caused by the welding cracks.

SSN-21 program office officials stated that periodic SSN-21 schedule revisions are expected and are typical during concurrent design and construction of a new submarine class, given the unexpected events that are part of the process of building a new class of submarines. They also stated that revising the drawing issue schedule and resequencing construction work helps the designers and Electric Boat to complete work on a more realistic timetable.

# Potential Effects of Subsystem and Weapon System Development Problems on SSN-21

The SSN-21 will be equipped with new major subsystems that incorporate technological advances designed to provide increased ship quieting, a more capable combat system, greater weapons load, and the ability to launch larger weapons. Critical to the SSN-21 achieving full performance, these systems allow the Navy to aggressively seek out and destroy enemy submarines and surface ships across a broad spectrum of tactics and climates. Of the 11 subsystems we examined,<sup>1</sup> the AN/BSY-2 combat system program continues to have schedule problems and the photonics mast periscope will not be installed on the first three SSN-21s. In addition, two weapons systems—the MK-48 closed-cycle advanced capability torpedo propulsion system (CCAPS) and the Sea Lance weapons systems—will not be installed on the SSN-21 as planned. As a result, the SSN-21 will not have the weapons capabilities planned and may be less capable than was originally planned when it is delivered to the Navy.

## SSN-21 Will Not Be Equipped With a New Periscope

The Navy is developing a nonpenetrating fiber optic periscope called the photonics mast for SSN-21 class submarines. The new periscope would be mounted on the submarine's hull, but unlike existing periscopes that breach the hull, it will allow surface activity to be viewed through a fiber optic cable extended through the submarine's hull. The new periscope will be a part of the submarine's sail (exterior to the submarine's hull) and will be raised and lowered hydraulically, thus reducing noise emissions.

Due to developmental delays, the Navy canceled plans to install the periscope on the lead SSN-21 and the next two follow-on SSN-21 class submarines during construction. Plans are to backfit the new periscope on these SSN-21s at a later date. Although the first three SSN-21 class submarines would still meet their performance goals without the new periscope, SSN-21 class submarines equipped with the new periscope are expected to perform at higher levels.

## Late AN/BSY-2 Delivery

The SSN-21's AN/BSY-2 combat system is designed to detect, classify, track, and locate targets faster, allow operators to perform multiple tasks and address multiple targets concurrently, and ultimately reduce the time between detecting a threat and launching weapons.

<sup>1</sup>The atmosphere control system; the ship navigation system; ship service turbine generator; the nuclear reactor; photonics periscope; propulsor; weapons stowage and handling system; ship control system; ship's data distribution system; ship communications system; and the AN/BSY-2 combat system.

To meet the SSN-21's schedule and to reduce software development risks, General Electric will deliver the first AN/BSY-2 system in two phases. During the first phase, all hardware and most software is to be delivered to the Navy in November 1993. The Navy, in turn, will deliver the hardware and software to Electric Boat in May 1994 as government-furnished equipment. Delivery of the second-phase software to the Navy is scheduled for November 1994. First-phase schedule problems discussed below are not expected to effect the second-phase delivery date.

A fully tested first-phase AN/BSY-2, consisting of all hardware and 3.4 million lines (94 percent) of software is scheduled for delivery to the Navy between late March 1994 and June 1994, instead of late November 1993. According to a General Electric official, the schedule delay is due primarily to insufficient staffing during the early phase of system development, and delays in General Electric's completion of an AN/BSY-2 system critical design review. Delivery of the second phase (about 225,000 lines of software) to the Navy and the software's installation on the SSN-21 is scheduled for November 1994. Until installation is complete, the AN/BSY-2 system will not achieve full performance, and the SSN-21 will not be able to meet its total mission requirements.

Delivery of the AN/BSY-2's first-phase capabilities could be further delayed, even though General Electric and the Navy have taken measures to reduce development problems. According to the contractor's system engineering manager, the first system is expected to encounter problems during the hardware and software integration and test phase of the program. This phase, generally the most difficult, is performed every 3 years, and is scheduled for completion just prior to first-phase delivery. Should the AN/BSY-2 experience problems during test and integration, the contractor will have minimal time to fully resolve them. According to the AN/BSY-2 deputy program manager, General Electric's planning for system test and integration includes time that may be needed for regression testing and problem resolution. Although the delay in SSN-21 delivery due to welding cracks could provide more leeway to the AN/BSY-2 contractor, the Navy, and the shipbuilder, no adjustment has been made to the AN/BSY-2 program's schedules.

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## **Navy Cancels Torpedo Propulsion System**

The Navy planned to equip SSN-21s with the MK-48 CCAPS torpedo. CCAPS was to provide existing MK-48 torpedoes with propulsion system improvements. Once launched, the torpedo was to travel undetected, at slow speeds, toward the target ship or submarine until closing within a

certain distance, then accelerating so that the target would be unable to take evasive action or counterattack.

According to the Navy and DOD, a torpedo with capabilities similar to CCAPS design is critical to the SSN-21s' ability to avoid detection after firing a weapon. An early Navy operational assessment shows that the SSN-21's mission effectiveness depends greatly on the performance of a weapon like the MK-48 CCAPS. This was reaffirmed by two subsequent assessments.<sup>2</sup> However, due to technical problems, CCAPS could not achieve its noise level goals, and the Navy canceled the CCAPS program in September 1991.

According to SSN-21 program officials, the Navy had not reviewed options for alternative weapons until after the January 1991 technical risk assessment had been completed. In November 1991, the Assistant Secretary of the Navy for Research and Development and Acquisition directed that modifications be made to the existing MK-48 advanced capability torpedo's propulsion system to meet the SSN-21's needs. The Navy stated that the modified torpedo propulsion system would be available for the SSN-21's operational test and evaluation.

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## Navy Cancels Sea Lance Weapons System

In December 1989, the Navy canceled the Sea Lance antisubmarine warfare standoff weapon that was planned for use on SSN-21 class submarines, other SSNs, and selected surface ships. The SSN version of the Sea Lance consisted of a quick reaction, conventional antisubmarine warfare tactical weapon capable of attacking hostile submarines at long ranges. Although an SSN-21 class submarine will be able to detect and locate enemy submarines at long ranges, it will not have a weapon to use at those ranges. Therefore, SSN-21 class submarines will have to fire torpedoes at shorter ranges, increasing its vulnerability to detection and counterattack.

According to the Navy, the Sea Lance program was canceled because of projected cost increases. The Navy estimated that it would cost \$986.2 million to complete its development over a 7-year period. This was about a \$300-million increase in total development costs over the fiscal year 1990 estimates, and \$504 million over the approved program estimate. Several factors account for program cost increases, including the

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<sup>2</sup>A December 1990 Operational Test and Evaluation Force assessment stated that while the SSN-21 encompasses remarkable advances in many areas, the ability to accomplish its mission throughout its ship life is linked to the development of a quiet torpedo such as the CCAPS. A January 1991 DOD SSN-21 technical risk assessment stated that if CCAPS does not perform as planned and an alternative weapon is not available, the SSN-21's effectiveness will be seriously degraded.

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Navy's intention to extend the Sea Lance test program to reduce risks. Extending the test program would have increased the total program cost and out-year cost estimates. The Sea Lance program manager stated that the Navy has no plans to develop an alternative to the submarine variant of the Sea Lance weapon system.

# Conclusions

The SSN-21 program has experienced significant changes and problems, and its future is uncertain. The number of submarines planned to be bought through fiscal year 1999 has been reduced by about 60 percent and the unit cost continues to escalate. Funds have been appropriated for construction of the first three submarines. The first SSN-21 is under construction and is experiencing problems. A March 16, 1992, ruling by the 4th U.S. Circuit Court of Appeals, on Newport News Shipbuilding's challenge to the award of the second SSN-21 construction contract, upheld the Navy's award of that contract to Electric Boat. According to a Navy program official, the second submarine's construction schedule will be affected, since the legal challenge was not resolved by January 1992. However, the administration's plan to terminate the program could make issues related to construction of the second and third SSN-21s academic.

The discovery of cracks in the first submarine's construction welds has added to the construction cost and schedule problems. Prior to the June 1991 discovery of the welding problem, the SSN-21's original construction schedule had been revised three times, primarily because of late delivery of required design data. In November 1991, the schedule was revised a fourth time due to the welding problems. At that time, the design and construction costs were estimated to increase 116 percent and 45 percent, respectively, and the submarine's delivery had been delayed for one year, until May 1996.

To correct the welding problems, in some cases, the old welds will be removed from the hull sections and components, and the parts cleaned and rewelded. In other cases, components will be replaced. The Navy, Electric Boat, and seven Navy consultants have determined its cause and recommended corrective actions, which are being instituted. Correcting this problem will increase the SSN-21's construction costs by more than \$68.6 million.

Before Electric Boat delivers the SSN-21 in May 1996, substantial design and construction work still must be completed. Also, it is too soon to predict whether all problems have been identified. However, based on prior submarine design and lead ship construction experiences, additional problems are likely to surface. Additionally, the SSN-21's performance capability may be further affected by the cancellation of the development of two weapons systems planned for use on SSN-21s. Although an alternative program for one weapon system is planned, it will not provide the capabilities planned in the canceled weapon system.

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Although the Bush administration plans to terminate the SSN-21 program after the first submarine and has submitted two rescission proposals for funds appropriated for construction of follow-on SSN-21s, the planned rescission still must go through the legislative review process and be accepted by the Congress. The affects that the termination of this program will have on the submarine shipbuilding industrial base may influence the Congress' consideration of the administration's plans to limit the SSN-21 program to construction of one submarine. Should the Navy be allowed to construct more than one SSN-21 class submarine, we believe it would be prudent for the Congress to defer authorizing construction of the follow-on submarines until the design has stabilized.

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## Recommendation

If the Congress decides not to approve the administration's request to rescind funds appropriated for construction of follow-on SSN-21s, we recommend that the Secretary of Defense direct the Secretary of the Navy to provide the Congress an assessment of the effect that problems in the lead ship design and construction and in subsystem and weapons system development will have on the cost, schedule, and performance of the follow-on SSN-21(s).

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## Matters for Congressional Consideration

If the Congress decides to continue with more than one SSN-21 class submarine, they may wish to consider restricting the use of funds already appropriated for the second and third submarines. Further, they may wish to delay funding additional submarines until the design has stabilized and planned modifications to the MK-48 advanced capability torpedo's propulsion system and the AN/BSY-2 combat system development efforts have matured.

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## Agency Comments

DOD generally agreed with our findings on the status of the SSN-21 design and lead ship construction program and provided additional comments, which we have incorporated throughout the report (see app. I).

DOD disagreed with our recommendation that the Congress be provided an assessment of the effect that problems in the lead ship design and construction and those in subsystem and weapon system development will have on the cost, schedule, and performance of follow-on SSN-21 class submarines. It also partially concurred with our matters for congressional consideration that the use of funds appropriated for construction of the third SSN-21 class submarine be restricted and funding of additional SSN-21

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class submarines be delayed until the design has stabilized and planned weapon system modifications and combat system development efforts have matured. In both instances, DOD's position is based on the Secretary of Defense's decision to build only one ship, and the intention to submit a rescission request for funds for the second and third ships.

Our recommendation and matters for congressional consideration are both contingent upon the construction of more than one SSN-21. On March 20, 1992, President Bush submitted to the Congress two rescission proposals totaling more than \$2.9 billion. These proposals relate to funds appropriated for the construction of the second and follow-on SSN-21s. However, if the Congress has not approved the rescission proposals within 45 days of continuous congressional session, the President must release the funds for the purposes appropriated. If the rescission proposals are not approved, we believe that an assessment of the potential effects problems in the SSN-21's design and construction could have on follow-on SSN-21 class submarines is needed. This assessment should be considered before the Navy authorizes SSN-22 construction and awards a contract for construction of SSN-23, and before the Congress considers funding further requests for follow-on SSN-21 class submarines.

# Comments From the Department of Defense

Note: GAO comments supplementing those in the report text appear at the end of this appendix.



## OFFICE OF THE UNDER SECRETARY OF DEFENSE

WASHINGTON, DC 20301-3000

7 MAR 1992

Mr. Frank Conahan  
 Assistant Comptroller General  
 National Security and International  
 Affairs Division  
 U.S. General Accounting Office  
 Washington, DC 20548

Dear Mr. Conahan:

This is the Department of Defense (DoD) response to the General Accounting Office (GAO) Draft Report, "NAVY SHIPS: STATUS OF SSN-21 DESIGN AND LEAD SHIP CONSTRUCTION PROGRAM," dated December 24, 1991 (GAO Code 394423/ OSD Case 8858-AX). The Department either concurs or partially concurs (with some specific exceptions) with all of the findings and non-concurs with the recommendation and the matter for Congressional consideration.

The report was written in the late 1990 timeframe, when the program envisioned by the DOD consisted of the acquisition of 12 submarines. While the report focuses on the lead ship construction program, the findings and recommendations were made in the context of a 12-submarine program acquisition plan. Since that time, based on the unprecedented change in the threat and on affordability concerns, the Secretary of Defense announced that only one ship will be built and is requesting a rescission of funds authorized in FY 1991 and FY 1992 for the second and third ships. The DoD understands that, until the rescission is approved by Congress, the GAO considers the program to consist of at least the first three ships. In any case, the program has changed significantly since the report was originally written and both the GAO findings and the DOD responses must be viewed in the context of a much reduced program.

The report findings address cost increases in the design and construction contracts. The Department concurs with those findings and offers additional comments in explanation of the cost increases, including the welding problem. The report also indicates that the design and construction are behind schedule. The Department partially concurs on that issue and offers specific comments in explanation--for example: the number of drawings has doubled, but that only represents a renumbering effort, not an increase in the volume of drawings or in the expected work. The DoD also illuminates the effect that the

See GAO comment.

**Appendix I**  
**Comments From the Department of Defense**

welding problem has had on the schedule. Finally, the report discusses the potential effect of the termination or delay of some subsystems, which the DOD addresses each in turn.

It continues to be the DOD position that management and oversight of the design and construction of the SSN-21 are sound and that the ship will meet the goals and thresholds. Therefore, the Department does not concur with the recommendations.

The detailed Department comments on the findings and recommendations are provided in the enclosure. The Department appreciates the opportunity to comment on the draft report.

Sincerely,

*C. Joseph Martin*  
For Frank Kendall  
Director  
Tactical Warfare Programs

Enclosure

GAO DRAFT REPORT - DATED DECEMBER 24, 1991  
(GAO CODE 394423) OSD CASE 8858-AX

"NAVY SHIPS: STATUS OF SSN-21 DESIGN AND LEAD SHIP  
CONSTRUCTION PROGRAM"

FINDINGS, RECOMMENDATION, AND MATTER FOR CONGRESSIONAL  
CONSIDERATION TO BE ADDRESSED IN THE DOD RESPONSE  
TO THE GAO DRAFT REPORT

\* \* \* \* \*

FINDINGS

**FINDING A: The Changing Submarine Threat.** The GAO reported that the Soviet submarine force is projected to maintain its numerical advantage through at least the year 2010 and is viewed by the Navy as its most capable potential foe. The GAO also reported that DOD threat assessments conclude that, in the years ahead, direct conflict between the U.S. and the Soviet Union would be very unlikely, and that regional conflicts involving other nations have a greater potential for U.S. involvement--although, currently, the submarines of those nations present only a limited threat to the Navy surface force. The GAO noted, however, that as those nations acquire submarines and related technologies from the former Soviet Union and various western countries, they will present a greater threat to U.S. naval forces. (pp. 16-27/GAO Draft Report)

**DoD Response:** Concur.

**FINDING B: Design Costs Estimated To Double.** The GAO reported that SSN-21 class design and lead submarine construction costs continue to increase. The GAO observed that total design costs are expected to more than double by the time the design is completed.

The GAO reported that, on June 30, 1991, Newport News estimated it would cost about \$644 million (current-year dollars) to design the SSN-21, an increase of \$341 million--\$195 million for contract changes and \$146 million for cost growth. The GAO reported that the Electric Boat design director attributed the estimated tripling of its design subcontract to (1) underfunding of the contract by the Navy, (2) unanticipated difficulties

Now on p. 12.

in coordinating responsibilities and obtaining information from Newport News Shipbuilding, and (3) the modular design of the submarine, making the preparation of the drawings more costly and time consuming.

The GAO reported that the SSN-21 program office attributes the \$341 million increase in design costs to:

- an original budget estimate that was based largely on historical SSN-688 design information;
- the unanticipated complexity of incorporating modular construction concepts into the new SSN-21 design;
- the cost of two shipyards concurrently designing the SSN-21;
- the cost of implementing advanced computer-aided design methods for modular construction; and
- the cost of obtaining equipment to meet the SSN-21 performance requirement.

The GAO found that \$118 million of the \$341 million increase in the estimated cost to complete design occurred between June 1990 and September 1990, and resulted from negotiated work changes between Newport News Shipbuilding and the Navy. (pp. 28-31/GAO Draft Report)

**DoD Response:** Concur. The original baseline for the SEAWOLF detail design contract at \$330M was consistent with the design budget established at the outset of the SEAWOLF program in 1983. That budget was based on the costs of designing the SSN 688 class of ships adjusted parametrically for differences between SSN 688 and SSN-21. In the intervening 8 years, a number of factors have increased both the scope and cost of the SSN-21 class design effort and include the following:

- modular design complexity not factored in original budget;
- extensive producibility reviews not included in the budget base;
- qualification costs for new components not included in the budget base;
- design integration costs higher for two company SEAWOLF design than for single company 688 class design; and

Now on pp. 18-20.

- training, qualification, and retention of computer aided design workforce, as well as revision of design procedures, required a longer startup period than planned.

The total estimated design cost for the SSN-21 is approximately \$1.02 billion. The GAO report discusses the detailed design contract cost at the Lead Design Yard, for which the Program Manager provides an estimate at completion of \$601 million. The remainder of the costs are associated with the contract for the design of the power plant (at \$221 million), fees for both contracts, design support for the ship in the 1995-1997 time period (which would have been assumed by follow-on ships now not planned, some engineering development components (prototypes) and construction support recently identified, NAVSEA start-up sunk costs of \$11 million and anticipated labor rate increase at the Lead Design Yard due to overhead increase (\$15 million).

The report does not adequately reflect the fact that the SEAWOLF Program Manager rebaselined the detail design contract on June 20, 1990, and also consistently compares the latest revised contractor's estimate to the original basic contract. Such comparisons are not representative of the current contractual agreement with the lead design yard.

**FINDING C: Construction Costs Estimated To Increase.**

The GAO reported that SSN-21 class design and lead submarine construction costs continue to increase. The GAO observed that construction costs for the first SSN-21 are expected to increase about 25 percent.

The GAO reported that a Supervisor of Shipbuilding (Groton) official attributed the estimated cost increases to the original Electric Boat target cost not reflecting total SSN-21 construction costs. The GAO explained that, as the actual construction costs were developed, it became clear that Electric Boat could not construct the SSN-21 for the original estimate, which had been based on historical data from the Electric Boat Trident and SSN-688 submarine construction programs. The GAO reported that Electric Boat officials attributed the cost increases primarily to SSN-21 construction schedule revisions caused by late delivery of construction drawings.

The GAO observed, however, that other factors contributed significantly to contract cost increases, including about 1.4 million of the 2.4 million in increased contract labor hours associated with SSN-21 construction. The GAO noted that the increase in labor hours was attributed to (1) unanticipated costs related to implementing the

second phase of the Electric Boat manufacturing resource plan, (2) a reassessment of trades labor during the SSN-22 estimating process, and (3) an unanticipated review of specifications by Electric Boat quality and engineering departments. The GAO found that the remaining one million hours is due to two revisions to the SSN-21 construction schedule, new construction activities, and the Electric Boat desire to resequence construction events. (pp. 32-35/GAO Draft Report)

**DoD Response:** Concur. At the time the report was written, the SEAWOLF SSN-21 was intended to be the lead ship of a new class of attack submarines. Lead ships historically encounter problems in construction, similar to those described by the GAO--which, in turn, lead to schedule delays and cost increases. The FY 1993 budget submission for the Department of Defense reflects a decision to terminate SEAWOLF construction with the lead ship. That will result in overhead at Electric Boat and its subcontractors being charged across fewer platforms, and will likely result in higher costs for the SSN-21.

**FINDING D: SSN Welding Cracks.** The GAO reported that the discovery of welding cracks in the first SSN-21 are estimated to further increase construction costs and delay delivery of the lead submarine. The GAO found that cracks found in the hull welds and some metal fabrication welds will increase SSN-21 construction costs by more than \$77 million (current-year dollars) above the Electric Boat June 30, 1991, estimated \$183 million cost increase. The GAO noted that Electric Boat estimates that it will need to work two or three shifts, 6 days per week, through May 1993, to resolve the welding problem.

The GAO reported that an analysis of the problem by a joint Electric Boat and Navy team determined the weld cracks were caused by welding procedures and the carbon content of the welding wire, both of which were in accordance with Navy specifications. The GAO noted that the Navy and Electric Boat are continuing to evaluate the impact of the welding problem. The GAO explained that the problems should not affect the delivery of future SSN-21s, but more stringent welding procedures and wire specifications will increase the cost of each follow-on SSN-21 class submarine by about \$10 million. (pp. 35-37/GAO Draft Report)

**DoD Response:** Partially concur. The HY-100 welding problem has been corrected. The resolution of the problem required the replacement of all the HY-100 welds; revision of welding procedures, weld material specifications, and fabrication specifications; and institution of a weld product verification program. Welding on the lead ship has resumed and is proceeding

Now on pp. 20-22.

Now on pp. 22-24.

without difficulty.

**FINDING E: SSN-21 Design Behind Schedule.** The GAO reported that, even before the discovery of the welding cracks, the SSN-21 May 1995 delivery date was not likely to be met. The GAO reported that the submarine design was behind schedule because neither Newport News Shipbuilding nor Electric Boat provided adequate design data in support of the SSN-21 construction schedule. The GAO noted that, as a result, the construction schedule has been revised several times and it appears that the submarine delivery date may have slipped even without the welding problems.

The GAO reported that the potential for slipping the delivery date exists because Electric Boat had not received design data in support of the SSN-21 construction schedules. The GAO noted that the lack of design data resulted in only two million labor hours actually being spent on construction through March 1991 --instead of the four million estimated.

The GAO found that, as of May 1991, both Newport News Shipbuilding and Electric Boat, collectively, had issued less than half of all drawings scheduled to be issued by that time. The GAO explained that, according to Navy and Newport News Shipbuilding officials, the more than 500,000 hours that the SSN-21 class design is behind schedule primarily is due to the lack of early design information, drawing schedule revisions, and late design drawings. The GAO also found that, since 1989, the total number of original drawings to be issued by November 1992 has increased from 3,000 to 6,760. The GAO noted that, since it takes from 9 to 18 months to finish a drawing, the increase is significant. (pp. 38-45/GAO Draft Report)

**DoD Response:** Partially concur. The design effort is supporting the current lead ship construction schedule (revision E). The scheduled ship delivery date is May 1996. The construction schedule in effect at the time of the HY-100 problem was the third revision or revision D (revision A was the original lead ship construction schedule). Although the shipbuilder created a fourth revision to the design schedule as part of formulating revision E, the SEAWOLF Program Manager elected to maintain the design effort to the previous construction schedule, revision D. The action was taken to maintain the manning and cost profiles that were in place to ensure schedule margin for the delivery of design products. The SEAWOLF Program Manager continues to hold both design yards accountable for maintaining delivery of the design products to support revision D. Even though the current ship delivery date is May 1996, both design

Now on pp. 27-29.

yards are working to deliver design products predicated on the May 1995 delivery date.

The assertion that the volume of SEAWOLF drawings doubled since 1989 is incorrect. During the period from July 1990 until April 1991, four initiatives were approved by the SEAWOLF Program Manager to streamline drawing preparation and continue to provide the shipbuilder design information that supported modular construction. Several of those efforts resulted in a renumbering which appears to be an increase in the numbers of drawings; however, the number of manhours of effort required to produce the Configuration Drawings and Ship Construction Drawings at Newport News went from 2607 thousand in December 1990 (before the renumbering) to 2624 thousand manhours in August 1991 (after the renumbering) representing a change of about a half of a percent.

**FINDING F: SSN-21 Construction Behind Schedule.** The GAO reported that, even before the discovery of the welding cracks, the SSN-21 May 1995 delivery date was not likely to be met. The GAO found that the SSN-21 construction schedule had been revised three times since 1989, primarily because too many drawings were delivered late. The GAO explained that late design drawings were the result of (1) a \$75 million congressional reduction in design funding at the beginning of FY 1991, reducing design staff and drawing production, and (2) Electric Boat needing modular construction drawings earlier with more detail than those issued to shipbuilders of prior submarine classes. The GAO noted that a Newport News Shipbuilding and Conversion official agreed with the Newport News Shipbuilding view that Electric Boat has been late consistently in completing its drawings and has performed poorly, thereby contributing to the problem. The GAO observed that Electric Boat has reduced the number of late drawings and expects to continue to improve in this area.

The GAO reported that the SSN-21 construction schedule was revised for the third time in March 1991, and with each revision postponed and/or resequenced work schedule, construction has fallen behind schedule. The GAO noted that the discovery of the welding cracks led to the revision of the construction schedule for a fifth time, and delayed the SSN-21 delivery by a year--until May 1996.

The GAO concluded that the reduced threat and the time needed to correct the welding problem offer the Navy the opportunity to (1) restructure the SSN-21 program, (2) bring the design and construction of the SSN-21 into proper balance, and (3) allow subsystem and alternative weapon system development efforts to mature to the point

Now on pp. 29-30 and 35-36.

that they support the SSN-21 program. The GAO further concluded that, given the uncertainties, it may be premature to buy additional SSN-21s. (pp. 45-47 and 56-58/GAO Draft Report)

**DoD Response:** Partially concur. Prior to the discovery of the HY-100 welding problems, the construction schedule had been revised only three times vice the four times reported in the report. As noted in the DOD response to Finding E, the SEAWOLF Program Manager elected to maintain the design effort to the previous construction schedule (Revision D) to ensure schedule margin for the delivery of design products. The expected delivery date remains May 1996. The FY 1993 Budget submission for the Department of Defense reflects a decision to terminate SEAWOLF construction after completion of the SSN-21. That move was made in light of the significant reduction in the threat occasioned by the collapse of the Soviet Union.

**FINDING G: Potential Effects of Subsystem and Weapon System Development Problems on the SSN-21.** The GAO reported that, due to developmental delays, the Navy has cancelled plans to install on the SSN-21 and the next two follow-on SSN-21 class submarines a nonpenetrating fiber optic periscope, called the photonics mast, which the Navy is developing for the SSN-21 class submarines.

The GAO reported that a fully tested first-phase AN/BSY-2, consisting of all hardware and 3.4 million lines of software is scheduled for delivery to the Navy in early April 1994, instead of late November 1993 - which is only two months before the Navy is required to deliver the system to Electric Boat. The GAO found that, until installation is complete, the AN/BSY-2 system will not achieve full performance, and the SSN-21 will not be able to meet its total mission requirement. The GAO also found that the delivery of the AN/BSY-2 first-phase capabilities could be delayed beyond April 1994, even though General Electric and the Navy have taken measures to mitigate development problems. The GAO noted that, although the delay in SSN-21 delivery due to welding cracks could provide more leeway to the AN/BSY-2 contractor, the Navy, and the shipbuilder, no adjustment has been made to the AN/BSY-2 program schedules.

The GAO also reported that in September 1991, the Navy cancelled plans to equip the SSN-21 with the MK-48 Closed Cycle Advanced Capability Torpedo Propulsion System due to technical problems. The GAO noted that, in November 1991, the Secretary of the Navy announced plans to modify the existing Mk-48 advanced capability torpedo propulsion system to meet the SSN-21 needs. The GAO noted, however, that it is not expected to achieve the noise reduction

levels that were required for the Closed Cycle Advanced Capability Torpedo Propulsion System.

The GAO also reported that, in December 1989, the Navy cancelled the Sea Lance antisubmarine warfare standoff weapon, which was planned for use on the SSN-21 class submarines, other SSNs, and selected surface ships. The GAO noted that, as a result, the SSN-21 class submarines will have to fire torpedoes at shorter ranges, increasing their vulnerability to detection and counterattack.

The GAO concluded that, based on prior submarine design and lead ship construction experiences, additional problems are likely to surface. The GAO also concluded that the performance capability of the SSN-21 may be further affected by the cancellation of the development of two weapon systems planned for use on the SSN-21 class submarines. (pp. 48-55/GAO Draft Report)

Now on pp. 31-34.

**DoD Response:** Partially concur. Cancellation of the Closed Cycle Advanced Capability Propulsion System weapon system may result in degraded SSN-21 performance from that projected in the Early Operational Assessment report of April 20, 1990. However, new software for acoustic processing (software version 8.5 or newer) for the MK-48 Advanced Capability torpedo have been made since the assessment. Performance using the improved MK-48 Advanced Capability Torpedo in lieu of the Closed Cycle Advanced Propulsion System may not be as good as the Early Operational Assessment projected. Results of a Navy study (using the MK-48 Advanced Capability torpedo as the only anti-submarine warfare weapon) to determine threshold values for the Test and Evaluation Master Plan are not yet available.

Survivability of the SSN-21 may be degraded from that projected in the Early Operational Assessment report of April 20, 1990. The Closed Cycle Advanced Propulsion System was to be a quiet running torpedo that would have reduced significantly target alertment to being attacked. The Navy plans to modify the existing MK-48 Advanced Capability torpedo propulsion system, but the modifications are not expected to achieve the quietness goals specified for the Closed Cycle Advanced Propulsion System torpedo. The SSN-21 survivability may not be as good as projected in the Early Operational Assessment, but a quiet Advanced Capability Propulsion System would provide a significant improvement over existing survivability.

Cancellation of the SEA LANCE weapons system may result in degraded SSN-21 performance from that projected in the Early Operational Assessment report of April 20, 1990. The assessment showed the SEA LANCE primarily enhanced

performance during reengagement following an initial Closed Cycle Capability Advanced Propulsion System torpedo attack that failed.

A subsequent report, the Anti-Submarine Warfare Standoff Weapon Study, was submitted to Congress by Assistant Secretary of the Navy (Research, Development, and Acquisition) in August 1991. The study showed that employment of SEA LANCE would not produce a significant gain in initial attack operational effectiveness because of the inability of current or projected sensors to detect and localize a target at longer ranges.

The GAO discussion provided no information on delays in delivery of AN/BSY-2 software and hardware that had not been included in previous reports.

While the fiber optic periscope will not be installed on the SSN-21 during new construction, current plans call for it to be backfitted onto SSN-21 later.

\* \* \* \* \*

#### RECOMMENDATION

**RECOMMENDATION 1:** The GAO recommended that the Secretary of Defense direct the Secretary of the Navy provide the Congress an assessment of the extent that problems in the lead ship design and construction, and in subsystem and weapon system development, affect the cost, schedule, and performance of follow-on SSN-21 class submarines. (p. 58/GAO Draft Report)

**DoD Response:** Nonconcur. The Secretary of Defense has decided to build only one ship and intends to submit a rescission request for funds for the second and third ships. Accordingly, an additional report to Congress related to follow-on SSN-21 class submarines is not necessary.

#### MATTER FOR CONGRESSIONAL CONSIDERATION

**SUGGESTION 1:** The GAO suggested that the Congress consider restricting the use of funds appropriated for construction of the third SSN-21 class submarine and delay funding additional SSN-21 class submarines until the Secretary of Defense provides the Congress with an assessment of the extent to which problems in the lead ship design and construction, and in subsystem and weapon system development affect the cost, schedule, and performance of follow-on SSN-21 class submarines.

Now on p. 36.

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**Appendix I**  
**Comments From the Department of Defense**

Now on p. 36.

(p. 59/GAO Draft Report)

**DoD Response:** Partially concur. As indicated above, the Secretary of Defense has decided to build only one ship and intends to submit a rescission request for funds for the second and third ships.

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**Appendix I**  
**Comments From the Department of Defense**

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The following is GAO's comment on DOD's letter dated March 27, 1992.

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**GAO Comment**

This report was drafted in late 1991 and informal comments were obtained from the DOD on February 13, 1992.

# Official Response From the Department of Defense



OFFICE OF THE UNDER SECRETARY OF DEFENSE

WASHINGTON, DC 20301-3000

03 SEP 1992

ACQUISITION

Mr. Frank C. Conahan  
Assistant Comptroller General  
National Security and International Affairs Division  
U.S. General Accounting Office  
Washington, D.C. 20548

Dear Mr. Conahan:

This is the Department of Defense (DoD) response to the General Accounting Office (GAO) final report GAO/C-NSIAD-92-11, entitled--"NAVY SHIPS: Status of SSN-21 Design and Lead Ship Construction Program," dated June 4, 1992 (GAO Code 394423/OSD Case 8858-AX). The Department concurs and/or partially concurs (with some specific exceptions) with all of the findings, and non-concurs with the recommendation and the matter for Congressional consideration.

The GAO report addresses the status of the SSN-21 construction program and reviews several problem areas encountered during design and early fabrication and the implications of related program cancellations. As stated in the previous comments on the draft report, the DoD concurs in general with the GAO assessment of the submarine threat and SSN-21 design and construction cost estimates. The DoD only partially concurs, however, with the GAO findings on SSN-21 welding cracks, SSN-21 design and construction schedules, and the effects of subsystem and weapon system development problems on SSN-21 performance.

The program has changed significantly since audit work underlying the report, and both the GAO findings and the prior DoD response must be viewed in the context of a much reduced program. Concerning the recommendation, a reporting process already is in place to facilitate cost and schedule monitoring for submarine construction. As for the matter for Congressional consideration, the utility of a restriction on funds, which would create further program delays and cost growth, is questionable.

The management and oversight of the design and construction of the SSN-21 are sound, and while difficulties have been encountered, no external influence is required to facilitate improvement to the management, processes, or controls directed to the successful completion of SSN-21/22 construction. Therefore, the DoD does not concur with the recommendation or the matter for Congressional consideration.

Frank Kendall  
Director, Tactical Systems

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# Major Contributors to This Report

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