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Report to the Secretary of Defense

April 1998

NEW ATTACK SUBMARINE

More Knowledge Needed to Understand Impact of Design Changes

GAO/NSIAD-98-38

GAO

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

National Security and
International Affairs Division

B-277780

April 30, 1998

The Honorable William S. Cohen
The Secretary of Defense

Dear Mr. Secretary:

The Navy plans to spend $64 billion to acquire 30 New Attack Submarines (NSSN) over the next 18 years. According to the Navy, these purchases will allow it to maintain its force structure goals and the current submarine industrial base. As part of our efforts to assist in the oversight of major weapon systems acquisition programs, we reviewed (1) the status of the NSSN development program, (2) current information on the antisubmarine warfare threat, and (3) the Navy's plans to model the NSSN's survivability. We are providing the results of our review for your use in oversight of the NSSN program.

Background

The NSSN program is intended to address the Joint Chiefs of Staff requirement for 10 to 12 new attack submarines with Seawolf level quieting by the year 2012 and to maintain future force structure goals. In funding the NSSN program, Congress expected the Navy to deliver a less costly submarine than its predecessor, the Seawolf, without compromising military utility. The NSSN is expected to be a highly effective multimission platform capable of performing antisubmarine and antisurface ship missions and land attack strikes as well as mine missions, special operations, battle group support, and surveillance. The NSSN is also expected to be as quiet as the Seawolf, include a vertical launch system, and have improved surveillance as well as special operations characteristics to enhance littoral warfare capability. While the NSSN is expected to perform effectively against the most capable, open ocean, nuclear attack submarine threat, it will be slower and less capable in diving depth and arctic operations and will carry fewer weapons than the Seawolf.

The Navy's fiscal year 1999 budget request contained about $1.5 billion for procurement of the second NSSN and $504.7 million for advanced procurement of the third authorized NSSN. The Navy also requested about $219 million for continued research and development activities. Public Law 105-56[1] appropriated funds and Public Law 105-85[2] provided

[1]The Department of Defense Appropriations Act, 1998.

[2]The National Defense Authorization Act for Fiscal Year 1998.

authorization for the contractor teaming arrangement to build the first four new attack submarines. The Navy has established performance levels to ensure that the NSSN will have the capabilities to successfully conduct its missions. Operational requirements documents are required for the ship and its major subsystems. These documents establish the optimal (objective) and minimal (threshold) requirements related to the submarine's performance. For the most part, according to the NSSN program manager, the NSSN is being designed to meet a cost-effective balance at a performance level that meets or exceeds minimum requirements. The Navy is also establishing detailed technical specifications for the design of individual subsystems.

To gain assurance that the designs of the submarine and its subsystems will result in the submarine successfully performing its various missions, the Navy requires that the Program Manager use computer simulations as a principal tool to model the NSSN's capabilities against existing and potential threats. An example is the modeling performed for the June 1995 NSSN milestone II cost and operational effectiveness analysis. Based on the results, both the Department of Defense (DOD) and the Navy believe the baseline NSSN design satisfies military requirements. The Navy also seeks assurance by requiring that weapon systems be tested and evaluated in their anticipated operational environment and against the anticipated threat. This mission is performed by the Operational Test and Evaluation Force, which was established by the Secretary of the Navy to be the Navy's sole independent agency for these activities.

Results in Brief

Since modeling the NSSN survivability in 1995, the Navy, because of technical and funding limitations, has modified the design for some subsystems that reduce performance below the optimal levels used to model the 1995 baseline design. Other systems also have developmental problems. At the same time, Navy threat assessments have reported that the open ocean, antisubmarine warfare threat has improved, resulting in a more capable threat than previously projected.

The Navy tester's 1997 assessment report concluded that the NSSN could potentially be operationally effective and suitable, but noted a number of significant changes and risks in the development program. The report also noted several technological advances in the open ocean antisubmarine warfare threat. In addition, the report stated that budgetary pressures resulted in trade offs in some of the performance modeled in the NSSN

milestone II cost and operational effectiveness analysis and the tester's 1995 early operational assessment.

As of November 1997, the Navy program manager planned no additional survivability modeling to test the NSSN with its potential for reduced performance against the improved threat. However, as a result of its 1997 assessment, the Navy tester recommended that the Navy develop a new modeling baseline that reflects the reduced performance of some subsystems and that this new design baseline be evaluated against the increased threat. Without such modeling, DOD and Navy program officials appear to have little basis for their confidence that the currently designed submarine will perform as expected.

Changes Made in Approved NSSN Design and Potential for More

Since the Navy modeled the NSSN in 1995, a number of subsystems in development have encountered financial constraints and developmental problems. These financial constraints resulted in modifying the design requirements for some of the subsystems to reduce the performance capabilities. Significant development risks are also present in other subsystems that could further affect planned performance. The Navy's tester noted that many of the potential risks are the result of program restructuring to mitigate the effects of internally directed funding cuts. He expressed concern that the combined effects of the reductions in performance and developmental risks may affect the NSSN's operational effectiveness.

Reduced Capability Subsystems

The Navy has restructured two key NSSN subsystems—electronics warfare and acoustic intercept. The Navy has also reduced or will reduce some operational performance requirements to the minimum acceptable levels for the NSSN to successfully complete assigned missions.

The electronics warfare system enables the NSSN to covertly monitor intelligence targets and record electronics data. Because of internally directed fiscal year 1998 funding cuts, some system capability was removed. The reduced capability system will not meet the optimal performance levels modeled in the 1995 assessment, but it is projected to meet minimum levels. The Navy has established the detailed technical specifications that will be important to meeting those projections but has not approved all of the operational requirements documents.

Public Law 105-56 provided increased funding to restore some of the critical elements of the electronics warfare subsystem—such as specific emitter identification, full implementation of precision radar band direction finding, and interception of frequency-hopping communications. Public Law 105-85 authorized the increase.

The acoustic intercept system provides defensive capability for the submarine and according to a Navy official, is critical to its survival. Like the electronics warfare system, the acoustic intercept system was restructured because of fiscal year 1998 internal funding cuts. Although the restructured system will have fewer capabilities than the original one, limited computer modeling indicates that if the restructured system performs as expected, there is no statistical difference in performance. The question is whether the restructured system will perform as expected. In the June 1997 operational assessment of this system, the Navy tester noted several deficiencies in achieving required performance. (Detailed information on these deficiencies is classified.) As a result, the Navy tester recommended approval for only a single unit for backfit testing on 688I class submarines and only one unit for release to support the first NSSN contingent upon resolution of these issues.

Subsystems Experiencing Developmental Problems

The submarine's propulsor and external communications systems are experiencing development problems. These problems, although not unusual at this stage in a weapon program, present significant risks in meeting performance requirements. Also, the design for the lower cost alternative to the present towed array has not been approved, nor has a contractor been selected.

The propulsor provides thrust to move the submarine through the water. Cavitation[3] noise from the propulsor is critical to the ability of enemy submarines or surface ships to detect the submarine and, consequently, has a major impact on a submarine's survivability and operational effectiveness. Currently, there is no cavitation performance requirement in the NSSN operational requirements document, but there are program office cavitation design goals.

The Navy, through large-scale vehicle testing, determined that an interim propulsor design did not meet the program office's cavitation design goals. As a result, it has developed two alternative designs that it began to test in March 1998. To meet the lead ship NSSN production schedule, the Navy

[3]The noise generated by the movement of the submarine's propulsor.

must select from these alternatives during the one remaining large-scale vehicle test before a propulsor for the lead ship is produced. If the alternative designs do not meet cavitation goals, the Navy plans to backfit another redesigned propulsor on the lead ship.

The external communications system was restructured in August 1996 to provide a cost-effective means of introducing commercial hardware and software technologies in order to meet the NSSN development schedule and operational requirements. This system consists of several components such as the submarine high data rate antenna system, various radio frequency receivers, imagery and teleconference video capability, and internal data distribution systems.

Improvements in the data rate capability of the external communications system depend on the high data rate antenna system and the amount of satellite resources allocated to submarine platforms. As currently designed, with a 17-inch antenna, the Navy tester noted that the submarine's system will only be able to process the required amounts of data if all of the Navy's current satellite resources are allocated to support submarine communications. The Navy is attempting to establish a concept of operations among satellite scheduling units that will allocate appropriate resources to the deployed submarine. Program office officials said the Navy has alternative ways to provide the required satellite resources such as using different frequencies on satellites or leasing commercial satellites.

In addition, the Navy has not completed an overall operational requirements document for submarine external communication systems. As such, the NSSN external communications system design has not been finalized. These documents are required to ensure that the system configuration is properly designed to meet minimum performance requirements.

Status of TB-29 Towed Array

The TB-29 towed array and its processing system are critical to NSSN operations in detecting, tracking, and, if required, attacking a threat submarine. This system enables the NSSN to hear acoustic noises made by threat submarines. However, the Navy has determined that the current TB-29 system is too expensive. Also, the contract for the current TB-29 expired in fiscal year 1997.

The Navy is looking for a comparable system at a lower cost than the TB-29 array. Navy officials told us that required technology is available and that it is a matter of selecting a design and a contractor to produce the system. They believe there is sufficient time to develop and procure a new system to meet the delivery of the first NSSN. However, there is no approved design for the new system. Some developmental funding has been specifically identified. Navy officials said the Chief of Naval Operations has fully supported completing the TB-29 follow-on development and procurement in future years' budget submissions.

According to the program manager, a request for proposal for the design of a new array will be issued early in fiscal year 1998. The Navy expects to award a contract for the development and production of the new array in the third quarter of fiscal year 1998.

A More Capable Threat Has Been Defined

In April 1996, the Office of Naval Intelligence revised its classified underseas threat assessment and noted several technological advances in the open-ocean, antisubmarine warfare threat. Several improvements resulting in a more capable threat were noted over the previous threat of record, which the Navy used to model the survivability of the NSSN design in the 1995 assessment. (Details of these improvements are classified.) Facing a more capable threat, and without an increase in submarine capability, the risk to the NSSN's survivability is likely to increase.

Navy Does Not Plan Survivability Modeling of Changes in Design and Threat

The Commander, Operational Test and Evaluation Force, conducted NSSN operational assessments in April 1995 and again in January 1997. (Detailed results of these assessments are classified.) The 1995 assessment was conducted using computer simulated modeling of the baseline NSSN design against the threat projected at that time. As a result of the 1995 assessment, the Navy tester expressed concern that if the NSSN were just to meet minimum requirements for survivability, the NSSN may not be operationally effective against the most capable threat that the Navy was projecting at that time.

The 1997 assessment was based on a more limited amount of information, such as changes outlined in budgetary documents, and did not include an in-depth survivability modeling as was done for the 1995 assessment. The Navy tester's report noted reduced performance of several subsystems and developmental problems in others that also will result in reductions in planned performance. The report pointed out that many of the affected

subsystems, such as the acoustic intercept system and the propulsor, are necessary to support the NSSN's operational effectiveness and survivability.

The Navy tester concluded that the NSSN could potentially be operationally effective and suitable. However, he recommended that a new NSSN modeling baseline be established to reflect more current information, because the performance of some subsystems had been reduced below the performance modeled in the 1995 NSSN milestone II cost and operational effectiveness analysis and the April 1995 early operational assessment. The tester also recommended that this new design baseline be evaluated against the currently projected threat.

Navy program officials are cognizant of the Navy tester's report but have indicated that there are no plans to perform an updated survivability modeling of the total system against the new threat. Navy program officials told us that they have modeled, or plan to model, the performance of individual subsystems instead. Program officials also stated that even at the current reduced performance levels, the subsystems discussed will still meet NSSN minimum requirements. However, the submarine's survivability has only been assessed using performance levels above the minimum requirements.

Conclusions and Recommendation

The combined effects of a more capable threat, the reduction of some system performance requirements, and the risks inherent in new development could affect the NSSN's operational effectiveness. Without an evaluation that reflects current conditions, DOD and Navy program officials appear to have little basis for their confidence in how the submarine, with its design changes, will perform. Given the complexities and uncertainties in weapon system acquisitions, encountering performance problems during the development phase is not unusual. At this point in the NSSN program, using modeling tools to identify and correct problems that could affect the system's survivability, such as those described in this report, would allow changes to be made in development schedules and funding profiles at a much lower cost than if problems were identified later.

To avoid spending funds on construction from a design that may require costly modifications to meet requirements, we recommend that the Secretary of Defense require the Secretary of the Navy to conduct survivability modeling to assess the impact that reduced capabilities of various subsystems have on ship survivability when integrated into the overall NSSN design. Available research and development funding could be

used for this modeling. Further, we recommend that the Secretary of Defense take steps to ensure that the results are used in making fiscal year spending decisions on the program.

Agency Comments

DOD provided written comments on a draft of this report, which are reprinted in appendix I. DOD stated that it agreed with the recommendation in our draft report to conduct sufficient survivability modeling to assess the extent to which the NSSN will be fully capable of countering the threat and meeting all its mission requirements. In its comments, DOD acknowledged that the performance of some subsystems was reduced below that used to model the survivability of the NSSN during the milestone II cost and operational assessment and the 1995 early operational assessment. DOD laid out the process by which it makes decisions on what testing is needed and how the test results are used. DOD offered, as an example, that design changes to the Acoustic Intercept Receiver and to the Electronic Warfare Support Measures suites were assessed and determined to have reduced performance. The program's management concluded that the reduced performance of these subsystems would not compromise ship survivability and, therefore, no higher level modeling was required. DOD also stated that operational assessments, already scheduled for fiscal year 2000 on an interim basis and fiscal year 2002 for a final report, will assess the impact on overall NSSN performance of changes to the design, validated threat projection, and demonstrated subsystem performance.

The intent of our recommendation, however, was to have DOD conduct survivability modeling. As we point out in the report, until the cumulative effect of subsystem changes, including reduced performance, on overall ship survivability is modeled, it will not be known if the NSSN will perform as intended. For example, while performance modeling indicates that the restructured acoustic intercept system may perform as expected, this does not answer the question of what impact the system's reduced capabilities have on ship survivability when integrated into the overall NSSN design. Therefore, although important, individual assessments of subsystem performance such as those conducted in the Janaury 1997 operational assessment, do not provide information on overall survivability when they are integrated into the overall submarine design.

Likewise, the second phase of operational testing discussed in our report and scheduled to be reported on in fiscal year 2000 will not include an assessment of the overall survivability of the NSSN at reduced levels of

subsystem performance, unless explicitly requested and paid for by the program sponsor. Program officials have no plans to do so. As we note, the Navy rejected the recommendation in the January 1997 operational assessment that a new NSSN baseline be established to reflect more current information and be evaluated against the currently projected threat. Based on our discussions with Navy officials, there is no indication that tests scheduled for fiscal year 2000 will include an assessment of overall survivability nor that the results of the tests will be used to make modifications to the program. If the combined reduction of subsystem performance is subsequently found to affect overall ship survivability, the NSSN program could face expensive modifications or reduced capability. Therefore, we have modified our draft report recommendation to clarify what we meant by sufficient survivability modeling.

DOD concurred with our recommendation that the Secretary of Defense take steps to ensure that the modeling results are used in making fiscal year spending decisions on the program. DOD officials have stated that it now plans to conduct comprehensive annual reviews of the NSSN program.

Scope and Methodology

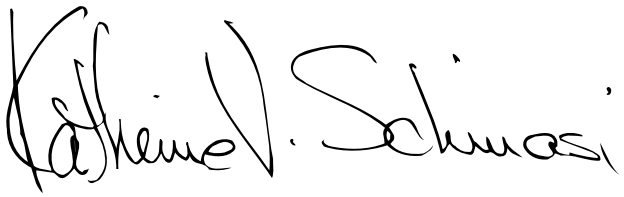
We analyzed Navy and DOD documents and studies such as the NSSN cost- and operational effectiveness analysis and discussed the status of the NSSN's acquisition with Navy program officials in Washington, D.C.; at the Naval Undersea Warfare Center, Newport, Rhode Island; and the Naval Surface Warfare Center, Carderock Division. We held additional discussions with officials from the offices of the Chief of Naval Operations; the Assistant Secretary of the Navy for Research, Development, and Acquisition; the Secretary of Defense; and the Program Executive Office for Submarines. We also discussed program acquisition status with (1) representatives from Electric Boat Corporation, Groton, Connecticut, and Newport News Shipbuilding and Drydock Company, Newport News, Virginia; (2) the Supervisors of Shipbuilding at these respective shipyards; and (3) representatives from Lockheed Martin Federal Systems, Manassas, Virginia. In addition, we analyzed the threat modeling and other testing results contained in the NSSN's operational assessments and discussed the results with representatives of the Commander, Operational Test and Evaluation Force, Norfolk, Virginia. Discussions on the capabilities of the projected submarine threat were held with representatives of the Office of Naval Intelligence, the Defense Intelligence Agency, and the Central Intelligence Agency.

We conducted our review between December 1996 and March 1998 in accordance with generally accepted government auditing standards.

We are sending copies of this report to the four congressional Defense committees, the Secretary of the Navy, and the Assistant Secretary of the Navy for Research, Development, and Acquisition. Upon request, we will make copies available to other interested parties.

Please contact me on (202) 512-4841 if you or your staff have any questions concerning this report. Major contributors to this report are in appendix II.

Sincerely yours,



Katherine V. Schinasi
Associate Director, Defense
Acquisitions Issues

Contents

Abbreviations

DOD	Department of Defense
NSSN	new attack submarine

Comments From the Department of Defense

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ACQUISITION AND TECHNOLOGY

30 MAR 1998

Ms. Katherine V. Schinasi
Associate Director, Defense
Acquisition Issues
National Security and International
Affairs Division
U.S. General Accounting Office
Washington, D.C. 20548

Dear Ms. Schinasi:

This is the Department of Defense (DoD) response to the General Accounting Office (GAO) draft report, "NEW ATTACK SUBMARINE: More Knowledge Needed to Understand the Impact of Design Changes," dated February 25, 1998, (GAO Code 707217/OSD Case 1551). The Department concurs with the report.

The Department will conduct sufficient modeling and analysis to assess the extent to which the New Attack Submarine (NSSN) will be capable of countering the threat and meeting all mission requirements when changes are made to ship subsystems or threat projections. A follow-on Operational Assessment (OT-IIA2) by the Navy Operational Test and Evaluation Force is planned with an interim report in Fiscal Year 2000 and a final report in Fiscal Year 2002. The modeling and analysis results, as well as other program reviews and warfare assessments, will continue to be used in making fiscal year spending decisions on the New Attack Submarine program.

The Department's most recent validated system threat assessment was published in July 1997. This assessment details the worldwide threat and concludes that technological improvements to open-ocean threat submarines as described in the April 1996 threat assessment are possible; however, the assessment also notes financial and technical difficulties that could markedly delay these improvements. Updated threat projections are used as inputs into an ongoing modeling program that the Department uses to monitor NSSN performance against the projected threat.

The detailed comments to the report recommendations are provided in the enclosure.

The Department appreciates the opportunity to comment on the draft report.

Sincerely,

George R. Schneiter
Director
Strategic and Tactical Systems

Enclosure

GENERAL ACCOUNTING OFFICE DRAFT REPORT - DATED FEBRUARY 25, 1998

(GAO CODE 707217) OSD CASE 1551

"NEW ATTACK SUBMARINE: MORE KNOWLEDGE NEEDED TO UNDERSTAND THE IMPACT OF DESIGN CHANGES"

* * * * *

DOD COMMENTS IN RESPONSE TO THE RECOMMENDATIONS

Now on p. 7.

RECOMMENDATION 1: The GAO recommended that the Secretary of Defense require the Secretary of the Navy to conduct sufficient survivability modeling to assess the extent to which the NSSN will be fully capable of countering the currently projected threat and meeting all mission requirements. (p. 7/GAO Draft Report)

DOD RESPONSE: Concur. As changes occur, the Department will conduct sufficient modeling and analysis to assess the effect a change may have on the ability of the New Attack Submarine (NSSN) to counter the threat and meet all mission requirements.

The process by which this occurs involves use of the NSSN Test and Evaluation Integrated Product Team, chartered to identify and coordinate modeling and testing for the program, to evaluate design or threat changes or actual demonstrated subsystem performance. For example, when technical changes to subsystems are proposed, analysis or modeling will be performed at the subsystem level to assess the effect of the proposed changes. If these subsystem changes result in no significant performance changes, or result in no significant decrement from the designed subsystem, the modifications will be implemented. If, however, modeling or analysis shows that the changes could prevent the program from meeting performance thresholds, additional modeling or analysis will be done at a higher level to assess the impact of the proposed changes. The results will then be used to restructure the program, so long as the change does not prevent NSSN from meeting performance thresholds. Examples of this are:

- Design changes to the Active Intercept Receiver (AN/WLY-1) and the Electronic Warfare Support Measures (ESM) suites were assessed in this fashion, and the results provided confidence to the program management that the program could be restructured without compromising ship survivability.

- After the Milestone II Cost and Operational Effectiveness Analysis, one-quarter scale modeling of the interim propulsor design was conducted, demonstrating that it was unlikely to meet program cavitation goals. As a result, a propulsor design improvement program was implemented. Follow-on one-quarter-scale modeling and testing from this program led to design improvements which have been incorporated into two one-quarter-scale propulsors which are currently being tested.

Additionally, at-sea technical and operational test results of subsystems back-fit into improved Los Angeles class submarines will be available prior to NSSN delivery, including key components of the Command, Control, Communications, and Intelligence suite, such as the ESM, AN/WLY-1, and other sonar subsystems. These results will be used to verify subsystem performance and to refine future modeling and analysis.

The Department is fully committed to a continuing program of tailored analysis and modeling for the NSSN Program.

Additional modeling and simulation and analysis will be accomplished during the next Operational Assessment (OT-IIA2), a planned element of the program, which will be directed by the Navy's Operational Test and Evaluation Force. The objective of OT-IIA2 is to assess the impact of changes to the design or the validated threat projection, and demonstrated subsystem performance on overall NSSN performance. An interim report is planned for Fiscal Year 2000, with a final report in Fiscal Year 2002.

The TB-29A, the follow-on to the TB-29 towed array, is funded in the Fiscal Year 1999 President's Budget and the associated Future Years Defense Program. Procurement is planned to begin in Fiscal Year 2000, with deliveries in Fiscal Year 2002. The TB-29A procurement profile supports NSSN delivery.

Now on p. 8.

RECOMMENDATION 2: The GAO recommended that the Secretary of Defense take steps to ensure that the modeling results are used in making Fiscal Year spending decisions on the program. (p. 7/GAO Draft Report)

DOD RESPONSE: Concur. Within the Office of the Secretary of Defense, the program is reviewed quarterly by the Defense Acquisition Executive using inputs from all staff disciplines. Annually, Integrating Integrated Product Team meetings, co-chaired by the Navy and the Office of the Secretary of Defense, perform a comprehensive review of the NSSN program. These reviews use projected performance trends from modeling and simulation results, demonstrated subsystem performance, and continuous risk analyses.

A core element which feeds information to these top level reviews is the NSSN Test and Evaluation working-level Integrated Product Team, consisting of representatives from the following offices:

- Naval Sea Systems Command Test and Evaluation
- NSSN Program Office
- Navy Operational Test and Evaluation Force
- Deputy Chief of Naval Operations for Resources, Warfare Requirements & Assessments
- Director of Navy Test and Evaluation and Technical Requirements
- Office of the Secretary of Defense, Director of Operational Test and Evaluation
- Office of the Secretary of Defense, Director of Test, Systems Engineering, and Evaluation

It is important to note that, while resources and data are shared during modeling and testing, analysis and reporting of conclusions by participating organizations remain independent.

Finally, the Department also uses warfare assessments, such as the recently completed Anti-Submarine Warfare Assessment, for developing the Future Years Defense Program.

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