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Report to the Chairman, Subcommittee on Defense, Committee on Appropriations, House of Representatives

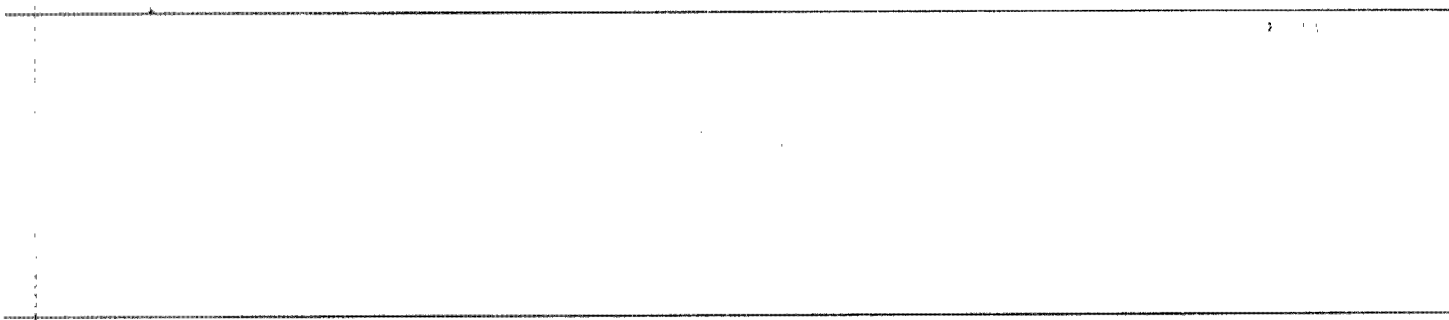
March 1988

TEST AND EVALUATION

An Assessment of Navy's Long-Term Underwater Test Resources Plan



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**National Security and
International Affairs Division**

B-210919

March 28, 1988

The Honorable Bill Chappell, Jr.
Chairman, Subcommittee on Defense
Committee on Appropriations
House of Representatives

Dear Mr. Chairman:

This report is in response to your December 3, 1986, request asking us to follow-up on the Navy's Long-Term Underwater Support Resources Plan. You also asked us to assess the Department of Defense Inspector General's (DOD/IG) report on Navy acoustic ranges, and to determine if test resource management problems in planning, organization, and sponsorship exist in the Army, Air Force, and Navy warfare areas other than antisubmarine warfare.

Although test resources provide the means that DOD uses to evaluate the performance of major weapon system acquisition programs, until recently they have received relatively little management attention. If testing is inadequate because test resources are not available, an unproven, unsafe weapon system could be fielded and military readiness could be impaired. Recent DOD initiatives to improve test resource development, planning, and management should enhance the quality of test and evaluation. To meet test requirements in the most cost-effective manner and to ensure support for the most critical programs, overall priorities need to be set; all options need to be analyzed; and a comprehensive strategy, with the necessary organizational support, needs to be developed. These matters are summarized below and discussed in more detail in the appendixes.

Navy's Long-Term Underwater Support Resources Plan

The Navy's plan, which covers four separate resource categories—tracking ranges, ship noise measurement facilities, targets, and real-time simulators—does a good job of matching existing capabilities with requirements to identify shortfalls. However, it does not:

- combine proposed development programs contained in these separate resource categories, nor set overall priorities for test resource needs; however, resources within each category are prioritized;
- include acoustic requirements data from fleet units, the major users of acoustic measurement facilities;

- include all options for meeting weapon systems noise measurement requirements, including those valued at \$5 million or less; or
- present a cost-effective rationale for the future use of the Atlantic Undersea Test and Evaluation Center.

DOD/IG's Report on Acoustic Measurement Facilities

The DOD/IG reviewed eight existing and two planned Navy acoustic measurement facilities and found low utilization and duplication among the facilities. The IG recommended that the Navy modify its plans for new facilities, which would result in estimated savings of \$71.4 million, and consolidate existing facilities, saving an estimated \$4.9 million in annual operating costs. The Navy disagreed on technical and economic grounds with these recommendations.

We found that all costs of implementing the report's recommendations were not considered in computing the savings. IG officials believe that their recommendations are feasible and cost-effective alternatives for the Navy to consider. They felt confident that the Navy could effect savings if these recommendations or some derivative were implemented. When our review was concluded, the IG and the Navy were undergoing a resolution process to settle their differences. If agreement cannot be reached, the case could be referred by the IG to the Deputy Secretary of Defense for a final resolution.

Test Resource Planning Initiatives

While we found no organizational problems during our review in the other Navy warfare areas or in the other services, we did find that the Office of the Secretary of Defense and the military services are in the process of implementing initiatives to improve test resource planning. These planning initiatives were started because of a lack of emphasis on and coordination of test resource acquisition. However, although it is too early to assess the viability and effect of these initiatives, they appear to be a step in the right direction.

Recommendations

We recommend that the Secretary of Defense require the Secretary of the Navy to revise the Long-Term Underwater Support Resources Plan to

- integrate and rank test resource development programs,
- obtain and incorporate underwater acoustic measurement requirements from fleet units,

- present all feasible options to meet weapon systems acoustic measurement requirements and eliminate dollar thresholds so that additional options can be considered, and
- determine whether the Atlantic Undersea Test and Evaluation Center is the most cost-effective alternative to meet unit training requirements beyond the next 5-year period (1988 to 1993).

As you requested, we did not obtain official DOD comments on this report; however, we did discuss its contents with responsible officials. Navy officials generally agreed with the intent of our recommendations except for presenting the planned test resource development program in priority order. They believe that ranking the programs within respective categories, as they did in the plan, provides adequate information to support programmatic decisions. We believe that given the limited funds available, such ranking would enable decisionmakers to focus on the most critical test resource requirements.

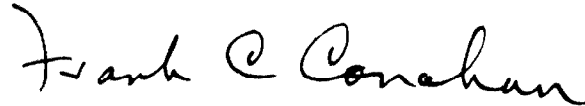
Objectives, Scope, and Methodology

We reviewed the Navy's Long-Term Underwater Support Resources Plan to determine its comprehensiveness and usefulness as a management tool. We also analyzed the DOD/IG's report on acoustic ranges to determine if the conclusions and recommendations were adequately supported. To determine if test resource management problems exist throughout DOD, we examined the military services' and the Office of the Secretary of Defense's long-term planning processes that identify, program, and fund test resource requirements. Our work included interviewing DOD officials and reviewing DOD regulations, directives, and documents. Our work was performed in accordance with generally accepted government auditing standards between February and September 1987. We performed follow-up work at the Office of the DOD/IG in December 1987.

We are sending copies of this report to other concerned congressional committees; the Secretaries of Defense and the Army, Navy, and Air

Force; and the Director, Office of Management and Budget. Copies will be made available to others upon request.

Sincerely yours,

A handwritten signature in cursive script that reads "Frank C. Conahan". The signature is written in black ink and is positioned below the typed name.

Frank C. Conahan
Assistant Comptroller General

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Abbreviations

AUTEK	Atlantic Undersea Test and Evaluation Center
DOD	Department of Defense
DOT&E	Director, Operational Test and Evaluation
IG	Inspector General
NAVSEA	Naval Sea Systems Command
OSD	Office of the Secretary of Defense
R&D	research and development
RDT&E	research, development, test and evaluation

The Navy's Long-Term Underwater Support Resources Plan

Introduction

There has been long-standing congressional interest in the need for long-term test resource planning. In a 1984 report,¹ we recommended that the Navy assess its underwater range² requirements in the Caribbean. The report emphasized the criticality of completing a long-term study before the expiration of the first 5 years of an agreement between the governments of the United States and the Bahamas for the use of the Atlantic Undersea Test and Evaluation Center (AUTEK). We reported that the study was necessary to substantiate the Navy's future requirements for AUTEK and justify a decision to exercise an option for its use for an additional 5 years. DOD concurred that such a study was needed, and the Congress requested that the study be completed before the Navy expended funds for AUTEK's modernization.

In 1986³ we followed up on the Navy's progress in performing a long-term assessment of those requirements. We concluded that the Navy's range development plan, published in November 1984, was incomplete because it did not include fleet training range requirements, the major work load of underwater ranges. The plan focused primarily on research, development, test and evaluation (RDT&E) underwater range requirements and capabilities.⁴ The Navy stated it would complete an assessment of all underwater range requirements in late calendar year 1986.

In January 1987, the Navy decided to combine underwater range requirements and those for targets and simulation⁵ capabilities in order to develop a more comprehensive antisubmarine warfare test resource plan. On June 30, 1987, the Navy published its Long-Term Underwater Support Resources Plan, which contained an Executive Summary and four volumes addressing tracking ranges, ship noise measurement facilities, targets, and simulators.

¹The Navy Should Assess Its Long-Term Undersea Test and Evaluation Needs (GAO/C-NSIAD-84-2, Apr. 23, 1984).

²Ranges are underwater facilities needed for tracking surface, submerged, and in-air vehicles, testing weapon systems, and making noise measurements.

³Test Range Needs: Future Navy Underwater Range Requirements Need to Be More Fully Assessed (GAO/NSIAD-87-30BR, Oct. 31, 1986).

⁴Underwater Range Requirements Study, November 1984.

⁵A process that attempts to duplicate how a weapon performs using computers and other instruments.

Our evaluation focused on the plan's usefulness as a management tool for matching future weapon systems' resource requirements with current capabilities. We examined the plan's effectiveness in identifying shortfalls and in presenting programs to address these shortfalls. We did not evaluate the technical merits of the plan or whether its objectives were attainable. Although our review focused on underwater ranges, we noted that the plan also addressed limitations of underwater target and simulation capabilities. We reported on these matters in our June 1986 report.⁶

During our review, we contacted Navy personnel at the Office of the Deputy Chief of Naval Operations for Submarine Warfare; the Office of Research, Development, and Acquisition; the Naval Air Systems Command; the Naval Sea Systems Command (NAVSEA); the Naval Underwater Systems Center (Systems Center); and the David Taylor Naval Ship Research and Development Center, who were responsible for the data included in the plan.

Navy Plan Can Be a More Effective Management Tool

The Navy's criteria⁷ used in developing a comprehensive long-term plan requires (1) the identification and prioritization of all requirements, (2) the comparison of requirements with capabilities to identify limitations, and (3) a description of options, together with an evaluation of their ability to overcome these limitations. For planning to be effective, all options should be presented so decision-makers can evaluate and choose the best approach.

The Navy's plan met some, but not all, of these criteria. It effectively matches existing capabilities with requirements to identify shortfalls, and provides long-term programs that address these shortfalls for the four test resource categories covered in the plan. However, it does not:

- integrate and rank the proposed development programs established for the four test resource categories comprising the plan;
- include direct input from fleet units, the major users of acoustic measurement facilities;

⁶Early Testing of Major ASW Weapons Can Be Enhanced by Increased Focus on Test Resources (GAO/C-NSIAD-86-19, June 1986).

⁷This criteria was established to develop a long-term tracking range plan. However, the Navy expected the criteria to also be followed in the development of a long-term study of noise measurement facilities. We believe the Navy's criteria is acceptable and applies to the development of all long-term plans, including the Navy's recently completed test resource plan.

- present all options for meeting weapon systems noise measurement requirements; and
- consider options other than AUTEC to meet long-term unit training range requirements.

All Proposed Test Resource Development Programs Are Not Integrated and Ranked

Although the plan identified many test resource development programs, it did not integrate nor rank them to show their relative importance in meeting research and development (R&D) and training requirements. This is important because decision-makers need to focus on the most critical test resource requirements, given the limited funds available. Each of the plan's four volumes presented development programs to overcome limitations in test resource capabilities. Volume I identified development programs to support two important categories of tracking ranges, those needed to support weapon R&D systems and those needed to support training and tactics development. It also ranked those development programs under each category, but it did not present an integrated, prioritized list of development programs showing the relative importance of each. The other three volumes presented individual prioritized development programs and funding requirements; however, these also were not integrated in the plan. Information on these development programs was taken from each of the volumes and presented the same way in the plan's Executive Summary.

Fleet Input Needed to Ensure All Acoustic Measurement Requirements Are Identified

The plan distinguishes between two categories of acoustic measurement facilities: (1) engineering facilities that support comprehensive measurements of various NAVSEA-sponsored programs and (2) fleet facilities that support assessments of a ship's current acoustic vulnerability. Volume II of the plan, which discusses underwater acoustic measurement facilities, was prepared by NAVSEA. Even though the fleet's submarine community is a major user of measurement facilities, it was not asked to identify requirements for such facilities. NAVSEA, to identify capabilities, requested information from the management of those facilities; and to identify requirements, they requested information from Navy program offices. A Navy official responsible for developing volume II told us that familiarity with fleet needs compensated for the lack of formal fleet input. However, fleet units have since been requested by NAVSEA to comment on acoustic measurement requirements contained in the approved plan.

In contrast, when volume I, Tracking Ranges was prepared, fleet units were formally requested to identify their long-term underwater training

range requirements. These requirements were then incorporated into the plan before it was published. The fleet also had opportunities to review drafts of the plan.

Plan Needs to Present All Options for Meeting Weapon Systems Acoustic Measurement Requirements

The Navy has recognized the need for increased capabilities to perform stringent weapon system noise measurement specifications (i.e., a new advanced torpedo must be measured acoustically at all operating depths). However, the plan only presented one option to satisfy these measurement requirements—to use one location for shallow water torpedo acoustic measurements and use existing arrays, consisting of a string of hydrophones to do measurements in deep water at another location. Other options are available, and should have been included in the plan. For example, a Systems Center official who also presented weapon systems acoustic requirements in another section of the plan, told us that an option not considered would be to perform both shallow and deep water acoustic measurements together to allow for more meaningful data analysis. The official stated that the plan should have mentioned two locations instead of one for shallow water measurements and questioned the availability of arrays to do deep water measurements. A NAVSEA official told us that another option available would be to use one location for shallow water testing and to use a portable array for deep water measurements. Such an array was estimated to cost less than \$5 million to develop and was not included because the plan only addressed items in excess of \$5 million.

According to NAVSEA officials responsible for coordinating the plan's various volumes, the plan did not present additional options because the Navy had not decided on the best approach to meet its weapon systems acoustic measurement requirements. In addition, the plan's omission of improvement programs costing less than \$5 million precluded a more complete presentation of options available to meet weapon systems noise measurement requirements.

Plan Should Reassess AUTEK's Role and Cost Effectiveness Supporting Changing Work Load

In the past, because of its low ambient noise levels,⁸ AUTEK primarily supported R&D requirements for submarine and surface ship acoustic noise measurements at its acoustic measurement range, one of three ranges at AUTEK. However, that range is closed and in standby status and will no longer be used to support noise measurement programs. The

⁸Ambient noise refers to the noise of the ocean itself and its sources, including tides, surface waves, winds, ship traffic, biological organisms, and rain.

Navy has future plans to use AUTEK's remaining two ranges to primarily support training requirements; and to a lesser extent, R&D work. Training requirements do not depend on a quiet acoustic environment and it is projected that the R&D work load will decline significantly in the near term.

AUTEK is the most costly of three sites covered by an agreement between the United States and the Commonwealth of the Bahamas. AUTEK costs the United States \$10 million per year over an initial 5-year period and the Bahamian Government is asking for an increase in compensation not to exceed 10 percent. The agreement is currently being renewed for a second 5-year period. AUTEK's support funding amounted to about \$65 million in fiscal year 1987, excluding the compensation for the use of the site.

A principal factor in the original selection of AUTEK was its extremely low and stable ambient acoustic conditions, which are critical to measuring radiated noise. AUTEK's three ranges and their location are shown in figure I.1. Its acoustic measurement range supported submarine and surface ship acoustic tests. This range was closed in 1987. The remaining operating ranges, a weapons range and a Fleet Operational Readiness Accuracy Check Site, provide underwater surface and in-air tracking of ships and weapon systems to support R&D and training programs and assess fleet operational readiness and sensor accuracy testing,⁹ respectively. The primary use of these two currently operating facilities is in support of fleet training and fleet readiness testing,¹⁰ which do not depend on AUTEK's unique acoustic environment. The Navy's plan states that the acoustics range is no longer needed to support noise measurement programs.

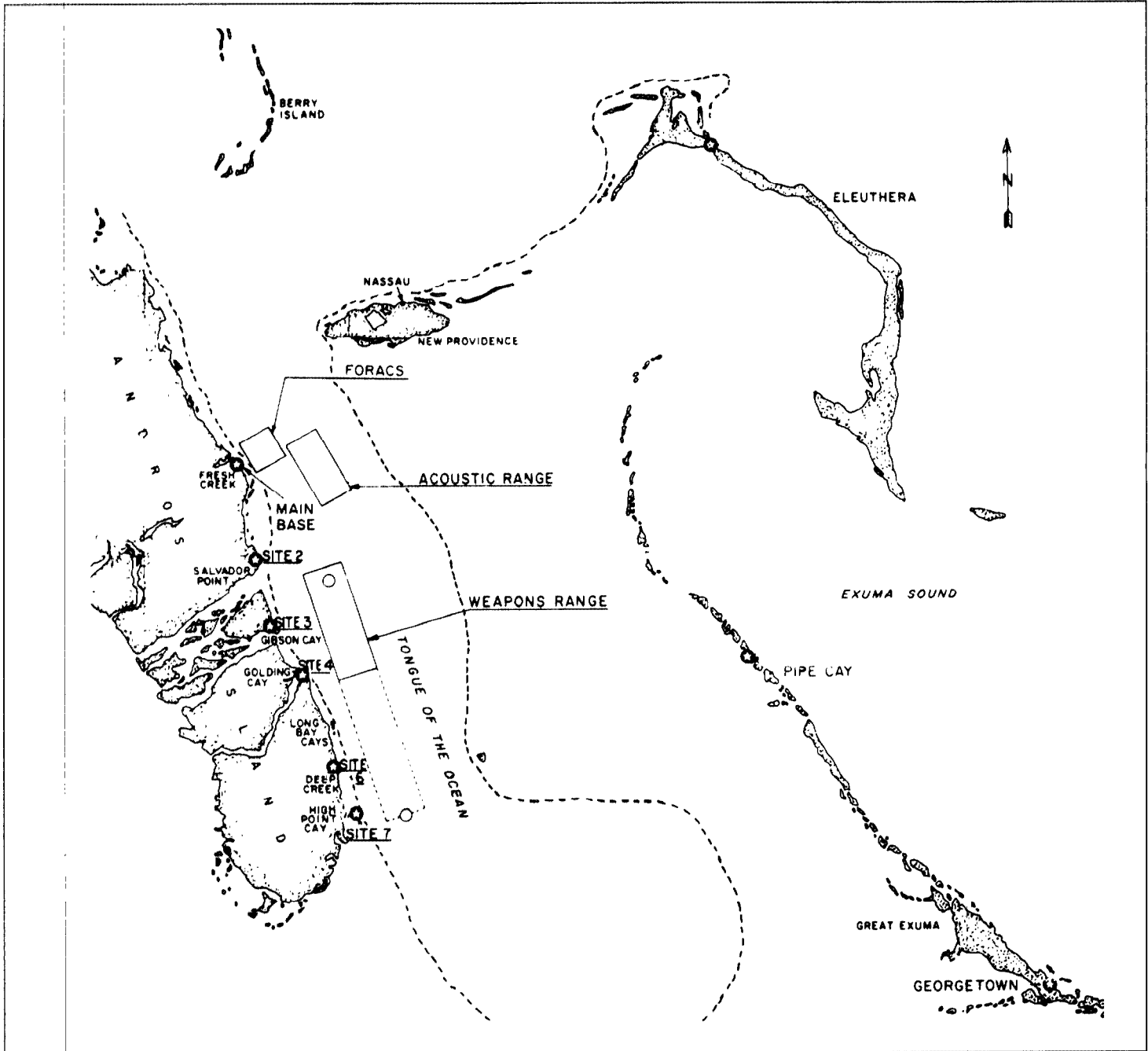
The Navy's 1984 underwater range study stated that AUTEK's acoustic conditions were critical to meeting R&D programs for towed arrays¹¹ and torpedo development and acoustic measurements. The current long-range plans rely on the USNS HAYES for these acoustic measurements and changes the use of AUTEK to primarily a unit training facility.

⁹Includes sonars, radars, and periscopes.

¹⁰Includes testing that is not R&D or training, such as weapon acceptance testing and equipment calibrations.

¹¹Towed arrays are primarily target detection systems pulled by submarines.

Figure I.1: Location of AUTEC's Three Ranges



AUTEC's weapons range is evolving from an R&D support activity to primarily a fleet training activity and, based on near-term projections, that evolution will continue. For example, the projected near-term R&D work load for AUTEC is decreasing because it is dominated by the Advanced Capability Torpedo (ADCAP) which will be completed shortly. The R&D work load is expected to remain nearly constant, although at a substantially lower level.

The Navy's future RDT&E emphasis is on sensor programs, which require larger test areas than are presently available. AUTEC's weapons range, for example, is too small (9 by 21 nautical miles) to provide the diversity required for operational realism during testing, and to support fleet training exercises, which require a 150 by 100 nautical mile environment.

The Navy plans to meet its future requirements for RDT&E programs and fleet training by using a combination of small, medium, and large ranges. Recognizing the size limitations, the Navy plan proposes to continue using AUTEC's weapons range to support primarily unit training and hardware readiness requirements and some R&D work. To meet the Navy's RDT&E and training requirements, which cannot be met by AUTEC's weapons range, the plan proposes a medium-sized RDT&E range and a large tactical training range at a site off Eleuthera Island in the Bahamas. The Navy believes combining these ranges together can save operational costs because assets and operating areas can be shared. The medium-sized RDT&E range would support the development of long-range weapons and sensors and the large training range would support training involving many ships and development of antisubmarine warfare tactics. Both of these proposed ranges would have to be added to the Bahamian lease agreement.

Conclusions

The Navy has developed a test resource plan that includes not only underwater range facilities, but also targets and simulation requirements. While the plan establishes prioritized development programs funding requirements to address capability shortfalls for each of the test resource categories, it does not integrate and prioritize these programs. To be more useful as a decision-making tool, the plan should consolidate and prioritize all proposed test resource development and acquisition programs so that the most critical test resource development programs are supported.

To help ensure that the fleet's acoustic measurement requirements are properly addressed, fleet units should be asked to provide their requirements. The Navy has not followed a consistent approach in identifying fleet requirements for specific test resources. In preparing the tracking range volume of the plan, the Navy asked the fleet to identify their requirements. That approach was not followed in preparing the acoustic measurement facility volume of the plan.

The plan does not present all options for meeting the Navy's acoustic noise measurement requirements. Although options to meet weapon system requirements can cost less than \$5 million, the Navy decided to review only those development programs costing at least \$5 million. This eliminated some alternatives from being considered in the plan. We believe the Navy's plan needs to present all options that could meet these requirements regardless of dollar thresholds.

A significant portion of AUTEK's work load, i.e., training, does not depend on its favorable acoustic background conditions. The plan should consider other options, such as Eleuthera (see p. 14), to meet unit training range requirements that are currently done at AUTEK. Because AUTEK costs the Navy about \$75 million per year and has one of the quietest acoustic environments in the world, we believe the Navy should reassess and determine whether AUTEK's future use—primarily supporting training activities—is the most cost-effective use of this facility.

Recommendations

We recommend that the Secretary of Defense require the Secretary of the Navy to revise the Long-Term Underwater Support Resources Plan to

- integrate and rank all test resource development programs,
- obtain and incorporate underwater acoustic measurement requirements from fleet units,
- present other options to meet weapon system acoustic measurement requirements and eliminate dollar thresholds so that additional options can be considered, and
- determine whether the AUTEK is the most cost-effective alternative to meet unit training requirements beyond the next 5-year period (1988 to 1993).

DOD/IG Report on Underseas Test Capabilities

Introduction

Acoustic measurement facilities have an important role in the United States' efforts to develop and maintain quiet submarines. These facilities support programs to decrease submarines' detectability to enemy sonars (submarine's acoustic vulnerability) by providing an appropriate environment for collecting, processing, and analyzing ships' acoustic data. With information on a submarine's noise patterns, referred to as an acoustic signature, its current acoustic vulnerability can be decreased by resolving its noise problems before deployment. To decrease the acoustic vulnerability of future submarines, information on current submarine classes is used in R&D programs to design quieter ships.

In its report on *Underseas Test Capabilities* (July 13, 1987), the DOD/IG evaluated the Navy's eight current and two planned acoustic measurement facilities on the East and West Coasts and found low use and duplication among the facilities. The DOD/IG recommended that the Navy (1) modify its plans for new facilities, thereby saving \$71.4 million in construction, instrumentation, and conversion costs and (2) consolidate existing facilities, saving \$4.9 million in annual operating costs.

The Navy disagreed with the report, citing various technical, programmatic, and financial reasons for not implementing the DOD/IG recommendations. When our review was concluded, the IG and the Navy were undergoing a resolution of disputed audit findings and recommendations to settle issues raised by the report. If an agreement cannot be reached, the case could be referred to the Deputy Secretary of Defense for final resolution.

Questions remain, however, as to whether the DOD/IG report's recommendations would allow the Navy to meet its acoustic measurement requirements. (See pp. 20-26 for a discussion of these issues.) IG officials told us that they did not perform detailed, technical analyses in developing their recommendations. However, they said that they did sufficient work to demonstrate that their recommendations are feasible and cost-effective alternatives to Navy's current plans. IG officials also stated that they asked the Navy to propose alternative actions to their draft report and provide official Navy positions to the final report recommendations. Because the Navy has disagreed with the recommendations in the final DOD/IG report, IG officials said that alternative actions may result from the resolution process.

The cost savings cited in the report may not materialize because the recommendations may change as a result of the resolution process. Moreover, we found that the calculation of cost savings did not include all

costs associated with the IG proposals, such as the cost of terminating the current shipbuilding contract for the USNS HAYES. IG officials told us, however, that they were confident the Navy would save money if either their recommendations or some derivative thereof were implemented.

To assess the DOD/IG report, we evaluated the audit methodology and technical support for the recommendations through a review of available documents and discussions with the audit staff. We also obtained documents from and interviewed Navy officials in the Office of the Deputy Chief of Naval Operations for Submarine Warfare; NAVSEA; the David Taylor Naval Ship Research and Development Center (David Taylor Center); and the Naval Underwater Systems Center (Systems Center). We used this information to better understand the Navy's requirements for acoustic measurement facilities. We did not evaluate the cost-effectiveness of the Navy's planned approach for meeting these requirements.

Background

To support noise reduction efforts, surface ships and submarines undergo various tests at acoustic measurement facilities. These acoustic tests fall into two broad categories—radiated noise and target strength. A radiated noise test measures noise emitted into the water by a ship's machinery or propeller, which could be detected by an enemy's passive sonar.¹ A target strength test measures an externally transmitted sound that echoes off a ship's structure. This test determines a ship's acoustic response to an active sonar. While radiated noise tests account for the majority of ship acoustic tests, target strength measurements are becoming increasingly important, according to the Navy.

Acoustic tests meet the needs of both R&D programs and the fleet. To aid in R&D, acoustic tests provide detailed, comprehensive data that is used, among other things, to modify and develop ship designs to make ships quieter. Engineering tests include the following NAVSEA funded tests:

- New construction tests determine the acoustic signatures of newly delivered ships. These tests last 5 to 7 days and provide the Navy with the first comprehensive data on a ship's acoustic characteristics.

¹Passive sonar is the detection of objects by listening to and identifying their radiated noise. In active sonar detection, sounds transmitted from a sonar are sent to an object and back.

- Post-overhaul tests assess the effectiveness of the overhaul, redefine ships' acoustic signatures, and determine acoustic characteristics requiring additional R&D efforts. Tests last 4 days.
- Submarine mid-operational tests² update a submarine's acoustic signature between overhauls, usually every 4 years, and provide a current vulnerability assessment before deployment. Tests last 2 days.

Fleet support tests, on the other hand, provide operational data to meet fleet needs. The fleet funds these tests, which include the following:

- Submarine predeployment tests³ assess the degradation of a submarine's acoustic signature, resolve acoustic irregularities, and provide a current vulnerability assessment before deployment. Tests last 12 hours.
- Surface ship predeployment tests⁴ provide a current vulnerability assessment and resolve acoustic irregularities before deployment. Tests last 12 hours.

The Navy has two types of facilities to conduct acoustic measurements. The first type, the engineering facility, measures the low noise levels of submarines. An engineering facility must be located in water with low ambient noise, free from outside noise interference. This facility also requires strings of hydrophones, referred to as arrays, sensitive enough to measure extremely low noise levels. The second type, the fleet support facility, tolerates noisier water and less sensitive arrays than an engineering facility.

Navy Plans for Improving R&D Acoustic Measurement Facilities

To improve its ability to measure current and future quiet class submarines, the Navy plans to develop new engineering facilities on both the East and West Coasts by fiscal year 1991. It also plans to upgrade the engineering facilities' instrumentation through fiscal year 1996.

On the East Coast, the Navy plans to replace its current engineering facility, the Mobile Noise Barge, with another mobile facility, the converted USNS HAYES. To meet the requirements of a mobile engineering facility, the HAYES is undergoing a conversion that includes a major noise reduction program to decrease its emitted noise while both moored

²Referred to as Submarine Extended Operating Cycle Trials for attack submarines and Extended Operating Cycle Trials for ballistic missile submarines.

³Referred to as Fleet Acoustical Silencing Trials for Atlantic Coast submarines and Submarine Predeployment Acoustic Trials for Pacific Coast submarines.

⁴Referred to as Surface Ship Radiated Noise Measurements.

and underway. Funds currently authorized for the HAYES conversion total \$54.2 million, \$33.9 million of which has gone towards the original conversion contract.⁵ Unlike the current mobile facility, which does not tow an array, the HAYES will measure radiated noise by towing an array alongside a submarine undergoing the acoustic test. The HAYES will also be able to support target strength measurements.

The Navy's facility improvement program calls for the installation of a new facility in Behm Canal, Alaska, by fiscal year 1991 to replace the current West Coast engineering facilities. The cost of the initial installation is estimated at \$36.8 million, which includes instrumentation and construction costs. According to Navy plans, the Behm Canal facility will include a fixed measurement site,⁶ shore facilities to house laboratory and support equipment, and a static measurement site.⁷ The Navy plans to do all submarine engineering trials on the West Coast at the Behm Canal facility. It also plans to close down the Carr Inlet facility in Washington State, and to use the Santa Cruz facility in California for submarine predeployment tests only.

Further, this program calls for time-phased improvements in the instrumentation of both engineering facilities. The Navy plans to develop and install increasingly more sensitive measurement arrays by fiscal years 1991, 1992, and 1996. The program also calls for the development of a towed array for the HAYES by fiscal year 1992. Both facilities' processing and analysis systems will also be upgraded to handle new data requirements. Total program costs come to about \$153 million, including costs for the Behm Canal shore construction and initial installation.

To continue new R&D efforts concerning target strength measurements, the Navy plans to install a new acoustic measurement facility in Exuma Sound⁸ because no existing facility can meet the new requirements. The HAYES will be used in conjunction with this facility to deploy arrays and process data. The facility will be operational in the early 1990s and its estimated cost is \$99 million.

⁵The conversion contract was awarded February 20, 1987, to the Tacoma Boatbuilding Company of Washington State.

⁶At a fixed measurement site, a ship's radiated noise is measured as the ship moves past arrays moored to the bottom of the site.

⁷At a static measurement site, a submarine is suspended underwater with its propulsion system off. Static sites can support both radiated noise and target strength measurements.

⁸A body of water located in the Bahamas, adjacent to AUTECH.

Navy Believes the DOD/IG Recommendations May Not Meet Its Acoustic Measurement Requirements

The DOD/IG report's recommendations for modifying and consolidating acoustic measurement facilities called for the Navy to take specific actions that would avoid unnecessary expenditures. However, DOD/IG officials told us that because the Navy disagrees with the final report, alternative actions may result from the resolution process. The report's recommendations represent what the IG believes are more cost-effective alternatives than the Navy considered when deciding how to meet its acoustic measurement requirements. The Navy disagreed on technical and economic grounds with the report's recommendations, raising technical questions regarding the feasibility of implementing the IG's alternatives. The following section discusses some of the technical issues to be resolved.

Replace the USNS HAYES With a Fixed Facility and an Existing Ship

The DOD/IG's report recommended that the Navy (1) cancel the HAYES conversion and, instead, install a fixed measurement site at AUTECH site 7 in the southern Tongue of the Ocean⁹ and (2) use an existing ship to tow an array. According to the report, this alternative could support all acoustic measurement functions planned for the HAYES and would save \$44.2 million.

These cost savings, identified in the IG's final report, may not materialize. The IG's cost-savings estimate was based on the assumption that the Navy would save the entire amount budgeted to convert the HAYES, \$54.2 million. However, the Navy awarded the conversion contract in February 1987, after the DOD/IG's draft report was issued. Because some contract funds have been expended and termination costs would be incurred, the Navy would not realize all these savings if this recommendation were implemented.

There are two technical issues associated with this recommendation: (1) whether noise interference at AUTECH in the Tongue of the Ocean would interfere with acoustical measurements and (2) whether or not other ships could do what the Navy is expecting the HAYES to do.

Noise Interference at AUTECH Site 7

The issue of noise interference at AUTECH site 7 is unresolved. (See p. 13 for a map of this area.) Since 1969, officials from the David Taylor Center have argued that noise from the AUTECH weapons range would

⁹Name given to the body of water where AUTECH's activities take place.

interfere with engineering measurements in the Tongue of the Ocean.¹⁰ In concluding that weapons range noise would not interfere at site 7, the IG relied on several sources, including a 1969 acoustic study by the David Taylor Center, which covered site 1 as well as information provided by the management of AUTEK, the Systems Center.¹¹ This information included a March 1987 Systems Center draft report on noise interference levels in the Tongue of the Ocean, specifically site 7 and the cul-de-sac.¹² This report concluded that engineering measurements could be done at both locations.

During interviews with Navy officials, they raised questions as to whether noise from weapons range activities would prohibit engineering measurements at site 7. According to Systems Center personnel and the 1987 draft report, engineering measurements could be made at site 7 with more sophisticated arrays, which will be required anyway for future measurements of quiet submarines. These personnel stated, however, that the cul-de-sac would be a better location than site 7 because the weapons range noise would not reach the cul-de-sac.

According to Systems Center officials, the Systems Center has never studied in detail the feasibility or cost-effectiveness of installing a facility at site 7 or the cul-de-sac. The Systems Center had begun a study, but the Assistant Secretary of the Navy (Shipbuilding and Logistics) ordered an end to such studies in February 1987. This was when the Navy contracted with the Tacoma Boatbuilding Company to convert the HAYES.

NAVSEA personnel disagreed with both alternatives for an engineering facility at AUTEK. They cited technical problems with the Systems Center's suggestion to use sophisticated arrays to screen out weapons range noise at site 7. NAVSEA personnel also stated that reflections of weapons range noise in the cul-de-sac could interfere with engineering measurements. If the weapons range unit training activities were moved to another location such as the planned new ranges off of Eluthera, the

¹⁰To avoid weapons range noise, David Taylor Center operates its current engineering facility, the Mobile Noise Barge, in Exuma Sound, and plans to operate the HAYES there as well.

¹¹If the DOD/IG recommendations were implemented, the Systems Center would operate the East Coast engineering facility, AUTEK site 7, which would provide all submarine engineering and fleet support tests on the East Coast. David Taylor Center would no longer operate an East Coast facility.

¹²Site 7 is an area of the Tongue of the Ocean that has an existing system for tracking ships undergoing tests. The cul-de-sac is another area of the Tongue of the Ocean that is located farther away from the weapons range than is site 7. No area in the cul-de-sac has a tracking system in place.

noise problem at site 7 and the cul-de-sac would be eliminated. (See pp. 11-14.)

IG officials said that their definition of site 7 includes any area in the southern Tongue of the Ocean, not just the area at site 7 with the existing tracking system. They stated that a facility in any other area of south Tongue of the Ocean would cost more to install than one would at site 7.

Future Submarine Measurements With a Towed Array

The Navy has other ships that may be able to tow an array to meet future submarine measurements. According to IG personnel, the Navy has existing ships that could do so, with the resulting data processed ashore. The IG report suggested the ATHENA¹³ class ships, which currently support other towed array programs. Two ATHENAs currently conduct tests most of the year, and one other ATHENA has been converted to support a specific program. The IG also suggested submarines for submarine-on-submarine tests.¹⁴

The feasibility of using the ATHENA class ships is unresolved. IG officials told us that the Navy has four ATHENAs in "mothballs" which could be used to support the Navy's towed array tests. However, these ships may require modification to meet the Navy's needs. The Navy says the ships must be quiet and have an on-board capability to process and analyze collected data. The IG says that collected data can be processed ashore and that the ATHENAs can be modified to suppress radiated noise. Any modification to the ATHENA should be taken into account when assessing the cost-effectiveness of this recommendation.

The suitability of using submarines to tow an array for noise measurements is also unresolved. According to NAVSEA officials, submarines cannot accommodate the measurement system that will be required for radiated noise measurements. Further, data available at the IG office shows that the measurement system for submarine-on-submarine tests is in an initial development stage and is being designed for only limited submarine noise measurements.

IG officials stated that they presented the above proposals as options for the Navy to consider, not as proven alternatives for towing an array.

¹³The ATHENA is a class of research ships that supports Navy RDT&E programs.

¹⁴In a submarine-on-submarine test, one submarine would tow an array alongside another submarine undergoing the acoustic test.

New Requirement for the USNS
HAYES

The Navy's plan for a new target strength measurement facility raises questions on the feasibility of canceling the contract for the HAYES conversion. The Navy plans to install this facility in Exuma Sound, and to use the HAYES to deploy arrays and process the measurement data. According to the facility's program manager, another ship with array handling and data processing capabilities would be needed to support the facility if the HAYES is not available.

IG officials told us that the Navy did not tell them about the requirement for the HAYES to perform target strength measurements at the time they made the recommendation. However, IG officials still believe the ATHENA could support the planned facility. They also believe the Navy needs to demonstrate that either the ATHENA cannot support the facility, or the HAYES is uniquely required to do so.

IG officials said they did not closely examine target strength measurement requirements because they believed the requirements were being addressed by an existing Navy program in the 1986 AUTECH Instrumentation and Modernization Plan. This plan contained a proposal for a new target strength measurement system, but it was subsequently removed.¹⁵ IG personnel believed that the proposed system would meet all Navy target strength requirements. However, according to a Systems Center official who prepared the Instrumentation and Modernization Plan, this measurement system would not support the same type of measurements as those planned for the Exuma Sound facility.

Decommission the
Research Vessel DEER
ISLAND in Fiscal Year
1988

The DOD/IG's report recommended that the research vessel DEER ISLAND be decommissioned in fiscal year 1988 to save \$1.4 million annually. The report proposed that the DEER ISLAND's work load be transferred to the St. Croix acoustic measurement facility in the Virgin Islands, a facility that can do only surface ship tests. The IG initially based this recommendation on data that showed low use of the DEER ISLAND in 1985 when its work load consisted primarily of surface ship tests. IG officials told us that they also relied on utilization data contained in the Navy's Long-Term Underwater Support Resources Plan as well as statements from a fleet official who said that surface ships prefer to go to St. Croix for acoustic tests because the St. Croix facility is part of a large training range.

¹⁵In September 1987, after the IG report was issued, the proposal for a target strength measurement system was removed from the AUTECH Instrumentation and Modernization plan.

Two factors raise questions over the feasibility of this recommendation: the DEER ISLAND's submarine work load has increased, and it is used by surface ships that do not go to St. Croix for training activities. In January 1987, when the AUTEAC acoustic measurement range was placed in standby status, the DEER ISLAND absorbed AUTEAC's acoustic measurement work load. As a result, the DEER ISLAND supports submarine predeployment tests that were previously done at AUTEAC. The DEER ISLAND continues to provide acoustic tests in the northern Tongue of the Ocean for surface ships not scheduled to operate at the St. Croix facility.

IG personnel told us that the DEER ISLAND's current submarine work load could be transferred to the Mobile Noise Barge, and some of its surface ship work load transferred to the St. Croix facility. For those surface ships not scheduled for training at St. Croix but requiring an acoustic test, the IG believes the Mobile Noise Barge could satisfy these requirements.

Questions remain as to whether the Mobile Noise Barge could absorb a large portion of the DEER ISLAND's current work load without hindering fleet access to acoustic tests. In its plan for acoustic measurement facilities, the Navy stated that these facilities must be available to meet the ships' schedules, particularly those of submarines requiring mid-operational tests. Based on historical data presented in the Navy plan, the IG proposal would increase the barge's usage rate to about 65 percent. However, Navy projections indicate the rate would increase to about 93 percent through fiscal year 1990. It is unclear how this increased work load would affect the barge's accessibility to fleet users.

IG officials told us that they believe the Mobile Noise Barge could absorb most of the DEER ISLAND's work load, based on the barge's current usage rate of about 39 percent. According to historical data in the IG report, this proposal would increase the usage rate to about 62 percent.¹⁶ IG personnel stated that they believe the Mobile Noise Barge could increase its work load to that level without creating scheduling conflicts for fleet users.

In its comments on the IG report, the Navy responded only to the report's statement that St. Croix could absorb all of the DEER ISLAND's work load. The Navy said that the St. Croix facility is an inappropriate

¹⁶The IG data projects no change in the work load for East Coast facilities, while the Navy data projects an increase.

environment for conducting submarine tests, and could not meet the needs of all surface ships requiring an acoustic test.

Move the Mobile Noise Barge to Behm Canal

The DOD/IG's report recommended that the Navy modify its plans for the new West Coast engineering facility at Behm Canal. Specifically, the IG recommended that the Navy (1) move the current mobile facility, the Mobile Noise Barge, from the East Coast to Behm Canal to serve as a moored laboratory and replace the planned on-shore laboratory and (2) continue to use the existing static measurement site at Carr Inlet, which the Navy plans to close. According to the report, these modifications would save \$27.2 million in construction and instrumentation costs for the Behm Canal facility, and \$1.4 million in annual costs associated with operating the Mobile Noise Barge on the East Coast.

Questions remain on the suitability and cost-effectiveness of using the Mobile Noise Barge as an alternative to the Navy's planned shore laboratory at the Behm Canal. Navy officials told the IG that the barge is structurally sound and that the Navy plans to move the barge to the West Coast to conduct acoustic tests on the converted HAYES.

Other Navy officials told us that the barge would require extensive modifications to make it seaworthy to transit to the Behm Canal, and quiet enough to make engineering measurements once there. In addition, they said future instrumentation will require more laboratory space than that available on the Mobile Noise Barge.

IG officials agreed that the Mobile Noise Barge may require quieting for future engineering measurements. They also agreed that any modifications to the barge would increase the costs for this proposal.

Close Santa Cruz Facility

The DOD/IG's report recommended that the Navy close the Santa Cruz facility after the new Behm Canal facility becomes operational, for an annual savings of \$2.1 million. After the Behm Canal facility opens in 1991, the Navy plans to use Santa Cruz for submarine predeployment tests only, and projects annual usage of only 12 days for this facility. According to the IG, Santa Cruz's remaining submarine work load could be absorbed by the San Clemente facility, which currently conducts only surface ship tests.

Questions remain on the feasibility of closing the Santa Cruz facility and transferring its future submarine work load to the San Clemente facility.

According to NAVSEA officials, the Santa Cruz facility must remain open because San Clemente does not have the required instrumentation to support any submarine tests, and would require major improvements to do so. In reviewing this issue, the IG relied primarily on statements from the San Clemente management that the facility would require only a new array to conduct submarine tests. The IG report did not include costs for either closing Santa Cruz or installing a new array at San Clemente. IG officials said that closure costs were not readily available. However, they believed costs to close Santa Cruz would be minimal and a new array would cost about \$1.5 million.

DOD/IG Cost Savings May Not Materialize

It remains unresolved whether implementing the IG recommendations for new engineering facilities would save \$71.4 million over the life of the facilities. The cost savings are uncertain because all costs were not included in the savings calculations, and because the cost estimates may change during the resolution process if the recommendations change.

In comparing the HAYES to a new facility at AUTECH site 7, all costs associated with implementing each alternative were not included. The IG calculated a savings of \$44.2 million for its proposal. The IG compared only its estimated savings associated with canceling the HAYES conversion, \$54.2 million,¹⁷ with its estimated cost of \$10 million to install two arrays at AUTECH site 7. The IG identified these savings after the Navy awarded the HAYES contract. Although actual termination costs were not known, the report should have identified the potential impact of terminating the contract. Other potential cost increases associated with implementing the recommendation include

- future instrumentation for the HAYES,
- upgrades to AUTECH instrumentation to meet future measurement requirements,
- use of an existing ship to tow an array and to support the proposed target strength measurement facility, and
- maintenance and operations for the respective facilities.

IG officials acknowledged that their cost estimates for a new facility at AUTECH are not fixed, and may change depending on the facility's location in the Tongue of the Ocean and on the sophistication of the facility's arrays. If the facility were to be located away from the existing tracking

¹⁷This figure represents total program costs for the HAYES conversion, of which \$33.9 million was for the conversion contract, and the remainder for other program functions.

system at site 7, the cost estimates for the facility would increase to include costs for additional data transmission cables, a tracking system, and navigational aids for the ships undergoing the tests. Further, the IG's cost estimate of \$10 million to install two arrays may also increase to between \$15 million and \$20 million if more sophisticated arrays are required.¹⁸

Other estimated savings did not include all costs associated with the alternatives presented. The Behm Canal estimates did not include costs for making the Mobile Noise Barge quiet or transporting it to the West Coast. According to Navy officials, modification costs for the barge would total about \$20 million.¹⁹ In addition, the calculation of savings from closing the Santa Cruz facility did not include one time capital costs of a new array at the San Clemente facility or the costs associated with closing Santa Cruz. The IG said it estimated the costs for the new array to be about \$1.5 million, based on other arrays the Navy has installed.

Conclusions

Differences of opinion exist over the technical feasibility and cost-effectiveness of the recommendations contained in the DOD/IG's report on acoustic measurement facilities. Most importantly, technical issues associated with closing existing facilities, canceling the HAYES conversion, and modifying Behm Canal plans remain unresolved. Thus, it was uncertain, at the time of our review, whether the facilities recommended by the IG would allow the Navy to meet its acoustic measurement requirements in the most timely and cost-effective manner.

Because of the significance of the potential savings associated with the IG's recommendations and the technical issues that have remained unresolved within the Navy, it is important that an appropriate and early resolution be reached that will allow the Navy to meet its acoustic requirements in the most cost-effective manner.

¹⁸The IG based its cost figures on three estimates received from Systems Center officials. These estimates totaled \$10 million, \$15 million, and \$20 million, respectively, and varied according to type of array. In its report, the IG included only the cost estimate for the least capable array, \$10 million.

¹⁹This estimate includes costs for making the Mobile Noise Barge seaworthy.

Long-Term Test Resource Planning by DOD

Our 1986 report¹ identified problems with the Navy's test resource management in the antisubmarine warfare area. The Committee asked whether organizational problems existed in the other Navy warfare areas, such as antisurface ship and antiair warfare, and in the other military services. To respond to this request, we interviewed DOD officials in the Office of the Secretary of Defense (OSD) and in the Army, Navy, and Air Force involved in test resource management. We obtained and analyzed directives and supporting documentation. While we found no organizational problems in the other Navy warfare areas or in the other services, we noted that OSD and the military services are in the process of implementing initiatives to improve test resource planning. These planning initiatives were begun because of a lack of emphasis on and coordination of test resource acquisition. It is too early to assess the viability and impact of these initiatives; however, they appear to be a step in the right direction. Effective identification of long-term test resource needs should provide a sound basis for prioritization and trade-offs and also ensure that sufficient test resources are in place when needed. This appendix briefly discusses the status of these initiatives.

OSD Initiatives

OSD has begun several initiatives to improve test capabilities and bring a central focus to test resource management. Establishing the DOD Test and Evaluation Council, which reports to the Defense Acquisition Board, has brought a high level focus and emphasis on test resources. The Council is emphasizing long-range planning and is developing a comprehensive test investment strategy based on the military service's test resource requirements. Chaired by the Director, Operational Test and Evaluation (DOT&E), the Council includes the service acquisition secretaries as well as other high level acquisition executives.

OSD, through DOT&E, is also addressing the problem of test realism by initiating an Operational Test and Evaluation Capabilities Improvement Program. The program is the result of a 1986 DOT&E effort that identified serious shortfalls in operational test and evaluation capabilities. To address this problem and enable the testing of weapon systems in a more realistic air-land battle scenario, the program is to develop a largely mobile field operational testing capability. It is also developing a threat support data base to identify program test dates, threat simulator requirements, shortfalls, and resource requirements. The data base is

¹Test Resources: Early Testing of Major ASW Weapons Can Be Enhanced by Increased Focus on Test Resources (GAO/C-NSIAD-86-19, June 30, 1986).

expected to provide DOT&E and the services with a comprehensive overview of threat simulator support for operational testing and identification of shortfalls.

Services Are Taking Steps to Identify Long-Term Test Needs

In support of OSD initiatives, the military services have begun long-term planning to identify test resource requirements. In the past, Army test and evaluation resource requirements were addressed in the Program Objective Memorandum development process with constrained budgetary guidance, resulting in only a 5- to 6-year projection of required resources. As a result of the DOD Test and Evaluation Council initiatives, the Army is beginning to plan for test resources out to the year 2002. To identify its needs, the Army prepared a Long-Range Research, Development and Acquisition Plan. The plan provides mission area information, listing systems to be acquired, second generation and product improvement systems, and technology thrusts that will lead to new systems. Both operational and development test needs are addressed.

To date, the Navy's test resource planning has covered only the antisubmarine warfare area. The Long-Term Underwater Test Resource Support Plan, discussed in appendix I, identifies antisubmarine warfare test resource requirements into the year 2007. We were told that the Navy plans to do similar comprehensive long-term planning for test resources supporting other areas such as antiair warfare and antisurface ship warfare.

The Air Force's test resource plan covers 20 years. Because it is not constrained by expected funding, it identifies test resource shortfalls. It also identifies the weapon systems being supported, the time frames in which the test resources will be required, and includes both development and operational requirements.



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