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BY THE COMPTROLLER GENERAL

Report To The Congress

OF THE UNITED STATES

Alternatives To Consider In Planning Integrated Logistics Support For The Trident Submarine

The Integrated Logistics Support Plan for Trident ensures that the submarine will be adequately maintained There is time to implement additional controls and procedures that can improve logistics support planning for the submarine

The report presents several alternatives for the Navy and DOD logistics planners to consider in the still developing Trident logistics program Also, it asks several questions that need to be answered before proceeding further

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COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D C 20548

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To the President of the Senate and the
Speaker of the House of Representatives

This report describes the problems the Navy is encountering in the Integrated Logistics Support plan for the still developing Trident submarine. It also suggests logistics alternatives which, we believe, can improve Trident's logistics support planning.

We initiated this review after preliminary research indicated that problems existed in the Navy's planning for the Integrated Logistics Support program for the Trident submarine.

We are sending copies of this report to the Director, Office of Management and Budget, and the Secretaries of Defense and the Navy.

Comptroller General
of the United States

COMPTROLLER GENERAL'S
REPORT TO THE CONGRESS

ALTERNATIVES TO CONSIDER IN PLANNING INTEGRATED LOGISTICS SUPPORT FOR THE TRIDENT SUBMARINE

D I G E S T

This report evaluates the Trident submarine's Integrated Logistics Support plan, identifies the current status of several of its logistics elements, and concludes that while these submarines will be adequately maintained, a more comprehensive plan is needed.

The plan was developed to sustain the Trident submarines' requirements, which include having submarines on patrol 70 days and being able to deliver 24 missiles to their assigned targets.

Trident's operational cycle renders it more available than the present fleet ballistic missile submarines. The Trident cycle consists of a 70-day patrol followed by a 25-day refit and test period and is to continue for 9 years.

The Integrated Logistics Support plan includes collecting and retaining information on equipment, maintenance tasks, repair parts, and critical Trident components. This process is known as Logistics Support Analysis. It is essential to defining support requirements, predicting logistics costs, and evaluating logistics alternatives.

Due to an inadequately executed Logistics Support Analysis process, implementation of the supply support plan has been delayed. Similar delays in the submarine's delivery lessened the impact of the support plan delay on the overall Trident program. (See p. 14.)

The supply support plan does not use the most accurate data to develop estimates on the reliability of Trident's components. Nor has the Trident Logistics Support Analysis process had sufficient information to

select equipment and evaluate logistics alternatives early in the program. (See p. 10.)

GAO believes that it is still not too late for Navy logistics planners to consider other, more accurate methods for supplying the submarine. (See ch. 3.) Also, there is still time to implement a five-crews-for-three-submarines concept which could save $8.1 million per year, or $243 million over the Trident's life cycle. (See ch. 5.)

More detailed planning could also be of value in the program. For example, the original plans for the Trident's transit of Connecticut's Thames River were not sufficiently detailed and did not consider all interacting elements. (See ch. 7.)

Consideration of the following questions by the Department of Defense (DOD) and Navy logistics planners could help them develop a more comprehensive plan for this vital weapon system:

--Should DOD monitor the development of Trident's Integrated Logistics Support plan and Logistics Support Analysis process?

--How many Trident submarines will be built?

--How will technological advances in strategic systems affect future Trident decisions?

RECOMMENDATIONS

The Secretary of Defense should require the Navy to:

--Use the DOD standard to develop a Logistics Support Analysis program. (See p. 15.)

--Use the Trident Support Site to support other Navy programs, especially during Trident's early operational years. (See p. 20.)

--Test a five-crews-for-three-submarines policy for Trident submarines. (See p. 28.)

--Develop detailed plans for delivery of future submarines and other vessels to the areas where they will be used. (See p. 50.)

The Secretary of Defense and the Secretary of the Navy should fully explore alternatives to the Trident east coast facility and present the options and tradeoffs available to the Congress. Until the tradeoffs are adequately considered, a decision to develop an east coast Trident support site could be premature. (See p. 33.)

AGENCY COMMENTS

GAO met with representatives from the Office of the Secretary of Defense and the Navy to discuss the issues and recommendations in the draft report. DOD officials generally agreed with the recommendations, except for the proposed Trident staffing concept. (See ch. 5.) They also suggested that GAO revise the recommendations on the Trident maintenance and supply concepts. (See chs. 3 and 4.)

Contents

ABBREVIATIONS

DOD	Department of Defense
GAO	General Accounting Office
ILS	Integrated Logistics Support
LSA	Logistics Support Analysis

CHAPTER 1

INTRODUCTION

U.S. strategic nuclear weapons can be launched from bombers, fixed silos, or submarines. Together, the three are commonly referred to as the Triad. The Trident weapon system, which will become part of the Triad, consists of longer range Trident missiles, a nuclear powered submarine with 24 missile tubes, and an integrated support system concentrated at a new submarine base at Bangor, Washington.

The Trident submarine, scheduled for deployment in August of 1981, will join and later replace the Polaris and Poseidon submarines in the sea-based strategic nuclear force. The Trident submarine will be larger, carry more missiles, and is designed to meet a more demanding operational schedule than existing fleet ballistic missile submarines. For the Trident submarine to meet its operational goals, an Integrated Logistics Support (ILS) system has been established. This system includes a shore-based facility that will support management for the submarine's life cycle and many other logistics elements that were specifically designed for the Trident submarine.

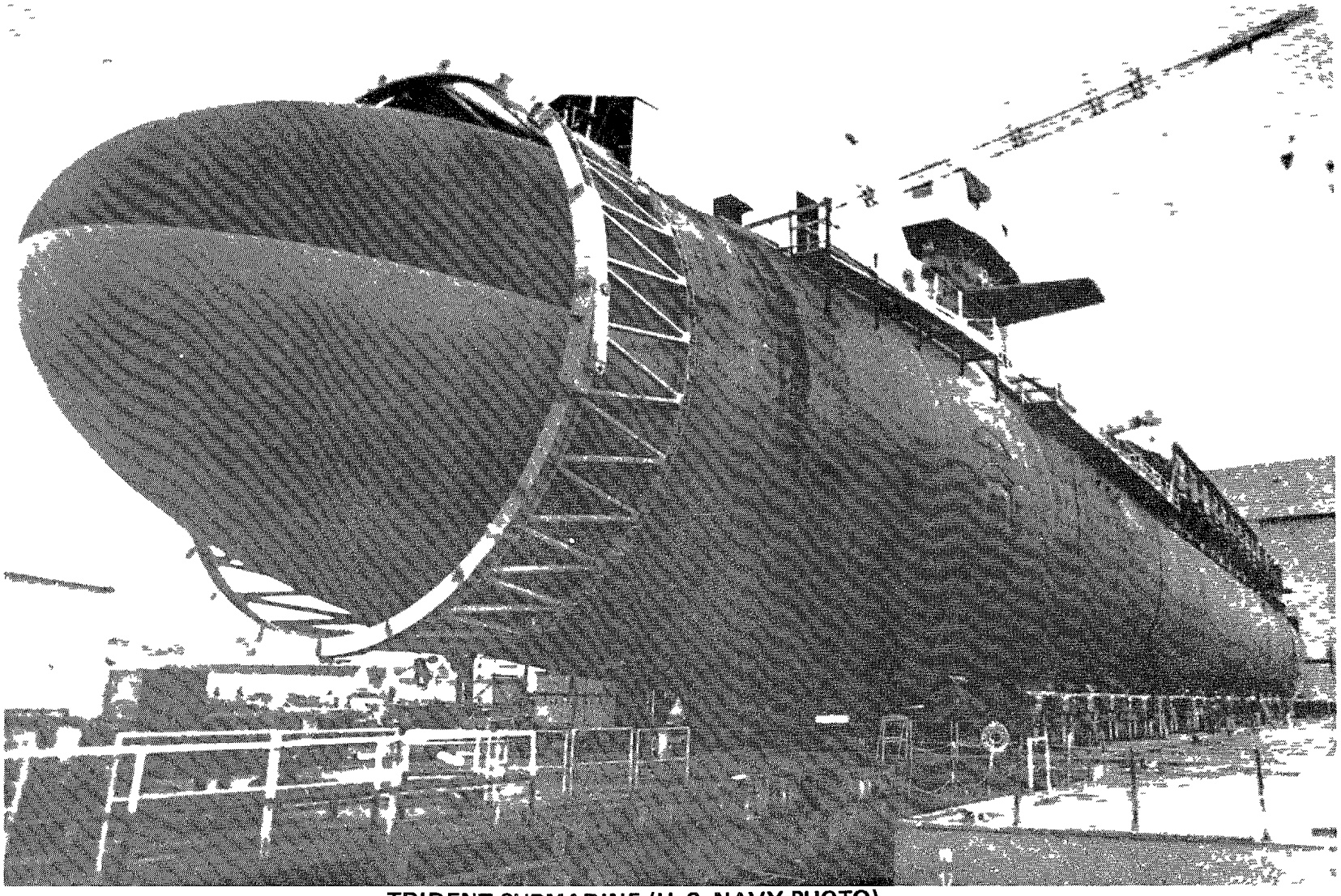
The ILS plan was developed to ensure that all support considerations, such as maintenance, supply, training, personnel, and transportation, are properly planned, coordinated, and developed. (See p. 3.) The plan also sought to ensure effective and economical support of the submarine for its life cycle.

If ILS is planned effectively, the amount of support and its cost should balance with system effectiveness.

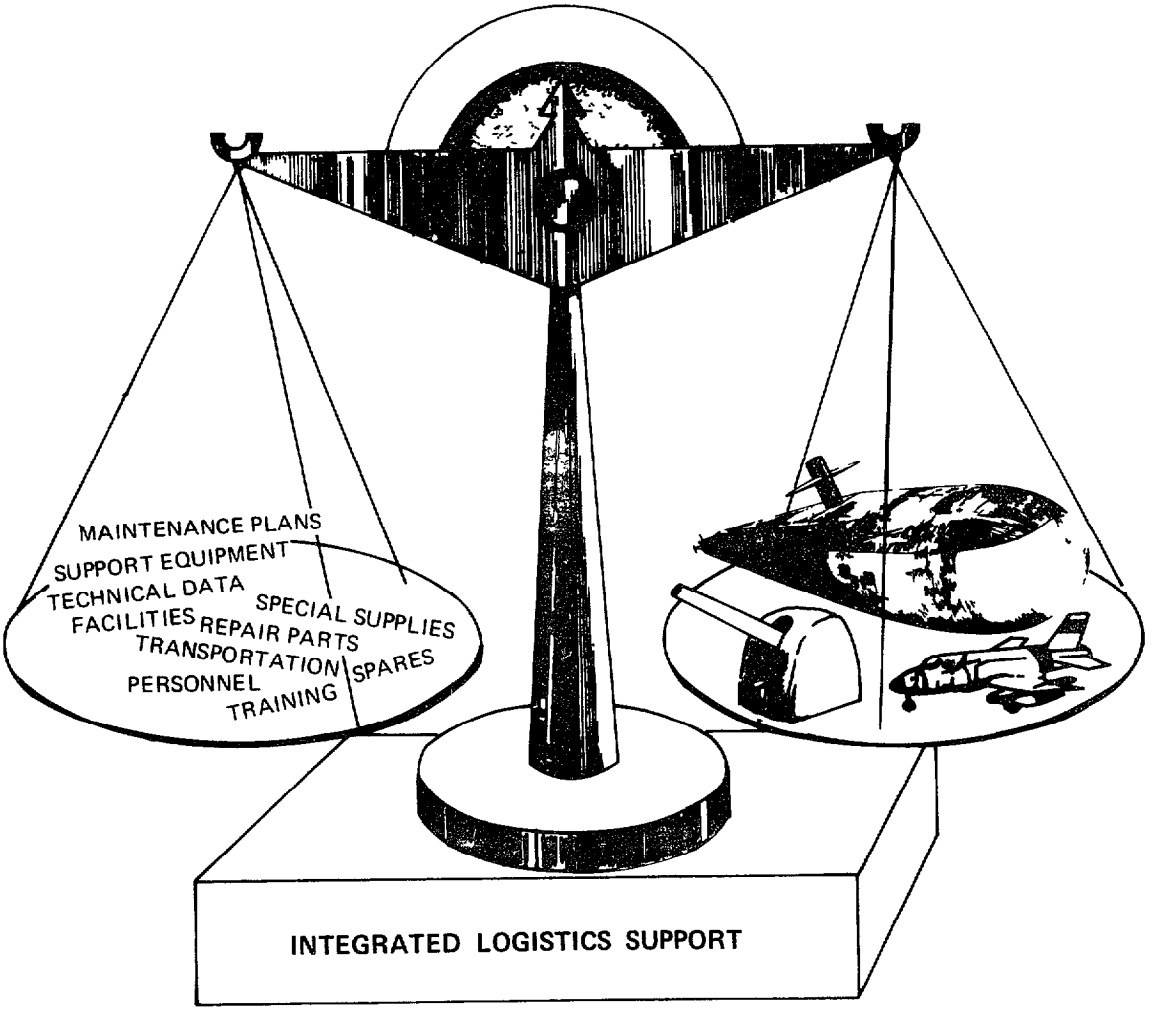
SCOPE OF REVIEW

Our work was conducted at the Project Manager's Office, Washington, D.C.; Naval Submarine Base, Bangor, Washington; Trident Support Activity, Mechanicsburg, Pennsylvania; and the shipbuilder's facility in Groton, Connecticut.

The organizations responsible for the Trident submarine's ILS system are presented on page 4.



TRIDENT SUBMARINE (U S NAVY PHOTO)


MAINTENANCE PLANS
SUPPORT EQUIPMENT
TECHNICAL DATA
FACILITIES
TRANSPORTATION
PERSONNEL
TRAINING
SPECIAL SUPPLIES
REPAIR PARTS
SPARES
INTEGRATED LOGISTICS SUPPORT

TRIDENT ILS SYSTEM ORGANIZATION

PROJECT MANAGER — TRIDENT SYSTEM

PROVIDES OVERALL DIRECTION, CONTROL AND INTEGRATION OF THE TRIDENT SYSTEM AND DERIVES IMMEDIATE SUPPORT FROM THE ELEMENTS IDENTIFIED BELOW

TRIDENT SUPPORT ACTIVITIES, MECHANICSBURG DEDICATED LIFE CYCLE SUPPORT ORGANIZATION

TRIDENT SUPPORT SITE PROVIDES LOGISTICS SUPPORT IN THE OPERATIONAL PHASE

PROJECT MANAGER, SHIP ACQUISITION PROJECT ACQUISITION AND ILS MANAGEMENT OF SHIP SYSTEMS

PROJECT MANAGER, SPECIAL COMMUNICATIONS PROJECT ACQUISITION AND ILS MANAGEMENT OF COMMUNICATION SYSTEMS

OFFICER IN CHARGE OF CONSTRUCTION DESIGN AND CONSTRUCTION OF FACILITIES

DIRECTOR, STRATEGIC SYSTEMS PROJECT ACQUISITION AND MANAGEMENT OF MISSILE SYSTEMS

CHAPTER 2

TRIDENT'S ILS PLAN

Over the life cycle of a weapon system, logistics support represents a major portion of the total cost and is sometimes the principal cost element. Therefore, for major systems to be cost effective, logistics support must relate to their design, development, test and evaluation, production, and operation.

The Department of Defense (DOD) has directed that an ILS planning approach be used to develop an effective and efficient support program with priorities that are consistent with major program objectives. Accordingly, an ILS plan was developed for the Trident program to ensure that all logistics support for the operational Trident submarine was properly planned, coordinated, and developed.

Although several basic questions remain unanswered for the still developing Trident logistics support program, the ILS approach we examined should generally ensure that the Trident system will be adequately maintained. This is because of Trident's unique design features and dedicated support facilities. The unanswered questions are:

--Should DOD monitor ILS plans and Logistics Support Analysis (LSA) development?

--How many Trident submarines will be constructed?

--How will technological advances in strategic systems affect future Trident decisions?

ILS PLANNING IS NECESSARY

Logistics support includes many tasks that affect many organizations. In the past, the various support tasks--such as maintenance, provisioning, and staffing--were managed independently, and some support tasks were not considered at all during the management process. This management approach was not effective. The various support elements were not properly integrated and communications among organizational entities were inadequate. Such problems can be overcome through properly integrated planning.

ILS, a composite of the support tasks or elements necessary to ensure effective and economical support of a system at all levels of maintenance for its life cycle, can assist

effective logistics planning. The principal elements of a thorough ILS plan include

--maintenance planning,

--supply support,

--facilities,

--personnel and training,

--transportation and handling,

--support and test equipment,

--technical data,

--logistics support resource funds, and

--logistics support management information.

ILS ensures that these support elements are integrated with other system requirements and with each other. Although each element is usually managed separately, all the other elements must be considered when planning, coordinating, and controlling all logistics support tasks necessary to support the major system. Logistics element management begins with the early phases of logistics planning at system inception and extends through use and phasing out of the system. (See p. 8.) Thus, ILS is characterized by open communication channels among all logistics managers, contributing to the integrative nature of ILS planning.

An important tool of an effective ILS plan is LSA. LSA provides and maintains information on the performance of all logistics elements and emphasizes their interrelationships throughout system design and development. LSA, the integrative force in the ILS plan, enables the ILS manager to evaluate and make decisions on the program as the design matures. Furthermore, the LSA process should collect data on proposed design changes and identify the logistics resources needed to support design configurations at all levels of maintenance. (See p. 9.)

DOD's policy on ILS

DOD has long recognized the need for comprehensive logistics support of major systems. DOD's policy stresses

that ILS is an integral part of system acquisition and operation. The object of DOD's policy is to make sure that systems are capable and available when needed by requiring an effective and efficient logistics support program. The policy also emphasizes that the cost of planning, developing, acquiring, and managing logistics resources is an inherent part of the cost of an operational system.

THE TRIDENT ILS PLAN

An ILS plan was developed to sustain the Trident submarines' program objectives, which include having the submarines on patrol 70 days and being able to deliver 24 missiles to their assigned targets. The operational cycle of a 70-day patrol at sea, followed by 25 days for refitting and testing, is planned to continue for about 9 years. This renders Trident more available for patrols than existing fleet ballistic missile submarines.

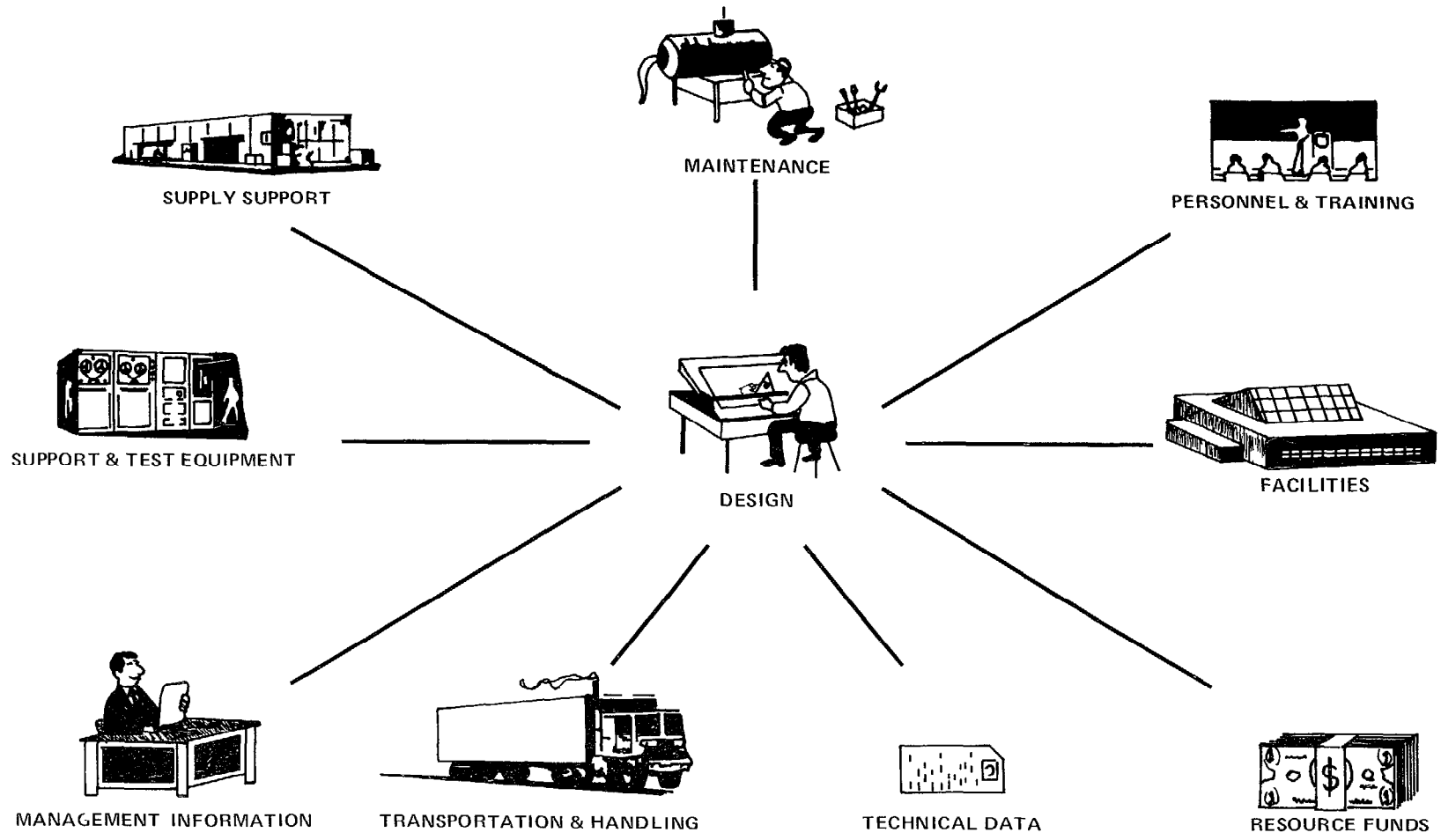
Comparison of Trident and Poseidon Operational Cycles

	Trident	Poseidon
	(days)	(days)
Patrol duration	70	68
Refit duration	25	32
Total	95	100

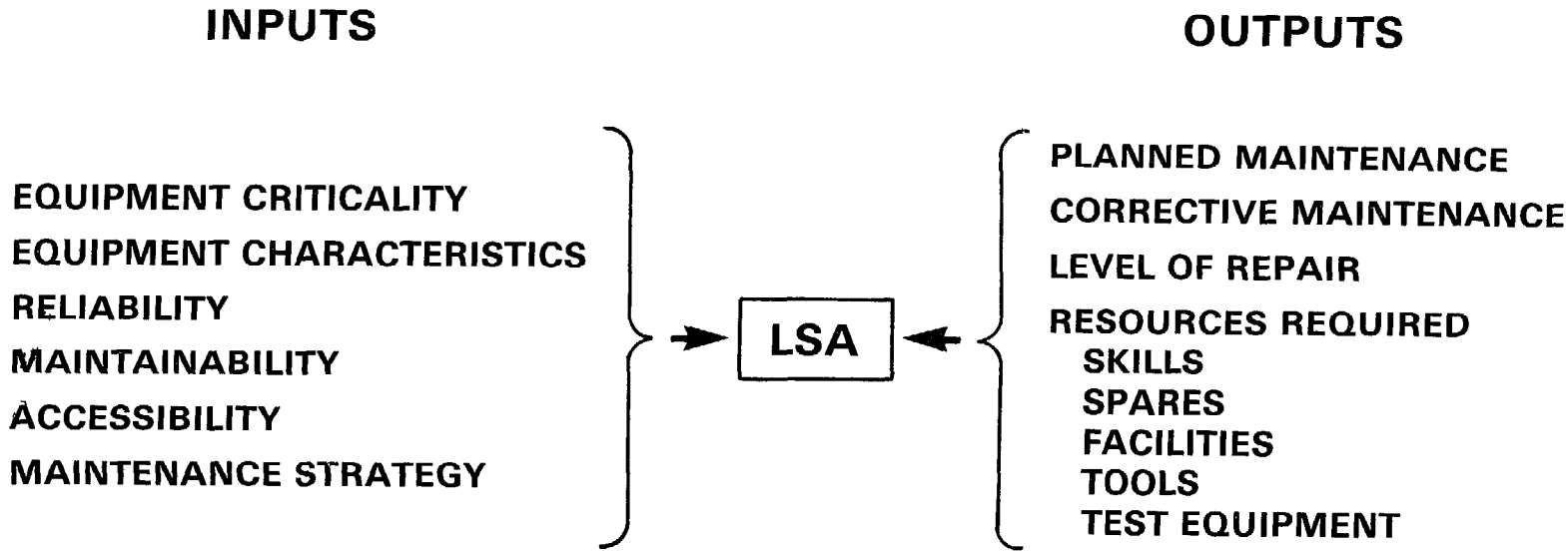
The Trident submarine has no extended refit activity. However, the Poseidon has a 62-day extended refit after every 11th patrol. Trident enters a major overhaul for 12 months after patrol 34, whereas the Poseidon enters a major overhaul for 19 months after patrol 33. The operational availability for Trident and Poseidon is 66 and 55 percent, respectively.

The Trident ILS plan was designed to coordinate and control the logistics tasks necessary to support 10 Trident submarines at a support site dedicated to this weapon system. The plan integrates support planning concepts into the entire Trident design and development process. For example, standardized equipment and larger passageways to enable rapid removal and replacement of that equipment have been designed for the Trident. Also, a management support activity and a support base have been established to support Trident submarines. Furthermore, the logistics elements mentioned on

ILS PROVIDES THE VEHICLE TO INTEGRATE SUPPORT CONSIDERATIONS INTO WEAPON SYSTEM DESIGN



LOGISTICS SUPPORT ANALYSIS (LSA)



page 5 are being considered together as Trident's operational and support requirements are set up. Because of this, Trident should meet its operational goals.

Two unique logistics support systems of the Trident ILS plan are:

--The Trident Support Site at Bangor, Washington.

--The Trident Support Activity at Mechanicsburg, Pennsylvania.

The Trident Support Site will be the focal point of shore-based support for the Trident submarine. It will provide for submarine refitting, maintenance, crew training, missile assembly and reworking, and personnel support for both military personnel and their dependents. In the past, Trident support was provided at different locations and for different vessels.

The Trident Support Activity, Mechanicsburg, will provide technical and management support for key logistics functions during submarine acquisition and throughout its life cycle. This organization includes an inventory control point, a logistics data system, and a logistics technical data management program.

Trident's ILS plan includes an LSA process which collects and retains information on equipment, maintenance tasks, repair parts, and critical Trident components These data items are considered together when providing the total resources needed by all Trident components in the LSA data file. DOD principles for LSA management state that the essentials of an LSA program are to

--analyze and define logistics support requirements,

--predict logistics support costs, and

--evaluate logistics alternatives.

Although DOD contends that an effective LSA process should influence the design of a weapon system and provide subsystem alternatives, the Trident LSA process did not do this. Even though Navy officials agree that the Trident LSA process did not influence subsystem support and selection, they contend that it is difficult to conduct an LSA process concurrent with ship design and construction. This difficulty arises because the Navy does not have sufficient

computer capacity to conduct the necessary tradeoff analyses that are an inherent product of an effective LSA process. Navy officials agree that this capability should be developed and applied to future shipbuilding programs.

QUESTIONS TO CONSIDER TO IMPROVE LOGISTICS SUPPORT PLANNING

DOD has established criteria that should provide effective and affordable logistics support systems. The ILS directives and the LSA standards provide a good guide to military logistics planners. Furthermore, compliance with these criteria can optimize the Nation's investment in defense capabilities.

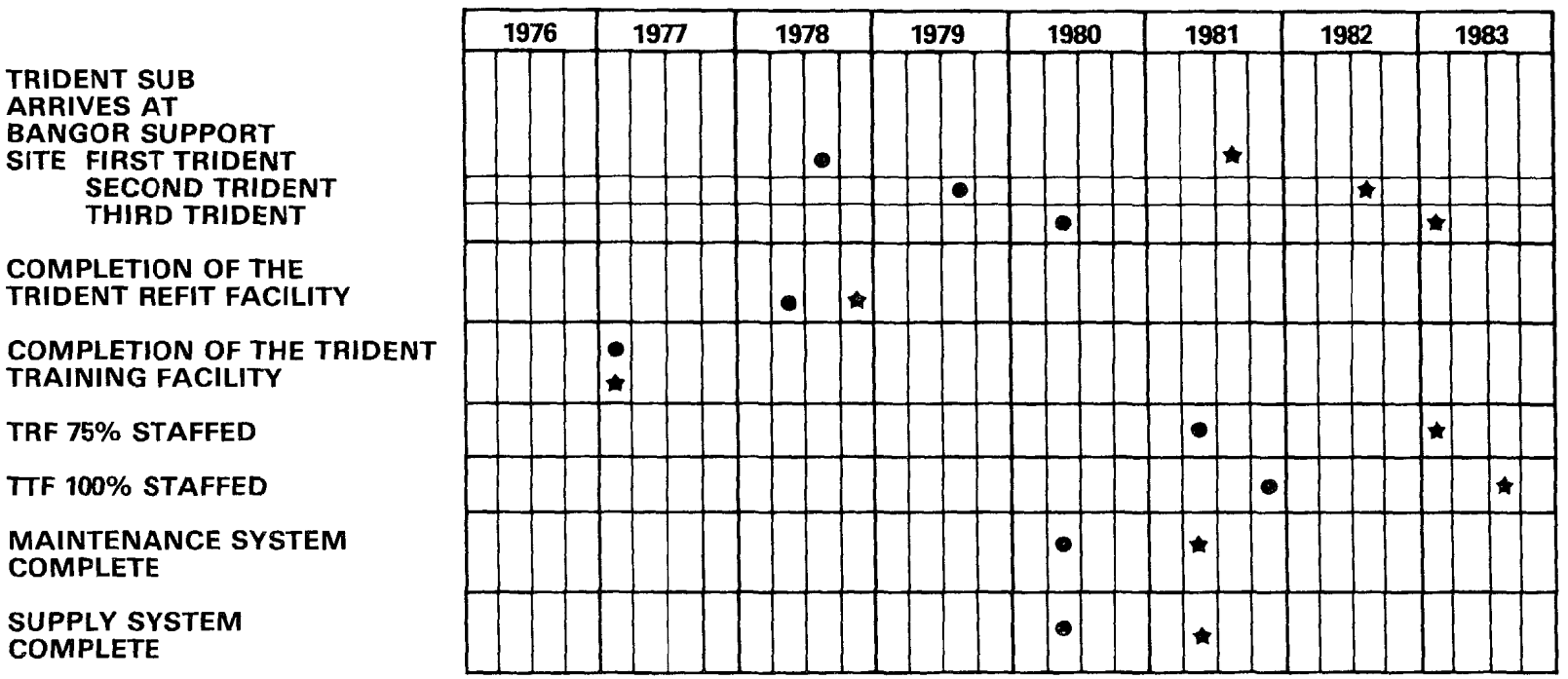
The Trident submarine will play an important role in our strategic defense capabilities. Because the Trident program is still developing, DOD and Navy logistics planners will be making many more decisions to ensure that the Trident submarine program is successful. For example, there is still time for Navy planners to save costs in Trident's staffing by implementing a five-crews-for-three-submarines concept. (See ch. 5.)

To assist Navy planners in making other critical decisions, we believe they should answer certain basic questions discussed below. Answers to these questions might provide them with alternatives or improvements to their present plans.

How many Trident submarines will be constructed? And should Trident have a base that will not support other Navy vessels? The submarine base at Bangor, Washington, was constructed to support 10 Trident submarines. However, DOD has not predicted the number of Trident submarines that will be constructed. We believe that reasonable estimates must be developed to construct logistics plans for any other submarines. Furthermore, the Trident submarine base is not scheduled to support other Navy vessels, yet it may have enough capacity to do so. Navy logistics planners may want to consider this when developing logistics designs for other vessels. (See chs. 4 and 6.)

When will Trident submarines be based on the east coast? And how many submarines will justify a base similar to Bangor? The east coast of the United States is presently involved in support activities for fleet ballistic missile

COMPARISON BETWEEN ORIGINAL AND CURRENT MILESTONES FOR THE TRIDENT SUBMARINE AND ITS INTEGRATED LOGISTICS SUPPORT SYSTEM



submarines. The availability of support facilities there may not require the extensive construction that took place at Bangor. (See ch. 6.)

How will technological advances in strategic systems affect future decisions on the Trident program? Continuing triumphs in advancing the state of the art for strategic weapon systems should be considered when developing support for the Trident submarine. The potential for improvements in missile technology, antisubmarine warfare, and submarine construction must be considered in programs that take place over many years.

DOD planners of future weapon systems may want to consider the following questions. Hindsight has shown us that Trident planners could have improved their plans by answering these questions.

Should DOD monitor ILS planning to ensure that cost is an inherent part of a logistics support program? DOD directives established cost as a design feature equal in importance to performance requirements. By monitoring the cost of logistics resources, DOD planners have better information on the affordability of major weapon systems. The Trident program did not maintain records on the costs of logistics resources.

Should DOD monitor the status of LSA development to ensure that it is available early in an ILS program? LSA should be the single source of information that identifies the logistics requirements for a major weapon system throughout its developmental cycle. During the design phase, LSA should identify logistics deficiencies to assist in selecting among support alternatives. The Trident program did not have an LSA process in the design phase of the weapon system. We believe that the result of this may have been having less information than needed to make decisions on alternative support techniques.

Once these questions are answered, DOD and Navy logistics planners should improve their framework for a comprehensive approach to logistics support planning.

CHAPTER 3

THE TRIDENT INTEGRATED SUPPLY SUPPORT CONCEPT

To meet its mission requirements, a major weapon system depends on the availability of supplies at the time and place they are needed. Supply support is, then, an essential element of logistics which ensures prompt provisioning, distributing, and restocking of spares, repair parts, and special supplies.

Trident's supply support plan was developed considering its stringent availability requirements (70-day patrol, 25-day refit, and 9 years between overhauls). The principal features of the plan are

--a refit facility dedicated to Trident,

--a Trident logistics data system, and

--a strategy to resupply the submarine within its refit period.

This supply support plan was designed to identify all Trident supply requirements and to ensure that they would be provided in an orderly and timely manner. However, due to delays in implementing the LSA process, this plan has been delayed. Similar delays in the submarine's delivery have lessened the impact of support plan delays on the overall program.

LSA AND TRIDENT'S SUPPLY SUPPORT PLAN

The Trident supply support plan identified LSA as the vehicle for gathering information that would identify Trident's supply requirements. As explained in chapter 2, LSA's primary objective is to generate information on all support considerations necessary to ensure the effective and economical support of a weapon system, such as Trident, for its life cycle. The purpose of the LSA process is not data collection itself, but using information to develop and maintain a deliverable product--the submarine and its support network--at a lower cost.

LSA effect on Trident's supply support

Because LSA was not executed early in Trident's acquisition cycle, it has not been totally effective in establishing supply support requirements. Effective LSA evolves as a program progresses and should be developed before production begins. However, according to current Navy estimates, the Trident LSA documentation will not be complete until March 1981, 4 months after the scheduled delivery of the submarine. Since LSA has not been completed, Navy logistics planners have had to devise alternate sources to determine Trident's supply support requirements.

If LSA is to be effective, it must be developed early enough in the ship's acquisition cycle to be used as a common source for all logistics support requirements, including supply support. When alternate sources of information are developed, the cost savings and management control which should be derived from using the "integrated" approach are lost.

Should the Navy have a standard LSA program?

A standard LSA program can help logistics planners use LSA early in a weapon system's acquisition process. DOD has prepared a standard LSA implementation guide that has a detailed explanation of LSA, a sample data system, and a presentation of standard data elements. It specifically provides for operator and maintenance considerations and shows how to make maximum use of LSA early in the acquisition cycle.

This guide also establishes the following essentials for every LSA program:

--Analysis and definition of logistics support requirements.

--Prediction of logistics support costs.

--Evaluation of logistics alternatives.

These program essentials are conducted throughout the acquisition cycle, making LSA the single analytical effort necessary for an effective logistics support plan.

Navy logistics planners should consider using a standard LSA program in all Navy weapon programs. A standard approach can assist logistics plans and provide for the early implementation of this important management tool.

INITIAL PROVISIONING: A KEY ELEMENT OF TRIDENT'S SUPPLY SUPPORT PLANNING

Provisioning, one of the most important functions of a supply support program, is the process of determining how many and what kind of spare and repair parts, tools, and support and test equipment are required to maintain a weapon system. The Trident provisioning process identifies all supply items that will be stocked on the submarine, at the Trident Refit Facility and Training Facility, and at Navy supply depots.

Navy estimates of the costs to acquire the initial supply stock for the first Trident submarine are presented below.

Estimated Costs for Initial Provisioning for Spare and Repair Parts (note a)

	Amount (millions)
Trident submarine	$4.0
Trident refit facility	3.6
Trident training facility	2.0
System stock for new Navy-managed items	4.0
Additional system stock to support Navy-managed Trident items already in the supply system	0.5

a/These estimates include only spare and repair parts to support Trident's mechanical, electrical, and electronic equipment. They do not include the cost of items in the Trident Planned Equipment Replacement Program.

Can Navy-wide parts replacement factors be used for Trident?

Determining supply support requirements before submarine deployment is difficult. Although Navy logistics managers have improved their predictions of supply support requirements, the accuracy of supply provisioning estimates largely depends on the reliability of the data used.

One significant variable of Trident provisioning is the estimate of an item's expected failure rate. Because many of Trident's parts are already in the Navy supply system, historical data is available from which failure rates can be computed. In Navy supply terminology, these failure rates are referred to as the "best replacement factor."

If a part is common to many different classes of ships in the Navy, the best replacement factor for that part is based on its fleetwide usage. Previous Navy studies indicate that a best replacement factor based on fleetwide usage may not represent usage rates on strategic submarines. One study determined that, for 70 percent of the items examined, fleetwide best replacement factors were greater than best replacement factors computed for the same items using only strategic submarine data. Thus, using the higher fleetwide failure rates could result in buying more parts than will be needed to support Trident.

The Trident provisioning process uses a best replacement factor based on fleetwide usage patterns. We asked Navy officials whether a best replacement factor based on submarine rather than fleetwide patterns would be more appropriate for the Trident provisioning process. Navy officials offered varying opinions on this issue, although most agreed that a best replacement factor based on submarine patterns would be more representative of Trident's expected usage patterns. For example, the Director of the Navy's Strategic Systems Project Office said that replacement factors are computed for both the weapon system and the ship system components for existing ballistic missile submarines. He also said that replacement factors developed solely from ballistic missile submarine data provides a better base for computing replacement requirements.

Since the best replacement factor is such a significant variable in the calculation of the items to be stocked during provisioning, we believe the data should be that which most represents Trident's expected usage patterns.

CONCLUSIONS

Supply support, an essential element of logistics, ensures prompt provisioning, distributing, and restocking of spare and repair parts and special supplies. This does not mean providing such service at any cost. Supply support should be conducted in a manner that provides only the supplies necessary to maintain a weapon system.

The Trident supply support program does not use the most accurate data for developing estimates on the reliability of Trident's components. This lack of data could result in excessive supply expenditures. Furthermore, Navy logistics planners should consider introducing an LSA program early in all major support systems.

RECOMMENDATIONS

We recommend that the Secretary of Defense direct the Navy to

--use the DOD standard to develop an LSA program and

--compute replacement factors using strategic submarine data only.

AGENCY COMMENTS

As noted in chapter 2, the Navy agrees that the Trident LSA process was not executed early in the development phase. It contends that insufficient computer capacity precluded effective implementation of a timely LSA process. The Navy further agrees, however, that its data base capacity should be expanded to conduct an effective LSA process on future shipbuilding programs.

With regard to the computation of replacement factors using strategic submarine data only, the Navy stated that there is no empirical evidence to support the premise that strategic submarine data is superior to fleetwide usage data. However, we contend, as does the Director of the Navy's Strategic Systems Project Office, that replacement factors developed solely from ballistic missile submarine data provides a better base for computing submarine requirements.

CHAPTER 4

MAINTENANCE PLANNING: AN INTEGRAL PART OF ILS

The maintenance plan for the Trident submarine identifies ILS requirements. The requirements for other logistics support elements cannot be defined until maintenance concepts and goals are established.

Although Trident's maintenance concepts and goals were established early in the program, there are alternatives that Trident's logistics managers should consider. These alternatives suggest that maintenance goals can be improved.

MAINTENANCE CONSIDERED IN TRIDENT SUBMARINE DESIGN

The Trident submarine must be maintained during a 25-day refit period between 70-day patrols. To develop a maintenance plan to meet the demands of this stringent new program, maintenance considerations were introduced early in Trident program planning. As a result, maintenance needs influenced the design of some Trident components and the arrangement of equipment on the submarines. The following are the most significant design features that resulted from this planning:

--Three logistics hatches, 6 feet wide, to assist the rapid loading of Trident's components and parts.

--Standard components and equipment that are interchangeable on all Trident submarines.

--Equipment designed for rapid removal, handling, and replacement.

IS SCHEDULED MAINTENANCE A GOOD PHILOSOPHY?

The maintenance philosophy adopted for some Trident components is based on a scheduled overhaul cycle. Estimates were made to determine the period during which each Trident item can be expected to work acceptably before requiring refurbishment. This period is called its "periodicity." On the basis of these periodicities, refit schedules are being developed that show which items will be changed during each refit.

While the Navy is implementing the planned refurbishment of Trident equipment, this may not be the answer to achieving effective operational support. For example, a study by the Center for Naval Analyses showed that planned refurbishment does not reduce failures of equipment and, ironically, some equipment failed more frequently after scheduled maintenance. The study also showed that the accident rate increased 8 percent and the incident (less serious than an accident) rate increased 24 percent during the five quarters after scheduled overhauls were done.

As an alternative to the scheduled overhauls of Trident equipment, Navy planners should establish a reliability centered maintenance program. Essentially, this maintenance approach is concerned wih monitoring the condition of equipment, rather than replacing it on a programed basis.

Reliability centered maintenance has become an acceptable industry and DOD means of using maintenance resources. When applied to aircraft, the concept has not jeopardized safe aircraft operation, and it has greatly reduced maintenance costs and improved aircraft availability. As pointed out in our 1978 report entitled "The Navy's Ship Support Improvement Project," DOD and the Navy have developed an integrated, engineered, reliability centered maintenance strategy to improve surface ship maintenance functions. This strategy should also be applied to the Trident maintenance program. Properly applied, it should be effective in decreasing Trident's maintenance requirements without adversely affecting safety of the submarine's mission.

CAN THE TRIDENT REFIT FACILITY BE USED MORE PRODUCTIVELY?

The repair facility at the Trident Support Site has more extensive facilities and equipment than that normally found at a fleet ballistic missile submarine facility. This facility will consist of refit service and magnetic silencing piers, a drydock, repair shops, and other waterfront facilities.

The Trident repair activity is at the heart of the Refit Industrial Facility. This facility contains over 6 acres of floor space and houses many repair shops and management offices.

Trident's triangular shaped refit pier consists of two 600-foot piers and one 690-foot drydock. The refit pier was designed to provide services to 3 submarines and can support a squadron of 10 Tridents once it is fully operational. In the center of the refit pier is a 58,000 square foot maintenance support building. This building supports submarine maintenance--such as drydocking, hull blasting, and painting--that cannot be done at the Refit Industrial Facility. In addition, the ship's crew will use equipment stored here for minor repairs.

According to Navy planning documents, the refit facility will be 56 percent staffed by August 1981 when the first Trident will arrive at Bangor, 70 percent staffed by August 1982 when the second submarine arrives, and 79 percent staffed by December 1983 when the fourth submarine is expected to arrive.

Plans call for doing only Trident related work at the facility even during the program's early phases. This may not be an efficient use of logistics resources. For example, due to the delayed delivery date of the first and later submarines, the extensive refit and repair facilities will be available long before the first submarine arrives.

Non-Trident maintenance work may be possible at the facility before the first Trident arrives for refit in 1981. This would be an effective way to test the facilities, systems, and equipment and would provide valuable experience for the military and civilian personnel who have already been assigned there.

Other ship maintenance and support might also be done during Trident's early operational years at the refit facilities. During this period, probably no more than one submarine, and often none, will be at the facility, due to their patrol requirements.

Trident related maintenance and supply work probably will not provide efficient use of refit facility equipment and personnel during these early periods. Navy officials should consider whether the Bangor facilities can be used for other Navy maintenance and support work. We believe this can be done without compromising Trident's operational availability requirements.

CAN THE MAINTAINABILITY FEATURES IN TRIDENT'S DESIGN BE APPLIED TO FUTURE SUBMARINE DESIGN?

Improving the maintainability of the ship's systems and equipment was a goal of Navy planners early in Trident's development. The 6-foot hatches, equipment design, and handling provisions to help equipment removal, as well as the equipment and component design for rapid disconnection and reconnection, are all features which should greatly improve the maintainability of the Trident over other submarines. While Trident's increased size allowed these features, contractor officials said they can also be scaled for a smaller submarine.

We believe that when the submarine is operational, a thorough cost-benefit analysis should be done to determine the extent to which these and other unique Trident design features improve the maintainability and availability of Trident systems. Navy planners should then evaluate the practicability of applying these features to future submarine design programs.

CONCLUSIONS

The maintenance plan for the Trident submarine was an important consideration early in the program. Because of this plan, many beneficial design features resulted which the Navy should consider incorporating into future submarine design.

We also believe that there may be less costly alternatives to a scheduled maintenance program. Evidence shows that equipment monitoring procedures may be superior to equipment replacement practices. New maintenance practices, such as reliability centered maintenance, which have been very successful in industry and DOD, should be more quickly implemented. Such concepts should be considered in ILS planning for new programs because they can significantly affect logistics support plans, including the facilities needed.

Furthermore, the Bangor submarine base has many facilities that may be able to support other Navy programs, especially during Trident's early operational years.

RECOMMENDATIONS

We recommend that the Secretary of Defense require the Navy to

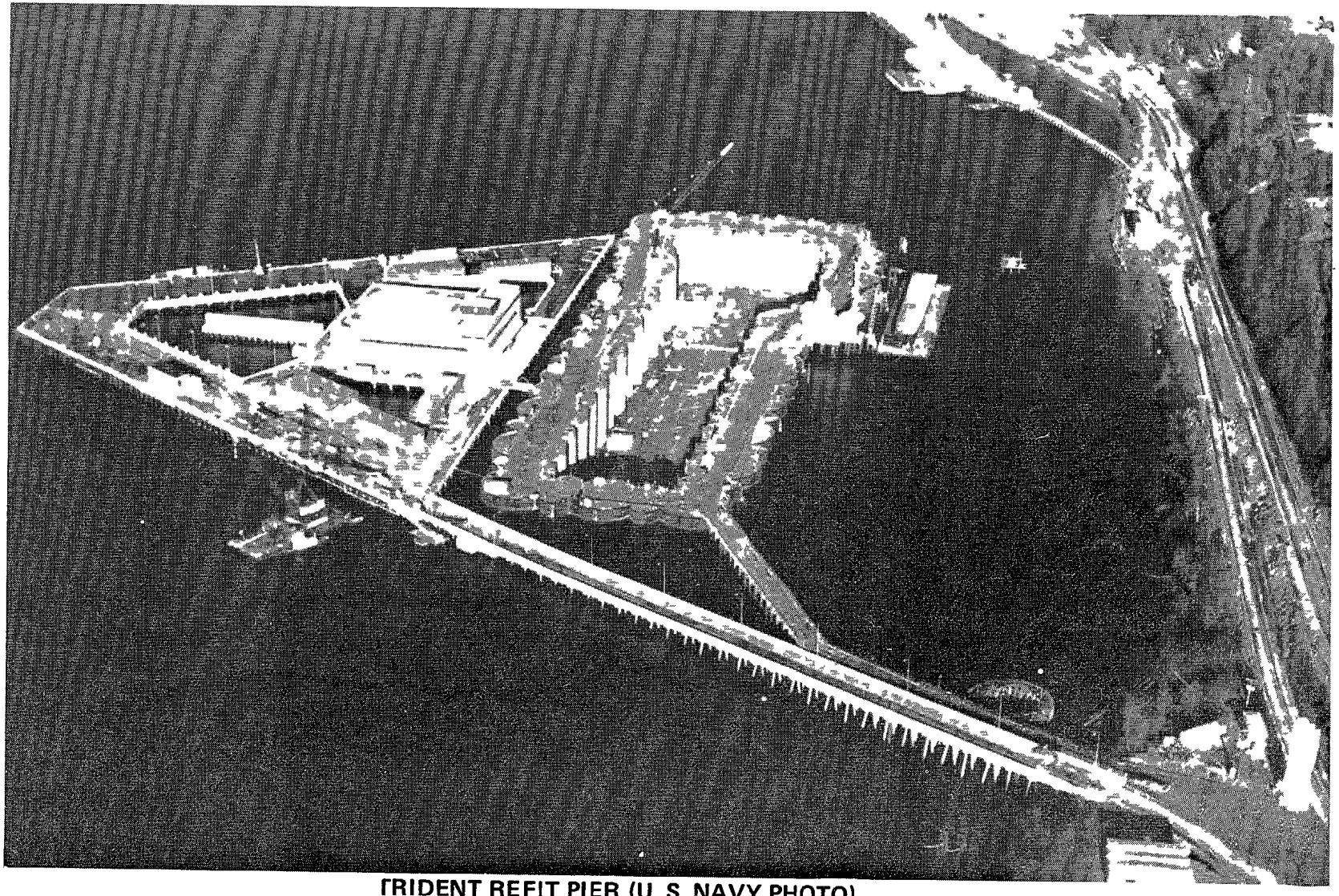
--implement a reliability centered maintenance approach to maintain Trident equipment and components and

--use the facilities at Bangor to support other Navy programs when staffing is not commensurate with Trident's workload, especially during Trident's early operational years.

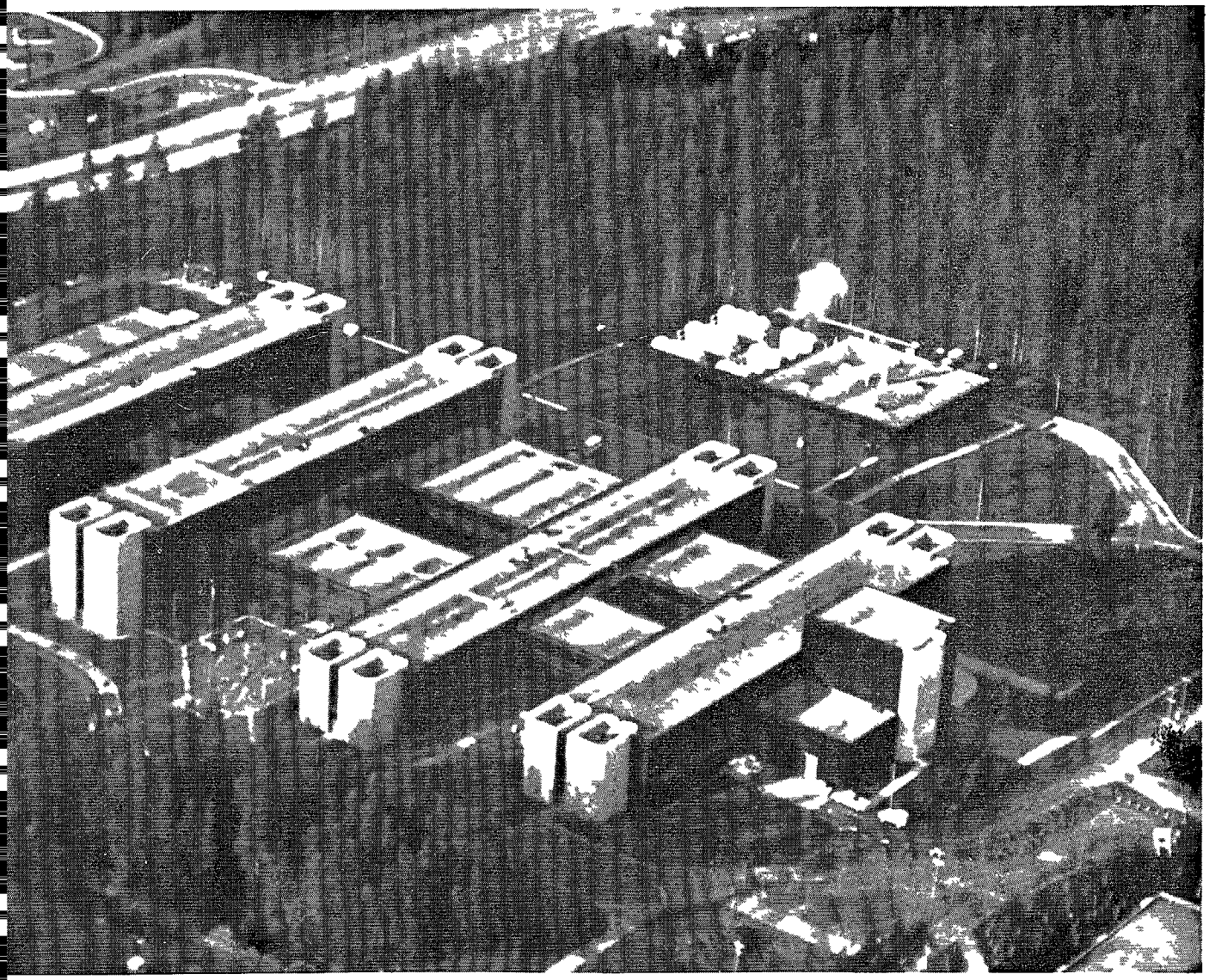
AGENCY COMMENTS

Navy officials generally agreed with our recommendations. However, with regard to our recommendation on the reliability centered maintenance approach for Trident's equipment and components, they stated that they are going to use a hybrid approach that incorporates this issue. Their approach supplements the scheduled replacement of Trident's equipment with a performance monitoring program. This program will provide a basis for adjusting the periodicity of planned replacement factors based on actual trends and experiences.

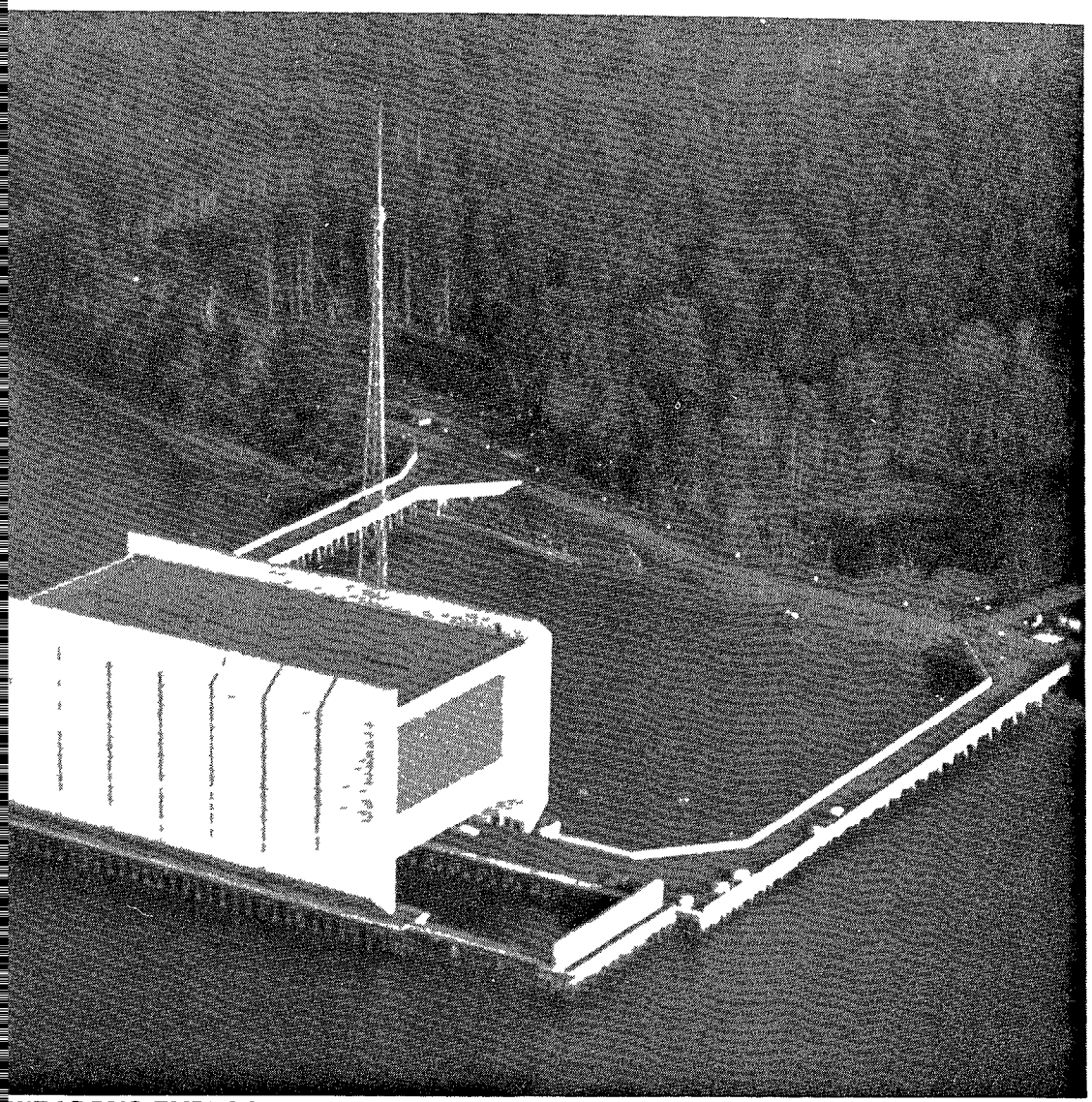
Although the Trident maintenance approach is an improvement over the planned replacement concept, it nonetheless may be redundant. We contend that the performance monitoring program may be sufficient alone to identify Trident's components that require replacement or repair.



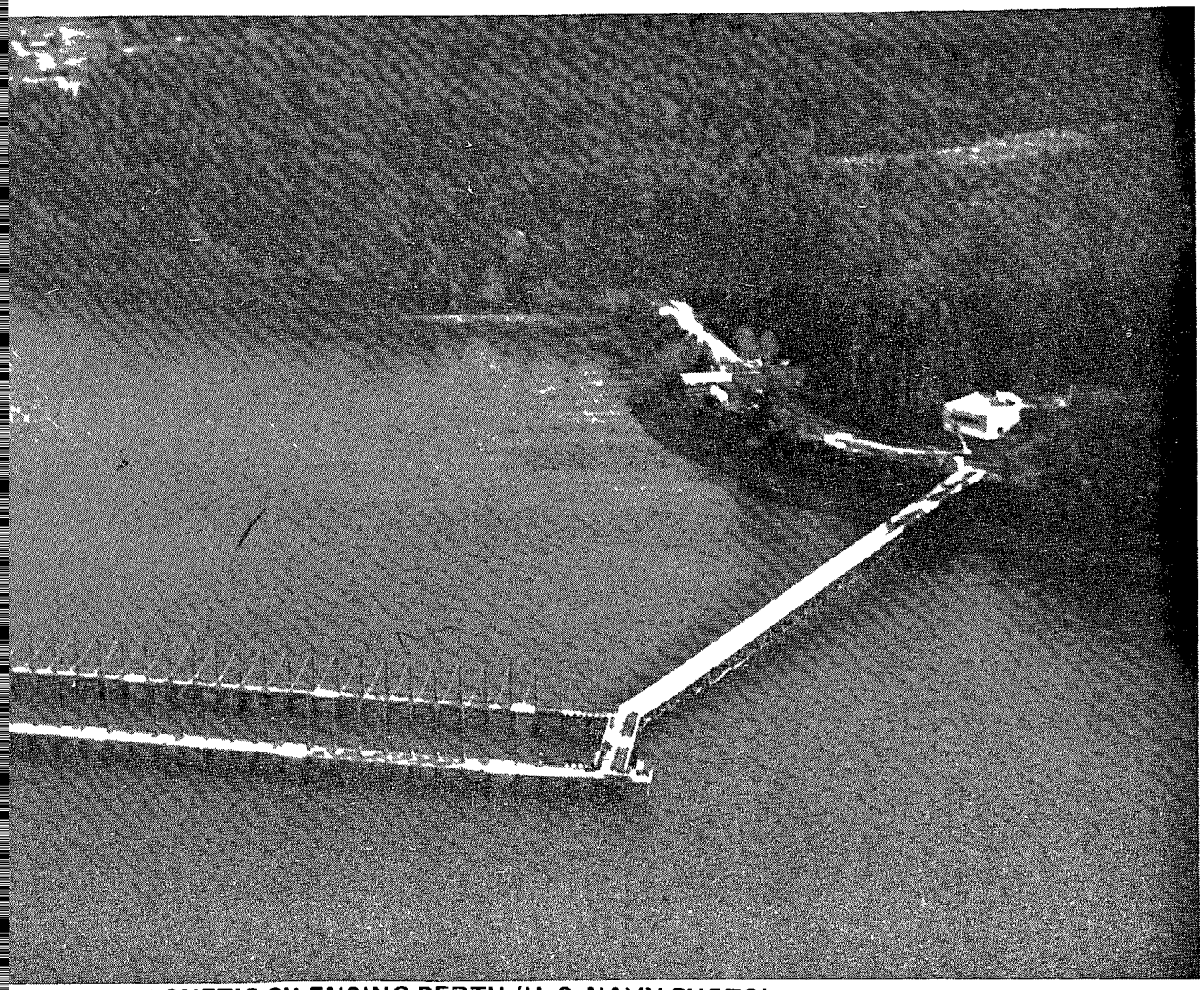
TRIDENT REFIT PIER (U S NAVY PHOTO)



TRIDENT TRAINING FACILITY (U S NAVY PHOTO)



WEAPONS EXPLOSIVE HANDLING WHARF (U S NAVY PHOTO)



MAGNETIC SILENCING BERTH (U S NAVY PHOTO)

CHAPTER 5

TRIDENT'S PERSONNEL REQUIREMENTS CAN BE REDUCED

In general, Trident's ILS plan for the personnel and training element has been well managed. This element of the ILS plan provides for operational and maintenance training, contains personnel selection criteria, provides for acquiring staff for the Trident support organizations, and contains the submarine's crew requirements. This ILS plan appears to satisfy Trident's staffing and training requirement and has been revised to reflect delays in the submarine's construction program. For example, personnel hiring and training dates have been pushed back to keep the plan in phase with Trident's estimated delivery date. (See p. 12.)

However, the Navy may have overlooked an opportunity to reduce Trident's staffing requirements. Because of delays in the Trident program, the Navy still has time to take advantage of an alternative to Trident's new crew requirements. Doing so could save millions of dollars that could be used to strengthen other Navy programs.

TRIDENT CREWS CAN BE ASSIGNED MORE EFFICIENTLY

Currently, the Navy assigns two crews to each fleet ballistic missile submarine. One crew operates the submarine while the other crew is in port undergoing training, taking leave, and generally getting ready to go back to sea. The Trident submarine staffing plan calls for a similar assignment of two crews to each submarine. However, the Navy investment in the Trident Support Site may allow and even require an alteration to this traditional submarine staffing policy.

Our previous reports have suggested that fleet ballistic missile submarine crews could be used more efficiently by assigning five crews to three submarines. The Navy has not endorsed the five-crews-for-three-submarines suggestion for other fleet ballistic missile submarines, but the Trident submarine is different. Its support design (as we explain later) actually promotes this concept. Furthermore, changing to our suggested crew assignment policy could reduce crew requirements and personnel costs.

Navy views on the five-crews-for-three-submarines concept

The Navy said the five-crews-for-three-submarines concept was inappropriate because

--fleet ballistic missile submarine crews would be required to rotate assignments on three different submarines and would have a difficult time adjusting to their operating peculiarities and configurations;

--patrol time would be increased, which would decrease the time allowed for critical training while not at sea; and

--morale would be adversely affected, due to the increased time on patrol.

These arguments, we believe, do not apply to Trident for several reasons.

Submarine design

The Trident submarines have been designed and are being constructed with a standard configuration that applies very precise specifications consistently to all of them. As a result, all Trident submarines should be similar. We believe that Trident crews, which will be some of the most technically trained personnel in the military, should have little difficulty adjusting to the peculiarities, if any exist, of three similar vessels.

Dedicated support site

The naval submarine base at Bangor has a Trident training facility that will provide professional development training to Trident's crewmembers. Current fleet ballistic missile submarine crewmembers often spend many days between patrol periods traveling to training locations that are far away from their operational port. The existence of the Trident training facility removes this requirement. Trident crews will be able to attend training sessions at their submarine's operational port, thus saving many days that would otherwise be spent traveling to a training facility.

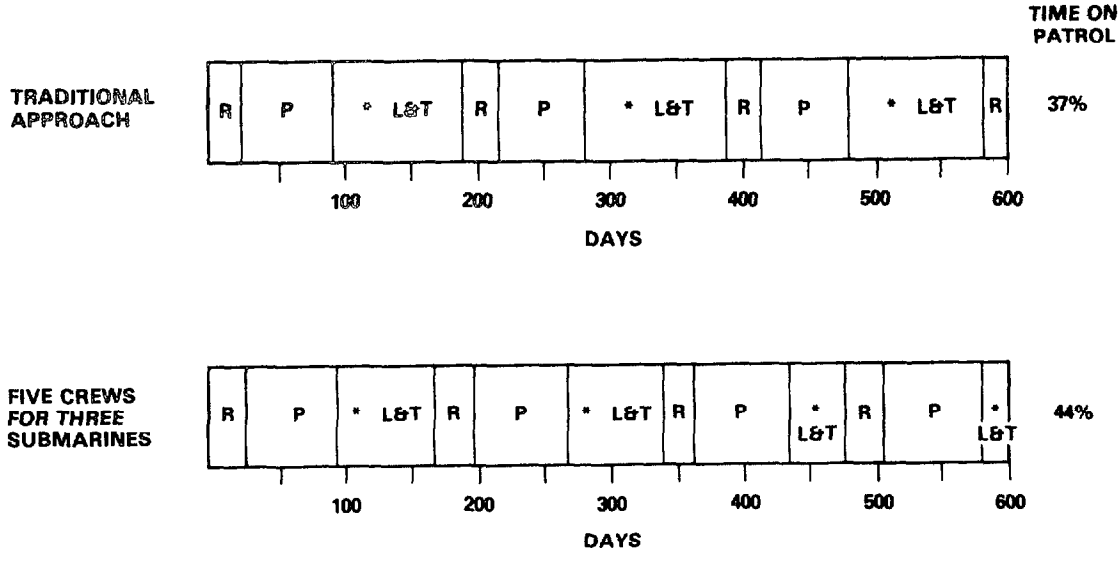
Crew morale

Crew morale is an important element of military duty that, according to the Navy, will suffer if crewmembers spend more time on patrol. The five-crews-for-three-submarines concept requires a submariner to be on patrol 44 percent of his duty with a Trident submarine squadron. On a conventional sea duty tour, fleet ballistic missile submarines

spend 37 percent of their time on patrol. Although the crew assignment policy we suggest requires a Trident submarine crew to be on patrol longer, the personal benefits of the Trident Support Site should outweigh this factor.

For example, the Trident Support Site has extensive facilities for recreation and excellent housing for Trident crewmembers and their families. Furthermore, unlike current fleet ballistic missile submarine operations, Trident crewmembers involved in training and submarine refit operations will remain at their home port and can return to their individual quarters after normal working hours.

CREW PATROL CYCLES UNDER THE TRADITIONAL AND FIVE-CREWS-FOR-THREE-SUBMARINES STAFFING CONCEPTS



*CREWS COMING OFF PATROL WILL BE AVAILABLE FOR 18 DAYS TO ASSIST REFIT ACTIVITIES
R = REFIT P = PATROL L&T = LEAVE AND TRAINING

Reduction in crew costs

Not only is the Trident program suited to having five crews for three submarines, but also, using this concept would reduce total crew numbers. This would help the Navy in two ways.

First, 16.7 percent fewer people would be needed, reducing money spent on personnel costs and lessening the support requirements for these people. Using personnel costs estimates DOD developed in December 1977, we determined that $8.1 million per year could be saved by a Trident submarine squadron (10 submarines) that assigned five crews to three submarines.

These savings, in constant December 1977 dollars, over the Trident squadron's life cycle, add up to $243 million.

Secondly, the Navy would have to spend less time and money recruiting, training, and retaining the types of individuals required to staff a Trident submarine. Easing the difficult task of staffing this submarine with qualified individuals is in the Navy's best interest.

CONCLUSIONS

In general, Trident's ILS plan for the personnel and training element has been well managed. However, we believe that delays in the Trident submarine delivery still give the Navy time to implement a more efficient crew staffing policy--five-crews-for-three-submarines.

We believe the Navy's reasons for not implementing the five-crews-for-three-submarines concept do not apply to crews assigned to Trident submarines. The unique submarine design, the Navy's investment in the Trident Support Site, and the actions taken to improve the crews' standard of living argue for strong consideration of the five-crews-for-three-submarines concept.

We estimate that by using this concept, a Trident submarine squadron could save $8.1 million per year, or about $243 million over its life cycle.

RECOMMENDATION

We recommend that the Secretary of Defense require the Navy to adopt a five-crews-for-three-submarines policy for

Trident submarines on a test basis. This policy should be tested over a 3-year period or more.

AGENCY COMMENTS

Navy officials still believe that our recommendation is inappropriate. In their opinion, the Trident operational concept does not favor the five-crews-for-three-submarines staffing plan.

They commented that the five-crews-for-three-submarines concept reduces the amount of time between patrols that is available for submarine proficiency training and other extracurricular career enhancing activities. Furthermore, the Trident maintenance concept requires that both crews participate in the 18-day refit period between patrols. Navy officials believe that this maintenance concept, coupled with the reduced time between patrols, further constrains the amount of time available for training while not at sea.

The Navy considers crew morale as the most important reason for not endorsing the five-crews-for-three-submarines concept. Navy officials stated that the increased patrol time associated with this staffing concept will adversely affect crew morale and, ultimately, their retention rates.

We contend, however, that the facility and personnel conveniences that are a part of the Trident operational plan lend strong support for testing the five-crews-for-three-submarines staffing concept.

CHAPTER 6

TRIDENT'S EAST COAST FACILITY: CONSIDERATIONS FOR NAVY LOGISTICS MANAGERS

The Navy has indicated that it will station Trident submarines on the east coast of the United States and that it is planning to construct a facility at Kings Bay, Georgia, to support them. However, we believe that several key issues must be resolved before effective planning can begin for the Trident east coast support site. These issues are:

--How many Trident submarines will be based on the east coast?

--When will Trident submarines be available on the east coast?

--Should the east coast facility mirror the facilities at Bangor?

--Are Trident submarines necessary on the east coast?

The Navy, in answering these questions, should explore alternative answers and present them and available tradeoffs to the Congress.

HOW MANY TRIDENT SUBMARINES WILL BE BASED ON THE EAST COAST?

To be realistic, logistics support plans should be designed considering the total weapon systems requiring support. Without this information, facilities and supplies may not be efficiently constructed and ordered. The Trident logistics support plan was designed, however, without information on the total number of submarines to be constructed.

According to DOD, the future Trident force size has not been determined because of several unresolved issues, including:

--The outcome of the Strategic Arms Limitation Talks II.

--The Trident system's role in national strategic policy.

--The retirement dates for the Polaris and Poseidon submarines.

--The evolution of national strategic objectives.

Navy officials insist that because of these and other issues, only DOD can determine the Trident force size.

We believe that DOD should interact with the Congress and estimate the most reasonable outcome of all events that dictate the Trident force size. We also believe that the minimum number of submarines needed to justify construction of a base that will serve only one kind of submarine is a key issue needing resolution early.

WHEN WILL EAST COAST SUBMARINES BE AVAILABLE?

Planning, designing, and developing the Trident facility (assuming one is needed) will be extremely important and very costly. Knowing when the submarines will be available will be the key to avoiding unnecessary building and other logistics support costs. Building too soon could create unnecessary maintenance costs; building too late could create unnecessary storage costs. Any east coast planning should consider this.

Because of the delays that have occurred in the Trident program and the possibility for future delivery delays, we believe that the Navy logistics planners should not prepare an east coast support program too far in advance of weapon system delivery. The Trident submarine construction program should be carefully integrated with all logistics elements and other strategic program decisions. This should avoid unnecessary costs, inherent in the development of a support facility, that are not in phase with submarine delivery schedules.

HOW SHOULD TRIDENT SUBMARINES BE SUPPORTED ON THE EAST COAST?

The Bangor submarine base is dedicated to the management, maintenance, supply, and personnel needs of the Trident weapon system. The submarine base has facilities to provide technical training to Trident crewmembers, repair sophisticated electronic and mechanical systems, and store missile components. The east coast Trident facility, however, may not require similar support facilities.

The east coast of the United States, unlike the west coast, already has several locations that can support some of Trident's logistics elements. For example, two locations on the east coast, New London, Connecticut, and Charleston, South Carolina, have training facilities for fleet ballistic missile submarine crewmembers. Additionally, three locations on the east coast are involved in support for the Trident missile system: Charleston, South Carolina; Kings Bay, Georgia; and Cape Canaveral, Florida. Finally, unlike the west coast, fleet ballistic missile submarines are now supported on the east coast at Charleston, South Carolina. And, since June 30, 1979, fleet ballistic missile submarines deploy from Kings Bay, Georgia. When planning support facilities for the Trident submarine on the east coast, the Navy should, we believe, consider (1) the facilities that have been constructed to support the current fleet ballistic missile submarines and (2) the locations that can already support some Trident logistics elements.

SHOULD THE EAST COAST FACILITY MIRROR THE BANGOR SUBMARINE BASE?

The Trident logistics support program at Bangor is an innovative and highly experimental approach to submarine support. Never before has a Navy vessel been subjected to the degree of ILS planning that Trident has received. Yet, only real experiences will prove the validity of Trident's complicated plan. Considering this, any east coast support facility design should not be completed until experience has been gained from an operational Bangor support site.

Expecting logistics systems to be revised after a base is in operation is quite normal, for planners cannot predict without error the specific outcome of all events. We, therefore, urge Navy planners to collect sufficient, competent data on the logistics support mechanisms at Bangor before developing logistics plans for Trident's east coast facility.

ARE TRIDENT SUBMARINE FACILITIES NECESSARY ON THE EAST COAST?

One other option Navy logistics planners should consider is the need for a Trident submarine facility on the east coast. Can Trident submarines deployed from the Bangor submarine base support strategic targets, normally the responsibility of east coast fleet ballistic missile

submarines? And does the future Trident missile range affect the location of a Trident submarine support facility? We also believe that Navy planners should determine whether submarines deployed from Bangor will have enough range and missile power to protect targets now defendable only from both coasts before developing an east coast facility plan.

As for the first issue, Navy planners should consider the high cost associated with developing an east coast support facility and should weigh this cost against the possible effect on a Trident submarine and crew transiting to a distant location. Secondly, the Trident missile range should obviously be considered when developing logistics scenarios. Advances in missile technology should be recognized by submarine logistics planners and be reflected in their facility plans. Indeed, the consequences of these two issues, and possibly others, may negate the need for Trident's east coast facility.

CONCLUSIONS

The objective of logistics support planning is to provide the optimal level of support at the proper location and at the right time. Planning for the optimal logistics support needs of Trident submarines on the east coast of the United States is an extremely difficult task, especially when there are so many unknowns. These include the number of Trident submarines to be based on the east coast. When will they be there? How will they be supported?

RECOMMENDATION

We recommend that the Secretary of Defense and the Secretary of the Navy fully explore the alternatives to the Trident east coast facility and present the options and tradeoffs available to the Congress. Until the tradeoffs are adequately considered, a decision to develop an east coast Trident support site could be premature.

AGENCY COMMENTS

Although DOD officials made no specific comments on the issues we presented in this chapter, they agreed that the questions we raised should be considered during the development of the Trident east coast facility logistics plans. They also stated that although Kings Bay, Georgia, has been identified as the preferred location for the Trident submarine base on the east coast, it will not be specifically designated as such until an environmental impact study on this issue is completed.

CHAPTER 7

TRIDENT'S DREDGING PLAN

To accommodate the Trident submarine's size, certain water areas need dredging. The Navy plans to spend about $5 million to dredge a channel 500 feet wide for nearly 4 miles to allow the submarine safe passage from the shipbuilder's facility in Connecticut to open sea.

Although the Navy originally planned for the Trident's transit in this channel, its original plan was not detailed enough to consider all the interactive elements. These elements include the tidal patterns and the required clearance between the bottom of the channel and the submarine.

THE NEED FOR DREDGING

Trident will be the largest submarine ever constructed for the United States. And, with the possible exception of the Soviet Typhoon class submarine (still being built), Trident will be the largest submergible weapon system in the world. Because of the Trident's size, certain water areas will have to be dredged. The Navy plans to dredge the Thames River Channel in Connecticut to allow Trident access to the ocean during sea trials. This location will not become a base supporting Trident deployments.

Dredging issue history

The Navy's original plan did not adequately address the dredging issue. For example, early in the Trident program, the Navy believed that the 36-foot deep Thames River Channel, combined with a 2.5-foot high tide and lightened ship conditions, could accommodate the Trident submarine's passage in the channel during sea trials. However, after the shipbuilder advised the Navy in March 1978 that it did not consider the Thames River Channel depth adequate to support the Trident submarine, the Navy had to examine alternative courses of action. The shipbuilder also advised the Navy that although tidal variations would provide additional depth, negative factors, such as the duration of tides, would remove this variable from consideration.

According to the Navy, the Trident submarine could transit the Thames River Channel by offloading ballast, thus lessening the submarine's draft, and proceeding at

high tide. This alternative, however, would provide only a 3-foot clearance between the bottom of the channel and the submarine. The Navy has stated that this alternative is not acceptable because a minimum 4-foot clearance is required for safety. And such a clearance, again, according to the Navy, can only be maintained by dredging the channel. This safety factor was not specifically identified in the Navy's original plan.

Responding to this, the Chief of Naval Operations has decided that the only prudent course of action is to dredge the existing 500-foot wide, 36-foot deep channel to a depth of 4 feet for a distance of 3.8 miles. This official estimated the cost of this dredging at $5.5 million and established the following milestones.

Commence environmental impact statement	June 1978
Award dredging contract	Oct. 1978
Commence dredging	Nov. 1979
Complete dredging	June 1980
Trident sea trials	July 1980

Although the Navy apparently planned for Trident transits in the Thames River early in the Trident program, its original plan was not detailed enough to consider all the interactive elements. These elements include the tidal patterns in the Thames River and the required clearance between the bottom of the channel and the submarine.

We believe future plans need to specifically address issues of this type. When plans have to be changed, the alternatives and tradeoffs that have been considered should be adequately documented.

AGENCY COMMENTS

DOD officials made no comments on this chapter.

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