

GAO

Report to the Assistant Secretary of the
Navy (Shipbuilding and Logistics)

June 1988

NAVY
MAINTENANCE

Ship Maintenance
Strategies Need Better
Assessments



042432/136067



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

National Security and International
Affairs Division

B-230550

June 14, 1988

The Honorable Everett Pyatt
The Assistant Secretary of the Navy
(Shipbuilding and Logistics)

Dear Mr. Pyatt:

This report presents the results of our review of the Navy's revised ship maintenance strategies. Since the early 1970s, the Navy has revised its strategies for maintaining and modernizing ships by scheduling fewer overhauls and, instead, performing shorter, more frequent depot level repairs. The cost of ship maintenance and modernization was \$5.6 billion in fiscal year 1987.

The Navy lacks a number of essential management features in its ship maintenance program. When the Navy first extended operating cycles of ships and revised maintenance strategies in 1970, it based these changes on engineering analyses and program assessments. However, we found that recent changes to the ship maintenance strategies often were not supported by engineering studies or reliable program assessments. Instead, the changes responded primarily to unfunded maintenance requirements and budget cuts. Although these budget cuts created pressure on the Navy to reduce expenditures, we believe that they did not eliminate the need to perform engineering studies before making basic changes to the maintenance strategies.

Since the Navy did not perform detailed engineering analyses, it does not know with certainty what the optimum frequency and level of repair is for key ship systems and equipment. Also, the Navy cannot reasonably predict if it is taking additional risks, such as reduced material readiness, reduced operational availability, and higher maintenance costs.

In addition, the Navy is not able to measure the results of the recent changes in maintenance strategies. Neither we nor the Navy can assess the recent revisions because (1) the Navy has not established criteria for measuring the results of different maintenance strategies, (2) management information systems do not provide the data needed to assess the results of the maintenance strategies, (3) the Navy does not fully consider the various indicators of the material condition of ships (such as equipment malfunction rates) when changing strategies, and (4) the Navy does not document the condition of a ship's key systems at the

time a ship enters a new strategy and track them to determine if longer periods between overhauls result in savings or additional costs and downtime. We recognize that many ships have not followed a particular maintenance strategy long enough to measure the results. However, unless the above deficiencies are addressed, the Navy will not be in a position to evaluate future strategy changes.

Program managers need feedback on how the various maintenance strategies are working as input to future decisions on operating cycles and maintenance strategies. So that data are available for an effective feedback loop, we recommend that you

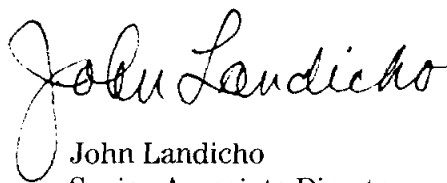
- perform detailed engineering analyses of optimum frequency and type of maintenance for all ships,
- establish criteria for evaluating the effects of changes in maintenance strategies and operating cycles,
- collect the data needed for evaluating different maintenance strategies in the management information systems, and
- use the above information to compare the costs and benefits of different maintenance strategies and provide managers with necessary data to make decisions on sustaining or modifying strategies in light of maintenance costs and operational availability of ships.

We discussed a draft of this report with Department of Defense and Navy officials. They generally agreed with the intent of our recommendations. The officials stated that the Navy is developing a structured methodology for determining the most appropriate maintenance strategy assignment for ships. The methodology will include the use of quantitative assessment criteria. The officials cautioned, however, that evaluations of maintenance strategy changes may not be needed in some cases. As an example, they stated that the time and cost required to perform engineering studies and program assessments for ships reaching the end of their service lives may never be recaptured.

We would appreciate being notified about any actions you plan to take on the recommendations. We discuss our findings in greater detail in appendix I.

We are sending copies of this report to the Secretaries of Defense and the Navy.

Sincerely yours,

A handwritten signature in cursive script that reads "John Landicho". The signature is written in black ink and is positioned above the printed name and title.

John Landicho
Senior Associate Director

Contents

Letter		1
Appendix I		6
Observations on Ship	Objectives, Scope, and Methodology	8
Maintenance	Essential Management Features Are Missing	9
Strategies		
Tables		
	Table I.1: Total Number of Availabilities	6
	Table I.2: Maintenance Strategies for Active Ships	7
	Table I.3: Costs and Ships From 1975 to 1989	8

Abbreviations

EOC	Extended Operating Cycle
NAVSEA	Naval Sea Systems Command
PMA	Phased Maintenance Availability
PMP	Phased Maintenance Program
PROG	Progressive Overhaul Program
ROH	Regular Overhaul
SRA	Selected Restricted Availability

Observations on Ship Maintenance Strategies

The Navy has revised its ship maintenance strategies. It has moved from regular scheduled overhauls performed every 3 to 4 years toward shorter, more frequent, intermittent depot level repairs called selected restricted availabilities (SRAs) and phased maintenance availabilities (PMAs). This trend for the period between 1983 and 1989 is shown in table I.1.

Table I.1: Total Number of Availabilities

Fiscal year	Overhauls	Intermittent availabilities		Total
		SRAs	PMAs	
1983	59	72	8	80
1984	53	88	10	98
1985	55	106	17	123
1986	33	99	31	130
1987	39	108	54	162
1988(est)	27	86	65	151
1989(est)	23	100	58	158

In 1970 the Navy first extended the operating cycle of nuclear powered-ballistic missile submarines. Based upon favorable results, the Navy applied the extended operating cycle (EOC) philosophy to nuclear powered-attack submarines and some surface ships in 1974. The Navy expanded the philosophy in the mid to late 1970s by adding the Phased Maintenance Program (PMP) for support ships and the Progressive Overhaul Program (PROG) for ships designed for component removal and replacement. Today, the Navy maintains its active fleet of submarines and surface ships under one of the following four basic strategies.

- Traditional regular overhaul (ROH). ROH is a long-standing approach to depot level maintenance. The original operating cycle was approximately 36 months between major overhauls with no scheduled depot level repairs in between. The overhauls normally lasted 8 to 12 months and were designed to keep a ship operating for 3 or more years between overhauls. The Navy plans to terminate this strategy when the ships currently in the ROH program are retired.
- Extended operating cycle (EOC). Under EOC, the Navy extended operating cycles between major overhauls to as much as 15 years. Overhauls are supplemented by one to four shorter, intermittent depot level SRAs of 2 to 4 months' duration.
- Phased Maintenance Program (PMP). In lieu of regular overhauls, maintenance is performed at 15 to 18-month intervals through a series of short,

Appendix I
 Observations on Ship Maintenance Strategies

frequent depot level PMAs of 2 to 4 months' duration. The scope of the intermittent maintenance is essentially the same under PMP and EOC.

- Progressive Overhaul Program (PROG). In this strategy, the Navy overhauls a ship progressively and continuously throughout its operating cycle by performing a depot level SRA every 2 years and a major modernization every 10 years. The Navy initially used this strategy on the FFG-7 frigate class ship and, with some modification, later applied it to the SSBN-726 Ohio class submarine and other ships.

The number of active ships using each of these strategies as of December 1987 is shown in table I.2.

Table I.2: Maintenance Strategies for Active Ships

Strategy	No. of ships
ROH	21
EOC	283
PMP	141
PROG	60
Total	505

Under the various maintenance strategies, the Navy maintains, repairs, and sometimes makes improvements to ships to modernize them. Costs for the ship maintenance and modernization program for the active fleet have increased from \$1.6 billion in fiscal year 1975 to an estimated \$4.8 billion in fiscal year 1989. We could not determine what impact strategy changes had on the increase in maintenance costs because of the many changes taking place in the Navy fleet. For example, during the same period, the number of active ships has increased from 496 to a projected 553. The growth in costs and ships is shown in table I.3.

Appendix I
Observations on Ship Maintenance Strategies

Table I.3: Costs and Ships From 1975 to 1989

Dollars in millions				
Fiscal year	Maintenance	Modernization	Total dollars	Total ships
1975	\$1,140.5	\$434.5	\$1,575.0	496
1976	1,490.5	569.8	2,060.3	484
1977	1,903.4	669.2	2,572.6	477
1978	2,563.5	545.2	3,108.7	468
1979	2,508.9	772.3	3,281.2	473
1980	2,642.5	763.1	3,405.6	479
1981	3,195.0	952.7	4,147.7	491
1982	3,632.3	932.8	4,565.1	513
1983	4,201.2	896.6	5,097.8	513
1984	4,214.7	1,086.5	5,301.2	523
1985	4,779.6	1,397.7	6,177.3	542
1986	4,179.7	1,398.6	5,578.3	540
1987	4,244.4	1,344.7	5,589.1	546
1988(est)	3,632.0	1,024.4	4,656.4	545
1989(est)	3,747.4	1,077.0	4,824.4	553

The Chief of Naval Operations; the Commander, Naval Sea Systems Command (NAVSEA); and the fleet commanders have primary responsibility for the ship maintenance and modernization program.

Objectives, Scope, and Methodology

Our objectives were to (1) determine the basis for the Navy's changes in maintenance strategies and (2) identify the effects of the revised strategies on the availability of ships for fleet operations, the material condition of the ships, and the costs of maintenance.

We obtained and reviewed various Navy documents. They included policies and procedures for ship maintenance, studies and other reports that assessed the effects and results of the revised maintenance strategies, workload projections, inspection and readiness reports, budget requests, and other funding documents. We also interviewed management and maintenance officials at many levels, including those at Navy and fleet headquarters, naval shipyards, and intermediate maintenance activities.

Using three different NAVSEA ship maintenance databases, we attempted to identify ships with adequate information to compare the cost of maintenance, the condition of the ship, and the amount of time the ship was available to be operated under its original maintenance strategy and its revised strategy. We wanted to determine the effects of the changed

strategy. We were unable to do so because the databases provided only limited quantitative data on ship costs, availability, and readiness under the revised and original strategies.

Our review was made in accordance with generally accepted government auditing standards and was performed between April 1987 and December 1987.

Essential Management Features Are Missing

The Navy lacks a number of essential management features in the ship maintenance program. First, the Navy made decisions to place certain classes of ships in different maintenance strategies quickly in response to budget adjustments without essential supporting data. Second, the Navy has not established criteria for assessing proposed changes, and the maintenance strategies for surface ships have been in a constant state of revision. Third, data needed to manage the program effectively are not available. Finally, there is no feedback loop that tells managers how the program is working.

Recent Revisions Are Not Supported by Engineering Studies

Initially, when the Navy began to revise the maintenance strategies in the 1970s, it based the changes on engineering analyses and program assessments. The goals were to maintain a ship's condition while sustaining or increasing the amount of time the ship was available for operations. Recently, however, many of the changes to the Navy's strategies for ship maintenance have not been supported by engineering studies or reliable program assessments. We found that many of the recent changes responded primarily to unfunded maintenance requirements or budget cuts. Unless engineering studies and program assessments are made, the Navy will not be in a position to evaluate strategy changes. Since the Navy did not perform detailed engineering studies, it cannot predict with assurance the risks associated with the recent changes made in ship maintenance strategies and the attendant extensions in operating cycles.

In July 1984, the Commander, NAVSEA, stated:

"Operating cycles should not be extended without engineering and reliability data to indicate impact on readiness and cost will be acceptable....It is important that implementation be carried out in a controlled manner, based on sound engineering analysis of maintenance requirements."

According to Navy officials and documents, within the last several years, the Navy has made major revisions to the maintenance strategies of 60 percent of the surface force ships without engineering analyses or justifications. These revisions were made for budgetary reasons, and they included operating cycle extensions and changes in maintenance strategies.

For example, in January 1986 the Chief of Naval Operations directed that 50 combatant type surface ships be moved from the EOC program to the PMP. These ships included certain classes of destroyers (DDG-2 and DDG-37) and frigates (FFG-1, FF-1037, FF-1040, and FF-1098). The Navy based the decision to change the maintenance strategies for these ships on budgetary constraints and not on technical or engineering analyses. Only a quick comparison of costs was made.

In another example, the Navy extended the operating cycles for the FF-1052 and DD-963 class ships from 60 to 80 months in June 1986. At the same time, the number of SRAS changed from two to three and the duration of these SRAS was changed from 6 to 8 weeks. The extensions were not based on engineering analyses but on the Navy's reflex reaction to budget constraints.

Evaluation Criteria Are Lacking for Changing Strategies

The Navy has not developed criteria for moving ships to a particular maintenance program. In order to make this determination, we believe the Navy needs to set the following criteria. For each ship the Navy needs to evaluate the mix of overhauls, SRAS, or other maintenance availabilities that will achieve the least costly and most timely maintenance strategy for meeting operational needs. For ships that have changed strategies or are being considered for change, cumulative information on how much each maintenance availability costs and how long it takes would enable the Navy to compare maintenance costs and the time a ship was available for operations under earlier and current strategies and perhaps project them for a contemplated strategy. Similarly, considerations of the material condition of ships while they are available for operations (as reflected in material condition rates) must be evaluated to enable the Navy to compare whether a ship would operate better under a prior, current, or projected maintenance strategy.

For example, a January 23, 1986, NAVSEA report on certain ships in the EOC program noted that the program had been in effect for 7 years. During that time the condition of the ships improved and the interval between regular overhauls increased by 31 percent. However, because

SRAS performed between overhauls took longer than planned, the time during which the ships were available for operations did not increase. Also, maintenance costs increased by 7.2 percent. The NAVSEA report did not cite the reasons for the cost increases. Many other surface ships have not operated long enough in a revised strategy to be able to measure the results.

In March 1985 the Chief of Naval Operations announced plans to establish a Systems and Equipment Maintenance Monitoring for Surface Ships program at NAVSEA. The program's objective is to employ engineering analysis as a basis for extending the interval between overhauls while maintaining operational readiness and reducing maintenance costs. Although announced in 1985, this program only applies to a few classes of ships and the program for the first two classes is not scheduled to be fully implemented until 1991. This program is a step in the right direction, but the Navy must evaluate and closely monitor the program to ensure that its objective is achieved. If expanded to additional classes of ships, the program should help alleviate some of our concerns.

Additional Data Are Needed to Manage the Program

Management information systems do not collect the data needed to perform an effective analysis of the maintenance strategies or reveal indicators of problems. The various indicators on the material condition of ships, such as equipment malfunction rates, are not monitored to decide if a different maintenance strategy is needed. Historical maintenance data on staff-days, costs, and operational availability are incomplete and limited and are reported by fiscal year rather than individual maintenance availability. As a result, the Navy does not know if ships are better or worse under the recent changes than they were previously. Managers cannot easily monitor if the new strategies are providing more operational time along with an acceptable readiness risk. In addition, the longer the Navy delays in developing a baseline, the more difficult it will be to evaluate changing strategies.

Although several NAVSEA offices are starting to develop a central database on how the ships are performing under the current strategies, these efforts primarily involve collecting summary data on trends in cost and length of depot level maintenance. On the basis of our attempt to evaluate the maintenance strategies, we believe additional detailed data on individual ships are needed to perform an effective evaluation. First, the Navy needs to collect more detailed cost, staff-day, and ship maintenance availability data on an individual ship basis on the existing strategies. The Navy, in the future, could use the data to compare the

historical and the revised strategies and to decide if it should sustain, modify, or terminate any of the strategies. The Navy should collect the data for each of the three levels of maintenance—organizational, intermediate, and depot. Second, the Navy should collect and incorporate the various indicators on the material condition of the ships into its comparisons to better assess the effects of the revised strategies on the readiness of the fleet. Any future revisions to the maintenance strategies should be preceded by the establishment of assessment criteria that include quantitative measurements of operational availability, material condition, future maintenance needs, and cost.

**Overall Effect of
Maintenance Strategies Is
Not Known**

The Navy has reported in its budget submissions to the Congress that if it receives the requested budget, there will not be any ship maintenance backlog. However, some Navy officials believe that the recent changes in ship maintenance strategies are resulting in substantial deferred maintenance that may become a “bow wave” of uncompleted work. We could not substantiate either position because of a lack of documentation. Also, Navy officials could not furnish us specific examples of mission critical repair work that had not been funded or performed. Neither we nor the Navy can determine what the overall effect is of the recent revisions to maintenance strategies for surface ships and extensions of operation cycles. Thus, the long-term impact of changes in strategies remains uncertain.

Requests for copies of GAO reports should be sent to:

U.S. General Accounting Office
Post Office Box 6015
Gaithersburg, Maryland 20877

Telephone 202-275-6241

The first five copies of each report are free. Additional copies are \$2.00 each.

There is a 25% discount on orders for 100 or more copies mailed to a single address.

Orders must be prepaid by cash or by check or money order made out to the Superintendent of Documents.

