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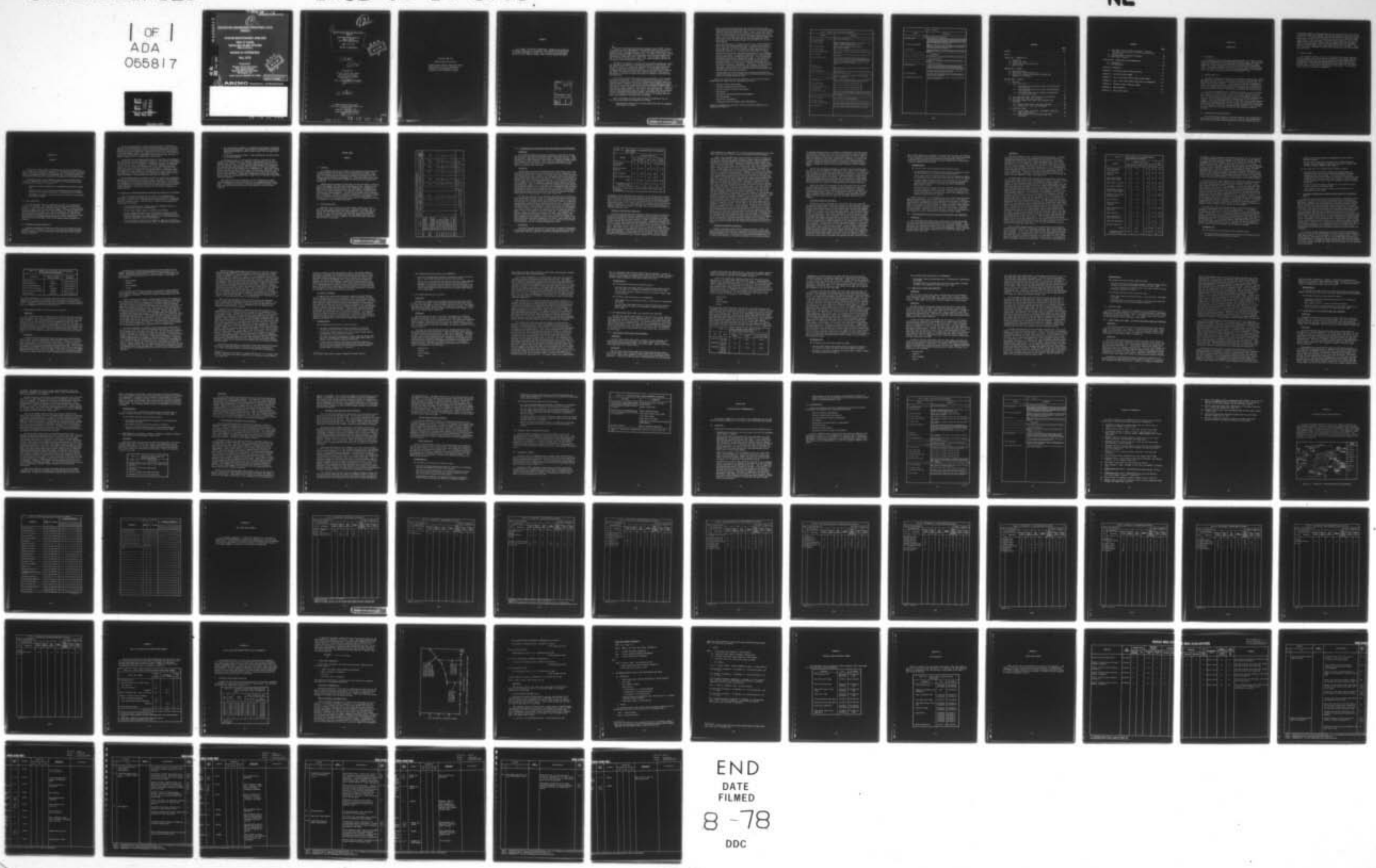

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DESTROYER ENGINEERED OPERATING CYCLE (DDEOC)

SYSTEM MAINTENANCE ANALYSIS

DDG-37 CLASS DISTILLING PLANT SYSTEM

SMA 37-103-531

REVIEW OF EXPERIENCE

May 1978

Prepared for

Director, Escort and Cruiser
Ship Logistic Division
Naval Sea Systems Command
Washington, D.C.

under Contract N00024-78-C-4062

ARINC RESEARCH CORPORATION

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FOREWORD

This report, the Review of Experience, documents the historical maintenance experience for the DDG-37 Class Distilling Plant System. It has been developed for NAVSEA 934X, the sponsor of the Destroyer Engineered Cycle (DDEOC) Program, under Contract N00024-78-C-4062.

SUMMARY

The goal of the Destroyer Engineered Operating Cycle (DDEOC) Program is to effect an early improvement in the material condition of ships, at an acceptable cost, while maintaining or increasing their operational availability during an extended operating cycle. In support of this goal, System Maintenance Analyses (SMAs) are being conducted for selected systems and subsystems of designated surface combatants. The principal element of an SMA is the Review of Experience (ROE). This report documents the ROE for the DDG-37 Class Distilling Plant System.

The ROE is an analysis of existing and anticipated problems that affect the operational performance or maintenance program of a ship system. The ROE report serves as a vehicle for assessing the significance and consequences of identified maintenance problems. It also presents specific recommendations and a system maintenance policy for preventing or reducing the impact of problem occurrence while improving material condition and maintaining or increasing system availability throughout an extended ship operating cycle.

The Distilling Plant System ROE included an analysis of all available maintenance data sources. The documented maintenance experience of the system was reviewed through analysis of Maintenance Data System (MDS) data, Casualty Reports (CASREPs), and system overhaul records. Initial findings from these sources were correlated with Planned Maintenance System (PMS) requirements, system alteration information, and system technical manuals to identify maintenance problems. Ship surveys were conducted and discussions were held with appropriate technical codes to validate identified problems, identify undocumented maintenance problems, and determine the status of current and planned actions affecting the system. All findings were evaluated, and appropriate conclusions were developed.

Major conclusions resulting from the Review of Experience for the Distilling Plant System are summarized as follows:

- Comprehensive overhauls of the distillation units will be necessary during Baseline Overhaul.

- DDG-37 Class ships have produced and used fresh water at a rate averaging 550 to 600 gallons per hour; that is 10 to 20 percent more than the rated distillation unit output. Ship's Forces have used two methods of operating the distillation units to achieve this production, neither described in existing operating documentation for the units. It is concluded that some of the burden reported against the distillation units has resulted from the high demands for fresh water and from the operating methods used by Ship's Force to meet those demands.
- Except for overhauls of the distillation units, all maintenance of Distilling Plant System components can be accomplished by Ship's Force, with some assistance from IMAs. Except for the brine overboard pump motor, all Distilling Plant System components can be maintained according to a "fix-when-fail" maintenance strategy.
- The PMS for this system, when modified according to the recommendations in this report, is adequate to maintain the Distilling Plant System throughout an extended operating cycle. The "on-condition" maintenance requirements included in the PMS, in conjunction with the requirements to record distillate production and salinity, generate evidence of the need for corrective maintenance of the distillation units and accessories. Therefore, no additional "on-condition" maintenance requirements are necessary for the distillation units. The analysis also concluded that monitoring pump discharge pressure might be an effective method of determining the need for pump corrective maintenance.
- Accomplishment of several ShipAlts during Baseline Overhaul will improve the condition and reliability of the Distilling Plant System during an extended operating cycle.

Actions and planning activities identified by the Distilling Plant System Review of Experience are categorized as follows:

- Baseline Overhaul Requirements
- Intracycle Maintenance Requirements
- Follow-on Regular Overhaul Requirements
- PMS Changes
- Reliability and Maintainability Improvements
- IMA Improvements
- Depot-level Improvements
- Integrated Logistics Support (ILS) Improvements

Specific recommendations resulting from this Review of Experience are summarized in Table S-1.

Table S-1. SUMMARY OF DISTILLING PLANT SYSTEM ROE RECOMMENDATIONS

Component	Recommendation
Baseline Overhaul Requirements	
A. Repairs and Overhauls	
1. Distillation Units	Overhaul in accordance with TRS 0531-086-612 (Bethlehem Steel). Inspect and replace or calibrate the water meters. Overhaul to Class B specifications (Cleaver-Brooks).
2. Brine Overboard Pumps	Repair as shown to be necessary by POT&I and ship's CSMP. (APLs 016020333 and 016020507).
3. Salt Water Feed Pumps	Repair as shown to be necessary by POT&I and ship's CSMP (APL 016110073).
4. Salt Water Heater Drain Pumps	Repair as shown to be necessary by POT&I and ship's CSMP (APLs 016020324 and 016020506).
5. Distillate Pumps	Repair as shown to be necessary by POT&I and ship's CSMP (APLs 016020332 and 016020505).
6. Pump motors and controllers	Overhaul two brine pump motors (APL 174750529) in accordance with TRS 0531-086-614. Repair the salt water feed pump motor (APL 174750532), the salt water heater drain pump motors (APLs 174750530 and 174750672), and two distillate pump motors (APLs 174750531 and 174750348) as shown to be necessary by POT&I and ship's CSMP. Inspect and clean all pump motor controllers and replace the heater contacts.
B. Alterations	
1. Distillation Units	Install ShipAlt DDG-37-1216D (Ameroyal injection equipment) on DDG-41, DDG-37, and DDG-46.
2. Brine Overboard Pumps	Relocate the brine overboard pumps to the next lower level by installing ShipAlt DDG-37-188D.
Intracycle Maintenance Requirements	
	No scheduled periodic repairs or overhauls were identified as being necessary by this analysis.
Follow-On Regular Overhaul Maintenance Requirements	
1. Distillation Units	Acid-clean, inspect, and hydrotest the units. Make other repairs to the units as shown to be necessary by the inspection and ship's CSMP.
2. Brine Overboard Pumps	Repair as shown to be necessary by POT&I and ship's CSMP.
3. Salt Water Feed Pumps	Repair as shown to be necessary by POT&I and ship's CSMP.
4. Salt Water Heater Drain Pumps	Repair as shown to be necessary by POT&I and ship's CSMP.
5. Distillate Pumps	Repair as shown to be necessary by POT&I and ship's CSMP.
6. Pump motors and controllers	Overhaul the brine overboard pump motor in accordance with TRS 0531-096-614. Repair all other pump motors as shown to be necessary by POT&I and ship's CSMP. Inspect and clean all pump motor controllers, and replace the contacts and heaters.
PMS Changes	
1. Brine Overboard Pumps	Delete inspection of internal parts (MRC 11-Y868-C on MIP E-14/653-21 and MIP E-14/676-41, APLs 016020333 and 016020507).
2. Salt Water Feed Pumps	Delete MRC B5-J29E-N from MIP A-19/250-B5 (Inspect Pump Internal Parts).
3. Salt Water Heater Drain Pumps	Delete the inspection of internal parts (MRC 11-Y868-C on MIP E-14/658-31, APL 016020324; and MRC 30-W330-A on MIP E-14/557-30, APL 016020506).
4. Distillate Pumps	Delete the inspection of internal parts (MRC 11-Y868-C on MIP E-14/636-21, APL 016020332; and MRC 30-W330-A on MIP E-14/558-30, APL 016020505).

(continued)

Table S-1. (continued)	
Component	**Recommendation**
Reliability and Maintainability Improvements	
1. Distillation Units	Review current Distillation Unit operating procedures and evaluate the effects of those procedures on system components. The review should specify standardized operating procedures (to replace the existing EOSS) and should recommend, where necessary, any design changes to system components that are necessary to reliably produce the needed distillate.
2. Distilling Plant System Pumps	Evaluate the results of the FF-1052 Class tests of the use of pump discharge pressure as an indicator of the need for maintenance. If the test results indicate that the technique is effective, consider the technique for the DDG-37 Class Distilling Plant System Pumps.
3. Electric Motors	NAVSEC should complete its review of the sealed insulation system rewind and vacuum pressure impregnation procedures and implement the system as soon as possible.
IMA Improvements	
	No IMA improvements were identified as being necessary by this analysis.
Depot-Level Improvements	
	No Depot-level improvements were identified as being necessary by this analysis.
Integrated Logistics Support	
1. Distillation Units	Incorporate the standardized operating procedures (resulting from the review of current operating procedures) into EOSS procedure EV/186. Change the allowance for the water meter (APL 109030005, MSN 9G-6680-00-174-6135) to one per ship and stock to that allowance as soon as possible. Investigate replacing the non-COSAL-supported Ameroyal injection pumps with the pumps specified by ShipAlt DDG-37-1216D.
2. Brine Overboard Pumps	Add a note to EOSS procedure EV/186 to throttle the pump discharge valve to produce a steady, non-fluctuating reading on the discharge pressure gage if cavitation is suspected.
3. Cleaver-Brooks Distillation Units	Develop Technical Repair Standards (TRSs) for the Cleaver-Brooks Distillation Units (APL 080030009)

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CONTENTS

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

In support of the Destroyer Engineered Operating Cycle (DDEOC) Program, sponsored by NAVSEA 934X, System Maintenance Analyses (SMAs) are being conducted on selected systems and subsystems of program-designated surface combatants. The principal element of an SMA is the Review of Experience (ROE). This report documents the ROE for the DDG-37 Class Distilling Plant System, which was selected for analysis because equipments of this system are on the DDG-37 Class Maintenance Critical Equipment List.

1.2 PURPOSE AND SCOPE

The ROE is an analysis of existing and anticipated problems that affect the operational performance or maintenance programs of a ship system. The ROE report serves as a vehicle for assessing the significance and consequences of identified problems. It also presents specific recommendations and a system maintenance policy directed toward preventing or reducing the effects of problems while improving material condition and maintaining or increasing system availability throughout an extended ship operating cycle.

The analysis documented herein applies specifically to the Distilling Plant System of the DDG-37 Class. Only those system components that had been installed or were on board ship as of the fourth quarter of Fiscal Year 1976 were considered. The analysis used all available documented data sources from which system maintenance problems could be identified and studied. These include Maintenance Data System (MDS) data, Casualty Reports (CASREPs), and system overhaul records, in addition to Planned Maintenance System (PMS) requirements data, system alteration documentation, and system technical manuals. Sources of undocumented data employed in this analysis included discussions with Ship's Force and other cognizant technical personnel.

1.3 SYSTEM FUNCTION AND DESCRIPTION

The Distilling Plant System on each ship comprises two steam-operated low-pressure, two-stage flash-type distillation units, various pumps and motors, and miscellaneous valves and piping. Each distillation unit has a rated design output of 12,000 gallons per day, producing fresh water having a salinity content not exceeding 0.065 epm chlorides (0.25 grain of sea salt per gallon). The heat to operate each unit is provided by auxiliary exhaust steam, while the salt water is supplied to each unit by a centrifugal pump taking suction from a sea chest. The fresh water produced by each unit is pumped either to reserve feedwater tanks or potable water storage tanks by another centrifugal pump. Other centrifugal pumps remove the condensed auxiliary exhaust steam and the brine resulting from unit operation. Fresh water production is measured by water meters installed in the outlet piping from each plant.

1.4 REPORT FORMAT

The remaining chapters of this report describe the analysis approach utilized (Chapter Two), briefly define significant system maintenance problems encountered and discuss potential problem solutions (Chapter Three), and summarize conclusions and recommendations derived from the analysis (Chapter Four). Specific analyses and evaluations supporting the results of this effort are included as appendixes to this report. A list of selected references precedes the appendixes.

CHAPTER TWO

APPROACH

Primary data sources used in performing the ROE for the Distilling Plant Systems are identified in Section 1.2. The data were used to identify, define, and analyze maintenance problems that will significantly affect the systems' maintenance program. A recommended course of action relative to the maintenance program was formulated on the basis of the analysis results.

The analysis began at the component level at which Allowance Parts List (APL) numbers are assigned. It comprised the following major steps as described in Sections 2.1 through 2.3:

- Compiling relevant documented and undocumented maintenance history data
- Analyzing these data to identify and define maintenance problems expected to have significant impact on maintenance of the systems
- Recommending a specific course of action for solution of the system maintenance problems

2.1 DATA COMPILATION

The analysis began with the compilation of data on the maintenance history of the systems. The data file generated consisted of four key elements: an MDS data bank, a CASREP narrative summary, a system overhaul experience summary, and a system ShipAlt summary. A library of appropriate technical manuals, bulletins, etc., was also compiled. All MDS data reported for the DDG-37 Class from 1 January 1970 through 31 October 1976 were screened for information pertinent to the system. Overhaul experience was obtained from Mechanized Departure Reports for the DDG-37 Class. Continued reference was made to all of the noted sources throughout the analysis.

2.2 MAINTENANCE PROBLEM DEFINITION

Potential maintenance problems associated with the systems and their components were identified by a process of screening data from the above-described sources as well as from ship surveys and discussions with Navy technical personnel.

MDS data constituted the initial and primary source of information used in the screening process. This data base includes all part and labor records, as well as narrative material, describing maintenance actions reported against system components. Maintenance actions are represented by Job Control Numbers (JCNs). The purpose of the first step in the screening process was to identify the maintenance actions that had been reported against components of the systems under investigation.

The man-hour and part-expenditure burdens incurred for each component were calculated with the assistance of computers. The burdens were computed not only for the selected components individually but also, as appropriate, for each generic class of components. Individual components or component classes that had contributed significantly to the system's maintenance burden were selected for the analysis described below. Components were also selected for this purpose if they had generated a significant number of CASREPs or if other sources of information (e.g., ship surveys or overhaul experience) disclosed reasons for significant concern regarding maintenance problems or the maintenance programs for the components.

Selected components were analyzed in detail to define each maintenance problem in terms of several specific factors: the effect of the problem on the component and system, the interval between occurrences of the problem, the redundancy of the affected components within the system, the criticality of the component to the system, the resources required to perform the maintenance necessary to correct the problem, and the expected component or system downtime.

2.3 ANALYSIS OF COMPONENT MAINTENANCE PROBLEMS AND DEFINITION OF SOLUTIONS

Once the component problems and the causes of the problems were identified, solutions were sought by examining each problem in relation to the extent to which it is recognized and its susceptibility to established types of corrective action. These analysis criteria can be expressed by the following questions:

- Is the problem known to the Navy technical community and has a solution been proposed or established?
- Will a design change reduce or eliminate the problem?
- Is the problem PMS-related? Can the problem be reduced or eliminated by changes to PMS? (These changes might include adding or deleting requirements, changing periodicity, or developing material condition assessment tests and procedures.)
- Can the problem be reduced or eliminated by improving Ship's Force Intermediate Maintenance Activity (IMA), or depot-level capabilities?

- Can the problem be reduced or eliminated by periodically performing restorative maintenance? Should this be accomplished at a Selected Restricted Availability (SRA) by Ship's Force, IMA, or depot-level facilities?
- Is the run-to-failure concept a viable maintenance strategy for the associated equipment?

An affirmative answer to any question resulted in analysis of the effects of the solution and in an estimate, when possible, of the cost to implement the solution. A negative answer prompted the analyst to go to the next question. After all the questions were answered, the alternative near-term and long-term solutions were evaluated and the most acceptable alternatives defined and documented as recommendations. "Near-term" recommended solutions, as used in this report, are those that should be, and are likely to be, accomplished before completion of the initial DDG-37 Class Baseline Overhaul (BOH). "Long-term" recommended solutions are those that are not likely to be accomplished until some or all of the DDG-37 Class BOHs have been completed.

The historical overhaul experience for all installations of each selected component was then correlated with the recommended problem solutions. An evaluation was made to establish the Baseline Overhaul, intracycle, and follow-on Regular Overhaul requirements for each selected component.

CHAPTER THREE

RESULTS

3.1 OVERVIEW

This chapter presents the results of the analysis of historical maintenance experience for the DDG-37 Class Distilling Plant System. Data screening resulted in the selection of 12 Distilling Plant System components as the major maintenance-burden contributors (see Table 3-1; for complete system definition see Appendix A). Sixty-four parts within these 12 components were identified as items requiring detailed analysis (see Appendix B).

CASREP analysis supported the MDS data screening performed in defining repetitive problems and significant maintenance actions. Appendix C summarizes the CASREPs submitted against the components of the Distilling Plant System, shows the percentage of the total number of CASREPs attributable to each system component, and indicates the types of failures experienced by system components. A review of the manning levels, personnel water consumption, and make-up feedwater consumption is presented in Appendix D to determine the current load on the Distilling Plant System. A discussion of each system maintenance problem and its recommended solutions are presented in the following paragraphs.

3.2 DISTILLATION UNITS

Each DDG-37 Class ship utilizes two 2-stage, flash-type, 12,000 gallon-per-day (gpd) distillation units. Hulls DDG-37 through -39, -45, and -46 have Bethlehem Steel units (APL 080100016), while hulls DDG-40 through -44 have Cleaver-Brooks (now Aqua-Chem) units (APL 080030009). Similar in design and size, the units are each composed primarily of a salt water heater, two flash chambers, two distillate stage condensers, various valves, and piping.

Table 3-1. MAINTENANCE BURDEN SUMMARY FOR DDG-37 CLASS DISTILLING PLANT SYSTEM COMPONENTS

APL	Nomenclature	Applicable Ships	Components per Ship	Total Component Population	Total Ship Operating Time (Ship-Years)	Ships Reported	JCNs	Ship's Force Man-Hours	IMA Man-Hours	Total Man-Hours	Parts Cost (Dollars)	Average Man-Hours/ Component Operating Year
080100016	Distilling Plant (Beth. Steel) (Includes: Salt-Water Heater, Air Ejectors & Air Ejector Condensers)	5	2	10	25.8	5	175	4,145	1,362	5,507	19,621	106.7
109030005	Water Meter	5	2	10	25.8	3	25	291	193	484	1,393	9.4
080030009	Distilling Plant (Cleaver-Brooks) (Includes: Salt Water Heater, Air Ejectors, Air Ejector Condensers, & Feed Regulating Valve)	5	2	10	26.1	5	222	1,946	1,079	3,025	17,812	58.0
016020333	Brine Overboard Pump (Beth Steel Plant)	5	2	10	25.8	5	88	1,784	851	2,635	21,787	51.1
016020507	Brine Overboard Pump (Cleaver-Brooks Plant)	5	2	10	26.1	5	85	1,278	585	1,863	12,663	35.7
016110073	Salt Water Feed Pump	10	2	20	51.9	10	190	2,290	1,598	3,888	8,900	37.4
016020324	Salt Water Heater Drain Pump (Beth. Steel Plant)	5	2	10	25.8	5	45	1,077	340	1,417	2,793	27.5
016020506	Salt Water Heater Drain Pump (Cleaver-Brooks)	5	2	10	26.1	5	45	266	267	533	3,427	10.2
016020332	Distillate Pump (Beth. Steel Plant)	5	2	10	25.8	5	54	445	446	891	8,776	17.3
016020505	Distillate Pump (Cleaver-Brooks Plant)	5	2	10	26.1	5	62	309	298	607	6,327	11.6
174750529	Brine Overboard Pump Mtr.	10	2	20	51.9	10	57	633	505	1,138	1,538	11.0
174750532	Salt Water Feed Pump Mtr.	10	2	20	51.9	10	51	628	252	880	1,299	8.5
						Totals	1,099	15,092	7,776	22,868	106,366	
				Total Reported for All System Components			1,349	16,220	8,741	24,691	137,025	
		Percent of Total Reported Accounted for by Selected APLs					81	93	89	93	78	

3.2.1 Bethlehem Steel Distillation Units and Accessories (APL 080100016)

Background

The 12,000-gpd distillation units installed in hulls DDG-37 through DDG-39, DDG-45, and DDG-46 are Bethlehem Steel Model MF2-12B units. They are two-stage, flash-type distillation units. Each stage contains a stage condenser, two vapor separators, three layers of submerged scrubber plates, and a number of flash orifices. The various heat exchangers, the air ejectors, the salt water heater drain regulating valve, and the water meter are mounted on the unit shell.

Discussion

The MDS data showed that the Bethlehem Steel distillation units experienced the highest corrective maintenance burden of all components in the Distilling Plant System. A total of 175 JCNs, 4,145 Ship's Force man-hours, 1,362 IMA man-hours, and $19,621 in part replacement costs were reported against these units during the data period. This burden averaged about 107 man-hours and $380 per unit per operating year. It is high partly because of the complexity of the distillation units and partly because of maintenance problems. Only one CASREP was submitted against these units during the CASREP data period. It is concluded that the Bethlehem Steel distillation units have experienced a large corrective maintenance burden without a corresponding reduction of ship capabilities. A review of historical Ship Alteration and Repair Package (SARP) data determined that, as a minimum during Regular Overhauls, distillation units were acid-cleaned and hydrostatically tested and underwent a basic post-repair test.

The MDS data were analyzed to determine the causes of the large corrective maintenance burden. Table B-1 in Appendix B summarizes the significant parts usage reported against the Bethlehem Steel units. Because of the low usage, it is expected that none of the parts listed will represent a maintenance problem during an extended operating cycle. An analysis of the MDS transaction data showed that repairs to the heat exchangers (such as plugging tubes, replacing tubes, and re-tubing entire heat exchangers), air ejector problems (such as worn nozzles), acid-cleaning, and replacing worn internal parts accounted for the majority of the reported man-hour burden. Table 3-2 presents a listing of that data. The remainder of the man-hour burden was reported for repairs of leaks, drain valves, water meters, and other minor repairs to the units. The reported burden for heat exchangers, acid cleaning, and worn internal parts is related to the high distillation production demanded of the units. These items are discussed together. The air ejector burden is not a function of the distillate production rate and is discussed separately below.

Air Ejector

The burden reported against the air ejectors, although it represents a significant portion of the man-hour burden reported against the distillation units, does not represent a repetitive maintenance problem. One

Table 3-2. MAJOR SOURCES OF BETHLEHEM STEEL DISTILLATION UNIT BURDEN					
Reason	Reported Man-Hours				
	JCNs	Ship's Force	IMA	Total	Parts Costs
Air Ejector Problems	17	636	207	843	$3,815
Heat Exchanger Repairs	13	1,025	548	1,573	5,324
Acid Cleaning	12	849*	114	963	106
Worn Internal Parts	6	177	72	249	0
Total	48	2,687	941	3,628	$9,245
Percentage of APL 080100016 Total	27.4	64.8	69.1	65.9	47.1

*Includes 564 man-hours to correct leaks found after acid-cleaning.

maintenance action represented 405 man-hours of the 843 man-hours reported, or about 48 percent of the man-hour burden reported against the air ejectors. Only three of the five ships reported corrective maintenance against the air ejectors, indicating that there have been no repetitive problems. Although some wear of air ejector nozzles has occurred, there have been few nozzle replacements. It is concluded that the current maintenance as expressed in PMS will be adequate to maintain the air ejectors throughout an extended operating cycle.

Effects of Distillation Production

A review of distillation unit operating logs and records of personnel fresh water and make-up feedwater consumption and discussions with ship personnel indicated that the distillation units have produced an average of about 553 gallons per plant per hour, or about 10 percent more than the design rating of 500 gallons per plant per hour. Appendix D discusses the history of fresh water production and consumption by the DDG-37 Class ships. It also estimates the time a ship can operate if one distillation unit fails, providing a guide to the criticality of failures to system components. The result of this demand for and production of distillate has been worn internal parts and erosion and thinning of the tubes in distillation unit heat exchangers. This is caused by the salt water flow through the heat exchangers and the requirements for acid cleaning. The air ejector problems are independent of the increased demand for distillate, because their operation is independent of the system operating parameters that have been varied by Ship's Force to meet the increased distillate demands.

Ship's Force personnel have used two methods to meet the demand for distillate. Both methods involve changes to system operating parameters, and each has definite advantages and disadvantages. Neither method is documented in the Engineering Operational Sequencing System (EOSS) procedures for distilling plants. Personnel on some ships have increased steam flow to the salt water heater and increased salt water flow through the heater, while maintaining the first stage design inlet temperature of 170°F. By maintaining the first stage inlet temperature at 170°F, the scaling of the heater and air ejector condenser as a result of the higher flow rate is increased only moderately. However, the increased salt water velocity through the various heat exchanger tubes and the distillation units significantly increases erosion of tubes and wear of internal parts. This effect is evidenced by the high man-hour burden reported against the units for repairs to the heat exchangers and internal parts and by the number of tube plugs installed in heat exchangers. Personnel on other ships have increased unit production by increasing steam flow to the salt water heater, but by maintaining the design salt water flow rate through the heater, they have allowed the inlet temperature to the first stage to rise to 190°F to 200°F. This method keeps the salt water velocity the same, limiting the erosion of the tubes and internal parts, but vastly increased scaling results from the higher temperature. Scaling can be held to a minimum with either method if a scale inhibitor, such as Ameroyal, is injected into the salt water feed upstream of the heat exchangers. This has been recognized by the Navy, leading to the recent development of a ShipAlt to install the proper injection equipment on DDG-37 Class ships (the preliminary ShipAlt Record was completed in January 1978). Lack of an authorized ShipAlt has not deterred Ship's Force from obtaining the benefits of Ameroyal, as hulls DDG-38, DDG-39, and DDG-45 have installed equipment to inject Ameroyal. On the basis of discussions with ship personnel, it appears that none of this equipment is supported in the coordinated Ships Allowance List (COSAL) and repair parts are hard to obtain. Use of Ameroyal has allowed the distillation units to produce up to 650 gallons of distillate per plant per hour during under-way operations while maintaining or increasing the time between acid-cleanings. Distillation unit manufacturers have recommended that, with the injection of Ameroyal or some other scale inhibitor, the second method (increased inlet temperature) is preferred if increased distillate production is necessary, to avoid the increased erosion and subsequent burden caused by the high velocity of salt water through the heat exchangers associated with the first method.

<u>Distillate Production Conclusions</u>

Several conclusions result from the above discussion. First, the distillation units have been major contributors to the Distilling Plant System maintenance burden and have required a significant amount of major corrective maintenance. On the basis of historical maintenance data, it is likely that some major corrective maintenance will be required during an extended operating cycle. In addition, because most of the units will not have been overhauled since the last ship overhaul or anti-air warfare (AAW) conversion, those units will have accumulated a minimum of about 36 months of operation before entry into Baseline Overhaul. It is unlikely that the distillation units will operate for an additional 60 months (for a total of about 100 months) without an overhaul or significant major repairs. Therefore, the distillation units should be overhauled during Baseline Overhaul according to the applicable Technical Repair Standard (TRS).

Second, two undocumented methods of operating the distillation units are used to meet the demand for distillate. Thus, there is no standard Navy procedure for increasing distillation unit production. The Distilling Plant operating procedures should be reviewed, and because of the erosion experienced by the units, the effects of the two methods of operation on system components should be evaluated. The final outputs of this review should be standardized operational methods (to replace the current EOSS) and recommendations (where necessary) regarding any design changes to the units that would be required to reliably produce the needed distillate.

Third, the injection of Ameroyal to the salt water feed has allowed the distillation units to continuously produce distillate at rates in excess of the design rating. ShipAlt DDG-37-1216D should be installed on those ships that do not already have Ameroyal injection equipment. To ensure adequate supply support of the Ameroyal injection pumps, the Navy should investigate replacing the non-COSAL-supported Ameroyal injection pumps installed on DDG-37 Class ships with the pumps specified by the ShipAlt.

Water Meter Wear-Out and Supply

Additional review of the MDS data showed that there was a wear-out problem and a supply problem with the water meters (APL 109030005) installed on the distillation units. Although the meters did not contribute significantly to the man-hour burden, 12 water meters were replaced (see Appendix B, Table B-2) on three of the five applicable ships. The average burden to replace or calibrate a water meter was about two to three man-hours, which is not a large burden. The current replacement cost of the meter is $247. Discussions with Ship's Force indicated that, as with the meter installed on FF-1052 Class ships, the gear train in the meter wears out and breaks. A failure of this kind eliminates the water meter as a condition assessment tool for determining the overall condition of the distillation units. Personnel from DDG-37 Class ships reported that supply support for the meters was inadequate. No allowance for a spare meter is permitted, and Ship's Force stated that it took from six to eight months to obtain a replacement. Ship's Force cannot repair the water meter, because no repair parts are stocked on board. According to a note on the APL and the Source, Maintenance, and Recoverability (SM&R) Code (PB2GG), all repairs are supposed to be accomplished by shore repair facilities and Naval shipyards. Thus, a failure of a water meter means that Ship's Force will have to determine distillation unit output by sounding the appropriate tanks until the failed meter can be repaired or replaced. To prevent this situation, an allowance for one spare meter should be added to the APL, the ships should be stocked to that allowance, and the meters should be inspected and replaced or calibrated during Baseline Overhaul to ensure availability of water meters during an extended operating cycle.

Recommendations

For the near term, the following actions should be taken:

- Two Bethlehem Steel distillation units should be overhauled during Baseline Overhaul in accordance with TRS 0531-086-612.
- ShipAlt DDG-37-1216D (Install Ameroyal Injection Equipment) should be accomplished during Baseline Overhaul on hulls DDG-37 and DDG-46.
- To ensure adequate supply support of the Ameroyal injection pumps, the Navy should investigate replacing the non-COSAL-supported pumps installed on DDG-37 Class ships with those specified by ShipAlt DDG-37-1216D.
- The allowance for the water meter APL 109030005 (NSN 9G-6680-00 174-6135) should be changed to one per ship, and the meter stocked to that allowance as soon as possible. The meters should be inspected and replaced or calibrated as shown to be necessary by the inspection during Baseline Overhaul.

For the long term, it is recommended that the current Distilling Plant operating procedures be reviewed and that the effects of the two undocumented methods of operation on system components be evaluated. This review should specify standardized operating procedures (to replace the current EOSS) and recommend any design changes to Distilling Plant System components that are required to reliably produce the needed distillate. During the follow-on Regular Overhaul, the units should be acid-cleaned, inspected, and hydrotested. Other repairs should be made as shown to be necessary by the inspection and the Current Ship's Maintenance Project (CSMP).

3.2.2 Cleaver-Brooks Distillation Units and Accessories (APL 080030009)

Background

The 12,000-gpd distillation units installed in hulls DDG-40 through DDG-44 are manufactured by Cleaver-Brooks (now known as Aqua-Chem). They are two-stage, flash-type distillation units. Each stage contains a stage condenser, two sections of demister mesh steam separators, splash baffles, and perforated flash plates. The various heat exchangers, the air ejectors, the salt water heater drain regulating valve, and the water meter are mounted on the unit shell.

Discussion

MDS data included 222 JCNs, 1,946 Ship's Force man-hours, 1,079 IMA man-hours, and $17,812 in part replacement costs reported against the Cleaver-Brooks distillation units during the data period. This burden averaged 58.0 man-hours and $341 in part replacement costs per unit per operating year. Five CASREPs were submitted against these units, two for problems with the feed regulating valve, and one each for excessive salinity, air ejector problems, and tube deterioration. It is concluded from these data that the distillation units have been the source of a large corrective maintenance burden, but that this has not repetitively limited ships' capabilities. A review of historical SARP data showed that, as a minimum during Regular Overhauls, distillation units were acid-cleaned and hydrotested and underwent a basic post-repair test.

The maintenance burden experienced by the Cleaver-Brooks distillation units is the result of many types of maintenance actions. The major reasons for maintenance and the sources of the burden are listed in Table 3-3. Several of the maintenance burden sources listed had approximately the same numbers of JCNs as the Bethlehem Steel units, which had essentially equivalent operating time (see Table 3-2 for the Bethlehem Steel data). However, the burden associated with those JCNs was much lower than the burden reported against the Bethlehem Steel units. As an example, a total of 1,573 man-hours were reported by 13 JCNs against the Bethleham Steel units for "Heat Exchanger Repairs". This is an average of 121 man-hours per JCNs. In contrast, a total of 459 man-hours were reported by 12 JCNs against the Cleaver-Brooks units repairs to the same units. This is an average of 38 man-hours per JCN, or less than one-third of the man-hour burden per JCN reported against the Bethlehem Steel units. The MDS transaction narratives showed that the types of failures experienced by Cleaver-Brooks units were similar to those experienced by the Bethlehem Steel units, but that the burden associated with those failures was much less for the Cleaver-Brooks units. The majority of the burden reported against the Bethlehem Steel units was the result of four failure modes, while a major portion of the burden reported against the Cleaver-Brooks units was the result of 14 failure modes. It was also determined that while there were several JCNs that had a large man-hour burden (greater than 400 man-hours) reported against the Bethlehem Steel units, there were no similar large burden actions reported against the Cleaver-Brooks units. It is concluded that the heavy demand for distillate has resulted in the same failure modes for the Cleaver-Brooks units as the Bethlehem-Steel units, but that the repairs to the Cleaver-Brooks units have required a lower man-hour expenditure than the repairs to the Bethlehem Steel units.

Only the burden reported against the Cleaver-Brooks heat exchangers was determined to represent a maintenance problem. None of the other items listed in Table 3-3 had a very high man-hour burden when compared with the heat exchangers. As a result, these items are not considered to be maintenance problems. The Cleaver-Brooks units, like the Bethlehem Steel units, have been required to produce distillate at a rate about 10 percent higher than their design rating of 500 gallons per hour because of the demand for make-up feedwater and potable fresh water. In view of the similarities in

Table 3-3. MAJOR SOURCES OF THE CLEAVER-BROOKS DISTILLATION UNIT BURDEN

Reason	Reported Man-hours				Part Costs
	JCNs	Ship's Force	IMA	Total	
Feed Regulating Valve Failures	14	47	101	148	2767
Heat Exchanger Repairs	12	252	207	459	213
Valve Maintenance, Other Than Listed	12	62	63	125	556
Water Meter Failures	12	70	35	105	494
Air Ejector Failures	12	41	25	66	1620
Thermometer Calibrations or Replacement	12	28	33	61	204
Ameroyal Installation or Maintenance	7	51	4	55	1049
Acid Cleaning	6	54	22	76	46
Steam Regulation Problems	6	12	51	63	0
Gauge Calibration or Replacement	5	30	0	30	1256
Worn Internals	4	96	0	96	1080
Drain Regulating Valve Inoperative	4	34	28	62	168
Leaks and Hydrotests	4	26	2	28	0
Overhaul Requested	4	22	0	22	0
Totals	114	825	571	1396	9516
Percentage of APL 08003009 Totals	51.4	42.4	52.9	46.1	53.4

the number of JCNs reported for heat exchanger repairs and the similarities in the heat exchanger repairs reported in the MDS against the two designs, it is concluded that this heavy demand for distillate has degraded the heat exchangers in the Cleaver-Brooks units in the same ways as it has the Bethlehem Steel units. That is, the higher salt water velocity through the tubes in the heat exchangers resulting from the operational methods employed by Ship's Force to meet the demands for fresh water has eroded the tubes and caused leaks. Therefore, repeating a recommendation made for the Bethlehem Steel units, the operating procedures should be reviewed and the effects of the different methods of operation evaluated. The final outputs of these efforts should be standardized operational methods (to replace the current EOSS) and recommendations, where necessary, of any design changes to the units that would be required to reliably produce the needed distillate.

To meet the fresh water demands, Ship's Forces have installed Ameroyal injection equipment to reduce the scaling in the heat exchangers. Four ships with Cleaver-Brooks distillation units (DDGs-40, -42, -43, and -44) have installed Ameroyal injection equipment. As with the equipment installed on DDGs-38, -39, and -45, this equipment is not COSAL-supported, and repair parts are difficult to obtain. From discussions with Ship's Force, it was determined that Ameroyal has been beneficial in permitting the high rates of distillation without significantly reducing the time before acid-cleaning the heat exchangers becomes necessary. As noted in Section 3.2.1, ShipAlt DDG-37-1216D has been developed to install Ameroyal injection equipment on DDG-37 Class ships. Because of the benefits of the use of Ameroyal, it is recommended that this ShipAlt be accomplished on DDG-41. It is also recommended that the Navy investigate replacing the non-COSAL-supported injection pumps (installed by Ship's Force) with the pumps specified in the ShipAlt to ensure adequate supply support for those pumps.

The data have shown that the distillation units have experienced a significant maintenance burden during the data period. It is likely, therefore, that some major corrective maintenance will be required during an extended operating cycle to return unit material condition to acceptable levels. Because most of the distillation units will not have been overhauled since the last ship overhaul or AAW conversion, those units will have accumulated a minimum of about 36 months of operation before entry into Baseline Overhaul. It is unlikely that the distillation units will operate for an additional 60 months (for a total of about 100 months) without an overhaul or significant major repairs. Therefore, it is recommended that the distillation units be overhauled during Baseline Overhaul.

Recommendations

For the near term, the following actions should be taken:

- Two Cleaver-Brooks distillation units should be overhauled to Class B specifications during Baseline Overhaul.

- ShipAlt DDG-37-1216D should be accomplished on DDG-41 during Baseline Overhaul.
- The Navy should investigate replacing the non-COSAL-supported Ameroyal injection pumps with the pumps specified in ShipAlt DDG-37-1216D to ensure adequate supply support.

For the long term, the following actions should be taken:

- The current Distilling Plant operating procedures should be reviewed and the effects of the operating procedures on system components should be evaluated. This review should specify standardized operating procedures (to replace the current EOSS) and recommend, where necessary, any design changes to Distilling Plant System components that are required to reliably produce the needed distillate.
- During the follow-on Regular Overhaul the units should be acid-cleaned, inspected, and hydrotested.
- Other repairs should be made as shown to be necessary by the inspection and Ship's CSMP.

3.2.3 On-Condition Maintenance Strategy Considerations for Distillation Units

The *FF-1052 Class Distilling Plant System Review of Experience* recommended that the distillation units be maintained using an on-condition maintenance strategy. The second volume of that report, entitled *Development of Performance Monitoring and Material Condition Assessment Criteria for the FF-1052 Class Distilling Plant System,* found that at the system level, monitoring distillate production and distillate salinity would give an adequate indication of distillation unit performance and material condition. Distillate production and distillate salinity are both measured by installed meters; both must be recorded hourly by Ship's Force on the Distilling Plant Operating Record. The distillation units installed on the DDG-37 Class ships are very similar to units installed on the FF-1052 Class ships. (The Cleaver-Brooks units installed on hulls DDG-40 through DDG-44 are the predecessors of the Aqua-Chem units installed on all FF-1052 Class ships. Cleaver-Brooks Special Products, Inc., became the company now known as Aqua-Chem.) Because of the similarities between the FF-1052 and DDG-37 Class distillation units, it is concluded that at the system level, monitoring distillate production and distillate salinity of the DDG-37 Class distillation units should give an adequate indication of distillation unit condition.

A review of the PMS requirements for the DDG-37 Class distillation units, as listed on the pertinent MIPs and MRCs, showed several maintenance requirements that are to be performed on an "on-condition" basis. That is, the maintenance specified by the MRC is to be accomplished only when the noted performance or operating parameter reaches the limiting value stated on the MRC. Table 3-4 summarizes these requirements and lists the distillation unit accessory affected, the condition being assessed, and the parameter that is monitored.

Table 3-4. SUMMARY OF DISTILLATION UNIT ON-CONDITION PMS MAINTENANCE REQUIREMENTS		
Accessory	Material Condition Being Assessed	Parameter Monitored
Feed Heater	Scale	Steam Pressure
Steam Strainer	Plugging	Steam Pressure
Air Ejector Nozzle	Wear	Steam Pressure
Air Ejector Strainer	Plugging	Steam Pressure
Brine Suction Strainer	Plugging	Water Level
Check Valve	Opening	Water Pressure

These PMS requirements, in conjunction with other PMS requirements and the requirement to record distillate production and salinity, are considered adequate to maintain the distillation units throughout an extended operating cycle. Therefore, no additional requirements for material condition assessment are recommended for the distillation units.

3.3 BRINE OVERBOARD PUMPS (APLs 016020333 and 016020507)

Background

Only a portion of the salt water feed that flows through each distillation unit flashes into steam. The salt water, or brine, that does not flash must be removed. This is accomplished by a one-stage centrifugal pump that takes suction on the bottoms of both flash chambers and pumps the brine overboard. There are two brine overboard pumps installed on each ship, one per distillation unit. Although the APL numbers for the pumps supplied with the Bethlehem Steel and Cleaver-Brooks distillation units are different, the pumps are virtually identical. They were manufactured by Warren Pumps, Inc., and are rated at 35 pounds per square inch (psi) and 160 gallons per minute (gpm).

Discussion

A review of the MDS data showed that these pumps contributed significantly to the corrective maintenance burden reported against the Distilling Plant System. Table 3-1 summarizes the burden data. Together, the brine pumps contributed 173 JCNs, 3062 Ship's Force man-hours, 1436 IMA man-hours, and $33,950 to the total system corrective maintenance burden. They required an average of 43 man-hours of maintenance and about $327 worth of parts per pump per operating year. During the data period, there were only two CASREPs submitted for wear or failure of the pumps. The DDG-37 Class Repair Profile indicated that these pumps were usually overhauled during Regular Overhauls.

An analysis of the MDS narrative transaction data showed that the average time between significant maintenance actions was about 10 to 14 months. Throughout the discussions of Distilling Plant System pumps, the term "significant maintenance action" refers to repair or replacement of the following:

- Wearing Rings
- Impeller
- Rotor Assembly
- Casing

In the majority of the transaction data, the narrative reported degraded pump condition (that is, pump discharge pressure was low, output was low, or the pump was vibrating). Ship's Force repaired many pumps without IMA assistance.

The high corrective maintenance burden experienced by these pumps was the result of two factors. First, the time between overhaul or replacement of wearing rings is short as compared to fresh water pumps because of the high rate of brine flow through the pumps. Second, the brine overboard pumps were originally located directly under the distillation units when the DDG-37 Class ships were built, making it difficult to reach the pumps to perform the required maintenance. Both distillation unit designs specified a similar location for the brine overboard pumps. Several ships (DDG-40 through DDG-44) have moved their brine overboard pumps (APL 016020507), in accordance with ShipAlt DDG-37-188D, to the deck below the distillation units to make them more accessible. This ShipAlt has been installed on only one of the ships (DDG-39) with APL 016020333. Accurate installation dates for this ShipAlt could not be obtained, preventing an analysis and comparison of the maintenance burden reported against the pumps before ShipAlt installation and after installation. There is, however, a significant difference in the maintenance burden reported against the two different APLs.

The large difference in reported parts costs between the two APLs is the result of a need for a new brine overboard pump by DDG-37 and of two parts requests for a new pump in the same JCN. The JCN narrative submitted by DDG-37 personnel stated that the pump casing was worn excessively and needed to be built up. Because a new pump was ordered, it is concluded that adequate repairs could not be made. There was no indication that both installed pumps needed to be replaced or required major repairs. Therefore, it is concluded that the second request for a new pump was unnecessary and was an error, an attempt to ensure receipt of a new pump, or an attempt to obtain a complete spare pump. The parts costs represented by these two requests totaled $10,162, which is slightly more than the difference between the reported costs of the two pump APLs. Excluding the purchase of the new pump by DDG-37, the reported parts costs for the two APLs are approximately the same.

Because the pumps represented by the two APLs are virtually identical, and because APL 016020507 has experienced higher part usage with a lower burden (see Appendix B, Tables B-4 and B-5), it is believed that the difference in burden is partly the result of the more difficult access to brine overboard pump APL 016020333 as compared to APL 016020507. This conclusion is substantitated by the difference in man-hours reported against each APL. The number of JCNs reported for each APL was about the same (88 JCNs against APL 016020333 versus 85 JCNs against APL 016020507). However, the mean repair burden (29.9 man-hours per JCN for APL 016020333 and 21.9 man-hours per JCN for APL 016020507) and the distribution of man-hours to the JCNs was significantly different for the two APLs. About 59 percent of the JCNs submitted against APL 016020333 took more than 10 man-hours to complete. For APL 016020507, about 41 percent took more than 10 man-hours to complete. Thus, it required more man-hours to complete a maintenance action on APL 016020333 than on APL 016020507. It is concluded that the difference is the result of the more difficult access to APL 016020333.

DDG-37 will be the seventh ship to have the ShipAlt accomplished, when its pumps (APL 016020333) are moved during the current overhaul. The other three ships are programmed to have the ShipAlt accomplished within the next four fiscal years. It is recommended that the ShipAlt be accomplished during Baseline Overhauls.

Because only two CASREPs were submitted against these pumps, it is concluded that the failures affecting the pumps did not appreciably reduce ships' capabilities. Although the time between replacement of wearing rings or overhaul is short, the low criticality of these pumps does not warrant establishing a "hard-time" overhaul or replacement of the wearing rings. In addition, recent studies and tests conducted by NAVSEC (PHILADIV)* have shown that the criterion specified in PMS for the replacement of pump wearing rings (twice design clearance) is conservative and does not reflect the clearance that would represent significant degradation of pump performance. The criterion was shown to be valid for pumps that are more complex than the brine overboard pumps (and all the other single-stage pumps in the Distilling Plant System). However, the tests were discontinued before a full range of clearances could be evaluated. On the basis of the test results, it is concluded that the annual "open and inspect" PMS action is too frequent and can be deleted. Therefore, a "fix-when-fail" maintenance strategy is recommended for the brine overboard pumps. Because Ship's Force can maintain these pumps during an extended operating cycle, with some assistance from IMAs, these pumps should be repaired during Baseline Overhaul and the follow-on Regular Overhaul as shown to be necessary by Pre-Overhaul Test and Inspection (POT&I) and ship's CSMP.

The review of experience for the FF-1052 Class Distilling Plant System** found that it would be possible to determine the material condition of single-stage centrifugal pumps by monitoring pump performance parameters

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*NAVSEC (PHILADIV) Letter Report to NAVSEA (PMS-306) Ser. 153, 16 March 1976.

***FF-1052 Class Distilling Plant System Review of Experience, DDEOC SMA 201-531*, July 1976.

instead of relying on "open and inspect" actions. The second volume of that report, *Development of Performance Monitoring and Material Condition Assessment Criteria for the FF-1052 Class Distilling Plant System,* found that pump discharge pressure could be used to indicate the need for maintenance. The report recommended that a class-wide test be performed to evaluate the use of this technique. Because of the similarities of the pumps used in the FF-1052 Class and DDG-37 Class Distilling Plant Systems, it is recommended that the results of the FF-1052 Class test be evaluated and, if the technique of using pump discharge pressure to indicate the need for maintenance is found to be effective, that the technique be considered for the DDG-37 Class Distilling Plant System pumps.

Operational Procedures

A comparison of Engineering Operational Sequencing System diagrams and the Distillation Unit technical manuals showed a difference in operational procedures that may have contributed to the high maintenance burden and to the short time between major maintenance for these pumps. Distilling Plant Technical Manual 358-0354 contains a recommendation to distillation unit operators to throttle the brine overboard discharge valve "enough to produce a steady, non-fluctuating discharge pressure"* on the pump discharge pressure gage when the pump cavitates. However, EOSS operating procedure EV/186 does not include that procedure, requiring only that the valve be opened when the distillation unit is placed in operation. It is possible that brine overboard pumps are cavitating some of the time they operate, accelerating wear of the internal pump parts. Therefore, a note should be added to the EOSS procedure instructing the operator to throttle the brine overboard discharge valve if the brine overboard pump cavitates.

Recommendations

The following near-term actions should be taken:

- Two brine overboard pumps should be repaired as shown to be necessary by POT&I and ship's CSMP during Baseline Overhaul.
- ShipAlt DDG-37-188D (Relocate the Brine Overboard Pumps) should be accomplished during Baseline Overhaul.
- The "open and inspect" maintenance actions should be deleted from the brine overboard pump Maintenance Index Pages (MIPs) (MRC 21-Y868-A on MIP E-14/653-21 and MIP E-14/676-41).
- A note should be added to EOSS operating procedure EV/186 to throttle the brine overboard discharge valve to produce a steady, non-fluctuating reading on the brine overboard pump discharge pressure gage if cavitation is suspected.

**Distilling Plant Technical Manual,* NAVSHIPS 358-0354, Page 32.

The following long-term actions are recommended:

- Two brine overboard pumps should be repaired as shown to be necessary by ship's CSMP and POT&I during the follow-on ROH.
- The results of the FF-1052 Class tests of the use of pump discharge pressure as an indicator of the need for maintenance should be evaluated. If the test results indicate that the technique is effective, consideration should be given to using this technique for DDG-37 Class Distilling Plant System brine overboard pumps and all other system pumps.

3.4 SALT WATER FEED PUMP (APL 016110073)

Background

Salt water is supplied to and pumped through the distillation units by salt water feed pumps. These one-stage centrifugal pumps take suction on a sea chest and pump salt water through the units at 45 psi and 170 gpm. Two pumps are installed on each ship, one supplying each plant. All DDG-37 ships have these pumps, which were made by the Aurora Pump Company, a division of the General Signal Corporation.

Discussion

MDS data showed that the 20 salt water feed pumps had a reported maintenance burden of 190 JCNs, 2,290 Ship's Force man-hours, 1,598 IMA man-hours, and $8,900 in part replacement costs. The corrective maintenance burden averaged 37 man-hours and $86 per pump per operating year. There were no CASREPs submitted against this pump. The DDG-37 Class Repair Profile indicated that the salt water feed pumps are normally overhauled during Regular Overhauls.

The large corrective maintenance burden reported against the salt water feed pump was caused primarily by wear of impellers, shaft sleeves, and impeller and casing wearing rings. Table B-6 in Appendix B summarizes the part usage data reported against the salt water feed pumps. It shows a high ratios of parts replaced to total population, indicating that the wearing parts were replaced frequently. An analysis of the MDS narrative transaction data showed that the average time between significant maintenance actions (as reported in the MDS) was about 14 to 15 component-operating-months. The term "significant maintenance action" refers to repair or replacement of the following:

- Wearing Ring
- Impeller
- Rotor Assembly
- Casing

This interval is short when compared to fresh water pumps,primarily because of the salt water flow through the pump.

As is shown in Appendix D, the distillation units have been operated to produce as much as 600 gallons of fresh water per hour. One method used to produce that quantity of fresh water involves increasing steam flow to the salt water heater and increasing the salt water feed rate to maintain the first stage inlet temperature at the design rating of 170°F. This increases the flow rate through the salt water feed pumps and thus increases the rate of wearing ring erosion. The higher flow rate decreases wearing ring life and reduces the time between replacements or pump overhauls. The other method used to increase water production does not increase the salt water flow rate, and consequently does not degrade the salt water feed pump. Therefore, repeating a recommendation from Section 3.2, standardized operating procedures should be developed to maximize water output and minimize component degradation.

MRC B5-J29E-N on MIP A-19/250-B5 specifies an annual inspection of the pump internal parts, including measuring wearing ring clearances. The review of the MDS narrative transaction data identified several instances of overhauls or wearing ring replacements that Ship's Force thought were required by PMS, when it was actually calling only for an inspection. A sample narrative for one maintenance action reads as follows: "Pump due for annual overhaul as per PMS". This sample is typical of narratives for other maintenance actions reported in MDS and confirms that Ship's Force interprets "open-and-inspect" PMS requirements as overhaul requirements. As a result, it is very likely that the inspection has resulted in replacement of wearing rings and that some corrective maintenance was accomplished earlier than was necessary simply because an inspection was scheduled.

The criticality of the salt water feed pumps is relatively low; they can tolerate some material condition degradation before overhaul is required. Although salt water feed is necessary for the production of fresh water, the firemain can be used in place of the salt water feed pumps to supply the distillation units. This can be accomplished by isolating the affected salt water feed pump and using the fire main to supply salt water through the inlet acid-cleaning connection. Unless this connection is piped directly, the switchover from the salt water feed pump to the firemain can be accomplished within two to three hours by connecting the distillation units to the firemain with a fire hose. The criticality of the pumps is also reduced because the average repair time is less than the time a ship can operate with only one distillation unit operating. That is, the average repair burden for corrective maintenance actions is about 30 man-hours, or within two calendar days if two men perform the work. These ships can operate for about three days with one distillation unit operating (if the feedwater and potable water tanks are reasonably full), so a ship can maintain normal operations while repairs are being made. Because of the factors that reduce the criticality of the salt water feed pumps, it is concluded that they can be maintained under a "fix-when-fail" maintenance strategy during the operating cycle. The annual inspection of pump internal parts is unnecessary and should be deleted from the pump MIP. Because of the low criticality and the capabilities of Ship's Force to repair the pumps, repairs to these pumps during Baseline Overhaul and the Follow-On Regular Overhaul should be based on POT&I results and ship's CSMP.

Recommendations

The following near-term actions should be taken:

- Two salt water feed pumps should be repaired during Baseline Overhaul as shown to be necessary by POT&I results and ship's CSMP.
- MRC B5-J29E-N should be deleted from MIP A-19/250-B5 (Inspect pump internal parts).

The following long-term actions are recommended:

- These pumps should be maintained under a "fix-when-fail" maintenance philosophy.
- Two salt water feed pumps should be repaired during the Follow-On Regular Overhaul as shown to be necessary by POT&I results and ship's CSMP.

3.5 SALT WATER HEATER DRAIN PUMPS (APLs 016020324 and 016020506)

The auxiliary exhaust steam supplied to the salt water heater condenses while giving up its heat to the incoming sea water. It then drains into the drain regulator, where it is drawn away by the salt water heater drain pump and pumped into the condensate system. Two different pumps are installed on DDG-37 Class ships to accomplish this, but they are manufactured by the same company, Warren Pumps, Inc. APL 016020324 is installed with the Bethlehem Steel distillation units and is rated at 53 psi and 10 gpm. APL 016020506 is installed with the Cleaver-Brooks distillation units and is rated at 63 psi and 15 gpm.

3.5.1 Warren Model 1-SED-6 Pump (APL 016020324)

Background

The salt water heater drain pumps installed with the Bethlehem Steel distillation units are Warren Pumps, Inc., Model 1-SED-6 single-stage, close-coupled, horizontally mounted, centrifugal pumps. They are driven at a constant speed by an electric motor.

Discussion

The salt water heater drain pumps had a reported maintenance burden of 1,417 man-hours, for an average of about 28 man-hours per pump per operating year. Ship's Force reported 1,077 man-hours, while IMAs reported 340 man-hours. A total of $2,793 was spent on replacement parts, for an average of about $54 per pump per operating year. There were no CASREPs submitted against these pumps. The DDG-37 Class Repair Profile showed that these pumps were usually overhauled during Regular Overhauls.

A review of the MDS part usage data showed that the major wearing pump parts -- the shaft sleeve and the wearing rings -- experienced the highest usage (see Appendix B, Table B-7). An analysis of individual maintenance transaction data showed that the majority of the corrective maintenance burden was in the replacement of those parts, and that the parts were replaced because pump output was low or because there was evidence of internal part wear. The analysis also showed that the average time between significant maintenance actions (as reported in the MDS) was 44 to 56 component-operating-months. The term "significant maintenance action" refers to repair or replacement of the following:

- Wearing Ring
- Impeller
- Rotor Assembly
- Casing

The other parts experiencing high replacements (replacements greater than 50 percent of the part population) such as the water ring, impeller nut, and sleeve bearing, were replaced as necessary in conjunction with the replacement of the wearing rings. The high part replacements experienced by these pumps are not unusual when compared to the usage experienced by the pumps (APL 016020506) installed on hulls DDG-40 through DDG-44 or by the two-stage pump (APL 016150569) installed on some FF-1052 Class ships. The types of parts replaced were similar and the ratios of the part replacements to the total part population were high for all three pumps. All operate under similar operating conditions for about the same operating time, with approximately the same system requirements (see Table 3-5 for a comparison).

Table 3-5. AVERAGE OPERATING TIME COMPARISON FOR SALT WATER HEATER DRAIN PUMPS

APL	Hulls	Number of Pumps	Ship Operating Years	Ship Operating Years Per Pump
016150569	FF-1052 FF-1077	52	108.8	2.09
016020506	DDG-40 - DDG-44	10	26.1	2.61
016020324	DDG-37 - DDG-39, DDG-45, DDG-46	10	25.8	2.58

A comparison of the part usage data showed that the wearing rings were replaced at ratios to population (times 100) of about 104 (APL 016150569), 110 (APL 016020506), and 145 (APL 016020324). Shaft sleeves were replaced at ratios of 130 (APL 016020324) to 245 (APL 016150569). APL 016020506 does not have a shaft sleeve, as the packing is installed directly around the pump shaft. From these data, it is concluded that the high part usage experienced by the DDG-37 Class salt water heater drain pumps is not unusual when compared to the FF-1052 Class pump.

A review of the MDS data showed that Ship's Force reported about 76 percent of the man-hours reported against this pump, while IMAs reported the rest. This indicates, as would be expected, that Ship's Force performs most of the corrective maintenance required by the pumps. Additional review of the data showed that the average burden was about 32 man-hours per JCN, or between one and two days if two men performed the maintenance. Because a ship can maintain operations for about three days with only one distillation unit operating, the experienced repair time indicates that a pump can be repaired (if the repair parts are available) before there is a significant degradation of ship capabilities. The lack of CASREPs submitted against the pump substantiates that conclusion, and indicates that, although pump failures have occurred, the failures have not seriously degraded ship capabilities. The MDS data also showed that Ship's Force replaced wearing rings, impellers, shaft sleeves, etc., as necessary during the data period. Although IMAs were requested to make major pump repairs, the MDS narrative data indicate that some major repairs were accomplished by Ship's Force. It is concluded from these data that Ship's Force can normally repair the pumps, and that failures to the pumps do not significantly degrade ship capabilities. Because these factors reduce the criticality of an operational failure of the pumps, it is further concluded that the pumps should be maintained under a "fix-when-fail" maintenance strategy. Maintaining the pumps under such a strategy would make the PMS-required cyclic inspection of internal parts unnecessary, allowing deletion of MRC 11-Y868-C from MIP E-14/658-31. The low criticality of the pumps and Ship's Force capabilities to repair them before significant degradation of ship capabilities lead to the conclusion that pump repairs scheduled for Baseline Overhaul and the follow-on Regular Overhaul should be made as shown to be necessary by POT&I and ship's CSMP.

Recommendations

The following near-term actions should be taken:

- Two salt water heater drain pumps should be repaired as shown to be necessary by POT&I and ship's CSMP during Baseline Overhaul.
- The cyclic inspection of pump internal parts (MRC 11-Y868-C) should be deleted from MIP E-14/658-31.

The following long-term actions are recommended:

- These pumps should be maintained under a "fix-when-fail" maintenance philosophy.
- The pumps should be repaired during the follow-on Regular Overhaul as shown to be necessary by POT&I and ship's CSMP.

3.5.2 Warren 1-CV-7 Pump (APL 016020506)

Background

The salt water heater drain pumps installed with the Cleaver-Brooks distillation units are Warren Pumps, Inc., model 1-CV-7 vertical, single-stage, flexibly coupled centrifugal pumps with externally lubricated thrust bearings. These pumps are driven at constant speed by an electric motor.

Discussion

The MDS corrective maintenance burden reported against these pumps totaled 533 man-hours, or about 10 man-hours per pump per operating year. Ship's Force used 266 man-hours, while IMAs used 267 man-hours. A total of $3,427 was spent for pump replacement parts, for an average of about $66 per pump per operating year. There were no CASREPs submitted against these pumps. The DDG-37 Class Repair Profile showed that these pumps were usually overhauled during Regular Overhauls.

A review of MDS transactions showed that the majority of the maintenance burden was reported for replacement of the major wearing parts and that the average burden was about 12 man-hours per JCN. Thus, a pump can easily be repaired in one day if two men do the work. From the reported man-hour consumption, it can be seen that Ship's Force and IMAs shared the maintenance burden equally. However, the MDS transaction narratives indicate that IMAs spent the majority of their time in large maintenance actions. These data also show that Ship's Force personnel were capable of overhauling these pumps without IMA assistance, although IMAs were often requested to overhaul them. Thus, it appears that Ship's Force can maintain these pumps with some assistance from IMAs.

A review of the part replacement data for these pumps (see Table B-8) showed that the bearings and casing wearing rings experienced the highest ratios of replacements to population. In addition, the average time between significant maintenance actions was found to be 48 to 56 component-operating months. The term "significant maintenance action" refers to repair or replacement of the following:

- Wearing Ring
- Impeller
- Rotor Assembly
- Casing

The replacement ratios experienced by these pumps are similar to those for the other salt water heater drain pumps. The high bearing replacements could indicate a maintenance problem; however, a review of individual maintenance transactions showed that a majority of the bearing replacements occurred in conjunction with wearing ring replacements and, according to the MDS narrative, that the wearing ring replacements occurred because of wear or low output. There was no indication that the bearings were replaced because of wear-out or that the wearing rings were replaced because the bearings had worn. Therefore, it is concluded that most of the bearing replacements were convenience replacements that do not represent maintenance problems. It is also concluded that the part replacements experienced by these pumps are typical and represent normal wear.

The maintenance burden reported against this pump averages about 10 man-hours per pump per operating year. This is much lower than the 28 man-hours per pump per operating year reported against APL 016020324. A comparison of the two pumps indicated a construction difference that affects the time required to replace wearing parts or to overhaul the pumps. APL 016020324 is a close-coupled pump that has the major wearing parts attached to the extended motor shaft. The inlet and outlet piping must be disconnected in order to replace wearing rings or to overhaul the pumps. After repairs are made, the pump and motor must be realigned and the piping reconnected. APL 016020506 is a flexibly coupled pump with a split casing that can be removed for access to the major parts without disconnecting the inlet and outlet piping and without disturbing the pump-to-motor alignment. The average man-hour burden per JCN was about 32 man-hours for APL 016020-324 and 12 man-hours for APL 016020506, indicating that the average repair burden was higher for APL 016020324 than for APL 016020506. Therefore, it is concluded that fewer man-hours are required to complete repairs of APL 016020506 than APL 016020324 because of the time required to realign APL 016020324 and its motor and reconnect the inlet and outlet piping.

Although these pumps do not have redundant installations, their criticality is low for the following reasons. First, Ship's Force can adequately maintain the pumps with some assistance from IMAs. Second, because the ship can maintain operation for about three days if only one distillation unit is operating, the ability of Ship's Force to repair the pumps within one day indicates that no significant degradation of ship capabilities would occur if a pump were to fail. In addition, the lack of CASREPs submitted against these pumps indicates that, historically, pump failures have not seriously degraded ships' capabilities. It is, therefore, concluded that these pumps should be maintained under a "fix-when-fail" maintenance strategy. Maintaining the pumps under such a strategy would make the cyclic inspection of pump internal parts unnecessary, so MRC 30-W330-A on MIP E-14/357-30 should be deleted. Because of the low criticality of the pumps and the ability of Ship's Force to repair them, the salt water heater drain pumps should be repaired during Baseline Overhaul and the follow-on Regular Overhaul, as shown to be necessary by POT&I and ship's CSMP.

Recommendations

The following near-term actions should be taken:

- Two salt water heater drain pumps should be repaired during Baseline Overhaul as shown to be necessary by POT&I and ship's CSMP.
- The cyclic inspection of pump internal parts (MRC 30-W330-A) should be deleted from MIP E-14/557-30.

The following long-term actions should be taken:

- These pumps should be maintained under a "fix-when-fail" maintenance philosophy.
- The pumps should be repaired as shown to be necessary by POT&I and ship's CSMP during the follow-on Regular Overhaul.

3.6 DISTILLATE PUMPS

The fresh water, or distillate, produced in the distillation units is pumped from the flash chambers by one-stage centrifugal pumps to the potable fresh water and make-up feedwater tanks. The pumps used in the DDG-37 Class are manufactured by Warren Pumps, Inc. Two different pump models are used for the distillation units installed in this class.

3.6.1 Warren Pumps, Inc. Model 1 1/2-SECA-6 Distillate Pump (APL 016020332)

Background

The distillate pumps associated with the Bethlehem Steel distillation units are Warren Pumps, Inc., model 1 1/2-SECA-6 centrifugal pumps. These pumps are single-stage, close-coupled, horizontally mounted, motor-driven pumps rated at 40 psi and 18 gpm. Two pumps are installed on each of the hulls DDG-37 through DDG-39, DDG-45, and DDG-46.

Discussion

A review of MDS data showed that 54 JCNs, 445 Ship's Force man-hours (50 percent of APL total), 446 IMA man-hours (50 percent of APL total), and $8,776 in part replacement costs were reported against these pumps during the data period (see Table 3-1). These totals represent an average of 17 man-hours and $170 per pump per operating year. A review of the CASREP data showed that there were no CASREPs submitted against these pumps during the data period, indicating that there was no significant degradation of ships' capabilities as a result of pump failure. The DDG-37 Class Repair Profile indicated that these pumps were usually overhauled during Regular Overhauls.

An analysis of individual maintenance transactions showed that the maintenance burden reported against these pumps was primarily the result of the replacement of pump wearing parts. Table B-9 in Appendix B summarizes the part replacements reported against these pumps and shows that casing wearing rings, shaft sleeves, and impellers experienced high numbers of replacements in proportion to their population. Lantern rings, impeller nuts, and sleeve bushings experienced lower ratios of parts replaced to total part population and do not represent a maintenance problem. The high part replacements are not unexpected, for two reasons. First, the pumps are rated for higher output than is demanded of them: they are rated at 18 gpm, but the highest rate they are required to pump is only about 10 gpm. They are never operated at full flow capacity. The MDS transaction narratives indicate that wearing rings and impellers have worn rapidly, reducing pumps' output and necessitating their replacement. Second, these pumps take suction on the second stage flash chamber, which operates at a vacuum of 3.15 inches Hg (absolute). The vacuum in the second stage flash chamber draws air through the pump packing into the flash chamber, with the result that the pump loses suction and runs dry, rapidly wearing the internal parts. The shaft sleeve, lantern ring, and packing must be in good condition to give reliable operation and rated pump output. A review of the MDS transaction narratives showed that Ship's Force was aware of the relationship between output and the condition of the packing, shaft sleeves, and lantern rings. In several cases, the narrative stated that the shaft sleeve was worn or that output was low, necessitating replacement of the shaft sleeve and packing. Adherence to the PMS will minimize the effects of shaft sleeve, packing, and lantern wear. The lack of CASREPs indicates that Ship's Force was capable of repairing the pumps and did not consider the "failures" to significantly reduce system or ship capabilities.

A review of MDS narratives showed that Ship's Force was capable of making any necessary repairs to the distillate pumps. Even though IMAs were requested to overhaul some pumps, Ship's Force performed enough major corrective maintenance to indicate adequate repair capability. A review of the MDS data showed that Ship's Force was able to make repairs in less than 10 man-hours about 70 percent of the time. In contrast, IMAs completed only about 33 percent of the repair actions in less than 10 man-hours, indicating that they performed mostly major maintenance. It is concluded that, in the event of pump failure or reduced output, Ship's Force is capable of making repairs within one to two days. Because a ship can maintain operations with only one distillation unit operative for about three days if the tanks are full, no serious loss of capability would occur with the failure of a distillate pump (assuming that parts to repair the pump are available). Therefore, these pumps should be maintained according to a "fix-when-fail" maintenance strategy. The PMS-required cyclic inspection of internal parts is unnecessary, and MRC 11-Y868-C should be deleted from MIP E-14/636-21.

The ability of Ship's Force to repair these pumps and the lack of CASREPs indicate that failures to the pumps have not significantly reduced ship capabilities. In addition, because the average repair time (one to two days) is less than the time a ship can operate with only one distillation unit operating, the ship can maintain normal operations while repairs are made. Therefore, it is concluded that overhaul of these pumps by a depot-level facility is not warranted for Baseline Overhaul because of the on-board repair capability and the limited degradation of ship capabilities that occurs when a pump fails. However, it should be anticipated that repairs will be required during Baseline Overhaul; the extent of the repairs should be determined by a POT&I and a ship's CSMP. The necessary repairs should be accomplished by Ship's Force or an IMA.

Recommendations

For the near term, Ship's Force or an IMA should repair two distillate pumps on the basis of POT&I results and ship's CSMP during Baseline Overhaul.

The following long-term actions should be taken:

- These pumps should be maintained according to a "fix-when-fail" maintenance strategy.
- MRC 11-Y868-C should be deleted from MIP E-14/636-21.
- During the follow-on Regular Overhaul, these pumps should be repaired as shown to be necessary by POT&I and ship's CSMP.

3.6.2 Warren Model 1-CV-7 Distillate Pump (APL 016020505)

Background

The pumps associated with the Cleaver-Brooks distillation units are Warren Pumps, Inc., Model 1-CV-7 distillate pumps. They are single-stage, flexibly coupled, vertically mounted centrifugal pumps with externally lubricated thrust bearings. They are rated at 42 psi, pumping distillate at 15 gpm. Two of these pumps are mounted on each of hulls DDG-40 through -44.

Discussion

The corrective maintenance burden experienced by these pumps was determined by a review of MDS data. The review showed (see Table 3-1) that 62 JCNs, 309 Ship's Force man-hours, 298 IMA man-hours, and $6,327 in part replacement costs were reported against these pumps during the data period. These totals represent an average of 12 man-hours and $121 per pump per operating year. There were no CASREPs reported against these pumps during the data period. As with the other distillate pumps, the DDG-37 Class Repair Profile showed that these pumps were usually overhauled during Regular Overhauls.

Replacements of internal wearing parts were the primary causes of the corrective maintenance burden. A summary of the part replacement data (see Table B-10 of Appendix B) shows that the casing wearing rings, the lower bearing, and the ball thrust bearing experienced replacements much greater than their proportion to the total part population. The sleeve bearing also experienced high replacements, but at a much lower rate than the other parts. The high rate of replacements of the wearing rings and bearings are not surprising, considering the difference between the pump output rating and the actual operating condition. As with the other distillate pumps, the design flow rate is higher than actually experienced by the pumps. The pumps are rated at 15 gpm, while the highest flow rate likely to be demanded of the pump would be about 10 gpm, indicating that they never operate at full capacity.

The MDS narratives reported that the wearing rings have worn, resulting in decreases in pump output and necessitating replacement of the wearing rings. In addition, the pumps take suction on the second stage flash chamber, which operates at a vacuum of 3.15 inches of Hg (absolute). This vacuum draws air through the packing and the lower bearing into the flash chamber. As a result, the pump loses suction and runs dry, rapidly wearing the wearing rings. The lower bearing and packing must be in good condition for reliable operation and rated output. Adherence to the PMS will minimize the effects of packing and lower bearing wear.

The lack of CASREPs submitted against these pumps indicates that Ship's Force has been able to repair the pumps without significant reduction of system or ship capabilities. A review of the MDS transaction narratives showed that the ball-thrust bearings seem to have been replaced when the pumps were opened for overhaul or replacement of the wearing rings or lower bearings. Ship's Force did not indicate that the bearings had been wearing out. There was no indication in the MDS narratives that the ball-thrust bearing had experienced wear-out problems. Therefore, it is concluded that wear-out was not a significant failure mode for the ball-thrust bearings and that those bearings were replaced as a matter of convenience during the replacement of wearing rings and lower bearings.

The review of MDS narratives also indicated that Ship's Force is capable of maintaining these pumps with some assistance from IMAs. Although the man-hour burden associated with IMAs is about the same as the Ship's Force burden (49 percent vs. 51 percent), the narrative and MDS summary indicate that IMAs expend the majority of their effort in large maintenance actions. While Ship's Force completed corrective maintenance in less than 10 man-hours 83 percent of the time, IMAs completed only 44 percent of their corrective maintenance in less than 10 man-hours. Although IMAs often overhauled distillate pumps, Ship's Force was also capable of overhauling them. Thus, unless major casing repairs are required, Ship's Force is capable of adequately maintaining the distillate pumps. The MDS data indicate that Ship's Force can replace the major wearing parts (wearing rings, impeller, lower bearing, and ball-thrust bearing) within one to two days if the repair parts are available. Because a ship can maintain operations with only one distillation unit operative, for about three days if the tanks are full, no serious reduction in capability would occur with the failure of a distillate pump. Therefore, these pumps should be maintained according to a "fix-when-fail" maintenance strategy. The annual PMS inspection of internal parts is unnecessary, and MRC 30-W330-A should be deleted from MIP E-14/558-30.

Ship's Force ability to repair these pumps and the lack of CASREPs indicate that failures of the pumps have not significantly reduced ship capabilities. In addition, the experienced average repair of one to two days is less than the three days a ship can operate with only one distillation unit operating, so the ship can continue normal operations while repairs are accomplished. Therefore, routine overhaul of these pumps by a depot-level facility in accordance with TRS is not warranted for Baseline Overhaul. However, it should be anticipated that repairs will be required during Baseline Overhaul; the extent of the repairs should be determined by a POT&I and a ship's CSMP. The necessary repairs should be accomplished by Ship's Force or an IMA.

Recommendations

For the near-term, two distillate pumps should be repaired during Baseline Overhaul as shown to be necessary by POT&I and ship's CSMP.

The following long-term actions should be taken:

- These pumps should be maintained according to a "fix-when-fail" maintenance philosophy.
- MRC 30-W330-A should be deleted from MIP E-14/558-30.
- During the follow-on Regular Overhaul, these pumps should be repaired as shown to be necessary by POT&I and ship's CSMP.

3.7 PUMP MOTORS (APL 174750532, 174750529, 174750531, 174750348, 174750530, AND 174750672) AND CONTROLLERS (VARIOUS APLS)

Background

Each DDG-37 Class ship has two salt water feed pump motors, two brine overboard pump motors, two salt water heater drain pump motors, and two distillate pump motors. All of these squirrel-cage induction motors are manufactured by the Reliance Electric Company and require 440-Vac power. There is one controller associated with each motor. Table 3-6 shows how the motors are used.

Table 3-6. DISTILLING PLANT SYSTEM PUMP MOTOR APPLICATIONS

APL	Application
174750530 174750672	Salt Water heater drain pump motors
174750531 174750348	Distillate pump motors
174750529	Brine overboard pump motor
174750532	Salt water feed pump motor

Discussion

The salt water heater drain pump motors and the distillate pump motors experienced very low maintenance burdens. One CASREP was submitted against APL 174750530 for shorted motor windings. This type of report is important because Ship's Force does not have the capability to rewind motors and must request outside assistance to restore a motor to an acceptable condition. However, submission of only one CASREP does not indicate a significant maintenance problem. It is concluded that these motors operated reliably throughout the data period and that they are likely to continue reliable operation during an extended operating cycle. Repairs during Baseline Overhaul should be determined by POT&I and ship's CSMP. No scheduled restorative maintenance will be required during the cycle. The brine overboard pump motor and the salt water feed pump motors did not operate as reliably during the data period; they are discussed in the following paragraphs.

Brine Overboard Pump Motor (APL 174750529)

The brine overboard pump motor experienced a moderate corrective maintenance burden in comparison with other Distilling Plant System components. A total of 1138 man-hours were reported against these motors, for an average of about 11 man-hours per motor per operating year. Ship's Force reported 633 man-hours, while IMAs reported 505 man-hours. Part replacement costs totaled $1,538, for an average of about $15 per motor per operating year. Five CASREPs were submitted against these motors, all for shorted or open motor windings. The DDG-37 Class Repair Profile showed that these motors were usually overhauled during Regular Overhauls.

The primary cause of the reported corrective maintenance burden was the replacement of motor bearings: about 50 percent of the man-hours and 74 percent of the JCNs. Table B-11 in Appendix B summarizes the part replacement data for this motor and shows that a large number of bearings were replaced during the data period. Three factors contributed to the replacements: first, some bearings were replaced because of failures; second, some motor bearings were replaced when the motors' associated pumps were opened for replacement of internal parts; third, the brine overboard pump and motor are located directly under the distillation units. This location tends to be wet and hot, which accelerates the breakdown of motor insulation and can cause corrosion of the bearings. When a motor is disassembled to dip and bake or rewind the rotor, the bearings must be removed. The MDS narrative data showed that except for one action, bearings were replaced during each action in which this motor was dipped and baked or rewound. Five CASREPs were submitted against this motor for shorted or open windings, which supports the conclusion that the temperature and humidity have resulted in motor rewindings.

Moving the brine overboard pumps from directly under the distillation units to the next lower deck (ShipAlt DDG-37-188D) can reduce the number of bearing replacements. This ShipAlt was introduced to improve the maintainability of the pumps (see Section 3.3 for a discussion of the ShipAlt as it applies to the pumps), but it will also improve the maintainability of the motors. In addition, it will reduce the number of bearing replacements resulting from the rewinds caused by excessive humidity and temperature. This ShipAlt should be installed during Baseline Overhaul. Because of the lack of redundancy and the lack of an on-board capability to dip and bake or rewind the motors, it is also recommended that the motors be overhauled during Baseline Overhaul and the follow-on Regular Overhaul in accordance with TRS 0531-086-614.

Salt Water Feed Pump Motor (APL 174750532)

The salt water feed pump motor experienced a total maintenance burden of 880 man-hours during the data period, for an average of about eight man-hours per motor per operating year. Ship's Force expended 628 man-hours, while IMAs expended 252 man-hours. Part replacements cost $1,299, or about $12 per motor per operating year. There were no CASREPs submitted against these motors during the data period. The DDG-37 Class Repair Profile indicated that these motors were usually overhauled during Regular Overhauls.

As with the brine overboard pump motor, the primary cause of the corrective maintenance burden (about 48 percent of the labor man-hours and 76 percent of the JCNs) was the replacement of motor bearings. Table B-12 of Appendix B summarizes the part replacements for this motor and shows a large number of bearing replacements reported against the motor. A review of the MDS maintenance action transaction data showed that bearings were replaced because of failure or were replaced concurrently with major pump repairs. In many cases, the bearings needed replacement to restore the motor to service. In the other cases, there was no indication of bearing failure and it appeared that motor bearings were replaced as a matter of convenience.

Salt water feed pump and motor redundancy is built into the system. In the event of motor failure, the firemain system can supply the distillation units with feedwater. On some ships this capability is "hard-wired"; that is, the piping and valves necessary to switch from feed pump to firemain operation are already installed. In other ships, the capability is provided by connecting a fire hose to the distillation unit inlet acid-cleaning connection (downstream from the salt water feed pump). Thus, a failure to either the salt water feed pump or its driving motors does not seriously degrade the ship's capability to make fresh water. The lack of CASREPs submitted against this motor substantiates this conclusion. In addition, a ship can maintain normal operations with a distillation unit connected to the firemain until IMA assistance can be obtained to correct the motor failure. Because of these factors, the salt water feed pump motor should be maintained under a "fix-when-fail" maintenance philosophy.

The criticality of the salt water feed pumps and motors is such that they can tolerate some material condition degradation before overhaul is required because the firemain can supply salt water feed to the distillation units in the event of failure to either the salt water feed pump or its associated motor. The motor criticality is also reduced because, with the exception of failures requiring motor rewind, Ship's Force can maintain the motors. In the event of a failure requiring a rewind, the ability to use the firemain to supply the distillation units with salt water feed allows the ship to maintain normal operations until IMA assistance can be obtained to rewind the motor. Without changing the salt water feed supply from the salt water feed pumps to the firemain, the ship can still operate for about three days with only one unit operating, allowing sufficient time to obtain IMA assistance. Therefore, because of the factors that reduce the criticality of the salt water feed pump motors, repairs to these motors during Baseline Overhaul and the follow-on Regular Overhaul should be based on POT&I results and ship's CSMP.

Electric Motor Winding Insulation

The MDS and CASREP data indicate that some motor rewinds have been necessary partly as a result of the hot, wet environment of the engine rooms in which the pumps are located. As noted in the DDG-37 Class Firemain and Auxiliary Machinery Cooling Water Systems SMA (SMA 37-201-521, February 1978), NAVSEC is investigating the use of a "sealed insulation system" to improve the moisture-proofing of electric motors. This new system uses different varnishes and a vacuum-pressure impregnation procedure that shows promise of effectively protecting the windings from moisture. Therefore, the NAVSEC review of the sealed insulation system rewind and vacuum-pressure impregnation procedures should be completed and the system implemented as soon as possible.

Motor Controllers

A review of the MDS data showed little maintenance reported against the motor controllers during the data period. No CASREPs were submitted against them, leading to the conclusion that motor controller failures did not significantly degrade ship capabilities. It is judged that reliable operation can be assured by inspecting and cleaning the motor controllers and replacing their contacts and heaters during Baseline Overhaul. The specified PMS will be adequate to maintain the controllers during an extended operating cycle.

Recommendations

The following near-term actions should be taken:

- Two brine overboard pump motors should be overhauled in accordance with TRS 0531-086-614 during Baseline Overhaul.
- The salt water feed pump motors, distillate pump motors, and the salt water heater drain pump motors should be repaired on the basis of the POT&I results and ship's CSMP.
- During Baseline Overhaul, all pump motor controllers should be inspected and cleaned and the contacts and heaters replaced.

- ShipAlt DDG-37-188D, which moves the brine overboard pumps and motors from underneath the distillation units, should be accomplished during Baseline Overhaul.

The following long-term actions should be taken:

- Two brine overboard pump motors should be overhauled in accordance with TRS 0531-086-614 during the follow-on Regular Overhaul.
- The salt water feed pump motors, the distillate pump motors, and the salt water heater drain pump motors should be repaired on the basis of POT&I results and the ship's CSMP during the follow-on Regular Overhaul.
- The NAVSEC review of the sealed insulation system rewind and vacuum-pressure impregnation procedures should be completed and the system implemented as soon as possible.
- During the follow-on Regular Overhaul, all pump motor controllers should be inspected and cleaned and the contacts and heaters replaced.

3.8 TECHNICAL REPAIR STANDARD DEVELOPMENT

Technical Repair Standards have been developed for some of the Distilling Plant System components installed on DDG-37 Class ships. These include TRSs for the Bethlehem Steel distillation units and the pumps associated with those units. (For a complete list of TRSs established for this system, see Appendix E.) However, no TRSs exist for the Cleaver-Brooks distillation units. To ensure adequate repairs of DDG-37 Class Distilling Plant Systems during Baseline Overhaul, it is recommended that a Technical Repair Standard be developed for the Cleaver-Brooks distillation units.

3.9 MAINTENANCE STRATEGY

This analysis has recommended several changes that should be made to PMS and EOSS to ensure acceptable operation of the Distilling Plant System during an extended operating cycle. With the inclusion of the changes to PMS and EOSS, specific components of the Distilling Plant System should be maintained during an extended operating cycle under the applicable maintenance strategy listed in Table 3-7.

Overhaul of these components during Baseline Overhaul and Regular Overhaul should be accomplished by depot facilities in accordance with established Technical Repair Standards; minor repairs (intended for completion during overhauls) can usually be accomplished by Ship's Force alone, or with the assistance of an IMA.

Table 3-7. DISTILLING PLANT SYSTEM MAINTENANCE STRATEGIES	
Strategy	Component
Fix-when-fail (with PMS-required "on-condition" maintenance actions and/or open-and-inspect actions included)*	Distillation Units (includes accessories) Motor Controllers
Fix-when fail (with PMS-required open-and-inspect actions deleted or nonexistent)	Brine Overboard Pumps Salt Water Heater Drain Pumps Distillate Pumps Salt Water Feed Pumps Pump Motors (except Brine Overboard Pump Motors)
Periodic Overhaul	Brine Overboard Pump Motor

*Corrective maintenance accomplished primarily by Ship's Force and IMAs.

CHAPTER FOUR

CONCLUSIONS AND RECOMMENDATIONS

This chapter summarizes the conclusions and recommendations resulting from the Review of Experience of the DDG-37 Class Distilling Plant System.

4.1 CONCLUSIONS

Significant conclusions resulting from this Review of Experience are:

- Comprehensive overhauls of the distillation units will be necessary during Baseline Overhaul.
- DDG-37 Class ships have produced and used fresh water at a rate averaging 550 to 600 gallons per hour; that is 10 to 20 percent more than the rated distillation unit output. Ship's Forces have used two methods of operating the distillation units to achieve this production, neither described in existing operating documentation for the units. It is concluded that some of the burden reported against the distillation units has resulted from the high demands for fresh water and from the operating methods used by Ship's Force to meet those demands.
- Except for overhauls of the distillation units, all Distilling Plant System components can be maintained by Ship's Force, with some assistance from IMAs. Except for the brine overboard pump motor, all Distilling Plant System components can be maintained according to a "fix-when-fail" maintenance strategy.
- The PMS for this system, when modified according to the recommendations in this report, is adequate to maintain the Distilling Plant System throughout an extended operating cycle. The "on-condition" maintenance requirements included in the PMS, in conjunction with the requirements to record distillate production and salinity, indicate the need for corrective maintenance of the distillation units and accessories. Therefore, no additional "on-condition" maintenance requirements are necessary for the distillation units. The analysis also indicated that monitoring pump discharge pressure might be an effective method of determining the need for pump corrective maintenance.

- Accomplishment of several ShipAlts during Baseline Overhaul will improve the condition and reliability of the Distilling Plant System during an extended operating cycle.

4.2 RECOMMENDATIONS

Actions and planning activities recommended by the Distilling Plant System Review of Experience are categorized as follows:

- Baseline Overhaul Requirements
- Intracycle Maintenance Requirements
- Follow-on Regular Overhaul Requirements
- PMS Changes
- Reliability and Maintainability Improvements
- IMA Improvements
- Depot-Level Improvements
- Integrated Logistics Support Improvements

Specific recommendations resulting from this Review of Experience are summarized in Table 4-1. No recommendations regarding IMA or depot-level improvements resulted from this analysis. A detailed list of recommended PMS changes is presented in Appendix F (DDEOC MRC Evaluation Table); action items based on the recommendations are listed in Appendix G (DDEOC Action Table).

Table 4-1. SUMMARY OF DISTILLING PLANT SYSTEM ROE RECOMMENTATIONS

Component	Recommendation
Baseline Overhaul Requirements	
A. Repairs and Overhauls	
1. Distillation Units	Overhaul in accordance with TRS 0531-086-612 (Bethlehem Steel). Inspect and replace or calibrate the water meters. Overhaul to Class B specifications (Cleaver-Brooks).
2. Brine Overboard Pumps	Repair as shown to be necessary by POT&I and ship's CSMP. (APLs 016020333 and 016020507).
3. Salt Water Feed Pumps	Repair as shown to be necessary by POT&I and ship's CSMP (APL 016110073).
4. Salt Water Heater Drain Pumps	Repair as shown to be necessary by POT&I and ship's CSMP (APLs 016020324 and 016020506).
5. Distillate Pumps	Repair as shown to be necessary by POT&I and ship's CSMP (APLs 016020332 and 016020505).
6. Pump motors and controllers	Overhaul two brine pump motors (APL 174750529) in accordance with TRS 0531-086-614. Repair the salt water feed pump motor (APL 174750532), the salt water heater drain pump motors (APLs 174750530 and 174750672), and two distillate pump motors (APLs 174750531 and 174750348) as shown to be necessary by POT&I and ship's CSMP. Inspect and clean all pump motor controllers and replace the heater contacts.
B. Alterations	
1. Distillation Units	Install ShipAlt DDG-37-1216D (Ameroyal injection equipment) on DDG-41, DDG-37, and DDG-46.
2. Brine Overboard Pumps	Relocate the brine overboard pumps to the next lower level by installing ShipAlt DDG-37-188D.
Intracycle Maintenance Requirements	
	No scheduled periodic repairs or overhauls were identified as being necessary by this analysis.
Follow-On Regular Overhaul Maintenance Requirements	
1. Distillation Units	Acid-clean, inspect, and hydrotest the units. Make other repairs to the units as shown to be necessary by the inspection and ship's CSMP.
2. Brine Overboard Pumps	Repair as shown to be necessary by POT&I and ship's CSMP.
3. Salt Water Feed Pumps	Repair as shown to be necessary by POT&I and ship's CSMP.
4. Salt Water Heater Drain Pumps	Repair as shown to be necessary by POT&I and ship's CSMP.
5. Distillate Pumps	Repair as shown to be necessary by POT&I and ship's CSMP.
6. Pump motors and controllers	Overhaul the brine overboard pump motor in accordance with TRS 0531-096-614. Repair all other pump motors as shown to be necessary by POT&I and ship's CSMP. Inspect and clean all pump motor controllers, and replace the contacts and heaters.
PMS Changes	
1. Brine Overboard Pumps	Delete inspection of internal parts (MRC 11-Y868-C on MIP E-14/653-21 and MIP E-14/676-41, APLs 016020333 and 016020507).
2. Salt Water Feed Pumps	Delete MRC B5-J29E-N from MIP A-19/250-B5 (Inspect Pump Internal Parts).
3. Salt Water Heater Drain Pumps	Delete the inspection of internal parts (MRC 11-Y868-C on MIP E-14/658-31, APL 016020324; and MRC 30-W330-A on MIP E-14/557-30, APL 016020506).
4. Distillate Pumps	Delete the inspection of internal parts (MRC 11-Y868-C on MIP E-14/636-21, APL 016020332; and MRC 30-W330-A on MIP E-14/558-30, APL 016020505).

(continued)

Table 4-1. (continued)

Component	Recommendation
Reliability and Maintainability Improvements	
1. Distillation Units	Review current Distillation Unit operating procedures and evaluate the effects of those procedures on system components. The review should specify standardized operating procedures (to replace the existing EOSS) and should recommend, where necessary, any design changes to system components that are necessary to reliably produce the needed distillate.
2. Distilling Plant System Pumps	Evaluate the results of the FF-1052 Class tests of the use of pump discharge pressure as an indicator of the need for maintenance. If the test results indicate that the technique is effective, consider the technique for the DDG-37 Class Distilling Plant System Pumps.
3. Electric Motors	NAVSEC should complete its review of the sealed insulation system rewind and vacuum pressure impregnation procedures and implement the system as soon as possible.
IMA Improvements	
	No IMA improvements were identified as being necessary by this analysis.
Depot-Level Improvements	
	No Depot-level improvements were identified as being necessary by this analysis.
Integrated Logistics Support	
1. Distillation Units	Incorporate the standardized operating procedures (resulting from the review of current operating procedures) into EOSS procedure EV/186. Change the allowance for the water meter (APL 109030005, MSN 9G-6680-00-174-6135) to one per ship and stock to that allowance as soon as possible. Investigate replacing the non-COSAL-supported Ameroyal injection pumps with the pumps specified by ShipAlt DDG-37-1216D.
2. Brine Overboard Pumps	Add a note to EOSS procedure EV/186 to throttle the pump discharge valve to produce a steady, non-fluctuating reading on the discharge pressure gage if cavitation is suspected.
3. Cleaver-Brooks Distillation Units	Develop Technical Repair Standards (TRSs) for the Cleaver-Brooks Distillation Units (APL 080030009)

SOURCES OF INFORMATION

The specific sources of information used as the basis for the Review of Experience of the Distilling Plant System are listed below.

1. Generation IV MDS part and maintenance data for DDG-37 Class, 1 January 1970 through 30 October 1976.
2. CASREP data for DDG-37 Class, 1 July 1973 through 30 June 1976.
3. Trip Reports (dated 25 August, 29 August, and 30 August, 1977), ARINC Research visit to DDG-45, DDG-44, COMNAVSURFLANT (DDG-37 Class Type desk).
4. NAVSHIPS 358-0364, Technical Manual, *12,000 gpd Distilling Plant, Pumps, and Motors (APL 080100016, Bethlehem Steel)*.
5. NAVSHIPS 358-0354, Technical Manual, *12,000 gpd Distilling Plant (APL 080030009, Cleaver-Brooks)*.
6. NAVSHIPS 347-3370, Technical Manual, *Distillate Pump (APL 016020505), Salt Water Heater Drain Pump (APL 016020506), and Brine Overboard Pump (APL 016020507)*.
7. NAVSHIPS 347-3100, Technical Manual, *Salt Water Feed Pump (APL 016110073)*.
8. Ship Alteration Record (NAVSEA 4720/4) for ShipAlt DDG-37-188D.
9. OPNAVINST 4790.4, *Ship's Material Maintenance Management (3M) Manual*, Volumes I, II, III, dated 1 June 1973.
10. Maintenance Index Pages for Distilling Plant System.
11. Type Commander's COSAL, SURFLANT (19 May 1975) and SURFPAC (19 August 1975).
12. COMNAVSURFLANTINST 9000.1, NAVSURFLANT Maintenance Manual, 12 June 1975.
13. COMNAVSURFPACINST 4700.1, *COMNAVSURFPAC Ship and Craft Material Maintenance Manual*, Volume I, 6 June 1975.
14. Repair Profile for Baseline Overhaul of DDG-37 Class, July 1977.
15. Baseline SARP for Baseline Overhaul of DDG-37 Class, prepared by PERA (CRUDES) for NAVSEA 934, June 1977.

16. DDG-37 Class Repair Profile, prepared by PERA (CRUDES), June 1977; and SARP data summarized from the 1974 ROH of DDG-37, the 1977 COH of DDG-38, the 1975 COH of DDG-45, and the 1975 ROH of DDG-46.

17. *FF-1052 Class Distilling Plant System Review of Experience (SMA 201-531)*, prepared for NAVSEA 934X, July 1976.

18. NAVSHIPS 0905-475-4020, *Ship Information Book for USS Coontz*, Volume 2, March 1972.

19. Engineering Operational Sequencing System (EOSS) for USS Coontz (DDG-40), dated July 22, 1977.

20. Mechanized Departure Reports for DDG-37 Class AAW Conversions, Regular Overhauls, and Complex Overhauls; various dates.

APPENDIX A

DISTILLING PLANT SYSTEM DEFINITION

The Distilling Plant System discussed in this report consists of the major components listed in Table A-1, which lists component nomenclatures, component APL numbers as derived from the Type Commanders' COSAL (Coordinated Ship Allowance List), and APL quantities per ship. In developing this table, an attempt was made to resolve inconsistencies among Type Commanders' COSAL and MDS data, but all such inconsistencies could not be resolved. This configuration is the best estimate from all available data sources. A block diagram of a distillation unit and its associated pumps and accessories is presented in Figure A-1.

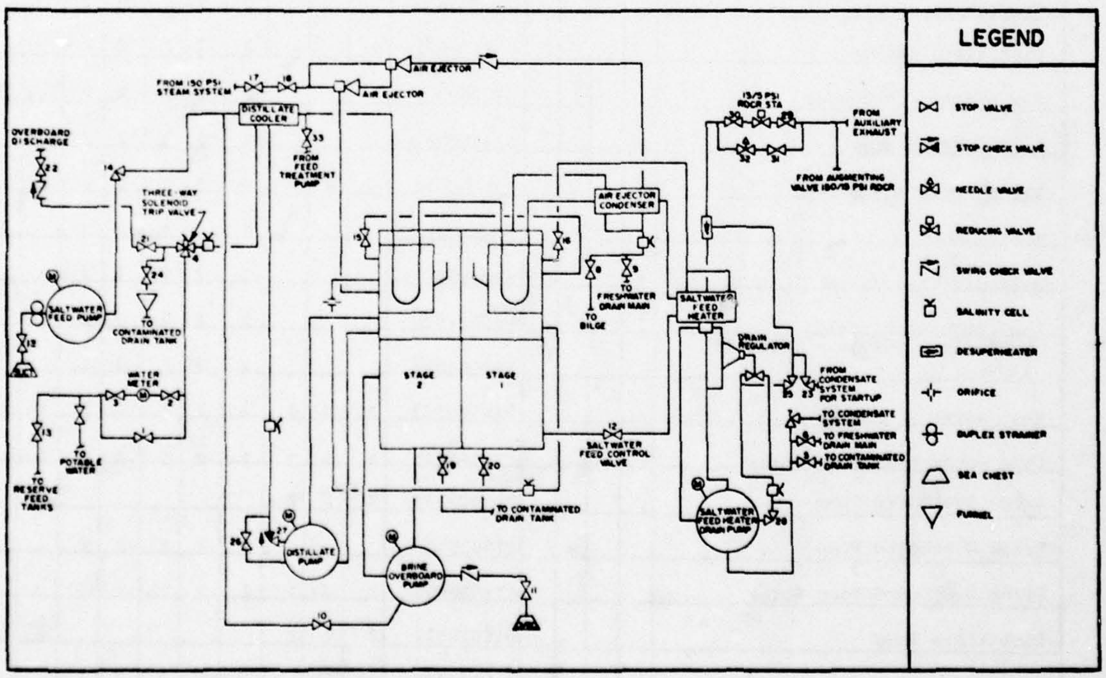

Figure A-1. DIAGRAM OF A DISTILLATION UNIT AND ACCESSORIES

Table A-1. DDG-37 CLASS DISTILLING PLANT SYSTEM MAJOR COMPONENTS

Nomenclature	SWBS	EIC	APL/CID	Quantity by Hull Number									
				DDG-37	DDG-38	DDG-39	DDG-40	DDG-41	DDG-42	DDG-43	DDG-44	DDG-45	DDG-46
Distillation Unit	531	TK03	080100016	2	2	2						2	2
Distillate Cooler			030190042	2	2	2						2	2
Air Ejector Condenser			040150071	2	2	2						2	2
Salt Water Heater			074150010	2	2	2						2	2
Air Ejector Assembly			730800100	2	2	2						2	2
Water Meter			109030005	2	2	2						2	2
Solenoid Trip Valve			882181019	2									
Solenoid Trip Valve			882180536		2								
Solenoid Trip Valve			882180475			2							
Solenoid Trip Valve			882182268									2	2
Distillation Unit			080030009				2	2	2	2	2		
Distillate Cooler			032140001				2	2	2	2	2		
Air Ejector Condenser			040960001				2	2	2	2	2		
Salt Water Heater			074450001				2	2	2	2	2		
Air Ejector Assembly			730060010				2	2	2	2	2		
Water Meter			109030010				2	2	2	2	2		
Solenoid Trip Valve			882180307				2	2	2	2	2		
Feed Regulating Valve			882051542				2	2	2	2	2		
(Equivalent Valves - Total of 2/Ship)			882055997				2	2	2	2	2		
Salt Water Feed Pump			016110073	2	2	2	2	2	2	2	2	2	2
Salt Water Feed Pump Motor			174750532	2	2	2	2	2	2	2	2	2	2
Brine Overboard Pump			016020333	2	2	2						2	2
Brine Overboard Pump			016020507				2	2	2	2	2		
Brine Overboard Pump Motor			174750529	2	2	2	2	2	2	2	2	2	2
Distillate Pump			016020332	2	2	2						2	2
Distillate Pump			016020505				2	2	2	2	2		

(continued)

Table A-1. (continued)													
Nomenclature	SWBS	EIC	APL/CID	Quantity by Hull Number									
				DDG-37	DDG-38	DDG-39	DDG-40	DDG-41	DDG-42	DDG-43	DDG-44	DDG-45	DDG-46
Distillate Pump Motor	531	TK03	174750531	2	2	2						2	2
Distillate Pump Motor			174750348				2	2	2	2	2		
Salt Water Heater Drain Pump			016020324	2	2	2						2	2
Salt Water Heater Drain Pump			016020506				2	2	2	2	2		
S.W. Heater Drain Pump Motor			174750530	2	2	2						2	2
S.W. Heater Drain Pump Motor			174750672				2	2	2	2	2		
Flexible Coupling (for Distillate Pump and Salt Water Heater Drain Pumps)			782350002				4	4	4	4	4		

APPENDIX B

MDS PARTS USAGE SUMMARY

This appendix summarizes, in Tables B-1 through B-12, usage data on significant part replacements in high-burden components of the Distilling Plant System. Included in the tables are the total number of parts replaced, the ratio of parts replaced to total population, and the number of JCNs (Job Control Numbers) in which use of each part was reported.

Table B-1. PART USAGE DATA - DISTILLATION UNIT (APL 080100016)*

Number of Ships Applicable: 5 ** Total Number of Components: 10

Part Identification		Cost per Unit (Dollars)	Quantity per Component	Total Part Population	Number Replaced	Ratio (×100) of Parts Replaced to Total Population	Number of JCNs Reported	Number of Ships Reported
NIIN	Nomenclature							
Various	Thermometers	12-14	18	180	12	7	8	5
Various	Gages	9-44	9	90	26	29	21	5
289-0594	Tube Plug (5/8")+	1	812+	3248	284	9	4	3
289-0995	Tube Plug (3/4")++	2	268++	1072	108	10	2	2

* Includes APLs 050150071, 074150010, and 730800100
** DDGs 37-39, 45, 46
+ Number of 5/8" tubes on one unit; up to 20% (162 tubes) may be plugged in each unit (2 plugs per tube)
++ Number of 3/4" tubes in one unit; up to 20% (54 tubes) may be plugged in each unit (2 plugs per tube)

Table B-2. PART USAGE DATA - LIQUID WATER METER (APL 109030005)

Number of Ships Applicable: 5* | Total Number of Components: 10

Part Identification		Cost per Unit (Dollars)	Quantity per Component	Total Part Population	Number Replaced	Ratio (×100) of Parts Replaced to Total Population	Number of JCNs Reported	Number of Ships Reported
NIIN	Nomenclature							
174-6135	Water Meter	247	1	10	12	120	9	3

*DDGs 37 - 39, 45, 46

Table B-3. PART USAGE DATA - DISTILLATION UNIT (APL 080030009)*

Number of Ships Applicable: 5** — Total Number of Components: 10

Part Identification		Cost per Unit (Dollars)	Quantity per Component	Total Part Population	Number Replaced	Ratio (×100) of Parts Replaced to Total Population	Number of JCNs Reported	Number of Ships Reported
NIIN	Nomenclature							
174-6145	Water Meter	194	1	10	8	80	7	4
241-2153 242-2163 242-2164 242-2194	Thermometers	12-23	10	100	17	17	9	5
242-2195							9	5
289-0594	S.W. Heater Tube Plugs	1	209+	836	70	8	3	2
207-2041	Feed Regulating Valve	361	1	10	18++	180	15	5
Various	Gages	9-96	4	40	80	200	11	5

*Includes APLs 040960001, 074450001, 109030010, 730060010, and 882051542

**DDGs 40-44

+Number of tubes in each heater; up to 20% (41 tubes) may be plugged in each heater (2 plugs per tube)

++Allowed as an on-board spare on APL 882051542 but listed here because burden data was reported against APL 080030009

Table B-4. PART USAGE DATA - BRINE OVERBOARD PUMP (APL 0160200333)

Number of Ships Applicable: 5* — Total Number of Components: 10

Part Identification		Cost per Unit (Dollars)	Quantity per Component	Total Part Population	Number Replaced	Ratio (×100) of Parts Replaced to Total Population	Number of JCNs Reported	Number of Ships Reported
NIIN	Nomenclature							
289-4442	Casing Wearing Ring	24	1	10	23	230	18	5
289-5965	Casing Wearing Ring	13	1	10	22	220	18	5
308-7174	Impeller Wearing Ring	11	2	20	22	110	18	5
308-7176	Shaft Sleeving	60	1	10	27	270	22	5
612-7533	Impeller	1340	1	10	3	30	3	3
612-7540	Lantern Ring	18	1	10	3	30	3	3
612-7541	Sleeve Bushing	6	1	10	11	110	10	5
612-7542	Impeller Nut	29	1	10	3	30	3	3

*DDGs 37-39, 45, 46

Table B-5. DDG-37 CLASS PART USAGE DATA - BRINE OVERBOARD PUMP (APL 016020507)

Number of Ships Applicable: 5* — Total Number of Components: 10

Part Identification		Cost per Unit (Dollars)	Quantity per Component	Total Part Population	Number Replaced	Ratio (×100) of Parts Replaced to Total Population	Number of JCNs Reported	Number of Ships Reported
NIIN	Nomenclature							
222-2568	Rubber Sheet (Deflect-or)	9	1	10	6	60	3	2
289-4442	Casing Wearing Ring	24	1	10	30	300	24	5
289-5965	Casing Wearing Ring	13	1	10	27	270	25	5
308-7174	Impeller Wearing Ring	11	2	20	52	260	24	5
308-7176	Shaft Sleeve	60	1	10	36	360	27	5
475-2659	Impeller Nut	57	1	10	4	40	4	2
612-7540	Lantern Ring	18	1	10	11	110	10	5
612-7541	Sleeve Bushing	6	1	10	12	120	9	4

*DDGs 40 - 44

Table B-6. DDG-37 CLASS PART USAGE DATA - SALT WATER FEED PUMP (APL 016110073)

Number of Ships Applicable: 10*

Total Number of Components: 20

Part Identification		Cost per Unit (Dollars)	Quantity per Component	Total Part Population	Number Replaced	Ratio (×100) of Parts Replaced to Total Population	Number of JCNs Reported	Number of Ships Reported
NIIN	Nomenclature							
119-3368	Deflector	9	1	20	14	70	12	7
393-3486	Shaft Sleeve	37	1	20	49	245	40	10
440-3594	Impeller Nut	13	1	20	9	45	8	5
580-9197	Casing Wearing Ring	7	1	20	85	425	50	10
580-9198	Impeller Wearing Ring	6	1	20	89	445	48	10
625-3849	Lantern Ring	20	1	20	19	95	18	8
632-1337	Impeller	439	1	20	14	70	14	8

*DDGs 37 - 46

Table B-7. PART USAGE DATA - S.W. HEATER DRAIN PUMP (APL 016020324)

Number of Ships Applicable: 5*

Total Number of Components: 10

Part Identification		Cost per Unit (Dollars)	Quantity per Component	Total Part Population	Number Replaced	Ratio (×100) of Parts Replaced to Total Population	Number of JCNs Reported	Number of Ships Reported
NIIN	Nomenclature							
218-4451	Shaft Sleeve	33	1	10	13	130	12	4
218-4452	SPT-Gland	83	1	10	2	20	2	2
369-0056	Water Ring	39	1	10	6	60	6	4
394-6388	Impeller Nut	16	1	10	7	70	6	3
398-9458	Casing Wearing Ring	11	1	10	11	110	10	4
398-3459	Casing Wearing Ring (U.S.)	8	1	10	14	140	13	5
420-7251	Sleeve Bearing	9	1	10	7	70	6	4
555-2007	Deflector	8	1	10	3	30	3	3

*DDGs 37 - 39, 45, 46

Table B-8. PART USAGE DATA - S.W. HEATER DRAIN PUMP (APL 016020506)

Number of Ships Applicable: 5*

Total Number of Components: 10

Part Identification		Cost per Unit (Dollars)	Quantity per Component	Total Part Population	Number Replaced	Ratio (×100) of Parts Replaced to Total Population	Number of JCNs Reported	Number of Ships Reported
NIIN	Nomenclature							
083-2852	Impeller Nut	28	2	20	4	20	2	2
097-0983	Shaft Collar	51	1	10	3	30	2	2
152-0513	Lower Bearings	79	1	10	13	130	11	5
156-7529	Ball Bearing	16	1 pr.	10 pr.	13 pr.	130	10	5
218-4219	Casing Wearing Ring	19	1	10	11	110	8	4
218-4443	Pump Shaft	207	1	10	2	20	2	2
293-1647	Deflector	14	1	10	3	30	2	2
674-1725	Sleeve Bearing	36	1	10	7	70	5	3

*DDGs 40 - 44

Table B-9. PART USAGE DATA - DISTILLATE PUMP (APL 016020332)

Number of Ships Applicable: 5* — Total Number of Components: 10

Part Identification		Cost per Unit (Dollars)	Quantity per Component	Total Part Population	Number Replaced	Ratio (×100) of Parts Replaced to Total Population	Number of JCNs Reported	Number of Ships Reported
NIIN	Nomenclature							
218-4300	Deflector	16	1	10	3	30	3	3
289-4443	Casing Wearing Ring (U.S.)	9	2	20	34	170	14	5
308-7177	Shaft Sleeve	80	1	10	17	170	15	5
579-5648	Nut (Impeller)	59	1	10	5	50	5	3
612-7538	Lantern Ring	22	1	10	6	60	6	4
612-7539	Sleeve Bushing	29	1	10	8	80	8	4
612-7543	Impeller	1060	1	10	11	110	7	4

*DDGs 37 - 39, 45, 46

Table B-10. PART USAGE DATA - DISTILLATE PUMP (APL 016020505)

Number of Ships Applicable: 5*

Total Number of Components: 10

Part Identification		Cost per Unit (Dollars)	Quantity per Component	Total Part Population	Number Replaced	Ratio (×100) of Parts Replaced to Total Population	Number of JCNs Reported	Number of Ships Reported
NIIN	Nomenclature							
152-0513	Lower Bearing	79	1	10	16	160	14	5
156-7529	Ball Thrust Bearing	16	1	10	14	140	10	4
218-4219	Casing Wearing Ring	19	1	10	20	200	15	5
218-4443	Pump Shaft	207	1	10	2	20	2	2
293-1647	Deflector	14	1	10	3	30	2	2
674-1725	Sleeve Bearing	36	1	10	6	60	6	4

*DDGs 40 - 44

Table B-11. PART USAGE DATA - BRINE OVERBOARD PUMP MOTOR (APL 174750529)								
Number of Ships Applicable: 10*							Total Number of Components: 20	
Part Identification		Cost per Unit (Dollars)	Quantity per Component	Total Part Population	Number Replaced	Ratio (×100) of Parts Replaced to Total Population	Number of JCNs Reported	Number of Ships Reported
NIIN	Nomenclature							
155-6266 155-6302 156-5044	Motor Bearings	7-16	2	40	101	252	34	10

*DDGs 37 - 46

Table B-12. PART USAGE DATA - SALT WATER FEED PUMP MOTOR (APL 174750532)								
Number of Ships Applicable: 10*							Total Number of Components: 20	
Part Identification		Cost per Unit (Dollars)	Quantity per Component	Total Part Population	Number Replaced	Ratio (×100) of Parts Replaced to Total Population	Number of JCNs Reported	Number of Ships Reported
NIIN	Nomenclature							
155-6266 156-5044 277-0007	Motor Bearings	7-16	2	40	68	170	29	10

*DDGs 37 - 46

APPENDIX C

DDG-37 DISTILLING PLANT SYSTEM CASREP SUMMARY

DDG-37 Class Distilling Plant System CASREP data for the period 1 July 1973 through 30 June 1976 were reviewed to determine the types of critical failures experienced by the system. Fourteen CASREPs from Equipment Identification Code (EIC) TK were reviewed. A summary of these reports, by component and failure type, is presented in Table C-1.

Table C-1. DDG-37 CLASS DISTILLING PLANT SYSTEM CASREP SUMMARY

Reason for CASREP	Number of CASREPs	Percent of Total CASREPs	Number of Ships
Distillation Unit			
Excessive salinity or impure water	1*		1
Air ejectors	1*		1
Tube deterioration	2**		2
Subtotal	4	28.5	
Brine Overboard Pump - wear or failure	2**	14.3	2
Motors - shorted or open windings			
Brine overboard pump motor	5†		5
Salt water heater drain pump motor	1††		1
Subtotal	6	42.9	
Feed Regulating Valve	2*	14.3	2
Grand Total	14	100.0	-

*Submitted against Cleaver-Brooks units
**One report each submitted against Bethlehem Steel and Cleaver-Brooks units
†One report submitted against Bethlehem Steel units
††Submitted against Bethlehem Steel units

APPENDIX D

DDG-37 CLASS FRESH WATER PRODUCTION AND CONSUMPTION

This appendix considers the fresh water production and consumption for a typical DDG-37 Class ship, and shows that the installed distillation units must produce about ten percent more water than the design rating to satisfy consumption needs. In addition, the time a DDG-37 Class ship could operate before the water supply was depleted if one distillation unit failed was estimated. It was found that a ship could operate for about three days before the water supply was depleted, permitting normal water consumption. If personnel water consumption were limited, a ship could operate for an indefinite period with no lack of fresh water.

1. HISTORICAL FRESH WATER PRODUCTION

A sample of distillation unit operating logs was reviewed to determine the quantity of fresh water produced by DDG-37 Class ships. The results of this review are summarized in Table D-1.

Table D-1. HISTORICAL FRESH WATER PRODUCTION FOR DDG-37 CLASS SHIPS BASED ON OPERATING LOGS

Hull (DDG-)	Crew Size	Date of Log	Water Production, gph		
			Min.	Max.	Total (gpd/unit)
44*	404	29 Dec 1976	270	590	13,368
44*	404	30 Dec 1976	140	600	13,573
37*	389	28 Jul 1977	290	610	13,272
37*	389	25 Jul 1977	370	700	15,260
45**	374	11 Apr 1977	350	590	13,020
45**	374	1 Apr 1977	450	510	11,750
45**	374	24 Apr 1977	480	630	14,390
45**	374	25 Apr 1977	230	660	12,640
					107,273

*Under way
**At anchor

In addition, distillate production figures were obtained from the USS PRATT (DDG-44) for February 2 through 17, 1978. Distillate production for the period totaled 422,662 gallons. Including that information with the data in Table D-1, the average fresh water production (P) was 13,275 gallons per day per unit, or about 533 gallons per hour per unit. On the basis of a small sample of historical data, the DDG-37 Class ships have been able to produce more fresh water per hour than the design rating of 500 gallons per hour. The average historical production is greater than the design rating by:

$$\frac{(553-500)}{500} \times 100 = 10.6 \text{ percent}$$

2. FRESH WATER CONSUMPTION

Fresh water consumption (and therefore production) depends on the following factors:

- (LAMPS) Helicopter water washdown requirements
- Make-up feedwater consumption
- Crew Size
- Per Capita Water Consumption

The fresh water requirements resulting from these factors are itemized and totaled in the following paragraphs.

Helicopter Consumption C_h

Because several DDG-37 Class ships are authorized to land, refuel, and maintain LAMPS helicopters, an allowance must be made for helicopter washdown. Helicopter Facilities Bulletin No. 1C requires a minimum of 100 gallons of fresh water per day per helicopter. Therefore, helicopter water consumption is taken to be 100 gallons per day.

Make-up Feedwater Consumption C_{muf}

Make-up feedwater consumption is a function of ship speed, operating time at a given speed, and plant "tightness". For the purposes of this analysis, it is estimated that DDG-37 Class ships operate ten percent of the time at about 27 knots and 90 percent of the time at about 16 knots. The make-up feedwater consumption that corresponds to those speeds can be obtained from Figure D-1, which is a plot of historical average make-up feedwater consumption as a function of ship speed. Because this figure represents trial data and not normal steaming conditions or plant "tightness", it was assumed that make-up feedwater consumption was approximately 20 percent higher during normal steaming than during trials. This assumption is reasonable when compared to historical make-up feedwater consumption for FF-1052 Class ships, which averaged from 5 to 40 percent higher than Training and Readiness Manual specifications, tending to support this assumption.

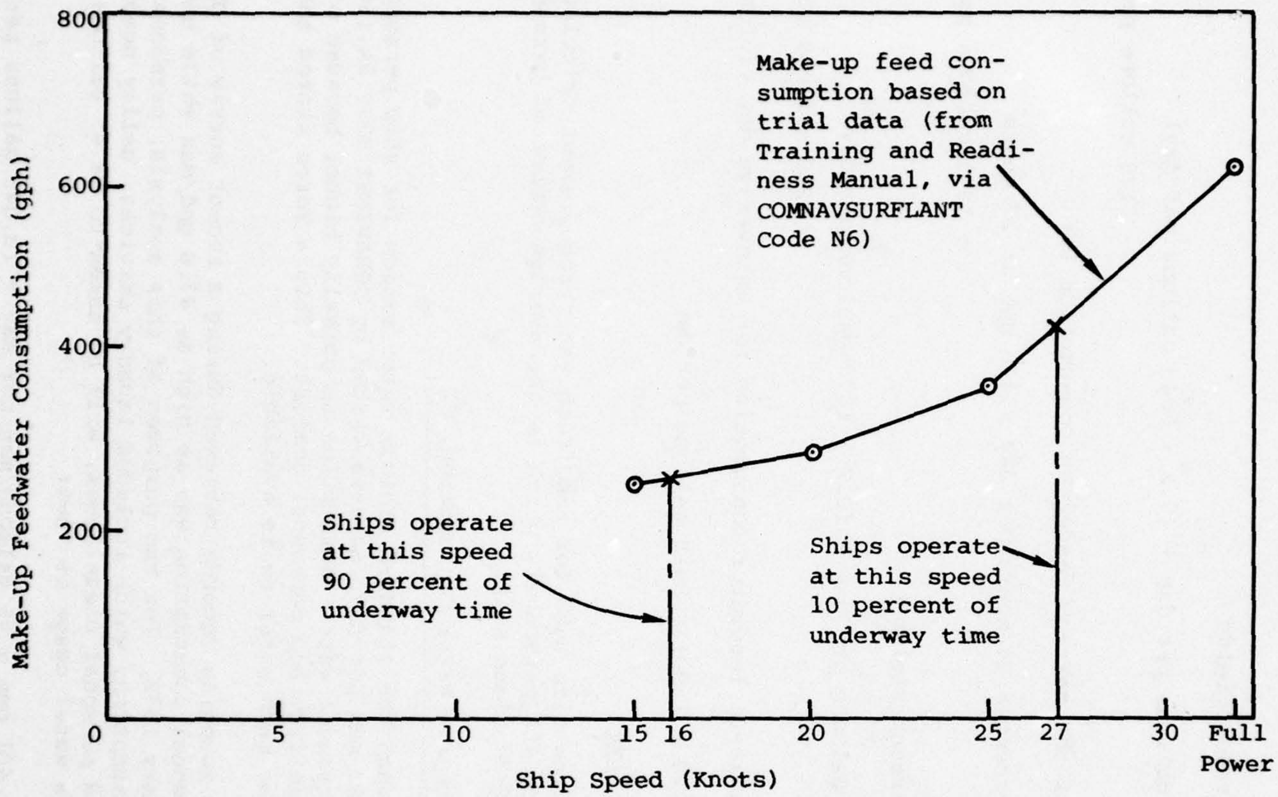

Figure D-1. DDG-37 CLASS MAKE-UP FEEDWATER CONSUMPTION VS. SHIP SPEED

The resulting make-up feedwater consumption at 16 knots is:

90 percent × 24 hours per day × 275 gph at 16 knots

= 5940 gallons per day

plus 20 percent yields

5940 gallons per day + (0.2 × 5940 gallons per day)

= 7128 gallons per day

At 27 knots the make-up feedwater consumption is:

10 percent × 24 hours per day × 448 gph at 27 knots

= 1075 gallons per day

plus 20 percent yields

1075 gallons per day + (0.2 × 1075 gallons per day)

= 1290 gallons per day

Totaling make-up feedwater consumption for an average day yields

C_{muf} = (7128 + 1290) = 8418 gallons per day

Crew Size

The crew size used for the fresh water requirement calculations is taken to be 401 personnel, which is the average number of personnel aboard DDG-37 Class ships.

Per capita Water Consumption, C_p

Although the standard minimum water ration for ship personnel is 30 gallons per man per day, as established by OPNAVINST 9330.5A (30 August 1965), personnel water consumption is normally higher because of concerns for habitability and personnel comfort. Ship's Force stated that the crew will use as much water as is available.

Tank sounding records reviewed during a recent survey of DDG-44 showed that personnel consumption was as high as 47.8 gpd/man while under way during February 1978. For the purposes of this analysis, personnel fresh water consumption, which includes laundry services, galley needs, drinking water, and personal cleanliness, will be taken to be 45 gallons per man day. Crew water usage is then:

C_p = 401 men × 45 gallons/man per day = 18,045 gallons per day

Total Daily Water Consumption

$TDWC = C_p + C_{muf} + C_h$

where: TDWC is the total daily water consumption

C_p is daily personnel consumption

C_{muf} is daily make-up feedwater consumption

C_h is daily helicopter consumption

Thus,

$$TDWC = (18{,}045 + 8418 + 100) \text{ gallons per day}$$
$$= 26{,}563 \text{ gallons per day (two-plant operation)}$$
$$= 553 \text{ gallons per plant per hour}$$

3. ESTIMATED OPERATING TIME IF ONE DISTILLATION UNIT FALLS

A. Assumptions

- Total fresh water storage capabilities = 38,192 gallons*
- Full Tanks
- 401 persons on board
- Water Ration
  - •• Design Rating - 30 gallons/man/day
  - •• Experienced - 45 gallons/man/day
  - •• Stringent - 5 gallons/man/day
- Make-up feedwater consumption taken from Figure D-1, at speeds specified in case studies
- Helicopter usage = 100 gallons/day

B. Method

The estimated time a DDG-37 Class ship can sustain operation if one distillation unit fails is calculated for the following cases:

Case 1: During transit

Case 2: During operation

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*NAVSHIPS 0905-475-4020, *Ship Information Book for USS COONTZ*, Volume 2, March 1972 and Engineering Operational Sequencing System (EOSS) diagram TSDF/048, for USS COONTZ (DDG-40), dated 22 July 1977.

Using the logic presented in the FF-1052 Class Distilling Plant System SMA*, the following is obtained:

$$t = \frac{I}{C_2 - C_1}$$

where I = fresh water tank capacity = 38,192 gallons

C_1 = operating plant output (constant), gallons/hour

C_2 = average fresh water usage (constant), gallons/hour

t = operating time until fresh water tanks are empty

C. Case Studies

Case 1: During transit: Make-up feedwater usage = 330 gallons/hour

For personnel consumption = 45 gpd/man, C_2 = 1086 gallons/hour, and t = 3.0 days

For personnel consumption = 30 gpd/man, C_2 = 835 gallons/hour, and t = 5.6 days

For stringent personnel consumption = 5 gpd/man, C_2 = 418 gallons/hour, and with usage less than production, the ship can operate indefinitely with one plant in operation.

Case 2: Make-up feedwater usage = 351 gallons/hour

For personnel consumption = 45 gpd/man, C_2 = 1107 gallons/hour, and t = 2.9 days.

For personnel consumption = 30 gpd/man, C_2 = 856 gallons/hour, and t = 5.2 days.

For stringent personnel consumption = 5 gpd/man, C_2 = 438 gallons/hour. Use is less than production, and the ship can operate indefinitely with one plant in operation.

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*SMA 201-531, ***FF-1052 Class Distilling Plant System Review of Experience,*** July 1976, pp E-1 through E-10.

APPENDIX E

TECHNICAL REPAIR STANDARD SUMMARY

This appendix lists the Technical Repair Standards (TRSs) applicable to Distilling Plant System components.

Component	APL	TRS Number
Distillation Unit	080100016 080030009	0531-086-612 None
Salt Water Feed Pump	016110073	0531-086-616
Brine Overboard Pump	016020333 016020507	0531-086-624 None
Salt Water Heater Drain Pump	016020324 016020506	0531-086-628 None
Distillate Pump	016020332 016020505	0531-086-626 None
Brine Overboard Pump Motor	174750529	0531-086-614
Salt Water Feed Pump Motor	174750532	0531-086-614
Distillate Pump Motor	174750531 174750348	0531-086-614 0531-086-614
Salt Water Heater Drain Pump Motor	174750530 174750672	0531-086-614 None

APPENDIX F

MRC EVALUATION

Table F-1 specifies the Maintenance Index Pages (MIPs) applicable to the DDG-37 Class Distilling Plant System. In addition, the MRC Evaluation Table in this appendix lists the Maintenance Requirement Cards (MRCs) that should be deleted.

Table F-1. DDG-37 CLASS DISTILLING PLANT SYSTEM MIPs

Component	APL	MIP Number
Distillation Units	080100016 080030009	E-14/693-B6 E-14/693-B6
Chemical Treatment Unit (Ameroyal)	None	E-14/782-A5
Brine Overboard Pump	016020333 016020507	E-14/653-21 E-14/676-41
Salt Water Feed Pump	016110073	A-19/250-B5
Salt Water Heater Drain Pump	016020324 016020506	E-14/658-31 E-14/557-30
Distillate Pump	016020332 016020505	E-14/636-21 E-14/558-30
Pump Motors	174750532 174750529 174750530 174750531 174750348 174750672	EL-4/28-17 EL-4/28-17 EL-4/28-17 EL-4/28-17 EL-4/28-17 EL-4/28-17
Motor Controllers	Various	EL-3/25-66

APPENDIX G

DDEOC ACTION TABLE

DDEOC action items are presented in the table of this appendix. The format of the table is arranged to display the status of changes being implemented through completion of the Class Maintenance Plan and to serve as a ready reference to specific paragraphs in Chapter Three that address in detail the problems involved.

DDEOC MRC EV

MRC TITLE	MRC NUMBER	CURRENT STATUS		MAN-HOURS ALLOWED		PERIODICITY	
		OLD WITH REVISION	NEW	PRE-DDEOC M/H	POST-DDEOC M/H	PRE-DDEOC	POST
Inspect pump internal parts	B5-J29E-N	X		10.0	0	A	–
Inspect internal parts for wear; measure clearances	11-Y868-C	X		5.0	0	C	–
Inspect internal parts; measure clearances	30-W330-A	X		8.0	0	A	–
Inspect internal parts for wear; measure clearances	11-Y868-C	X		5.0	0	C	–
Inspect internal parts; measure clearances	30-W330-A	X		8.0	0	A	–
Inspect internal parts for wear; measure clearances.	11-Y868-A	X		5.0	0	A	–

*P = PERFORM MAINTENANCE; S = SURVEY INSPECTION
**MAINTENANCE LEVEL = SHIP'S FORCE, IMA, DEPOT, ETC.

SHIP CLASS: DDG-37
SMA NO: 37-103-531
SYSTEM: Distilling Plant

C MRC EVALUATION

C	PERIODICITY		TYPE*	MAINTENANCE LEVEL**	WHERE PERFORMED	DATA RECORDED	REMARKS
	PRE-DDEOC	POST-DDEOC	P–PERF. S–SURV.		I–IN PORT S–AT SEA	YES NO	
	A	-	S	Ship's Force	I,S	No	Salt Water Feed Pumps, APL 016110073, MIP A-19/250-B5, delete MRC
	C	-	S	Ship's Force	I,S	No	Salt Water Heater Drain Pump, APL 016020 324, MIP E-14/658-31, delete MRC
	A	-	S	Ship's Force	I,S	No	Salt Water Heater Drain Pump, APL 016020 506, MIP E-14/557-30, delete MRC
	C	-	S	Ship's Force	I,S	No	Distillate Pump, APL 016020332, MIP E-14/ 636-21, delete MRC
	A	-	S	Ship's Force	I,S	No	Distillate Pump, APL 016020505, MIP E-14/ 558-30, delete MRC
	A	-	S	Ship's Force	I,S	No	Brine Overboard Pumps, APLs 016020333 and 016020507; MIPs E-14/653-21 and E-14/676-41; delete MRC.

DDEOC ACTION T

1 ACTION ITEM *		2 DDEOC EVALUATION **	3 ACTION ITEM DESCRIPTION	4 REPORT REFERENCE (PARA.)	5.
a. NO.	b. TITLE				
I	Baseline Overhaul Requirements, Repairs		Bethlehem Steel Distillation Units: Overhaul; inspect and replace or calibrate the water meter.	3.2.1	
			Cleaver-Brooks Distillation Units: overhaul to Class B specification (APL 080030009)	3.2.2	
			Repair two Brine Overboard Pumps as shown to be necessary by POT&I and ship's CSMP.	3.3	
			Repair Salt Water Feed Pumps as shown to be necessary by POT&I and ship's CSMP.	3.4	
			Repair the Salt Water Heater Drain Pumps as shown to be necessary by POT&I and ship's CSMP.	3.5.1 and 3.5.2	
			Repair the Distillate Pumps as shown to be necessary by POT&I and ship's CSMP.	3.6.1 and 3.6.2	
			Overhaul two Brine Overboard Pump motors in accordance with the TRS.	3.7	
			Repair the Salt Water Feed Pump motors, the Salt Water Heater Drain Pump motors and Distillate Pump motors as shown to be necessary by POT&I and ship's CSMP.	3.7	
			Inspect and clean all pump motor controllers, and replace the contacts and heaters.	3.7	
	Baseline Overhaul Requirements, Alterations		Install Ameroyal injection equipment on DDG-37, DDG-41, and DDG-46.	3.2.1 and 3.2.2	
			Relocate the Brine Overboard Pumps to the next lower level.	3.3	

* NOTE 1: DEVELOPING ACTIVITY FILL IN THE FOLLOWING BLOCKS: 1a, b; 3; 4; 5 (IF KNOWN); 6a, IF REQUIRED FOR CONTINUAT

** NOTE 2: DDEOC EVALUATION – APPROVED, FURTHER STUDY REQ'D, ETC.

† NOTE 3: RESPONSIBILITY – ACTIVITY RESPONSIBLE FOR TAKING THE ACTION.

SHIP CLASS: DDG-37
SMA NO: 37-103-531
SYSTEM: Distilling Plant

DDEOC ACTION TABLE

	4. REPORT REFERENCE (PARA.)	5. RESPONSIBILITY †	6. SCHEDULING DATES a. REQD.	b. START	c. COMP.	7. REMARKS, FUNDING IMPLICATIONS, ETC.	8. ACTUAL ACTION TAKEN
:	3.2.1	TYCOM				APL 080100016, TRS 0531-086-612	
	3.2.2	TYCOM				(If TRS development is complete by BOH, use TRS)	
s ship's	3.3	TYCOM				APLs 016020333 and 016020507.	
own to SMP.	3.4	TYCOM				APL 016110073	
Pumps and	3.5.1 and 3.5.2	TYCOM				APLs 016020324 and 016020506	
wn to SMP.	3.6.1 and 3.6.2	TYCOM				APLs 016020332 and 016020505	
motors	3.7	TYCOM				APLs 174750529; TRS 0531-086-614	
tors, otors n to SMP.	3.7	TYCOM				APLs 174750530, 17475-0672, 174750531,174750348 and 174750532.	
on- and	3.7	TYCOM					
t	3.2.1 and 3.2.2	TYCOM				ShipAlt DDG-37-1216D	
to the	3.3	TYCOM				ShipAlt DDG-37-188D	

FOR CONTINUATION OF DEVELOPING ACTIVITY TASK; 7, AS NECESSARY.

DDEOC ACTION

1 ACTION ITEM * a. NO.	1 ACTION ITEM * b. TITLE	2. DDEOC EVALUATION **	3. ACTION ITEM DESCRIPTION	4. REPORT REFERENCE (PARA.)
II II	Intracycle Maintenance Requirements Requirements		No scheduled repairs or overhauls were identified as being necessary by this analysis.	
III	Follow-on Regular Overhaul Maintenance Requirements		Acid-clean, inspect, and hydrotest the distillation units. Make other repairs as shown to be necessary by the inspection and ship's CSMP.	3.2.1 and 3.2.2
			Repair the Brine Overboard Pumps, the Salt Water Feed Pumps, the Salt Water Heater Drain Pumps, and the Distillate Pumps as shown to be necessary by POT&I and ship's CSMP.	3.3, 3.4, 3.5, and 3.6
			Overhaul the brine overboard pump motors. Repair all other pump motors as shown to be necessary by POT&I and ship's CSMP.	3.7
			Inspect and clean all pump motor controllers, and replace the contacts and heaters.	3.7
IV	PMS Changes		Salt Water Feed Pumps; delete the inspection of pump internal parts.	3.4
			Salt Water Heater Drain Pumps: delete the inspection of internal parts.	3.5
			Distillate Pumps; delete the inspection of pump internal parts.	3.6
			Brine Overboard Pumps; delete the inspection of pump internal parts.	3.3

* NOTE 1: DEVELOPING ACTIVITY FILL IN THE FOLLOWING BLOCKS: 1a, b; 3; 4; 5 (IF KNOWN); 6a, IF REQUIRED FOR CONTINU

** NOTE 2: DDEOC EVALUATION – APPROVED, FURTHER STUDY REQ'D, ETC.

† NOTE 3: RESPONSIBILITY – ACTIVITY RESPONSIBLE FOR TAKING THE ACTION.

SHIP CLASS: DDG-37
SMA NO: 37-103-531
SYSTEM: Distilling Plant

DDEOC ACTION TABLE

	4 REPORT REFERENCE (PARA.)	5 RESPONSIBILITY †	6 SCHEDULING DATES a REQD.	b START	c COMP.	7 REMARKS, FUNDING IMPLICATIONS, ETC.	8 ACTUAL ACTION TAKEN
ere is							
the pairs spec-	3.2.1 and 3.2.2	TYCOM				APLs 080100016 and 080030009	
the ter late POT&I	3.3, 3.4, 3.5, and 3.6	TYCOM				APLs 016020333, 01602-0507, 016110073, 0160-20324, 016020506, 016020332, 016020505	
ors and	3.7	TYCOM				APLs 174750529, 0531-086-614, 174750532, 174750530, 174750672, 174750531, 174750348	
ontrol-	3.7						
in-	3.4	NAVSEA				MRC B5-J29E-N, MIP A-19/250-B5	
ete the	3.5	NAVSEA				APL 016020324; MRC 11-Y868-C, MIP E-14/658-31; APL 016020506; MRC 30-W330-A, MIP E-14/557-30.	
ction	3.6	NAVSEA				APL 016020332; MRC 11-Y868-C, MIP E-14/636-21; APL 016020505; MIP 30-W330-A, MIP E-14/558-30	
inspec-	3.3	NAVSEA				MRC 11-Y868-C on MIPs E-14/653-21 (APL 016020333 and E-14/676-41 (APL 016020507).	

QUIRED FOR CONTINUATION OF DEVELOPING ACTIVITY TASK; 7, AS NECESSARY.

DDEOC ACTION T

1. ACTION ITEM * a. NO.	b. TITLE	2. DDEOC EVALUATION **	3. ACTION ITEM DESCRIPTION	4. REPORT REFERENCE (PARA.)	5.
V	Reliability and Maintainability Improvements (Cont.)		Distillation Units: Review the current unit operating procedures and evaluate the effects of those procedures on system components. Specify standardized operating procedures and recommend, where necessary, design changes to system components.	3.2.1 and 3.2.2	
			Distilling Plant System Pumps: Evaluate the results of the FF-1052 Class tests of the use of pump discharge pressure as an indicator of the need for maintenance. If the test results indicate that the technique is effective, consider the technique for the DDG-37 Class Distilling Plant System pumps.	3.3.-3.6	
			Complete the review of the sealed insulation system rewind and vacuum pressure impregnation procedures and implement them.	3.7	
VI	IMA Improvements		No IMA improvements were identified necessary by this analysis.		
VII	Depot-Level Improvements		No Depot-level improvements were identified as necessary by this analysis.		
VIII	Integrated Logistics Support Improvements		Distillation Units: incorporate the standardized operating procedures (resulting from the review of current operating procedures) into EOSS.	3.2.1 and 3.2.2	
			Brine Overboard Pumps: add a note to EOSS to throttle the brine overboard pump discharge valve to produce a steady, nonfluctuating reading on the discharge pressure gage if cavitation is suspected.	3.3	
			Develop Technical Repair Standards for the Cleaver Brooks Distillation Units	3.8	

* NOTE 1: DEVELOPING ACTIVITY FILL IN THE FOLLOWING BLOCKS: 1a, b; 3; 4; 5 (IF KNOWN); 6a, IF REQUIRED FOR CONTINUATI

** NOTE 2: DDEOC EVALUATION – APPROVED, FURTHER STUDY REQ'D, ETC.

† NOTE 3: RESPONSIBILITY – ACTIVITY RESPONSIBLE FOR TAKING THE ACTION.

SHIP CLASS: DDG-37

SMA NO: 37-103-531

SYSTEM: Distilling Plant

DDEOC ACTION TABLE

	4. REPORT REFERENCE (PARA.)	5. RESPONSIBILITY †	6. SCHEDULING DATES a. REQD.	b. START	c. COMP.	7. REMARKS, FUNDING IMPLICATIONS, ETC.	8. ACTUAL ACTION TAKEN
ent te ystem erat- neces- nents.	3.2.1 and 3.2.2	NAVSEA and NAVSEC				APLs 080100016 and 080030009	
uate ts of s an e. e lling	3.3.-3.6	NAVSEA and NAVSEC					
l	3.7	NAVSEC				Reference: SMA 37-201-521, (DDG-37 Class Firemain and Auxiliary Machinery Cooling Water Systems February 1978)	
enti- result- ating	3.2.1 and 3.2.2	NAVSEA and NAVSEC				APLs 080100016 and 080030009; EOSS procedure EV/186	
o EOSS p , non- e ected.	3.3	NAVSEA				APLs 016020333 and 016020507; EOSS procedure EV/186	
for the	3.8	NAVSEA and PERA(CRUDES)				APL 080030009	

UIRED FOR CONTINUATION OF DEVELOPING ACTIVITY TASK; 7, AS NECESSARY.

DDEOC ACTION

1 ACTION ITEM * a. NO.	b. TITLE	2. DDEOC EVALUATION **	3 ACTION ITEM DESCRIPTION	4. REPORT REFERENCE (PARA.)	5
VIII	Integrated Logistics Support Improvements (Cont.)		Bethlehem Steel Distillation Units: Change the allowance for the water meter to one per ship and stock to that allowance as soon as possible.	3.2.2	
			Investigate replacing the non-COSAL supported Ameroyal injection pumps with the pumps specified by ShipAlt DDG-37-1216D.	3.2.1 and 3.2.2	

* NOTE 1: DEVELOPING ACTIVITY FILL IN THE FOLLOWING BLOCKS: 1a, b; 3; 4; 5 (IF KNOWN); 6a, IF REQUIRED FOR CONTINUA

** NOTE 2: DDEOC EVALUATION – APPROVED, FURTHER STUDY REQ'D, ETC.

† NOTE 3: RESPONSIBILITY – ACTIVITY RESPONSIBLE FOR TAKING THE ACTION.

SHIP CLASS: DDG-37

SMA NO: 37-103-531

SYSTEM: Distilling Plant

DDEOC ACTION TABLE

	4. REPORT REFERENCE (PARA.)	5. RESPONSIBILITY †	6. SCHEDULING DATES a. REQD.	b. START	c. COMP.	7. REMARKS, FUNDING IMPLICATIONS, ETC.	8. ACTUAL ACTION TAKEN
eter low-	3.2.2	NAVSEA				APL 109030005 (NSN 90-6680-00-174-6135)	
with 37-	3.2.1 and 3.2.2	NAVSEA					

UIRED FOR CONTINUATION OF DEVELOPING ACTIVITY TASK; 7, AS NECESSARY.