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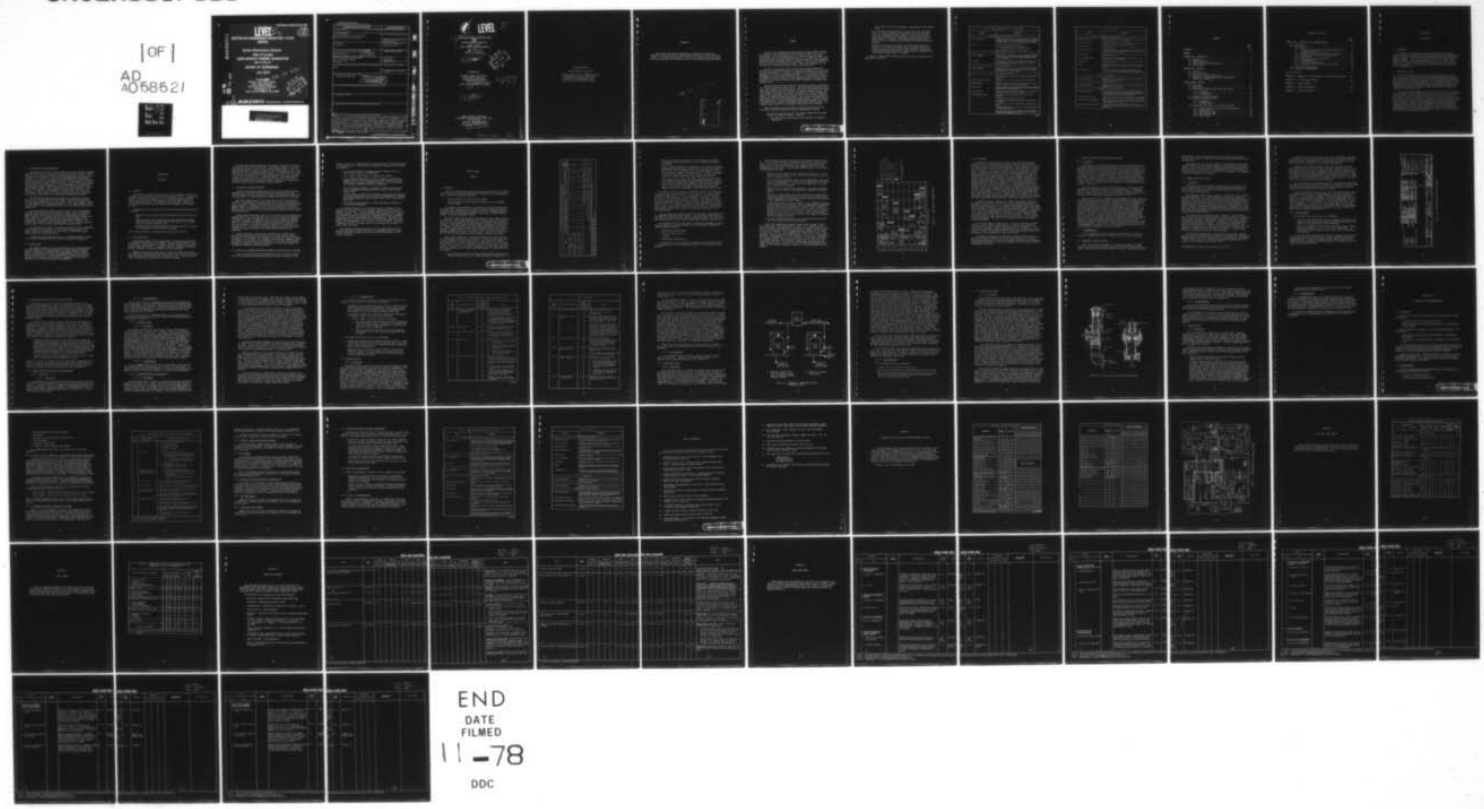

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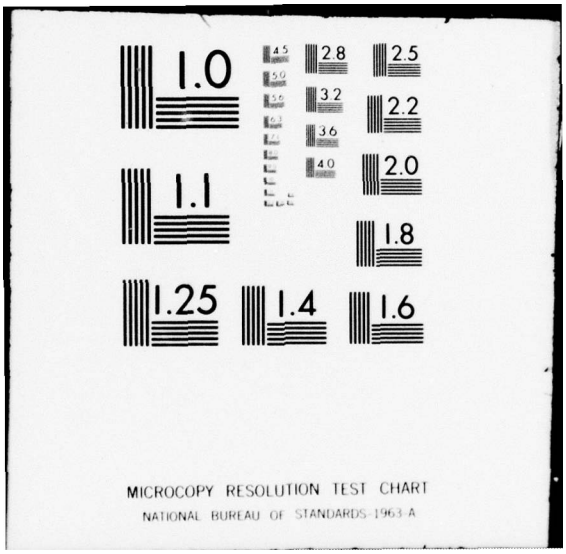
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Publication 1652-03-23-1785

LEVEL II

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DESTROYER ENGINEERED OPERATING CYCLE (DDEOC)

System Maintenance Analysis

DDG-37 CLASS

SHIPS SERVICE TURBINE GENERATOR

SMA 37-203-311

REVIEW OF EXPERIENCE

July 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

UNCLASSIFED-UNLIMITED

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER 1652-03-23-1785	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE *(and Subtitle)* Destroyer Enginerred Operating Cycle Ships Service Turbine Generator		5. TYPE OF REPORT & PERIOD COVERED
		6. PERFORMING ORG. REPORT NUMBER 1652-03-23-1785
7. AUTHOR(s) R. Comstock		8. CONTRACT OR GRANT NUMBER(s) N00024-78-C-4062
9. PERFORMING ORGANIZATION NAME AND ADDRESS ARINC Research Corporation 2551 Riva Road Annapolis, Maryland 21401	LIBRARY ARINC RESEARCH CORP. 2551 RIVA ROAD ANNAPOLIS, MD. 21401	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Naval Sea Systems Command Washington, D.C.		12. REPORT DATE July 1978
		13. NUMBER OF PAGES
14. MONITORING AGENCY NAME & ADDRESS *(if different from Controlling Office)* same		15. SECURITY CLASS. *(of this report)*
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT *(of this Report)* UNCLASSIFED-UNLIMITED DISTRIBUTION STATEMENT A Approved for public release Distribution Unlimited		
17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*		

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

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 opearating cycle. In support of this goal, System Maintenance Analyses (SMAa) are being conducted for selected systems and subsystems of designated surface combants. The principal element of an SMA is the Review of Experience (ROE). This report documents the ROE for the DDG 37 Class Ships Service Turbine Generator System.

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Unclassified Unlimited

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

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(DDEOC)

SYSTEM MAINTENANCE ANALYSIS,

DDG-37 CLASS
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under Contract (15) N00024-78-C-4062

(12) 71 p.

by

(10) R. Comstock

ARINC Research Corporation
a Subsidiary of Aeronautical Radio, Inc.
2551 Riva Road
Annapolis, Maryland 21401

Publication (14) 1652-03-23-1785

400 247

Prepared under Contract N00024-78-C-4062,
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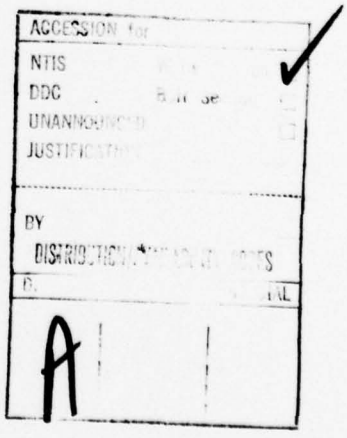
FOREWORD

This report, the Review of Experience, documents the historical maintenance experience for the DDG-37 Class Ships Service Turbine Generator System. It has been developed for NAVSEA 934, the sponsor of the Destroyer Engineered Operating 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 Ships Service Turbine Generator 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 Ships Service Turbine Generator 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 ship alterations, and system technical manuals to identify maintenance problems. Ship surveys were conducted and discussions were held with appropriate technical codes to validate identified problem areas, 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 Ships Service Turbine Generator System are summarized as follows:

- The DDG-37 Class SSTG has two major design weaknesses that cause chronic maintenance problems. They are:
  - The main lube oil pump bearing (ball bearing) is improperly lubricated.

- The control oil filtering system is inadequate for the required task.

- Once the design weaknesses above are rectified, some SSTG components will require corrective maintenance during the operating cycle, but accomplishing major preventive maintenance at fixed intracycle intervals is not warranted. A run-to-failure maintenance strategy is adequate. Some scheduled major restorative maintenance will be required during Baseline Overhaul and Regular Overhaul.

- During any maintenance performed on the SSTGs which involves opening of the control oil system, casual contamination of that system can occur which may cause control problems. Extreme care during maintenance periods must be taken to avoid contamination of and maintain a clean control oil system.

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

Table S-1. SUMMARY OF RECOMMENDED ACTIONS, DDG-37 CLASS SSTG SYSTEM

Component	Recommendation
Baseline Overhaul Requirements and ShipAlt Requirements	
1. SSTG, All Components	Accomplish those repairs and restorative maintenance on the SSTG as required by CSMP and POT&I. Accomplish as a minimum the restorative maintenance indicated in Table 4-1 of this report. Accomplish repairs in accordance with TRSs 0311-86-600 and 0311-86-601 only where indicated in Table 4-1.
2. ShipAlts	Accomplish two of three outstanding ShipAlts: DDG-37-1226K, Replace bus-tie circuit breakers. DDG-37-1281D, Install mod kit on SSTG Main Lube Oil Pump. Cancel ShipAlt DDG-37-1213D; relocate centrifugal filter.
Intracycle Maintenance Strategy	
1. SSTG, All Components	Accomplish PMS in accordance with requirements as modified by recommendations indicated in DDEOC MRC Evaluation Table, Appendix D. Perform corrective maintenance at the organizational level supported by an IMA or depot as necessary.
2. Relief Valves	When relief valves, submitted for cyclic tests, are found to be used in an out of specification installation, IMA and ship jointly confirm and document future usability, or replace if required.
Follow-On Requirements	
1. SSTG, All Components	Accomplish repairs or overhaul the SSTG as required by CSMP and POT&I. The requirements (less ShipAlts) indicated in Table 4-1 are recommended as minimum for ROH restorative maintenance.
Planned Maintenance System Changes	
	(Detailed changes are listed in Table D-1, DDEOC MRC Evaluation Table of Appendix D)
1. Lube Oil and Control Oil Systems	Change periodicity of purification of SSTG lube oil from monthly to weekly.
2. Flexible Coupling	Periodicity designation of the flexible coupling inspection is changed from C-2 to 36M-1 (this preserves present frequency).
3. Duplex Strainer	Change to periodicity of cleaning duplex strainers adds situation requirements for the first day after light-off and for the first two days after bearing repairs have been accomplished.
4. Centrifugal Filter	Change to periodicity of cleaning the centrifugal filter adds quarterly requirement in addition to situation requirement.
5. Various Components of SSTG	Caution added not to use hand oil pump except in event of actual emergency. Encourage draining SSTG sump while oil is warm. Draw sample of oil for laboratory analysis prior to purification and cleaning sump. Preferred source of refill oil for SSTG is storage tank and not settling tank. Recommends accomplishing quarterly inspection of reduction gear just prior to cleaning lube oil sump. Cautions to ensure control oil 10-micron filter is well drained before opening and that extreme caution be used to ensure that no contamination enters control oil system when filter is open.

(continued)

Table S-1. (continued)

Component	Recommendation
Reliability and Maintainability	
1. SSTG Main Lube Oil Pump	Investigate further modifications of SSTG Main Lube Oil Pump to provide strained and/or filtered oil to the pump bearing.
2. Control Oil Hand Pump	Investigate modification to control oil system to eliminate unfiltered oil supply to servomotor and actuator via hand pump.
3. Strained Control Oil	Investigate modification to lube oil/control oil system to strain all oil in duplex strainer.
4. Duplex Strainer and Cooler	Investigate modification to relocate duplex strainer and cooler to a more accessible location and to reduce requirements for removal and opening of piping for access to SSTG components.
5. 10 Micron Filter	Investigate necessity for bypass relief valve in 10-micron filter. Remove and plug if not required.
6. Control Oil Maintenance	Emphasize requirement to all maintenance levels that control oil must be maintained free from contamination.
7. In-Line Filters	Investigate use of in-line wire mesh filters as "last chance" filters in control oil lines.
8. Gaskets	Replace spiral wound gaskets in lube oil and control oil system flanges with 1/32-inch gasket material, symbol 2290. Reface flanges where required.
9. Centrifugal Filters	Reinstall water drain cocks on centrifugal filters where they have been removed. Operators should utilize these filters in accordance with operating instructions provided in the SSTG Technical Manual.
IMA Improvements	
1. Control Oil Maintenance	Emphasize need for strict lube oil and control oil system maintenance procedures to avoid contamination.
Depot-Level Improvements	
1. Control Oil Maintenance	Emphasize need for strict lube oil and control oil systems maintenance procedures to avoid contamination.
Integrated Logistics Support Improvements	
1. Technical Manual Rewrite	Ensure that adequate and accurate text and figures are included in the Technical Manual for the DDG-37 Class SSTG, which is now being rewritten. Particular attention should be given to providing troubleshooting and repair procedures for the Speed Control Governor System.
2. EG-3P Actuator with Oil Motor	Ensure that precise description of actuator is used, i.e., EG-3P with oil motor and not EG-3P with oil pump. Remove ambiguity in APL 701110322.
3. Ball Bearings, Lube Oil Maintenance	Support educational effort to upgrade fleet personnel knowledge regarding ball bearing lubrication and lube oil maintenance and techniques to avoid casual contamination in oil systems.
4. Bearing Installation and Lubrication	Support general upgrade of shipboard equipment and personnel skills required to replace ball bearing. Provide Ship's Force with ball bearing heater ovens.

CONTENTS

CONTENTS (continued)

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

In support of the Destroyer Engineered Operating Cycle (DDEOC) Program, sponsored by NAVSEA 934, 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 Ships Service Turbine Generator 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 impact of problem occurrence while improving material condition and maintaining or increasing system availability throughout an extended ship operating cycle.

The analysis documented herein is specifically applicable to the Ships Service Turbine Generator (SSTG) System of the DDG-37 Class. Only those system components that had been installed or were on board ship as of 30 September 1976 were considered. The analysis used all available documented data sources from which system maintenance problems could be identified and studied. These included 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 operating force and other cognizant technical personnel.

1.3 SYSTEM FUNCTION AND DESCRIPTION

Each ship of the DDG-37 Class has four Ships Service Turbine Generators rated at 1000 kW each, which provide electrical power for the ship. These SSTGs were all installed as part of the AAW Modernization Program, replacing smaller 750 kW units. The new SSTGs are manufactured to a DeLaval Turbine, Inc., design. The generator was manufactured by General Dynamics and the turbine and reduction gear by DeLaval. The turbines are six-stage impulse type and are rated at 10,981 rpm with a design steam inlet pressure of 1050 psig at 940°F temperature. The single-reduction, single-helical reduction gear reduces turbine speed to the 1200 rpm required for a three-phase, 60-Hz generator. The synchronous, salient pole, continuous duty generator is rated at 1000 kilowatts, 0.8 power factor, 450 volts, and 1602 amperes. The generator is totally enclosed with Class H insulation and is air-to-water cooled for a 50°C ambient temperature operation.

The SSTGs may be operated either singly or in parallel, two being sufficient for normal ship electrical loads. During battle conditions, all four would be operated in a "split plant" setup. No provision is made for paralleling with the emergency generators. Two SSTGs (numbers 1A and 1B) are located in the forward engine room, and two (numbers 2A and 2B) are located aft.

The electro-hydraulic control system consists of several components that keep the generator speed constant while under load. A load sensor, frequency sensor, amplifier, power supply, permanent magnet alternator (PMA), actuator, and servomotor are all part of the governor system. Generator speed can be controlled manually by changing the speed setting potentiometer that changes the control system reference voltage. The actuator and servomotor utilize the SSTG lube oil at 85 psig for hydraulic power to position the turbine steam admission throttle valves.

The lubrication and control oil system consists of the main (sometimes called attached) lube oil pump, a motor-driven auxiliary pump, a two-section hand pump, a duplex strainer and cooler, and various filters, relief valves, and regulating valves.

A listing of system components within the system boundaries included in the analysis documented by this report is presented in Appendix A.

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 selected list of references precedes the appendixes.

CHAPTER TWO

APPROACH

2.1 OVERVIEW

This chapter describes the approach to the performance of the Review of Experience for the Ships Service Turbine Generator System. Primary data sources are identified in Section 1.2. The data were used to identify, define, and analyze maintenance problems that significantly affect the SSTG maintenance program. A recommended system maintenance program for the extended operating cycle was formulated on the basis of the analysis results.

The major steps of the Ships Service Turbine Generator System ROE were as follows:

- 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 system during the extended operating cycle
- Analyzing problems and formulating alternative solutions as a basis for recommending a system maintenance program

Each of these activities is described in the following sections.

2.2 DATA COMPILATION

The analysis began with the compilation of a comprehensive data base of the maintenance history of the system. The data file consisted of three key elements: an MDS data bank, a CASREP narrative summary, and a system overhaul experience summary. A library of ShipAlt information, technical manuals, bulletins, and related documents was also assembled.

Commencing with DDG-37 (then DLG-6) in 1968, all ships of the class have completed a Modernization period during which the four new 1000-kilowatt SSTGs were installed, replacing four 750-kilowatt units. Only the data on these Post-Modernization SSTGs were utilized in this ROE.

The MDS data included maintenance experience in the DDG-37 Class from 1 January 1970 through 30 October 1976. The number of ships in the data base varied from one to nine as ships completed Modernization. This Post-Modernization period represents a total of 35.6 ship operating years. USS KING (DDG-41) had not completed Modernization as of October 1976 and therefore was not considered in the review, leaving only nine of the ten ships in the class in this analysis. CASREP information on Post-Modernization of SSTGs for the period 1 July 1973 through 30 June 1976 was reviewed. Overhaul information was obtained from DDG-37 Class Departure Reports and authorized Ship Alteration and Repair Packages (SARPs).

2.3 MAINTENANCE PROBLEM DEFINITION

Potential maintenance problems associated with the systems and their components were identified by screening data obtained from the above-described sources as well as from ship surveys, discussions with Navy technical personnel, and, when appropriate, NAVSEA special-interest programs.

MDS data constituted the initial and primary source of information screened. The resulting 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 screening process was to identify the maintenance actions that had been reported against components of the system under investigation.

Computer-assisted analysis quantified the man-hour and part-expenditure burdens incurred for each component, 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 substantially to the system's maintenance burden were selected for analysis if they had generated a significant number of CASREPs or if other sources of information (e.g., ship surveys or overhaul experience) disclosed concern regarding maintenance problems or the maintenance programs for the components.

Detailed analysis of the selected components was directed toward defining 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 component 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.

2.4 ANALYSIS OF COMPONENT MAINTENANCE PROBLEMS AND DEFINITION OF SOLUTIONS

Once the component maintenance problems and their causes 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 are expressed in 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 it be reduced or eliminated by changes to PMS? (These changes might include adding or deleting requirements, changing requirement frequency, or developing material condition assessment tests and procedures.)
- Can the problem be reduced or eliminated by improving the 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 and are likely to be accomplished prior to a ship's entry into DDEOC. Long-term recommended solutions are those likely to be accomplished subsequent to a ship's entry into DDEOC.

The historical overhaul experience for all installations of each selected component was correlated with the recommended problem solutions. An evaluation then was made to establish the BOH requirements for each selected component.

CHAPTER THREE

RESULTS

3.1 OVERVIEW

Early Post Modernization problems with the new SSTGs for DDG-37 Class ships results in their being placed on the Maintenance Critical Equipment List. Two chronic problems noted were:

- Bearing failures in the main lube oil pump
- Erratic governor control caused by malfunction of the Woodward EG-3P actuator

To develop a clear definition of the kinds of SSTG maintenance problems that have occurred and can be expected to recur during an extended operating cycle, this Review of Experience included a comprehensive examination of all SSTG maintenance problems identified in the MDS, CASREP system, and other maintenance records.

Screening of MDS data yielded the maintenance burden summary presented in Table 3-1. This summary discloses that the SSTG System of the DDG-37 Class received an average of 459 man-hours of maintenance per ship operating year. Five system components were found to contribute 95 percent of the burden, with the highest individual burden attributed to the turbine. The relative contribution to the total maintenance burden of all five components is apparent from the last column of Table 3-1, which shows the average man-hours per component operating year. The total cost burden of each of the five components can also be compared from the data shown.

Upon initial examination, the man-hour and parts-cost data of Table 3-1 might suggest misleading conclusions as to where the most severe maintenance problems are occurring in the SSTG. The turbine, for example, would appear to be a greater maintenance problem than either the governor or main lube oil pump. This disparity in the data is the result of several factors. A review of the narrative statements in the MDS data indicated many inappropriate entries listed under the "Turbine" or "Generator" APLs, for example:

- Many entries were noted for deferred maintenance, particularly for lube-oil related PMS actions. These entries add man-hours for

Table 3-1. MAINTENANCE BURDEN SUMMARY DATA FOR SHIPS SERVICE TURBINE GENERATOR SYSTEM

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
057150225	Turbine, 1000 kW Steam Generator	9	4	36	35.6	9	556	7400	2108	9508	41,059	66.8
161340005	Generator, AC 440V 1000 kW	9	4	36	35.6	9	100	3090	307	3397	4,286	23.9
016160562	Pump, Main (Attached) Lube Oil	9	4	36	35.6	6	66	1487	0	1487	16,222	10.4
701110322	Governor, Electric Turbine	9	4	36	35.6	7	71	680	99	779	24,053	5.5
883114077	Relief Valve, 1.5 IPS	9	4	36	35.6	2	11	213	126	339	558	2.4
						Totals	804	12870	2640	15510	86,178	
						Total Reported for All System APLs	908	13397	2935	16332	90,170	459**
						Percent of Total Reported Accounted for by Selected APLs	89	96	90	95	96	

*Only 9 of 10 ships in class were included in the analyses. DDG-41 was not included in the data base for period of data analyzed. As of report date, 10 ships and 40 components are actual population.

**Total Man-Hours/Total Ship Operating Time = $\frac{16332}{35.6}$ = 459 Man-Hours/Ship-Years

work not accomplished. Since 1971, the reporting of deferred maintenance is not required unless it is considered maintenance-significant.

- Design problems regarding the inadequacy of the lube oil strainer spray shield sometimes were assigned to the turbine APL instead of the lube oil cooler (strainer) APL. The spray shield is a new device having no common specification for the shields installed in the first several ships of the DDG-37 Class. As such, this item represents a design problem and not a maintenance problem.
- Three entries by one ship alone added 1503 man-hours (44 percent of the total for all ships) to the generator APL burden. These three entries indicated the changing of SSTG lube oil system piping flange faces from a configuration using flexitallic gaskets back to the original "flat-face" configuration for 1/32-inch gaskets, which is not considered a corrective maintenance action.

An analysis of parts ordered by these ships (which is an indication of parts replaced and which will be referred to herein as "parts usage") provided the data shown in Table B-1 of Appendix B. A ratio of parts replaced to total population of selected parts in the SSTG is shown and is a factor for inclusion of a part in the table. The highest ratio is 625 for an expendable 10-micron filter element in the control oil filter. Likewise high are the generator brushes, another expendable item, with a ratio of 136.8. The remaining parts with a ratio over 100 are associated with the main lube oil pump. With ratios of 55.6 and 44.4, the oil pump drive assembly bearing and actuator are relatively high within their functional group.

Only two items were ordered by seven or more ships — the actuator and the expendable 10-micron filter element. The generator brushes and the main lube oil pump bearing were each ordered by six ships. All other parts were ordered by five or fewer ships, with ratios generally less than 50.

For reasons that will be discussed in following paragraphs, the parts listed in Table B-1 have been grouped into four functional subsystems of the SSTG System as follows:

- Turbine and reduction gear
- Generator and electrical
- Governor
- Lubrication and control oil

The boundaries of these functional groupings are indicated in Figure A-1 of Appendix A and were established to assist in further analysis of problems.

Further analysis of parts replaced provided the data shown in Figure 3-1. Six parts were selected for display in this figure, the purpose of which is to indicate the frequency of parts usage by ship quarter after modernization. (Note that the loading and frequency sensors have been grouped as one for clarity.) For the data shown in Figure 3-1, the following observations are made:

- Three of the nine ships have not replaced the main lube oil pump bearing, one with nearly 5 years' operating time and the other two with an average of 3 years.
- Of the six ships replacing a main lube oil pump bearing, the usage rate of that bearing was 75 percent of the population in the first year out of conversion. In the first year and a half, the usage rate increased to 121 percent.
- Eleven of the 16 actuators were replaced in the same or adjacent quarter as a main lube oil pump bearing was replaced (for a given ship).
- Main lube oil pump bearing casualties frequently occurred within 1 year after major maintenance to the SSTG, and was usually accompanied by problems in the governor system, mainly with the actuator or the frequency and loading sensors.
- The ship that used the largest quantity of the expendable 10-micron filter elements also had no main lube oil pump bearing replacements and only one actuator replacement in nearly 5 years of operation. The usage rate for 10-micron filters by that ship is 3.8 times the average of that of the other eight ships. This suggests the probability that the quality of the lube oil/control oil maintenance program for SSTGs is directly relatable to the number of casualties that may be expected to occur.
- No recurring parts-usage pattern was identified that might prove useful for scheduling periodic maintenance.

Thirty-three CASREPs were submitted against SSTG Systems of DDG-37 Class ships since their modernization. Table C-1 of Appendix C breaks down the CASREPs by category and by functional system and component, showing for each functional system the percentage of CASREPs and the number of ships that reported. The 33 CASREPs were experienced by eight of the nine ships, with a total ship operating time of 20.9 years in the period analyzed. This averages to 1.6 SSTG CASREPs per ship in the 3-year period. Two of the 33 CASREPs were in the C4 category. On the basis of CASREPs, the problems with the governor and the lubrication and control oil systems clearly dominate. The fractional CASREPs were assigned where one CASREP indicated several problems, such as two different bearings being wiped. No discernible pattern of casualties could be determined from the CASREPs.

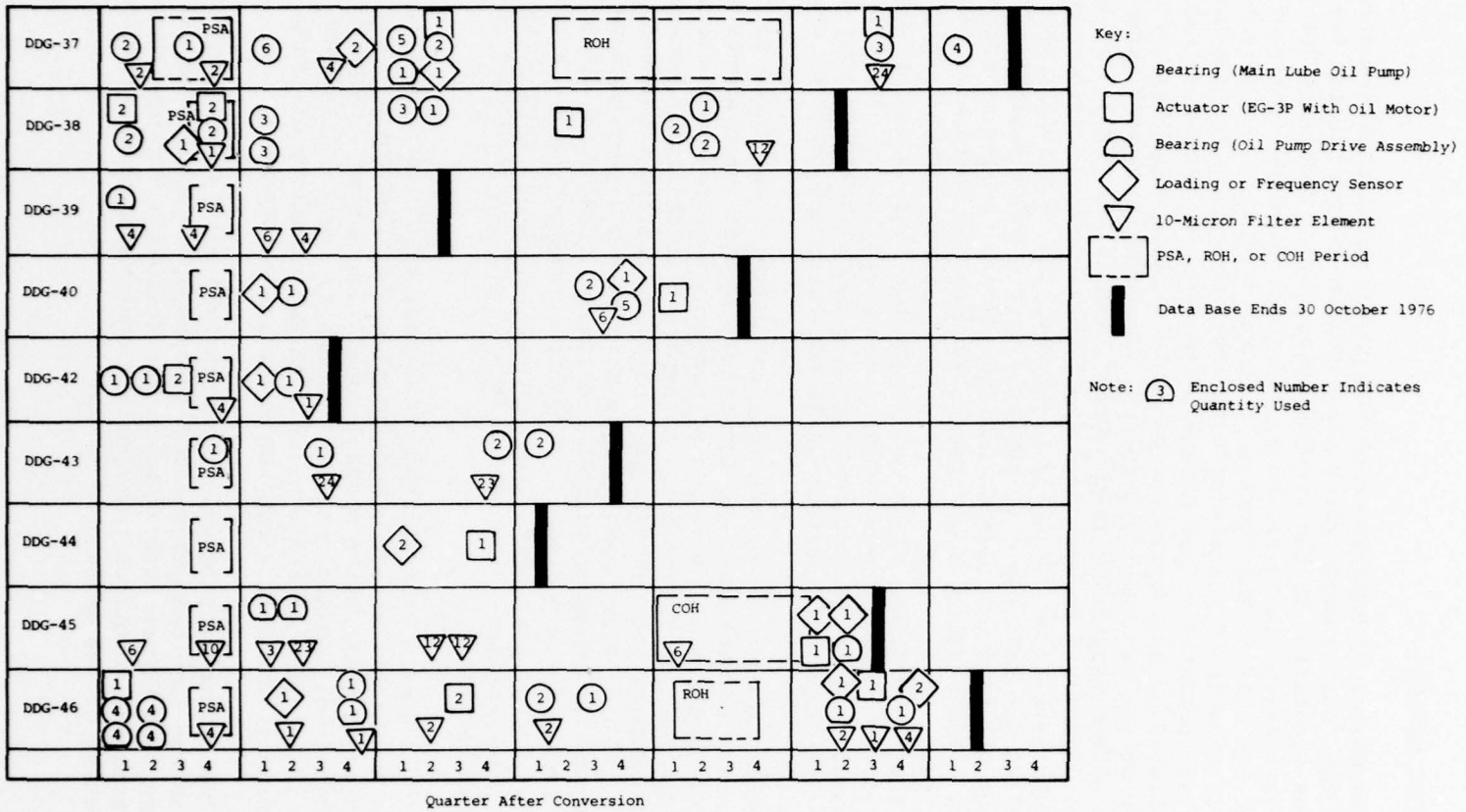


Figure 3-1. SHIP USAGE OF SELECTED PARTS

3.2 SSTG SYSTEM

The Review of Experience of the DDG-37 Class SSTG has shown that system not to be a major maintenance burden except for the two chronic problems identified in the previous paragraph. With four SSTGs, the electric power system is sufficiently redundant to allow continued full operation of the ship in the event of failure of up to two SSTG sets. Ship's Force is capable of performing extensive corrective maintenance on these SSTGs, as indicated by the nature of the PMS requirements that must be accomplished by ship operating personnel. This capability includes correction of the two chronic problems. Although equipment redundancy, the nature of PMS inspection requirements, and Ship's Force corrective maintenance capability suggest an overall repair-on-condition maintenance approach, such is not entirely possible. The requirement that precisely controlled electric power be supplied to the vital systems of the ship dictates the need for eliminating the chronic problem of erratic governor control. While it is reasonable to assume that there will be some bearing and actuator problems as well as other failures during a ship operating cycle for these SSTGs, it is not reasonable that so many problems should occur within the first year after a modernization or overhaul. Nor is it reasonable that these problems continue sporadically on some ships throughout their operational periods while not occurring on other ships at all.

Focusing on governor control, the actuator was found to be the primary source of problems. An indication of what improvements might be possible in terms of reduction of corrective maintenance was made by examining the data of Figure 3-1. An apparent relationship between part usage of the actuator and the main lube oil pump bearing was noted. If all actuator part usages accompanied by a main lube oil pump bearing replacement in the same or adjacent quarter are ignored, only five actuator usages would remain for a period of 35.6 ship operating years. Further, there would be no actuator part usages on any ship until late in the third year after modernization. The result is a 69 percent reduction in actuator usage and problems.

For the main lube oil pump bearings, if all such bearings replaced within 1 year of overhaul, modernization, or PSA are not counted, the reduction in that part's usage is nearly 60 percent. Similarly, if the oil pump drive assembly bearing (accessory drive unit) usage is not counted where it is shown in conjunction with the main lube oil pump bearing, the reduction in the former bearing's use is 76 percent.

The common link between the main lube oil pump bearing and the actuator is the lube oil/control oil system, specifically the oil itself. Keeping that common link in mind, the following sections discuss problems and recommend solutions for specific equipments within the four functional subsystems of the SSTGs.

3.3 TURBINE AND REDUCTION GEAR FUNCTIONAL SYSTEM

3.3.1 Discussion

Historically, the DDG-37 Class SSTG turbines and reduction gears have not required excessive corrective maintenance. Less than half of the applicable ships reported maintenance actions with journal bearings, thrust bearings, labyrinth ring packing assemblies, and observation windows during the data period. It is anticipated that correction of these failures is normally within the capability of Ship's Force. Similar corrective maintenance actions will be required during an extended operating cycle at random and infrequent intervals. However, the severity of these failures is not sufficient to warrant routine replacement of these components on a periodic basis. A continuation of the present run-to-failure maintenance strategy is adequate.

Five ships reported usage of the ball bearing in the oil pump drive assembly for a total of 20 usages in a total population of 36 bearings. Failure of this ball bearing is closely related to failures of the main lube oil pump ball bearing and will be discussed in greater detail in conjunction with the main lube oil pump (see Subsection 3.6.4).

Twenty percent of the 33 CASREPs reported against the SSTGs during the 20.9 ship operating years included in the CASREP data period concerned the turbine and reduction gear functional system. Of the 6-1/2 CASREPs comprising that 20 percent, 4-1/2 were for thrust and journal bearings. This is a good performance record over the data period. It is considered acceptable and requires no changes in current maintenance approach. The other two CASREPs in this functional system involve unique problems with throttle valve linkage that have been corrected or otherwise suitably resolved. A review of current maintenance requirements indicated that, with one exception, no changes would be required for extending the maintenance cycle. The exception concerns the maintenance requirement (MRC 84 E51V N) to inspect the high-speed flexible coupling once each cycle. Extension of that requirement beyond the present 36-month interval is considered undesirable. The current frequency designation of once per cycle is recommended for change to once per 36 months, which would maintain the current frequency regardless of the cyclic period.

3.3.2 Recommendation

It is recommended that the frequency of MRC 84 E51V N on MIP E-13/171-17 be changed from cyclical to 36 months for the flexible coupling.

3.4 GENERATOR FUNCTIONAL SYSTEM

Other than routine replacement or reseating of brushes, the SSTG generators and associated components such as coolers, bearings, switchboards, and alarms are relatively problem-free and do not warrant detailed

investigation. Review of the applicable PMS documents revealed that current requirements are adequate to support the intracycle maintenance of the generator.

Ship Alteration DDG-37-1226K replaces the main generator and bus-tie circuit breakers with new breakers capable of sustaining increased fault current. This will allow greater reliability when paralleling generators. This ShipAlt has little effect on the maintenance of the SSTG Systems reviewed in this analysis but is included for information. No recommendations are considered to be warranted.

3.5 GOVERNOR FUNCTIONAL SYSTEM

3.5.1 Discussion

The initial symptom of governor system problems is reported to be erratic speed control. The causes of governor system problems are not easy to localize because the SSTG Technical Manual does not provide a clear guide to troubleshooting.

The frequency sensors, loading sensors, and amplifier show a significant combined usage. This is not considered excessive but could be reduced. Usages for these three components have occurred on about half of the ships of the class. If usage of the frequency and loading sensor components that have occurred concurrent with that for the actuator are not considered (see Figure 3-1), only one-third or five usages remain. Since sensor, actuator, and amplifier problem symptoms are similar, it is probable that some of the sensors and amplifiers used concurrently with actuators were used unnecessarily because the exact problem cause could not be identified by troubleshooting.

The Woodward EG-3P actuator has been a problem, with seven ships — nearly half of the total class population — reporting usage of 16 actuators. This actuator provides a hydraulically positioned output with a useful work capacity of about 1 foot-pound, in response to an electrical signal from the load and frequency sensors. The electrical signal positions a pilot valve that moves in a rotating bushing to reduce friction. The hydraulic oil supply for the actuator is provided by an 85 psi branch (the control oil system) from the lubrication oil system. A hydraulic gear motor in the actuator drives the rotating bushing.

The slightest contamination of the control oil can cause the pilot valve to hang up and cause erratic operation of the actuator. Whereas the Woodward bulletin for this actuator calls for installation of a 40-micron filter for the control oil, the Navy has approved installation of a 10-micron* filter and added a centrifugal filter.

*10 microns equal about 4 ten-thousandths of an inch.

The SSTG Technical Manual contains very little information regarding the Woodward EG-3P actuator and has not been useful to operators and maintenance personnel. The manual is currently being rewritten, but the new revision was not available for review during this analysis.

Woodward Bulletin 82560B describes two EG-3P actuators, one with an oil motor and one with an oil pump. The SSTG Technical Manual does not distinguish between the two. To confuse matters even more, the APL for the governor lists two actuator assemblies, each with a different NSN and each immediately referencing the other's NSN listed two lines away. There is no other distinctive description on the APL page to indicate a possible difference, if any, between the two actuators (see Figure 3-2). The actuator with the oil motor is the correct component.

The lack of clearly defined maintenance and troubleshooting procedures and parts descriptions for the EG-3P actuator is reflected by the fact that during depot-level repair periods, control system components are being returned to the manufacturer for repair and rework.

As indicated earlier in this chapter, the suspected underlying cause of actuator and most governor system problems is the cleanliness of the control oil. The evidence of linkage of actuator/governor problems to other oil system problems, particularly those that require the control oil system to be opened and thus subjected to entry of contaminants, is too strong to ignore. For that reason, it is believed that the most significant recommendations to reduce governor system problems are those that concern lubrication and control oil. With proper control oil maintenance, these governor systems should provide adequate, relatively trouble-free service for an extended operating cycle.

3.5.2 Recommendations

The following near-term actions are recommended:

- Include in the SSTG Technical Manual a complete description of the governor control system and include detailed troubleshooting procedures for organization maintenance personnel.
- Remove the ambiguity in APL 701110322 and clearly specify the use of the EG-3P actuator with oil motor in the SSTG System. Use nomenclature "EG-3P Actuator with oil motor" where referenced in Navy documents.

For the long term, provide formal training to organization, IMA, and depot-level personnel for SSTG governor control system maintenance and troubleshooting. Continue to accomplish major repair of the system's Woodward governor components by the manufacturer in conformance with current Navy depot-level practice.

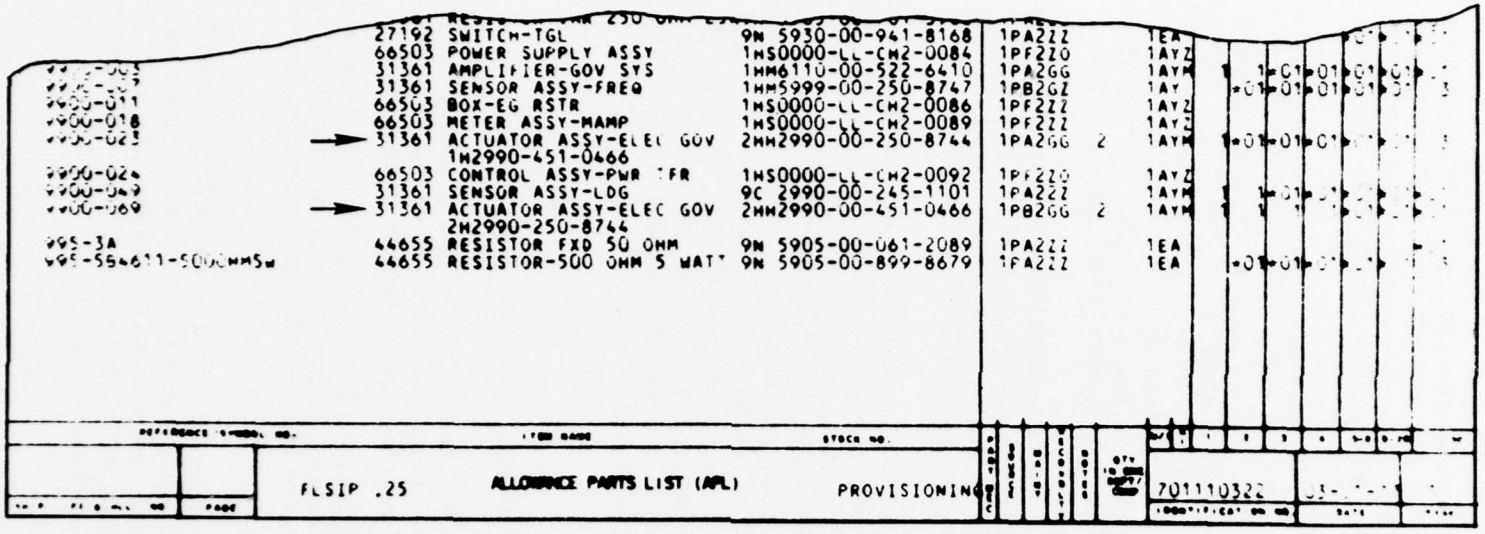


Figure 3-2. ACTUATORS LISTED ON APL 701110322

3.6 LUBRICATION AND CONTROL OIL FUNCTIONAL SYSTEM

The following subsections address problems associated with the lubrication and control oil system. As indicated by Figure A-1 of Appendix A, this system comprises several pumps, filters, strainers, a cooler, a motor, valves, gages, and piping. The life of all bearings of the SSTG and the function of all hydraulically operated control features are dependent upon the quality of the oil provided. As indicated, the oil itself is the common linkage element in casualties, specifically the two chronic problems: failure of the main lube oil pump ball bearing and erratic governor control.

Discussions with operating personnel revealed that some ships are changing lube oil in the SSTG as often as every 3 days, or 10 times more frequently than the MRC monthly requirement. This has not necessarily resulted in a reduction of SSTG problems on those ships. These personnel were also concerned with what they believed to be an excessive amount of maintenance required in several areas of the lubrication and control oil system. A careful examination of the Technical Manual for this system was made to determine if specific weaknesses might exist that could be causing the problems. The examination revealed the following:

- Operating personnel are not provided with accurate information regarding system configuration. The SSTG Technical Manual portrays an inaccurate and incomplete schematic (Figure 10-9 of Technical Manual 0961-LP-033-3010) of the lubrication and control oil system, specifically in the areas related to the two chronic problems. The control oil supply to the actuator is not correctly shown, and the schematic shows every bearing in the SSTG system except the main lube oil pump ball bearing, the one that frequently fails.
- Several sources for casual contamination of the control oil system exist, as discussed in the following subsections.

Because of the lack of suitable technical information, maintenance personnel at all levels of maintenance do not appear to fully understand the control oil system and do not appreciate the need to maintain not just the oil but the entire control oil system free from contamination.

3.6.1 Casual Sources for Control Oil Contamination

3.6.1.1 Hand Pump

3.6.1.1.1 Discussion

The hand pump for the control oil system pumps oil directly from the sump to the actuator through a fine mesh filter, bypassing the control oil filters. A fine mesh filter is inadequate for removing contaminants, and thus the hand pump is a potential source of gross contamination. Both ships visited used the hand pump infrequently and would do so only upon failure of both other pumps.

3.6.1.1.2 Recommendations

For the near term, it is recommended that all written references to use the hand pump be removed and operators advised that hand pumps should not be used except in an emergency. Operators should be further advised that, following emergency use of the hand pump, oil passed into the actuator is likely to be contaminated and should be removed from the system before operating the SSTG again.

For the long term, it is recommended that an investigation be conducted into redesigning the control oil system so that the hand pump delivers adequately filtered oil.

3.6.1.2 10-Micron Filter

3.6.1.2.1 Discussion

The 10-micron filter has a relief valve set for a differential of 15 psi to bypass oil if the filter is clogged. There is no prescribed test verifying that relief setting. Upon sudden contamination of the control oil supply, for example by any bearing failure in the system, the 10-micron filter could quickly become clogged and pass contaminated oil through the bypass. There is no way of knowing if this has happened. If the contaminants are sufficiently large, it is possible that the bypass could be wedged open by them and continue to pass unfiltered oil after correction of the casualty and replacement of the filter. Control oil differential readings would not indicate this situation. Unless the operator is observing the gage at the instant the bypass opens, it is doubtful he will note the sudden fluctuation and change in pressure as being detrimental. It should be noted that a bypass is not essential in this application as it is elsewhere in the lubrication oil system since a lack of control oil pressure will trip the generator off-line. This is probably the desired action if the 10-micron filter becomes suddenly clogged.

3.6.1.2.2 Recommendation

It is recommended that the necessity for the bypass relief valve for the 10-micron filter be reevaluated. If the valve is not required, it should be removed and the bypass plugged. If the valve must remain, some manner of testing it should be devised and included in PMS requirements.

3.6.1.3 Maintenance-Related Contamination

3.6.1.3.1 Discussion

The oil passing into the control oil system does not pass through the duplex strainer and cooler. After a failure of the main lube oil pump bearing on one ship, it was reported that all of the free balls were found in the 10-micron filter. This implies free flow of any contaminants in the sump to the control oil system filters and also adds credence to the previous statement regarding the clogging of the 10-micron filter and the

wedging open of the bypass valve. Replacing the 10-micron filter element is a potential source of contamination. The filter should be well drained prior to removing the contaminated filter element. Wiping the filter chamber clean should be accomplished with the old filter element still in place to avoid contamination of the clean oil side of the chamber.

If contamination seems to seek the control oil side as indicated above, then there is no provision for filtration of gross-sized contaminants in the system prior to entry into the control oil side and the 10-micron filter. Use of a wire-mesh on-line filter prior to the 10-micron filter should be investigated to provide protection of the 10-micron filter from gross contamination. Since MDS data indicate that a significant number of maintenance actions have occurred within 1 year after major maintenance periods, it is concluded that special attention is required at such times. Extreme caution by the maintenance personnel must be exercised to avoid contamination of the control oil system. Any maintenance performed in which contaminated oil is found or suspected should also result in changing the oil and 10-micron filter prior to operating the SSTG. Current instructions for frequency of shifting lube oil strainers on the SSTG differ between EOSS instructions and MRCs. The best of both should be combined, retaining the special attention required during the first 48 hours after either bearing repairs or the discovery of contaminated lube oil.

Corrective maintenance performed on either the main lube oil pump or the upper end of its drive assembly will require breaking open the control oil lines. During this process the control oil can become contaminated. Careful rerouting of control oil lines to avoid the requirement of opening that system for nonrelated maintenance is a desirable goal.

Operating personnel on both ships visited were concerned with what they believed to be an excessive amount of maintenance required to stop leaks in lubrication oil system piping. The constant breaking open of these lines to correct leaks carries the risk of contaminating the control oil. The lube oil piping flanges, which currently use spiral wound gaskets, are being converted to use 1/32-inch gasket material, Symbol 2290, which seems to hold better. This is now a PEB item. When completed, this action should significantly reduce the incidence of flange leaks and reduce the need for opening the system and risking casual contamination of the lube oil.

Operating personnel indicated that the duplex strainers are very awkward to shift and clean, particularly with the spray shields in place. Relocation of these strainers would facilitate proper strainer maintenance and would eliminate some of the lube oil piping congestion on the SSTGs. These SSTGs are installed in a very tight space on DDG-37 Class ships. Any changes to relieve that situation would be desirable.

3.6.1.3.2 Recommendations

The following near-term actions are recommended (see Table 3-2 for a summary of all proposed lube oil-related MRC changes):

- Reemphasize at all maintenance levels that the control oil system must be maintained free of contaminants. Spiral wound gaskets and flange faces for those gaskets should be replaced by flat-face flanges and 1/32-inch gasket material, Symbol 2290.
- As indicated in Table 3-2, change the "Inspect and Clean Duplex Oil Strainer", MRC 17 L41K N, to read as follows:

  "Shift, inspect, and clean strainers as follows:

  a. Once every watch during the first 24 hours of operation; then once every 24 hours, or when the oil pressure drop across the active strainer increases to 5 psi; or as a result of lube oil inspection.

  b. Once every watch for the first 48 hours of operation, when bearing repairs have just been accomplished; then as above."

The following long-term actions are recommended:

- Investigate relocation of the duplex strainer and cooler. Concurrently, investigate relocation of all lube and control oil lines so that their removal will not be required incident to other non-lube oil-related maintenance.
- Investigate use of in-line wire mesh filters as "last chance" filters in control oil lines before the 10-micron filter, or consider straining and cooling the control oil before passing it to the control oil filters.

3.6.2 Quality of Oil

3.6.2.1 Discussion

Operating personnel expressed the belief that the frequency of changing or purifying lubrication oil (control oil) should be increased. The frequency of purification recommended by the Technical Manual is once weekly. The current PMS requirement has extended that to once per month. One of the two ships visited was changing SSTG lube oil weekly and the other ship was changing it every three days. When questioned as to why they were changing oil so frequently, the response was that such action was needed to keep the SSTGs running without problems. There is no known reason or rationale supporting the monthly PMS requirement to change oil, except to reduce the preventive maintenance workload. It appears the workload has not been reduced on some ships, and the weekly requirement of the Technical Manual should be reinstated. Until such time as a real-time analysis of the lube oil can indicate a precise requirement as to when to

Table 3-2. PROPOSED MRC CHANGES TO DDG-37 CLASS SSTG SYSTEM MIP E13/171-17

MRC Control Number	Maintenance Requirement	Periodicity Code		Remarks
		Present	Proposed	
T75 H31S N	Test operate combination low lube oil pressure alarm and switch	M	M	Add Caution: Do not operate hand lube oil pump except in event of actual casualty in which lube oil pressure drops below 4 psig at remote bearing while turbine is rotating. A change to procedure 1.c is anticipated in accordance with NAVSEC Spdltr 6154B/RK serial 876 dated 3 November 1977. This change will lower the minimum lube oil pressure at the most remote bearing to 4 psig vice 9 psig.
17 L39X N and	Purify lube oil	M-3R	W-2R	Add Note: This maintenance is best accomplished immediately upon securing SSTG while lube oil is still warm.
17 L39Y N	Clean sump and purify oil	Q-1R	Q-1R	Add Note: The preferred source of oil to fill the sump is clean oil from a storage tank. Oil may be purified from a settling tank if no other source is available.
17 L39X N	Purify lube oil	M-3R	W-2R	Change Procedures: 1.e, f, and k to read: e. Unlock and open storage or settling tank outlet valve. f. Operate purifier and purify oil from storage or settling tank to SSTG sump at 160°F. k. Shut and lock storage tank or settling tank outlet valve and SSTG sump suction discharge valve.
17 L39Y N	Clean sump and purify oil	Q-1R	Q-1R	Add Related Maintenance: Q-5 Add Note: Draw sample of lube oil for laboratory analysis prior to purification. Add Note: When scheduled, accomplish in conjunction with Q-5, Inspect Reduction Gears. Change Procedure to read: Change M-3R to read "W-2R where occurring". After 1.c add: Caution: Exercise extreme care to avoid introduction of any contaminants into sump. Certain areas of the sump are inaccessible due to baffles. Change 1.j to read: Purify oil from storage tank/settling tank as described on MRC W-2R.

(continued)

Table 3-2. (continued)

MRC Control Number	Maintenance Requirement	Periodicity Code		Remarks
		Present	Proposed	
17 L41A N	Inspect reduction gears	Q-5	Q-5	Add Related Maintenance: Q-1R. After Procedure 1.i add: Note: Accomplish Q-1R.
17 L41C N	Renew control oil filter element	Q-7	Q-7R	Add Note: Accomplish quarterly or when control oil pressure drops to 75 psig or whenever maintenance is performed in which contaminated oil is present, whichever occurs first. Add Caution: Exercise extreme caution to ensure that no contaminants enter the control oil system as a result of opening this filter. Ensure that the filter is well drained and has been empty for several minutes prior to opening filter and removing filter element. Do not use hand pump to prime system; test for leaks after changing filter element. Use auxiliary lube oil pump.
84 E51V N	Inspect flexible coupling	C-2	36M-1	This change of frequency from C-2 (cyclic) to 36M-1 will maintain the current 36-month cycle regardless of the anticipated extended cycle. Further extension of the frequency interval is considered unacceptable.
17 L41H N	Turn idle turbine shaft several revolutions	R-4W	R-4W	Add Caution: Do not use hand lube oil pump to supply lube oil for this maintenance action. Change procedures by eliminating all reference to hand operated lube oil pump.
17 L41J N	Inspect and clean duplex lube oil strainer	R-10	R-10	Change Note 1 to read: Shift, inspect, and clean strainers as follows: a. Once every watch during the first 24 hours of operation; then once every 24 hours or when oil pressure drop across active strainer increases to 5 psi or as a result of lube oil inspection. b. When bearing repairs have just been accomplished -- once every watch for the first 48 hours of operation, then as above.
17 L41K N	Clean and inspect centrifugal separator	R-11	Q-8R	Change Note 1 to read: Accomplish quarterly or after 500 hours of operation, whichever occurs first.

change the oil, the hard-time weekly requirement should be established as a minimum SSTG lube oil change or purification requirement (see MRC 17 L39X N, Table 3-2).

The PMS requirement of MRC 17 L39Y N to clean the SSTG lube oil sump instructs personnel to "ensure top, sides, and corners are free of foreign matter" and to "inspect for foreign matter". The MRC neglects to mention that baffle plates within the sump and limited access preclude thorough accomplishment of these tasks. The tasks should be prefaced with the words "where accessible".

Other minor but meaningful changes can be made to the above-mentioned MRCs and other MRCs for the SSTG regarding lube oil maintenance. Several cards indicate the lube oil settling tank as the source of oil for replenishing the SSTG sump when changing or purifying oil. Unless adequate time for cooking and settling the oil in the settling tank has been provided, the preferred source of replenishment oil is from a storage tank. The quarterly requirement to clean the SSTG lube oil sump should be accomplished in conjunction with the inspection of the SSTG reduction gear. Since the sump is under the reduction gear, the inspection is enhanced as well as the opportunity to flush out contamination that may have entered the sump when opening the reduction gear casing. A note should be added to appropriate cards (this applies to all machinery with oil sumps) that the oil sump should be drained while still warm, preferably immediately upon securing the equipment. This will flush out fine contaminants still suspended in the oil. Oil samples for analysis should also be drawn at this same time even if analysis is not immediately available.

Several MRCs direct nonemergency use of the hand lube oil pump. These cards should be changed to prescribe use of this pump only in an emergency.

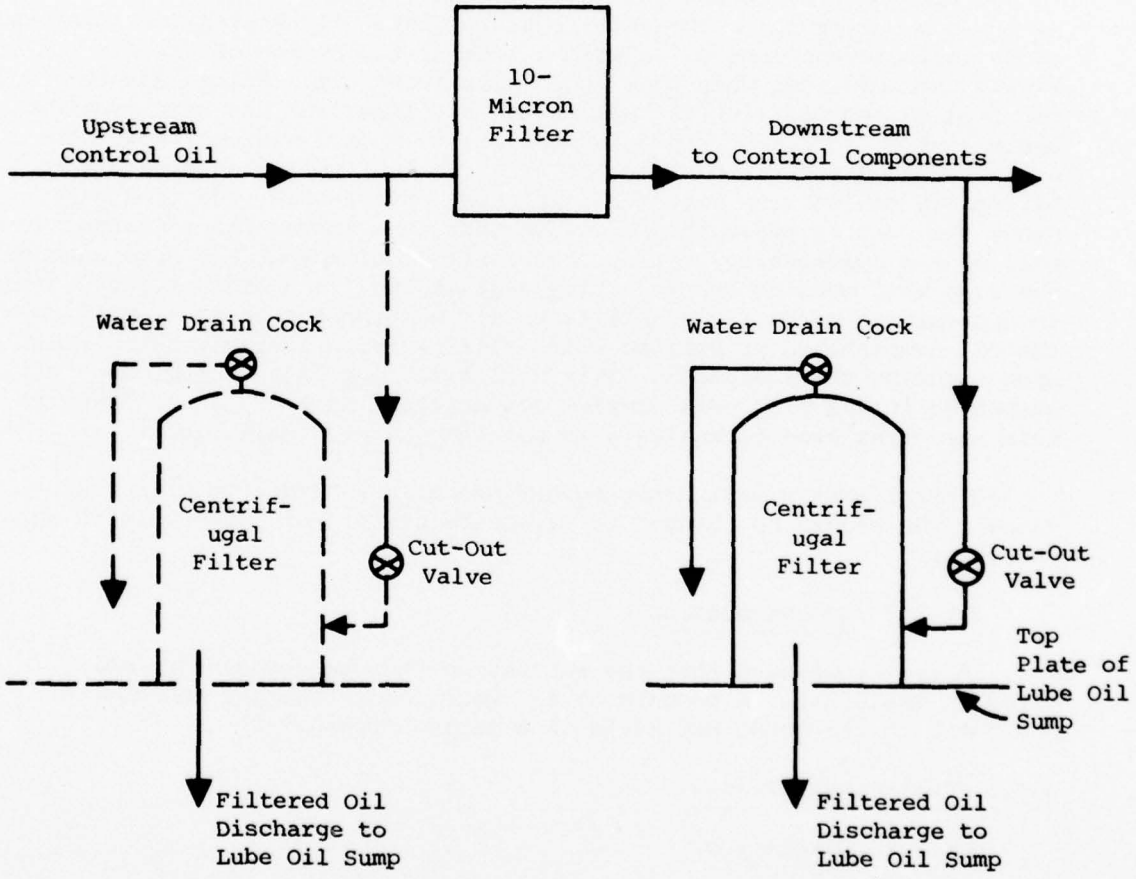
3.6.2.2 Recommendation

It is recommended that the entries on MRCs be changed as indicated in Table 3-2. A summary of all recommended changes to MRCs is presented in the DDEOC MRC Evaluation table, Appendix D.

3.6.3 Centrifugal Filter

3.6.3.1 Discussion

The centrifugal filter is designed to separate water and solids from the lubrication and control oil system. On the two ships visited, the filter was found to be installed in the two locations shown in Figure 3-3. Ship Alteration DDG-37-1213D authorizes the relocation of the "Weatherhead" centrifugal filter in the control oil system to a point upstream of the 10-micron filter. The stated purpose of this ShipAlt is to extend the replacement cycle of the 10-micron filter cartridges. Contrary to the intent of the ShipAlt, the position of the centrifugal filter either before



a. Upstream - ShipAlt DDG-37-1213D Configuration (some ships are already configured with this ShipAlt)

b. Downstream - Present Configuration

Figure 3-3. UPSTREAM VS. DOWNSTREAM LOCATION, CENTRIFUGAL FILTER

or after the 10-micron filter will have no impact on the replacement frequency of the 10-micron filter element. Referring to Figure 3-3, the centrifugal filter is designed to discharge to a sump or reservoir. With the centrifugal filter downstream, oil enters the 10-micron filter direct from the main lube oil pump at about 85 psi. There is a slight pressure drop through the 10-micron filter, depending upon its cleanliness. This oil then passes in one branch to the control devices (including the actuator) and in another branch to the centrifugal filter. The centrifugal filter uses two reaction nozzles to derive its rotation. The discharges from those nozzles are to the rotating bowl of the filter and then to the sump, at a rate of about 2 gallons per minute. When in operation, this centrifugal filter will cause a very slight pressure drop between the 10-micron filter and the other control devices. If the centrifugal filter is mounted upstream of the 10-micron filter, this slight pressure drop will occur before the 10-micron filter. Because of the lube oil pump's capacity, however, the pressure drop may not be as much. In either location the oil from the centrifugal filter discharges directly to the sump, and the oil to the 10-micron filter inlet comes directly from the sump via the main lube oil pump and regulating valve. The quality of the oil in the sump is a function of many factors, including the length of time the centrifugal filter has operated but not of the centrifugal filter's location. Thus there is no reason to move the centrifugal filter from its present location, wherever installed in the lubrication and control oil system.

On one ship visited, the centrifugal filters were secured and not utilized. On the other ship, they were utilized but there was no record or recollection of the last time they were cleaned. PMS requirements are to clean these centrifugal filters every 500 hours of operation. A hard-time calendar requirement (e.g., quarterly) would establish greater visibility for the cleaning requirement of this filter.

On both ships visited a pipe plug was installed in place of the water drain cock. The operators stated that the filters had not been used to separate water from the system. In summary, although not a source of contamination, the centrifugal filters are not being used as intended in the SSTG lube oil and control oil system.

3.6.3.2 Recommendations

The following actions are recommended:

- ShipAlt DDG-37-1213D should be cancelled.
- Water drain cocks should be installed and the filters utilized.
- MRC 17 L41K N should be changed to indicate that cleaning of the filter is to be accomplished quarterly or every 500 hours of operation, whichever occurs first.

3.6.4 Main Lube Oil Pump

3.6.4.1 Discussion

The main lube oil pump ball bearing has experienced a high usage rate. Of the six ships which used this bearing, the usage rate was an average of 75 percent of the total population within the first year after overhaul. In the first year and a half, that percentage increased to 121 percent. Overall, the usage rate is 186.1 percent.

The high failure rate of this bearing has been attributed by the pump manufacturer to excessive thrust forces from the pump power rotor. A modification kit has been provided by the manufacturer to alleviate this problem. ShipAlt DDG-37-1281D installs this modification kit on the SSTG main lube oil pump. The ShipAlt is intended to reduce the axial load on the power rotor ball bearing by adding a balance piston arrangement to eliminate most of the rotor thrust created by the pressure differential on the inlet and outlet ends of the rotor. This will improve the reliability of the main lube oil pump but to an unknown extent. This analysis indicates that the failure of the main lube oil pump ball bearing may more likely be a result of using both unstrained or unfiltered oil directly from the sump (see Figure 3-4). For example, any contamination in the sump, flushed from any part of the lube oil system, can presently pass around or through the main lube oil pump bearing and cause that bearing to fail. A significant number of these bearings have failed either after major maintenance or initial SSTG installation, a period when lube oil is commonly contaminated from flushing the system of particles that have entered the open lubrication and control oil system.

As of this time, there is no evidence to indicate the degree of success of the above-mentioned modification kit. Although this modification will remove the bearing from its present location directly in the pump oil flow discharge, it will continue to use unstrained and unfiltered oil direct from the sump for lubrication of the bearing. After installation of the modification kit, the failure rate of this bearing should be closely monitored until such time as an acceptable improvement is noted. When possible, failed bearings should be obtained and analyzed to determine the actual cause of failure. Should a high failure rate of this bearing continue, further modification of the SSTG main lube oil pump may be necessary to isolate its bearing from the unstrained oil and provide it with filtered or strained and cooled oil.

The accessory drive ball bearing supporting the upper end of the main lube oil pump drive shaft (see Figure 3-4) has a replacement ratio of 55.6. Figure 3-1 shows that 15 of the 20 ball bearings were used within a period of less than 6 months after either a conversion, post-shakedown availability, or overhaul. Fourteen of those same 20 bearings were used concurrently (in the same quarter and on the same ship) with the main lube oil pump bearing. A reasonable assumption is that this bearing fails or is damaged as a result of high loads (both axial and radial) incurred when

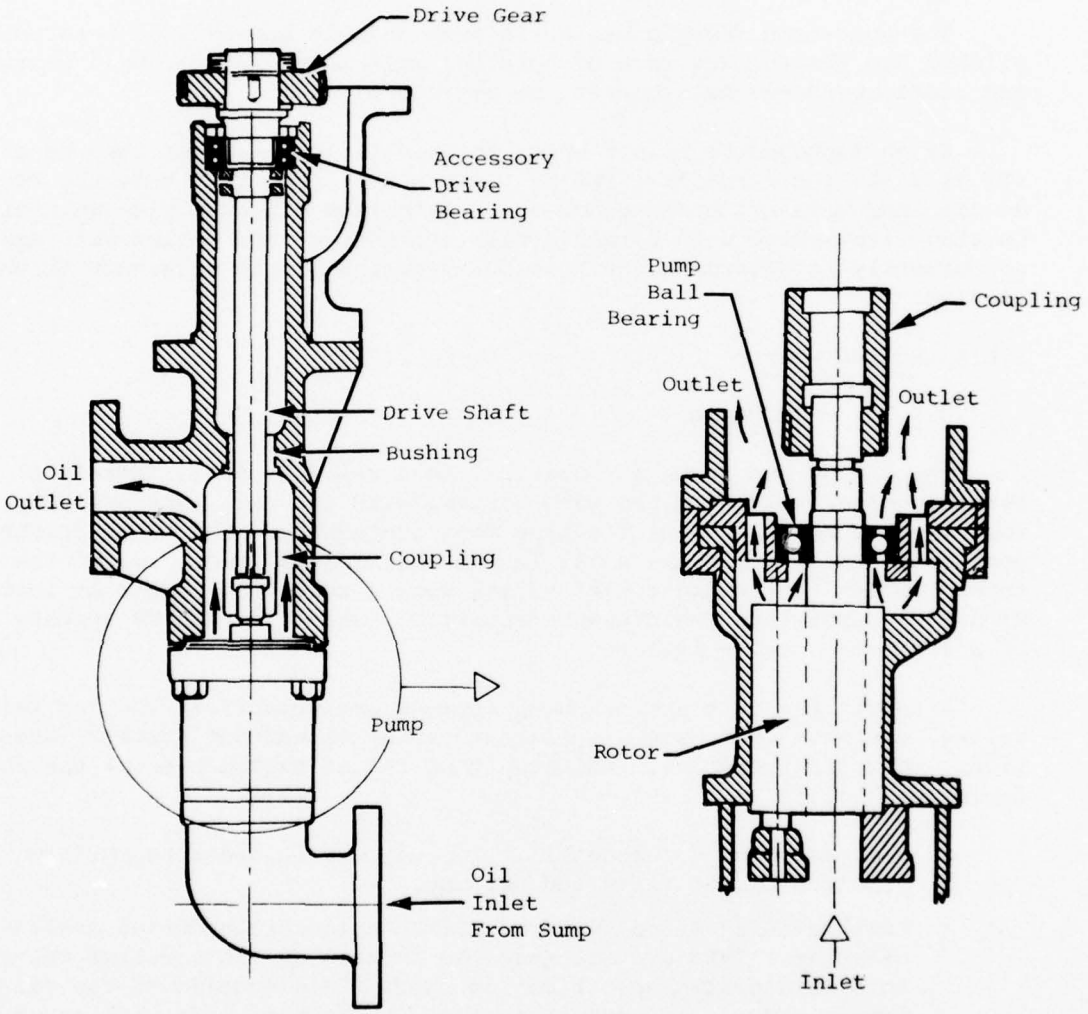


Figure 3-4. MAIN LUBE OIL PUMP (BEFORE MODIFICATION)

the pump bearing fails. Personnel on one ship visited stated that a recent pump bearing failure had caused the pump rotors to seize, which then caused the drive shaft to shear. In such cases, good maintenance practice would require replacement of the accessory drive bearing. The conclusion is that this bearing generally is, and should be, replaced concurrently with replacement of the main lube oil pump bearing.

3.6.4.2 Recommendations

The near-term recommendation is that ShipAlt DDG-37 1281-D be accomplished and the failure rate of both the main lube oil pump ball bearing and accessory drive ball bearing be monitored.

If an improvement is not noted in this failure rate at the end of one year for the first five DDG-37 Class ships completing BOH, the recommended long-term action is to design a main lube oil pump with an isolated bearing (lubricated with either grease or filtered and cooled oil) and concurrently to determine the need for redesign of the accessory drive bearing.

3.6.5 Relief Valves

3.6.5.1 Discussion

The fifth item shown in Table 3-1 is a relief valve. There are several relief valves in the SSTG System, with the main lube oil pump relief valve being the one reported most frequently. The three CASREPs concerning relief valves are all lube oil system-related. Two of the three CASREPs concerning relief valves were a result of incorrect installation by a depot-level maintenance activity. The third CASREP appears to be a legitimate valve failure.

Although the cost and man-hour burdens are relatively low for relief valves, the man-hours were significant enough to warrant further investigation. Operating personnel indicated that relief valves present the following problems:

- Some are nearly inaccessible for removal in order to perform required cyclic tests and setting.
- Calibrated/reset valves are difficult to obtain during availabilities. IMAs are not required to test or set a relief valve to a SSTG system specification that falls outside of the valve's design range. In such cases the ship is then left with an uncalibrated relief valve. Either a new valve within specifications should be procured or the old valve determined to be suitable and then calibrated. It appears that the installing shipyard used valves that did not precisely meet required specifications but nonetheless fulfill the job. This assumption is substantiated by the many variations of relief valves noted in Table A-1, Appendix A. Several of the valves indicated to be used in the system

did not directly correspond to a relief valve for the system as specified in its Technical Manual.

3.6.5.2 Recommendations

It is recommended that, when an out-of-specification relief valve is found to be installed in an SSTG System and an IMA will not calibrate it, the ship and an IMA jointly determine whether continued usage of that valve is in order. If such usage is not in order, a new valve having an operating range within the system specification should be procured at the earliest possible opportunity. If continued use of the valve is in order, all relevant facts should be documented to preclude future calibration delays.

It is further recommended that the accessibility of the relief valves be investigated; and, where advisable and feasible, they be relocated during BOH.

CHAPTER FOUR

CONCLUSIONS AND RECOMMENDATIONS

4.1 CONCLUSIONS

Two chronic problems are associated with the SSTG System of DDG-37 Class ships:

- Bearing failures in the main lube oil pump
- Erratic governor control caused by malfunction of the Woodward EG-3P actuator

These problems are traceable to two major design weaknesses in the SSTG System:

- The main lube oil pump bearing (ball bearing) is improperly lubricated.
- The control oil filtering system is inadequate for the required task.

Once these design weaknesses are rectified, some SSTG components will require corrective maintenance during the operating cycle, but accomplishing major preventive maintenance at fixed intracycle intervals is not warranted. A run-to-failure maintenance strategy is adequate.

Components of the DDG-37 Class SSTG System are capable of operating throughout an extended (54 ± 6 months) operating cycle without major restorative maintenance. Some scheduled major restorative maintenance will be required during BOH and ROH.

4.2 RECOMMENDATIONS

Actions and planning activities identified by the SSTG 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

The recommendations that follow will address each of the above categories.

4.2.1 Baseline Overhaul (BOH) Repair Requirements and ShipAlt Requirements

The Review of Experience for the DDG-37 Class SSTG System does not substantiate that block overhaul of the system components is warranted during BOH beyond the minimum restorative maintenance indicated below. During BOH, accomplish only those repairs and preventive maintenance on the SSTG as required by the Current Ships Maintenance Project (CSMP) and POT&I. In addition, for BOH, accomplish as a minimum the restorative maintenance indicated in Table 4-1. Where indicated in Table 4-1, maintenance should be accomplished in accordance with Technical Repair Standards 0311-86-600 and 0311-86-601 (the latter is to be issued August 1978).

The minimum restorative maintenance is recommended on the basis of historical repair profiles, 1200 psi improvement program recommendations, and PEB/LOE recurring discrepancies. Tests of the SSTG System should be conducted in accordance with the 1200 psi Test Procedure No. 311-310-C0022.

Two of the three ShipAlts applicable to the SSTG System should be accomplished not later than BOH. They are:

- DDG-37-1226K -- Replace main generator and bus-tie circuit breakers
- DDG-37-1281D -- Install mod kit on SSTG main lube oil pump

The third ShipAlt applicable to the class, DDG-37-1213D, concerns relocation of the Weatherhead centrifugal filter. That ShipAlt should be cancelled.

4.2.2 Recommended Intracycle Maintenance Strategy

There are no major problems in the DDG-37 SSTG System that indicate excessive or unusual maintenance requirements other than those major design weaknesses discussed in Section 4.1. Other minor problems, many of which are noted in this Review of Experience, can be expected to occur during an extended operating cycle at random and infrequent intervals, at which time corrective maintenance can be accomplished. Therefore, the

Table 4-1. MINIMUM BASELINE OVERHAUL, REGULAR OVERHAUL, AND SHIPALT REQUIREMENTS

SWBS	Equipment, Component, and Subsystem	Recommended Minimum Repair Action
311	SSTG Generators	Accomplish the following minimum repairs: (1) Slip rings – polish (2) Brush holders – clean (3) Brushes – replace (4) Stator – clean on ship (5) Meters – calibrate
311	SSTG Turbines	Accomplish the following minimum repairs: (1) Control system (governors, actuators and steam admission valves), overhaul in accordance with TRS No. 0311-086-601.* (TRS 0311-086-601 to be issued August 1978.) Note: Woodward governor components are to be repaired by Woodward Governor Company.* (2) Thrust – set (3) Overspeed trip – reset (4) PM Alternator – Class B Overhaul* (5) Throttle valves and steam strainers – Class B Overhaul**
341	SSTG Lube Oil System Main, Auxiliary, and Hand-Operated Lube Oil Pumps	(1) Class B Overhaul hand-operated pumps. (2) Class B Overhaul auxiliary lube oil pump, motor and controller. (3) Accomplish ShipAlt DDG-37-1281-D, SSTG Lube Oil Pump Modification Kit.** If accomplished, Class B Overhaul SSTG main lube oil pump.
341	Duplex Strainer	Class B Overhaul. Includes coolers, bypass valve, relief valve, and vent valves. Hydro-test coolers.**
341	Lube Oil Piping	Install proper face flanges in SSTG lube oil piping system.** Note: The above is a PEB item for accomplishment during BOH.
311	Main Generator and Bus-Tie Circuit Breakers	Accomplish ShipAlt DDG-37-1226K; parallel operation of all Ships Service Turbine Generators.** Modify the existing switchboard bus to accommodate the additional distribution cabinet and to sustain the increase in fault current to 100,000 amperes.
311	Calibration and Testing	Clean and calibrate approximately 48 gages and 36 thermometers prior to testing SSTG.** Ensure installation of vent, drain, and gage cut-out valves and fittings for SSTGs IAW prescribed plans.** Conduct regulation and parallel testing of all generators. Test results will ascertain adjustments needed on the voltage and frequency regulators and any additional repairs required.** Test in accordance with 1200 PSI Test Procedure, No. 311-310-C0022.

*Denotes change to DDG-37 Baseline Overhaul SARP.
**Denotes addition to DDG-37 Baseline Overhaul SARP.

intracycle maintenance requirements should continue to be accomplishing PMS with modifications as noted in PMS system changes, Subsection 4.2.4.

Corrective maintenance should be performed as required at the organizational level, supported by an IMA or depot as necessary.

4.2.3 Follow-On Regular Overhaul Requirements

For follow-on ROH, accomplish repairs and overhaul the SSTG as required by the CSMP and POT&I. The requirements (less ShipAlts) indicated in Table 4-1 are recommended as the minimum for Regular Overhaul restorative maintenance.

4.2.4 PMS Changes

The maintenance strategy expressed within Maintenance Index Pages E-13/171-17 for the SSTG turbine and EL-7/100-60 for the generator is considered adequate, with some minor changes recommended concerning frequency and notes of caution added regarding lube oil and control oil. The recommended changes to frequency of maintenance are indicated in the DDEOC MRC Evaluation table, Appendix D, and apply only to the turbine MIP. There are no changes recommended for the generator.

With the recommended changes incorporated, the current PMS requirements are considered adequate for maintaining the SSTG System throughout an extended operating cycle.

4.2.5 Reliability and Maintainability Improvements

Strict lube oil and control oil system maintenance procedures by all activities that have direct contact with the SSTG components is essential. Knowledge of the lube oil and control oil systems and the probable points of entry for contamination is essential prior to opening these systems for preventive or corrective maintenance. Elimination of casual points of entry for contamination should be accomplished wherever cost effective.

4.2.6 IMA Improvements

Emphasize the need for strict contamination control during lube oil and control oil system maintenance in accordance with the recommendations of this report.

4.2.7 Depot-Level Improvements

Emphasize the need for strict contamination control during lube oil and control oil system maintenance in accordance with the recommendations of this report.

4.2.8 Integrated Logistics Support Improvements

The present SSTG Technical Manual is being rewritten. A draft of the revised version was not available for review during this analysis. As a minimum, the revised manual should contain the following modifications:

- Figure 10-9 of the old manual, showing the oil system schematic, should be revised to accurately show the control oil system, the main lube oil pump bearing, and the centrifugal filter.
- The speed control governor section should be revised to show details of the actuator and control oil system and to provide troubleshooting and repair procedures in sufficient detail for Ship's Force personnel to effect repairs within the capability of their skills and repair equipment.
- The nomenclature for the EG-3P actuator should be made more precise (i.e., "EG-3P with oil motor" and NOT "with oil pump").
- Remove ambiguity in APL 701110322 showing the "actuator" listed twice with two different NSNs.

4.3 ADDITIONAL RECOMMENDATIONS

Further recommendations resulting from this study are as follows:

- Implement an educational effort to upgrade fleet personnel knowledge regarding ball bearing lubrication, lube oil and control oil maintenance, and techniques to avoid casual contamination in oil systems.
- Support a general upgrade of shipboard equipment and personnel skills required to replace ball bearings. Provide ships with bearing heater ovens for proper initial installation of ball bearings.

4.4 LISTINGS OF RECOMMENDATIONS

Specific recommendations of this ROE are summarized in Table 4-2. A detailed listing of recommended PMS changes is included in the DDEOC MRC Evaluation table of Appendix D. All recommended solutions to component problems and requirements for BOH, intracycle maintenance, and follow-on ROH are listed in the DDEOC Action Table of Appendix E.

Table 4-2. SUMMARY OF RECOMMENDED ACTIONS, DDG-37 CLASS SSTG SYSTEM

Component	Recommendation
Baseline Overhaul Requirements and ShipAlt Requirements	
1. SSTG, All Components	Accomplish those repairs and restorative maintenance on the SSTG as required by CSMP and POT&I. Accomplish as a minimum the restorative maintenance indicated in Table 4-1 of this report. Accomplish repairs in accordance with TRSs 0311-86-600 and 0311-86-601 only where indicated in Table 4-1.
2. ShipAlts	Accomplish two of three outstanding ShipAlts: DDG-37-1226K, Replace bus-tie circuit breakers. DDG-37-1281D, Install mod kit on SSTG Main Lube Oil Pump. Cancel ShipAlt DDG-37-1213D; relocate centrifugal filter.
Intracycle Maintenance Strategy	
1. SSTG, All Components	Accomplish PMS in accordance with requirements as modified by recommendations indicated in DDEOC MRC Evaluation Table, Appendix D. Perform corrective maintenance at the organizational level supported by an IMA or depot as necessary.
2. Relief Valves	When relief valves, submitted for cyclic tests, are found to be used in an out of specification installation, IMA and ship jointly confirm and document future usability, or replace if required.
Follow-On Requirements	
1. SSTG, All Components	Accomplish repairs or overhaul the SSTG as required by CSMP and POT&I. The requirements (less ShipAlts) indicated in Table 4-1 are recommended as minimum for ROH restorative maintenance.
Planned Maintenance System Changes	
	(Detailed changes are listed in Table D-1, DDEOC MRC Evaluation Table of Appendix D)
1. Lube Oil and Control Oil Systems	Change periodicity of purification of SSTG lube oil from monthly to weekly.
2. Flexible Coupling	Periodicity designation of the flexible coupling inspection is changed from C-2 to 36M-1 (this preserves present frequency).
3. Duplex Strainer	Change to periodicity of cleaning duplex strainers adds situation requirements for the first day after light-off and for the first two days after bearing repairs have been accomplished.
4. Centrifugal Filter	Change to periodicity of cleaning the centrifugal filter adds quarterly requirement in addition to situation requirement.
5. Various Components of SSTG	Caution added not to use hand oil pump except in event of actual emergency. Encourage draining SSTG sump while oil is warm. Draw sample of oil for laboratory analysis prior to purification and cleaning sump. Preferred source of refill oil for SSTG is storage tank and not settling tank. Recommends accomplishing quarterly inspection of reduction gear just prior to cleaning lube oil sump. Cautions to ensure control oil 10-micron filter is well drained before opening and that extreme caution be used to ensure that no contamination enters control oil system when filter is open.

(continued)

Table 4-2. (continued)

Component	Recommendation
Reliability and Maintainability	
1. SSTG Main Lube Oil Pump	Investigate further modifications of SSTG Main Lube Oil Pump to provide strained and/or filtered oil to the pump bearing.
2. Control Oil Hand Pump	Investigate modification to control oil system to eliminate unfiltered oil supply to servomotor and actuator via hand pump.
3. Strained Control Oil	Investigate modification to lube oil/control oil system to strain all oil in duplex strainer.
4. Duplex Strainer and Cooler	Investigate modification to relocate duplex strainer and cooler to a more accessible location and to reduce requirements for removal and opening of piping for access to SSTG components.
5. 10 Micron Filter	Investigate necessity for bypass relief valve in 10-micron filter. Remove and plug if not required.
6. Control Oil Maintenance	Emphasize requirement to all maintenance levels that control oil must be maintained free from contamination.
7. In-Line Filters	Investigate use of in-line wire mesh filters as "last chance" filters in control oil lines.
8. Gaskets	Replace spiral wound gaskets in lube oil and control oil system flanges with 1/32-inch gasket material, symbol 2290. Reface flanges where required.
9. Centrifugal Filters	Reinstall water drain cocks on centrifugal filters where they have been removed. Operators should utilize these filters in accordance with operating instructions provided in the SSTG Technical Manual.
IMA Improvements	
1. Control Oil Maintenance	Emphasize need for strict lube oil and control oil system maintenance procedures to avoid contamination.
Depot-Level Improvements	
1. Control Oil Maintenance	Emphasize need for strict lube oil and control oil systems maintenance procedures to avoid contamination.
Integrated Logistics Support Improvements	
1. Technical Manual Rewrite	Ensure that adequate and accurate text and figures are included in the Technical Manual for the DDG-37 Class SSTG, which is now being rewritten. Particular attention should be given to providing troubleshooting and repair procedures for the Speed Control Governor System.
2. EG-3P Actuator with Oil Motor	Ensure that precise description of actuator is used, i.e., EG-3P with oil motor and not EG-3P with oil pump. Remove ambiguity in APL 701110322.
3. Ball Bearings, Lube Oil Maintenance	Support educational effort to upgrade fleet personnel knowledge regarding ball bearing lubrication and lube oil maintenance and techniques to avoid casual contamination in oil systems.
4. Bearing Installation and Lubrication	Support general upgrade of shipboard equipment and personnel skills required to replace ball bearing. Provide Ship's Force with ball bearing heater ovens.

LIST OF REFERENCES

The following selected references were used as a basis for the Review of Experience of the Ships Service Turbine Generator System.

1. NAVSHIPS SIB-SLB-9-1 N.S. 0905-475-4010, *Ship Information Book, USS COONTZ (DLG-9) (DDG-40).*

2. NAVSHIPS 0961-033-3010, *Technical Manual, DeLaval 1000 KW Ships Service Turbine Generators (being revised).*

3. NAVSEA 0941-LP-053-6080, *1200 PSI Propulsion Plant Test and Certification Manual, DDG-37 Class.*

4. NAVSEA 0900-LP-060-2010 (Revision 1), *Technical Manual, Electrical Machinery Repair, Volume I, Electric Motor Repairs.*

5. NAVSEA Index of Cruiser/Destroyer Technical Repair Standards, August 1975 (TRS 0311-086-600).

6. PERA(CRUDES) PHILANAVSHIPYD, 30 June 1977, *Ship Alteration Information Manual.*

7. PERA(CRUDES) Index of Cruiser/Destroyer Technical Repair Standards, August 1976.

8. Naval Ships' Technical Manual, various chapters.

9. OPNAVINST 4790.4, *Ship's Material Maintenance Management Manual (3-M),* Volumes I-III, 1 June 1973.

10. Generation IV MDS Part and Maintenance Data for DDG-37 Class, 1 January 1970 through 30 October 1976.

11. CASREPs for DDG-37 Class, 1 July 1973 through 30 June 1976.

12. Engineering Operational Procedures (EOP) for DDG-40.

13. CNSL CSMP Report 1, 22 February 1978, *Alteration Management System, Alteration Status Matrix.*

14. Maintenance Index Pages (MIPs) and Maintenance Requirement Cards (MRCs) for DDG-37 Class Ships Service Turbine Generator components.

15. Type Commander's COSAL, SURFLANT (28 April 1976) and SURFPAC (23 June 1976).

16. Ship Alteration and Repair Packages (SARPs) for DDG-37, -38, -40, -43, -45, and -46.

17. Depot-level Departure Reports for DDG-37 Class.

18. DDEOC repair requirements for BOH of DDG-37 Class.

19. Allowance Parts List (APLs) for selected components of the Ships Service Turbine Generator System.

20. Trip Report (14, 15 March 1978); ARINC Research Corporation visit to:

    COMNAVSURFLANT
    USS PRATT (DDG-44)
    USS MAHAN (DDG-42)

21. Woodward Bulletin 825608, *EG-3P Actuator*, Woodward Governor Company, Ft. Collins, Colorado.

APPENDIX A

BOUNDARIES OF SHIPS SERVICE TURBINE GENERATOR SYSTEM

The 1000-kW Ships Service Turbine Generator System discussed in this report consists of the components listed in Table A-1. The table also lists APL numbers and APL quantities per ship. In developing this table, an attempt was made to resolve inconsistencies among Type Commander's COSAL and MDS reporting data, but all such inconsistencies could not be resolved. This configuration is the best estimate from all available data sources. Note that the Steam Seal and Drain System, the Condenser, and the Air Ejectors are not included in this report.

Figure A-1 is a system diagram of the SSTG.

Table A-1. COMPONENTS OF SSTG SYSTEM

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
SHIPS SERVICE TURBINE ELECTRIC GENERATOR*													
TURBINE STM GEN 1000 KW	311	310C	057150225	4	4	4	4	4	4	4	4	4	4
COOLER FD 36.0 SQ FT CLG SUR	341	310D	030300091	4	4	4	4	4	4	4	4	4	4
COOLER FD 609 SQ FT CLG SUR	311	310C	032180024	4	4	4	4	4	4	4	4	4	4
PUMP RTY PWR 35 GPM 80 PSI ATT	341	310D	016160562	4	4	4	4	4	4	4	4	4	4
PUMP RTY PWR 18 GPM 85 PSI MD			016160567	4	4	4	4	4	4	4	4	4	4
PUMP RTY PWR 18 GPM MD			016160973				1						
PUMP RTY HND 0.75 x 0.75 9.5 GPM 75 RPM			017920008	4	4	4	4	4	4	4	4	4	4
STARTER MTR SZ Ø			151403043	Precise configuration data unavailable.									
STARTER MTR SZ 1			151901105										
STARTER MTR SZ 1			151903721										
MOTOR AC 440V 2HP 3485 RPM			174752283	4	4	4	4	4	4	4	4	4	4
COUPLING SHFT FLEX MAX BORE .750			780130001	4	4	4	4	4	4	4	4	4	4
BEARING ASSY THR PVT SGMT DBL 5.00 x 5.00	311	310C	370010289	4	4	4	4	4	4	4	4	4	4
BEARING ASSY THR PVT SGMT DBL 5.00 x 5.00			370010304	4	4	4	4	4	4	4	4	4	4
PRECIPITATOR ELCTSTC	341	310D	480790022	4	4	4	4	4	4	4	4	4	4
FILTER FD PRESS			481160008	4		4		4	4		2	4	4
FILTER FD PRESS			481550001		4		4			4	2		
FILTER FD PRESS			481550006			4							
GOVERNOR ELEC TURB*	311	310C	701110322	4	4	4	4	4	4	4	4	4	4
VALVE TRP THRTL W/OIL CYL 3.00 IN			883000332	4	4	4	4	4	4	4	4	4	4
STRAINER 3.00 IN			754880030	4	4	4	4	4	4	4	4	4	4
VALVE CHK LFT GLB 1.00 IPS 600 PSI			882033147	4	4		4			4	4	4	4
VALVE GLB 1.00 IPS 600 PSI			882056013	8								8	8
VALVE RELF 4.00 x 5.00 IPS			883112753	4	4	4	4	4	4	4	4	4	4
VALVE RELF 1.50 IPS 5 to 10 PSI	341	310D	883114075	4				4	4			4	4

*Critical Equipment List Item

(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
VALVE RELF 1.50 IPS 50 to 70 PSI	341	310D	883114076	4		4		4	4			4	4
VALVE RELF 1.50 IPS 100 to 130 PSI			883114077	4	4	4	4	4	4	4	4	4	4
VALVE RELF 1.00 IPS 21 to 30 PSI			882111549					4	4				
VALVE RELF 1.00 IPS 50 to 70 PSI			883114074	4				4	4			4	4
SWITCH SLR			212100411	4								4	
SWITCH RTY			212900877	2									
SWITCH PRESS 0-15 LBS			219990132		4		4					4	
SWITCH PRESS 1-15 LBS			610010641						4				
LIGHT IND			239990043		2	2	2		4	2	2	2	
LIGHT ASSY IND	▼	▼	249990180		2		2			2	2	2	
MOTOR GENERATOR 26V	311	310C	182890010	4	4	4	4	4	4	4	4	4	4
GENERATOR AC 450V 1000 KW 1200 RPM			161340005	4	4	4	4	4	4	4	4	4	4
REGULATOR V & EXCIN SYS			420320023	4	4	4	4	4	4	4	4	4	4
PANEL PWR DISTRN C-5336			502070009	2	2	2	2	2	2	2	2	2	2
PANEL GEN SYNCH	▼	▼	503420004	4	2	2	2	4	4	2	2	2	2

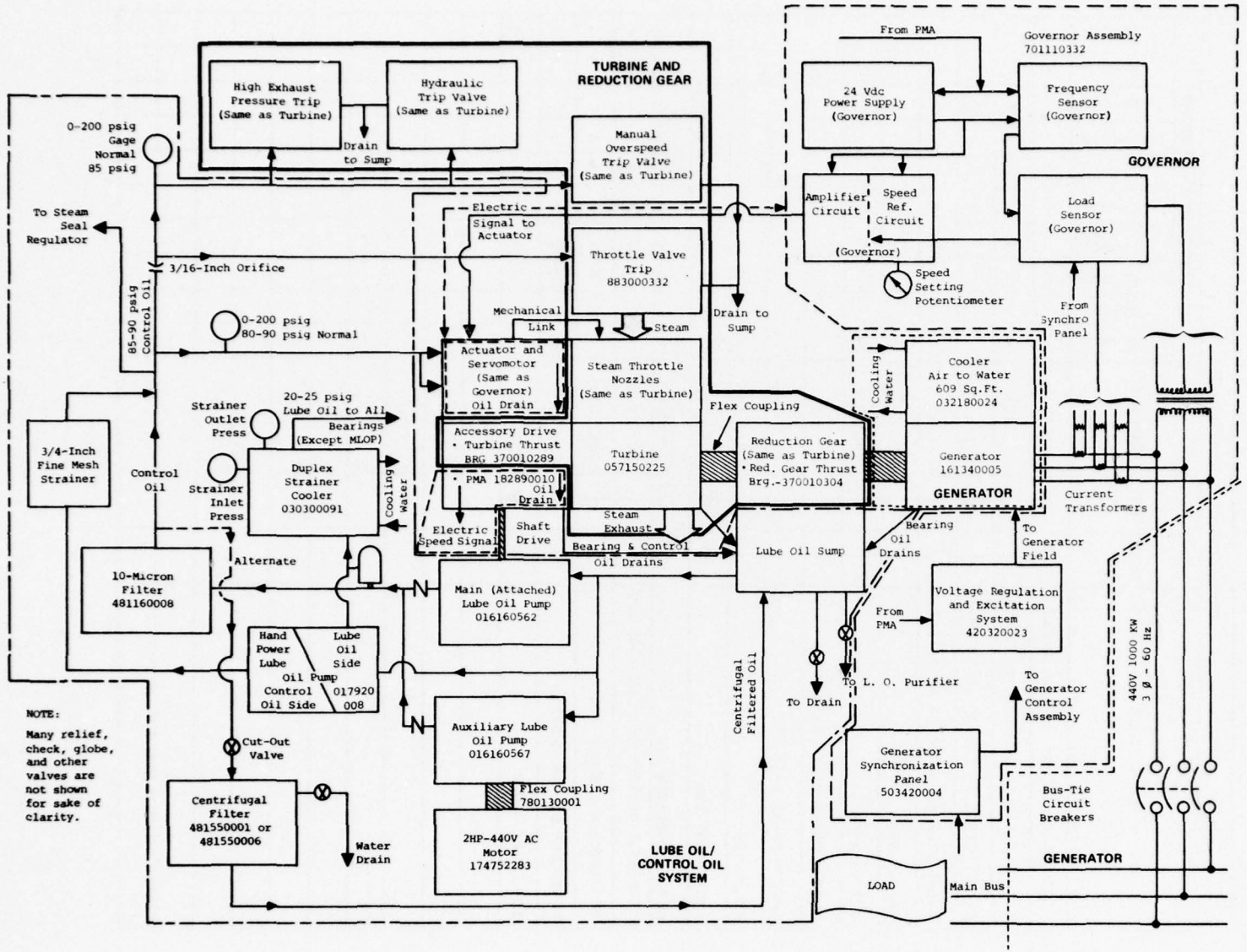


Figure A-1. DIAGRAM OF DDG-37 CLASS SSTG SYSTEM

APPENDIX B

MDS PART USAGE SUMMARY

Table B-1 identifies parts used by two or more ships of the DDG-37 Class SSTG System. Two exceptions are listed that had a unit-of-issue cost greater than one thousand dollars. Only nine ships are applicable since DDG-41 was not included in the data base.

Table B-1. PARTS USAGE FOR SSTG SYSTEM, DDG-37 CLASS SHIPS

Part Identification		Cost Per Unit (Dollars)	Quantity Per Component	Total Part Population	Number Replaced	Ratio (x100) of Parts Replaced to Total Population	Number of Ships Reported
NSN	Nomenclature						
Turbine and Reduction Gear							
1H 2825-082-1034	Packing Assembly	237.00	2 AY	72	5	6.9	3
9Z 3110-156-7897	Bearing (Oil Pump Drive Assy.)	5.26	1 EA	36	20	55.6	5
2H 2825-466-0365	Bearing	2076.75	1 AY	36	5	13.9	3
2H 2825-466-0366	Bearing	2530.00	1 AY	36	2	5.6	1
9G 6680-527-6255	Window - Observation	1.30	12 EA	432	63	14.6	4
Generator							
9G 5977-848-5196	Brush - Electric	2.15	4 EA	144	197	136.8	6
9G 6115-471-3402	Alternator	1175.00	1 EA	36	1	2.8	1
Governor							
2H 2990-250-8744 2H 2990-451-0466	Actuator	977.75	1 AY	36	16	44.4	7
9Z 3120-760-5707	Bushing	455.00	1 EA	36	2	5.6	2
9C 4730-947-5807	Filter (10 Micron Element)	6.23	1 EA	36	225	625.0	7
9C 2990-245-1101	Sensor (Loading)	222.71	1 AY	36	7	19.4	5
1H 5999-250-8747	Sensor (Frequency)	173.57	1 AY	36	8	22.2	4
1H 6110-522-6410	Amplifier (Gov. System)	336.63	1 AY	36	12	33.3	5
Lubrication and Control Oil							
9Z 3110-155-6198	Bearing (Main L.O. Pump)	1.80	1 EA	36	67	186.1	6
9Z 5340 664-2753	Ring - Ret (Main L.O. Pump)	0.07	1 EA	36	75	208.3	4
9C 4320-764-6501	Housing (Main L.O. Pump)	312.40	1 EA	36	10	27.8	3
9C 4320-764-6505	Rotor, Power	347.27	1 EA	36	11	30.6	4
9C 4320-773-7106	Rotor, Idler	266.29	2 AY	72	25	34.7	4
9Z 5340-737-0329	Spacer (Special)	45.00	1 EA	36	13	36.1	3
9Z 5340-804-7697	Ring - Ret. (Main L.O. Pump)	0.10	1 EA	36	40	111.1	5
9Z 3110-554-3238	Bearing (Aux. L.O. Pump)	1.33	1 EA	36	9	25.0	4

APPENDIX C

CASREP SUMMARY

Table C-1 summarizes categories of CASREPs reported for the Ships Service Turbine Generator System and lists the number of each category experienced by ships of the DDG-37 Class. The fractional CASREPs result from multiple problems listed under one CASREP. The problems have been apportioned under each functional subsystem.

Table C-1. CASREP ANALYSIS OF DDG-37 CLASS SSTG SYSTEM, POST-CONVERSION, 1 JULY 1973 TO 30 JUNE 1976

System, Subsystem, or Component	CASREPs Reported				Totals	Percent of Total	Number of Ships Reported
	C-1	C-2	C-3	C-4			
• Governor (General)		6	1		7	21	5
• Actuator		4		½	4½	14	4
• Frequency Sensor		2		½	2½	7	3
• Governor Tach Transformer		2			2	6	2
Governor Total		14	1	1	16	48	7
• Main Lube Oil Pump		4			4	12	2
• Auxiliary Lube Oil Pump			1		1	3	1
• Relief Valves		1	2		3	9	2
Lubrication and Control Oil Total		5	3		8	24	4
• Journal Bearings		¼	2	1	3¼	10	4
• Thrust Bearings		1¾			1¾	6	1
• Throttle Valve Linkage		2			2	4	1
Turbine and Reduction Gear Total		3½	2	1	6½	20	4
• Brushes and Slip Rings		1			1	3	1
• Insulation		½			½	2	1
• Oil Seals		1			1	3	1
Generator Total		2½			2½	8	3
Total of All Systems	-0-	25	6	2	33	100	8

Note: Fractional values indicate CASREPs that dealt with more than one functional problem.

APPENDIX D

DDEOC MRC EVALUATION

The DDEOC MRC Evaluation form in this appendix addresses the Maintenance Index Pages (MIPs) applicable to the Ships Service Turbine Generator System and lists the Maintenance Requirements Cards (MRCs) that should be modified and indicates where changes are needed.

The following is an explanation of the column headings:

- MRC Title - Description of maintenance specified by MRC
- MRC Number - Identification number of MRC
- Responsibility - Organizations responsible for change (if any)
- Current Status - Self-explanatory
- Man-Hours - Personnel time burden allotted to complete maintenance action
- Frequency - When the MRC maintenance action is to be performed, e.g., D = Daily, W = Weekly, M = Monthly, Q = Quarterly, S = Semiannually, A = Annually, C = Once Every Cycle, R = As Required
- Type - Perform maintenance (P), or survey material condition of components (S)
- Who Performs Test - Maintenance action or test to be performed by tender, or DDEOC site team, or Ship's Force personnel
- Where Performed - Self-explanatory
- Data - Indicates whether data are recorded during performance of maintenance action

DDEOC MRC EVALUATION

MRC TITLE	MRC NUMBER	RESPONSIBILITY		CURRENT STATUS			MAN-HOURS		FREQUENCY		
		NAVSEA	DDEOC	OLD WITH NO CHANGE	OLD WITH REVISION	NEW	PRE DDEOC M/H	POST DDEOC M/H	PRE DDEOC	POST DDEOC	P-S-
Test operate combination low lube oil pressure alarm and switch	T75 H31S N	X			X		0.6	0.6	M	M	
Purify lube oil	17 L39X N	X			X		4.0	4.0	M-3R	W-2R	
and											
Clean sump and purify oil	17 L39Y N	X			X		5.6	5.6	Q-1R	Q-1R	
Purify lube oil	17 L39X N	X			X		4.0	4.0	M-3R	W-2R	
Clean sump and purify oil	17 L39Y N	X			X		5.6	5.6	Q-1R	Q-1R	

*P = PERFORM MAINTENANCE; S = SURVEY INSPECTION

SHIP CLASS: DDG-37

SMA NO: 37-203-311

SYSTEM: SSTG

DEOC MRC EVALUATION

MAN-HOURS		FREQUENCY		TYPE*	WHO PERFORMS TEST			WHERE PERFORMED	DATA	REMARKS
RE DDEOC M/H	POST DDEOC M/H	PRE DDEOC	POST DDEOC	P-PERF. S-SURV.	TENDER	DDEOC	SHIP	I-IN PORT S-AT SEA	YES NO	
0.6	0.6	M	M	P			x	I/S	No	Add Caution: Do not operate hand lube oil pump except in event of actual casualty in which lube oil pressure drops below 4 psig at remote bearing while turbine is rotating. Change to Procedure 1.c is anticipated in accordance with NAVSEC SpdLtr 6145B/RK Serial 876 dated 3 Nov. 77. Lowers minimum pressures to 4 psig.
4.0	4.0	M-3R	W-2R	P			X	I/S	No	Add Note: This maintenance is best accomplished immediately upon securing SSTG while lube oil is still warm.
5.6	5.6	Q-1R	Q-1R	P			X	I/S	No	Add Note: The preferred source of oil to fill the sump is clean oil from a storage tank. Oil may be purified from a settling tank if no other source is available.
4.0	4.0	M-3R	W-2R	P			X	I/S	No	Change Procedures: 1.e, f, and k to read: e. Unlock and open storage or settling tank outlet valve. f. Operate purifier and purify oil from storage or settling tank to SSTG sump at 160 degrees Fahrenheit. k. Shut and lock storage tank or settling tank outlet valve and SSTG sump suction discharge valve.
5.6	5.6	Q-1R	Q-1R	P			X	I/S	No	Add Related Maintenance: Q-5. Add Note: Draw sample of lube oil for laboratory analysis prior to purification. Add Note: When scheduled, accomplish in conjunction with Q-5, Inspect Reduction Gears Change Procedure to Read: (Change M-3R to read W-2R where occurring.) After 1.c. add Caution: Exercise extreme care to avoid introduction of any contaminants into sump. Certain areas of the sump are inaccessible due to baffles. Change 1.j to Read: Purify oil from storage tank/settling tank as described on MRC W-2R.

MRC TITLE	MRC NUMBER	RESPONSIBILITY		CURRENT STATUS			MAN HOURS		FREQUENCY	
		NAVSEA	DDEOC	OLD WITH NO CHANGE	OLD WITH REVISION	NEW	PRE DDEOC M/H	POST DDEOC M/H	PRE DDEOC	POST DDEOC
Inspect Reduction Gears	17 L41A N	X			X		0.8	0.8	Q-5	Q-5
Renew control oil filter element	17 L41C N	X			X		1.0	1.0	Q-7	Q-7R
Inspect flexible coupling	84 E51V N	X			X		15.0	15.0	C-2	36M-1
Turn idle turbine shaft several revolutions	17 L41H N	X			X		0.4	0.4	R-4W	R-4W
Inspect and clean duplex lube oil strainer	17 L41J N	X			X		1.0	1.0	R-10	R-10
Clean and inspect centrifugal separator	17 L41K N	X			X		0.6	0.6	R-11	Q-8R

*P = PERFORM MAINTENANCE; S = SURVEY INSPECTION

SHIP CLASS: DDG-37
SMA NO: 37-203-311
SYSTEM: SSTG

EOC MRC EVALUATION

MAN HOURS		FREQUENCY		TYPE*	WHO PERFORMS TEST			WHERE PERFORMED	DATA	REMARKS
E DDEOC M/H	POST DDEOC M/H	PRE DDEOC	POST DDEOC	P-PERF. S-SURV.	TENDER	DDEOC	SHIP	I-IN PORT S-AT SEA	YES NO	
0.8	0.8	Q-5	Q-5	P			X	I/S	No	Add Related Maintenance: Q-1R. After Procedure 1.i add: Note: Accomplish Q-1R
1.0	1.0	Q-7	Q-7R	P			X	I/S	No	Add Note: Accomplish Quarterly or when control oil pressure drops to 75 psig, or whenever maintenance is performed in which contaminated oil is found, whichever occurs first. Add Caution: Exercise extreme caution to ensure no contaminants enter the control oil system as a result of opening this filter. Ensure the filter is well drained and has been empty for several minutes prior to opening filter and removing filter element. Do not use hand pump to prime system and test for leaks after changing filter element. Use auxiliary lube oil pump.
15.0	15.0	C-2	36M-1	P			X	I	Yes	Change frequency from cycle to 36M. This is a 6-month requirement in Technical Manual that has been extended to 36 months by current cycle. Further extension to 60-month DDEOC cycle is unwise.
0.4	0.4	R-4W	R-4W	P			X	I/S	No	Add Caution: Do not use hand lube oil pump to supply lube oil for this maintenance action. Change procedures by eliminating all reference to hand-operated lube oil pump.
1.0	1.0	R-10	R-10	P			X	I/S	No	Change Note 1 to read: Shift, inspect, and clean strainers as follows: a. Once every watch during the first 24 hours of operation; then once every 24 hours or when oil pressure drop across active strainer increases to 5 psi or as a result of lube oil inspection. b. When bearing repairs have just been accomplished, once every watch for the first 48 hours of operation; then as above.
0.6	0.6	R-11	Q-8R	P			X	I/S	No	Change Note 1 to read: Accomplish quarterly or after 500 hours of operation, whichever occurs first.

2

APPENDIX E

DDEOC ACTION TABLE

DDEOC action items are presented in the table of this appendix. The table is formatted to provide the implementation status of changes through completion of the Class Maintenance Plan and to serve as a ready reference to specific sections in Chapter Three that address in detail the problems involved.

DDEOC ACTION TABLE

1 ACTION ITEM *		2 DDEOC EVALUATION **	3 ACTION ITEM DESCRIPTION	4 REPORT REFERENCE (PARA.)	5 RESPONSIB
a. NO.	b. TITLE				
1.	BASELINE OVERHAUL REQUIREMENTS				
	a. SSTG, All Components		Accomplish repairs and restorative maintenance on the SSTG as required by CSMP and POT&I. Accomplish minimum Baseline Overhaul requirements as indicated by Table 4-1 of this report.	4.2.1	NAVSEA 9
	b. ShipAlts		Accomplish ShipAlts DDG-37-1226K, Replace Bus-Tie Cricuit Breakers; and DDG-37-1281D, Install Mod kit on SSTG Main Lube Oil Pump.	3.3.1, 3.6.4, 4.2.1	NAVSEA 9
2.	INTRACYCLE MAINTENANCE STRATEGY				
	a. SSTG, All Components		Accomplish PMS in accordance with existing requirements as modified by recommendations in Table 3-2 of this report.	3.6.2 and 4.2.2	TYCOM
	b. Relief Valves		IMA and ship jointly confirm and document usability of out-of-specification relief valves and replace SSTG system relief valves as needed.	3.6.5	TYCOM
3.	FOLLOW-ON REQUIREMENTS				
	SSTG, All Components		Accomplish repairs and restorative maintenance on the SSTG as required by CSMP and POT&I. Accomplish minimum requirements as indicated by Table 4-1 of this report.	4.2.3 and 4.2.1	NAVSEA 93
4.	PLANNED MAINTENANCE SYSTEM CHANGES				
	a. Lube Oil and Control Oil Systems		Change periodicity of purification of SSTG lube oil from monthly to weekly.	4.2.4 and 3.6.2	NAVSEA 04
	b. Flexible Coupling		Periodicity designation of the flexible coupling inspection is changed from C-2 to 36M-1 (this preserves present frequency).	3.3.1	NAVSEA 04 NAVSEC

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

** 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: 37-203-311

SYSTEM: SSTG

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
in- IP ie	4.2.1	NAVSEA 934					
lace ube	3.3.1, 3.6.4, 4.2.1	NAVSEA 934					
st- - t.	3.6.2 and 4.2.2	TYCOM					
ment ief	3.6.5	TYCOM					
y 1 of	4.2.3 and 4.2.1	NAVSEA 934					
	4.2.4 and 3.6.2	NAVSEA 046					
le -2	3.3.1	NAVSEA 046/ NAVSEC					

2.

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

DDEOC ACTION TABL

1 ACTION ITEM * a. NO.	b. TITLE	2 DDEOC EVALUATION **	3 ACTION ITEM DESCRIPTION	4 REPORT REFERENCE (PARA.)	5 RESP
4.	PLANNED MAINTENANCE SYSTEM CHANGES (continued)				
	c. Duplex Strainer		Change to periodicity of cleaning duplex strainers adds situation requirements for the first day after light-off and for the first two days after bearing repairs have been accomplished.	3.6.1.3	NAVSE
	d. Centrifugal Filter		Change to periodicity of cleaning the centrifugal filter adds quarterly requirement in addition to situation requirement.	3.6.3	NAVSE
	e. Various Components of SSTG		Caution added not to use hand oil pump except in event of actual emergency.	3.6.1.1	NAVSE
			Encourage draining SSTG sump while oil is warm.	3.6.2	NAVSE
			Draw sample of oil for laboratory analysis prior to purification and cleaning sump.	3.6.2	NAVSE
			Preferred sources of refill oil for SSTG is storage tank and not settling tank.	3.6.2	NAVSE
			Recommends accomplishing quarterly inspection of reduction gear just prior to cleaning lube oil sump.	3.6.2	NAVSE
			Cautions to ensure control oil 10-micron filter well drained before opening and that extreme caution be used to ensure no contamination enters control oil system when filter is open.	3.6.1.3	NAVSE
5.	RELIABILITY AND MAINTAINABILITY				
	a. SSTG Main Lube Oil Pump		Investigate further modifications of SSTG Main Lube Oil Pump to provide strained and/or filtered oil to the pump bearing.	3.6.4	NAVSE
	b. Control Oil Hand Pump		Investigate modification to control oil system to eliminate unfiltered oil supply to servomotor and actuator via hand pump.	3.6.1.1	NAVSE

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

** 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: 37-203-311

SYSTEM: SSTG

)DEOC 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
ex for the ave	3.6.1.3	NAVSEA 04					
ire-ent.	3.6.3	NAVSEA 04					
	3.6.1.1	NAVSEA 04					
is	3.6.2	NAVSEA 04					
ysis p.	3.6.2	NAVSEA 04					
TG	3.6.2	NAVSEA 04					
pec-	3.6.2	NAVSEA 04					
on d stem	3.6.1.3	NAVSEA 04					
STG g.	3.6.4	NAVSEA 934					
1 pply ump.	3.6.1.1	NAVSEA 934					

2

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

1 ACTION ITEM *		2 DDEOC EVALUATION **	3 ACTION ITEM DESCRIPTION	4 REPORT REFERENCE (PARA.)	5
a. NO.	b. TITLE				
5.	RELIABILITY AND MAINTAINABILITY (continued)				
	c. Strained Control Oil		Investigate modification to lube oil/control oil system to strain all oil in duplex strainer.	3.6.1.3	NAV
	d. Duplex Strainer and Cooler		Investigate modification to relocate duplex strainer and cooler to a more accessible location and to reduce requirements for removal and opening of piping for access to SSTG components.	3.6.1.3	NAV
	e. 10-Micron Filter		Investigate necessity for bypass relief valve in 10-micron filter. Remove and plug if not required.	3.6.1.2	NAV
	f. Control Oil Maintenance		Emphasize requirement to all maintenance levels that control oil must be maintained free from contamination.	3.6.1.3	NAV TYC
	g. In-Line Filters		Investigate use of in-line wire mesh filters as "last chance" filters in control oil lines.	3.6.1.3	NAV
	h. Gaskets		Replace spiral wound gaskets in lube oil and control oil system flanges with 1/32-inch gasket material, Symbol 2290. Replace flanges where required.	3.6.1.3	TYC
	i. Centrifugal Filters		Reinstall water drain cocks on centrifugal filters where they have been removed. Operators should utilize these filters in accordance with operating instructions provided in the SSTG Technical Manual.	3.6.3	Shi
6.	IMA IMPROVEMENTS				
	Control Oil Maintenance		Emphasize need for strict lube oil and control oil system maintenance procedures to avoid contamination.	3.6.1.3	NAV
7.	DEPOT-LEVEL IMPROVEMENTS				
	Control Oil Maintenance		Emphasize need for strict lube oil and control oil systems maintenance procedures to avoid contamination.	3.6.1.3	NAV

* NOTE 1: DEVELOPING ACTIVITY FILL IN THE FOLLOWING BLOCKS: 1a, b; 3; 4; 5 (IF KNOWN); 6a, IF REQUIRED FOR CONTINUATION
** 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: 37-203-311

SYSTEM: SSTG

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
l/ l in	3.6.1.3	NAVSEA 934					
e e equire- ping	3.6.1.3	NAVSEA 934					
lief and	3.6.1.2	NAVSEA 934					
nance n-	3.6.1.3	NAVSEA 047/ TYCOM					
n	3.6.1.3	NAVSEC 6154					
e oil l1/32- Re-	3.6.1.3	TYCOM					
ifugal . rs tions l.	3.6.3	Ship's Force					
nd dures	3.6.1.3	NAVSEA 047/043					
nd ed-	3.6.1.3	NAVSEA 047/043					

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

2

DDEOC ACTION TABLE

1 ACTION ITEM* a. NO.	1 ACTION ITEM* b. TITLE	2 DDEOC EVALUATION**	3 ACTION ITEM DESCRIPTION	4 REPORT REFERENCE (PARA.)	5 RESPONSIBILITY†
8.	INTEGRATED LOGISTICS SUPPORT IMPROVEMENTS				
	a. Technical Manual Rewrite		Ensure that adequate and accurate text and figures are included in the Technical Manual for the DDG-37 Class SSTG, which is now being rewritten. Particular attention should be given to providing troubleshooting and repair procedures for the Speed Control Governor System.	3.5.1	NAVSEA
	b. EG-3P Actuator with Oil Motor		Ensure that precise description of actuator is used, i.e., EG-3P with oil motor, and not EG-3P with oil pump. Remove ambiguity in APL 701110322.	3.5.1	NAVSEA
	c. Ball Bearings, Lube Oil Maintenance		Support educational effort to upgrade fleet personnel knowledge regarding ball bearing lubrication and lube oil maintenance and techniques to avoid casual contamination in oil systems.	4.3	NAVSEA NAVSEC
	d. Bearing Installation and Lubrication		Support general upgrade of shipboard equipment and personnel skills required to replace ball bearings. Provide Ship's Force with ball bearing heater ovens.	4.3	NAVSEA

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

** 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: 37-203-311

SYSTEM: SSTG

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
t and ch is ntion hoot- ed	3.5.1	NAVSEA 046					
l emove	3.5.1	NAVSEA 045					
all te-	4.3	NAVSEA 04/ NAVSEC 6148D					
equip-	4.3	NAVSEA 04					

2

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

DDEOC ACTION TABL

1 ACTION ITEM * a. NO.	b. TITLE	2 DDEOC EVALUATION **	3 ACTION ITEM DESCRIPTION	4 REPORT REFERENCE (PARA.)	5 RESP
8.	INTEGRATED LOGISTICS SUPPORT IMPROVEMENTS				
	a. Technical Manual Re-write		Ensure that adequate and accurate text and figures are included in the Technical Manual for the DDG-37 Class SSTG, which is now being rewritten. Particular attention should be given to providing troubleshooting and repair procedures for the Speed Control Governor System.	3.5.1	NAVSE
	b. EG-3P Actuator with Oil Motor		Ensure that precise description of actuator is used, i.e., EG-3P with oil motor, and not EG-3P with oil pump. Remove ambiguity in APL 701110322.	3.5.1	NAVSE
	c. Ball Bearings, Lube Oil Maintenance		Support educational effort to upgrade fleet personnel knowledge regarding ball bearing lubrication and lube oil maintenance and techniques to avoid casual contamination in oil systems.	4.3	NAVSE NAVSE
	d. Bearing Installation and Lubrication		Support general upgrade of shipboard equipment and personnel skills required to replace ball bearings. Provide Ship's Force with ball bearing heater ovens.	4.3	NAVSE

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

** 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: 37-203-311

SYSTEM: SSTG

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
t and ch is ntion hoot-ed	3.5.1	NAVSEA 046					
l emove	3.5.1	NAVSEA 045					
all te-	4.3	NAVSEA 04/ NAVSEC 6148D					
equip-	4.3	NAVSEA 04					

2

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