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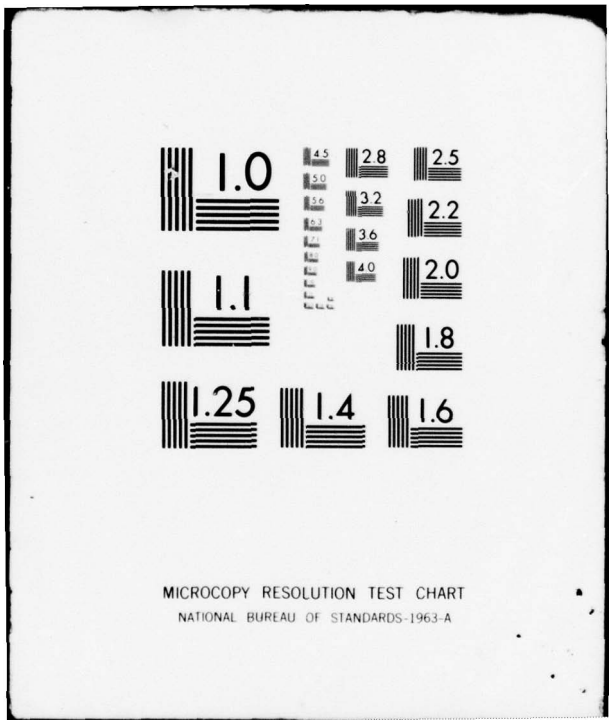
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DESTROYER ENGINEERED OPERATING CYCLE (DDEOC)

System Maintenance Analysis
DDG-37 CLASS
MAIN LUBE OIL AND PROPULSION TRANSMISSION SYSTEMS

SMA 37-107-240

REVIEW OF EXPERIENCE

May 1978

Prepared for

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

under Contract N00024-78-C-4062

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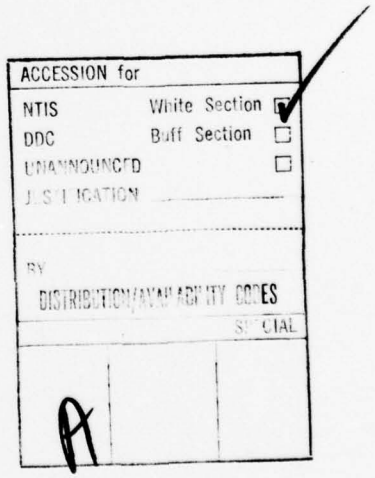
FOREWORD

This report, the Review of Experience, documents the historical maintenance experience for the DDG-37 Class Main Lube Oil and Propulsion Transmission Systems, presents an analysis of the problems encountered, and recommends actions to improve system material condition. It has been developed for NAVSEA 934X, the sponsor of the Destroyer Engineered Operating Cycle (DDEOC) Program, under Navy 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 Main Lube Oil and Propulsion Transmission Systems.

The ROE is an analysis of existing and anticipated problems that affect the operational performance and maintenance programs of a ship system. The ROE report serves as a vehicle for assessing the significance and consequences of identified maintenance problems. The report also recommends specific actions and a system maintenance policy that will prevent or reduce the impact of problem occurrence while improving material condition and maintaining or increasing system availability throughout an extended ship operating cycle.

The Main Lube Oil and Propulsion Transmission Systems ROE includes an analysis of all available maintenance data sources. The documented maintenance experience of the system was reviewed through analysis of data from the Maintenance Data System (MDS), Casualty Reports (CASREPs), and system overhaul records. Initial findings from these sources were correlated with Planned Maintenance System (PMS) requirements, system alterations, and system technical manuals to identify maintenance problems. Ship surveys were conducted and discussions were held with appropriate technical groups to validate identified problem areas, identify undocumented maintenance problems, and determine the status of current and planned actions affecting the Main Lube Oil and Propulsion Transmission Systems. All findings were evaluated and appropriate conclusions developed. Recommendations were then formulated to implement existing and newly defined corrective actions to minimize the occurrence of identified maintenance problems and their impact on an extended operating cycle.

The major findings and conclusions resulting from the Review of Experience for the Main Lube Oil and Propulsion Transmission Systems are summarized as follows:

- Main Lube Oil Systems
  - •• The DDG-37 Class Main Lube Oil System is reliable; however, the lube oil purifiers of this system have experienced significant numbers of failures of spindle bearings and idler pulley bearings.
  - •• Most failures of spindle bearings and idler pulley bearings are attributed to inadequate lubrication of these bearings.
  - •• Main Lube Oil System CASREPs have been few and minor.
  - •• The Main Lube Oil System can be expected to continue the same reliable performance during the extended operating cycle and should not require major restorative maintenance.
  - •• Accomplishment of the one outstanding ShipAlt, DLG9-367K, Low Lube Oil Pressure Alarm, on all ships of the DDG-37 Class will reduce the probability of catastrophic failure of the Main Lube Oil System.
- Propulsion Transmission System
  - •• The DDG-37 Class Propulsion Transmission System is reliable and currently suffers no chronic maintenance problems. Propulsion Transmission System CASREPs have been few and minor, and the system has not contributed significantly to the overall class maintenance and parts usage burdens.
  - •• The Propulsion Transmission System can be expected to continue the same reliable performance during the extended operating cycle and should not require major restorative maintenance.

Reliable operation of the Main Lube Oil and Propulsion Transmission Systems can be enhanced if several recommended changes are performed in the following areas:

- Baseline Overhaul (BOH) Requirements
- Intracycle Maintenance Requirements
- Follow-On ROH Requirements
- Reliability and Maintainability Improvements
- Planned Maintenance System Changes
- Integrated Logistic Support (ILS) Improvements

Tables S-1 and S-2 summarize all recommendations resulting from this Review of Experience.

Table S-1. SUMMARY OF ROE RECOMMENDATIONS FOR DDG-37 CLASS MAIN LUBE OIL SYSTEM

Component	Recommendation
Baseline Overhaul Requirements	
A. ShipAlts	
Main Lube Oil System	Accomplish ShipAlt DLG9-367K, Low Lube Oil Pressure Alarm, on all DDG-37 Class ships.
B. Repairs	
Main Lube Oil System	Perform repairs as shown to be necessary by Pre-Overhaul Tests and Inspections.
	Bring all Main Lube Oil Systems up to the highest feasible condition of cleanliness by thorough cleaning of all lube oil tanks and main reduction gear sumps. If necessary, flush piping to achieve maximum cleanliness.
Standby Service Pumps	During Baseline Overhaul of a pump, ensure that all tubes and passages for transmitting lubricating oil to the bearings within the pump transmissions are fully open and clean.
Intracycle Maintenance Requirements	
All Equipments of the Main Lube Oil System	Accomplish existing PMS requirements as modified by recommendations of this report.
Lube Oil Purifiers	DDEOC Technical Group observe and determine the usable life of lube oil purifier spindle bearings and develop predictions of when spindle bearings should be replaced.
	Advise DDG-37 Class ships that spindle bearings should be replaced in pairs, not singly.
Follow-On ROH Requirements	
All Equipments of the Main Lube Oil System	Perform repairs as shown to be necessary by Pre-Overhaul Tests and Inspections.
Reliability and Maintainability Improvements	
Main Lube Oil System	Maintain maximum possible degree of cleanliness in all parts of the system.
Lube Oil Purifiers	Place a warning sign on top of the belt guard of each lube oil purifier calling attention for the lubrication of spindle bearings once an hour and idler pulley bearings every two hours.
Duplex Strainers	Advise DDG-37 Class ships that the high frequency of tears and punctures in strainer baskets is attributed to sharp corners on magnets and lack of care in inserting the magnets.
	Round the sharp edges and corners on the magnets.
Planned Maintenance System Changes	
Main Lube Oil System	Revise Maintenance Requirement Cards (MRCs) A5 H81F and 76 K43 L to require gas freeing of reduction gear sumps, examinations for corrosion, and cleaning of settling tanks at the same frequency as reduction gear sumps.
Lube Oil Purifiers	Revise existing MRCs and add new PMS MRCs to specifically require (1) lubricating spindle and idler pulley bearings, (2) cleaning oil passages in lube oil purifier bearing pulley cap assemblies, (3) checking the cleanliness of felt bearing oil filters of bearing pulley cap assemblies, and (4) cleaning purifier bowls and checking bowl boss sleeves and drag assemblies.
Standby Service Pumps	Revise MRC 94 E 85M N, Lube Oil Pump, to reflect the guidance contained in Leslie Company drawings.
Depot-Level Improvements -- None	
***IMA Improvements* -- None**	
Integrated Logistic Support (ILS) Requirements	
Lube Oil Purifiers	Advise DDG-37 Class ships that NSN 1 HM 3110-00-991-0901 NT is the correct NSN for identifying purifier spindle bearings on lube oil purifiers, APL 760010033.
	Stock and issue spindle bearings in pairs, not singly. Change Allowance Parts Lists to reflect this policy.
	Issue a 1200 PSI Steam Propulsion Plant Improvement Advisory to call attention to the hourly lubrication requirements and to the requirement for cleaning purifier bowls every time the purifier is stopped and not less than once a watch.
	Revise the Engineering Operational Procedure for DDG-37 Class lube oil purifiers to require checking of the felt filter within the bearing pulley cap assembly, as well as lubrication of spindle bearings every hour and idler pulley bearings every two hours.
	Check existing training courses for DDG-37 Class lube oil purifiers to ensure that course instruction is included on their proper lubrication.
Duplex Strainers	Purchase specifications for replacement magnets should require the smoothing and rounding of sharp edges on the magnets.
Standby Service Pumps	Advise all DDG-37 Class ships of the existence of Leslie Company Drawings 1278F, Alt. 3 and 2838F, Alt. 1 to assist in the maintenance of Leslie pressure regulators for standby service pumps.

Table S-2. SUMMARY OF ROE RECOMMENDATIONS FOR DDG-37 CLASS PROPULSION TRANSMISSION SYSTEM

Component	Recommendation
Baseline Overhaul Requirements	
A. ShipAlts	None.
B. Repairs	
All Equipments of the Propulsion Transmission System	Perform repairs as shown to be necessary by Pre-Overhaul Tests and Inspections and drydock inspections.
Intracycle Maintenance Requirements	
All Equipments of the Propulsion Transmission System	Accomplish existing PMS requirements as modified by recommendations of this report.
Follow-On ROH Requirements	
All Equipments of the Propulsion Transmission System	Perform repairs as shown to be necessary by Pre-Overhaul Tests and Inspections and drydock inspections.
Reliability and Maintainability Improvements -- None	
Planned Maintenance System Changes	
Line Shaft Bearings	Prepare and issue a new Maintenance Requirement Card that will call for a daily underway check of oiler ring rotation. Prepare and issue a new Maintenance Requirement Card that will call for an annual check of oiler ring joint tightness. When underway, the oiler rings of each line shaft bearing should be checked once a watch to ensure that the rings are free and rotating. Caution DDG-37 Class ships of the importance of tight oiler ring joints and the dangers of protrusions.
Depot-Level Improvements -- None	
IMA Improvements -- None	
Integrated Logistic Support (ILS) Requirements -- None	

CONTENTS

CONTENTS (continued)

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

In support of the Destroyer Engineered Operating Cycle (DDEOC) Program, sponsored by NAVSEA 934X, System Maintenance Analyses (SMAs) are being conducted on selected systems and subsystems of program-designated surface combatants. The principal element of an SMA is the Review of Experience (ROE). This report documents the ROE for the DDG-37 Class Main Lube Oil and Propulsion Transmission Systems, which was specifically selected for analysis because equipments of the systems 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 and maintenance programs 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 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 Main Lube Oil and Propulsion Transmission Systems installed on DDG-37 Class ships. Only those system components that had been installed or were on board ship as of the fourth quarter of 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 Ship's Force and other cognizant technical personnel.

1.3 SYSTEM FUNCTION AND BOUNDARIES

The Main Lube Oil System includes two independent, constant-pressure, forced-feed service systems for lubricating the main propulsion turbines and reduction gears in each engine room. An additional, separate subsystem is provided for (1) filling lube oil tanks, (2) transferring lube oil between tanks, and (3) purifying the lube oil. The forced-feed service systems consist of sumps at the base of each main reduction gear unit, turbine-driven standby lube oil service pumps, motor-driven emergency lube oil service pumps, attached lube oil service pumps driven off the main reduction gears, duplex magnetic type discharge strainers, lube oil coolers, and the necessary piping and fittings for control of the lube oil. These additional subsystems consist of storage and settling tanks, motor-driven lube oil pump transfer capability (utilizing either service pumps or purifier pumps), motor-driven centrifugal purifiers, lube oil heaters, and the necessary piping and fittings for controlling the transfer and purification of the lube oil.

The Propulsion Transmission System transmits rotary power from the two main propulsion engines to two fixed-pitch propellers. This rotary power is transmitted from the propulsion turbines to the propellers via two sets of locked train reduction gears and propeller shafting. The propeller shafting is fitted with thrust bearings, in-board line shaft bearings, stern tube seals, stern tube and strut bearings, and the fixed-pitch propellers. The propellers absorb the transmitted rotary power and convert this energy into a reactive thrust force that propels the ship. A list of system components 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

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

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

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

2.1 DATA COMPILATION

The analysis began with the compilation of comprehensive data on the maintenance history of the system. The data file generated consisted of four key elements: an MDS data bank, a CASREP narrative summary, a system overhaul experience summary, and a system Ship Alteration (ShipAlt) summary. A library of appropriate technical manuals, bulletins, and related documents was also compiled. All MDS data reported for the DDG-37 Class from 1 January 1970 through 31 October 1976 were screened for information relevant to the system. Information on system overhaul experience was obtained from Departure Reports; Ship Alteration and Repair Packages (SARPs) for DDG-37, -45, and -46; and the DDEOC Baseline Overhaul Repair Requirements for the DDG-37 Class. The status of applicable ShipAlts was determined from review of PERA (CRUDES) PHILANAVSHIPYD documents, as well as from COMNAVSURFLANT CSMP Report 1 of 16 February 1977.

2.2 MAINTENANCE PROBLEM DEFINITION

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

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

Computer-assisted analysis quantified the man-hour and part-expenditure burdens incurred for each component. These calculations were performed not only for the selected components individually but also, as appropriate, for each generic class of components. Individual components or component classes that had contributed significantly to the systems' maintenance burden were selected for the analysis described below. Components were also 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 significant 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.

2.3 ANALYSIS OF COMPONENT MAINTENANCE PROBLEMS AND DEFINITION OF SOLUTIONS

Once the component problems and the causes of the problems were identified, solutions were sought by examining each problem in relation to the extent to which it is recognized and its susceptibility to established types of corrective action. These analysis criteria 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 the problem be reduced or eliminated by changes to PMS? (These changes might include adding or deleting requirements, changing periodicity, or developing material condition assessment tests and procedures.)

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

An affirmative answer to any question resulted in analysis of the effects of the solution and in an estimate, when possible, of the cost to implement the solution. A negative answer prompted the analyst to go to the next question.

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

CHAPTER THREE

ANALYSIS RESULTS

3.1 OVERVIEW

This chapter presents the results of the analysis of historical maintenance experience for the DDG-37 Class Main Lube Oil and Propulsion Transmission Systems. Preliminary analysis of the MDS data resulted in the identification of 11 system components that warranted detailed analysis. The MDS maintenance burden data for these 11 components are summarized in Table 3-1.

A review of part replacement histories identified 24 replacement parts within 8 of the components as requiring further analysis. Pertinent data for these parts are summarized in Appendix B. CASREP analysis supported the MDS data screening performed in defining significant maintenance actions. Appendix C summarizes the CASREP distribution for the Main Lube Oil and Propulsion Transmission Systems and indicates the percentage of total system CASREPs attributed to certain components as well as the types of failures experienced. Ship survey results and discussions with Navy technical code personnel confirmed the existence of maintenance problems suggested by the analysis. A discussion of each system's identified maintenance problems and recommended solutions is presented in the following sections.

3.2 GENERAL SYSTEM CONSIDERATIONS

Detailed analysis of the 11 components identified as being major contributors to the overall system maintenance burden revealed that 9 of these have experienced intracycle maintenance actions that warrant individual discussion. The two remaining components are the attached lube oil service pump (APL 016160417) in the Main Lube Oil System and the shaft seals (APLs 831000032, 831000033, 831000179) in the Propulsion Transmission System. From the data presented in Table 3-1, it is concluded that these two components have not historically represented significant intracycle maintenance burdens, as indicated by the relatively low number of maintenance actions over the data period, the low average man-hour expenditure per equipment per operating year, and the few reports of mechanical problems. Therefore, it

Table 3-1. MAINTENANCE BURDEN SUMMARY FOR DDG-37 CLASS MAIN LUBE OIL AND PROPULSION TRANSMISSION SYSTEMS

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
Main Lube Oil System												
760010033	Lube Oil Purifier	10	2*	19*	51.9	10	493	2540	382	2922	91423	29.6
057150137 057150170 057150179	Steam Turbine, L.O. Stand-by Service Pump	10	2	20	51.9	10	208	1803	592	2395	27864	23.1
016160255	Pump End, L.O. Standby Service Pump	10	2	20	51.9	10	88	1359	516	1875	3650	18.0
016160417	Attached L.O. Svc. Pump	5	2	10	25.8	2	13	702	165	867	3990	16.8
750080084 750260010 750440006	L.O. Duplex Strainers	10	2	20	51.9	10	85	537	688	1225	4866	11.8
882260200 882260480	Governor Valve, L.O. Standby Service Pump	10	2	20	51.9	10	105	785	290	1075	7882	10.4
						Totals	992	7726	2633	10359	139675	
Propulsion Transmission System												
691050039 691050040 691050043 691050044	Main Reduction Gears (DeLaval)	5	2	10	25.8	5	140	1915	506	2421	10513	46.9
691150094 691150095	Main Reduction Gears (Allis Chalmers)	5	2	10	26.1	5	77	539	145	684	6850	13.1
371010128 371010129	Line Shaft Bearings	10	6	60	51.9	10	94	2646	1350	3996	3129	12.8
834000364 834000365	Propeller Assembly	9**	2	18	48.0	7	25	33	850	883	143043	9.2
831000032 831000033 831000179	Shaft Seals	10	6	60	51.9	10	39	370	398	768	1524	2.5
						Totals	375	5503	3249	8752	165059	
						Grand Totals	1367	13229	5882	19111	304734	
						Total Reported for Both Systems	1755	16352	8283	24635	322910	
						Percent of Total Accounted for by Selected APLs	78	81	71	78	94	

*Only one Lube Oil Purifier of this APL aboard DDG-46.
**None of these APLs aboard DDG-41.

is concluded that these components are reliable and should not require major restorative maintenance during an extended operating cycle. The limited mechanical maintenance actions reported against these components have primarily involved the following:

- Attached Lube Oil Service Pump
  - Thrust bearing excessively worn
  - Pump vibrating due to bearing failure in pump end drive
  - Pinion drive gear worn and scored, causing vibration

  (Each of the above was reported once by one ship of the DDG-37 Class)
- Shaft Seals
  - Excessive sea water leak-off through seal (reported once by each of 6 ships of the DDG-37 Class)
  - Filter housings of the sealing subsystem clogged with mud or marine life (reported once by one ship of the DDG-37 Class)

CASREP analysis presented in Table C-1 (Appendix C) substantiates that these mechanical problems have not caused critical failures on DDG-37 Class ships. This finding supports the conclusion regarding the reliability of these components. They will therefore not be discussed further in this analysis; however, recommendations regarding Baseline Overhaul requirements and intracycle maintenance strategies for these components are presented.

The nine system components that were subjected to detailed analysis because of significant or unique maintenance experience are:

- Main Lube Oil System
  - Lube Oil Purifier (APL 760010033)
  - Steam Turbine of Lube Oil Standby Service Pump (APLs 057150137, 057150170, 057150179)
  - Governor Valve, Lube Oil Standby Service Pump (APLs 882260200, 882260480)
  - Pump End of Lube Oil Standby Service Pump (APL 016160255)
  - Lube Oil Duplex Strainers (APLs 750080084, 750260010, 750440006)
- Propulsion Transmission System
  - DeLaval Main Reduction Gears (APLs 691050039, 691050040, 691050043, 691050044)
  - Allis-Chalmers Main Reduction Gears (APLs 691150094, 691150095)
  - Propeller Assembly (APLs 834000364, 834000365
  - Line Shaft Bearings (APLs 371010128, 371010129)

These systems and their respective selected components are discussed in detail in the following sections of this report. Reduction gear units have been combined according to manufacturer. To present the analysis results in a logical manner, functionally similar equipments (e.g., steam turbines and governor valves of the lube oil standby service pumps, lube oil duplex strainers, propeller assemblies, and line shaft bearings) are grouped and discussed together.

3.3 MAIN LUBE OIL SYSTEM

3.3.1 Lube Oil Purifier

All ships of the DDG-37 Class, except DDG-46, are equipped with three Penwalt Corporation Equipment Division (formerly Sharples Corporation) type 14VN2P centrifugal purifiers (APL 760010033); two are used for lube oil purification, and one is used as a JP-5 purifier. DDG-46 is equipped with two type 14VN2P purifiers and one type 14VN2P-SN purifier (APL 760010081). The latter purifier is used by DDG-46 for lube oil purification and is designed to meet high shock loading and low noise-signal requirements in accordance with Military Specification MIL-P-20632A (SHIPS). In this respect, it differs from the earlier type 14VN2P purifier, which was designed to Military Specification MIL-P-2063A (SHIPS). The following discussion addresses only the type 14VN2P purifier (APL 760010033), since DDG-46 MDS data show no significant existing problems with the type 14VN2P-SN purifier.

3.3.1.1 Problem Identification

The type 14VN2P purifier represents a proven and conservative design. It is known to be dependable and relatively maintenance-free if it is given the care and maintenance recommended by the manufacturer. However, the DDG-37 Class MDS data (Table 3-1) indicate that the lube oil purifier's man-hour burden (29.6 man-hours per component operating year) and parts cost burden ($91,423) have exceeded those of all other components in the Main Lube Oil System.

Table B-1 (Appendix B), a parts usage summary, provides an indication of the sources of DDG-37 Class purifier problems. Not only does this purifier experience the greatest need for frequent replacement of many different parts, but also the higher percentages of parts replaced can be directly related to problems focused in three bearing assemblies: spindle bearing, drag, and idler pulley bearing. Figure A-1 (Appendix A) schematically locates these assemblies, and Figures A-2 through A-6 (reproduced from NAVSHIPS Technical Manual 0945-003-6010) depict the more important (but not all) parts listed in Table B-1 (Appendix B). Thus the analysis has identified the following seven problems within type 14VN2P purifiers of the DDG-37 Class:

- High replacement rates for ball bearings associated with the spindle bearing assembly

- High replacement rates for spindle flexible couplings
- High replacement rates for the ball bearings of idler arm pulleys
- Frequent oil leaks through the rotary seals of purifier seals
- Excessive wear of drag shells and bowl boss sleeves
- Excessive vibration of the purifier bowls during operation
- Resultant damage to purifier bowls and covers following failure of other parts

Subsequent discussions in this section will address the causes of these problems and the recommended solutions.

3.3.1.2 Spindle Bearing Problems

On the basis of (1) a detailed review of the MDS narrative reports, (2) careful study and analysis of the manufacturer's maintenance and lubrication plans, and (3) on-board discussions with operating personnel during ship visits, it has been concluded that spindle bearing failures are primarily attributable to inadequate lubrication. One of the two ships visited did not perform routine lubrication of these bearings or cleaning of lubrication filters and passages, while the second ship simply packed the bearings with a grease not recommended by the purifier manufacturer and ignored the intended lubrication plan of the designer.

Other possible causes for individual failures are the following:

- Dirt contamination of the lubricating oil applied to the bearings
- Misalignment, incorrect fit-up, or distortion of the bearing housing during renewal installation
- Excessive radial loads arising from mechanical unbalance of the purifier bowl

It is not possible to state specifically which failures can be attributed to the above causes; however, there is strong evidence to support the conclusion that inadequate lubrication is the root cause of most failures in the spindle bearing assembly.

In Figure A-2 (Appendix A), note that the felt bearing oil filter is inserted in the top of the bearing pulley cap assembly, and beneath this felt filter are four (3/32-inch in diameter) lubricating oil access holes. These access holes provide passageways for the lubricating oil to flow downward to the pair of spindle ball bearings and to a lubricating oil reservoir in the bottom of the bearing pulley. It is believed that these two features are the key to the high failure rate of spindle bearings in the lube oil purifier. They are important elements of the manufacturer's

lubrication method for this isolated bearing assembly. The manufacturer provides the following lubrication guidance for the spindle bearing assembly (NAVSHIPS Technical Manual 0945-003-6010, page 6-1):

"(a) Use only high-grade ball bearing oil with a viscosity of about 80 seconds Saybolt @ 130°F, Military Symbol 2075.

(b) Oil only when the bearing is running. If oiling is done when the machine is at rest the oil will contaminate the flexible coupling and cause it to tear.

(c) Put a few drops of oil on top of the spindle once an hour. Centrifugal force throws the oil to the wall of the bearing pulley cap from which point it flows through small holes into the bearing assembly. When the purifier is stopped, the oil in the bearings flows down into an oil well at the bottom of the pulley. When the purifier is restarted, the oil rises under centrifugal force and again lubricates the bearings.

(d) Keep the bearing seal ring in good condition. It expands under centrifugal force to seal the joint between the pulley and pulley cap. If it is torn, the seal will not hold, oil will escape, and the bearings may run dry between oilings.

(e) Run a small wire through the oil holes in the bearing pulley cap occasionally to make sure they are clear and not clogged."

Note in the above that the manufacturer does not mention the felt bearing oil filter. In fact, the felt bearing oil filter is mentioned by the manufacturer only on page 4-10 of NAVSHIPS Technical Manual 0945-003-6010, and none of its drawings clearly depict this filter. For this reason, the filter has been added to Figure A-3 (Appendix A) of this report.

From the foregoing, it is evident that whenever the purifier is in operation, it must be periodically lubricated by an operator. The use of this mode has been confirmed by NAVSEC technical personnel. Further, the operator must be aware (1) that lubricating oil must be applied hourly to the spindle bearings but only when the purifier is operating and (2) that a dirty felt filter in the top of the bearing pulley cap assembly can prevent the flow of lubricating oil to the spindle bearings. In addition, the operator must be aware of the importance of the bearing seal ring within the outer face of the bearing pulley cap assembly. He must be aware that it is necessary to replace this seal if the bearing pulley cap assembly is removed for any reason, and he must know of the existence of the oil access holes in the cap assembly and of the importance of keeping these holes unclogged.

On the basis of visits to two ships of the DDG-37 Class, it is known that not all ship personnel are fully aware of these purifier details; and since the reported usage of related parts appears low, there is a basis for doubt that class-wide awareness exists. For example, although 338 spindle bearings have been requisitioned, the parts usage data indicated that only 31 bearing seal rings (NSN 9Z 5330-00-196-5385) were requisitioned. Spindle

bearings cannot be replaced without removing the bearing pulley cap assembly, which correctly requires a concomitant renewal of the bearing seal ring. The requisitioning of only 31 bearing seal rings suggests that this seal was not renewed each time spindle bearings were replaced.

Similarly, parts usage data indicate that only 7 of 10 DDG-37 Class ships requisitioned felt bearing oil filter replacements (NSN 1HM 4420-00-469-1080), for a grand total of 35. In other words, there is no indication that these filters have ever been changed on three ships. Considering the entire DDG-37 Class, the rate of felt filter replacement for lube oil purifiers is 0.035 filter per lube oil purifier per ship operating year. This low replacement rate suggests that DDG-37 Class ships currently are not changing these filters very frequently. In addition, there is a possibility that some DDG-37 Class ship personnel may not know of the manufacturer's intended plan for lubricating the purifier spindle bearings, since existing PMS requirements do not give attention to these bearings.

A review of current PMS requirements for the DDG-37 Class lube oil purifiers has shown no current requirement on any Maintenance Requirement Card (MRC) to do any of the following:

- Lubricate the spindle bearing assembly
- Clean oil passages in the bearing pulley cap assembly
- Check the felt bearing oil filter for cleanliness and renew if necessary

Table 3-2, which gives the rate of replacement of spindle bearings per ship operating year, shows that approximately two thirds of the DDG-37 Class ships replaced two sets of spindle bearings each operating year. In addition, two of the ships had significantly high rates of bearing replacement.

During assembly of the data for Table 3-2, it was established that DDG-37 Class ships are reporting usage of spindle bearings against two different identifying numbers: NSN 1 HM 3110-00-991-0901 NT and NSN 9Z 3110-00-100-2419. Technical personnel at SPCC, Mechanicsburg, Pennsylvania, have advised that the former number is correct, while the latter number is obsolete and does not appear on any authorized Allowance Parts List (APL) for lube oil purifiers. NAVSEC technical personnel have advised that these spindle bearings should be replaced in pairs, not singly, to provide for proper load distribution and to ensure equivalent clearances and bearing cleanliness. This replacement practice is not currently required; existing usage data show that odd numbers of bearings are being placed on order, as well as even numbers, which suggests the occurrence of single replacements. Moreover, the Allowance Parts List for the DDG-37 Class lube oil purifier, APL 760010033, lists a quantity of "2 each" for the spindle bearing (NSN 1 HM 3110-00-991-0901 NT) rather than "1 pair". A change in the APL to show the latter designation would better reflect the intention of replacing matched pairs of ball bearings rather than single bearings. It is reasonable to conclude that these bearings should be changed periodically since

Table 3-2. RELATIVE RATES OF REPORTED SPINDLE BEARING REPLACEMENT IN THE DDG-37 CLASS LUBE OIL PURIFIERS

Hull Number	Total Number of Spindle Bearing Replacements	Replacements per Ship Operating Year
DDG-37	67	11.7
DDG-38	78	14.2
DDG-39	27	5.3
DDG-40	27	4.7
DDG-41	17	4.3
DDG-42	15	3.0
DDG-43	25	4.4
DDG-44	25	4.3
DDG-45	34	7.7
DDG-46	23	4.2

their cost (about $22 per pair) is far lower than that of replacing a badly damaged purifier bowl assembly (about $1869 each) following failure and seizure of the bearings. Note that Table B-1 (Appendix B) shows that 18 bowl assemblies have been reported as replaced.

In this review, it was not possible to determine a replacement interval for the spindle bearings because of the lack of appropriate data. To make such a determination, it is recommended that the DDEOC Technical Group establish a monitoring program to develop predictions of when spindle bearings normally require replacement. There would then be a technical basis for making replacements in advance of mechanical failures.

3.3.1.3 Causes of Other Parts Problems

Spindle Flexible Couplings

Table B-1 (Appendix B) indicates that spindle flexible couplings (NSN 1H 3010-00-600-6789) are ranked second as a high-usage part on DDG-37 Class lube oil purifiers. Spindle flexible couplings are specifically designed (1) to absorb vibration due to out-of-balance conditions in the purifier bowl and (2) to provide a point of failure if the spindle ball bearings should seize. Thus a limited amount of replacement is normally expected. In addition, when a high rate of failure by seizing of the spindle ball bearings exists, there is a direct inflation of the flexible coupling failure rate. However, it appears that a probable additional cause of failure is improper lubrication of the spindle ball bearing

assemblies. Some ship's personnel may be applying lubrication to these bearings while the purifier is not operating. Under these circumstances, the lubricating oil runs downward onto the flexible coupling, contaminating it and causing it to tear earlier.

The uncertainty regarding purifier lubrication practices within the DDG-37 Class raises the possibility that some flexible couplings are probably always immersed in lubricating oil, although the manufacturer warns against this practice in NAVSHIPS Technical Manual 0945-003-6010 (page 6-1). A possibility also exists that torn pieces of this neoprene coupling may clog the felt filter in the groove of the bearing pulley cap. If this felt filter has been removed and not replaced, small pieces of torn neoprene also may enter and clog the four 3/32-inch-diameter oil passages holes previously discussed.

In summary, the high usage rate for these couplings is explainable and understandable, and it should decrease once the manufacturer's lubrication instructions are followed more closely throughout the DDG-37 Class.

Idler Pulley Ball Bearings

It is believed that the idler pulley ball bearings, like the spindle bearings, have been failing primarily as a result of inadequate lubrication. The manufacturer provides, on page 6-1 of NAVSHIPS Technical Manual 0945-003-6010, the following lubrication guidance for these bearings:

"Idler Pulley:

(a) Use the same oil as for the spindle bearing assembly.

(b) Oil only when the idler is running.

(c) Put a few drops of oil in the idler pulley cap opening every two or three hours."

A review of current PMS requirements shows that there is no current requirement to perform all of the lubrication procedures recommended by the manufacturer. Seizure of these bearings should decrease if the manufacturer's lubrication instructions are followed more closely.

Pump Seals

The purifier pump rotary seal (NSN 9C 4330-00-218-5965) is a bellows type shaft seal equipped with an internal carbon ring; it is manufactured by the John Crane Packing Company of Chicago, Illinois. The manufacturer cautions that the seals must be handled with considerable care during installation. If misaligned or dropped, the carbon seals could crack, ruining the seal and necessitating another replacement. Both the MDS narratives and the parts usage data confirm that DDG-37 Class ships frequently replace these seals, and discussions with ship personnel indicate that unacceptable loss of lube oil prompts replacement at the slightest evidence of leakage.

Drag Spring, Bowl Boss Sleeves, and Purifier Bowl

The excessive wear experienced by drag springs and bowl boss sleeves, as well as vibration of the purifier bowl, is directly related to ignoring the manufacturer's recommended maintenance procedure set forth on page 4-20 of NAVSHIPS Technical Manual 0945-003-6010. This procedure, reproduced as Figure 3-1, specifically calls for the following maintenance actions:

- Cleaning of purifier bowl every time the centrifuge is stopped
- Removal, washing, and inspection of the drag once a week
- Renewal of the drag bushing whenever it is worn as much as 1/16 inch in diameter
- Renewal of the bowl boss sleeve when it is worn 3/64 inch in diameter or is badly scored

Existing PMS Maintenance Requirement Cards do not achieve these ends; thus a number of additions and revisions to these cards are recommended. These involve formal scheduling of bowl cleaning and checks on the bowl sleeve. Checks on the drag bushing and drag spring are also introduced. The purpose of these changes, shown in detail in Appendix D, is to fill the gaps in the maintenance procedure.

Purifier Bowls and Covers

Damage to lube oil purifier bowls and covers is usually the final incident in a series of related events resulting from marginal operational and maintenance practices. Inadequate lubrication of spindle and idler bearings and excessive dirt in the purifier bowl initiate the process. These are followed by excessive heat build-up in the bearings and excessive wear of the drag bushing and bowl boss sleeve. Thereafter, the added clearances in the drag assembly allow increased eccentricity of the dirty, spinning purifier bowl. It then becomes a progressively worsening situation, and it is merely a matter of time before the spindle bearings become so hot that they seize. The idler bearing pulley then shears away from the flexible coupling, and at that point the purifier bowl assembly is spinning freely and eccentrically. Eventually, the bowl spins to a stop and, in doing so, may strike the bowl cover and damage both itself and the cover. Clearly, the solution lies in careful observance of the manufacturer's lubrication and maintenance guidance, particularly with respect to frequent cleaning of the purifier bowls and hourly lubrication of spindle bearings.

3.3.1.4 Recommendations for Lube Oil Purifiers

The following actions are recommended to correct the current maintenance problems of DDG-37 Class lube oil purifiers:

- A 1200 PSI Steam Propulsion Plant Improvement Program Advisory should be issued as soon as possible to call attention to the manufacturer's hourly lubrication requirements for lube oil purifiers. In addition, the Engineering Operational Procedure for

Maintenance Procedure		
Duty	When Done	Purpose
Clean bowl thoroughly.	Every time the centrifuge is stopped.	To remove solids and preserve balance.
Keep bowl protecting cap in place on bowl top threads.	Always when bowl is not coupled to spindle.	To prevent defacement.
Remove drag, wash, and inspect all parts.	Once a week.	To remove impurities and check for bushing wear.
Renew drag spring.	Once a year.	To maintain proper drag action.
Renew drag bushing.	Whenever it is worn as much as 1/16 inch in diameter.	To assure smooth running and protect feed nozzle from wear.
Renew bowl boss sleeve.	When it is worn 3/64 inch in diameter or badly scored.	To assure smooth running and protect bowl boss threads from wear.
Renew belt.	Whenever it is frayed.	To avoid shutdown from belt breakage.
Check alignment of belt on pulleys.	Whenever the centrifuge is started.	To prevent belt wear.
Study the lubricating requirements (Chapter 6) and follow these without fail.		

Figure 3-1. MANUFACTURER'S RECOMMENDED MAINTENANCE PROCEDURE FOR THE LUBE OIL PURIFIER

DDG-37 Class Lube Oil Purifiers (as set forth in the Engineering Operational Sequencing System) should be revised to require daily checking of the felt filter within the bearing pulley cap, as well as lubrication of spindle bearings every hour and lubrication of idler pulley bearings every two hours. These documents also should call attention to the requirement that purifier bowls be cleaned every time the purifier is stopped and not less than once a watch.

- PMS Maintenance Index Page E11/65-96 should be revised to incorporate the following:*
  - Add requirements to lubricate spindle bearing assemblies and idler pulley bearings (MRC 96K78XN)
  - Formally schedule cleaning of the purifier bowl as well as dimensional checks on the bowl boss sleeve (new MRC)
  - Formally schedule cleaning of oil passages in the bearing pulley cap assembly (new MRC)
  - Check the drag bushings more frequently as recommended by the manufacturer (MRC 96K78ZN)
  - Inspect the purifier more frequently and add a check on the lube oil passages and the felt filter in the bearing pulley cap assembly (MRC 96K78YN)
- A warning sign should be placed on the top of the belt guard of each lube oil purifier calling attention to the requirements for lubricating the spindle bearing during operation once an hour and lubricating the idler pulley bearing every two hours.
- DDG-37 Class ships should be advised that spindle bearings should be replaced in pairs, not singly, and the Allowance Parts List for lube oil purifiers of the DDG-37 Class should be changed to indicate that the spindle bearings (NSN 1 HM 3110-00-991-0901 NT) are issued in pairs, not "2 each".
- Just as for the FF-1052 Class, the maintenance burden attributable to lube oil purifiers in the DDG-37 Class can also be reduced by improving the level of training for purifier operators. Fleet action to improve school attendance at the 10-day Lube Oil Purifier course at the Fleet Training Center is recommended. The course contents should also be checked to ensure that they adequately address the lubrication and maintenance needs identified in this report.

3.3.2 Lube Oil Standby Service Pumps (APL 016160255)

All ships of the DDG-37 Class are equipped with two turbine-driven lube oil standby service pumps manufactured by the DeLaval Steam Turbine Company, Trenton, New Jersey. During periods of starting, stopping, low

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*Appendix D provides further details of these recommended changes to the PMS for lube oil purifiers.

forward speed, and astern operations, the turbine-driven lube oil standby service pump is automatically brought up to speed. In this way, it augments the lube oil supply provided by the attached lube oil pump and ensures a continuous lube oil pressure of 25 PSIG at the most remote bearing within the system. The turbine-driven lube oil standby service pump is also provided with a recirculating line to permit pump idling without building up an excessive discharge pressure. The individual maintenance burdens attributed to the steam turbine ends and their governor valves, as well as the pump ends, are identified separately in Table 3-1. These MDS burdens, as well as mechanical problems, are discussed in the following subsections.

3.3.2.1 Problems of the Steam Turbines (APLs 057150137, 057150170, 057150179) and Governor Valves (APLs 882260200, 882260480)

The steam turbine ends of the lube oil standby service pumps and their related Leslie governors are significant sources of man-hour and dollar burdens for the Main Lube Oil System. They have been grouped by component rather than by APL number since all are of the same design. Table 3-1 shows that 23.1 maintenance man-hours per component operating year for the turbine end and 10.4 man-hours for the governor valves have been required. Analysis of MDS narrative reports and parts usage data (see Table B-1 in Appendix B) identified two significant mechanical problems associated with these turbine ends:

- The Leslie turbine governors (APLs 882260200, 882260480) operate erratically.
- Bearings in the turbine transmission are failing.

3.3.2.2 Causes of Leslie Governor Problem

Erratic operation of the Leslie governors was reported a total of 17 times by 8 of the 10 ships of the DDG-37 Class; it is believed that this problem is related to incorrect or inadequate maintenance and possibly to a lack of knowledge of detailed Leslie adjustment instructions. The manufacturer's instructions point out that sluggishness in operation can be caused by dirt or foreign matter carried with the steam into the governor and auxiliary pilots, interfering with movement of the working parts.

Discussions with Fleet personnel disclosed the existence of two Leslie Company drawings that are vital to performing proper maintenance on these governors. The drawings are generally known to those Fleet personnel who have worked in the repair shops of destroyer tenders. The technical manuals for some equipments utilizing Leslie governors will occasionally be found to contain the drawings; however, not all ships employing Leslie governors have copies of these drawings. On one of the two DDG-37 Class ships visited, there was no knowledge of the drawings, while such knowledge existed on the second ship only because one of the petty officers had attended the Leslie Company training course on governors and had used the drawings while assigned to a tender.

The two Leslie Company drawings are No. 1278F, Alt 3, 29 January 1948 and No. 2838F, Alt. 1, 20 June 1952. The first drawing provides maintenance instructions for top caps of the internal pilot-operated reducing valves, pump governors, and temperature regulators. The second drawing shows permissible permanent-set limits for the diaphragms of Leslie pump governors. These drawings do not appear in NAVSHIPS Technical Manual 347-2336 but are included in Appendix A of this report as Figures A-7 and A-8. According to Leslie personnel, failure to observe the critical dimensions shown in the upper part of Figure A-7 can cause erratic operation of Leslie governors. Attention is also directed to the number of replacements of governor valve diaphragms (NSN 9C 4820-00-036-1554) shown in Table B-1 (Appendix B). Figure A-8 shows that considerable permanent set in these diaphragms is permissible, and this guidance may aid in reducing the number of replacements, since it is possible that many diaphragms have been replaced unnecessarily.

There is no positive evidence in the MDS narrative reports that the reported erratic operation of Leslie governors is due to either dirt in these units or failure to follow these drawings. However, it is well known that Leslie governors that are overhauled by following the manufacturer's instructions and drawings rarely operate erratically. Therefore, it is engineering judgment that cleanliness and proper dimensional settings within the governor are the key to improving the erratic performance reported 17 times in the narrative reports. Moreover, from review of the existing PMS documents that apply to the Leslie governor, i.e., MIP E-9/78-37 and MRC 94 E85 M N, it also appears that the existence of the Leslie drawings may have been unknown to those who prepared the PMS documents; accordingly, these documents require attention. Specifically, the Maintenance Requirement Card (MRC) should be revised to include information on the proper cleaning solvent to be used on the governors, as well as provide reference to the Leslie Company drawings.

3.3.2.3 Causes of Transmission Bearing Problem

As will be noted from the parts replacement data in Table B-1 of Appendix B and the CASREP history in Table C-1 of Appendix C, the replacement of bearings in the transmissions of lube oil standby service pump turbines is not a class problem. MDS data contain 7 reports of 26 individual bearing replacements by only 6 ships of the DDG-37 Class (20 replacements on NSN 1 HM 2010-00-399-3455 and 6 replacements on NSN 1 HM 2010-00-399-3456), and 11 of the 26 replacements (42 percent) were on one ship.

An effort was made to isolate the cause or causes of these replacements by analysis of the MDS narratives and by discussions with ship operating personnel during ship visits. In neither of these areas was a positive cause clearly identified. Thus it is only possible to speculate on the underlying cause, which is most probably loss of lubrication. In this regard, it appears that there is no established procedure for assuring proper oil flow through all installed oil passageways to the bearings of the turbine transmission. Since this turbine transmission is equipped with

a self-contained, closed lubrication system, there is no way to determine if lube oil is actually passing through each passageway to its intended bearing. Consequently, a bearing could be starved for lubricating oil, although installed pressure and temperature gages indicate that conditions are otherwise normal. Subsequent observation of a temperature rise in the oil may be after bearing failure.

To check out the oil passageways, it would be necessary to disassemble the transmission completely. Clearly, this minute inspection of oil passageways is feasible only during major overhaul of the lube oil standby service pump. To positively preclude the loss of lubrication to these turbine transmission bearings during the extended operating cycle, these oil passageways should be checked for freedom from constriction during the Baseline Overhaul and also during each subsequent regular overhaul.

3.3.2.4 Recommendations for Standby Lube Oil Service Pumps

On the basis of the foregoing discussion, the following actions are recommended:

- Advise all DDG-37 Class ships of the existence of Leslie Company drawings, No. 1278F,Alt. 3 and No. 2838F,Alt. 1, for use in maintenance of Leslie governors, and revise PMS documents MIP E-9/78-37 and MRC 94 E85 M N to reflect the guidance contained in these drawings.
- During the Baseline Overhaul and each subsequent regular overhaul, check the oil passageways to the bearings of the turbine transmission for freedom from constriction.

3.3.3 Lube Oil Duplex Strainers (APLs 750080084, 750260010, 750440006)

Each DDG-37 Class ship is equipped with two 5-inch lube oil duplex strainers. These units strain and filter foreign matter from the lubricating oil before it enters the bearings and oil sprays. The construction of the duplex strainer permits diversion of lubricating oil flow through either of two chambers. Installed in each chamber is a removable wire-mesh strainer basket, or "sediment strainer element" as it is designated on the Allowance Parts Lists. Duplex strainers identified by APL 750080084 are originally equipped with removable arrays of bar magnets inserted within the baskets to further improve straining and to permit easier access for removal of ferrous particles. Some duplex strainers identified by APLs 750260010 and 750440006 are backfitted with removable horseshoe-type magnet arrays, although the Allowance Parts List does not now include these magnets as it does for the strainers of APL 750080084. These facts were learned during shipboard discussions.

3.3.3.1 Duplex Strainer Basket Problem and Its Cause

Table 3-1 shows that duplex strainers are responsible for a maintenance burden of an average of 11.8 man-hours per component per operating year. In view of the continuous use of these strainers while the ship is underway, it is not an excessive burden and is not indicative of any major problem. Further, MDS narrative reports revealed that 36 percent of the reported effort has actually been devoted to the maintenance of safety covers over the duplex strainers; thus only 64 percent is attributable to the strainers themselves. However, there was evidence in the MDS narratives of frequent recurrence of a minor problem -- discovery of tears or punctures in the wire mesh of the strainer baskets.

Since there are no moving parts within the wire mesh baskets of the duplex strainers, there is only one possible cause for these tears and punctures. Ship visits indicate that the wire mesh is being snagged and torn by the magnet corners as these magnet arrays are inserted into or removed from the strainer baskets. The clearances between the basket and magnets are approximately 1/4 inch; therefore, considerable care is necessary when these individual components are being assembled. The parts usage data shown in Table B-1 (Appendix B) do indicate five replacements of "sediment strainer elements"; however, the MDS narratives reveal that the ships obtain considerable assistance from tenders in the manufacture of replacement baskets.

3.3.3.2 Recommendations for Duplex Strainers

The initial recommendation is to advise ship personnel to exercise more care in assembling the parts of duplex strainers. However, the basic cause of the mesh tearing problem will be eliminated if ship personnel are instructed also to round the sharp edges and corners on the magnets. In addition, purchase specifications for replacement magnets should be modified to require that no sharp edges or corners exist on these magnets.

3.4 PROPULSION TRANSMISSION SYSTEM

3.4.1 Main Reduction Gears

3.4.1.1 Problems of Main Reduction Gears

Each DDG-37 Class ship is equipped with two main reduction gears: DDG-37, -38, -39, -45, and -46 utilize DeLaval units, while DDG-40 through -44 utilize Falk/Allis-Chalmers units. The APL/CID identifications of these reduction gears are listed in Table 3-1 and in Table A-2 of Appendix A. In Table 3-1, it will be noted that the MDS-reported average man-hour

expenditure per component per operating year for DeLaval reduction gears is 3.6 times greater than that for Allis-Chalmers reduction gears. Some of the variations in maintenance burdens could be attributed to the design difference between these gears.

On the basis of CASREP analysis, study of the narrative summaries, and discussions with operating personnel, it is concluded that neither of the manufacturer's reduction gears are experiencing any significant, class-wide mechanical problem. There is evidence from the narrative summaries that both manufacturers' reduction gears require a certain amount of characteristic corrective maintenance that can be caused by the following:

- Improperly functioning sight flow indicators
- Leaking oil seals
- Centrifuged dirt in flexible couplings
- Rust inside casing due to condensation
- Excessively worn jacking gears
- Excessive clearance in main thrust bearings

There is also evidence in the narrative summaries that the reported maintenance man-hours contain a mix of both PMS effort and corrective maintenance; however, neither gear design has experienced any significant mechanical problem. As stated above, some characteristic corrective maintenance is necessary on both the DeLaval and Falk/Allis-Chalmers gears, and the parts usage analysis has confirmed that the following two recurring maintenance situations affect parts usage:

- Malfunctioning of sight flow bushings and dirty observation windows on main reduction gears
- Discovery of centrifuged dirt in the flexible couplings of each main engine

3.4.1.2 Causes of Observation Window and Flexible Coupling Problems

Dirty sight flow bushings, dirty reduction-gear observation windows, and centrifuged dirt in flexible couplings all indicate that the lube oil circulated through some DDG-37 Class main engines must contain suspended dirt that was not removed by the duplex strainers or the lube oil purifiers. Since normal U.S. Navy engineering practice has always been to exercise the greatest care possible in maintaining cleanliness in Main Lube Oil Systems, it is unlikely that the dirt is being newly introduced by careless operational practices. An engineering evaluation of the sources of this dirt has been performed; it has considered available historical information in the DDG-37 Class MDS data, as well as documented PMS instructions. Because the historical information does not clearly identify a source of this dirt, it is an engineering judgment that the dirt must have already been present somewhere in the system. This assessment has been supported by discussions with ship personnel, who have confirmed that dirt is found frequently in

both the lube oil settling tanks and the lube oil storage tanks. It is only possible to speculate that the lube oil picks up dirt from these sources; however, there are no possible sources other than initially dirty lube oil being received.

In the effort to establish precisely the source of this dirt, it was found that the existing PMS requirements set forth on Maintenance Requirement Card A5 H81F N call for a semiannual cleaning and inspection of lube oil sumps beneath the reduction gears; there is no requirement to carry out the same sort of semiannual maintenance on lube oil settling tanks. Instead, MIP E-10/47-37 and MRC 76 K43L N call for the tanks to be cleaned only once every three years. As discussed previously, these tanks do accumulate dirt in their lower portions. Although their suction connections are well above the expected level of settled-out dirt, it is possible that the lube oil itself stirs up this dirt. It is concluded that both the settling tanks should be cleaned at the same time as the main lube oil sumps -- that is, at least semiannually -- to improve the cleanliness in these parts of the lube oil system. Similarly, lube oil storage tanks should be cleaned at the time of the Basline Overhaul and at every regular overhaul thereafter.

3.4.1.3 Recommendations for Main Reduction Gears

On the basis of the foregoing discussions, the following actions are recommended:

- Revise PMS requirements for the Propulsion Lube Oil System, MIP E-10/47-37, to require inspection and cleaning of lube oil settling tanks semiannually. In addition, when lube oil samples indicate the presence of excessive dirt in the lube oil, perform more frequent cleaning of these tanks as required.
- Clean lube oil storage tanks at the time of Baseline Overhaul and at every regular overhaul thereafter.

3.4.2 Propeller Assemblies

Each ship of the DDG-37 Class is equipped with two propeller assemblies, which are accessible only to divers when the ship is afloat. Apart from assisting tender personnel during their diver inspections of the hubs and propeller blades, no actual maintenance is performed on propellers by Ship's Force, as confirmed by a study of the narrative reports. Further corroboration came from discussions with ship personnel during ship visits. When a propeller requires repairs, the necessary work generally will be beyond Ship's Force capability, and the repairs will be undertaken by either a shipyard or a tender.

Table 3-1 reports 850 man-hours of IMA effort on propeller assemblies; it was established from the MDS narratives that most of this effort was devoted to diver inspections of the DDG-37 Class propellers. The $143,043 parts-cost burden shown in Table 3-1 is due to three propeller assembly replacements.

3.4.3 Line Shaft Bearing Assemblies

The inboard propulsion shafting of each DDG-37 Class ship is supported by six steady (spring) bearings, which are identified as Line Shaft Bearing Assemblies (APLs 371010128, 371010129) in Table A-3 (Appendix A). These anti-friction, metal-lined, horizontally split, ring-oiled bearings are spherically seated in bearing pedestals. Lubrication is provided by shaft-rotated oiler rings carrying oil from the oil sump in the pedestal up onto the shaft journal. These oiler rings hang loosely on the top of the shaft journal and are kept in proper longitudinal position on the shaft by fixed oil ring guides attached to the upper half of the spring bearing. Access covers are provided over these guides for inspection of the journals and oiler rings.

Analysis of DDG-37 Class MDS data indicates that each bearing has required an average of 12.8 man-hours per spring bearing operating year. The MDS narrative summaries indicate that this maintenance effort was expended primarily on repairs to oiler rings and replacement of wiped or otherwise damaged bearings. Both the low parts cost of $3129, shown in Table 3-1, and the low reported parts usage observed during the MDS data analysis establish that there is no serious, class-wide problem with DDG-37 Class spring bearings. However, there is evidence of a mechanical problem that appears to be immediately controllable without undue effort.

3.4.3.1 Line Shaft Bearing Problems and Their Cause

The MDS narratives revealed that 6 ships reported 10 instances of scored, wiped, or grooved steady bearings. Similarly, 3 ships submitted reports of oiler rings failing to rotate and properly lubricate the shaft journal surfaces. One ship attributed a wiped steady bearing directly to failure of the oiler rings to turn on the shaft. Analysis of the MDS narrative reports reveals that most steady bearing failures are related to (1) misalignment of the bearing, (2) poor adhesion of babbitt metal to the bearing shell, or (3) loss of or inadequate lubrication.

Misalignment and poor babbitt adhesion are quality control problems beyond the control of Ship's Force; they always require shipyard or industrial assistance. However, assurance of adequate lubrication of the steady bearings is an operational problem that Ship's Force must control. Fortunately, steady bearings are very simple mechanical devices that have been in marine use for many years, and their few problems are well understood. Inadequate lubrication is caused either by insufficient lubricating oil in the base sump of the bearing or by failure of the oiler rings to bring the lubricating oil up onto the shaft journal. If Ship's Force positively addresses these two requirements, there generally are few operational difficulties.

MDS data confirm that oiler rings do fail to rotate on occasion and thus cannot perform splash lubrication of the shaft journals. Discussions with ship personnel during ship visits also have further corroborated that there are occasional problems with the joints of oiler rings. The

oiler rings are made in halves, and there are two joints on each ring that are riveted together. It is possible for a mismatched or loose joint or a protruding rivet head to create an obstruction that can hang up on the oiler ring guides. Since clearances in these guides are so loose, the oiler rings may temporarily assume canted positions not exactly at a right angle to the shaft centerline. Hence, if there is a protrusion, lip, or crevice on the oiler ring, it may get caught in the guides when it is so canted.

Review of existing PMS requirements shows that no Maintenance Requirement Card or MIP E-12/139-A6 currently requires opening of spring bearing access covers during operation to ascertain that oiler rings are, in fact, rotating freely. Further, Maintenance Requirement Card 13 1 KLB N requires that oiler ring joints be inspected for tightness only once every three-year cycle. Therefore, new MRCs requiring daily checks of oiler rings (when the ship is underway) and annual checks for ring tightness are recommended. These MRCs are presented in Appendix D.

3.4.3.2 Recommendations for Line Shaft Bearings

On the basis of the foregoing discussion, the following actions are recommended for line shaft bearings:

- When the ship is underway, the oiler rings of each line shaft bearing should be checked at least once a watch to ensure that they are free and rotating.
- PMS requirements should be revised to require checks on oiler rings each watch.
- PMS requirements should be revised to require annual inspections of oiler rings instead of once each cycle.
- Ship personnel should be cautioned to ensure that there are no protrusions, lips, or cracks on the surfaces of oiler rings.

3.5 MAINTENANCE PHILOSOPHY

This analysis has included a detailed review of the following Maintenance Index Pages (MIP) and their associated Maintenance Requirement Cards:

MIP Control Number	System, Subsystem, or Component
E-2/14-95	Main Reduction Gears
E-9/78-37	Main Lube Oil Pump
E-10/47-37	Propulsion Lube Oil System
E-10/56-75	Lube Oil Purifier Heater
E-11/65-96	Purifier (Sharples)
E-12/139-A6	Main Shafting
E-21/3-93	Electric-Driven Lube Oil Pump
E-24/28-65	Main Lube Oil Cooler
E-44/10-66	Lube Oil Duplex Strainers

The maintenance philosophy expressed in these documents is generally adequate for maintaining the DDG-37 Class Main Lube Oil and Propulsion Transmission Systems throughout an extended operating cycle. However, as previously discussed, revisions to some Maintenance Index Pages and their Maintenance Requirement Cards appear necessary to improve preventive maintenance and reduce corrective maintenance. The recommended revisions of these existing documents and recommended write-ups of new MRCs are presented in Appendix D, together with a DDEOC MRC Evaluation summary.

3.6 BASELINE OVERHAUL REPAIR REQUIREMENTS

The Baseline Overhaul in the DDEOC Program is designed to provide the maintenance necessary to restore a ship to a condition in which, with a well engineered and executed maintenance program, it can be expected to perform satisfactorily over an extended operating cycle.

The "Repair Profile for Basline Overhaul (BOH) of DDG-37 Class", May 1977, sets forth a detailed listing of repair items to be expected for the Main Lube Oil and Propulsion Transmission Systems. The results of this analysis support the recommendations of this "Repair Profile for Baseline Overhaul (BOH) of DDG-37 Class"; however, three recommended additions are presented in Table 3-3.

Table 3-3. RECOMMENDED CHANGES TO THE DDG-37 CLASS REPAIR PROFILE FOR BASELINE OVERHAUL

SWBS	Repair Profile Item	Recommended Additions
123	Trunks and Enclosures	
	1. Tanks - Lube Oil	
	• Lube Oil Settling and Storage Tanks	The Repair Profile does not specifically mention cleaning the settling/storage tanks. To assure maximum possible cleanliness in the Main Lube Oil System, these tanks should be entered and totally cleaned and inspected for excessive corrosion.
262	Main Propulsion Lube Oil System	
	1. Main Lube Oil Standby Service Pumps	Repairs should include a check to ensure that all tubes and drilled passages transmitting lubricating oil to bearings within the pump transmissions are fully open and clean.
	2. Sump Tanks	The Repair Profile does not specifically mention the cleaning of main reduction gear lube oil sumps. To assure maximum possible cleanliness in the Main Lube Oil System, these sumps should be entered and totally cleaned during BOH.

3.7 BASELINE OVERHAUL SHIPALT REQUIREMENTS

This analysis has included a review of the status of ShipAlts applicable to the Main Lube Oil and Propulsion Transmission Systems of the DDG-37 Class. Available information indicates that there is only one applicable incomplete ShipAlt, DLG9-367K, Low Lube Oil Pressure Alarm, which has been completed only on DDG-45 according to discussions with PERA(CRUDES).

ShipAlt DLG-9-367K separates the main engine lube oil alarm from the other engineering plant lube oil alarms and provides the main engines with a unique audible signal and siren. The ShipAlt will provide for the early detection of lube oil failures so that corrective action can be taken before catastrophic failure occurs. Therefore, it is recommended that this ShipAlt be completed on all DDG-37 Class ships during BOH if not previously accomplished.

3.8 INTRACYCLE MAINTENANCE REQUIREMENTS

Analysis of the Main Lube Oil and Propulsion Transmission Systems has shown that these systems' components do not represent a major maintenance burden to the DDG-37 Class. It is concluded that all intracycle maintenance requirements for these two systems are adequately addressed by the current PMS procedures as modified by recommendations of this report.

3.9 FOLLOW-ON ROH REQUIREMENTS

The repair-type maintenance actions required by the Main Lube Oil and Propulsion Transmission Systems during follow-on regular overhuals will be defined primarily by Pre-Overhaul Tests and Inspections (POT&I) and drydock inspections. Technical Repair Standards that apply to all components of these two systems of the DDG-37 Class have not yet been issued. The three recommended additions to the Baseline Overhaul described in Table 3-3 are also recommended for accomplishment during each follow-on regular overhaul.

CHAPTER FOUR

CONCLUSIONS AND RECOMMENDATIONS

4.1 CONCLUSIONS

The following significant conclusions resulted from this Review of Experience:

- Main Lube Oil System
  - The DDG-37 Class Main Lube Oil System is reliable; however, the lube oil purifiers of this system have experienced significant numbers of failures of spindle bearings and idler pulley bearings.
  - Most failures of spindle bearings and idler pulley bearings are attributable to inadequate lubrication.
  - Main Lube Oil System CASREPs have been few and minor.
  - The Main Lube Oil System can be expected to continue with the same reliable performance during the extended operating cycle and should not require major restorative maintenance.
  - The Main Lube Oil System has not contributed significantly to the overall class maintenance and parts usage burden, although the lube oil purifiers are the source of the greatest burdens within this system.
  - Accomplishment of the one outstanding ShipAlt, DLG9-367K, Low Lube Oil Pressure Alarm, on all DDG-37 Class ships will reduce the probability of catastrohpic failure of the Main Lube Oil System.
- Propulsion Transmission System
  - The DDG-37 Class Propulsion Transmission System is reliable and currently suffers no chronic maintenance problems. Propulsion Transmission System CASREPs have been few and minor, and the system has not contributed significantly to the overall class maintenance and parts usage burdens.
  - The Propulsion Transmission System can be expected to continue the same reliable performance during the extended operating cycle and should not require major restorative maintenance.

4.2 RECOMMENDATIONS

Corrective actions and improvements required for the Main Lube Oil and Propulsion Transmission Systems are grouped as follows:

- Baseline Overhaul (BOH) Requirements
- Intracycle Maintenance Requirements
- Follow-On ROH Requirements
- Reliability and Maintainability Improvements
- Planned Maintenance System Changes
- Depot-Level Improvements
- IMA Improvements
- Integrated Logistic Support (ILS) Improvements

Tables 4-1 and 4-2 summarize all recommendations resulting from this Review of Experience. A detailed listing of recommended PMS changes is included in the DDEOC MRC Evaluation form (Appendix D). Actions items resulting from these recommendations are listed in the DDEOC Action Table (Appendix E).

Table 4-1. SUMMARY OF ROE RECOMMENDATIONS FOR DDG-37 CLASS MAIN LUBE OIL SYSTEM

Component	Recommendation
Baseline Overhaul Requirements	
A. ShipAlts	
Main Lube Oil System	Accomplish ShipAlt DLG9-367K, Low Lube Oil Pressure Alarm, on all DDG-37 Class ships.
B. Repairs	
Main Lube Oil System	Perform repairs as shown to be necessary by Pre-Overhaul Tests and Inspections.
	Bring all Main Lube Oil Systems up to the highest feasible condition of cleanliness by thorough cleaning of all lube oil tanks and main reduction gear sumps. If necessary, flush piping to achieve maximum cleanliness.
Standby Service Pumps	During Baseline Overhaul of a pump, ensure that all tubes and passages for transmitting lubricating oil to the bearings within the pump transmissions are fully open and clean.
Intracycle Maintenance Requirements	
All Equipments of the Main Lube Oil System	Accomplish existing PMS requirements as modified by recommendations of this report.
Lube Oil Purifiers	DDEOC Technical Group observe and determine the usable life of lube oil purifier spindle bearings and develop predictions of when spindle bearings should be replaced.
	Advise DDG-37 Class ships that spindle bearings should be replaced in pairs, not singly.
Follow-On ROH Requirements	
All Equipments of the Main Lube Oil System	Perform repairs as shown to be necessary by Pre-Overhaul Tests and Inspections.
Reliability and Maintainability Improvements	
Main Lube Oil System	Maintain maximum possible degree of cleanliness in all parts of the system.
Lube Oil Purifiers	Place a warning sign on top of the belt guard of each lube oil purifier calling attention for the lubrication of spindle bearings once an hour and idler pulley bearings every two hours.
Duplex Strainers	Advise DDG-37 Class ships that the high frequency of tears and punctures in strainer baskets is attributed to sharp corners on magnets and lack of care in inserting the magnets.
	Round the sharp edges and corners on the magnets.
Planned Maintenance System Changes	
Main Lube Oil System	Revise Maintenance Requirement Cards (MRCs) A5 H81F and 76 K43 L to require gas freeing of reduction gear sumps, examinations for corrosion, and cleaning of settling tanks at the same frequency as reduction gear sumps.
Lube Oil Purifiers	Revise existing MRCs and add new PMS MRCs to specifically require (1) lubricating spindle and idler pulley bearings, (2) cleaning oil passages in lube oil purifier bearing pulley cap assemblies, (3) checking the cleanliness of felt bearing oil filters of bearing pulley cap assemblies, and (4) cleaning purifier bowls and checking bowl boss sleeves and drag assemblies.
Standby Service Pumps	Revise MRC 94 E 85M N, Lube Oil Pump, to reflect the guidance contained in Leslie Company drawings.
Depot-Level Improvements -- None	
IMA Improvements -- None	
Integrated Logistic Support (ILS) Requirements	
Lube Oil Purifiers	Advise DDG-37 Class ships that NSN 1 HM 3110-00-991-0901 NT is the correct NSN for identifying purifier spindle bearings on lube oil purifiers, APL 760010033.
	Stock and issue spindle bearings in pairs, not singly. Change Allowance Parts Lists to reflect this policy.
	Issue a 1200 PSI Steam Propulsion Plant Improvement Advisory to call attention to the hourly lubrication requirements and to the requirement for cleaning purifier bowls every time the purifier is stopped and not less than once a watch.
	Revise the Engineering Operational Procedure for DDG-37 Class lube oil purifiers to require checking of the felt filter within the bearing pulley cap assembly, as well as lubrication of spindle bearings every hour and idler pulley bearings every two hours.
	Check existing training courses for DDG-37 Class lube oil purifiers to ensure that course instruction is included on their proper lubrication.
Duplex Strainers	Purchase specifications for replacement magnets should require the smoothing and rounding of sharp edges on the magnets.
Standby Service Pumps	Advise all DDG-37 Class ships of the existence of Leslie Company Drawings 1278F, Alt. 3 and 2838F, Alt. 1 to assist in the maintenance of Leslie pressure regulators for standby service pumps.

Table 4-2. SUMMARY OF ROE RECOMMENDATIONS FOR DDG-37 CLASS SYSTEM PROPULSION TRANSMISSION

Component	Recommendation
Baseline Overhaul Requirements	
A. ShipAlts	None.
B. Repairs	
All Equipments of the Propulsion Transmission System	Perform repairs as shown to be necessary by Pre-Overhaul Tests and Inspections and drydock inspections.
Intracycle Maintenance Requirements	
All Equipments of the Propulsion Transmission System	Accomplish existing PMS requirements as modified by recommendations of this report.
Follow-On ROH Requirements	
All Equipments of the Propulsion Transmission System	Perform repairs as shown to be necessary by Pre-Overhaul Tests and Inspections and drydock inspections.
Reliability and Maintainability Improvements -- None	
Planned Maintenance System Changes	
Line Shaft Bearings	Prepare and issue a new Maintenance Requirement Card that will call for a daily underway check of oiler ring rotation. Prepare and issue a new Maintenance Requirement Card that will call for an annual check of oiler ring joint tightness. When underway, the oiler rings of each line shaft bearing should be checked once a watch to ensure that the rings are free and rotating. Caution DDG-37 Class ships of the importance of tight oiler ring joints and the dangers of protrusions.
Depot-Level Improvements -- None	
IMA Improvements -- None	
Integrated Logistic Support (ILS) Requirements -- None	

REFERENCES

The specific sources of information used as a basis for the Review of Experience of the Main Lube Oil and Propulsion Transmission Systems are listed below:

1. Ship Information Book USS COONTZ (DLG-9) NAVSHIPS SIB-DLG-9-1 N.S. 0905-475-4010.
2. Generations III and IV MDS part and maintenance data for DDG-37 Class, 1 January 1970 through 31 October 1976.
3. CASREP data for DDG-37 Class for the period 1 July 1973 through 30 June 1976.
4. NAVSHIPS 341-1317, Technical Manual, DeLaval Propulsion Turbines and Reduction Gears (DDG-37, -38, -39, -45, and -46).
5. NAVSHIPS 341-1305, Technical Manual, Allis-Chalmers Propulsion Turbines and Reduction Gears (DDG-40, -41, -42, -43, and -44).
6. NAVSHIPS 347-2336, Technical Manual, DeLaval Lube Oil Standby Service Pump.
7. NAVSHIPS 0945-003-6010, Technical Manual, Sharples Lube Oil Centrifugal Purifier.
8. NAVSHIPS 0345-046-7000, Technical Manual, Sharples Lube Oil Centrifugal Purifier.
9. Ship Alteration Information Manual, PERA (CRUDES) PHILANAVSHIPYD, 30 June 1977.
10. Alteration Management System, Alteration Status Matrix, CNSL CSMP Report 1, 16 February 1977.
11. OPNAVINST 4790.4, Ship's Material Maintenance Management Manual (3-M) Volumes I-III, 1 June 1973.
12. Maintenance Index Pages (MIPs) for DDG-37 Class.
13. Type Commander's COSAL, SURFLANT (19 May 1975) and SURFPAC (19 August 1975).
14. Ship Alteration and Repair Packages (SARPs) for DDG-37, -45, and -46.
15. Depot Level Departure Reports for DDG-37 Class.

16. Repair Profile for Baseline Overhaul (BOH) of DDG-37 Class.

17. NAVSEA Index of Cruiser/Destroyer Technical Repair Standards (TRS) and Repair Material Requirement Lists (MRL), Issue No. 6, March 1978.

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

19. Naval Ships' Technical Manual, Chapter 9420, Propulsion Reduction Gears, Couplings, and Associated Components.

20. Visits to USS MAHAN (DDG-42) and USS PRATT (DDG-44) on 14-15 March 1978.

APPENDIX A

BOUNDARIES OF MAIN LUBE OIL AND PROPULSION TRANSMISSION SYSTEMS

The Main Lube Oil and Propulsion Transmission Systems discussed in this report consist of the components listed in Tables A-1 and A-2. The tables also list 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.

Figures A-1 through A-6 provide a schematic presentation of the DDG-37 Class lube oil purifiers as well as a depiction of the more important lube oil purifier parts. Figures A-7 and A-8 are reproductions of Leslie Company drawings applicable to the turbine governors of the lube oil standby service pump.

Table A-1. CONFIGURATION DATA FOR MAIN LUBE OIL 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
*	ATTACHED LUBE OIL SERVICE PUMP													
	PUMP RTY PWR 610 GPM 50 PSI ATT	262	FDØØ	016160322				2	2	2	2	2		
	PUMP RTY PWR 700 GPM 50 PSI ATT			016160417	2	2	2						2	2
	LUBE OIL STANDBY SERVICE PUMP		▼											
	PUMP RTY PWR 750 GPM 55 PSI TRD		FDØ1	016160255	2	2	2	2	2	2	2	2	2	2
	TURBINE STM LO SER PMP			057150137									2	
	TURBINE STM LO SER PMP			057150170	2	2	2	2	2	2	2			2
	TURBINE STM LO SER PMP			057150179								2		
	COUPLING SHFT FLEX MAX BORE 2.375			782350006	2	2	2	2	2	2	2	2	2	2
	VALVE PMP GOV 1.00 IPS 5 to 25 PSI			882260200	2	2	2	2	2	2	2	2		2
	VALVE PMP GOV 1.00 IPS 15 to 50 PSI			882260480									2	
	STRAINER Y 1.000 IN			750170101	2	2	2	2	2	2	2	2	2	2
	VALVE RELF 3.00 IPS 2 PSI SET			882117077	2	2	2	2	2	2	2	2	2	2
	VALVE RELF 1.50 IPS 11 to 32 PSI			882113674	-	-	-	-	-	-	-	-	2	-
	VALVE RELF .50 IPS 33 to 50 PSI			882115395	-	-	-	-	-	-	-	-	-	2
	VALVE NDL .25 IPS 600 PSI			882070263	2	2	2	2	2	2	2	2	2	2
	LUBE OIL EMERGENCY SERVICE PUMP		▼											
	PUMP RTY PWR 375 GPM 50 PSI MD		FDØ3	016160325	2	2	2	2	2	2	2	2	2	2
	MOTOR AC 440V 50HP			174750611	2	2	2	2	2	2	2	2	2	2
	STARTER MOTOR SZ 3			151203002	2	2	2	2	2	2	2	2	2	2
	SWITCH 1 ELMT PSH			212100193	2	2	2	2	2	2	2	2	2	2
	SWITCH DM 6982 ED 109			212101533	2	2	2	-	-	-	-	-	2	2
	SWITCH SLR 6982 ED 66-14			212101770	-	-	-	2	2	2	2	2	-	-
	SWITCH DM 6982 ED 109			212101845	-	-	-	-	-	1	-	-	-	-
	SWITCH 1 ELMT PSH 6981 ED 149			212103825	-	-	-	-	-	-	-	-	-	2
	SWITCH PRESS 60 to 900 LBS	▼	▼	610010439	2	2	2	2	2	-	2	2	2	2

*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
	SWITCH PRESS 3 to 50 LBS	262	FDØ3	610010505	-	-	-	-	-	4	-	-	-	-
	LIGHT IND TY B 41B			239990037	4	-	-	-	-	-	4	-	-	-
	COUPLING SHFT FLEX MAX BORE 2.625			782350007	2	2	2	2	2	2	2	2	2	2
*	MAIN LUBE OIL COOLER													
	COOLER FD 930 SQ FT TY A		FDØ7	03013035	2	2	2	2	2	2	2	2	2	2
	LUBE OIL SYSTEM PIPING													
	STRAINER DUPLEX 5.000 IN			750080084	2	2	2							
	STRAINER DUPLEX 5.000 IN			750260010				2	2	2	2	2		
	STRAINER DUPLEX 5.000 IN			750440006									2	2
	STRAINER Y 1.50 IPS			750170139	2	2	2	2	2	2	2	2	2	2
	VALVE RELF 5.00 IPS 11 to 28 PSI			882115447	2	2	2	2	2	2	2	2	2	2
	VALVE RELF 4.00 IPS 6 to 78 PSI			882116951	4	4	4	4	4	4	4	4	4	4
	VALVE RELF 3.50 IPS 63 to 71 PSI			882111560	2	2	2	2	2	2	2	2	2	2
	VALVE RELF .50 IPS 25 to 75 PSI			882117339	2	2	2	2	2	2	2	2	2	2
	VALVE GATE 2.00 IPS 150 PSI			882042701	Precise configuration data unavailable.									
	VALVE GATE 1.25 IPS 600 PSI			882042902										
	VALVE GATE 1.25 IPS 600 PSI			882045261										
	VALVE Y 1.00 IPS 1500 PSI			882010220										
	VALVE ANL 1.00 IPS 200 PSI			882000920										
	VALVE GATE 1.00 IPS 200 PSI			882043915										
	VAVLE GATE 1.00 IPS 125 PSI			882041665										
	VALVE NDL GLB .25 IPS 200 PSI			882070100										
	LUBE OIL STORAGE TANK LVL IND													
	INDICATOR SIGHT LIQ			459990059									4	
*	LUBE OIL PURIFIER													
	PURIFIER CTFGL LO			760010033	2	2	2	2	2	2	2	2	2	1

*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
PURIFIER CTFGL LO	262	FDØ7	760010081										1
MOTOR AC 440V 2HP	↓	↓	174030611	2	2	2	2	2	2	2	2	1	1
MOTOR AC 440V 2HP			174030804									1	1
STARTER MOTOR SZ 1			151900908										1
STARTER MOTOR SZ 1			151902810	2	2	2	2	2	2	2	1	2	1
STARTER MOTOR SZ 0			151903496								1		
COUPLING SHFT FLEX MAX BORE 1.000			780090002	2	2	2	2	2	2	2	2	2	2
SWITCH ASSY 2 ELMT 2 PSH			212900018	2	2	2	-	-	2	1	1	-	-
LUBE OIL HEATER													
HEATER STM HTG SUR 11.3 SQ FT			070010068	2	2	2	2	2	2	2	2	2	2

Table A-2. CONFIGURATION DATA FOR PROPULSION TRANSMISSION 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
*MAIN REDUCTION GEAR													
Gear Assy Spd Decr Mn	241	FCØ1	691050039	1		1							1
Gear Assy Spd Decr Mn			691050040	1	1	1							1
Gear Assy Spd Decr Mn			691050043		1							1	
Gear Assy Spd Decr Mn			691050044									1	
Gear Assy Spd Decr Mn			691150094				1	1	1	1	1		
Gear Assy Spd Decr Mn	↓	↓	691150095				1	1	1	1	1		
COUPLINGS													
Coupling Shft Flex Turb HP	242	FCØ1	789990047	-	-	-	2	2	2	2	2	-	-
Coupling Shft Flex Turb LP			789990048	-	-	-	2	2	2	2	2	-	-
Coupling Shft Flex Mn Gr			789990049	-	-	-	8	8	8	8	8	-	-
Coupling Shft Flex Mn Gr			789990050	-	-	-	4	4	4	4	4	-	-
Coupling Shft Flex Mn Gr		↓	789990051	-	-	-	4	4	4	4	4	-	-
Coupling Shft Flex		FEØ4	780190002	-	-	-	2	2	2	2	2	-	-
Coupling Shft Flex Max Bore 1.250		FCØ1	782350002	-	-	-	2	2	2	2	2	-	-
Coupling Shft Flex Max Bore .750	↓	↓	780090001	2	2	2	-	-	-	-	-	2	2
FILTERS													
Filter Air Elctstc	241	FCØ1	480790036	2	2	2	2	2	2	2	2	2	2
TURNING GEAR													
Motor AC 440v 3HP	241	FCØ1	174750650				2	2	2	2	2		
Motor AC 440v 3HP			174801195	2	2	-						2	2
Controller AC Sz 1			151202980				2	2	2	2	2		
Controller AC Sz 1			151901055	2	2	2						2	2
Switch 1 Elmt Push			212101921							2			
Switch Psh			212900875	-	2	2	-	-	-	-	-	-	-
Light Ind Ty B 41C	↓	↓	239990187	-	-	-	2	2	-	-	-	-	-

*Critical Equipment List Item

(continued)

Table A-2. (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
	BEARING ASSEMBLIES													
	Bearing Assy Thr Pvt Sgm Dbl 35.000 x 30.500	241	FCØ1	370010190	2	2	2	2	2	2	2	2		
	Bearing Assy Thr Pvt Sgm Dbl 35.000 x 30.500	↓	↓	370010287									2	2
	PROPULSION SHAFT													
	BEARINGS													
*	Bearing Assy Ln Shft Inbd 20.776 in Dia	244	FEØ3	371010128	2	2	2	2	2	2	2	2	2	2
*	Bearing Assy Ln Shft Inbd 19.135 in Dia			371010129	4	4	4	4	4	4	4	4	4	4
	Bearing Assy Ste Tb			371020336	2	2	2	2	2	2	2	2	2	2
	Bearing Assy Ste Tb			371020337	2	2	2	2	2	2	2	2	2	2
	Bearing Assy Strut Prop	↓	↓	371020338	2	2	2	2	2	2	2	2	2	2
	SHAFTS													
	Shaft Prosn Ship Dia 19.500 in Lgth 352.00 in	243	FEØ3	833000338	-	-	-	2	2	2	-	-	2	-
	Shaft Prosn Ship Dia 20.750 in Lgth 592.875 in			833000434	2	2	2	2	2	2	2	2	2	2
	Shaft Prosn Ship Dia 19.000 in Lgth 72.000 in			833000435	1	1	1	1	1	1	1	1	1	1
	Shaft Prosn Ship Dia 19.000 in Lgth 72.000 in			833000436	1	1	1	1	1	1	1	1	1	1
	Shaft Prosn Dia 19.000 in Lgth 263.688 in			833000437	1	1	1	1	1	1	1	1	1	1
	Shaft Pros Dia 19.000 in Lgth 263.625 in			833000438	2	2	2	1	1	1	2	2	1	1
	Shaft Pros Dia 19.000 in Lgth 263.625 in			833000439	1	1	1	1	1	1	1	1	1	1
	Shaft Pros Dia 19.000 in Lgth 263.625 in			833000440	1	1	1	1	1	1	1	1	1	1
	Shaft Prosn Dia 20.750 in Lgth 652.00 in			833000442	2	2	2	2	2	1	2	2	2	2
	Shaft Prosn Dia 20.750 in Lgth 375.688 in	↓	↓	833000443	2	2	2	2	2	1	2	2	2	2
	SHAFT SEALS													
	Seal Shaft Ste Tb ID 22.500 in	243	FEØ3	831000032	2	2	2	2	2	2	2	2	2	2
	Seal Shaft Ste Tb ID 22.625 in			831000033	2	2	2	2	2	2	2	2	2	2
	Seal Split Type for 22.500 in	↓	↓	831000179	2	2	2	2	2	2	2	2	2	2

*Critical Equipment List Item

(continued)

Table A-2. (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
PROPELLERS													
Propeller Assy 168.0000D 174.250 in PCH 4 BL RH	245	FEØ6	834000364	1	1	1	1		1	1	1	1	1
Propeller Assy 168.0000D 174.250 in PCH 4 BL LH	↓	↓	834000365	1	1	1	1		1	1	1	1	1
Propeller Assy 168.0000D 174.250 in PCH 4 BL LH			834000635					1					
Propeller Assy 168.0000D 174.250 in PCH 4 BL RH	↓	↓	834000642					1					

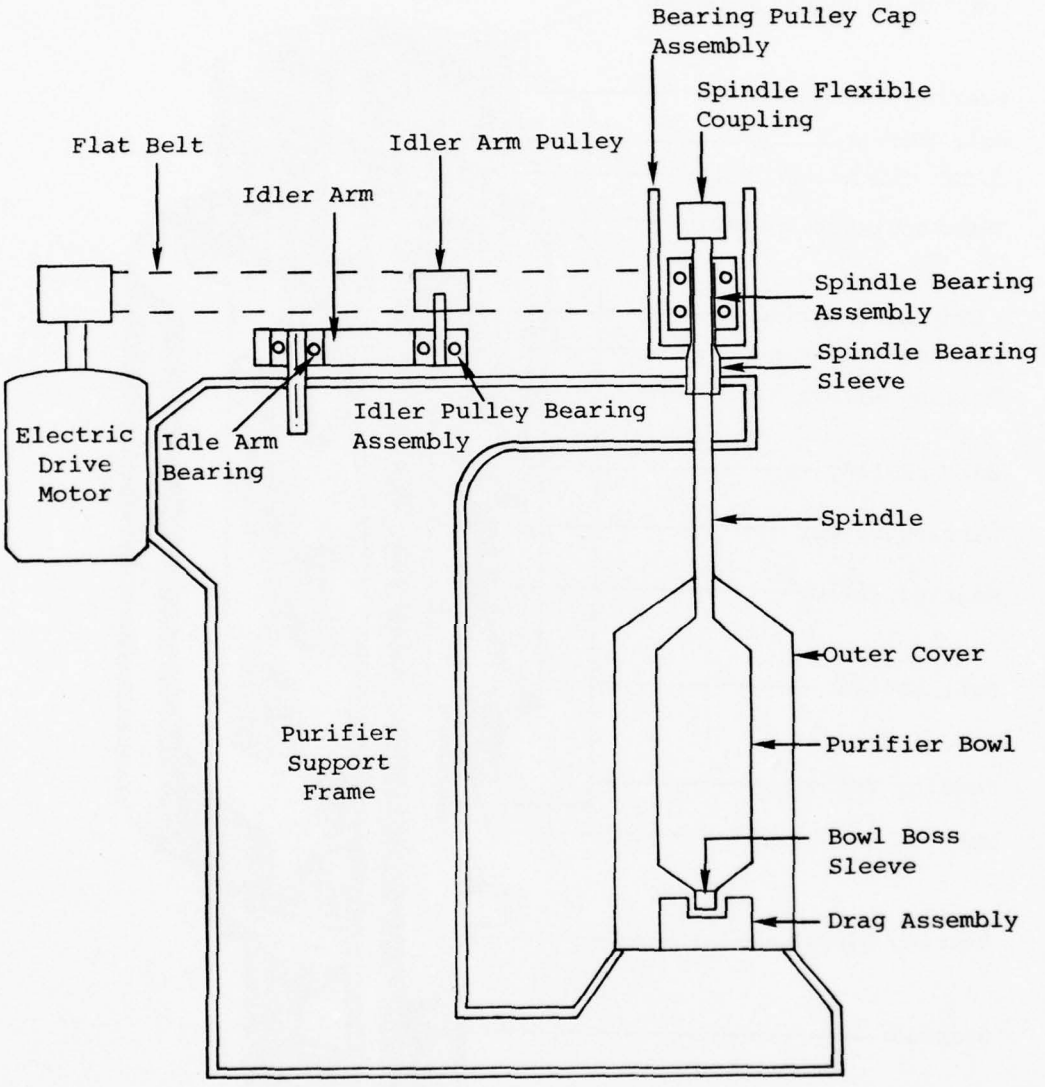


Figure A-1. SCHEMATIC DIAGRAM OF CENTRIFUGAL LUBE OIL PURIFIER

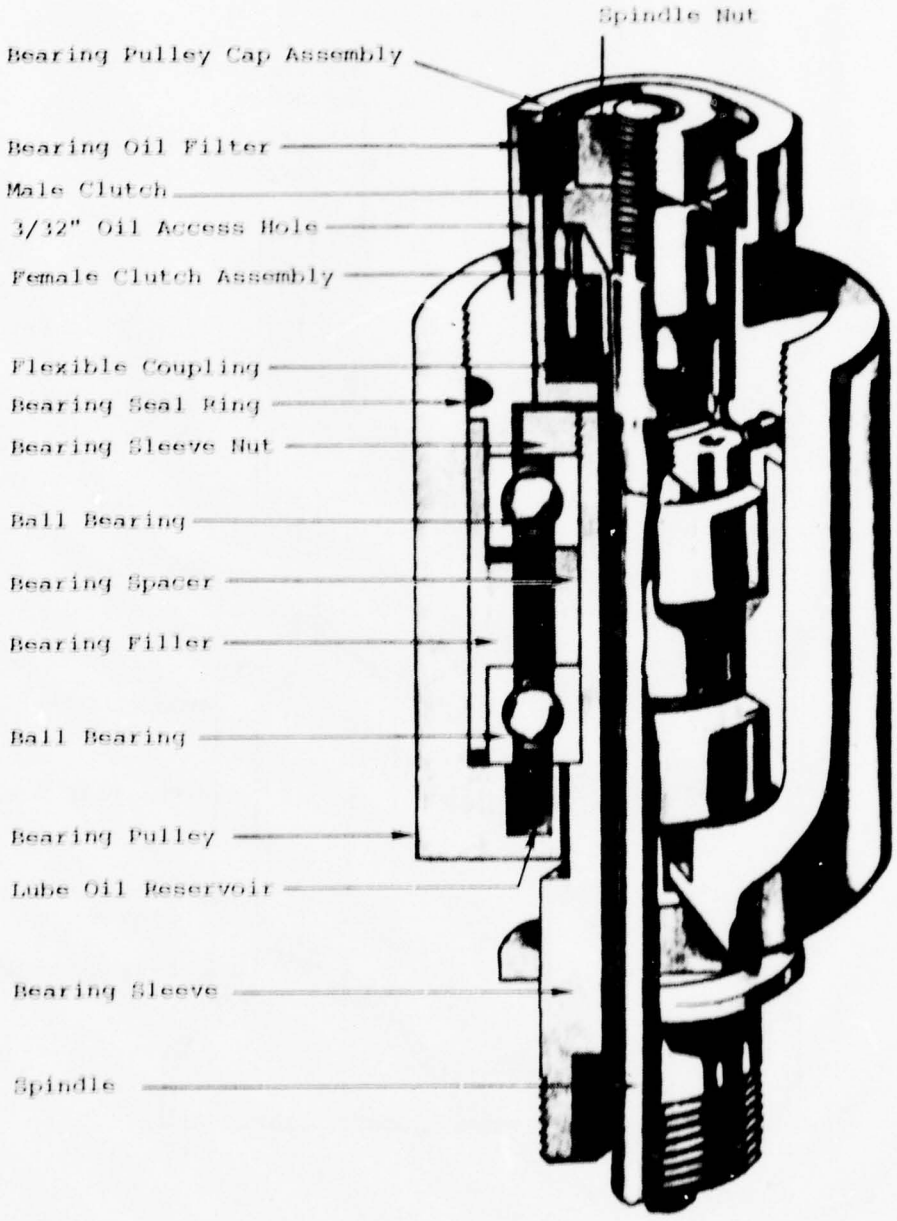


Figure A-2. SPINDLE BEARING ASSEMBLY (from NAVSHIPS Technical Manual 0945-003-6010, Figure 37, p. 4-7)

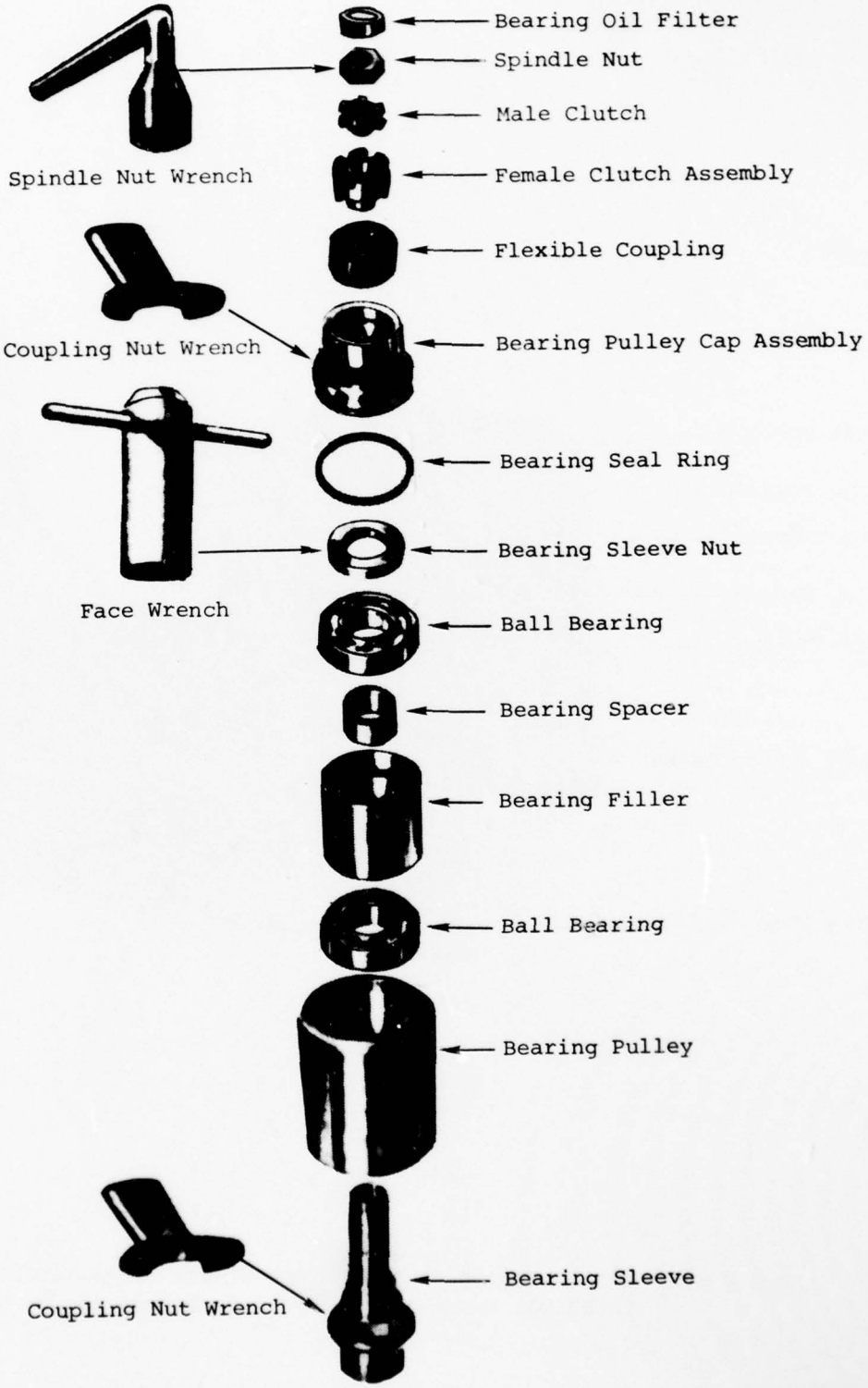


Figure A-3. PARTS AND TOOLS OF SPINDLE BEARING ASSEMBLY (from NAVSHIPS Technical Manual 0945-003-6010, Figure 38, p. 4-8)

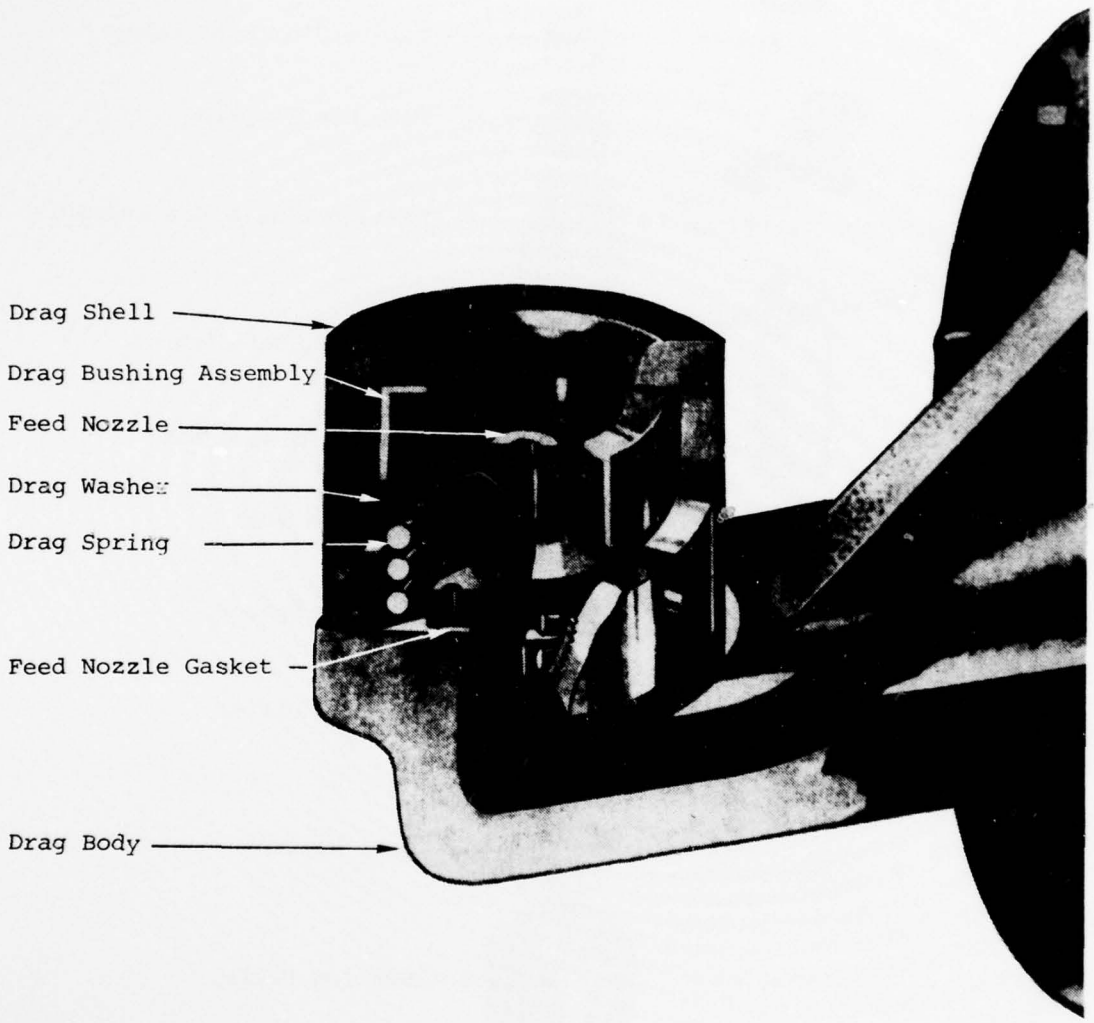


Figure A-4. DRAG ASSEMBLY OF LUBE OIL PURIFIER (from NAVSHIPS Technical Manual 0945-003-6010, Figure 46, p. 4-14)

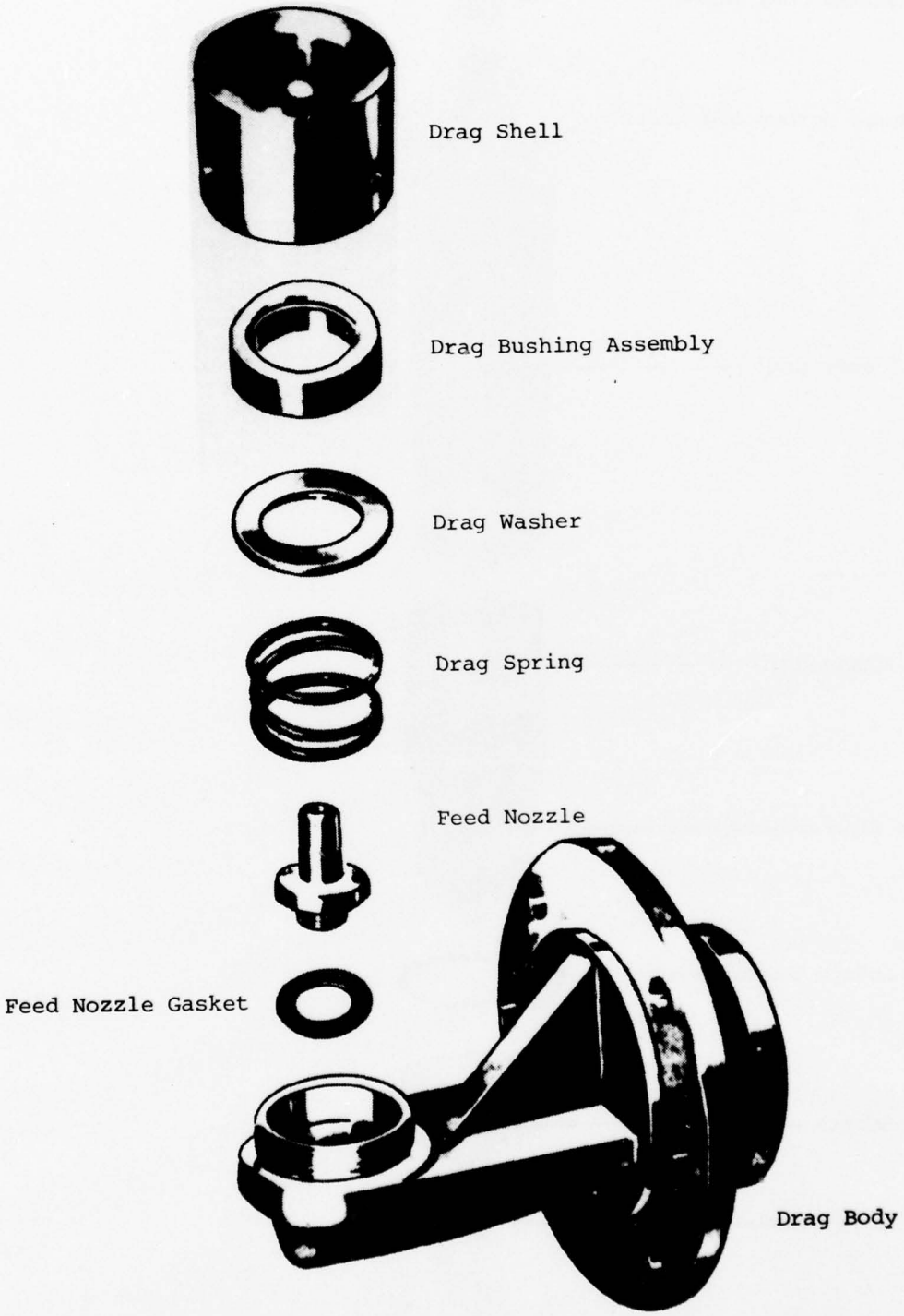


Figure A-5. DRAG PARTS OF LUBE OIL PURIFIER (from NAVSHIPS Technical Manual 0945-003-6010, Figure 48, p. 4-15)

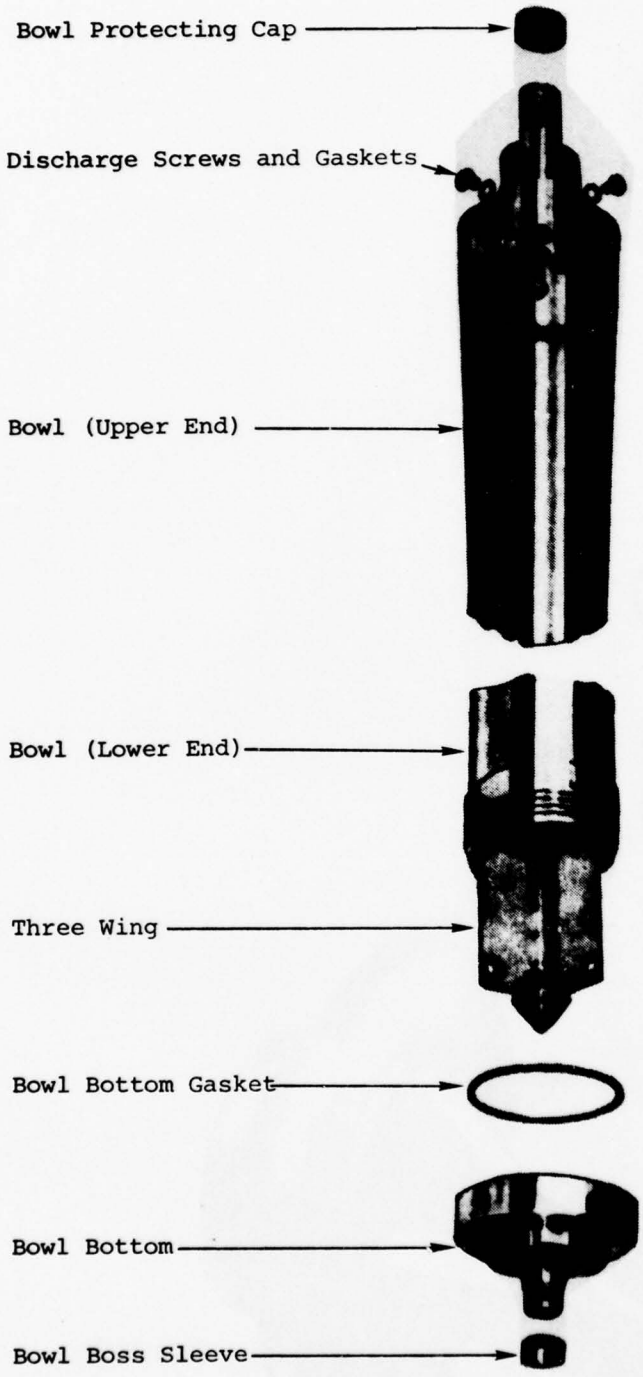
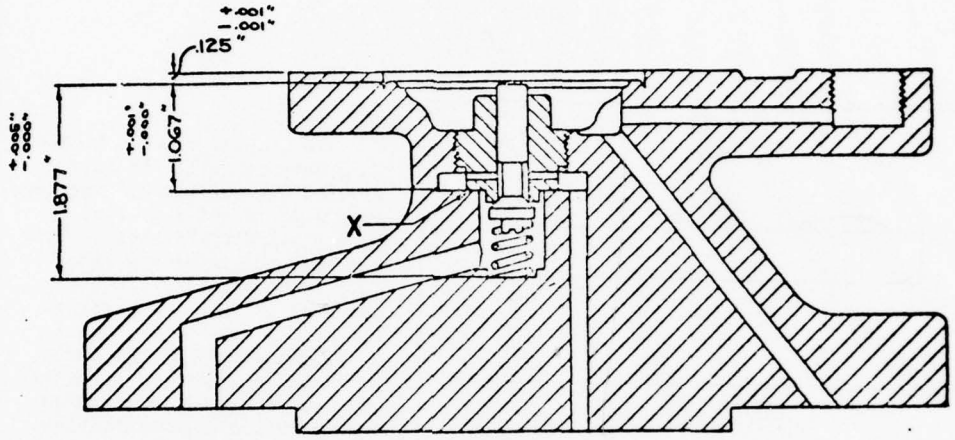


Figure A-6. BOWL PARTS OF LUBE OIL PURIFIER (from NAVSHIPS Technical Manual 0945-003-6010, Figure 30, p. 4-3)

Important points in cleaning and reassembling Top Cap Assembly



A. In order to obtain continually satisfactory service, the joint "X" between controlling valve seat and top cap must be maintained perfectly steam tight at all times.

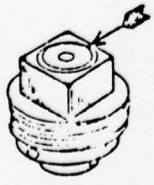
B. Clean all parts including threads with solvent.

C. Polish joint faces at "X" with crocus cloth for metal to metal joint.

D. When installing controlling valve seat, tighten firmly with wrench furnished for this purpose, and, when all way down, tap wrench to insure dead tight joint.

E. Correct clearance between top of controlling valve stem and diaphragm seat is .001" to .002". Maximum clearance permissable is .005".

F. If necessary to remachine top cap, tolerances given must be adhered to. Joint face "X" must be square with axis of thread and have straight smooth finish without any tool marks.



Groove

Ref. 21906 Controlling Valve Seat for Steel Regulators can be distinguished from Ref. 9433 by identification groove as shown on sketch.

LESLIE CO
LYNDHURST, NEW JERSEY

MAINTENANCE INSTRUCTIONS FOR TOP CAPS FOR ALL INTERNAL PILOT OPERATED REDUCING VALVES, PUMP GOVERNORS AND TEMPERATURE REGULATORS, 1/2" - 6" INCL.

DATE 1-23-47 DWG. NO. 1278 F, Alt. 3

DWN JT CKD

Printed in U. S. A.

Figure A-7. LESLIE COMPANY DRAWING NO. 1278 F, ALT. 3

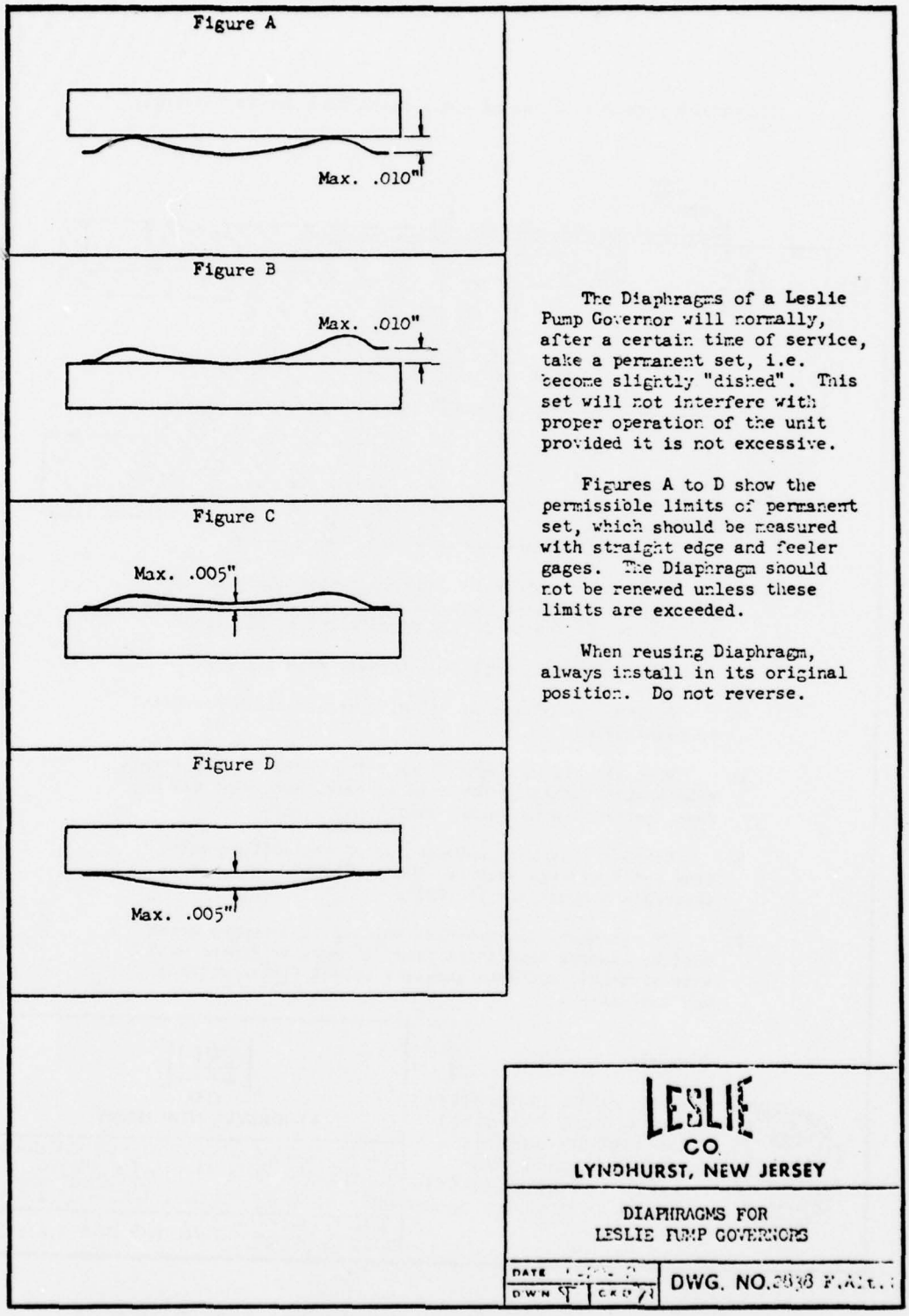


Figure A-8. LESLIE COMPANY DRAWING NO. 2838 F, ALT. 1

APPENDIX B

MDS PARTS USAGE SUMMARY

Table B-1 summarizes parts usage data for the Main Lube Oil System, and Table B-2 summarizes parts usage data for the Propulsion Transmission System.

Table B-1. PARTS USAGE SUMMARY FOR THE DDG-37 CLASS MAIN LUBE OIL SYSTEM

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
NIIN	Nomenclature						
Lube Oil Purifier, APL 760010033							
9Z 3110-00-100-2419 1 HM 3110-00-991-0901NT	Spindle Ball Bearing	11	2	38	338	889	10
1H 3010-00-600-6789	Spindle Flexible Coupling	1	1	19	135	710	10
1HM 3110-00-991-0896NT	Idler Pulley Ball Bearing	8	2	38	171	450	10
9C 3030-00-270-8356	Flat Belt	5	1	19	82	432	10
9C 4330-00-218-5965	Pump Rotary Seal	18	1	19	63	332	9
9Z 5360-00-292-4140	Drag Spring	1	1	19	60	316	10
9C 4330-00-028-[illegible]1	Bowl Boss Sleeve	8	1	19	58	305	10
9C 4330-00-218-5938	Spindle	39	1	19	57	300	10
9C 4330-00-534-5322	Bearing Pulley Cap Assy.	29	1	19	53	279	10
9C 4330-00-368-5782	Spindle Bearing Sleeve	29	1	19	42	221	9
2HH 4300-00-218-5956	Bowl Assembly	1869	1	19	18	95	7
Steam Turbine for Lube Oil Service Pump, APL 057150179							
1HM 2010-00-399-3455	Inboard Bearing	156	1	2	5	250	1
1HM 2010-00-399-3456	Pinion End Bearing	131	1	2	6	300	1
Steam Turbine for Lube Oil Service Pump, APL 057150170							
1H 2010-00-388-0993	Thrust Plate	30	1	16	11	69	5
1H 2010-00-399-3455	Inboard Bearing	156	1	16	15	94	5
Governor Valve for Lube Oil Standby Service Pump, APL 882260200							
9C 4820-00-036-1554	Diaphragm	2	2	36	73	203	9
9C 4320-00-367-1453	Liner	7	1	18	19	106	8
9C 4820-00-909-3134	Valve	28	1	18	23	128	9
Duplex Strainer, APL 750080084							
1HM 4730-00-860-6960	Sediment Strainer Element	328	2	12	5	42	3

Table B-2. PARTS USAGE SUMMARY FOR THE DDG-37 CLASS PROPULSION TRANSMISSION SYSTEM

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
NIIN	Nomenclature						
Main Reduction Gears, APLs 691050039, 691050040, 691050043, 691150095							
9Z 5365-00-619-0111	Sight Flow Bushing	3	4	20	32	160	2
9G 6680-00-527-6255	Observation Window	1	3	9	5	56	2
9G 6685-00-782-5247	Thermometer	20	20	120	21	17	2
Propeller Assembly, APLs 834000364, 834000365							
2S 2010-00-628-3117	Propeller	50500	1	9	2	22	1
2S 3010-00-628-3118	Propeller	50500	1	9	1	11	1

APPENDIX C

CASREP SUMMARY

Table C-1 summarizes categories of CASREPs reported for the Main Lube Oil System, and Table C-2 summarizes categories of CASREPs reported for the Propulsion Transmission System.

Table C-1. CASREP SUMMARY FOR THE DDG-37 CLASS MAIN LUBE OIL SYSTEM

Category	Number of Reports	Number of Ships Reporting	Percent of Total Reports
1. Main Lube Oil System Pumps	9		47
A. Attached Service Pump			11
i. Chipped teeth on bevelled pinion drive gear	1	1	
ii. Bent shaft on bevelled pinion drive gear	1	1	
B. Turbine-Driven Standby Service Pump			33
i. Turbine transmission bearings burnt and shaft scored	4	2	
ii. Turbine bearings worn beyond allowable limits	1	1	
iii. Steam leaks in stop valve	1	1	
C. Electric Emergency Service Pump			3
i. Excessive oil leaks	1	1	
2. Main Lube Oil Centrifugal Purifier	8		42
i. Motor windings shorted	4	2	
ii. Parts wear leading to imbalance	1	1	
iii. Inner cover in need of replacement	1	1	
iv. Spindle bearings, clutch assembly and flexible coupling damaged	1	1	
v. Excessive vibration due to bent motor shaft	1	1	
3. Miscellaneous	2		11
i. Pin-hole leak and hairline crack in duplex strainer	1	1	
ii. Gasket deteriorated in lube oil cooler	1	1	
Total	19	6*	100

*DDG-37, -40, -41, and -42 reported none.

Table C-2. CASREP SUMMARY FOR THE DDG-37 CLASS PROPULSION TRANSMISSION SYSTEM

Category	Number of Reports	Number of Ships Reporting	Percent of Total Reports
1. Propulsion Shaft Bearings	4		50
i. Bearing and shaft scored	1	1	
ii. Bearing babbitt metal separating from shell	1	1	
iii. Bearing wiped due to low lube oil	1	1	
iv. Bearing wiped due to flooding of shaft alley	1	1	
2. Main Engine Reduction Gears	2		25
i. Abnormal vibration in gears	1	1	
ii. Excessive vibration in turning gear	1	1	
3. Propellers:	2		25
i. Propeller and nut loose on shaft; locking key not in position	1	1	
ii. Blade damaged and curled due to striking submerged object	1	1	
Total	8	3*	100

*DDG-38, -39, and -45 only.

APPENDIX D

DDEOC MRC EVALUATION

The DDEOC MRC Evaluation form in this appendix specifies the Maintenance Index Pages of the Main Lube Oil and Propulsion Transmission Systems and their Maintenance Requirements Cards that should be modified or revised and indicates where new MRCs are needed.

The column headings of the DDEOC MRC Evaluation form are explained as follows:

- 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, A = Annually, C = Once every cycle, R = As required, etc.
- Type - Perform maintenance (P), or survey material condition of component (S)
- Who Performs Test - Maintenance action or test to be performed by tender, DDEOC Site Team, or Ship's Force personnel
- Where Performed (self-explanatory)
- Data - Indicates whether data are recorded during performance of maintenance action

Following the DDEOC MRC Evaluation form are examples of Maintenance Requirement Cards showing the recommended revisions to the MIP and MRC documents affected by this study.

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 DDEO
Main Reduction Gears M.I.P. E-2/14-95:										
Clean and Inspect Main Reduction Gear Sump	A5 H81F		X		X		24.0	24.0	S	S
Main Lube Oil Pump M.I.P. E-9/78-37:										
Clean and Inspect Leslie Regulator on Lube Oil Standby Service Pump	94 E85MN		X		X		2.0	2.0	A-1R	A-1R
Propulsion Lube Oil System M.I.P. E-10/47-37:										
Clean and Inspect Lube Oil Settling Tank	76 K43L		X		X		6.2	6.2	C-1	S-1R
Purifier (Sharples) M.I.P. E-11/65-96:										
Lubricate Pump Bearing	96 K78XN		X		X		0.1	0.1	D	R
Clean Purifier Bowl and Check Bowl Boss Sleeve	New		X			X	-	0.5	-	D
Clean Oil Passages in Bearing Pulley Cap Assembly	New		X			X	-	0.5	-	W
Inspect Drag Assembly	96 K78ZN		X		X		1.2	1.2	A	W
Inspect Lube Oil Purifier	96 K78Yn		X		X		1.0	1.0	S	Q
Main Shafting M.I.P. E-12/139-A6:										
Check Oiler Ring Rotation in Line Shaft Spring Bearings	New		X			X		0.5	-	D
Inspect Oiler Rings for Tightness	New		X			X		10.0	-	A

*P = PERFORM MAINTENANCE; S = SURVEY INSPECTION

SHIP CLASS: DDG-37

SMA NO: 37-107-240

SYSTEM: Lube Oil & Propulsion Transmission

DDEOC MRC EVALUATION

MAN-HOURS		FREQUENCY		TYPE*	WHO PERFORMS TEST			WHERE PERFORMED	DATA	REMARKS
PRE 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	
24.0	24.0	S	S	P,S			X	I		Adds requirements to gas-free sumps and to examine for corrosion.
2.0	2.0	A-1R	A-1R	P,S			X	I,S		Adds information on cleaning solvent. Adds information on Leslie drawings.
6.2	6.2	C-1	S-1R	P,S			X	I		Changes periodicity from C-1 to R, as required. Also requires that cleaning occur not less frequently than S.
0.1	0.1	D	R	P,S			X	I,S		Adds requirement to lubricate 2 more bearings on an hourly basis.
-	0.5	-	D	P,S			X	I,S	Yes	Formally schedules cleaning of bowl and checks on bowl sleeve.
-	0.5	-	W	P,S			X	I,S		Formally schedules cleaning of oil passages in bearing pulley cap assembly.
1.2	1.2	A	W	P,S			X	I,S	Yes	Changes periodicity from A-1 to W-2 and introduces a check on drag bushing as recommended by manufacturer.
1.0	1.0	S	Q	P,S			X	I,S		Changes periodicity from semiannually to quarterly. Adds a check on lube oil passages and felt filter in bearing pulley cap assembly.
	0.5	-	D	P,S			X	S		Adds a daily underway check of oiler ring rotation.
	10.0	-	A	P,S			X	I		Adds an annual check of oiler ring joint tightness.

SYSTEM	COMPONENT	MRC CODE
	Main Reduction Gear	E-2 S-[illegible]
SUBSYSTEM	RELATED MAINTENANCE	RATES / M/H
	None	Eng Off 8.0 MM1 16.0 2FN TOTAL M/H 24.0 ELAPSED TIME 8.0

MAINTENANCE REQUIREMENT DESCRIPTION

1. Clean and inspect sump.

SAFETY PRECAUTIONS

1. Comply with Navy Safety Precautions for Forces Afloat, OPNAVINST 5100 Series.

TOOLS, PARTS, MATERIALS, TEST EQUIPMENT

1. 24 gauge Wire
2. Lint-free rags
3. Pencil and paper
4. Gasket punch set
5. 1/2" drive Socket set
6. Circle and hole cutter
7. 6" Slip-joint pliers
8. 1-1/2 lb Ball peen hammer
9. 1/16" Gasket material, Symbol 2290
10. Portable extension explosion-proof light
11. Scissors
12. Bucket (2)
13. Wood block
14. Safety tags
15. Dustpan (2)
16. 6" Steel rule
17. Flange scraper

PROCEDURE

Preliminary

a. Permission to enter reduction gear must be obtained from Engineer Officer. This authority cannot be delegated..
b. De-energize turning gear motor controller and tag "Out of Service."
c. De-energize circuit to lube oil pump(s) and tag "Out of Service."
d. Wire lube oil pump(s) steam and main lube oil system isolation valves shut and tag "Do Not Open."
e. Wire main engine throttles shut and tag "Do Not Open."

1. Clean and Inspect Sump.
   a. Pump oil from sump to settling tank with lube oil purifier.

NOTE 1: Maintain lube oil in settling tank at 160 degrees Fahrenheit. Allow to settle for 24 hours.

Page 1 of 2

LOCATION	DATE	AS	H81F	N
	October 1975			

MAINTENANCE REQUIREMENT CARD (MRC)
OPNAV 4700.1 (REV. 11-75)

Procedure (Cont'd)

b. Clean area around inspection covers.
c. Inventory tools, rags, and materials which will be used to clean sump.
d. Remove dirt from area around access covers.
e. Remove access covers and gaskets.
f. Inspect oil residue for metallic particles and water.

NOTE 2: Report inspection findings to Engineer Officer.

g. Clean sump with lint-free rags.
h. Engineer Officer inspect sump and inventory tools, rags, and other material used to ensure nothing has been left in sump.
i. Clean gasket sealing surface.
j. Install new gaskets; reinstall inspection covers.
k. Remove wire and safety tags from isolation valve(s).
l. Remove safety tags from lube oil pump and turning gear motor controller circuits.
m. Start purifier and purify lube oil from settling tank to sump.
n. Fill sump to full mark; secure purifier.
o. Remove wire and safety tag from main engine throttles.
p. Operate lube oil pump and inspect sump for leaks.
q. Secure lube oil pump.

RECOMMENDED ADDITIONS:

To paragraph e. above add

"Ventilate sump; have Gas Free Engineer verify that sump is safe for entry."

To paragraph h. above add

" Inspect metal surfaces for evidence of corrosion."

Page 2 of 2

AS	H81F	N

MAINTENANCE REQUIREMENT CARD (MRC)
OPNAV 4700.1 (REV. 11-75)

SYSTEM	COMPONENT	MRC CODE
	Lube Oil Pump	E-9 A-1R

SUBSYSTEM	RELATED MAINTENANCE	RATES	M-H
	None	MM2	2.0

MAINTENANCE REQUIREMENT DESCRIPTION

1. Clean and inspect pump pressure regulator.

TOTAL M/H 2.0

SAFETY PRECAUTIONS

1. Comply with Navy Safety Precautions for Forces Afloat, OPNAVINST 5100 Series.

ELAPSED TIME 2.0

TOOLS, PARTS, MATERIALS, TEST EQUIPMENT

1. Scissors
2. Diaphragms
3. Safety tag
4. Feeler gauge
5. Crocus cloth
6. 6" Steel rule
7. 24 gauge Wire
8. 6" Slip-joint pliers
9. 12" Adjustable wrench
10. Special gaskets for caps
11. Fine valve grinding compound
12. _____ Combination wrenches
13. Special wrench, Mfr Part No. IHC403C
14. 3/32" Packing, Symbol 1103 or Teflon equivalent

PROCEDURE

NOTE 1: Accomplish annually, or when regulator starts hunting or overspeeding, whichever occurs first.

Preliminary

a. Wire applicable isolation valves shut and tag "Do Not Open."

1. Clean and Inspect Pump Pressure Regulator.
   a. Disconnect actuating line.
   b. Disconnect union below needle valve assembly.
   c. Remove bottom nuts holding superstructure to top cap.

NOTE 2: When necessary to disassemble superstructure, care must be taken to ensure diaphragm stem, cap, and disk are reinstalled in proper position and connecting rods are free in guides.

   d. Lift off superstructure; remove diaphragm.
   e. Remove control valve seat, valve, and spring.
   f. Remove top cap.
   g. Lift out piston and cylinder liner.

PAGE 1 OF 2

LOCATION	DATE	
	September 1974	N

MAINTENANCE REQUIREMENT CARD (MRC)

Procedure (Cont'd)

   h. Remove bottom cap.
   i. Remove main valve and spring.
   j. Clean piston and cylinder liner; inspect for pits, cracks, or erosion. Ensure piston rings are free in grooves of piston.
   k. Clean valves, valve seats, and springs. Inspect for cracks, pits, or erosion.
   l. Reinstall cylinder liner and piston.
   m. Apply a light coat of fine valve grinding compound to seating surface of main valve.
   n. Lap in main valve; remove valve grinding compound.
   o. Install new bottom cap gasket; reinstall bottom cap with main valve and spring.
   p. Install new top cap gasket; reinstall top cap.
   q. Apply a light coat of fine valve grinding compound to control valve seating surface.
   r. Lap in control valve; remove valve grinding compound.
   s. Reinstall control valve spring, valve, and valve seat.

NOTE 3: Work center supervisor analyze clearances; determine if part(s) renewal is warranted, dependent upon projected equipment usage before next scheduled accomplishment of this Maintenance Requirement.

   t. Measure clearance between stem and diaphragm seat. Clearance is, minimum 0.001", maximum 0.002".
   u. Install new diaphragm; reinstall superstructure.
   v. Reinstall bottom nuts holding superstructure to top cap.
   w. Reconnect union below needle valve assembly.
   x. Reconnect actuating line.

NOTE 4: Pump pressure regulator should be test operated as soon as system/plant conditions permit.

   y. Remove wire and safety tags from applicable isolation valves.

RECOMMENDED ADDITIONS:

1. Paragraphs j. and k. above should state solvent to be used for cleaning. Leslie Co. suggests kerosene.
2. Provide each ship with a copy of Leslie drawings No's. 1278F Alt3 of 29 Jan. '48 and 2838F Alt1 of 20 June '52.
3. Change paragraphs t. and u. above to reflect these drawings.

PAGE 2 OF 2

MAINTENANCE REQUIREMENT CARD (MRC)

SYSTEM, SUBSYSTEM, OR COMPONENT	REFERENCE PUBLICATIONS	DATE
Propulsion Lube Oil System		March 1977

SYSCOM MRC CONTROL NO	MAINTENANCE REQUIREMENT	MEN & QUALITY CODE	SKILL LEVEL	MAN HOURS	MAINTENANCE MATERIAL
76 K43K N	1. Sample and inspect lube oil in reduction gear. 2. Inspect lube oil system piping connections for leaks.	W-1	MM3	0.3	None
17 L39N N	1. Forward samples of lube oil from reduction gear and lube oil storage tank to a laboratory for chemical analysis.	Q-1	MM3	0.5	None
75 H24C N	1. Purify reduction gear lube oil. NOTE: Accomplish quarterly or after extended operations.	Q-2R	MM2	8.0	None
76 K43L N	1. Clean and inspect lube oil settling tank.	C-1	MM3 2FN Gas Free Eng	2.0 4.0 0.2	None
T 37 L82Q N	1. Test lube oil pump automatic start features. NOTE: Accomplish prior to turning main turbines.	R-1	MM1 MM3	0.2 0.2	None
T 37 L82R N	1. Test main lube oil system low lube oil pressure alarm. NOTE: Accomplish prior to turning main turbines.	R-2	MM1 MM3	0.2 0.2	None

RECOMMENDED CHANGES:

1. See MRC 76 K43L N "Clean and inspect lube oil settling tank." Recommend changing periodicity to "R-as required". In addition, the periodicity of cleaning lube oil settling tanks should be not less than "S-semi-annual" so as to at least match the cleaning frequency for lube oil sumps of main reduction gears. The purpose of the change to "R-as required" is to require actual cleaning of the settling tanks if the lube oil samples taken by MRC 17 L39N show a significant amount of suspended dirt in the lube oil. The change would then read " Accomplish semi-annually or whenever lube oil samples taken due to MRC 17 L39N N show excess suspended dirt, whichever occurs first." Delete comments of item 2. under Management aids below.

Management aids:

1. MRCs R-1 and R-2 contain blanks to be filled in by ship's force before implementation. Until these "fill-in" data elements are applied, Maintenance Requirement cannot be effectively accomplished.
2. Review MRC C-1 and omit requirement if not applicable; no feedback report required.

MAINTENANCE INDEX PAGE (MIP)
OPNAV 4790/3 (REV. 11/80)

SYSCOM MIP CONTROL NUMBER F-10/47-3

	COMPONENT	MRC CODE
Propulsion	Lube Oil System	B-10 C-1
SUBSYSTEM	RELATED MAINTENANCE	RATES / M/H
	None	MM3 2.0 2FN 4.0 Gas Free Eng 0.2 TOTAL M/H 6.2 ELAPSED TIME 2.0

MAINTENANCE REQUIREMENT DESCRIPTION

1. Clean and inspect lube oil settling tank.

SAFETY PRECAUTIONS

1. Comply with Navy Safety Precautions for Forces Afloat, OPNAVINST 5100 Series.

TOOLS, PARTS, MATERIALS, TEST EQUIPMENT

1. Portable blower
2. Gasket punch set
3. 1/2" drive Socket set
4. Circle and hole cutter
5. 1/2-lb Ball peen hammer
6. Explosion-proof portable light
7. 1/16" Gasket material, Symbol 2290
8. Bucket
9. Scissors
10. Wood block
11. Safety tags
12. Lint-free rags
13. Hand wire brush
14. 24 gauge Wire

PROCEDURE

Preliminary

a. Ensure settling tank is empty.
b. Wire filling and transfer valves to lube oil settling tank shut and tag "Do Not Open."

1. Clean and Inspect Lube Oil Settling Tank.
   a. Remove settling tank access cover and gasket.
   b. Ventilate tank; have Gas Free Engineer verify tank is gas free.

CAUTION: If wire brushing is necessary, ensure system is not contaminated through pipe openings in tank.

   c. Clean tank; inspect for corrosion.
   d. Install new gasket; reinstall access cover.
   e. Remove wire and safety tag; restore system to normal.

RECOMMENDED CHANGES:

1. Change periodicity to R-as required.
2. Require that cleaning occur not less than S-semi-annual to match cleaning of reduction gear sumps.
3. Require that cleaning take place whenever lube oil samples(taken by MRC 17 L39N) show continued presence of excessive dirt in the lube oil, as well as in the system.

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76 E39L

N

SYSTEM, SUBSYSTEM, OR COMPONENT: Purifier (Sharples)

REFERENCE PUBLICATIONS:

DATE: September 1976

	SYSCOM/NRC CONTROL NO		MAINTENANCE REQUIREMENT	PERIOD QUALITY CODE	SKILL LEVEL	MAN-HOURS	RELATED MAINTENANCE
	96 K78X	N	1. Lubricate pump bearing.	D-1	MM3	0.1	None
	96 K78Y	N	1. Inspect purifier.	S-1	MM2	1.0	None
T	75 H42N	N	1. Test operate duplex pumps.	S-2	MM3	0.2	None
	96 K78Z	N	1. Inspect drag assembly.	A-1	MM2	1.2	None
	96 K79A	N	1. Inspect three-wing.	A-3	MM2	0.7	None
	94 E57B	N	1. Inspect foundation bolts for tightness.	A-9	MM3	0.1	None
	75 H42P	N	1. Lubricate idler arm bearings.	36M-2	MM3	0.5	None
T	96 K79B	N	1. Test duplex pump relief valves.	36M-3	MM3	1.0	None
	75 H42E	N	1. Inspect pump flexible coupling. NOTE: Accomplish when motor and/or pump are removed for repairs.	R-1	MM2	1.0	None
	75 H42S	N	1. Clean and inspect strainer. NOTE: Perform if system has been operated during the past 7 days.	R-2W	MM3	0.5	None

A management aid: Review MRCs D-1, 36M-2, and R-2W. Omit requirements if not applicable; no feedback report required.

MAINTENANCE INDEX PAGE (MIP) OPNAV 4700.2 (REV. 11-75)

SYSCOM MIP CONTROL NUMBER: E-11/65-96

EXISTING VERSION

SYSTEM, SUBSYSTEM, OR COMPONENT: Purifier (Sharples)

REFERENCE PUBLICATIONS:

DATE: September 1976

SYSCOM/NRC CONTROL NO		MAINTENANCE REQUIREMENT	PERIOD QUALITY CODE	SKILL LEVEL	MAN-HOURS	RELATED MAINTENANCE
New		1. Lubricate various purifier bearings.	D-1	MM3	0.3	None
New		1. Clean purifier bowl and check bowl boss sleeve.	D-2	MM3	0.5	None
New		1. Clean oil passages in bearing pulley cap assembly.	W-1	MM3	0.5	None
96 K78Z	N	1. Inspect drag assembly	W-2	MM2	1.2	None
96 K78Y	N	1. Inspect purifier	Q-1	MM3	1.0	None
75 H42P	N	1. Lubricate idler arm bearings	Q-2	MM3	0.5	None
T 75 H42N	N	1. Test operate duplex pumps.	S-2	MM3	0.2	None
96 K79A	N	1. Inspect three-wing.	A-3	MM2	0.7	None
94 E57B	N	1. Inspect foundation bolts for tightness.	A-9	MM3	0.1	None
T 96 K79B	N	1. Test duplex pump relief valves.	36M-3	MM3	1.0	None
75 H42E	N	1. Inspect pump flexible coupling. NOTE: Accomplish when motor and/or pump are removed for repairs.	R-1	MM2	1.0	None
75 H42S	N	1. Clean and inspect strainer. NOTE: Perform if system has been operated during the past 7 days.	R-2W	MM3	0.5	None

MAINTENANCE INDEX PAGE (MIP) OPNAV 4700.2 (REV. 11-75)

SYSCOM MIP CONTROL NUMBER: E-11/65-96

RECOMMENDED REVISION

SYSTEM	COMPONENT	MRC CODE
	Purifier (Sharples)	E-11 D-1

SUBSYSTEM	RELATED MAINTENANCE	RATES	M/H
	None	MM3	0.1

MAINTENANCE REQUIREMENT DESCRIPTION

1. Lubricate pump bearing.

TOTAL M/H 0.1
ELAPSED TIME 0.1

SAFETY PRECAUTIONS

1. Comply with Navy Safety Precautions for Forces Afloat, OPNAVINST 5100 Series.

TOOLS, PARTS, MATERIALS, TEST EQUIPMENT

1. Rag
2. Oil can with oil, MIL-L-17672 Symbol 2075TH

PROCEDURE

NOTE: On purifiers provided with a pump bearing oil cup, the cup should be filled with clean oil as required.

1. Lubricate Pump Bearing.
   a. Clean area around fitting in upper end cover.
   b. Add a few drops of oil through fitting in upper end cover.

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96 K78X

LOCATION	DATE	
	September 1976	N

MAINTENANCE REQUIREMENT CARD (MRC)
OPNAV 4700-1 (REV. 11/68)

EXISTING VERSION

SYSTEM	COMPONENT	MRC CODE
	Purifier (Sharples)	E-11 R-2

SUBSYSTEM	RELATED MAINTENANCE	RATES	M/H
	None	MM3	0.1

MAINTENANCE REQUIREMENT DESCRIPTION

1. Lubricate pump bearing
2. Lubricate spindle bearing
3. Lubricate idler pulley bearing

TOTAL M/H 0.1
ELAPSED TIME 0.1

SAFETY PRECAUTIONS

1. Comply with Navy Safety Precautions for Forces Afloat, OPNAVINST 5100 Series.

TOOLS, PARTS, MATERIALS, TEST EQUIPMENT

1. Rag
2. Oil can with oil, MIL-L-17672 Symbol 2075TH

PROCEDURE

NOTE: On purifiers provided with a pump bearing oil cup, the cup should be filled with clean oil as required.

1. Lubricate Pump Bearing.
   a. Clean area around fitting in upper end cover.
   b. Add a few drops of oil through fitting in upper end cover.

2. Lubricate Spindle Bearing Assembly

   a. While purifier is inoperable inspect felt filter inside of bearing pulley cap groove once daily.
   b. Replace filter if it is clogged with dirt.

WARNING: Apply lubricating oil only when bearing is running in order not to contaminate flexible coupling.

   c. Put a few drops of oil on top of spindle once an hour while operating. Use only oil of Symbol 2075TH.

3. Lubricate Idler Pulley

WARNING: Apply lubricating oil only when the idler pulley is running.

   a. Using Symbol 2075TH oil, put a few drops of oil in the idler cap every two or three hours while operating.

RECOMMENDED REVISION

SYSTEM	COMPONENT	MRC CODE
	Purifier (Sharples)	E-11 D-2
SUBSYSTEM	RELATED MAINTENANCE	RATES / M/H
	None	MM3 / 0.5

MAINTENANCE REQUIREMENT DESCRIPTION

1. Clean purifier bowl and check bowl boss sleeve

TOTAL M/H 0.5
ELAPSED TIME 0.5

SAFETY PRECAUTIONS

1. Comply with Navy Safety Precautions for Forces Afloat, OPNAVINST 5100 Series.

TOOLS, PARTS, MATERIALS, TEST EQUIPMENT

1. Cleaning table with bowl vise.
2. Bowl Bottom Wrench
3. Bowl Holder
4. Three-Wing Puller Ass'y. (see page 2)

PROCEDURE

1. Clean Purifier Bowl & Check Bowl Boss Sleeve

CAUTION: (1) Do not remove the bowl from the frame until the bowl protecting cap is in place on the bowl top threads. (2) Clean bowl thoroughly every time the centrifuge is stopped in order to remove solids and preserve balance.

a. Remove spindle guard; screw into bearing base.
b. Remove bowl assembly from spindle.
c. Clean and inspect coupling threads.
d. Install protecting cap on bowl coupling.
e. Clean area around cover lid.
f. Remove cover lid and gasket; inspect gasket for cuts, tears,& distortion.

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LOCATION | DATE

MAINTENANCE REQUIREMENT CARD (MRC)
OPNAV 4700-1 (REV. 11/68)

Procedure (Cont'd)

g. Remove upper and lower covers.

CAUTION: Do not rest the bottom of the bowl shell on the deckplates, as nicks will prevent a proper seal. Also, keep top face of bowl free from dirt and nicks.

h. Remove purifier bowl.
i. Place bowl in bowl vise on cleaning bench and check condition of bowl sleeve. If it is worn 3/64 inch in diameter or is badly scored, it should be renewed.
j. Clean bowl as set forth in Chapter 4, pages 4-5 through 4-7 of Tech. Manual NAVSHIPS 0945-003-6010.
k. Reinstall purifier bowl.
l. Clean and reinstall upper and lower covers.
m. Reinstall cover lid gasket; clean and reinstall cover lid.
n. Remove protecting cap from bowl coupling threads.
o Reinstall bowl assembly on spindle.
p. Remove soindle guard from bearing base; rinstall spindle guard.

****

Tools, Parts, Materials, Test Equip.

5. Waste drain container
6. Portable extension light
7. Bowl cleaning rods,Types 1 & 2
8. Wash Container
9. Approved safety cleaning solvent
10. Bowl Brushes(soft bristle type)

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MAINTENANCE REQUIREMENT CARD (MRC)
OPNAV 4700-1 (REV. 11/68)

RECOMMENDED NEW MRC FOR
LUBE OIL PURIFIER

SYSTEM	COMPONENT	MRC CODE
	Purifier (Sharples)	E-11 W-1
SUBSYSTEM	RELATED MAINTENANCE	RATES / M/H
	None	MM3 / 0.5

MAINTENANCE REQUIREMENT DESCRIPTION

1. Clean oil passages in bearing pulley cap assembly.

TOTAL M/H 0.5
ELAPSED TIME 0.5

SAFETY PRECAUTIONS

1. Comply with Navy Safety Precautions for Forces Afloat, OPNAVINST 5100 Series.

TOOLS, PARTS, MATERIALS, TEST EQUIPMENT

1. Spindle Nut Wrench
2. Coupling Nut Wrench
3. Felt Bearing Oil Filter Replacement
4. Bearing Seal Ring 5. Wire (under3/32")

PROCEDURE

1. Clean Oil Passages in Bearing Pulley Cap Assembly

a. Using coupling nut wrench, remove bearing pulley cap assembly.
b. Remove felt bearing oil filter from groove in bearing pulley cap
c. Clean cap groove.
d. Clean each of the four 3/32 inch diameter oil passage holes in the bearing pulley cap assembly.
e. Remove the bearing seal ring from the bearing pulley cap assembly and examine the seating groove of the seal ring. Insure that groove is smooth.

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LOCATION | DATE

MAINTENANCE REQUIREMENT CARD (MRC)
OPNAV 4700.1 (C) (REV. 11/80)

Procedure (Cont'd)

WARNING: Always change the bearing seal ring whenever the bearing pulley cap assembly is unscrewed from the bearing pulley.

f. Replace the bearing seal ring with a new seal ring.
g. Replace the felt bearing oil filter with a new filter.
h. Reinstall the bearing pulley cap assembly exercising care not to damage the new bearing seal ring during reassembly.

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MAINTENANCE REQUIREMENT CARD (MRC)
OPNAV 4700.1 (C) (REV. 11/80)

RECOMMENDED NEW MRC FOR
LUBE OIL PURIFIER

SYSTEM	COMPONENT	MRC CODE
	Purifier (Sharples)	E-11 A-1
SUBSYSTEM	RELATED MAINTENANCE	RATES / M/H
	None	MM2 / 1.2

MAINTENANCE REQUIREMENT DESCRIPTION

1. Inspect drag assembly.

TOTAL M/H 1.2
ELAPSED TIME 1.2

SAFETY PRECAUTIONS

1. Comply with Navy Safety Precautions for Forces Afloat, OPNAVINST 5100 Series.

TOOLS, PARTS, MATERIALS, TEST EQUIPMENT

1. Scissors
2. Wood block
3. Safety tags
4. Drag spring
5. Lint-free rags
6. Protecting cap
7. Gasket punch set
8. Feed nozzle gasket
9. 1/2" drive Socket set
10. Combination wrench set
11. Circle and hole cutter
12. Feed nozzle face wrench
13. 1/2-lb Ball peen hammer
14. Bowl Coupling wrench (2)
15. Drag housing nut wrench
16. 1/16" Gasket material, Symbol 2150

PROCEDURE

Preliminary

a. De-energize circuit and tag "Out of Service.

1. Inspect Drag Assembly.

a. Remove spindle guard; screw into bearing base.
b. Remove bowl assembly from spindle.
c. Clean and inspect coupling threads. Threads should be sharp and unmarked.
d. Install protecting cap on bowl coupling threads.
e. Clean area around cover lid.
f. Remove cover lid and gasket; inspect gasket for cuts, tears, and distortion.
g. Remove upper and lower covers.
h. Remove purifier bowl.
i. Remove drag assembly feed piping.
j. Remove drag assembly and gasket.
k. Remove drag housing nut, drag bushing, washer, and drag spring.
l. Remove feed nozzle and gasket.
m. Clean mating areas of feed nozzle and drag body; inspect for erosion.
n. Install new gasket; reinstall feed nozzle.

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LOCATION

DATE September 1976

MAINTENANCE REQUIREMENT CARD (MRC)
OPNAV 4700-1 (5) (REV. 11/68)

Procedure (Cont'd)

o. Install new drag spring.
p. Clean drag washer; inspect for scoring.
q. Clean drag bushing; inspect for cracks, heat discoloration and uneven wear.
r. Reinstall washer, drag bushing, and drag housing nut.
t. Reinstall drag assembly feed piping.
u. Reinstall purifier bowl.
v. Clean and reinstall upper and lower covers.
w. Remove protecting cap from bowl coupling threads.
x. Reinstall cover lid gasket; clean and reinstall cover lid.
y. Reinstall bowl assembly on spindle.
z. Remove spindle guard from bearing base; reinstall spindle guard.
aa. Remove safety tag and energize circuit.
ab. Operate purifier; inspect for leaks, vibration, and unusual noise.
ac. Stop purifier.

RECOMMENDED REVISIONS/ADDITIONS:

The periodicity should be changed from A-1, that is annually, to W-2, that is weekly, in order to comply with the manufacturer's maintenance recommendations.

To paragraph q. above add
" Replace the drag bushing if it is worn as much as 1/16 inch in diameter. "

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MAINTENANCE REQUIREMENT CARD (MRC)
OPNAV 4700-1 (5) (REV. 11/68)

SYSTEM	COMPONENT	MRC CODE
	Purifier (Sharples)	E-11 S-1

SUBSYSTEM	RELATED MAINTENANCE	RATES	M/H
	None	MM2	1.0

MAINTENANCE REQUIREMENT DESCRIPTION

1. Inspect purifier.

TOTAL M/H 1.0
ELAPSED TIME 1.0

SAFETY PRECAUTIONS

1. Comply with Navy Safety Precautions for Forces Afloat, OPNAVINST 5100 Series.

TOOLS, PARTS, MATERIALS, TEST EQUIPMENT

1. Rags
2. Safety tag
3. 6" Steel rule
4. Protecting cap
5. 1/2" drive Socket set
6. 12" Adjustable wrench
7. Shielded extension light
8. Bowl coupling wrench (2)

PROCEDURE

Preliminary
a. De-energize circuit and tag "Out of Service."

1. Inspect Purifier.
a. Remove belt guard and drive belt.
b. Inspect motor, idler, and spindle pulley surfaces for grooves, nicks, scratches, and foreign material.
c. Inspect drive belt for cracks, fraying, and unusual wear.
d. Remove spindle guard; screw into bearing base.
e. Remove bowl assembly from spindle.
f. Clean and inspect coupling threads. Threads should be sharp and unmarked.
g. Install protecting cap on bowl coupling threads.
h. Clean area around cover lid.
i. Remove cover lid and gasket; inspect gasket for cuts, tears, and distortion.
j. Remove upper and lower covers.
k. Remove purifier bowl.
l. Clean bowl boss sleeve; inspect for cracks, heat discoloration, and uneven wear.

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LOCATION	DATE	N
	September 1976	

MAINTENANCE REQUIREMENT CARD (MRC)
OPNAV 4790-1 (C) (REV. 11/68)

Procedure (Cont'd)

m. Inspect brake:

CAUTION: Brake lining rivets must not be even with, or protrude from, surface of linings.

(1) Inspect linings for cracks, deterioration, and loose or missing rivets.
(2) Inspect lining thickness; minimum acceptable thickness is 1/8".
(3) Inspect brake springs, spring clips, and hinge for corrosion and distortion.

n. Remove spindle nut, male clutch, and spindle.
o. Remove female clutch and flexible coupling.
p. Inspect spindle flexible coupling:
(1) Clean male and female clutches; inspect for burrs, cracks, and corrosion.
(2) Clean flexible coupling; inspect for cuts, tears, and deterioration.
(3) Clean bearing pulley and clutch pins; inspect for bent and broken clutch pins.
q. Reinstall flexible coupling and female clutch.
r. Reinstall spindle, male clutch, and spindle nut.
s. Reinstall purifier bowl.
t. Clean and reinstall upper and lower covers.
u. Reinstall cover lid gasket; clean and reinstall cover lid.
v. Remove protecting cap from bowl coupling threads.
w. Reinstall bowl assembly on spindle.
x. Remove spindle guard from bearing base; reinstall spindle guard.
y. Reinstall drive belt and belt guard.
z. Remove safety tag and energize circuit.

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96 K78Y

RECOMMENDED REVISIONS/ADDITIONS :

Based on engineering judgement it is believed that the performance of lube oil purifiers would be enhanced if this MRC were performed quarterly instead of semi-annually. Recommend periodicity changes accordingly.

Following paragraph p.(3) above add these additional instructions:

" Using special coupling nut wrench, remove bearing pulley cap assembly. Perform following:
(1) Remove felt bearing oil filter located in the bearing pulley cap groove.
(2) Clean cap groove.
(3) Clean each of the four 3/32 in. oil flow holes within the bearing pulley cap assembly.
(4) Remove the bearing seal ring from the bearing pulley cap assembly and examine the seating groove for this seal ring. Insure that the groove is smooth.

WARNING: Always change the bearing seal ring whenever the bearing pulley cap assembly is unscrewed from the bearing pulley.

(5) Replace the bearing seal ring with a new seal ring.
(6) Replace the felt bearing oil filter with a new filter.
(7) Reinstall the bearing pulley cap assembly. "

SYSTEM, SUBSYSTEM, OR COMPONENT	REFERENCE PUBLICATIONS	DATE
Main Shafting		October 1976

SYSCOM MRC CONTROL NO			MAINTENANCE REQUIREMENT	MEMO RATE CODE	SKILL LEVEL	MAN-HOURS	SELF-MAINT. MAT.
13	1KKX	N	1. Lubricate main shaft bulkhead packing gland.	M-1	MM/EN3	0.2	None
13	1KKY	Y	1. Renew face seal lubricating water filter. NOTE: Accomplish quarterly or when flow through filter is sufficient to maintain a leakoff of 8 to 10 drops per minute from forward surface of seal assembly, whichever occurs first.	Q-1R	MM/EN3	0.3	None
T A6	K95E	N	1. Test inflatable shaft seal.	S-1	MM/EN1 MM/EN3	0.7 0.7	None
13	1KLA	N	1. Renew main shaft bulkhead packing.	C-2	MM/FN2 FN	3.0 3.0	M-1
13	1KLB	N	1. Inspect line shaft spring bearing. NOTE: Accomplish each cycle or as directed by physical analysis of oil, whichever occurs first.	C-6R	EngOff MMC/ ENC MM/EN1 MM/EN3 FN	 0.5 4.0 4.0 4.0	None
31	1CML	C	1. Inspect foundation bolts for tightness.	C-9	FN	0.1	None
13	1KLC	N	1. Sample and inspect lube oil. NOTE: Accomplish the day before getting underway, daily when underway, the day after entering port, and weekly when in port.	R-1	FN	0.2	None
13	1KLD	N	1. Reposition line shaft stern tube face seals. NOTE: Accomplish when stern tube gland leakoff becomes excessive.	R-2	MM/EN1 FN	2.9 2.9	S-1
			1. Request drydock activity to measure stern tube and strut bearing clearances and inspect condition of shaft covering. NOTE: Accomplish each regular availability and interim drydocking.	R-3 **			
			1. Request repair activity to renew inflatable shaft seals, face seals, and garter springs. NOTE: Accomplish each regular availability drydocking.	R-4 **			
			1. Request repair activity to perform bearing reaction test on line shaft spring bearings. NOTE: Accomplish after each regular availability drydocking.	R-5 **			

RECOMMENDED CHANGE:

1. Add a new MRC which will require a daily check while underway to ensure that oiler rings freely rotate on the shaft journals of line shaft spring bearings.
2. Add a new MRC requiring an annual check of oiler rings.

**For scheduling purposes only; no MRC is provided.

SYSTEM	COMPONENT	MRC CODE
Propulsion	Main Shafting	E-12 D-1

SUBSYSTEM	RELATED MAINTENANCE	RATES	M-H
Shafting, Mechanical	None	MM3	0.5

MAINTENANCE REQUIREMENT DESCRIPTION

1. Inspect line shaft spring bearing while shaft is turning to ensure oiler rings rotate.

TOTAL M-H 0.5
ELAPSED TIME 0.5

SAFETY PRECAUTIONS

1. Comply with Navy Safety Precautions for Forces Afloat, OPNAVINST 5100 Series.
2. Exercise caution around rotating shafts.

TOOLS, PARTS, MATERIALS, TEST EQUIPMENT

1. Flashlight
2. Adjustable wrench to open inspection ports.

PROCEDURE

NOTE: Accomplish once a day when underway.

1. Inspect line shaft spring bearings while shafts are rotating to insure that oiler rings freely rotate on the shaft journals while shaft is rotating.

PAGE 1 OF

LOCATION	DATE

MAINTENANCE REQUIREMENT CARD (MRC)
OPNAV 4700-1 (A) (REV 3-73)

RECOMMENDED NEW MRC
FOR LINE SHAFT BEARINGS

SYSTEM	COMPONENT	MRC CODE
Propulsion	Main Shafting	E-12 A-1

SUBSYSTEM	RELATED MAINTENANCE	RATES	M-H
Shafting, Mechanical, Bearings	None		

MAINTENANCE REQUIREMENT DESCRIPTION

1. Inspect line shaft spring bearing oiler rings

TOTAL M-H: 10
ELAPSED TIME: 3

SAFETY PRECAUTIONS

1. Comply with Navy Safety Precautions for Forces Afloat, OPNAVINST 5100 Series.

TOOLS PARTS MATERIALS TEST EQUIPMENT

Same as set forth for MRC 13 1KLB N

PROCEDURE

Note 1: Accomplish annually or whenever it appears that oiler rings are performing improperly.

PAGE 1 OF

Preliminary

a. De-energize circuit to jacking gear controller and tag "Out of Service."

1. Inspect line shaft spring bearing oiler rings

a. Remove foreign matter from bearing exterior.
b. Remove drain plug; drain sump.
c. Inspect drained oil for evidence of metallic particles.
d. Remove sump inspection covers, gaskets, and oil gauge.
e. Rig wire straps to bearing cap and chain hoist.
f. Remove tapered pins, cotter pins, nuts, and bolts.
g. Remove bearing cap and upper oil retaining covers and place on wood blocks.
h. Remove wire straps.
i. Install eyebolts into upper bearing shell.
j. Rig wire strap to upper bearing shell.
k. Remove cotter pins, nuts, and bolts.
l. Remove upper bearing shell and place on wood blocks.

LOCATION | DATE

MAINTENANCE REQUIREMENT CARD (MRC)
OPNAV 4790-1 (REV. 8-71)

Procedure (Cont'd)

m. Inspect journal for scores, grooves, discoloration, and babbitt deposits.
n. Inspect oil ring joints for tightness.
o. Inspect oil baffles for tightness on shaft.
p. Inspect bearing cap, pedestal, and oil retaining cover mating surfaces for nicks and burrs.
q. Apply a thin film of oil to journal.
r. Reinstall upper bearing shell, nuts, and bolts; tighten to previously established matchmarks and reinstall new cotter pins.
s. Remove wire strap and eyebolts.
t. Apply a light coat of Permatex to pedestal, cap, and two oil retaining cover mating surfaces.
u. Rig wire straps to bearing cap.
v. Reinstall bearing cap, taper pins, nuts, bolts, and cotter pins.

CAUTION: Ensure oil rings are positioned correctly relative to oil ring guides.

w. Remove wire straps.

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MAINTENANCE REQUIREMENT CARD (MRC)
OPNAV 4790-1 (REV. 8-71)

RECOMMENDED NEW MRC FOR
LINE SHAFT BEARINGS

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 problem involved.

DDEOC ACTION TABLE

ACTION ITEM * TITLE	DDEOC EVALUATION **	ACTION ITEM DESCRIPTION	REPORT REFERENCE (PARA.)	RESPONSIBILITY †	SCH REQD
Baseline Overhaul Requirements					
A. ShipAlts					
Main Lube Oil System		Accomplish ShipAlt DLG9-367K, Low Lube Oil Pressure Alarm, on all DDG-37 Class ships.	3.7	NAVSEA 934	
B. Repairs					
Main Lube Oil System		Perform repairs as shown to be necessary by Pre-Overhaul Tests and Inspections.	3.6	NAVSEA 934	
		Bring all Main Lube Oil Systems up to the highest feasible condition of cleanliness by thorough cleaning of all lube oil tanks and main reduction gear sumps. Flush piping if necessary to achieve maximum cleanliness.	3.4.1.2 and 3.6	NAVSEA 934	
Standby Service Pumps		During Baseline Overhaul of a pump, ensure that all tubes and passages for transmitting lubricating oil to the bearings within the pump transmissions are fully open and clean.	3.3.2.3	NAVSEA 934	
All Equipments of the Propulsion Transmission System		Perform repairs as shown to be necessary by Pre-Overhaul Tests and Inspections and drydock inspections.	3.6	NAVSEA 934	
Intracycle Maintenance Requirements					
[illegible]		Accomplish existing PMS requirements as modified by recommendations of this report.	3.5	TYCOM	
[illegible]		[illegible]	3.3.1.2	NAVSEA	
[illegible]		[illegible]	3.3.1.3	[illegible]	

SHIP CLASS: DDG-37

SMA NO: 37-107-240

SYSTEM: Main Lube Oil & Propulsion Transmission Systems

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
s	3.7	NAVSEA 934					
ry	3.6	NAVSEA 934					
the ess nks	3.4.1.2 and 3.6	NAVSEA 934					
ure	3.3.2.3	NAVSEA 934					
y	3.6	NAVSEA 934					
	3.5	TYCOM					
er	3.3.1.2	NAVSEA					
	3.3.1.2	NAVSEA 06					

DDEOC ACTION TABLE

1 ACTION ITEM *		2 DDEOC EVALUATION **	3 ACTION ITEM DESCRIPTION	4 REPORT REFERENCE (PARA.)	5 RESPONSIBILITY †
a NO.	b TITLE				
2.	Intracycle Maintenance Requirements (Cont.)				
	All Equipments of the Propulsion Transmission System		Accomplish existing PMS requirements as modified by recommendations of this report.	3.5	TYCOM
3.	Follow-On ROH Requirements				
	All Equipments of the Main Lube Oil System		Perform repairs as shown to be necessary by Pre-Overhaul Tests and Inspections.	3.9	NAVSEA 934
			Bring all Main Lube Oil Systems up to the highest feasible condition of cleanliness by thorough cleaning of all lube oil tanks and main reduction gear sumps. Flush piping if necessary to achieve maximum cleanliness.	3.4.1.2 and 3.9	NAVSEA 934
	Standby Service Pumps		Ensure that all tubes and passages for transmitting lubricating oil to the bearings within the pump transmissions are fully open and clean.	3.3.2.3	NAVSEA 934
	All Equipments of the Propulsion Transmission System		Perform repairs as shown to be necessary by Pre-Overhaul Tests and Inspections and drydock inspections.	3.9	NAVSEA
4.	Reliability and Maintainability Improvements				
	Main Lube Oil System		Maintain maximum possible degree of cleanliness in all parts of the system.	3.4.1.2	TYCOM
	Lube Oil Purifiers		Place a warning sign on top of the belt guard of each lube oil purifier calling attention to the need to lubricate spindle bearings once an hour and idler pulley bearings every two hours.	3.3.1.4	NAVSEA 06
	Duplex Strainers		Advise DDG-37 Class ships that the high frequency of tears and punctures in strainer baskets is attributable to sharp corners on magnets and lack of care in inserting the magnets. Round the sharp edges and corners on the magnets.	3.3.3.1	NAVSEA 06

* NOTE 1: DEVELOPING ACTIVITY FILL IN THE FOLLOWING BLOCKS: 1a & b, 2, 4, 5 (IF KNOWN); 6a IF REQUIRED FOR CONTINUATION OF DEVELOPMENT

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

† NOTE 3: RESPONSIBILITY - ACTIVITY RESPONSIBLE FOR TAKING THE ACTION

SHIP CLASS: DDG-37

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SYSTEM: Main Lube Oil & Propulsion Transmission Systems

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
as	3.5	TYCOM					
sary s.	3.9	NAVSEA 934					
o the lness	3.4.1.2 and 3.9	NAVSEA 934					
or bear- re	3.3.2.3	NAVSEA 934					
sary s	3.9	NAVSEA					
em.	3.4.1.2	TYCOM					
elt ing	3.3.1.4	NAVSEA 06					
ler							
igh	3.3.3.1	NAVSEA 06					
nets.							

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

DDEOC ACTION TABLE

1 ACTION ITEM *		2 DDEOC EVALUATION **	3 ACTION ITEM DESCRIPTION	4 REPORT REFERENCE (PARA.)	5 RESPONSIBILITY †
a. NO.	b. TITLE				
5.	Planned Maintenance System Changes				
	Main Lube Oil System		Revise MRCs A5 H81F and 76 K43 L to require gas freeing of reduction gear sumps, examinations for corrosion, and cleaning of settling tanks at same frequency as reduction gear sumps.	3.4.1.2	NAVSEA
	Lube Oil Purifiers		Revise existing and add new PMS Maintenance Requirement Cards to specifically require (1) lubrication of spindle and idler pulley bearings, (2) cleaning of oil passages in the lube oil purifier bearing pulley cap assemblies, (3) checks on the cleanliness of the felt bearing oil filters of bearing pulley cap assemblies, and (4) cleaning of purifier bowls and checks on bowl boss sleeves and drag assemblies.	3.3.1.2 and 3.3.1.4	NAVSEA
	Standby Service Pumps		Revise MRC 94 E 85M N, Lube Oil Pump, to reflect the guidance contained in Leslie Company drawings 1278F, Alt. 3, 29 Jan. 1948 and 2838F, Alt. 1, 20 June 1952.	3.3.2.2	NAVSEA
	Line Shaft Bearings		Prepare and issue a Maintenance Requirement Card that will call for a daily underway check of oiler ring rotation.	3.4.3.1	NAVSEA
			Prepare and issue a new Maintenance Requirement Card that will call for an annual check of oiler ring joint tightness.	3.4.3.1	NAVSEA
6.	Depot-Level Improvements		None.		
7.	IMA Improvements		None.		

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

** 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: 37-107-240

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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
› ear and fre-	3.4.1.2	NAVSEA 04					
inte- cally and g of ier checks ring oil mblies, and ag	3.3.1.2 and 3.3.1.4	NAVSEA 04					
mp, to Leslie Jan. 52.	3.3.2.2	NAVSEA 04					
quire- ly ion.	3.4.3.1	NAVSEA 04					
e r an	3.4.3.1	NAVSEA 04					

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

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DDEOC ACTION TABLE

1 ACTION ITEM * a. NO.	b. TITLE	2 DDEOC EVALUATION **	3 ACTION ITEM DESCRIPTION	4 REPORT REFERENCE (PARA.)	5 RESPONSIBILITY †
8.	Integrated Logistic Support (ILS) Requirements				
	Lube Oil Purifiers		Advise DDG-37 Class ships that NSN 1 HM 3110-00-991-0901 NT is the correct NSN for identifying purifier spindle bearings on lube oil purifiers APL 760010033.	3.3.1.2	NAVSEA 06
			Stock and issue spindle bearings in pairs, not singly. Change Allowance Parts Lists to reflect this policy.	3.3.1.2	NAVSUP
			Issue a 1200 PSI Steam Propulsion Plant Improvement Advisory calling attention to the hourly lubrication requirements and to the requirement to clean purifier bowls every time the purifier is stopped and not less than once a watch.	3.3.1.2	PMS 301
			Revise the Engineering Operational Procedure for DDG-37 Class lube oil purifiers to require checking of the felt filter within the bearing pulley cap assembly as well as hourly lubrication of spindle bearings and lubrication of idler pulley bearings every two hours.	3.3.1.2	NAVSEA 934
			Check existing training courses for DDG-37 Class lube oil purifiers to ensure they include course instruction on the proper lubrication of DDG-37 Class lube oil purifiers as discussed in this report.	3.3.1.2 and 3.3.1.4	
	Duplex Strainers		Purchase specifications for replacement magnets should require the smoothing and rounding of sharp edges on the magnets.	3.3.3.2	NAVSUP
	Standby Service Pumps		Make known to all DDG-37 Class ships the existence of Leslie Company drawings No. 1278F, Alt. 3 and No. 2838F, Alt. 1 to assist in the maintenance of Leslie pressure regulators for standby service pumps.	3.3.2.2	NAVSEA 06

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

** 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: 37-107-240

SYSTEM: Main Lube Oil & Propulsion Transmission Systems

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
t ear- 33.	3.3.1.2	NAVSEA 06					
irs, sts	3.3.1.2	NAVSUP					
t to d ed	3.3.1.2	PMS 301					
-	3.3.1.2	NAVSEA 934					
sure e pe port.	3.3.1.2 and 3.3.1.4						
nt and s.	3.3.3.2	NAVSUP					
the No. o res- umps.	3.3.2.2	NAVSEA 06					

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

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