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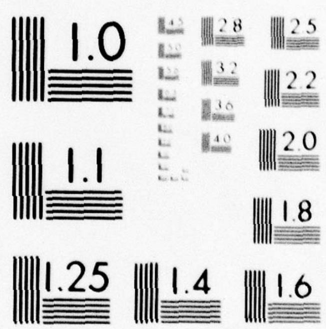

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DESTROYER ENGINEERED OPERATING CYCLE (DDEOC)

System Maintenance Analysis

CG-16 AND CG-26 CLASS ARMAMENT SYSTEMS

SWAB GROUP 700

SMA 1626-700

REVIEW OF EXPERIENCE

August 1979

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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This report, the review of experience, documents the historical maintenance experience for both CG-16 and CG-26 Class armament systems, SWAB Group 700. It presents an analysis of the existing maintenance policy and recommends specific maintenance actions and maintenance policy modifications to improve system material condition. It has been developed for NAVSEA 931X, the manager of the Destroyer Engineered Operating Cycle (DDEOC) Program, under Navy Contract N00024-78-C-4062.

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by
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Publication 1653-07-14-1998

FOREWORD

This report, the review of experience, documents the historical maintenance experience for both CG-16 and CG-26 Class armament systems, SWAB Group 700. It presents an analysis of the existing maintenance policy and recommends specific maintenance actions and maintenance policy modifications to improve system material condition. It has been developed for NAVSEA 931X, the manager 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 CG-16 and CG-26 Class armament systems, SWAB group 700.

The ROE is an analysis of the impact of the historical maintenance requirements on the operational performance or maintenance program of a ship system and the significance of these requirements to the DDEOC Program. The report documents a recommended system maintenance policy and specific maintenance actions best suited to meeting DDEOC goals.

The ROE for the armament systems included 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, the alterations program, and system technical manuals. Selected ships were surveyed and discussions were held with appropriate technical groups to validate identified maintenance requirements, to identify undocumented maintenance requirements, and to determine the status of current and planned actions affecting the armament systems. All findings were evaluated and appropriate conclusions were developed.

A recommended system maintenance policy was defined on the basis of these conclusions; recommendations were then made to implement the policy by periodically accomplishing specific types of corrective maintenance actions. These actions were documented for inclusion as tasks in the CG-16 and CG-26 Class maintenance plans. Also included, as appropriate, were recommendations for improving system preventive maintenance; integrated logistics support; reliability, maintainability and availability; and depot- and IMA-level capabilities. Implementing these combined recommendations will minimize the adverse impact of corrective maintenance requirements on the extended operating cycle.

The major findings and conclusions of this ROE for the CG-16 and CG-26 Class armament systems are summarized as follows:

- The CG-16 and CG-26 Class armament system equipments should perform reliably throughout an engineered operating cycle with no significant increase in corrective maintenance burden.
- Only a few, if any, major overhauls of armament system equipments should be required at BOH.
- Repair parts support for armament system equipments is adequate to maintain the equipment during an engineered operating cycle with no changes to stocking levels or excessive delays in availability.
- Planned maintenance system coverage for the armament system equipment is adequate and should ensure its reliable operation throughout an engineered operating cycle.
- Ship's force has demonstrated adequate capabilities to maintain the armament system components during an engineered operating cycle, with only limited IMA assistance.
- Mk 42 mod 10 gun mount failures and failure intervals are not predictable, precluding any recommendations for periodic maintenance or increased repair part stocking levels to improve reliability.
- The majority of the ASROC launching group failures are the result of corrosion, caused by the forward location and constant exposure of the launcher to salt spray.
- The large difference in torpedo tube maintenance burdens between the CG-16 Class and the CG-26 Class was due to the age of the CG-26 Class mounts and the replacement of CG-16 Class mounts during their modernization overhauls.

Reliable operation of the armament systems can be expected throughout an engineered operating cycle if the recommendations contained in this study are implemented and existing PMS maintenance requirements are adhered to.

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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

System maintenance analyses (SMAs) are being conducted as part of the Destroyer Engineered Operating Cycle (DDEOC) Program, managed by NAVSEA 931X. The principal element of an SMA is the review of experience (ROE) of selected systems and subsystems of program-designated surface combatants. This report documents the ROE for the CG-16 and CG-26 Class armament systems, SWAB group 700, which were selected for analysis because equipments of these systems have been major contributors to the CG-16 and CG-26 Class maintenance burden.

1.2 PURPOSE AND SCOPE

The ROE is an analysis of the impact of the historical maintenance requirements on a ship system's operational performance and maintenance program. It serves as a vehicle for documenting the significance of historical maintenance requirements to the DDEOC Program.

The objective of the ROE is to define and document a maintenance program for CG-16 and CG-26 Class ships that will prevent or reduce the need for unscheduled maintenance while improving material condition and maintaining or increasing ship availability throughout an extended ship operating cycle. The maintenance program defined and documented in an ROE for a selected equipment will be the basis for maintenance tasks to be developed for inclusion in the class maintenance plan (CMP).

The analysis documented in this report is specifically applicable to the armament systems, SWAB group 700, of the CG-16 and CG-26 Class ships. This analysis utilized all available documented data sources from which system maintenance experience could be identified and studied. These included maintenance data system (MDS) data, casualty reports (CASREPs), Board of Inspection and Survey (INSURV) reports, departure reports, ship's alteration and repair packages (SARPs), planned maintenance system (PMS) requirements data, system alteration documentation, and system technical manuals. Sources of undocumented data used in this analysis included discussions with ship's force and cognizant Navy technical personnel.

1.3 REPORT FORMAT

The remaining chapters of this report describe the analysis approach (chapter two), briefly present the significant system maintenance experience and discuss essential maintenance requirements (chapter three), and summarize the conclusions and recommendations derived from the analysis (chapter four).

CHAPTER TWO

APPROACH

2.1 OVERVIEW

This chapter describes the approach followed in performing the ROE for equipments and subsystems in the armament systems, SWAB group 700. These systems are identified for analysis in *DDEOC Selected Items for Analysis List, CG-16 and CG-26 Classes,* ARINC Research Publication 1653-06-TR-1875. Primary data sources were identified in section 1.2. The data were used to identify, define, and analyze maintenance requirements that have significantly affected the systems' operational availability and material condition. A recommended maintenance strategy and implementation procedures were formulated on the basis of analysis results. The major steps of the analysis were as follows:

- Relevant documented and undocumented historical maintenance data were compiled for the selected equipments or subsystems.
- These data were analyzed to identify and define recurring maintenance requirements that have a significant impact on the operational availability and material condition of these equipments or subsystems.
- The results of ROE analyses were compared with results of previously completed analyses of identical or functionally similar equipments or subsystems (on other classes of ships) to determine if previously identified maintenance strategies and implementation recommendations apply to CG-16 and CG-26 Class ships.
- If previously developed maintenance strategies and recommendations were determined to be applicable to similar equipments or subsystems of the CG-16 and CG-26 Class ships, they were identified and documented in this report. CMP tasks previously developed were modified to reflect their applicability to these two ship classes.
- When previously developed maintenance strategies and implementation recommendations were not applicable to CG-16 and CG-26 Class ships, a detailed maintenance analysis was conducted to develop the maintenance strategy to be recommended and the steps to be employed in implementing that strategy.

2.2 DATA COMPILATION

The analysis began with the compilation of comprehensive data on the maintenance history of the system. The data file assembled consisted of four key elements: an MDS data bank, a CASREP narrative summary, a system overhaul experience summary, and a system shipalt summary. A library of appropriate technical manuals, bulletins, and related documents was also assembled. The MDS data bank was compiled by examining all MDS data reported for the CG-16 and CG-26 Classes from 1 January 1970 through 31 December 1977. In the case of the CG-16 Class, MDS data reported between 1 January 1970 and completion of modernization were not considered. Thus the data bank for ships of this class includes only the MDS reported maintenance actions occurring between the end of modernization and 31 December 1977. CASREP information was obtained by reviewing CASREPs against the various armament system equipments during the data period 1 January 1972 through 31 August 1978. Overhaul information was obtained from authorized SARPs and departure reports for ships of both classes.

2.3 MAINTENANCE DATA ANALYSIS

Recurring maintenance requirements affecting the availability and material condition of subsystems or equipments were identified by screening data obtained from the above-described sources, as well as from ship surveys, discussions with Navy technical personnel, and NAVSEA special-interest programs.

MDS data provided the initial and primary source of information screened. The resulting data base includes all part and labor records, as well as narrative material, describing maintenance actions reported against system components. The purpose of the screening process was to identify the maintenance actions that had been reported against the armament system equipments.

Preliminary analysis of each of the equipments was directed toward determining the historical maintenance profile in terms of reported manhours per equipment operating year, types of maintenance actions commonly recurring, type and number of repair parts used, CASREP frequency, and past ROH experience. The historical maintenance profile was then compared with similar information developed for identical or functionally similar subsystems or equipments previously subjected to detailed analysis during the performance of ROEs for FF-1052 and DDG-37 Class ships. Further analysis was not conducted where the results of this comparison showed that the maintenance profile for the CG-16 or CG-26 Class equipment was essentially the same as that of an identical or functionally similar subsystem or equipment previously analyzed on another ship class. Instead, the maintenance strategy and implementation recommendations developed for the same or similar equipment on a previously analyzed ship class were identified as being applicable to the CG-16 or CG-26 Class ships, as documented in this report.

Where the results of the historical maintenance profile comparison did not reveal a marked similarity, a detailed maintenance requirements engineering analysis was conducted. Initially, man-hour and parts-usage trends were examined to determine if either parameter increased as a function of time after overhaul, indicating wear-out or deterioration. If no increasing trend was evident, it was assumed that the equipment or subsystem could be expected to continue to operate satisfactorily, exhibiting its current maintenance characteristics throughout an extended operating cycle. If an increasing trend was evident, additional analysis was conducted to identify apparent problems and establish the time at which planned restorative maintenance would be required to prevent an unacceptable increase in maintenance burden and downtime.

Detailed analysis was directed toward defining each recurring significant maintenance requirement in terms of several specific factors: the effect of the maintenance action on the subsystem or equipment, the interval between occurrences of the action, the redundancy of the affected subsystem or equipment, the criticality to mission accomplishment, the resources required to perform the necessary corrective maintenance, and the expected subsystem or equipment downtime.

Once the factors associated with the historically required maintenance actions were identified, the individual types of historical maintenance actions were analyzed to identify any design or maintenance-related problems that would have an impact on the selection of a maintenance strategy. Solutions were then sought by examining each problem in relation to the extent to which it was recognized and its amenability to established types of corrective action. These analysis criteria are expressed in the following questions:

- Is the problem known to the Navy technical community, and has a solution been proposed or established?
- Will a design change reduce or eliminate the problem?
- Is the problem PMS-related? Can it be reduced or eliminated by changes to PMS? (These changes might include adding or deleting requirements, changing periodicity, or developing material condition assessment tests and procedures.)
- Can the problem be reduced or eliminated by improving the system's integrated logistic support (ILS) at the ship's force level?
- Can the problem be reduced or eliminated by improving intermediate maintenance activity (IMA), or depot-level capabilities?
- Can this problem be reduced or eliminated by revising the existing maintenance strategy?

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 engineer to go to the next question. After all the questions concerning an individual problem were asked, the alternative solutions were evaluated and the most acceptable alternatives defined and documented as recommendations. These recommended solutions to identified design or maintenance-related problems were then considered during the definition of the maintenance strategy. A further series of implementation recommendations were then formulated to accomplish the objectives of the maintenance strategy selected for the engineered operating cycle (EOC).

2.4 MAINTENANCE PROGRAM DEFINITION

The recommended maintenance program stems directly from the subsystem and equipment maintenance strategies identified by the analysis. The total maintenance program includes both the scheduled and unscheduled preventive maintenance and "engineered" and "qualified" corrective maintenance required to maintain the subsystems and equipments at acceptable levels of material condition and availability over an extended operating cycle. Engineered corrective maintenance comprises those tasks that are well defined and must be accomplished periodically. Qualified tasks are those nonspecific repairs that are likely to be required but cannot be characterized precisely as to nature and frequency.

In development of the implementation recommendations, the results of the analysis were used to identify specific corrective maintenance tasks that would be required periodically. Once these tasks were identified, the frequency of accomplishment, the manpower resources required for accomplishment, and the maintenance level required to perform the work were determined for engineered tasks. Qualified maintenance tasks were also identified, on the basis of historical data, to reserve blocks of man-hours at specified intervals to complete required but nonspecific class C repairs on the subsystems or equipments under analysis.

Where appropriate, additional recommendations were developed for improving subsystem or equipment reliability, availability, and maintainability, system preventive maintenance, logistics support, and IMA- or depot-level capabilities.

The steps described in this section effectively define the maintenance program recommended for the subsystems and equipments identified for detailed analysis in this ROE. Recommendations resulting from this analysis will be used to develop the class maintenance plan (CMP).

CHAPTER THREE

ANALYSIS RESULTS

3.1 OVERVIEW

This chapter presents the results of an analysis of the corrective and preventive maintenance experience of selected equipment of the CG-16 and CG-26 Class armament systems. Equipments selected for analysis are:

- 5"/54 dual purpose gun mount Mk 42 mod 10 (CG-26 Class only)
- Guided missile launching system Mk 10 mods 5, 6, and 7
- ASROC launching group (CG-16 Class only)
- Surface vessel torpedo tubes (SVTT) Mk 32 mods 5 and 7

These equipments were selected from the *Selected Items for Analysis Lists, CG-16 and CG-26 Classes* (ARINC Research Publication 1653-06-TR-1875, February 1979) on the basis of their respective contributions to the total class maintenance burden as determined by their individual maintenance burden factor (MBF) ranking. The resulting maintenance burden factors reflect the total annual man-hours devoted to corrective or preventive maintenance of equipments included in a specific SWAB category by the combined ships of the class. The ranking of the SWAB categories represents the preventive and corrective maintenance burden contribution of each SWAB category relative to the total class burden. Three categories of information were used to determine this ranking: (1) ship's force and intermediate maintenance activity (IMA) corrective maintenance man-hour burden (MBF_{CM}) reported in the maintenance data system (MDS), (2) the annual planned maintenance system (PMS) man-hour burden (MBF_{PM}) as determined from equipment maintenance requirement cards (MRCs) and (3) the average number of man-days required for equipment repair during regular overhaul (ROH) as reported in class repair profiles. A summary of these data for the selected armament system equipments is presented in table 3-1, together with their relative corrective and preventive maintenance burden rankings.

Maintenance profiles for equipment common to both ship classes were compared. This comparison included the types of failures experienced, types of maintenance actions performed, parts used, and CASREPs submitted. When possible, selected equipment maintenance histories were also compared with previously documented FF-1052 and DDG-37 Class analysis results. These comparisons indicated that the maintenance requirements for identical

Table 3-1. DATA SUMMARY OF SELECTED EQUIPMENT FOR THE CG-16 AND CG-26 CLASS SHIPS							
SWAB Number	Selected Equipment	Applicable APLs	Corrective Maintenance Burden Rank Within Ship	Preventive Maintenance Burden Rank Within Ship	MBF_{CM}* (Man-Hours)	MBF_{PM}** (Man-Hours)	ROH Burden (Man-Days)
			CG-16 Class				
721-1 and 722-1	GMLS Mk 10 Mods 5 and 6		4	1	6,439	48,240	0
	• GMLS Mk 10 Mods 5 and 6	004120004					
	• Strikedown Elevators	590380001 590380002					
	• Electric Transfer Cart	853330001					
721-2 and 722-2	ASROC Launching Group		21	3	1,173	34,470	988
	• Stand	005020012					
	• Guide	005020019 005020020 005020021					
	• Train and Elevation Power	005020010					
	• Drivers	005020015					
	• Control Panel	005020013					
	• Carriage	005020016 005020017					
	• Launcher Simulator	005020014					
	• Cooler	030130461					
	• Heater	070010083					
	• Centrifugal Pumps	016060145 016150384					
	• Loader Crane	572090002 572130001 572280001					
750-1	Surface Vessel Torpedo Tubes		35	15	744	6,408	0
	• SVTT Mk 32 mods 5 and 7	006320222					
			CG-26 Class				
711-1	5"/54 Gun Mount Mk 42 Mod 10		2[illegible]	10	1,433	12,609	0
	• Gun Barrel Mk 18	006030019					
	• Stand	006050001					
	• Carriage	006050002					
	• Upper Hoist	006050003					
	• Firing Cutout	006050004					
	• Train Power Drive	006050005					
	• Elevation Power Drive	006050006					
	• Slide	006050007					
	• Fuse Setter	006050008					
	• Rammer	006050009					
	• Empty Case Ejector	006050010					
	• Gas Ejector	006050011					
	• Housing	006050012					
	• Shield	006050013					
	• Lower Hoist	006050014					
	• Mount Control	006050015					
	• Miscellaneous Hardware	006050016					
721-1 and 722-1	GMLS Mk 10 Mod 7		7	1	6,250	37,071	0
	• GMLS Mk 10 Mod 7	004120005					
	• Strikedown Elevators	590320003					
	• Electric Transfer Car	863330001 854441003					
750-1	Surface Vessel Torpedo Tubes		23	19	1,736	6,408	0
	• SVTT Mk 32 Mods 5 and 7						

*Combined average for the reported ship's force and IMA corrective maintenance man-hours expended on a particular equipment per year for the entire class population of that equipment.
**Total required annual PMS man-hours as reflected by appropriate MRCs for the entire class population of that equipment.

equipment are consistent, regardless of ship class. Sections 3.2 through 3.5 document the results of the maintenance analyses performed for the selected equipments of the CG-16 and CG-26 Class armament systems.

3.2 5"/54 DUAL PURPOSE GUN MOUNT (DPGM) MK 42 MOD 10 (SWAB 711-1) (CG-26 CLASS ONLY)

The 5"/54 Mk 42 mod 10 gun mount is a single-gun, dual-purpose mount used as a tactical weapon against surface, shore, and air targets. It is a modernized Mk 42 mod 7, incorporating many of the Mk 42 mod 9 features. The Mk 42 mod 10 contains a dual ammunition hoist system that is fully automatic once its loader drums have been filled. Two circular drums located in the lower ammunition handling room must be filled manually by a loading crew. Each drum holds 20 complete rounds of ammunition (projectile and powder). In automatic mode, with both drums continuously filled, the gun is capable of firing 35 to 40 rounds per minute. With only one hoist available (one-sided operation), the gun is capable of sustaining a rate of fire of 17 to 20 rounds per minute. Gun train and elevation orders, ammunition fuse-setting orders, and gun firing orders are normally received from the gun fire control system Mk 68; however, alternate sources for these orders are the one-man control (OMC) station in the gun mount and the EP2 control panel in the gun carrier room. System components selected for analysis are listed in table 3-2.

3.2.1 Background

Each CG-26 Class ship is equipped with one Mk 42 mod 10 gun mount. CG-26, which is decommissioned while undergoing repair and modernization, will be equipped with a Mk 42 mod 10 DPGM during overhaul. The remaining ships of the class were equipped with the Mk 42 mod 10 at various times during the data period, resulting in a total component operating time of 21.4 ship operating years.

3.2.2 Discussion

During the data period analyzed, a total of 376 maintenance actions were reported against the various gun APLs, with a total man-hour burden of 3,883 man-hours. This equates to an average resource expenditure of 181.4 man-hours per ship operating year. A summary of the Mk 42 mod 10 maintenance burden data by system component is presented in table 3-2.

Detailed analysis of MDS narrative data revealed that only 45 percent (170) of the reported maintenance actions were for corrective maintenance performed on gun system components. Parts-only actions accounted for 44 percent (164), PMS deferrals were responsible for five percent (20), and a group of 23 miscellaneous actions, not related to corrective maintenance, accounted for the remaining six percent.

Analysis of the 2,424 man-hours (2,401 ship's force and 23 IMA) and 170 JCNs attributed to corrective maintenance revealed that only three actions

Table 3-2. MAINTENANCE BURDEN SUMMARY FOR THE 5"/54 MK 42 MOD 10 GUN MOUNT						
Component Nomenclature	APL	JCNs	Ship's Force Man-Hours	IMA Man-Hours	Total Man-Hours	Man-Hours per Component per Ship Operating Year*
Mk 18 Gun Barrel	006030019	13	870	236	1,106	51.7
Mk 21 Mod 3 Stand	006050001	11	40	14	54	2.5
Mk 35 Mod 4 Carriage	006050002	27	202	17	219	10.2
Mk 2 Mods 6 and 7 Upper Hoist	006050003	16	28	0	28	1.3
Mk 1 Mod 2 Firing Cutout	006050004	2	3	0	3	0.1
Mk 19 Mod 3 Train Power Drive	006050005	7	4	0	4	0.2
Mk 19 Mod 3 Elevation Power Drive	006050006	13	197	0	197	9.2
Mk 31 Mod 3 Slide	006050007	45	138	1	139	6.5
Mk 29 Mods 2 and 3 Rammer	006050008	14	20	0	20	0.9
Mk 13 Mod 1 Gas Ejector	006050009	8	115	0	115	5.4
Mk 11 Mod 3 Housing	006050010	4	20	0	20	0.9
Mk 61 Mod 11 Shield	006050011	5	23	0	23	1.1
Mk 11 Mod 3 Housing	006050012	16	54	21	75	3.5
Mk 61 Mod 11 Shield	006050013	26	1,126	3	1,129	52.8
Mk 7 (All Mods) Lower Hoist	006050014	35	70	0	70	3.3
Mk 114 Mod 2 Control	006050015	102	415	0	415	19.4
Miscellaneous Hardware	006050016	32	266	0	206	12.4
Total		376	3,591	292	3,883	181.4

*Class operating years total 21.4.

were responsible for 44 percent (1,078 man-hours) of the man-hours reported. All three actions were reported by one ship (CG-32) and were related to the installation of a new gun port shield. Draining of the gun's anti-freeze system required 120 man-hours, actual installation of the shield required 828 man-hours, and 130 man-hours were reported for painting and preserving the mount following installation.

The remaining portion of the corrective maintenance burden (1,346 man-hours) consisted primarily of random, nonrepetitive failures and parts replacements. Replacement of light driver circuit boards (NSN 6U-1020-00-813-1528) was the only repetitive maintenance action and part usage reported, with a total of 34 light driver boards being used during the data period. The NAVSEA Reliability, Maintainability, and Availability Assessment report, dated 1 December 1977, prepared by Bird Engineering Research Associates, Inc., noted that the light driver board was the second most frequently replaced PC board in the Mk 42 mod 10 systems studied but that its performance has corresponded to predicted failure rates. Screening of the remainder of the CG-26 Class parts-usage data indicated that many parts were ordered in small quantities and that none were used repeatedly. Only six parts were ordered by more than two ships of the class and none of these exceeded a replacement rate of one part per ship operating year. It was, therefore, concluded that since gun system parts are either meeting their predicted failure rates or are experiencing random, non-repetitive usage, no recommendations concerning parts availability or reliability are warranted.

CG-26 Class ships submitted 49 CASREPs on the Mk 42 mod 10 gun mount. The nature of these CASREPs supports the MDS narrative and parts-usage analysis conclusion that the gun has not experienced any recurring maintenance problems. Although 13 of the CASREPs involved the upper hoist and eight were submitted for train power drive failures, all were the result of different failures. The reasons cited for a majority of the CASREPs was the breakage of parts, caused by component misalignment, malfunction of logic cards, and normal wear and tear; however, the randomness of occurrence makes it impractical to predict part failures or to provide a solution for decreasing the man-hour burden expended for repair of these failures. In addition, many of the problems identified from the maintenance data for the CG-26 Class ships such as failure of recoil/counter-recoil assembly, carrier assembly, and various switch and switch actuators, already have solutions available in the form of redesigned parts or ordalts. Other maintenance actions reported are concerned primarily with replacements of minor parts and control of hydraulic leakage and are not significant enough to affect gun mount maintenance strategy.

A total of 63 man-hours was reported for various routine weekly, monthly, and quarterly PMS actions. Primary reasons for these deferrals were listed as either a lack of time due to ship operating schedules, or a lack of materials, such as grease or hydraulic fluid. However, their total burden was not significant enough to affect the gun mount maintenance strategy. Star gauging of the gun barrel, which is a preventive maintenance action required annually (or after a specified number of rounds have been fired, depending on barrel type) by NAVSEAINST 8300.1A accounted for a total of 221 man-hours (18 ship's force and 203 IMA). This requirement is not listed in MIP G-031/10S-78 for the 5"/54 Mk 42 mod 10 gun mount. Since it is an annual or conditional preventive requirement, it should be included in the PMS as an A-R requirement, accomplished before completion of BOH and included in the CG-26 class maintenance plan for accomplishment at 12-month intervals.

Of the 23 miscellaneous actions reported for items other than corrective maintenance, three were responsible for nearly 88 percent (1,030 man-hours) of the man-hour burden reported against the entire group (1,175 man-hours). One action involved 850 ship's force man-hours for clean-up of the gun magazine and carrier room after the spaces were flooded. Another action reported 130 man-hours for ordalt installation, and the third was for 50 man-hours required to install a modification to the high-pressure air-system reducer. The remaining 20 maintenance actions and 145 man-hours were reported for ordering special tools, conducting special tests, and x-raying the gun shield.

Disregarding the man-hours reported for PMS and other miscellaneous actions results in a ship-operating-year maintenance burden of 113.3 man-hours, which corresponds to the 112.2 man-hours per year reported by the DDG-37 Class ships. This amount of maintenance is not considered excessive but does indicate that the potential exists for further improvement to gun system performance. Installation of the outstanding ordalt (which include many reliability-oriented changes) should improve gun reliability and assist in reducing the CG-26 Class Mk 42 mod 10 gun mount corrective maintenance burden.

Naval Ordnance Station, Louisville, personnel have reported that the service life between overhauls for the Mk 42 mod 10 gun mount is approximately 10 years. Only one CG-26 Class ship (CG-33) will have a gun mount with 10 years of service at BOH; however, the gun mounts of CG-27, -28, and -32 will surpass this 10-year mark before their first follow-on overhaul. It is recommended that these mounts be inspected at BOH for material condition in accordance with NAVSEA Instruction 8300.2A, which establishes the policy for the gun weapon system replacement program, and that the gun mounts be overhauled or repaired as necessary, on the basis of inspection results. For the remaining ships of the class, this same inspection procedure should be applied at their first follow-on regular overhaul. On the basis of the results of this study, no additional maintenance strategy recommendations are considered necessary and a run-to-failure strategy with accomplishment of associated PMS should provide adequate maintenance coverage during an extended operating cycle.

3.2.3 Recommendations

The results of this study indicate that the following recommendations should be adopted for the CG-26 Class Mk 42 mod 10 gun mounts:

- For BOH of CG-27, -28, -32, and -33, inspect the material condition of the Mk 42 mod 10 gun mount and overhaul or repair as determined necessary.

- Include an engineered CMP task to inspect the material condition of all Mk 42 mod 10 gun mounts at each ROH in accordance with NAVSEAINST 8300.2A.
- Repair or overhaul the 5"/54 Mk 42 mod 10 gun mount during ROH to correct discrepancies identified by pre-overhaul material condition inspection.
- Include an engineered CMP task to star gauge the Mk 42 mod 10 gun barrel annually in accordance with NAVSEAINST 8300.1A.
- Add the star gauge requirement to the PMS system MIP A-031/10S-78 for the Mk 42 mod 10 gun mount as an A-R requirement.

3.3 GUIDED MISSILE LAUNCHING AND HANDLING SYSTEM (SWAB GROUPS 721-1 AND 722-1)

The CG-16 and CG-26 Class guided missile launching and handling system includes the guided missile launching system, electric missile transfer car, and strikedown elevators.

The guided missile launching system has a dual configuration, consisting of an A side and a B side. Each side can be operated separately or both can be operated simultaneously.

The electric missile transfer car is a manually controlled vehicle designed to carry a missile or booster athwartship between the strikedown elevators and the rammer rails during replenishment or off-load. To assist in the alignment of the missile and booster during mating operations, the mating head assembly can be hydraulically elevated and the mating head floated, which enables the missile to be rotated 5 degrees about its axis.

The strikedown elevators move the missiles and boosters between the weather deck and the electric transfer car during replenishment or off-load.

3.3.1 Background

The CG-16 Class ships are each equipped with two fully independent launching systems. CG-26 Class ships have only one system per hull. All of the launching systems are Mk 10, with the mod 5 installed forward on the CG-16 Class, the mod 6 installed aft on the CG-16 Class, and the mod 7 installed forward on the CG-26 Class. APL 004120004 supports the Mk 10 mods 5 and 6 guided missile launching systems, and APL 004120005 supports the Mk 10 mod 7. Because of the functional similarity among the various mods, the systems for both ship classes will be discussed together.

Two types of electric transfer cars are used in the CG-16 and CG-26 Class ships. APL 853330001 is applicable to all transfer cars in the CG-16 Class. This same APL is applicable to two ships of the CG-26 Class, while the other seven CG-26 Class ships are equipped with a transfer car supported by APL 854410003.

The strikedown elevators for the CG-16 Class are documented under APLs 590380001 and 590380002. The strikedown elevators for the CG-26 Class are supported by APL 590320003.

3.3.2 Discussion

All of the equipments of the guided missile launching and handling system addressed in this report are functionally similar, if not identical, to equipments analyzed for the DDG-37 Class. Discussion of the CG-16 and CG-26 Class maintenance history analysis results will include a comparison with the DDG-37 Class analysis results previously documented.

Table 3-3 summarizes the initial comparison of maintenance man-hours per equipment operating year (EOY) between the classes. Although no two classes have the same burden for any piece of equipment, the figures are close enough to suggest that their histories are similar. The maintenance burdens for the Mk 10 guided missile launching system for all three classes are within 25 percent of the overall average of 428 man-hours per equipment operating year. The interclass comparisons for the electric transfer car and strikedown elevators also indicate that all three classes expended approximately the same amount of man-hours per equipment operating year.

Historical profiles for the CG-16 and CG-26 Classes were developed to determine if the recommendations contained in the DDG-37 Class System Maintenance Analysis (ARINC Research Publication 1653-06-5-1857) were applicable to these two classes. Table 3-4 is a comparison of repetitive actions discovered during the compilation of the historical profiles for the CG-16 and CG-26 Classes and the maintenance-significant items discussed in the DDG-37 Class SMA. As shown in table 3-4, all three ship classes have very similar maintenance histories in that only one of the 18 maintenance-significant items experienced by the DDG-37 Class ships was not common to the CG-16 and CG-26 Classes.

The first of the maintenance actions listed, weight testing, is required by NAVSHIPS Technical Manual (NSTM) 0901-LP-700-0000, Chapter 700, for all weapons handling equipment. For the guided missile handling and launching systems, this requirement includes the guided missile hoist Mk 21, the electric transfer car, and strikedown elevators. The maximum interval between weight tests is established as four years. The test is also required following any major repairs, such as overhaul of the equipment. These tests are not within the capability of ship's force and are normally conducted during ship overhauls or availabilities when outside assistance and facilities are available. It is recommended that these tests be accomplished on CG-16 and CG-26 Class ships before completion of baseline overhaul and be included in their class maintenance plans for intracycle testing at 48-month intervals.

Individual flexible hoses have not presented a reliability problem to either of the ship classes; however, their cumulative replacement total (71) represents a maintenance burden that requires attention. The maximum service life for wire-reinforced hoses is five years and for polyester-reinforced hoses, six years; therefore, periodic inspection of hoses is required to determine if they need to be replaced. This inspection requirement is covered by PMS (MIP A-708/4-47, MRC Q-1); however, to facilitate this required inspection, the ship's force needs a means of identifying

Table 3-3. COMPARATIVE ANALYSIS OF THE GUIDED MISSILE LAUNCHING AND HANDLING SYSTEM

Components	Ship's Force +IMA Man-Hours	Number of Components	Man-Hours per Equipment Operating Year (EOY)
DDG-37 Class			
Mk 10 Guided Missile Launching System			
004120001	20,835	9	491.0
004120004	-	-	-
004120005	-	-	-
Class Average*			491.0
Electric Transfer Car			
853330001	637	7	19.0
854410003	58	2	6.0
Class Average**			16.0
Strikedown Elevators			
590320001	155	9	4.0
590320002	127	9	3.0
590320003	-	-	-
Class Average†			3.5
CG-16 Class			
Mk 10 Guided Missile Launching System			
004120001	-	-	-
004120004	32,812	18	313.0
004120005	-	-	-
Class Average			313.0
Electric Transfer Car			
853330001	1,560	18	15.0

*GMLS average man-hours per equipment operating year = 428
**Electric Transfer Car average man-hours per equipment operating year = 19
†Strikedown Elevators average man-hours per equipment operating year = 2.5

(continued)

Table 3-3. (continued)

Component	Ship's Force +IMA Man-Hours	Number of Components	Man-Hours per Equipment Operating Year (EOY)
CG-16 Class (continued)			
Electric Transfer Car (continued)			
854410003	-	-	-
Class Average			15.0
Strikedown Elevators			
590320001	96	18	1.0
590320002	306	18	3.0
590320003	-	-	-
Class Average			2.0
CG-26 Class			
Mk 10 Guided Missile Launching System			
004120001	-	-	-
004120004	-	-	-
004120005	29,093*	9	479.0
Class Average			479.0
Electric Transfer Car			
853330001	893	2	67.0
854410003	742	7	16.0
Class Average			27.0
Strikedown Elevators			
590320001	-	-	-
590320002	-	-	-
590320003	296	18	2.0
Class Average			2.0

*Does not contain contributions from three JCNs with 10,169 erroneously reported man-hours.

Table 3-4. INTERCLASS HISTORICAL MAINTENANCE SUMMARY OF THE GUIDED MISSILE LAUNCHING AND HANDLING SYSTEM			
Maintenance Action	Class Applicability		
	DDG-37	CG-16	CG-26
1. Conduct Weight Tests	X	X	X
2. Replace Flexible Hoses	X	X	X
3. Analyze Hydraulic Oil	X	X	X
4. Calibrate Torque Wrench	X	X	X
5. Calibrate Gauge	X	X	X
6. Replace Relays	X	X	X
7. Replace Switches	X	X	X
8. Replace Filters	X	X	X
9. Replace U-Lugs	X	X	X
10. Replace Warm-Up Cables	X	X	X
11. Realign Loader Rails	X	X	X
12. Repair Dud Jet Units	X	X	X
13. Repair Door/Hatch Seals	X	X	X
14. Repair Magnetic Amplifier Assembly (EP2 Panel)	X		
15. Refurbish Launchers	X	X	X
16. Repair Electric Transfer Cars	X	X	X
17. Repair Anti-Icing System	X	X	X
18. Repair Launcher Contractor	X	X	X

the location of each hose. It is recommended that an equipment guide list (EGL) for all of the launching system flexible hoses be developed and provided to CG-16 and CG-26 Class ships.

Hydraulic oil analysis is a significant maintenance item; i.e., it requires outside assistance and appears frequently in the MDS as a deferred maintenance item since an analysis facility is not always readily available. It is not considered a major problem but should be included in the CG-16 and CG-26 class maintenance plans for annual accomplishment in accordance with existing PMS requirements.

Analysis of CG-16 and CG-26 Class maintenance data revealed that loader rail alignment was a frequently reported maintenance action; however, it was also evident that misalignment of the loader rail sections has various causes and occurs at random intervals. Since no repetitive cause of failure could be determined and realignment actions were not indicative of a periodic requirement, it is recommended that loader rails be aligned only in conjunction with a launcher overhaul as a post-installation check during baseline overhaul and subsequent regular overhauls.

The maintenance burden presented by the dud jettison units consisted primarily of unit overhauls or replacements and testing of high pressure air flasks. The remainder of the burden was for miscellaneous nonrepetitive repair and parts replacement, and only three CASREPs were submitted by CG-16 and CG-26 Class ships. Routine dud jettison unit overhaul or replacement is not justified by the maintenance histories of the two ship classes; however, pressure testing of the air flasks is required by NAVSHIPS Technical Manual 0901-LP-490-0003, Chapter 551. Pressure testing is required at six-year intervals and is accomplished at the depot level; therefore, it is recommended that dud jettison unit air flasks be tested during BOH and each subsequent ROH. On the basis of analysis results that indicated an occasional need for overhaul or replacement, it is also recommended that the CG-16 and CG-26 Class dud jettison units be inspected and tested before overhaul and repaired or replaced during BOH and each ROH on the basis of inspection results.

Replacement of missile house door and strikedown hatch seals and gaskets, although not a serious problem, does require attention. The maintenance history of the seals and gaskets does not warrant their periodic replacement; however, to ensure their best possible material condition in order to preserve watertight integrity during an extended operating cycle, it is recommended that they be replaced during BOH and included in the POT&I for subsequent ROHs, with repair or replacement as determined to be necessary by the inspection.

Historically, maintenance trends of GMLS Mk 10 launchers have indicated a need for overhaul after approximately 10 years of service. A mid-life refurbishment program, monitored by NSWSES, has been established to inspect and remove the launchers and forward them to NOS, Louisville, for class A overhauls as required. A refurbished unit is provided to replace the launcher, since overhaul time normally exceeds the ROH period of a ship. It is recommended that the guided missile launchers of the CG-16 and CG-26 Class ships be inspected during BOH and each subsequent ROH, with removal, overhaul, and replacement in accordance with this overhaul program.

Analysis of MDS, parts usage, and CASREP data for the remaining items of table 3-4 indicate that closer adherence to PMS and existing maintenance requirements will provide for satisfactory operation of the listed components, with only a minimum of maintenance during an extended operating cycle. For these components, standard POT&I should be accomplished during BOH and each subsequent ROH, with repairs based on inspection results and each ship's CSMP. No changes to the DDEOC intracycle run-to-failure maintenance strategy are considered necessary.

3.3.3 Recommendations

It can be concluded from this study that the guided missile launching and handling systems for the CG-16 and CG-26 Classes have experienced maintenance histories equivalent to those of the DDG-37 Class and that the following recommendations also documented in the DDG-37 Class system maintenance analysis are equally applicable to and should be adopted for them.

- Repair the Mk 10 GMLS and strikedown system during BOH, on the basis of POT&I results. (It is recommended that this task be added to the CG-16 and CG-26 Class repair requirements for BOH.)
- Overhaul the Mk 5 launcher at NOS, Louisville, during BOH in accordance with the mid-life refurbishment program. (This task is included in CG-16 and CG-26 repair requirements for BOH.)
- Conduct weight tests on all portions of the strikedown and handling systems during the last months of BOH. (It is recommended that this task be added to the CG-16 and CG-26 Class repair requirements for BOH.)
- Inspect all flexible hoses of the Mk 10 GMLS during BOH and, as required, replace as prescribed in MRC Q-1 (MIP A709/4-47). (It is recommended that this task be added to the CG-16 and CG-26 class repair requirements for BOH.)
- Remove hydraulic fluid samples in accordance with MRCs LU-1 and SU-1 (MIPs 5ZBAAGG and 5ZBAAF1) and forward to a suitable facility for analysis during BOH. (It is recommended that this task be added to the CG-16 and CG-26 Class repair requirements for BOH.)
- Align loader rails, if necessary, as determined by a post-installation check associated with launcher overhaul during BOH. (This task is included in CG-16 and CG-26 Class repair requirements for BOH.)
- During BOH, repair dud jettison units on the basis of POT&I results, with a pressure test of the high-pressure air flasks in accordance with NSTM 0901-490-003, Chapter 551. (It is recommended that this task be added to the CG-16 and CG-26 Class repair requirements for BOH.)
- Repair or replace seals and gaskets on strikedown hatches, blast doors, and blowout hatches during BOH. (This task is included in the CG-16 and CG-26 Class repair requirements for BOH.)
- Repair electric transfer car during BOH on the basis of POT&I results. (It is recommended that this task be added to the CG-16 and CG-26 class repair requirements for BOH and the CG-26 Class item for Class B overhaul during BOH be deleted.)
- Repair anti-icing system during BOH on the basis of POT&I results. (It is recommended that this task be added to the CG-16 and CG-26 Class repair requirements for BOH.)

- Include an engineered CMP task to conduct weight tests on all portions of the strikedown and handling systems at four-year intervals.
- Include an engineered CMP task to perform an annual Mk 10 GMLS system hydraulic oil analysis in accordance with MIP 5ZBAAGG/1-3 (MRC A-1).
- Include a qualified CMP task to align the loader rails if major repair or overhaul of the Mk 5 launcher is accomplished during ROH.
- Include a qualified CMP task to inspect and repair all portions of the guided missile launching and handling system during each ROH on the basis of POT&I results.
- Include an engineered CMP task to pressure-test high pressure air-flasks in the dud jettison units in accordance with NSTM, Chapter 551, during each ROH.
- Develop an equipment guide list identifying all flexible hoses in the guided missile launching and handling system.

3.4 ASROC LAUNCHING GROUP (SWAB GROUPS 721-2 AND 722-2) (CG-16 CLASS ONLY)

The function of the ASROC launching group Mk 16 is to load, stow, and launch antisubmarine rocket-thrown torpedoes and depth charge devices. Weapons are loaded by means of an installed electrohydraulic loader crane, which mates to the ASROC launcher. Weapons are stowed in four launcher guides, each containing two fully enclosed, temperature-controlled cells. The cells contain snubber and restraining devices for holding the weapons in position until launch, as well as hydraulic and pneumatic actuating and controlling equipment for operation of the snubbers, forward doors, and launch rail extension. The launcher can be rotated through 360°, with each guide independently elevated and depressed for weapon loading and launch. Major components of the ASROC launching group include the ASROC launcher Mk 112, launcher captain's control panel Mk 199, launcher simulator Mk 6, an ASROC heating and cooling system, and a loader crane.

3.4.1 ASROC Launcher Mk 112

3.4.1.1 Background

Each CG-16 Class ship is equipped with one ASROC launcher Mk 112 mounted forward of the ship's superstructure on the main deck. Major components of the launcher include the following:

- Guide Mk 7 mods 1 and 2, APLs 005020019, 005020020, and 005020021
- Carriage Mk 7 mods 2, 3,and 4, APLs 005020016 and 005020017
- Launcher stand Mk 107 mod 2, APL 005020012
- Train and elevation power drives Mk 61 mods 1, 2, and 3, APLs 005020010 and 005020015

Each of the launcher components is either identical to, or functionally similar to, ASROC launcher components installed on FF-1052 and DDG-27 Class ships. Discussion of maintenance analysis results for the CG-16 Class ASROC launching group will include a comparison with previously documented analysis results for the FF-1052 Class ASROC launching group (ARINC Research Publication 1645-50-4-1550, dated October 1976) and DDG-37 Class antisubmarine warfare system (ARINC Research Publication 1653-06-4-1856, dated December 1978).

3.4.1.2 Discussion

Analysis of the ASROC launcher Mk 112 maintenance data revealed that the launcher carriage and launcher guides were responsible for 95 percent of the total CG-16 Class launcher man-hour burden, while the launcher stand and train and elevation power drives were responsible for only five percent These same two components (launcher carriage and guides) were responsible for 93 percent of the FF-1052 Class launcher burden and 92 percent of the DDG-37 Class launcher burden. A summary of the maintenance burden data by ship class and launcher component is presented in table 3-5.

Launcher Carriage

The launcher carriage ranked highest among CG-16 Class launcher components, with an average of 80.1 man-hours per ship operating year. It also ranked highest in maintenance burden on the FF-1052 Class, with an average of 89.6 man-hours, and ranked highest on the DDG-37 Class, with 69.4 man-hours per ship operating year.

A review of CG-16 Class MDS narrative data did not reveal any repetitive carriage problems. The most frequently reported carriage failures, reported by all three classes, involved clogged hydraulic filters, corroded parts, and moisture in the hydraulic and pneumatic systems.

Table 3-6 lists the carriage parts associated with these failures and reported as the most frequently replaced (based on the total number replaced and their usage reported by more than two ships). From the values calculated for usage per ship operating year, it was concluded that none of the parts usage rates indicate any recurring maintenance problem. Only two parts, a pin (NSN 9Z-5340-00-740-6863) and a filter (NSN 9C-4330-00-203-3593) had a usage of more than one part per ship operating year. This usage is not considered excessive since neither part is critical to equipment operation, and individual on-board spares are adequate to cover the average usage rate. Parts-usage tables from FF-1052 and DDG-37 Class analyses were reviewed and revealed that these same parts had similar usage histories for those two classes.

Although analysis of CG-16 Class MDS and parts data did not indicate the existence of any recurring maintenance problems, a review of CG-16 Class CASREP data revealed that eight CASREPs (40 percent of the launching group total) were submitted for guide drive pin assembly failures. FF-1052 Class ships experienced a similar problem, since guide drive pin CASREPs accounted for 30 percent of their launching group total. The DDG-37 did not contain sufficient data for comparison.

Table 3-5. MAINTENANCE BURDEN SUMMARY OF THE LAUNCHER MK 112

Ship Class	Component	APL	Ship Operating Year (SOY)	Ship's Force Man-Hours	IMA Man-Hours	Total Man-Hours	Man-Hours per Component per SOY
CG-16	Guide	005020019 005020020 005020021	52.4	953	538	1491	7.1
	Carriage	005020016 005020017	52.4	3057	1129	4166	80.1
	Stand	005020012	52.4	61	0	61	1.2
	Train/Elevation Power Drives	005020010 005020015	52.4	176	63	239	2.3
FF-1052	Guide	005020021	126.0	6163	4331	10494	20.8
	Carriage	005020017	126.0	8307	2979	11286	89.6
	Train/Elevation Power Drives	005020015	126.0	1339	186	1525	6.0
	Stand	005020012	126.0	170	57	227	1.8
DDG-37	Guide	005020002	43.9	2622	1505	4127	23.5

Table 3-6. PARTS-USAGE SUMMARY OF THE CARRIAGE MK 7			
NSN	Nomenclature	Number Replaced	Number Replaced per Ship Operating Year
9C-4330-00-203-3593	Filter	79	1.8
9C-4820-00-535-6483	Valve	4	0.1
9N-5945-00-557-4846	Relay	8	0.2
2N-1440-00-673-7798	Seal Assembly	17	0.4
1A-1440-00-673-7840	Coupling	4	0.1
9N-5930-00-675-9621	Switch	8	0.2
9Z-5340-00-740-6863	Pin	126	2.9
9N-5935-00-817-7300	Connector	4	0.1
9Z-5340-00-899-6796	Spring	3	0.1
2A-4810-00-978-4575	Solenoid	4	0.1
1A-1440-00-673-7788	Boot	24	0.5

The guide drive pin assembly provides a mechanical link between the guide selected for weapon launch and the carriage torque tube. When a guide is selected, the guide drive pin is hydraulically rammed into the torque tube bushing, releasing the elevation stow latch assembly and activating an interlock to prevent movement of any other guide. As the selected guide elevates, the guide drive pin moves along a curved track under 4000 pounds of spring tension. These actions require close tolerances and reliable response by the components involved. Maintenance problems most frequently experienced are attributed to binding and misalignment of parts caused by corrosion, resulting in broken guide drive pin tracks and track supports, bent guide drive pin cylinders, corroded and scored guide drive pin sleeves, and broken retainer bolts. An improvement to the guide drive pin assembly, ordalt 8670, has been developed and installed on the CG-16 Class ships; therefore, no major guide drive pin assembly problems should be expected during an extended operating cycle.

Corrosion of carriage parts was reported in MDS by all three ship classes as the most frequent cause of failures. The launcher's location constantly subjects it to salt water spray and wave loading, which results in corrosion-related failures. The most frequently reported problem was damage to the boot (NSN 1A-1440-00-673-7788), a protective device for the guide drive pin and elevation stow latch assemblies. The damage allows the intrusion of salt water. This damage results from deterioration due to normal wear and tear or handling during removal and replacement of the carriage's center panel for maintenance. CG-16 Class ships reported replacing 24 of these boots during the data period, compared with 120 for the FF-1052 Class ships and 32 for the DDG-37 Class ships. Ordalt 7695 provides a different center panel and access door arrangement to reduce the incidence of damage from removal for maintenance. This ordalt has been installed on all CG-16 Class ships and, in conjunction with other anticorrosion ordalts either already installed or under development, should provide improved operation of the carriage during the extended operating cycle.

Launcher Guides

Repair of failures involving the four launcher guides ranked second on all three ship classes in their contribution to the ASROC launcher maintenance burden. CG-16 Class ships required an average of 7.1 man-hours per ship operating year, with a total of 1,491 man-hours (953 ship's force and 538 IMA) for guide maintenance. The majority of the CG-16 Class guide maintenance burden consisted of miscellaneous repairs involving replacement of such parts as cell thermometers, cell door gaskets, various hydraulic system valves and switches, and aft blast door quick disconnects. Guide parts most frequently used are listed in table 3-7 together with the total number replaced and their average replacement rates per ship operating year. The only parts that appear significant are studs and retaining rings; however, the guide APL provides adequate spares for their maintenance. Therefore, it was concluded that none of the parts experienced a significant usage rate, and no serious problems are expected for an extended operating cycle.

Table 3-7. PARTS-USAGE SUMMARY OF THE GUIDE MK 7

NSN	Nomenclature	Number Replaced	Number Replaced per Ship Operating Year
1A-6685-00-042-2318	Thermometer	28	0.6
9Z-5340-00-051-2358	Pin	19	0.4
9Z-5325-00-281-4015	Stud	2814	64.1
9Z-5340-00-523-8813	Ring, Retain	789	18.0
1A-1440-00-673-7892	Link	7	0.2
9N-5935-00-817-7300	Connector	3	0.1
9G-9340-00-946-1396	Window	30	0.7
2A-4810-00-978-4575	Valve	9	0.2
9N-5930-00-992-4870	Switch	7	0.2

Both DDG-37 and FF-1052 Class ships reported an average operating year guide man-hour requirement in excess of 20 man-hours compared with 7.0 man-hours for the CG-16 Class. This difference can be attributed to several causes:

- Although all three ship classes reported corrosion as the most frequent cause of guide-related failures, the CG-16 Class launcher is located behind the surface-to-air missile house, which provides some protection from salt water spray and wave loading.

- CG-16 Class launchers are not subject to damage or failures caused by gun blast shock from an adjacent 5"/54 gun mount.
- Anticorrosion and water tightness ordalts 6803, 7695, and 8613 were installed during the last half of the CG-16 Class reporting period, providing added protection and reducing the number of failures from salt water corrosion. These ordalts were not installed during any of the FF-1052 Class data period and were installed so late in the DDG-37 Class data period that their effectiveness could not be evaluated.

Launcher Stand and Train and Elevation Power Drives

The remaining CG-16 Class launcher components, the launcher stand and the train and elevation power drives did not present significant maintenance burdens to the class. The stand accounted for only five maintenance actions for a total of 61 man-hours (all ship's force), had no significant parts usage, and was responsible for no CASREPs. The train and elevation power drives accounted for 42 maintenance actions, 239 man-hours (176 ship's force and 63 IMA) for an average of 2.3 man-hours per ship operating year, had no significant parts usage, and were responsible for only one CASREP. It was therefore, concluded that these components should provide satisfactory operation during an extended operating cycle with no significant maintenance problems.

Maintenance Strategy

Although none of the launcher components individually presents any significant problems, their cumulative burden should warrant consideration for a class A launcher overhaul during BOH. The major overhaul program, established in 1969, provides procedures for the determination of an individual ASROC launcher's need for class A overhaul. The CG-16 Class launchers should be included in this program, inspected by the NAVSEACENs, and overhauled as required on the basis of inspection results. Since the average major overhaul cycle for bow-mounted launchers has been four to six years, the launchers should be inspected and overhauled, as required, during BOH and each subsequent ROH. Because of the documented corrosion problems, each launcher should be inspected during each SRA to assess the effects of anticorrosion ordalts installed. A reduction in corrosion problems, by installation of existing ordalts and overhaul before entering an extended operating cycle, should enable the ASROC launcher to perform satisfactorily with only a minimum of maintenance during an extended operating cycle.

3.4.1.3 Recommendations

On the basis of the results of this analysis, the following recommendations should be adopted for the CG-16 Class ships ASROC launcher:

- Accomplish outstanding launcher ordalts during BOH on as soon after as practicable.

- Accomplish class A overhaul of the ASROC launcher or replace it with a refurbished unit, as required, during BOH, on the basis of NAVSEACEN inspection results. (This task is included in the CG-16 Class Class repair requirements for BOH.)
- Include an engineered CMP task to inspect launcher components and assess the effects of corrosion during each DDEOC SRA.
- Include a qualified CMP task to repair the ASROC launcher during each DDEOC SRA, on the basis of results of corrosion inspections.
- Include an engineered CMP task to class B overhaul the ASROC launcher during each ROH, on the basis of inspection results.

3.4.2 Launcher Captain's Control Panel (LCCP) Mk 199

3.4.2.1 Background

Each CG-16 Class ship is equipped with one LCCP Mk 199 mod 3, 4, or 5. Because the APL supporting all three mods is the same (005020013), all were considered identical for analysis and no differentiation is made in the discussion of analysis results. Identical LCCPs were installed on FF-1052 and DDG-37 Class ships; however, only analysis results for the FF-1052 Class will be used to determine if an equivalency of maintenance histories exists between classes, because the DDG-37 Class LCCP was not analyzed and no data were available for comparison.

3.4.2.2 Discussion

A summary of CG-16 and FF-1052 Class ship LCCP maintenance burdens is presented in table 3-8. Although the two classes experienced different total man-hour LCCP maintenance burdens, there were many similarities in their maintenance histories. Both ship classes reported significantly lower LCCP maintenance resource expenditures, compared with the Mk 112 launcher, and the CASREPs submitted by each class consisted mostly of miscellaneous random failures. Both ship classes experienced only one repetitive component failure -- the train and elevation power drive amplifiers. CG-16 Class ships replaced 10 train and elevation power drive amplifier assemblies (NSN 2A-1440-00-858-6743) with only one of four LCCP CASREPs submitted for amplifier failure. FF-1052 Class ships replaced 20 power drive amplifiers, with 8 of 17 LCCP CASREPs submitted for amplifier failures. However, since the amplifier replacement rate experienced equates to only one every five ship operating years and ordalt 9481 is available to replace the amplifiers with an improved model, it is concluded that no significant LCCP maintenance problems should be expected during an extended operating cycle. Therefore, the present PMS procedures and the maintenance strategy of "run-to-failure" are satisfactory, and baseline overhaul and follow-on overhaul repairs should be based on current inspection procedures as outlined in POT&I memo 721JJ000010.

Table 3-8. MAINTENANCE BURDEN SUMMARY OF THE LCCP MK 199

Ship Class	Component	APL	Ship Operating Year (SOY)	Ship's Force Man-Hours	IMA Man-Hours	Total Man-Hours	Man-Hours per Component per SOY
CG-16	LCCP	005020013	52.4	336	30	366	7.0
FF-1052	LCCP	005020013	126.0	1548	231	1779	14.1

3.4.2.3 Recommendations

On the basis of the results of this analysis, the following recommendations for the LCCP Mk 199 should be adopted for the CG-16 Class ships:

- Perform POT&I on the launcher captain's control panel and repair as necessary during BOH. (It is recommended that this task be added to the CG-16 Class repair requirements for BOH.)
- Include a qualified CMP task to perform POT&I on the launcher captain's control panel during each ROH, with repairs based on inspection results.

3.4.3 ASROC Heating and Cooling System

3.4.3.1 Background

Each CG-16 Class ship is equipped with a system for circulating an ethylene-glycol solution through hoses, piping, and heat exchangers to control launcher guide temperatures. The major components of the system are:

- Fluid cooler, APL 030130461
- Fluid heater, APL 070010083
- Centrifugal pump (15 gpm), APL 016060145
- Centrifugal pump (183 gpm), APL 016150384

3.4.3.2 Discussion

Analysis of available CG-16 Class MDS, parts usage, and CASREP data indicates that the selected components of the heating and cooling system did not present a significant man-hour maintenance burden during the data period. The heating and cooling system components were responsible for only 309 CG-16 Class maintenance man-hours (245 ship's force and 64 IMA), an average of 1.5 man-hours per component operating year. Nearly all of the man-hours (307) were reported against the system's centrifugal pumps. A summary of the CG-16 Class heating and cooling system maintenance burden is presented in table 3-9.

Primary CG-16 Class pump failures consisted of normal wear to impellers, wearing rings, and mechanical seals. Although usage of these parts was minimal during the data period, the system MIP A-039/20-A6 requires inspection of the pump's internal parts and seal replacement in conjunction with each ROH (MRC C-4, -5, -6R, and -7R). In addition, MRCs C-1, -2, and -3 recommend the cleaning, inspection, and hydrostatic testing of system components each ROH. It is therefore recommended that these actions be accomplished during BOH and at each ROH. Since ship's force can adequately maintain the heating and cooling system pumps and the pumps have not presented a major man-hour burden to the ships, it is recommended that the PMS procedures be adhered to and the run-to-failure maintenance strategy be followed between ship overhauls.

Table 3-9. MAINTENANCE BURDEN SUMMARY OF THE ASROC HEATING AND COOLING SYSTEM

Ship Class	Component	APL	Ship Operating Year (SOY)	Ship's Force Man-Hours	IMA Man-Hours	Total Man-Hours	Man-Hours per Component per SOY
CG-16	Centrifugal Pumps	016060145 016150384	52.4	243	64	307	2.9
	Fluid Cooler	030130461	52.4	2	0	2	0
	Fluid Heater	070010083	52.4	0	0	0	0
FF-1052	Centrifugal Pumps	016150572 016210232	200.0	1,554	672	2,226	5.6
	Fluid Cooler	030010190	200.0	475	322	797	4.0
DDG-37	Centrifugal Pumps	016060145 016150384	54.6	105	518	623	11.4

The FF-1052 and DDG-37 Class ships also experienced a low relative maintenance burden for their heating and cooling systems. Pumps within these systems were also responsible for the majority of the burden, and the same parts (impellers, wearing rings, and mechanical seals) were replaced. The data for these components and parts similarly reflected neither a high parts-usage rate nor any repetitive maintenance problems.

3.4.3.3 Recommendations

On the basis of the results of this study, the following ASROC heating and cooling system recommendations should be adopted for the CG-16 Class:

- Clean, inspect, and hydrostatically test the ASROC heating and cooling system components during BOH in accordance with MIP A-039/20-A6 requirements.
- Include an engineered CMP task to clean, inspect, and hydrostatically test the ASROC heating and cooling system components during each ROH in accordance with MIP A-039/20-A6.

3.4.4 Launcher Simulator Mk 6

3.4.4.1 Background

Each CG-16 Class ship is equipped with a launcher simulator Mk 6 mod 2, APL 005020014. FF-1052 and DDG-37 Class ships were also equipped with this same simulator; however, only the FF-1052 analysis contained information on its maintenance. A summary of CG-16 Class and FF-1052 Class maintenance burden data is presented in table 3-10.

3.4.4.2 Discussion

The simulator Mk 6 experienced very low maintenance resource expenditures on both ship classes. CG-16 Class ships reported only 7 maintenance actions and a total of 40 man-hours (all ship's force) against the simulator during the data period. Analysis of MDS narratives and parts data revealed that random replacement of electronic components was responsible for the entire simulator maintenance burden. No recurrent problems or parts usage was indicated, and no CASREPs were submitted on the simulator. The FF-1052 Class ships' simulator Mk 6 had a nearly identical maintenance history. Random replacement of electronic components was also responsible for the majority of its maintenance burden and no repetitive problem was indicated in the three FF-1052 Class simulator CASREPs. The simulator Mk 6 can, therefore, be expected to provide satisfactory operation with no significant problems during an extended operating cycle, and no recommendations beyond adhering to the current run-to-failure strategy and the PMS maintenance procedures are considered necessary.

Table 3-10. MAINTENANCE BURDEN SUMMARY OF THE SIMULATOR MK 6

Ship Class	Component	APL	Ship Operating Year (SOY)	Ship's Force Man-Hours	IMA Man-Hours	Total Man-Hours	Man-Hours per Component per SOY
CG-16	Simulator	005020014	52.4	40	0	40	0.8
FF-1052	Simulator	005020014	126.0	296	40	336	2.6

3.4.5 ASROC Loader Crane

3.4.5.1 Background

Each CG-16 Class ship is equipped with one electrohydraulic loader crane, APLs 572090003, 572130001, and 572280001. The CG-16 Class loader crane is either identical to or functionally similar to those installed on the DDG-37 Class ships, and analysis results of the two classes were compared to determine if their maintenance histories were equivalent.

3.4.5.2 Discussion

CG-16 and DDG-37 Class loader crane maintenance burden data are summarized in table 3-11. The CG-16 Class ASROC loader crane experienced a maintenance burden of 1,086 man-hours (783 ship's force and 303 IMA), with an average of 20.7 man-hours per component operating year. A total of 189 man-hours and 41 JCNs were reported for PMS, weight testing, or calibration, and 15 unidentified maintenance actions accounted for 88 man-hours. A majority of the remaining maintenance burden (809 man-hours) consisted of replacement or manufacture of equipment covers and replacement of various parts (e.g., broken gages, seals, control handles, hydraulic system filters). A review of CG-16 Class parts-usage data indicated that none of these parts experienced usage beyond that which is planned for or stocked in accordance with the allowance parts lists (APL).

During the data period, 15 CASREPs were submitted by five CG-16 Class ships; however, these CASREPs were for random part failures caused primarily by corrosion and equates to only one CASREP every 3.6 ship operating years. Since none of the CG-16 Class CASREPs indicated the existence of a repetitive class maintenance problem and the loader crane was not a significant maintenance burden to the ships, the recommendation contained in the CG-16 Class BOH repair requirements to perform a class B overhaul should be deleted.

The DDG-37 Class has a similar maintenance history. Minimal corrective maintenance problems were reported against the loader crane and a large portion of the burden consisted of PMS requirements for weight testing and calibration. The maintenance burden remaining after subtracting the man-hours for these requirements from the total reported was considered insignificant.

Navy Ship's Technical Manual, Chapter 700, requires weight testing of weapons handling equipment at 48-month intervals or following major repairs to the equipment. It is recommended that the loader crane be weight tested just before the completion of BOH and that weight testing be included in the CG-16 Class CMP for accomplishment every 48 months. On the basis of the corrective maintenance burden presented, no further recommendations to loader crane maintenance, beyond the current strategy of run-to-failure with the performance of routine PMS procedures, is considered necessary to maintain reliable performance of the loader crane during an extended operating cycle.

Table 3-11. MAINTENANCE BURDEN SUMMARY OF THE LOADER CRANE

Ship Class	Nomenclature	APL	Ship Operating Year (SOY)	Ship's Force Man-Hours	IMA Man-Hours	Total Man-Hours	Man-Hours per Component per SOY
CG-16	Loader Crane	572090002 572130001 572280001	52.4	783	303	1,086	20.7
DDG-37	Loader Crane	572130001 572370001	43.9	1,164	354	1,518	34.5

3.4.5.3 Recommendations

On the basis of the results of this study, the following ASROC loader crane recommendations should be adopted for the CG-16 Class:

- Weight test the loader crane just before the completion of BOH. (This task is included in the CG-16 Class repair requirements for BOH.)
- Delete the CG-16 Class BOH repair requirement to perform a class B overhaul on the loader crane.
- Include an engineered CMP task to weight test the loader crane at 48-month intervals.

3.5 SURFACE VESSEL TORPEDO TUBES MK 32 MODS 5 AND 7 (SWAB 750-1)

The function of each surface vessel torpedo tube (SVTT) launcher is to stow and launch antisubmarine torpedoes from the weather deck of surface ships. Each launcher consists of three fiberglass-reinforced polyester tubes (or barrels) mounted on a trainable gear. Two barrels are mounted side-by-side with the third centered above. Each barrel is capable of stowing and launching one torpedo. The torpedoes are launched by releasing high pressure air (contained in a flask at the rear of each tube) into the barrel, which forces the torpedo out and away from the side of the ship.

3.5.1 Background

Each ship of the CG-16 and CG-26 Class has two Mk 32 mod 5 or 7 SVTT mounts installed. Both equipment mods are supported by APL 006320222, which lists various manufacturers for the SVTT components. The ships of both classes are equipped with identical or functionally similar mounts; however, analysis results for the maintenance data of each class will be discussed separately and their maintenance histories compared. Table 3-12 summarizes the maintenance burden data for each class.

3.5.2 Discussion

CG-16 Class

CG-16 Class ships reported 616 maintenance actions (or JCNs) against the SVTT APL during the data period, representing a maintenance burden of 4,075 man-hours. Parts-only actions accounted for 28 percent (172) of the JCN total. PMS deferrals were responsible for 15 percent (95 JCNs) and 1,379 of the man-hours reported (480 ship's force and 899 IMA). Another 4 percent (24 JCNs) and 173 man-hours (8 ship's force and 92 IMA) were reported for equipment calibration. The remaining burden, 325 maintenance actions and 2,523 man-hours (1,298 ship's force and 1,225 IMA), consisted primarily of miscellaneous nonrepetitive parts replacements.

Detailed analysis of the CG-16 Class MDS narratives and parts-usage data indicates that the ships were not experiencing any recurring maintenance problems. The majority of the failures reported were for random

Table 3-12. MAINTENANCE BURDEN SUMMARY OF THE SURFACE VESSEL TORPEDO TUBES

Class	Nomenclature	APL	Applicable Ships	Ship Operating Years	JCNs	Ship's Force Man-Hours	IMA Man-Hours	Total Man-Hours	Man-Hours per Component per Ship Operating Year
CG-16	Mk 32 Mods 5 and 7	006320222	9	52.4	616	1,859	2,216	4,075	38.8
CG-26	Mk 32 Mods 5 and 7	006320222	9	60.4	1,104	6,406	4,807	11,213	92.8

replacement of broken or missing parts and hardware. The parts most frequently replaced are listed in table 3-13, which also includes an average usage rate based on total ship operating years. Only items such as bearings and packing commonly having high usage rates exhibited a rate of more than one part per ship operating year. The CASREPs submitted by the CG-16 Class ships support the conclusion that no serious maintenance or parts usage problems exist for the class. A total of three CASREPs were submitted, all by one ship (CG-18). Two CASREPs were for failure of the firing cut-out microswitch on each mount and one was for a broken cable plug. Average downtime for parts was 48 hours. It is concluded, therefore, that a continuation of the run-to-failure maintenance strategy with the performance of routine PMS procedures is adequate to maintain the CG-16 Class SVTTs with reliable performance and minimal corrective maintenance throughout an extended operating cycle.

CG-26 Class

CG-26 Class ships reported a total of 1,104 maintenance actions and 11,213 man-hours (6,406 ship's force and 4,807 IMA) against the SVTT APL during the data period. This total includes 214 actions for parts only and 189 JCNs, representing 2,039 man-hours for PMS and equipment calibration deferrals. The remaining burden of 711 JCNs and 9,174 man-hours included 19 JCNs and 1,614 man-hours (172 ship's force and 1,442 IMA) for torpedo transfers. These actions involved loading and unloading torpedoes and are not related directly to corrective maintenance. For the purposes of this analysis, the burden associated with these JCNs was disregarded, leaving a maintenance burden of 682 JCNs and 7,560 man-hours (5,388 ship's force and 2,172 IMA) for the data period.

Analysis of the CG-26 Class corrective maintenance data indicated that the ships of this class experienced a SVTT maintenance history similar to that of the CG-16 Class; the majority of the actions reported involved random parts replacements with no indications of any repetitive problems. Although a larger number of parts were frequently replaced, none had a usage rate greater than one part per ship operating year, except consumables and items commonly having high usage. Table 3-14 presents a summary of the parts most frequently used by the CG-26 Class and their replacement rates. Nine CASREPs were submitted by the CG-26 Class for SVTT failures; none of these was for a repetitive casualty. The results of the review of the data and their similarity to those of the CG-16 Class led to the conclusion that no changes to the CG-26 Class current maintenance strategy of run-to-failure with associated performance of PMS procedures are required. In addition, recommendations concerning parts availability are not warranted, since no part exceeded its planned replacement or APL allowance level.

Review of the SVTT PMS and equipment calibration deferral actions for both ship classes revealed that hydrostatic testing of the SVTT air flasks and testing of the torpedo tube heat sensors were the items most often reported. Both are annual requirements listed on MIP J-4/4-A6. Responsibility for hydrostatic testing of the air flasks (MRC A-1) is assigned to the ship's force, but it is commonly deferred for outside assistance because of a lack of facilities or capabilities. The heat sensor test (MRC A-2R) is listed for tender accomplishment, since a constant temperature oil bath

Table 3-13. PARTS-USAGE SUMMARY FOR THE CG-16 CLASS SVTT

NSN	Part Nomenclature	Ships Reported	Number Replaced	Usage per Ship Operating Year*
1A-1045-012-4902	Cap Assembly	7	36	0.69**
1A-1045-014-5886	Cable	3	14	0.27**
1A-1045-020-9021	Switch	4	5	0.10**
1A-1045-052-7155	Cable	4	14	0.27
1A-6685-115-6762	Gauge	5	51	0.97**
1A-5330-167-8173	Gaskets	6	49	0.94**
9Z-3110-183-9164	Bearings	3	74	1.41**
9Z-5330-260-9311	O-Ring	5	121	2.31**
4N-1045-456-6145	Loading Tray	3	3	0.06
9N-5930-583-1640	Switch	5	9	0.17**
9N-5930-583-1653	Diaphragm	3	20	0.38**
9Z-5330-618-1920	Packing	3	105	2.00
1A-1045-623-0226	Valve	4	6	0.11**
1A-1045-623-0227	Muzzle Cover	6	19	0.36**
1A-1045-623-0228	Valve Control	4	10	0.19**
1A-4925-626-9773	Heat Gun	5	5	0.10
9N-5930-628-6343	Switch	4	11	0.21**
9Z-5330-640-9613	O-Ring	3	60	1.15
9Z-5330-641-0693	Packing	3	42	0.80**
9N-5930-646-8118	Switch	4	4	0.08**
9Z-5330-684-3420	Ring	3	15	0.29**
1A-1045-715-5497	Filter	5	28	0.53**
9Z-5330-720-2536	Packing	7	37	0.71**
9C-4730-722-3461	Nipple	4	11	0.21**
9Z-5330-725-4025	Gasket	3	18	0.34**
9Z-5330-726-1638	Gasket	4	22	0.42**
9Z-5330-805-2966	Packing	4	152	2.90**
9Z-5330-808-7611	O-Ring	6	39	0.74**
9Z-5330-816-3546	Packing	3	10	0.19
1A-5360-841-9014	Spring	3	41	0.78
9N-5930-843-1807	Pressure Switch	3	7	0.13**
9C-4720-843-9914	Hose	7	32	0.61**
1A-1045-909-0125	Lanyard	8	34	0.65**
1A-1045-955-5822	Gauge	8	34	0.65**
1A-1045-979-7703	Seal	3	15	0.29**
1A-1045-998-6194	Cable Assembly	5	31	0.59**
1A-1045-998-6195	Cable Assembly	7	33	0.63**
1A-1045-998-6196	Cable	6	23	0.44**
1A-1045-998-6199	Charging	3	8	0.15**

*Class operating years total 60.4.
**These parts experienced frequent usage on the CG-26 Class.

Figure 3-14. PARTS-USAGE SUMMARY FOR THE CG-26 CLASS SVTT

NSN	Part Nomenclature	Ships Reported	Parts Replaced	Usage per Ship Operating Year*
1A-1045-012-4902	Dust Cap Assembly	4	19	0.31**
1H-1045-014-5886	Plug Assembly	4	6	0.10**
1A-1045-020-9021	Pressure Switch	3	3	0.05**
1A-1045-052-7141	Firing Squib	3	13	0.22
9G-6685-115-6762	Pressure Gauge	3	34	0.56**
1A-5330-167-8173	Gasket	7	47	0.78**
9Z-3110-183-9164	Bearings	7	98	1.62**
9Z-5330-187-3608	Packing	3	6	0.10
9Z-5330-260-9311	Packing	4	101	1.67**
9G-5975-296-4096	Stuffing Tube	3	8	0.13
9G-5975-296-4097	Stuffing Tube	3	5	0.08
1H-1045-432-7541	Heat Sensor	3	5	0.08
1H-1045-455-9989	Support	3	23	0.38
1H-1045-456-0050	Support	4	31	0.51
9C-4730-541-7749	Pipe Plug	3	38	0.63
9G-9320-551-0557	Gasket	3	7	0.12
9N-5935-581-4558	Cover	5	16	0.26
9Z-5330-582-2111	Retainer	3	5	0.08
9N-5930-583-1640	Switch	7	18	0.30**
9N-5930-583-1653	Diaphragm	4	28	0.46**
9Z-5330-585-3339	Gasket	5	41	0.68
9C-4810-623-0226	Solenoid	5	23	0.38**
1A-1045-623-0227	Cover	7	20	0.33**
1A-1045-623-0228	Valve	5	21	0.35**
9N-5930-628-6343	Heater	6	22	0.36**
9Z-5330-641-0693	O-Ring	5	78	1.29**
1A-5930-646-8118	Switch	6	12	0.20**
1A-1045-653-9709	Heater	3	6	0.10
9Z-5315-664-0401	Pin	8	16	0.26
9Z-5330-684-3420	O-Ring	4	45	0.75**
1A-1045-698-0956	Clamp	4	36	0.60
1H-1045-710-2937	Tube	4	4	0.07

*Class operating years total 60.4.
**These parts experienced frequent usage on the CG-16 Class.

Table 3-14. (continued)

NSN	Part Nomenclature	Ships Reported	Number Replaced	Usage per Ship Operating Year*
1A-1045-715-5497	Filter	8	55	0.91**
9Z-5330-720-2536	Seal	8	67	1.11**
9C-4730-722-3461	Nipple	3	8	0.13**
9Z-5339-725-4025	Packing	5	61	1.01**
9Z-5330-726-1638	Gasket	5	30	0.50**
9Z-5315-753-3895	Spring	6	66	1.09
1A-1045-767-8202	Valve	7	36	0.60
9Z-5330-805-2966	Packing	6	106	1.75**
1A-5330-808-7611	Seal	7	72	1.19**
9N-5930-843-1807	Switch	3	14	0.23**
9C-4720-843-9914	Flexible Hose	6	21	0.35**
9N-5935-846-8101	Cannon Plug	4	29	0.48
2J-1045-888-7527	Breech	4	13	0.22
1H-1045-898-4614	Cable Assembly	4	15	0.25
2A-1045-898-4615	Valve	3	5	0.08
1A-1045-909-0125	Lanyard	6	28	0.46**
1A-1045-910-7044	Gasket	6	27	0.45
1A-1045-910-7069	Plunger	3	17	0.28
1A-5930-937-3577	Switch	6	34	0.56
2J-1045-937-8742	Torpedo	4	7	0.12
1A-1045-955-5822	Air Gage	9	106	1.75**
1A-1045-979-7703	Seal	7	44	0.73**
9G-5975-989-5045	Stuffing Tube	3	15	0.25
1A-1045-998-6194	Cable Assembly	7	23	0.38**
1A-1045-998-6195	Cable Assembly	6	29	0.48**
1A-1045-998-6196	Connector	6	24	0.40**
1A-1045-998-6199	Charging	4	5	0.08**

*Class operating years total 60.4.

**These parts experienced frequent usage on the CG-16 Class.

is required. Therefore, it is recommended that responsibility for the hydrostatic test of SVTT air flasks be changed to the IMA level. It is also recommended that the heat sensor test (MRC A-2R) be included in the class maintenance plans for both ship classes for annual accomplishment by an intermediate maintenance level activity.

During this analysis is was noted that the CG-26 Class consistently reported a maintenance burden greater than that of the CG-16 Class. CG-26 Class ships reported nearly three times the total man-hour burden of the CG-16 Class, more than twice the man-hours per component for each ship operating year, and over four times the cost for repair parts. In addition, CG-26 Class ships reported 2,555 more man-hours than the CG-16 Class for equipment overhauls and SVTT mount replacements. Personnel of the Naval Ordnance Station, Louisville (NOSL), reported that each CG-16 Class ship received two new Mk 32 mod 7 SVTT mounts during its modernization overhaul. Since these overhauls occurred between late 1968 and early 1973, the CG-16 Class ships operated throughout the data period with SVTTs that were newer and in much better material condition than those of the CG-26 Class. On the basis of the data presented, it was concluded that the maintenance burden difference for the two classes was a result of the difference in age of the equipments installed.

NOSL personnel also reported that the expected service life between overhauls for SVTTs is approximately 10 years. Since the maintenance histories of the two classes indicate that age is a factor in the amount of maintenance required for an SVTT mount and the mounts on the CG-16 and CG-26 Class ships will be approximately 10 years old at the time of BOH, it is recommended that the SVTTs receive a class B overhaul or be replaced with new or refurbished units that are available for requisition from Navy supply centers. For ROH, it is recommended that the SVTTs be subjected to POT&I, with overhaul or replacement based on inspection results.

3.5.3 Recommendations

On the basis of the results of this analysis, the following SVTT Mk 32 mods 5 and 7 maintenance recommendations should be adopted for the CG-16 and CG-26 Class ships:

- Perform class B overhaul on the Mk 32 SVTTs or replace them with refurbished units during BOH. (This task is included in CG-16 and CG-26 Class repair requirements for BOH.)
- Include a qualified CMP task to repair or replace the Mk 32 SVTTs with a refurbished unit, as necessary, during each ROH.
- Include an engineered CMP task to inspect the SVTT heat sensors every 12 months in accordance with MIP J-4/4-A6 (MRC A-2R).
- Change the accomplishment responsibility for the SVTT air flask hydrostatic test requirement on MIP J-4/4-A6 (MRC A-1) to the IMA level.

CHAPTER FOUR

CONCLUSIONS AND RECOMMENDATIONS

4.1 CONCLUSIONS

The following major conclusions resulted from this review of experience:

- The CG-16 and CG-26 Class armament system equipments should perform reliably throughout an engineered operating cycle with no significant increase in corrective maintenance burden.
- Only a few, if any, major overhauls of armament system equipments should be required at BOH.
- Repair parts support for armament system equipments is adequate to maintain the equipment during an engineered operating cycle with no changes to stocking levels or excessive delays in availability.
- Planned maintenance system coverage for the armament system equipments is adequate and should ensure reliable operation throughout an engineered operating cycle.
- Ship's force has demonstrated adequate capabilities to maintain the armament system components during an engineered operating cycle, with only limited IMA assistance.
- Mk 42 mod 10 gun mount failures and failure intervals are not predictable, precluding any recommendations for periodic maintenance or increased repair-part stocking levels to improve reliability.
- The majority of the ASROC launching group failures are the result of corrosion, caused by the forward location and constant exposure of the launcher to salt spray.
- The large difference in torpedo tube maintenance burdens between the CG-16 Class and the CG-26 Class was due to the age of the CG-26 Class mounts and the replacement of the CG-16 Class mounts during their modernization overhauls.

4.2 RECOMMENDATIONS

Corrective actions and planning activities identified by this ROE are categorized as follows:

- Baseline overhaul requirements
- Intracycle requirements
- Follow-on regular overhaul requirements
- Reliability and maintainability improvements
- PMS changes
- Integrated logistics support improvements
- Personnel training improvements
- Industrial facility improvements
- IMA improvements

Specific recommendations from this review of experience are summarized in table 4-1.

Table 4-1. SUMMARY OF ROE RECOMMENDATIONS			
Recommendation Number	Component	Recommendation	Reference Paragraph
		Baseline Overhaul Requirements	
1	Mk 42 Mod 10 Gun Mount	Conduct material condition inspection of the gun on CG-27, -28, -32, and -33 and overhaul or repair as necessary on the basis of inspection results.	3.2.2
2	GMLS Mk 10	Accomplish repairs on the GMLS and strikedown system as determined to be necessary by POT&I.	3.3.2
3	GMLS Mk 10	Remove and overhaul or replace launcher Mk 5 in accordance with the mid-life refurbishment program.	3.3.2
4	GMLS Mk 10	Accomplish weight test of shakedown and missile handling system components, in accordance with NSTM, Chapter 700, during the last months of BOH.	3.3.2
5	GMLS Mk 10	Inspect and replace as necessary all launching system flexible hoses in accordance with MRC Q-1 of MIP A-709/4-47.	3.3.2
6	GMLS Mk 10	Remove sample of system hydraulic fluids and forward to an appropriate facility for analysis in accordance with MRCs LU-1 and SU-1.	3.3.2
7	GMLS Mk 10	Align loader rails as post-installation check following major repair or overhaul of the launcher.	3.3.2
8	GMLS Mk 10	Repair dud jettison units as necessary on the basis of POT&I results.	3.3.2
9	GMLS Mk 10	Accomplish pressure test of dud jettison unit air flasks in accordance with NAVSHIPS Technical Manual, Chapter 551.	3.3.2
10	GMLS Mk 10	Repair or replace strikedown hatch, blast door, and blowout patch seals and gaskets.	3.3.2
11	GMLS Mk 10	Repair the GMLS Mk 10 electric transfer car as necessary on the basis of POT&I results.	3.3.2
12	GMLS Mk 10	Repair the GMLS Mk 10 anti-icing system as necessary on the basis of POT&I results.	3.3.2
13	ASROC Launcher Mk 112	Accomplish Class A overhaul or replace the ASROC launcher with a refurbished unit as determined to be necessary by NAVSEACEN material condition inspection.	3.4.1.2
14	ASROC LCCP Mk 199	Repair LCCP as necessary on the basis of POT&I results.	3.4.2.2
15	ASROC Heating/ Cooling System	Clean, inspect, and hydrostatically test the ASROC Heating and cooling system components in accordance with MIP A-039/20-A6 (MRC A-2R).	3.4.3.2
16	ASROC Loader Crane	Accomplish weight test of loader crane in accordance with NAVSHIPS Technical Manual, Chapter 700.	3.4.5.2
17	Surface Vessel Torpedo	Accomplish Class B overhaul or replace the SVTTs with refurbished units as determined to be necessary by a pre-overhaul material condition inspection.	3.5.2
		Intracycle Requirements	
18	Mk 42 Mod 10 Gun	Star gauge Mk 18 gun barrel annually.	3.2.2
19	GMLS Mk 10	Accomplish weight tests of missile strikedown and handling system components at 48-month intervals in accordance with NAVSHIPS Technical Manual, Chapter 700.	3.3.2
20	GMLS Mk 10	Ship's force remove hydraulic fluid samples and forward to an appropriate analysis facility every 12 months in accordance with MIP 5ZBAAGG/1-3 (MRC A-1).	3.3.2
21	GMLS Mk 10	Accomplish pressure test of dud jettison air flasks every 60 months in accordance with NAVSHIPS Technical Manual, Chapter 551.	3.3.2

(continued)

Table 4-1. (continued)

Recommendation Number	Component	Recommendation	Reference Paragraph
Intracycle Requirements (continued)			
22	ASROC Launcher Mk 112	Inspect the ASROC launcher for corrosion damage at each SRA.	3.4.1.2
23	ASROC Launcher Mk 112	Repair the ASROC launcher at each SRA to correct discrepancies identified during corrosion assessment inspection.	3.4.1.2
24	ASROC Loader Crane	Accomplish weight test of loader-crane and ASROC handling components at 48-month intervals in accordance with NAVSHIPS Technical Manual, Chapter 700.	3.4.5.2
25	Surface Vessel Torpedo	Test torpedo tube heat sensors every 12 months in accordance with MIP J-4/4A6 (MRC A-2R).	3.5.2
ROH Requirements			
26	MK 42 Mod 10 Gun	Accomplish material condition inspection and overhaul or remove and replace the Mk 42 mod 10 gun mount as determined from inspection results and in accordance with NAVSEAINST 8300.2A.	3.2.2
27	GMLS Mk 10	Align loader rails as post installation check in conjunction with major repairs or overhaul of GMLS launcher.	3.3.2
28	GMLS Mk 10	Repair GMLS Mk 10 and missile handling components as necessary on the basis of POT&I results.	3.3.2
29	ASROC Launcher Mk 112	Accomplish Class B overhaul of launcher.	3.4.1.2
30	ASROC LCCP Mk 199	Repair the LCCP as necessary on the basis of POT&I results.	3.4.2.2
31	ASROC Heating/Cooling	Clean, inspect, and hydrostatically test heating and cooling system components in accordance with MIP A-039/20-A6.	3.4.3.2
32	Surface Vessel Torpedo Tubes	Repair or overhaul SVTTs as required, on the basis of POT&I results.	3.5.2
Reliability and Maintainability Improvements			
33	Mk 42 Mod 10 Gun	Install outstanding OrdAlts at BOH or as soon as practicable.	3.2.2
34.	ASROC Launching Group	Install outstanding OrdAlts at BOH or as soon as practicable.	3.4.1.2
PMS Changes			
35.	Mk 42 Mod 10 Gun	Add the star gauge requirement of NAVSEAINST 8300.1A to MIP G-031/105-78 with a periodicity of A-R.	3.2.2
36.	GMLS Mk 10	Develop EGL for system flexible hoses.	3.3.2
37.	Surface Vessel Torpedo	Review hydrostatic test responsibility for SVTT air flasks for possible change to the IMA level.	3.5.2
ILS Improvements - None			
Personnel Training Improvements - None			
Industrial Facility Improvements - None			
IMA Improvements - None			

LIST OF REFERENCES

The following selected references were used as the basis for the review of experience of the CG-16 and CG-26 Class armament systems, SWAB Group 700:

1. Generation IV MDS narrative and part usage data for the CG-16 and CG-26 Class ships, 1 January 1970 through 31 December 1977.

2. CASREPs for the CG-16 and CG-26 Classes, 1 January 1972 through 31 August 1978.

3. The following technical manuals:

   - NAVSHIPS 0997-000-4010, *ASROC Heating and Cooling System*
   - NAVSHIPS 347-3463, *Circuiating Pump for ASW Fluid Cooler*
   - NAVSHIPS 320-0785, *ASROC Loader Crane*
   - NAVSHIPS 320-1000, *ASROC Loader Crane*

4. SECAS Report 502.1 for hulls CG-17, -18, -19, -20, -21, -22, -23, -24, -27, -28, -29, -30, -31, -32, -33, and -34, various dates.

5. Maintenance Index Pages and Maintenance Requirement Cards for armament system components.

6. CG-16 and CG-26 Class *Configuration Summary*, dated 13 December 1978.

7. COMNAVSURFLANT INST 900.1, *COMNAVSURFLANT Maintenance Manual*, 12 June 1975 through Change 5, dated 27 February 1978.

8. COMNAVSURFPAC INST 4700.1, *CONNAVSURFPAC Ship and Craft Material Maintenance Manual, Volume I*, 6 June 1975.

9. *CG-16 Class Repair Profile*, dated December 1978, prepared by PERA (CRUDES).

10. *CG-26 Class Repair Profile*, dated October 1975, prepared by PERA (CRUDES).

11. DDEOC repair requirements for BOH, CG-16 Class (July 1977) and CG-26 Class (August 1977).

12. Mechanized departure reports for CG-16 and CG-26 Class ships, various dates.

13. ShipAlt briefs and SAMIS data for armament system alterations, various dates.

14. Trip report dated 14 March 1979, ARINC Research Corporation visit to USS DALE (CG-19).