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TREND ANALYSIS OF REQUIRED WORK NOT COMPLETED DURING SURFACE SHIP AVAILABILITIES

by

Clifford A. Pish

June, 1999

Thesis Co-Advisors: John E. Mutty
Shu S. Liao

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TREND ANALYSIS OF REQUIRED WORK NOT COMPLETED DURING SURFACE SHIP AVAILABILITIES

Clifford A. Pish
Lieutenant Commander, United States Naval Reserve
B.A., Pennsylvania State University, 1984

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Author: Clifford A. Pish

Clifford A. Pish

Approved by: John E. Mutty

John E. Mutty, Co-Advisor

Shu S. Liao, Co-Advisor

Reuben T. Harris, Chairman
Department of Systems Management

ABSTRACT

The Ship Maintenance Program is designed to keep ships at the highest level of material condition practicable and to provide reasonable assurance that they will be available for operations to the fleet commanders. When the total cost of work required exceeds the level of funding for a maintenance availability, some of the work must be deferred. In this thesis the maintenance records available were examined to determine if trends exist in the type of work that is not being completed. Trends were established by comparing the required work items for ships prior to entering an availability to the records of jobs completed in the availability. Trends in certain categories, like engineering or habitability, may be factors that impact retention, environmental protection or other concerns facing the Navy. Further, the data for surface ship maintenance were assessed. This study found that data support the idea that a significant portion of work items pertaining to general categories of habitability (31%), weapons systems (23.1%) and electronics (18.1%) have been deferred for LPD availabilities between 1993 and 1998. The least deferred maintenance occurred in main propulsion (4.8%) and the electric plants (10.2%). This study was unable to identify any place where comprehensive historical data for surface ship maintenance availabilities are maintained.

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I. INTRODUCTION

A. BACKGROUND

The Ship Maintenance Program is one of two major components of the Navy's program for maintenance and modernization of ships. This program defines and manages the material condition requirements and the configuration of Navy ships. It defines key elements such as: depot-level availability intervals and duration, frequency of intermediate-level availabilities and any special maintenance, maritime support or infrastructure requirements. The Ship Maintenance Program is designed to keep ships at the highest level of material condition practicable and to provide reasonable assurance that they will be available for operations to the fleet commanders. The Fleet Modernization Program (FMP) is the second major component and is designed to maintain the integrity of ship configuration as changes are authorized. The maintenance and modernization programs and budgets are distinct, but the programs are closely related in their planning and execution. Work performed during surface ship maintenance availabilities may fall under the maintenance or modernization program. [Department of the Navy Instruction (1992)]

There are three echelons of maintenance: 1. Organizational – maintenance actions within the capabilities of ship's force. 2. Intermediate – maintenance accomplished by Intermediate Maintenance Activity (IMA) personnel on or at tenders, repair ships, aircraft carriers, Shore IMAs (SIMAs) and Naval Reserve IMA Maintenance Facilities (SIMA NRMFs). 3. Depot-level – maintenance that requires skills or facilities beyond

those of the organizational and intermediate levels and is performed by naval shipyards, private shipyards, naval ship repair facilities or item depot activities. [Department of the Navy Instruction (1992)]

The Ship Maintenance Program for each class of ship is documented in a Class Maintenance Plan (CMP). The CMP is a detailed, comprehensive document for implementing the maintenance plan for an entire ship class. It specifies key elements of availabilities such as duration, interval and frequency. The CMP also includes all preventive maintenance actions with recommended periodicity for accomplishment. [Department of the Navy Instruction (1992)] The Current Ship's Maintenance Project (CSMP) is the primary repository of information about the material condition of the ship. It is maintained by ship's force and the ship's Port Engineer and is used in conjunction with the CMP to form a work package for ship availabilities. [Meeting, Port Engineers (1999)] Port Engineers are responsible for all aspects of ship maintenance management. They identify maintenance needs, work with ship's force to facilitate the repair process, and oversee the actual completion of work. [American Management Systems, Inc. (1999)]

Depot-level availability work is then authorized based on an assessment of the relative risk of nonaccomplishment to personnel safety and ship mission readiness. Authorizations of repair work items are prioritized in descending order of risk to personnel safety and mission readiness. [Department of the Navy Instruction (1992)] When the total cost of work requirements exceeds the level of funding for an availability, some of the work must be deferred. The goal of this thesis has been to determine if there

is a trend in the type of work that is deferred based on the data available for a specific class of ship.

Identifying trends that exist in surface ship maintenance availabilities may help to increase funding levels to address categories of maintenance that have been ignored. Also, trends in certain categories of maintenance, such as habitability or engineering, may be studied as factors that impact retention, environmental protection or other concerns facing the Navy.

B. OBJECTIVES

This thesis has involved researching the impact of sending conventionally powered surface ships into depot-level maintenance availabilities that are not fully funded. Specifically, an examination of the maintenance records available was made to determine if any trends existed to the type of work that is not being completed. Further, the data available for surface ship maintenance availabilities were assessed. The thesis research included: (1) identification of work required for completion on specific ship's availabilities; (2) what remained to be completed at the end of the availabilities; (3) what, if any, growth work occurred, such as additional repairs required after an "open and inspect" work item; (4) summarizing the status of the Maintenance Data System (MDS) and the impact of not fully funding ship availabilities.

C. RESEARCH QUESTIONS

The following questions were addressed:

1. Primary:

Is there consistency in the type of work, like habitability, that is not being completed during regularly scheduled surface ship depot-level maintenance availabilities?

2. Secondary:

(1) What is the estimated cost of the required work that is not being completed?

(2) What is the distribution of the type of work completed based on category and cost?

(3) What data exist for surface ship availabilities?

(4) Can this analysis be conducted on any ship class in the fleet?

D. SCOPE OF THESIS

Existing data were examined for the maintenance availabilities of seven of the eleven LPD 4 class Landing Platform, Docks. From these records, three consecutive years of data existed for four of the ships, and one year of data existed for the remaining three. These data were evaluated for trends in the work not completed at the end of each availability. Additionally, data were obtained for unfunded maintenance for an eighth LPD. The LPD 4 class was chosen because of the maintenance records available from Port Engineers and American Management Systems (AMS), Inc. AMS developed the Maintenance Requirement System (MRS) database for the Naval Sea Systems Command

(NAVSEA). Further, the data available for other ship classes were researched to determine if sufficient amounts existed to conduct this study.

E. METHODOLOGY

The methodology included the following: (1) Literature review of reports, instructions, Class Maintenance Plan and Current Ship's Maintenance Projects. (2) Interviews with Port Engineers at Naval Station, San Diego and representatives of American Management Systems, Inc. (3) Collection of historical data for planned and completed maintenance availabilities of LPDs. (4) Analysis of the data for trends and statistical distribution of work categories.

(1) Literature Review: A review of literature was conducted on planning and execution of surface ship maintenance availabilities. This included Chief of Naval Operations (CNO) instructions, Current Ship's Maintenance Projects and the reports and notes of Port Engineers. Additionally, references were reviewed on statistical distribution to determine methods of interpreting the data and analysis with some missing data.

(2) Interviews: Interviews were conducted with Port Engineers at Naval Station, San Diego. Port Engineers are the focal point in all phases of surface ship maintenance. Interviews focused on data sources and the process used for planning and executing ship maintenance. Telephone interviews were also conducted with representatives of AMS, Inc. to discuss the MRS data, their sources and limitations.

(3) Data Collection: Historical data for the maintenance planned and completed during availabilities were collected from AMS and Port Engineers. Data contained in the CMP and CSMPs were reviewed and discussed with Port Engineers.

(4) Analysis: Data collected were evaluated by comparing the jobs completed with those jobs that were required for each availability. Work that was not completed was grouped by categories in an attempt to establish trends. The estimated cost was established for work not completed during each availability. The work completed was classified by category and percent total of cost for the availability. The data were evaluated in terms of completeness and effectiveness for recording ship maintenance.

F. ORGANIZATION OF STUDY

Chapter II contains a literature review. A discussion of maintenance records and the governing Office of the Chief of Naval Operations (OPNAV) instructions is provided. Further, mention is made of other references used in this study.

Chapter III contains the methods used for executing this research and the structure of the analysis.

Chapter IV presents the data and the results of the trend analysis. It also provides a discussion of the results. Graphs and statistical distribution for categories and cost are presented. The records available for surface ship maintenance are assessed.

Chapter V contains the conclusions and recommendations. It also presents observations, impressions and suggestions for further study.

II. LITERATURE REVIEW

Before analyzing the data of ship maintenance availabilities, references were studied to learn how they were planned. In particular, the process was studied to learn how a job would be initially chosen for a work package and what specific circumstances would lead to the item being deferred. Also, references were required to explain what items were available in records and what these items meant.

A. OPNAVINST 4700.7J

This Chief of Naval Operations (CNO) instruction establishes the policy and responsibility for determining, authorizing, planning, scheduling, performing, and evaluating the maintenance of ships. The instruction applies to all active and reserve ships of the United States Navy, except civilian operated ships assigned to the Military Sealift Command. The general policy states that ships will be maintained in a safe material condition, adequate to allow accomplishment of assigned missions. Maintenance actions are either preventive (intended to prevent or discover functional failures), or corrective (intended to return or restore equipment to acceptable performance levels). Preventive maintenance is detailed as Master Job Catalog (MJC) items for depot-level accomplishment. They are scheduled in accordance with the Periodic Maintenance Requirements Scheduling Subsystem of the Maintenance Resource Management Subsystem (MRMS) or an alternate CNO-approved maintenance scheduling system. These maintenance actions should then be accomplished as scheduled. [Department of the Navy Instruction (1992)]

The decision to perform repair work should be based on the actual equipment conditions. Safety related work items are mandatory and should be accomplished at the earliest opportunity. [Department of the Navy Instruction (1992)]

The CSMP is used by the ship to document all deferred preventive and corrective maintenance requirements regardless of the source of the requirements. It remains the primary source of information for the current material condition of a ship. [Meeting, Port Engineers (1999)]

Depot-level work determination is based on:

(1) CSMP records of deferred and completed maintenance.

(2) Objective evidence of degradation or failure determined by results of MJC items conducted by ship's force or support programs.

(3) Trend predictions of future failure in material condition.

(4) Time directed maintenance which is based on age reliability analysis, appropriate distribution of failures, and availability of an applicable maintenance action. [Department of the Navy Instruction (1992)]

Depot availability maintenance authorization is based on an assessment of the relative risk of non-accomplishment to personnel safety and ship mission readiness. Authorization of repair work items are prioritized in descending order of risk to personnel safety and mission readiness. Relative risk is defines as the product of the probability of failure before the next scheduled availability and a measure of the severity of the failure. [Department of the Navy Instruction (1992)]

Fleet Commanders in Chief (FLTCINCS), acting through their Type Commanders (TYCOMs) or other designated subordinates, authorize required maintenance actions based on safety considerations and on cost, schedule, and mission trade-offs, as required. The choice of required maintenance actions to be authorized is based on the risks discussed above. [Department of the Navy Instruction (1992)]

Repairs are executed, in accordance with technical requirements, at the lowest level practical that can assure proper accomplishment. If funding constraints exist, priority must be placed on providing ships that can safely and reliably perform their missions. [Department of the Navy Instruction (1992)]

B. OPNAVINST 4720.2G

The Fleet Modernization Program (FMP) was established for the orderly identification, approval, design, planning, programming, budgeting, and accomplishment of configuration changes that increase the capability or reliability of a ship to perform her assigned mission. This instruction covers alterations to commissioned ships and service craft of the U. S. Navy with the exception of Strategic Systems Program Alterations (SPALTS), temporary modifications approved by the Type Commander, Aircraft Launch and Recovery Equipment (ALRE), alterations affecting the TRIDENT system and nuclear propulsion plants. [Department of the Navy Instruction (1995)]

Changes to ship configurations are programmed for accomplishment through the FMP. The FMP consists of a multi-year schedule of equipment procurement and installation planned for accomplishment on each ship. This schedule is produced from

integrated, prioritized lists of ship alterations applicable to each class of ship. OPNAV resources develop and program this integrated plan. FMP funds are programmed by the OPNAV resource sponsors based on requirements identified by the appropriate Hardware Systems Command (HSC) Life Cycle Engineering Manager (LCEM) or Ship Program Managers (SPM). OPNAV develops the FMP in conjunction with FLTCINCS, TYCOMS, Commander, Naval Sea Systems Command (COMNAVSEASYSCOM), Commander, Naval Air Systems Command (COMNAVAIRSYSCOM), and Commander, Space and Naval Warfare Command (COMSPAWARSYSCOM). [Department of the Navy Instruction (1995)]

The FMP is intended to provide an orderly and studied process for the identification, approval, development, funding and execution of alterations to the characteristics of U. S. Navy ships and service craft. Unauthorized and unsupported alterations to ships are prevented by use of this program. Changes that are not authorized represent a cost to the Navy. This cost is seen in terms of loss of configuration control, inefficiencies due to unexpected interferences, systems and equipment which are not logistically supported, and resources expended for support for items which are no longer required. Therefore, all changes and variations from the approved class plans on ships, either in maintenance availabilities or in operations, are prohibited unless they follow the FMP process. This instruction also lists all the types of Ship Alterations (SHIPALTS) classified by title. [Department of the Navy Instruction (1995)]

C. CLASS MAINTENANCE PLAN

The CMP is a detailed, comprehensive document for implementing the maintenance program for an entire ship class. It specifies key elements such as: depot-level availability intervals and durations, frequency of intermediate-level availabilities, and any special maintenance support, or infrastructure requirements. [Department of the Navy Instruction (1992)] Port Engineers use the CMP as a tickler for depot level jobs that are due during the availability. A job is then created for those work items and entered into the CSMP. [Meeting, Port Engineers (1999)]

D. CLASS SUSTAINABILITY PLAN

The results from the literature review show no studies that specifically address the issue of deferred maintenance. However, there is one initiative to address primary maintenance concerns in the LPD 4 class. Every six months, the Port Engineers from both coasts attend an LPD sustainability conference. Maintenance issues and concerns are discussed and consensus is reached about pressing maintenance items for the class. The LPD 4 Class Sustainability Plan from June 1996 is shown in Table 2.1. It shows each item of concern, the fiscal year to complete, and applicability to each ship in the class. Most of the top priority items fell under the categories of pollution abatement and personnel safety. Lowest on the priority list were items dealing with Damage Control and ship structure. [Meeting, Port Engineers (1999)]

	HULL NUMBER	4	5	6	7	8	9	10	12	13	14	15
PRIORITY	ITEM	FY	FY	FY	FY	FY	FY	FY	FY	FY	FY	FY
1	INSTALL CROSS-FLOODING DUCTS	97	98	97	97	97	97	98	98	98		97
2A	OIL/WATER SEPARATOR	97	98	97	97	97	97	98	98	98	97	97
2B	BILGE PUMPS	97	98	97	97	97	97	98	98	98	97	97
2C	CONTAMINATED OIL SETTLING TANK	97	98	97	97	97	97	98	98	98	97	97
2D	TERMINATE FUEL OIL OVERFLOW	97	98	97	97	97	97	98	98	98	97	97
2E	OIL/WATER OVERFLOW	97	98	97	97	97	97	98	98	98	97	97
2F	TANK MODIFICATIONS	97	98	97	97	97	97	98	98	98	97	97
3A.1	CHILL WATER SYSTEM UPGRADES	97	98	97	97	97	98	98	98	98	97	97
3A.2	ADDITIONAL AIR CONDITIONING PLANT	99	98	99	99	99	98	98	98	98	99	99
3B	REPLACE MAIN FEED BOOSTER PUMPS	97	98	97	97	97	98	98	98	98	99	97
3C	FUEL OIL SERVICE PUMPS & REGULATORS	99	98	99	99	99	98	98	98	98	99	99
3D	CHESTERTON PACKING MAIN MACH ROOMS	97	98	97	97	97	97	98	98	98	97	97
3E	LAGGING MAIN MACH ROOMS	97	98	97	97	97	97	98	98	98	97	97
4	MACH SPACE FAN INTERLOCK	97	98	97	97	97	98	98	98	98	99	97
5	VENT MOD CHT COMPARTMENT	97	98	97	97	97	97	98	98	98	97	97
6	TITANIUM FIRE PUMPS	97	98	97	97	97	98	98	98	98		97
7	MAIN FEED PUMPS	97	98	97	97	97	97	98	98	98	99	97
8	SSTG UPGRADE FLAG SHIPS ONLY											
9	FIRE SFE FUEL OIL STRAINERS	97	98	97	97	97	97	98	98	98	97	97
10	MAIN CONDENSER ACCESSES	97	98	97	97	97	97	98	98	98	97	97
11	CIRCUIT BREAKER REPLACEMENT	99	98	99	99	99	98	98	98	98	99	99
12	HP DRAIN REPLACEMENT	97	98	97	97	97	97	98	98	98	97	97
13	LP AIR COMPRESSORS	99	98	99	99	99	98	98	98	98	99	99
14	DEGAUSSING SYSTEM	97	98	97	97	97	98	00	00	00	99	97
15	LCAC MODIFICATIONS	97	98	97	97	97	97	98	98	98	97	97
16	AN/SPS-67 RADAR	97	98	97	97	97	97	98	98	98	97	97
17	AN/UQN 4A FATHOMETER	97	98	97	97	97	97	98	98	98	97	97
18	SPS-40 RADAR	97	98	97	97	97	97	98	98	98	97	97
19	600 TO 150 PSIG REDUCERS	97	98	97	97	97	97	98	98	98	97	97
20	AUX COOLING WATER PUMPS	97	98	97	97	97	98	98	98	98	99	97
21	BOILER STOP AIR OPERATORS	99	98	99	99	99	98	98	98	98	99	99
22	DISTILLING PLANT PUMP REPLACEMENT	99	98	99	99	99	98	98	98	98	99	99
23	WELL DECK CORROSION	99	8&0	99	99	99	8&0	8&0	8&0	8&0	7&9	7&9
24	BALLAST SYSTEM CONTROL CONSOLE	99	00	99	99	99	98	00	98	00	99	99
25	AN/SPS-40 RADAR	99	98	99	99	97	98	98	98	98	97	97
26	CHT PIPING	99	00	99	99	99	00	00	00	00	99	99
27	BOILER SKIRT JOINTS	99	00	99	99	99	00	00	00	00	99	99
28	B & A CRANE	99	00	99	99	99	00	00	00	00	99	99
29	FUEL OIL TRANSFER PIPING	97	98	97	97	97	98	98	98	98	97	

Table 2.1 **LPD Class Sustainability Plan**

30	HOT WATER HEATERS	99	00	99	99	99	00	00	00	00	99	99
31	INTEGRATED LOGISTICS OVERHAUL	99	00	99	99	99	00	00	00	00		99
32	INTERNAL DRAFT GAGES	99	00	99	99	99	00	00	00	00	99	99
33	WEIGHT & MOMENT REMOVALS	99	00	99	99	99	00	00	00	00	99	99
34	HATCHES, DOORS, SCUTTLES	99	00	99	99	99	00	00	00	00	99	99
35	B & W BOILER DOWNCOMERS	99	00	99	99	99	00	00	00	00	99	99
36	BOILER CASING CONCENTRICITY		00				00	00	00	00		
37	FEED WATER DRAIN COLLECTING TANKS		00		99	99	00	00	00	00	99	99
38	STRUCTURE ISSUES		00				00	00	00	00		
39	BALLAST COMPRESSORS		00				00	00	00	00		
40	INSTALL HALON IN PMP & GEN ROOMS	99	00	99	99	99	00	00	00	00	99	99

Table 2.1 (Cont.) **LPD 4 Class Sustainability Plan**

E. SYSTEM WORK LIST INDEX NUMBER

The most crucial index used for this study was the System Work List Item Number (SWLIN) Table. A complete five digit SWLIN number gives a concise description of the area or equipment that is affected by each work item. Any maintenance that is performed can be categorized using the SWLIN table. SWLINs are separated under ten standard categories. Table 2.2 shows the ten categories and gives examples of what is found under each heading.

0XXXX	General Guidance and Administration (QA,trials,models,training)
1XXXX	Miscellaneous Hull Structure (System foundations, stacks,seachests,decks)
2XXXX	Miscellaneous Propulsion Plant Systems (Main engines, shafting, reduction gear, lube oil purifiers)
3XXXX	Miscellaneous Electric Plant (Generators, switchboards, lighting distribution)
4XXXX	Miscellaneous Command/Surveillance Systems (Navigation, communications, radar, sonar)
5XXXX	Miscellaneous Auxiliary Systems (Air conditioning, heating, fresh water, ballast, damage control)
6XXXX	Miscellaneous Outfit/Furnishings (Floor plates & grating, ladders, living spaces, work shops)
7XXXX	Miscellaneous Armament (Guns, mounts, small arms, munitions storage, ammo handling)
8XXXX	Integrated Engineering (ILS engineering, planning production, program management)
9XXXX	Ship Assembly/Support Services (Crane svcs, dock/undock, temp utilities/services, contract data)

Table 2.2 **SWLIN Category Summary**

III. METHODOLOGY

A. OVERVIEW

This chapter describes the data used in this study as well as the methodology used to analyze those data. A description of the sources used and the fields available in the data will be discussed to clarify the scope of the study. This will be followed by an explanation of why particular fields were chosen and what techniques were used to analyze them.

B. SOURCES

Two sources of data were used in this thesis. The first was American Management Systems, Inc. located in Fairfax, VA. AMS is responsible for the United States Navy's surface ship Maintenance Requirement System (MRS). The MRS was designed to assist the office of the Chief of Naval Operations, FLTCINCS and the Naval Sea Systems Command (NAVSEA) in defining surface ship maintenance requirements by recording the planning and execution of maintenance availabilities. [Telephone Conversation, AMS, Inc. Representative (1999)] Ship Alteration and Repair Package (SARP) data were depot level repair records maintained from 1968 to 1997. [Email, AMS, Inc. Representative (1999)] Authorized SARPs were prepared before a ship entered an availability, and completed SARPs recorded the work that was actually accomplished for each availability. [Telephone Conversation, AMS, Inc. Representative (1999)]

COMNAVSURFPAC Port Engineers were used as the second source of data. Port Engineers are located throughout the world with offices located near the geographic region of their assigned ship's homeport. The Pacific Fleet offices and their respective regional locations are Yokosuka and Sasebo (FAR EAST), Hawaii (MIDPAC), Bremerton, WA (PACNORWEST) and South West Regional Maintenance Center (SAN DIEGO). Five of the six LPDs assigned to the Pacific Fleet are homeported in San Diego, CA. [Meeting, Port Engineers (1999)] LPD Port Engineers at South West Regional Maintenance Center (SWRMC) were visited to obtain records of past depot maintenance availabilities and to discuss the surface ship maintenance program.

C. DATA

Data were collected for twelve depot level maintenance availabilities completed on seven ships. The period of maintenance was 1993 to 1998. Additionally, the list of maintenance deferred from 1998 on an eighth LPD was collected.

The SARP data for five ships included jobs that were authorized and jobs that were actually completed during each availability. Each SARP contained the entire work package broken down into individual job summaries. Each job summary contained 78 data fields. Appendix B gives the complete list of fields and a brief description of each. Table 3.1 shows the SARP data fields used to conduct this study.

FIELD	DESCRIPTION
SARP_TYPE	A-Authorized, C-Completed
HULL_NUM	Ship's hull number
GROWTH	Records whether this SWLIN line item contained any growth
HAB	TRUE if related to habitability
REP_ACT	Abbreviated code for repair activity Y-shipyard I-IMA F-ship's force G-other government
SWLIN	SWLIN number
TOT_DOL	Cost source total dollars

Table 3.1 **SARP Data Fields**

Data provided by the Port Engineers took a variety of forms. Production Estimates, Cost Performance Reports, Availability Briefing Sheets and Availability Schedule, Progress and Material Status Reports were all reviewed. Basic Work Item Index Reports were chosen to analyze because they provided the most consistency between Port Engineers. Though no two formats were exactly the same, they all contained the data fields necessary for this study. Specifically, these data fields were work item or SWLIN numbers, a description of the work completed during the availability and the cost. Additionally, the availability Briefing Sheets and Work Index cover pages were analyzed because they sometimes contained specific data for deferred maintenance.

D. ANALYSIS TECHNIQUES

To analyze the SARP data, the 78 fields were first reduced to the seven fields shown in Table 3.1 using Microsoft Excel. The data were sorted by SWLIN number and two records were printed for each availability, one for authorized work and one for

completed work. Sample authorized and completed SARP data are shown in figure 3.1. A complete SARP record is shown in Appendix C.

SARP_TYPE	HULL_NUM	GROWTH	HAB	REP_ACT	SWLIN	TOT_DOL
A	LPD 4	FALSE	FALSE	Y	11011	21025
A	LPD 4	FALSE	FALSE	Y	11021	8221
A	LPD 4	FALSE	FALSE	Y	11021	5533
A	LPD 4	FALSE	FALSE	Y	11021	6903
A	LPD 4	FALSE	FALSE	Y	11021	2845

SARP_TYPE	HULL_NUM	GROWTH	HAB	REP_ACT	SWLIN	TOT_DOL
C	LPD 4	FALSE	FALSE	Y	11011	21025
C	LPD 4	FALSE	FALSE	Y	11021	8221
C	LPD 4	FALSE	FALSE	Y	11021	6903
C	LPD 4	FALSE	FALSE	Y	11021	2845
C	LPD 4	TRUE	FALSE	Y	11021	12294

Figure 3.1 **Sample Authorized and Completed SARP DATA**

The seven fields were chosen to facilitate comparing authorized to completed work. By comparing an authorized SARP record to the same availabilities' completed SARP, the jobs which had not been completed were determined. Each SARP was separated by the ten SWLIN categories and the number of jobs authorized and completed in each category were summed. The associated costs of each SWLIN category were also summed. The authorized and completed SARPs were compared to produce a third record of the difference, if any, between the two.

The growth field in the completed SARP was checked to determine if that SWLIN had growth work associated with it. The Habitability field was then reviewed for applicability.

Several techniques were employed to yield the same results from the Port Engineers' data. First, all jobs on the Basic Work Item Index Reports were screened to ensure that each had a SWLIN. If no SWLIN was listed, three methods were used to assign one. 1) Sometimes a Work Item Number was used in lieu of a SWLIN. Work Item Numbers are eight digit numbers whose first five digits cross directly to SWLINs. The last three digits are used for internal codes. [Meeting, Port Engineers (1999)] 2) If no Work Item Number or SWLIN was given, a SWLIN was assigned if the job described could be matched to another job from the same Index Report or another availability. 3) The last method of assigning a SWLIN was to match the description of the job with the descriptions in the SWLIN table. When all jobs had a SWLIN assigned, the total number of jobs completed in each category and their associated costs were summed.

In some cases, the Port Engineers' records specifically listed the jobs that were deferred from an availability. If so, a SWLIN was assigned for each job, when required. The jobs were summed by category and, where possible, their respective costs.

If no data existed for the specific jobs deferred, an attempt to compare different Work Item Index Records was made. This technique was similar to the method employed for SARP records. A preliminary Work Item Index Report was compared to the Work Item Index Report after the availability was completed. The preliminary reports were used by the Port Engineers to assist in planning the availabilities. [Meeting, Port Engineers (1999)] Any jobs listed in the planning report that were not completed were considered deferred.

Sometimes, a preliminary report was reconstructed by adding the list of jobs deferred to those jobs that were completed. In this way, an "Authorized" list could be used to maintain consistency with the SARP data.

Jobs that contained growth work could only be determined if specifically noted in the remarks section of the Work Item Index Reports. Habitability items were determined by matching the jobs' SWLIN to habitability line items in the SWLIN table.

IV. DATA

The data presented here represent twelve maintenance availabilities and eight ships. Actual hull numbers were not used to prevent focusing on specific ships. The intent of this study was to develop a methodology for analyzing the data and identifying trends. Therefore, the ships used in this study are referenced as LPD A through LPD H.

A. LPD ALPHA

Table 4.1 is the SARP data for LPD A. This availability was completed in 1994. Growth work was recorded for 126 of the jobs completed. No jobs were indicated in the habitability field. Table 4.2 shows the distribution by percent of total jobs and total cost.

SWLIN CATEGORY	JOBS AUTHORIZED	COST	JOBS COMPLETED	COST	JOBS DEFERRED	COST
0XXXX	0	0	0	0	0	0
1XXXX	23	365,708	23	684,171	0	0
2XXXX	50	880,466	56	1,105,634	0	0
3XXXX	12	71,709	14	130,320	0	0
4XXXX	20	55,657	20	156,153	0	0
5XXXX	82	1,579,842	97	2,407,653	0	0
6XXXX	19	513,549	21	536,008	0	0
7XXXX	0	0	0	0	0	0
8XXXX	17	193,061	19	230,488	0	0
9XXXX	24	1,363,639	26	1,664,285	0	0
TOTAL	247	$5,023,631	276	$ 6,914,712	0	$0

Table 4.1 **LPD A 1994 SARP Data**

SWLIN CATEGORY	% OF JOBS AUTHORIZED	% OF COST	% OF JOBS COMPLETED	% OF COST	% OF JOBS DEFERRED	% OF COST
0XXXX	0.0	0.0	0.0	0.0	0.0	0.0
1XXXX	9.3	7.3	8.3	9.9	0.0	0.0
2XXXX	20.2	17.5	20.3	16.0	0.0	0.0
3XXXX	4.9	1.4	5.1	1.9	0.0	0.0
4XXXX	8.1	1.1	7.2	2.3	0.0	0.0
5XXXX	33.2	31.4	35.1	34.8	0.0	0.0
6XXXX	7.7	10.2	7.6	7.8	0.0	0.0
7XXXX	0.0	0.0	0.0	0.0	0.0	0.0
8XXXX	6.9	3.8	6.9	3.3	0.0	0.0
9XXXX	9.7	27.1	9.4	24.1	0.0	0.0
TOTAL	100.0	100.0	100.0	100.0	0.0	0.0

Table 4.2 **LPD A 1994 SARP Distribution**

The SARP distribution shows the largest percentage of total completed work occurring in SWLIN category 5XXXX, followed by category 2XXXX. No jobs were completed in categories 0XXXX and 7XXXX. The lowest percentage of total completed work was in category 3XXXX. The largest percentage of associated cost for completed work occurred in categories 5XXXX and 9XXXX. Categories 4XXXX and 3XXXX had the lowest percentage of cost for completed work. The percentage of completed work and the associated costs are shown in Figures 4.1 and 4.2.

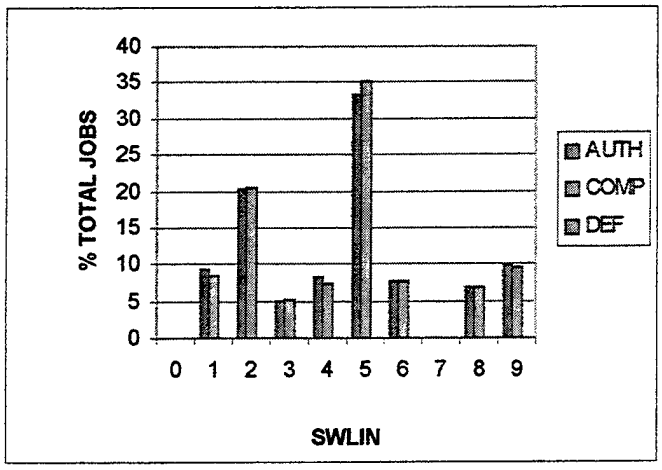

Figure 4.1 **LPD A Completed Work**

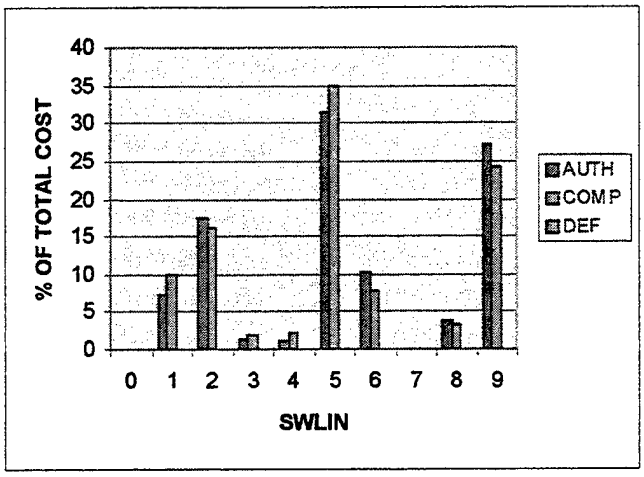

Figure 4.2 **LPD A Cost Distribution**

B. LPD BRAVO

This availability was completed in 1993. The SARP data showed no growth work, no habitability jobs and no deferred work. Table 4.3 shows the SARP data, and the percent distribution is contained in Table 4.4.

SWLIN CATEGORY	JOBS AUTHORIZED	COST	JOBS COMPLETED	COST	JOBS DEFERRED	COST
0XXXX	0	0	0	0	0	0
1XXXX	35	264,521	35	264,521	0	0
2XXXX	127	1,454,382	127	1,454,382	0	0
3XXXX	12	140,189	12	140,189	0	0
4XXXX	23	165,445	23	165,445	0	0
5XXXX	90	1,258,337	90	1,258,337	0	0
6XXXX	24	297,442	24	297,442	0	0
7XXXX	0	0	0	0	0	0
8XXXX	18	195,650	18	195,650	0	0
9XXXX	27	1,181,249	27	1,181,249	0	0
TOTAL	356	$4,957,215	356	$4,957,215	0	$0

Table 4.3 **LPD B 1993 SARP Data**

SWLIN CATEGORY	% OF JOBS AUTHORIZED	% OF COST	% OF JOBS COMPLETED	% OF COST	% OF JOBS DEFERRED	% OF COST
0XXXX	0.0	0.0	0.0	0.0	0.0	0.0
1XXXX	9.8	5.3	9.8	5.3	0.0	0.0
2XXXX	35.7	29.3	35.7	29.3	0.0	0.0
3XXXX	3.4	2.8	3.4	2.8	0.0	0.0
4XXXX	6.5	3.3	6.5	3.3	0.0	0.0
5XXXX	25.3	25.4	25.3	25.4	0.0	0.0
6XXXX	6.7	6.0	6.7	6.0	0.0	0.0
7XXXX	0.0	0.0	0.0	0.0	0.0	0.0
8XXXX	5.1	3.9	5.1	3.9	0.0	0.0
9XXXX	7.6	23.8	7.6	23.8	0.0	0.0
TOTAL	100.0	100.0	100.0	100.0	0.0	0.0

Table 4.4 **LPD B 1993 SARP Distribution**

LPD B had the largest percentage of jobs completed in category 2XXXX, followed by 5XXXX. Figure 4.3 shows the smallest percentage of total jobs completed were in categories 3XXXX and 8XXXX with no jobs completed for categories 0XXXX and 7XXXX. The most significant percentage of total cost was in 2XXXX and 5XXXX, followed closely by 9XXXX. The least significant portion of total cost for completed work occurred in categories 3XXXX and 4XXXX as seen in Figure 4.4.

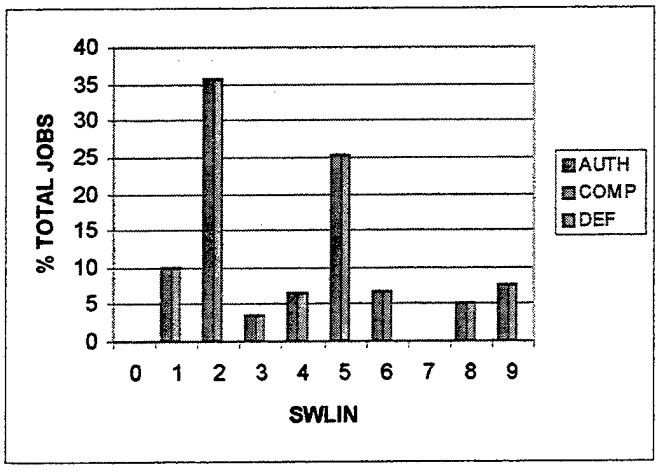

Figure 4.3 **LPD B Completed Work**

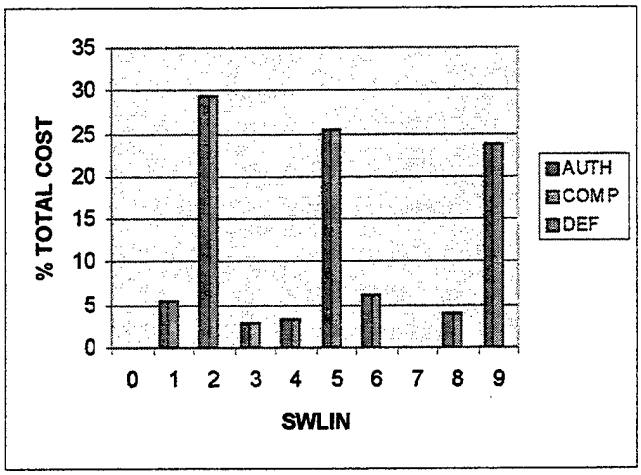

Figure 4.4 **LPD B Cost Distribution**

C. LPD CHARLIE

The SARP data for LPD C were obtained from an availability completed in 1993. Similar to LPD B, this SARP data showed no growth work, no habitability work, and no work deferred. Table 4.5 is LPD C SARP data, and Table 4.6 is the distribution.

SWLIN CATEGORY	JOBS AUTHORIZED	COST	JOBS COMPLETED	COST	JOBS DEFERRED	COST
0XXXX	0	0	0	0	0	0
1XXXX	39	470,110	39	470,110	0	0
2XXXX	49	432,995	49	432,995	0	0
3XXXX	8	95,167	8	95,167	0	0
4XXXX	4	8,077	4	8,077	0	0
5XXXX	44	982,797	44	982,797	0	0
6XXXX	32	732,435	32	732,435	0	0
7XXXX	1	16,795	1	16,795	0	0
8XXXX	22	67,245	22	67,245	0	0
9XXXX	22	799,624	22	799,624	0	0
TOTAL	221	$3,605,245	221	$3,605,245	0	$0

Table 4.5 **LPD C 1993 SARP Data**

SWLIN CATEGORY	% OF JOBS AUTHORIZED	% OF COST	% OF JOBS COMPLETED	% OF COST	% OF JOBS DEFERRED	% OF COST
0XXXX	0.0	0.0	0.0	0.0	0.0	0.0
1XXXX	17.6	13.0	17.6	13.0	0.0	0.0
2XXXX	22.2	12.0	22.2	12.0	0.0	0.0
3XXXX	3.6	2.6	3.6	2.6	0.0	0.0
4XXXX	1.8	0.2	1.8	0.2	0.0	0.0
5XXXX	19.9	27.3	19.9	27.3	0.0	0.0
6XXXX	14.5	20.3	14.5	20.3	0.0	0.0
7XXXX	0.5	0.5	0.5	0.5	0.0	0.0
8XXXX	10.0	1.9	10.0	1.9	0.0	0.0
9XXXX	10.0	22.2	10.0	22.2	0.0	0.0
TOTAL	100.0	100.0	100.0	100.0	0.0	0.0

Table 4.6 **LPD C 1993 SARP Distribution**

Figure 4.5 shows that LPD C completed the most work in categories 2XXXX and 5XXXX. There was no work completed in category 0XXXX and the least amount in 7XXXX and 4XXXX. The costs for this availability were highest in categories 5XXXX and 9XXXX. Categories 4XXXX and 7XXXX incurred the smallest cost for work completed. This is shown in Figure 4.6.

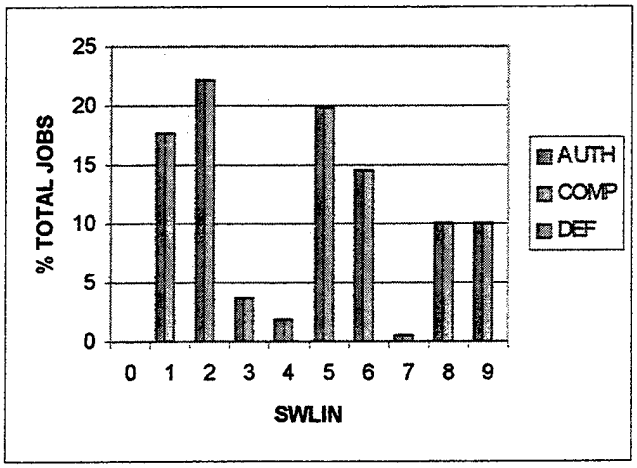

Figure 4.5 **LPD C Completed Work**

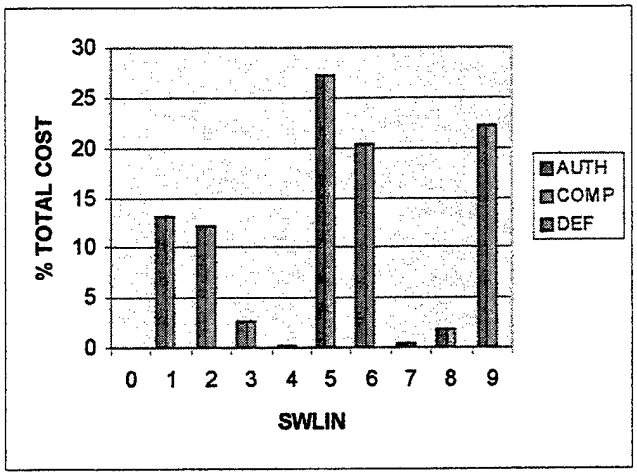

Figure 4.6 **LPD C Cost Distribution**

D. LPD DELTA

No data could be obtained for the completed availabilities of LPD D. However, work that was deferred from 1998 was analyzed. Tables 4.7 and 4.8 show the categories of work deferred and the percent distribution respectively.

SWLIN CATEGORY	JOBS AUTHORIZED	COST	JOBS COMPLETED	COST	JOBS DEFERRED	COST
0XXXX	-	-	-	-	0	0
1XXXX	-	-	-	-	0	0
2XXXX	-	-	-	-	0	0
3XXXX	-	-	-	-	0	0
4XXXX	-	-	-	-	0	0
5XXXX	-	-	-	-	5	150,000
6XXXX	-	-	-	-	49	4,798,000
7XXXX	-	-	-	-	1	200,000
8XXXX	-	-	-	-	0	0
9XXXX	-	-	-	-	0	0
TOTAL	-	-	-	-	55	$5,148,000

Table 4.7 **LPD D 1998 Deferred Work**

SWLIN CATEGORY	% OF JOBS AUTHORIZED	% OF COST	% OF JOBS COMPLETED	% OF COST	% OF JOBS DEFERRED	% OF COST
0XXXX	-	-	-	-	0.0	0.0
1XXXX	-	-	-	-	0.0	0.0
2XXXX	-	-	-	-	0.0	0.0
3XXXX	-	-	-	-	0.0	0.0
4XXXX	-	-	-	-	0.0	0.0
5XXXX	-	-	-	-	9.1	2.9
6XXXX	-	-	-	-	89.1	93.2
7XXXX	-	-	-	-	1.8	3.9
8XXXX	-	-	-	-	0.0	0.0
9XXXX	-	-	-	-	0.0	0.0
TOTAL	-	-	-	-	100.0	100.0

Table 4.8 **LPD D Deferred Work Distribution**

Figure 4.7 shows that LPD D deferred the majority of work in 1998 in SWLIN category 6XXXX. The smallest amount of work that was deferred occurred in category 7XXXX. Practically all of the cost associated with deferred work was also in category 6XXXX with minor amounts in 7XXXX and 5XXXX. The cost distribution is shown in Figure 4.8.

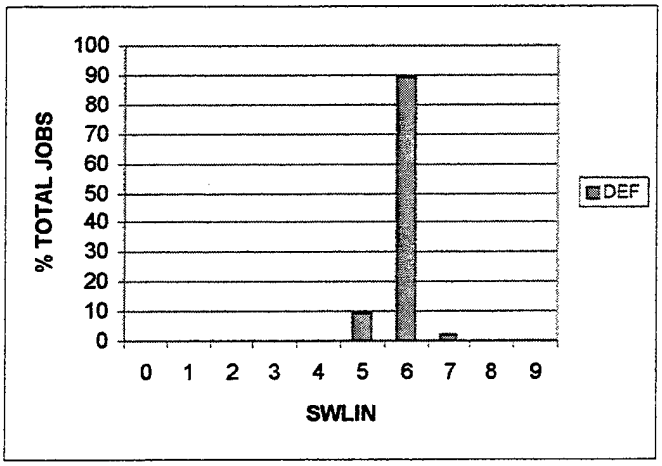

Figure 4.7 **LPD D Deferred Work**

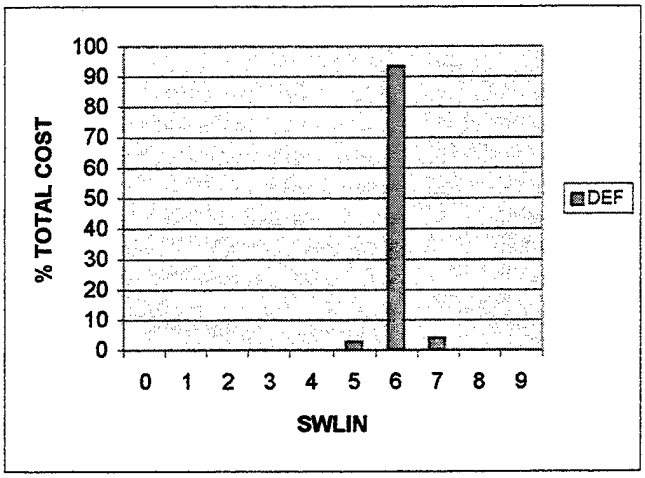

Figure 4.8 **LPD D Cost Distribution**

E. LPD ECHO

Data were analyzed for two of LPD E's availabilities. The first was a PMA completed in 1995, and the second was a DPMA completed in 1997. The PMA data are examples of where the "authorized" jobs list was reconstructed from the list of completed and deferred jobs. It was impossible to assign an estimated cost for the reconstructed authorized jobs. The DPMA data provided a summary cost of deferred work, but associated work items could not be determined. Tables 4.9 and 4.10 show the data and the distribution from the 1995 PMA. Work completed and the distribution from the 1997 DPMA are provided in Tables 4.11 and 4.12 respectively.

SWLIN CATEGORY	JOBS AUTHORIZED	COST	JOBS COMPLETED	COST	JOBS DEFERRED	COST
0XXXX	0	-	0	0	0	0
1XXXX	18	-	18	764,360	0	0
2XXXX	96	-	96	1,375,435	0	0
3XXXX	25	-	25	374,650	0	0
4XXXX	27	-	27	85,450	0	0
5XXXX	181	-	180	1,731,290	1	18,975
6XXXX	61	-	61	924,806	0	0
7XXXX	0	-	0	0	0	0
8XXXX	1	-	1	1,616,681	0	0
9XXXX	1	-	1	1,508,644	0	0
TOTAL	410	-	409	$8,381,316	1	$18,975

Table 4.9 **LPD E 1995 PMA Data**

SWLIN CATEGORY	% OF JOBS AUTHORIZED	% OF COST	% OF JOBS COMPLETED	% OF COST	% OF JOBS DEFERRED	% OF COST
0XXXX	0.0	-	0.0	0.0	0.0	0.0
1XXXX	4.4	-	4.4	9.1	0.0	0.0
2XXXX	23.4	-	23.5	16.4	0.0	0.0
3XXXX	6.1	-	6.1	4.5	0.0	0.0
4XXXX	6.6	-	6.6	1.0	0.0	0.0
5XXXX	44.1	-	44.0	20.7	100.0	100.0
6XXXX	14.9	-	14.9	11.0	0.0	0.0
7XXXX	0.0	-	0.0	0.0	0.0	0.0
8XXXX	0.2	-	0.2	19.3	0.0	0.0
9XXXX	0.2	-	0.2	18.0	0.0	0.0
TOTAL	100.0	-	100.0	100.0	100.0	100.0

Table 4.10 **LPD E 1995 PMA Distribution**

SWLIN CATEGORY	JOBS AUTHORIZED	COST	JOBS COMPLETED	COST	JOBS DEFERRED	COST
0XXXX	0	-	0	0	0	-
1XXXX	114	-	114	2,459,729	0	-
2XXXX	99	-	99	2,967,427	0	-
3XXXX	18	-	18	132,568	0	-
4XXXX	17	-	16	632,552	1	-
5XXXX	70	-	68	4,091,727	2	-
6XXXX	74	-	71	2,791,871	3	-
7XXXX	12	-	12	374,788	0	-
8XXXX	5	-	5	463,992	0	-
9XXXX	17	-	17	1,325,377	0	-
TOTAL	426	-	420	$15,240,031	6	$4,919,905

Table 4.11 **LPD E 1997 DPMA Data**

SWLIN CATEGORY	% OF JOBS AUTHORIZED	% OF COST	% OF JOBS COMPLETED	% OF COST	% OF JOBS DEFERRED	% OF COST
0XXXX	0.0	-	0.0	0.0	0.0	-
1XXXX	26.8	-	27.1	16.1	0.0	-
2XXXX	23.2	-	23.6	19.5	0.0	-
3XXXX	4.2	-	4.3	0.9	0.0	-
4XXXX	4.0	-	3.8	4.2	16.7	-
5XXXX	16.4	-	16.2	26.8	33.3	-
6XXXX	17.4	-	16.9	18.3	50.0	-
7XXXX	2.8	-	2.9	2.5	0.0	-
8XXXX	1.2	-	1.2	3.0	0.0	-
9XXXX	4.0	-	4.0	8.7	0.0	-
TOTAL	100.0	-	100.0	100.0	100.0	-

Table 4.12 **LPD E 1997 DPMA Distribution**

In 1995, LPD E completed the most jobs in categories 5XXXX and 2XXXX. No jobs were completed in 0XXXX and 7XXXX. The least amount of jobs were completed in 8XXXX and 9XXXX. All jobs deferred were in category 9XXXX. These results are shown in Figure 4.9. Category 5XXXX had the highest percentage of associated costs. Categories 8XXXX, 9XXXX and 2XXXX were very close behind. The smallest percentage of total cost for completed work was in categories 3XXXX and 4XXXX. All deferred costs occurred in category 5XXXX as shown in Figure 4.10.

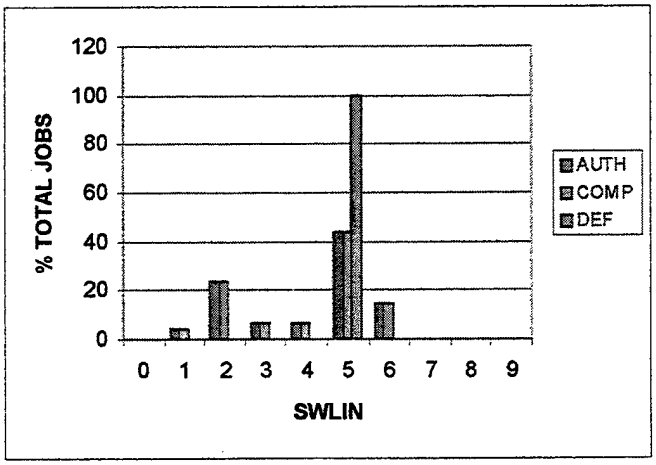

Figure 4.9 **LPD E 1995 Work**

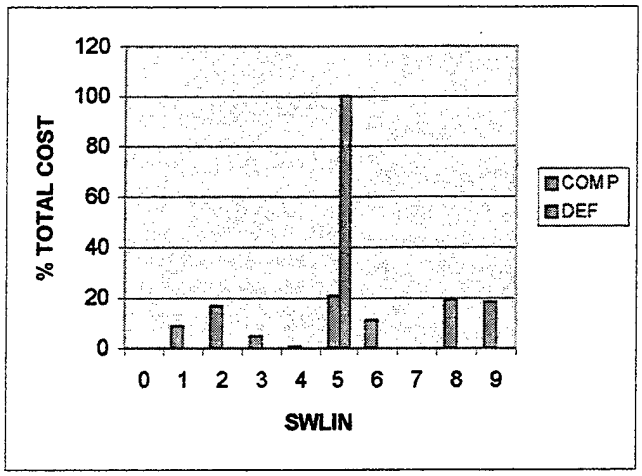

Figure 4.10 **LPD E 1995 Cost**

LPD E completed the most work in categories 1XXXX and 2XXXX in 1997. No work was completed in 0XXXX. The least amount completed was in categories 8XXXX and 7XXXX. Work was deferred most in categories 6XXXX and 5XXXX, and the least in category 4XXXX. These results are shown in Figure 4.11. LPD E incurred the most cost for work completed in category 5XXXX. Category 2XXXX had the second highest cost, followed closely by 6XXXX. The least percentage of total cost occurred in category 3XXXX, followed by 7XXXX and 8XXXX. This is shown in Figure 4.12.

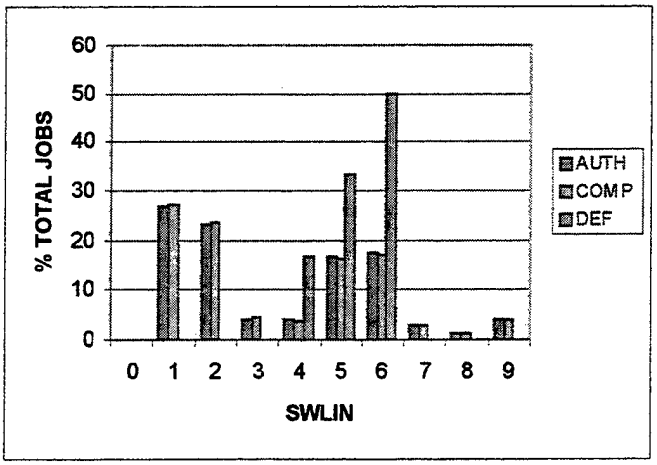

Figure 4.11 **LPD E 1997 Work**

Figure 4.11 **LPD E 1997 Work**

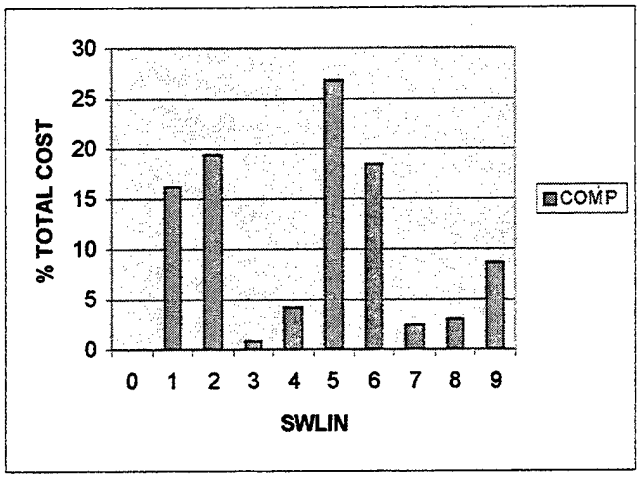

Figure 4.12 **LPD E 1997 Cost**

F. LPD FOXTROT

The most data were obtained for LPD F. The data for three availabilities spanning the years from 1992 to 1998 were analyzed. The 1992 SARP data are shown in Table 4.13. Its corresponding distribution appears in Table 4.14. The data showed no growth work, no habitability work and no work deferred.

SWLIN CATEGORY	JOBS AUTHORIZED	COST	JOBS COMPLETED	COST	JOBS DEFERRED	COST
0XXXX	0	0	0	0	0	0
1XXXX	19	435,581	19	435,581	0	0
2XXXX	20	220,597	20	220,597	0	0
3XXXX	13	145,248	13	145,248	0	0
4XXXX	15	309,538	15	309,538	0	0
5XXXX	161	1,789,806	161	1,789,806	0	0
6XXXX	71	1,078,438	71	1,078,438	0	0
7XXXX	0	0	0	0	0	0
8XXXX	19	407,976	19	407,976	0	0
9XXXX	18	692,075	18	692,075	0	0
TOTAL	336	$5,079,259	336	$5,079,259	0	$0

Table 4.13 **LPD F 1992 SARP Data**

SWLIN CATEGORY	JOBS AUTHORIZED	COST	JOBS COMPLETED	COST	JOBS DEFERRED	COST
0XXXX	0	0	0	0	0	0
1XXXX	19	435,581	19	435,581	0	0
2XXXX	20	220,597	20	220,597	0	0
3XXXX	13	145,248	13	145,248	0	0
4XXXX	15	309,538	15	309,538	0	0
5XXXX	161	1,789,806	161	1,789,806	0	0
6XXXX	71	1,078,438	71	1,078,438	0	0
7XXXX	0	0	0	0	0	0
8XXXX	19	407,976	19	407,976	0	0
9XXXX	18	692,075	18	692,075	0	0
TOTAL	336	$5,079,259	336	$5,079,259	0	$0

Table 4.14 **LPD F 1992 SARP Distribution**

The data for LPD F showed the most work completed in categories 5XXXX and 6XXXX during 1992. There were no jobs completed in 0XXXX and 7XXXX. The completed work for the remaining SWLIN categories was closely distributed between 3.9 and 6.0 percent. This is shown in Figure 4.13. Categories 5XXXX and 6XXXX also had the greatest percentage of total cost. The least cost occurred in categories 3XXXX and 2XXXX. The cost is displayed in Figure 4.14.

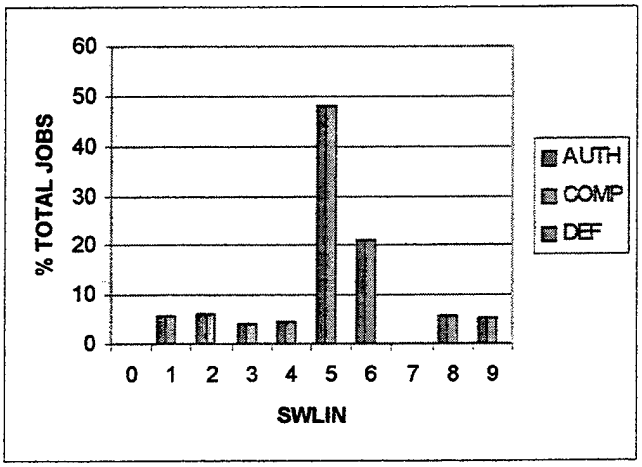

Figure 4.13 **LPD F 1992 Completed Work**

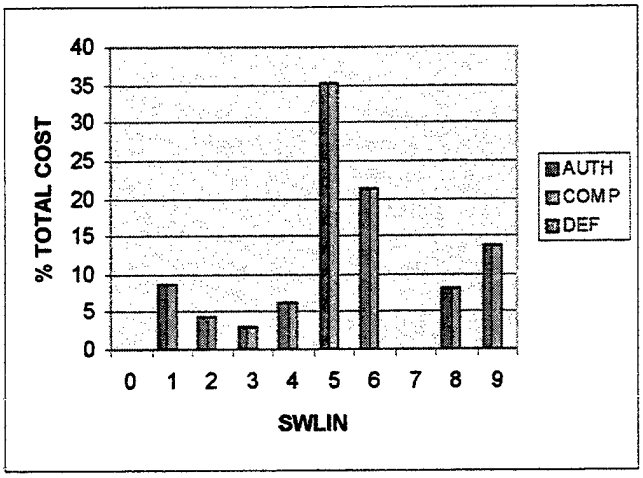

Figure 4.14 **LPD F 1992 Cost Distribution**

The next data set for LPD F is from a DPMA completed in 1997. The Data derived from a Basic Work Item Index are displayed in Table 4.15. This table has one extra column because only some of the deferred jobs had cost data associated with them. The cost for the remaining deferred jobs could not be determined. Likewise, the list of authorized jobs was reconstructed, so the associated costs could not be estimated. The corresponding distribution is found in Table 4.16.

SWLIN CATEGORY	JOBS AUTHORIZED	COST	JOBS COMPLETED	COST	JOBS DEFERRED	DEFERRED WITH COST	COST
0XXXX	2	-	2	221,359	0	0	0
1XXXX	69	-	11	425,334	58	45	906,841
2XXXX	70	-	43	1,465,692	27	19	275,563
3XXXX	11	-	3	43,072	8	6	47,324
4XXXX	21	-	3	111,136	18	11	171,336
5XXXX	197	-	75	2,808,712	122	77	1,389,901
6XXXX	104	-	7	1,044,702	97	86	2,608,725
7XXXX	2	-	0	0	2	2	28,478
8XXXX	21	-	21	217,328	0	0	0
9XXXX	26	-	25	1,565,716	1	0	0
TOTAL	523	-	190	$7,903,051	333	246	$5,428,168

Table 4.15 **LPD F 1997 DPMA Data**

SWLIN CATEGORY	% OF JOBS AUTHORIZED	% OF COST	% OF JOBS COMPLETED	% OF COST	% OF JOBS DEFERRED	% OF JOBS DEFERRED	% OF COST
0XXXX	0.4	-	1.1	2.8	0.0	0.0	0.0
1XXXX	13.2	-	5.8	5.4	17.4	18.3	16.7
2XXXX	13.4	-	22.6	18.5	8.1	7.7	5.1
3XXXX	2.1	-	1.6	0.5	2.4	2.4	0.9
4XXXX	4.0	-	1.6	1.4	5.4	4.5	3.2
5XXXX	37.7	-	39.5	35.5	36.6	31.3	25.6
6XXXX	19.9	-	3.7	13.2	29.1	35.0	48.1
7XXXX	0.4	-	0.0	0.0	0.6	0.8	0.5
8XXXX	4.0	-	11.1	2.7	0.0	0.0	0.0
9XXXX	5.0	-	13.2	19.8	0.3	0.0	0.0
TOTAL	100.0	-	100.0	100.0	100.0	100.0	100.0

Table 4.16 **LPD F 1997 DPMA Distribution**

In 1997, LPD F completed the most work in categories 5XXXX and 2XXXX. The least amount of work was completed in 7XXXX and 0XXXX. Most of the jobs deferred were in categories 5XXXX and 6XXXX. No jobs were deferred in 0XXXX and 8XXXX, and the least amount of deferred jobs occurred in 9XXXX and 7XXXX. The greatest percentage of total cost was in categories 5XXXX and 9XXXX. Category 2XXXX followed closely behind. The least amount of cost for completed work occurred in categories 3XXXX and 4XXXX. The work and cost distribution are shown in Figures 4.15 and 4.16 respectively.

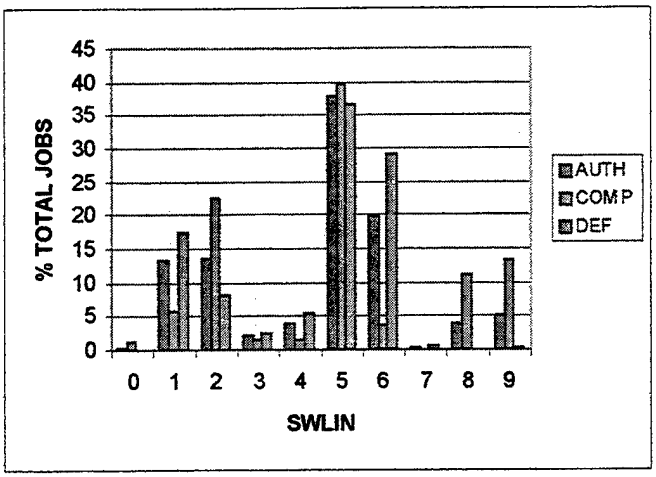

Figure 4.15 **LPD F 1997 Work**

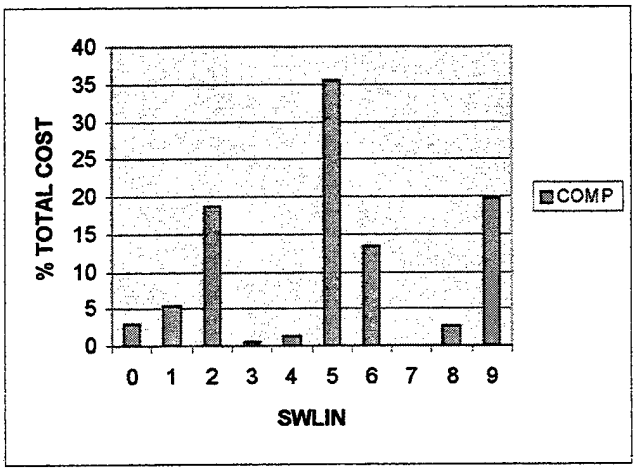

Figure 4.16 **LPD F 1997 Cost**

The third data set for LPD F came from a 1998 PRAV. The data showed all the work that was completed and deferred, but did not contain the cost of the deferred items. Since the authorized jobs list was reconstructed, the cost could not be estimated. Table 4.17 shows the PRAV data, and the distribution is in Table 4.18.

SWLIN CATEGORY	JOBS AUTHORIZED	COST	JOBS COMPLETED	COST	JOBS DEFERRED	COST
0XXXX	0	-	0	0	0	-
1XXXX	21	-	15	139,902	6	-
2XXXX	0	-	0	0	0	-
3XXXX	2	-	1	7,300	1	-
4XXXX	10	-	7	264,724	3	-
5XXXX	51	-	42	701,072	9	-
6XXXX	68	-	61	867,866	7	-
7XXXX	2	-	2	28,478	0	-
8XXXX	0	-	0	0	0	-
9XXXX	0	-	0	0	0	-
TOTAL	154	-	128	$2,009,342	26	-

Table 4.17 **LPD F 1998 PRAV Data**

SWLIN CATEGORY	% OF JOBS AUTHORIZED	% OF COST	% OF JOBS COMPLETED	% OF COST	% OF JOBS DEFERRED	% OF COST
0XXXX	0.0	-	0.0	0.0	0.0	-
1XXXX	13.6	-	11.7	7.0	23.1	-
2XXXX	0.0	-	0.0	0.0	0.0	-
3XXXX	1.3	-	0.8	0.4	3.8	-
4XXXX	6.5	-	5.5	13.2	11.5	-
5XXXX	33.1	-	32.8	34.9	34.6	-
6XXXX	44.2	-	47.7	43.2	26.9	-
7XXXX	1.3	-	1.6	1.4	0.0	-
8XXXX	0.0	-	0.0	0.0	0.0	-
9XXXX	0.0	-	0.0	0.0	0.0	-
TOTAL	100.0	-	100.0	100.0	100.0	-

Table 4.18 **LPD F 1998 PRAV Distribution**

The largest percentage of total jobs was completed in categories 6XXXX and 5XXXX for LPD F in 1998. There were no jobs completed in 0XXXX, 2XXXX, 8XXXX and 9XXXX. The lowest percentage of jobs completed was in category 3XXXX. The data showed the most deferred jobs in categories 5XXXX, 6XXXX and 1XXXX. The least of the total deferred jobs was in 4XXXX and 3XXXX. The distribution of work is shown in Figure 4.17. Figure 4.18 shows the largest percentage of

cost for completed work in categories 6XXXX and 5XXXX. Categories 3XXXX and 7XXXX were the least of those that actually incurred cost.

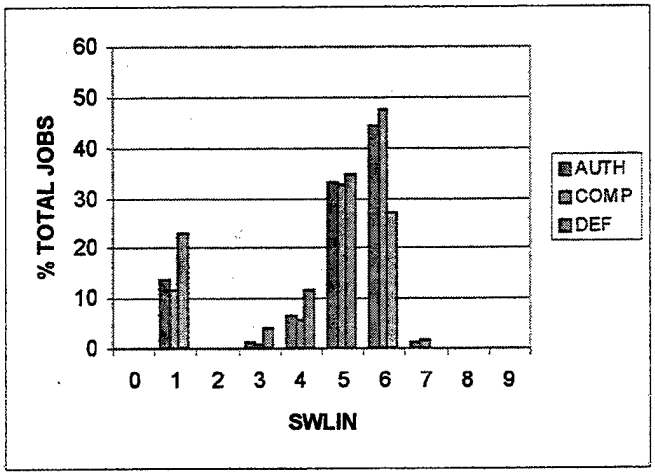

Figure 4.17 **LPD F 1998 Completed Work**

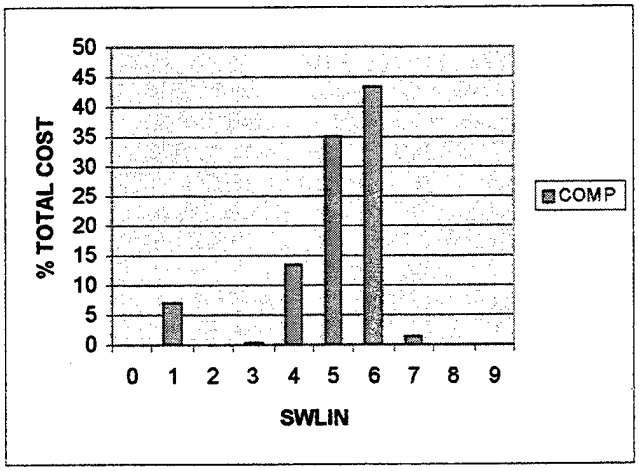

Figure 4.18 **LPD F 1998 Cost of Completed Work**

G. LPD GOLF

Two sets of data were analyzed for LPD G. The first was a list of deferred maintenance from a 1996 PMA. Though little information was gleaned, the data and distribution are shown in Tables 4.19 and 4.20 respectively.

SWLIN CATEGORY	JOBS AUTHORIZED	COST	JOBS COMPLETED	COST	JOBS DEFERRED	COST
0XXXX	-	-	-	-	0	-
1XXXX	-	-	-	-	1	-
2XXXX	-	-	-	-	2	-
3XXXX	-	-	-	-	0	-
4XXXX	-	-	-	-	1	-
5XXXX	-	-	-	-	4	-
6XXXX	-	-	-	-	3	-
7XXXX	-	-	-	-	0	-
8XXXX	-	-	-	-	0	-
9XXXX	-	-	-	-	0	-
TOTAL	-	-	-	$14,400,000	11	$1,600,000

Table 4.19 **LPD G 1996 PMA Data**

SWLIN CATEGORY	% OF JOBS AUTHORIZED	% OF COST	% OF JOBS COMPLETED	% OF COST	% OF JOBS DEFERRED	% OF COST
0XXXX	-	-	-	-	0.0	-
1XXXX	-	-	-	-	9.1	-
2XXXX	-	-	-	-	18.2	-
3XXXX	-	-	-	-	0.0	-
4XXXX	-	-	-	-	9.1	-
5XXXX	-	-	-	-	36.4	-
6XXXX	-	-	-	-	27.3	-
7XXXX	-	-	-	-	0.0	-
8XXXX	-	-	-	-	0.0	-
9XXXX	-	-	-	-	0.0	-
TOTAL		-	-	-	100.0	-

Table 4.20 **LPD G 1996 PMA Distribution**

Figure 4.19 shows the distribution of work deferred in 1996 for LPD G. The majority of work was in categories 5XXXX and 6XXXX. The least deferred categories were 1XXXX and 4XXXX. Categories 0XXXX, 3XXXX, 7XXXX, 8XXXX and 9XXXX had no work deferred.

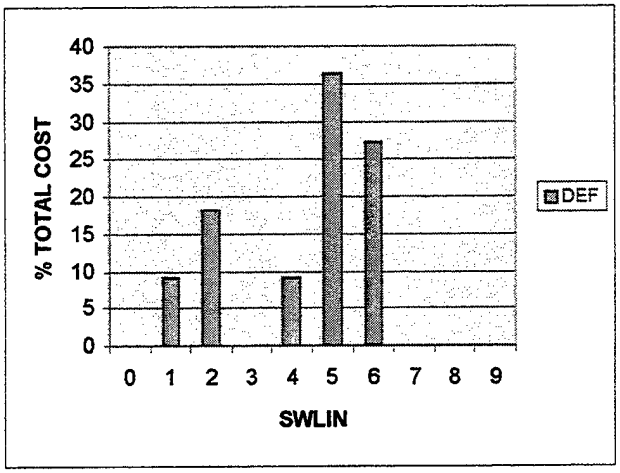

Figure 4.19 **LPD G 1996 Deferred Work**

The second set of data for LPD G was from a DPMA completed in 1998. The data were complete for the deferred and completed work, but the authorized work had to be reconstructed. The DPMA data is in Table 4.21, and Table 4.22 contains the distribution.

SWLIN CATEGORY	JOBS AUTHORIZED	COST	JOBS COMPLETED	COST	JOBS DEFERRED	COST
0XXXX	3	467,530	3	467,530	0	0
1XXXX	30	454,654	30	454,654	0	0
2XXXX	32	2,275,552	32	2,275,552	0	0
3XXXX	4	80,520	4	80,520	0	0
4XXXX	16	566,486	15	514,486	1	52,000
5XXXX	81	5,524,360	80	4,924,360	1	600,000
6XXXX	17	1,458,915	15	1,033,915	2	425,000
7XXXX	0	0	0	0	0	0
8XXXX	23	700,175	23	700,175	0	0
9XXXX	16	1,218,860	14	789,320	2	429,540
TOTAL	222	$12,747,052	216	$11,240,512	6	$1,506,540

Table 4.21 **LPD G 1998 DPMA Data**

SWLIN CATEGORY	% OF JOBS AUTHORIZED	% OF COST	% OF JOBS COMPLETED	% OF COST	% OF JOBS DEFERRED	% OF COST
0XXXX	1.4	3.7	1.4	4.2	0.0	0.0
1XXXX	13.5	3.6	13.9	4.0	0.0	0.0
2XXXX	14.4	17.9	14.8	20.2	0.0	0.0
3XXXX	1.8	0.6	1.9	0.7	0.0	0.0
4XXXX	7.2	4.4	6.9	4.6	16.7	3.5
5XXXX	36.5	43.3	37.0	43.8	16.7	39.8
6XXXX	7.7	11.4	6.9	9.2	33.3	28.2
7XXXX	0.0	0.0	0.0	0.0	0.0	0.0
8XXXX	10.4	5.5	10.6	6.2	0.0	0.0
9XXXX	7.2	9.6	6.5	7.0	33.3	28.5
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0

Table 4.22 **LPD G 1998 DPMA Distribution**

The 1998 data for LPD G showed that most of the work was completed in category 5XXXX. The least amount of jobs completed was in 0XXXX and 3XXXX with no work in category 7XXXX. Of the total deferred, the largest percentage was in 9XXXX and 7XXXX, and the least was in 4XXXX and 5XXXX. No work was deferred in the remaining categories. This data is displayed in Figure 4.20. The highest percentage of total cost for work completed occurred in category 5XXXX. The least cost occurred in 3XXXX, followed closely by 1XXXX, 0XXXX and 4XXXX. The largest percentage of total cost for jobs deferred also occurred in 5XXXX, then 6XXXX and 7XXXX. The lowest percentage of deferred cost occurred in 4XXXX. The cost distribution is shown in Figure 4.21.

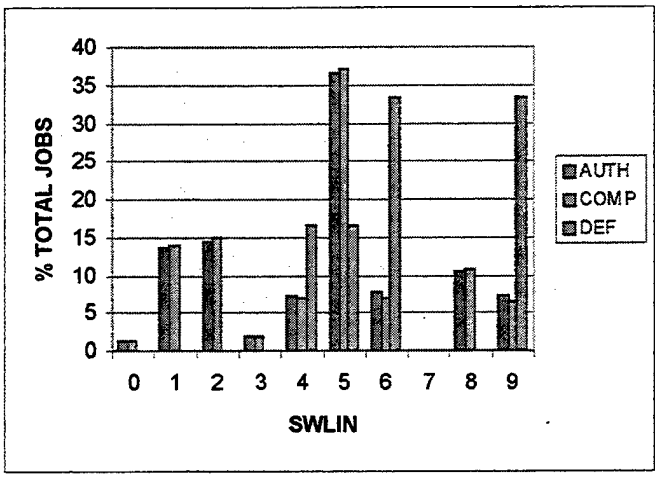

Figure 4.20 **LPD G 1998 Work**

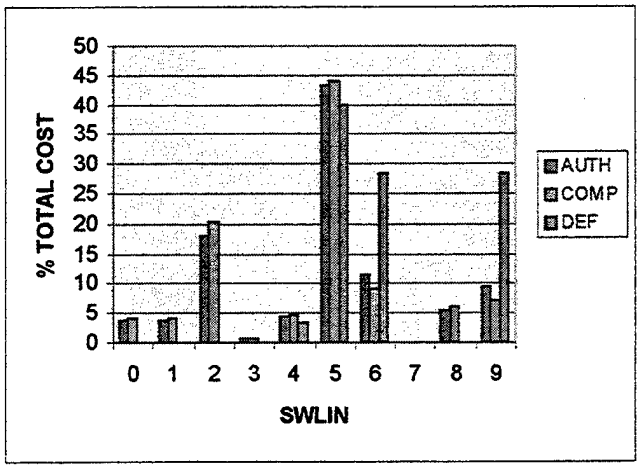

Figure 4.21 **LPD G 1998 Cost Distribution**

H. LPD HOTEL

SARP data from 1994 and 1995 were analyzed for LPD H. The 1994 data showed that 25 jobs had growth work associated with them, but no habitability work was recorded. The data also showed that all work for SWLIN items 3XXXX through 9XXXX were deferred in 1994. The only work completed was in SWLIN categories 1XXXX and 2XXXX. The 1994 SARP data are shown in Table 4.23, the distribution is in Table 4.24.

SWLIN CATEGORY	JOBS AUTHORIZED	COST	JOBS COMPLETED	COST	JOBS DEFERRED	COST
0XXXX	0	0	0	0	0	0
1XXXX	80	1,048,305	81	1,238,904	0	0
2XXXX	60	1,141,089	57	1,531,603	3	-390,514
3XXXX	4	121,956	0	0	4	121,956
4XXXX	14	73,404	0	0	14	73,404
5XXXX	55	579,891	0	0	55	579,891
6XXXX	10	138,674	0	0	10	138,674
7XXXX	3	22,589	0	0	3	22,589
8XXXX	23	289,858	0	0	23	289,858
9XXXX	22	1,559,800	0	0	22	1,559,800
TOTAL	271	$4,975,566	138	$2,770,507	134	$2,395,658

Table 4.23 **LPD H 1994 SARP Data**

SWLIN CATEGORY	% OF JOBS AUTHORIZED	% OF COST	% OF JOBS COMPLETED	% OF COST	% OF JOBS DEFERRED	% OF COST
0XXXX	0.0	0.0	0.0	0.0	0.0	0.0
1XXXX	29.5	21.1	58.7	44.7	0.0	0.0
2XXXX	22.1	22.9	41.3	55.3	2.2	-16.3
3XXXX	1.5	2.5	0.0	0.0	3.0	5.1
4XXXX	5.2	1.5	0.0	0.0	10.4	3.1
5XXXX	20.3	11.7	0.0	0.0	41.0	24.2
6XXXX	3.7	2.8	0.0	0.0	7.5	5.8
7XXXX	1.1	0.5	0.0	0.0	2.2	0.9
8XXXX	8.5	5.8	0.0	0.0	17.2	12.1
9XXXX	8.1	31.3	0.0	0.0	16.4	65.1
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0

Table 4.24 **LPD H 1994 SARP Distribution**

In 1994, LPD H completed the highest percentage of jobs in category 1XXXX. The lowest percentage was in category 2XXXX. No other maintenance was complete. The most deferred jobs were in category 5XXXX. The least deferred jobs were in 2XXXX, 7XXXX and 3XXXX. No maintenance was deferred in categories 0XXXX and 1XXXX. This is displayed in Figure 4.22. All of the cost was incurred in categories 1XXXX and 2XXXX. Category 2XXXX was the highest percentage of total cost. The highest percentage of deferred cost was in category 9XXXX. Category 2XXXX had

deferred jobs, but increased cost. The lowest deferred cost was in category 7XXXX. Cost data are shown in Figure 4.23.

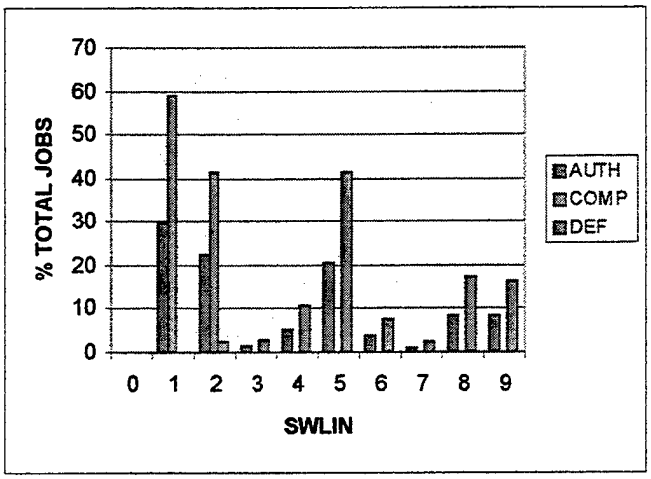

Figure 4.22 **LPD H 1994 Work**

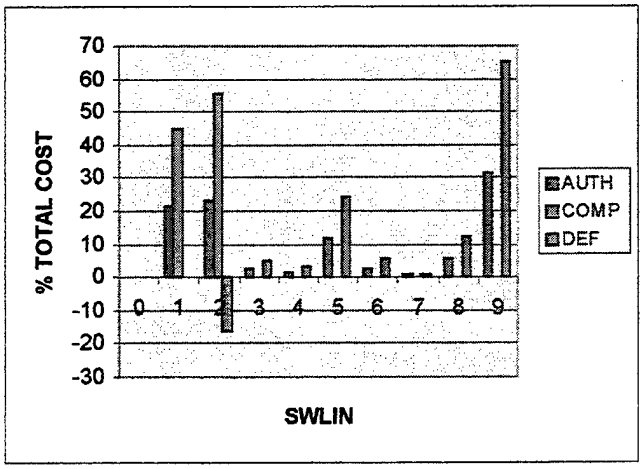

Figure 4.23 **LPD H 1994 Cost Distribution**

The 1995 SARP data for LPD H showed no growth work and no habitability work. The SARP data are in Table 4.25 and the distribution is in Table 4.26.

SWLIN CATEGORY	JOBS AUTHORIZED	COST	JOBS COMPLETED	COST	JOBS DEFERRED	COST
0XXXX	0	0	0	0	0	0
1XXXX	48	876,323	48	876,323	0	0
2XXXX	61	805,451	61	805,451	0	0
3XXXX	17	140,453	17	140453	0	0
4XXXX	42	423,771	42	423771	0	0
5XXXX	74	1,229,767	74	1229767	0	0
6XXXX	17	736,366	17	736366	0	0
7XXXX	5	55,636	5	55636	0	0
8XXXX	22	635,589	22	635589	0	0
9XXXX	20	2,530,132	20	2530132	0	0
TOTAL	306	$7,433,488	306	$7,433,488	0	$0

Table 4.25 **LPD H 1995 SARP Data**

SWLIN CATEGORY	% OF JOBS AUTHORIZED	% OF COST	% OF JOBS COMPLETED	% OF COST	% OF JOBS DEFERRED	% OF COST
0XXXX	0.0	0.0	0.0	0.0	0.0	0.0
1XXXX	15.7	11.8	15.7	11.8	0.0	0.0
2XXXX	19.9	10.8	19.9	10.8	0.0	0.0
3XXXX	5.6	1.9	5.6	1.9	0.0	0.0
4XXXX	13.7	5.7	13.7	5.7	0.0	0.0
5XXXX	24.2	16.5	24.2	16.5	0.0	0.0
6XXXX	5.6	9.9	5.6	9.9	0.0	0.0
7XXXX	1.6	0.7	1.6	0.7	0.0	0.0
8XXXX	7.2	8.6	7.2	8.6	0.0	0.0
9XXXX	6.5	34.0	6.5	34.0	0.0	0.0
TOTAL	100.0	100.0	100.0	100.0	0.0	0.0

Table 4.26 **LPD H 1995 SARP Distribution**

In 1995, LPD H had the greatest percentage of completed jobs in category 5XXXX and then 2XXXX. No work was done in category 0XXXX, and the least completed was in 7XXXX. This is shown in Figure 2.24. The greatest percentage of cost for completed jobs was in category 9XXXX. The least was in categories 7XXXX and 3XXXX. Figure 4.25 shows the cost distribution.

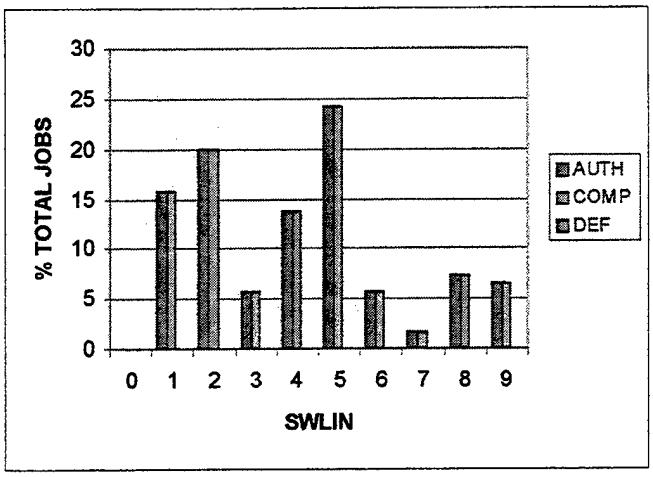

Figure 4.24 **LPD H 1995 Completed Work**

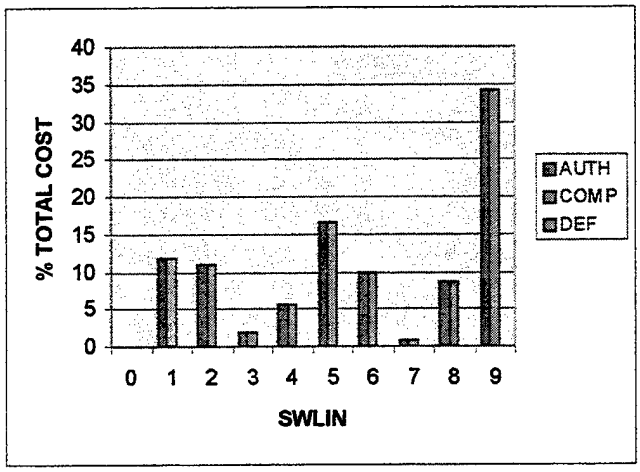

Figure 4.25 **LPD H 1995 Cost Distribution**

I. DATA ANALYSIS

The data were analyzed first on the basis of total jobs. Next, the data were analyzed by the total jobs in each SWLIN category. A compilation of the work completed and deferred across the thirteen data sets is shown in Tables 4.27 and 4.28 respectively.

SWLIN	DATA SET 1	DATA SET 2	DATA SET 3	DATA SET 4	DATA SET 5	DATA SET 6	DATA SET 7	DATA SET 8	DATA SET 9	DATA SET 10	DATA SET 11	DATA SET 12	DATA SET 13	TOTAL
0XXXX	0	0	0	0	0	0	0	2	0	0	3	0	0	5
1XXXX	23	35	39	0	114	18	15	11	19	0	30	81	48	433
2XXXX	56	127	49	0	99	96	0	43	20	0	32	57	61	640
3XXXX	14	12	8	0	18	25	1	3	13	0	4	0	17	115
4XXXX	20	23	4	0	16	27	7	3	15	0	15	0	42	172
5XXXX	97	90	44	0	68	180	42	75	161	0	80	0	74	911
6XXXX	21	24	32	0	71	61	61	7	71	0	15	0	17	380
7XXXX	0	0	1	0	12	0	2	0	0	0	0	0	5	20
8XXXX	19	18	22	0	5	1	0	21	19	0	23	0	22	150
9XXXX	26	27	22	0	17	1	0	25	18	0	14	0	20	170
TOTAL	276	356	221	0	420	409	128	190	336	0	216	138	306	2996

Table 4.27 **Work Completed (LPD A – LPD H)**

SWLIN	DATA SET 1	DATA SET 2	DATA SET 3	DATA SET 4	DATA SET 5	DATA SET 6	DATA SET 7	DATA SET 8	DATA SET 9	DATA SET 10	DATA SET 11	DATA SET 12	DATA SET 13	TOTAL
0XXXX	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1XXXX	0	0	0	0	0	0	6	58	0	1	0	0	0	65
2XXXX	0	0	0	0	0	0	0	27	0	2	0	3	0	32
3XXXX	0	0	0	0	0	0	1	8	0	0	0	4	0	13
4XXXX	0	0	0	0	1	0	3	18	0	1	1	14	0	38
5XXXX	0	0	0	5	2	1	9	122	0	4	1	55	0	199
6XXXX	0	0	0	49	3	0	7	97	0	3	2	10	0	171
7XXXX	0	0	0	1	0	0	0	2	0	0	0	3	0	6
8XXXX	0	0	0	0	0	0	0	0	0	0	0	23	0	23
9XXXX	0	0	0	0	0	0	0	1	0	0	2	22	0	25
TOTAL	0	0	0	55	6	1	26	333	0	11	6	134	0	572

Table 4.28 **Work Deferred (LPD A – LPD H)**

1. Analysis by Total Jobs

The twelve sets of data that had completed maintenance were used to produce Figure 4.26 showing total completed work. Similarly, the eight sets of data that had deferred maintenance were used for the total deferred work shown in Figure 4.27. These data were used to calculate the percentage of total jobs completed and deferred shown in Table 4.29 and Figure 4.28.

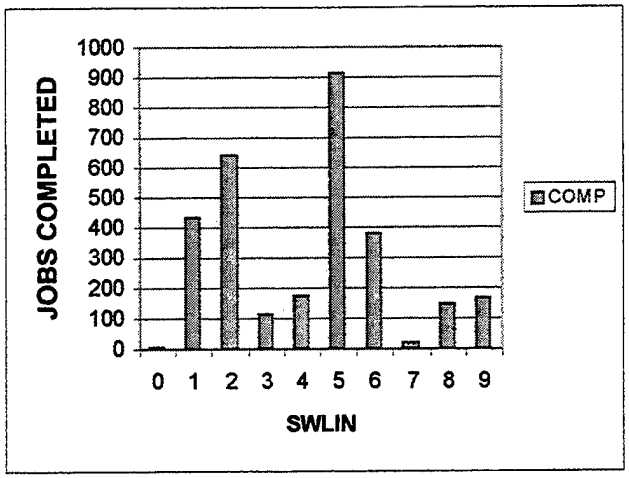

Figure 4.26 **Total Completed Work**

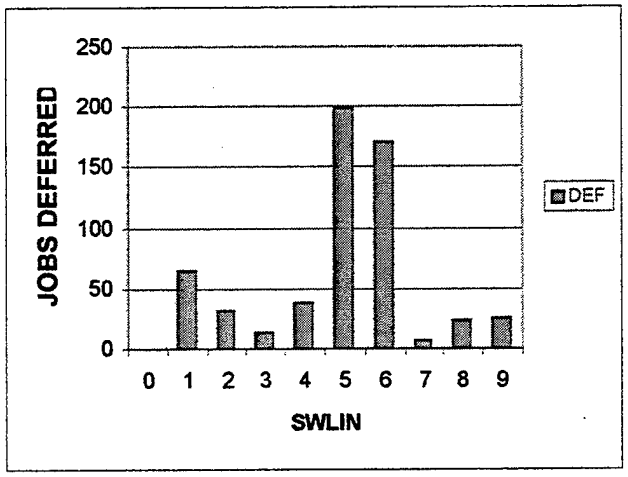

Figure 4.27 **Total Deferred Work**

SWLIN	% DEF	% COMP
0XXXX	0.0	0.2
1XXXX	11.4	14.5
2XXXX	5.6	21.4
3XXXX	2.3	3.8
4XXXX	6.6	5.7
5XXXX	34.8	30.4
6XXXX	29.9	12.7
7XXXX	1.0	0.7
8XXXX	4.0	5.0
9XXXX	4.4	5.7
	100.0	100.0

Table 4.29 **Percentage of Total Jobs Completed and Deferred**

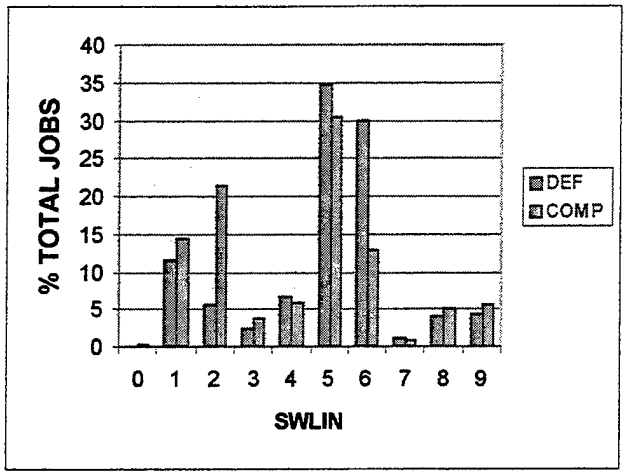

Figure 4.28 **Distribution of Total Completed and Deferred Work**

The data were insufficient to compile the total cost for deferred maintenance by individual SWLIN number. The total cost for work completed is shown in Table 4.30. The eleven data sets that contained cost data for completed maintenance were analyzed to show the distributions in Table 4.31 and Figure 4.29.

SWLIN	DATA SET 1	DATA SET 2	DATA SET 3	DATA SET 4	DATA SET 5	DATA SET 6	DATA SET 7	DATA SET 8	DATA SET 9	DATA SET 10	DATA SET 11	DATA SET 12	DATA SET 13	TOTAL
0XXXX	0	0	0	0	0	0	0	221,359	0	0	467,530	0	0	688,889
1XXXX	684,171	264,521	470,110	0	2,459,729	764,360	139,902	425,334	435,581	0	454,654	1,238,904	876,323	8,213,589
2XXXX	1,105,634	1,454,382	432,995	0	2,967,427	1,375,435	0	1,465,692	220,597	0	2,275,552	1,531,603	805,451	13,634,768
3XXXX	130,320	140,189	95,167	0	132,568	374,650	7,300	43,072	145,248	0	80,520	0	140,453	1,289,487
4XXXX	156,153	165,445	8,077	0	832,552	85,450	264,724	111,136	309,538	0	514,486	0	423,771	2,671,332
5XXXX	2,407,653	1,258,337	982,797	0	4,091,727	1,731,290	701,072	2,808,712	1,789,806	0	4,924,360	0	1,229,767	21,925,521
6XXXX	536,008	297,442	732,435	0	2,791,871	924,806	867,868	1,044,702	1,078,438	0	1,033,915	0	736,366	10,043,849
7XXXX	0	0	16,795	0	374,788	0	28,478	0	0	0	0	0	55,636	475,697
8XXXX	230,488	195,650	67,245	0	463,992	1,616,681	0	217,328	407,976	0	700,175	0	635,589	4,535,124
9XXXX	1,664,285	1,181,249	799,624	0	1,325,377	1,508,644	0	1,565,716	692,075	0	789,320	0	2,530,132	12,056,422
TOTAL	6,914,712	4,957,215	3,605,245	0	15,240,031	8,381,316	2,009,342	7,903,051	5,079,259	0	11,240,512	2,770,507	7,433,488	75,534,678

Table 4.30 **Total Cost for Work Completed (LPD A – LPD H)**

SWLIN	% COMP
0XXXX	0.91
1XXXX	10.87
2XXXX	18.05
3XXXX	1.71
4XXXX	3.54
5XXXX	29.03
6XXXX	13.30
7XXXX	0.63
8XXXX	6.00
9XXXX	15.96
TOTAL	100.00

Table 4.31 **Percentage of Total Cost for all Jobs Completed**

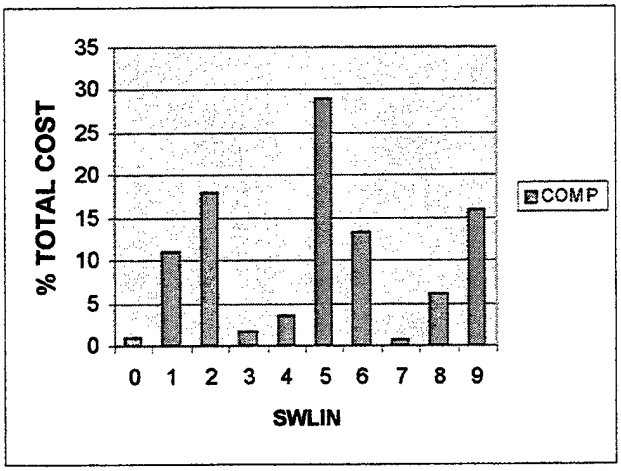

Figure 4.29 **Distribution of Total Cost for all Completed Work**

Table 4.32 shows the ten SWLIN categories sorted by most jobs deferred, most jobs completed and total cost of jobs completed.

ORDER	DEFERRED MOST	COMPLETED MOST	MOST COST TO COMP
1	5XXXX	5XXXX	5XXXX
2	6XXXX	2XXXX	2XXXX
3	1XXXX	1XXXX	9XXXX
4	4XXXX	6XXXX	6XXXX
5	2XXXX	4XXXX	1XXXX
6	9XXXX	9XXXX	8XXXX
7	8XXXX	8XXXX	4XXXX
8	3XXXX	3XXXX	3XXXX
9	7XXXX	7XXXX	0XXXX
10	0XXXX	0XXXX	7XXXX

Table 4.32 **Total Jobs Analysis**

2. Analysis by SWLIN

The total work completed and deferred in each SWLIN category was used to produce Table 4.33. From this, the distribution of work completed and deferred by SWLIN was calculated, and the results are shown in Figure 4.30.

SWLIN	TOTAL JOBS	% DEF	% COMP
0XXXX	5	0.0	100.0
1XXXX	498	13.1	86.9
2XXXX	672	4.8	95.2
3XXXX	128	10.2	89.8
4XXXX	210	18.1	81.9
5XXXX	1110	17.9	82.1
6XXXX	551	31.0	69.0
7XXXX	26	23.1	76.9
8XXXX	173	13.3	86.7
9XXXX	195	12.8	87.2
TOTAL	3568	16.0	84.0

Table 4.33 **Percentage of Authorized Jobs Completed and Deferred By SWLIN Category**

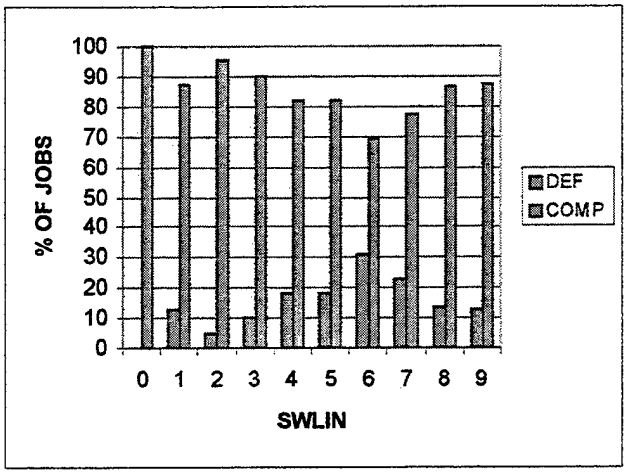

Figure 4.30 **Distribution of Authorized Jobs Completed and Deferred by SWLIN Category**

Table 4.34 shows the ten SWLIN categories sorted by most authorized jobs deferred and completed within each category.

ORDER	DEFERRED MOST	COMPLETED MOST
1	6XXXX	0XXXX
2	7XXXX	2XXXX
3	4XXXX	3XXXX
4	5XXXX	9XXXX
5	8XXXX	1XXXX
6	1XXXX	8XXXX
7	9XXXX	5XXXX
8	3XXXX	4XXXX
9	2XXXX	7XXXX
10	0XXXX	6XXXX

Table 4.34 **SWLIN Jobs Analysis**

J. SUMMARY OF DATA

Today, no data exist to document all of the maintenance (repair or preventive) that is completed throughout the life of any single surface ship in the United States Navy. As a result, availability data come in many different forms and from many different

sources. Also, the method of managing and conducting surface ship maintenance has changed over the years and exacerbated this problem.

As discussed in Chapter One, maintenance beyond the capability of ship's force and IMAs is performed at depot facilities. These periods when the ship is repaired at a depot facility were once accomplished in lengthy Overhauls, which could last beyond six months. In 1978, the Navy began to move to Phased Maintenance (PM) which reduced the timeframe to about ten weeks. Today, PM continues to evolve into Continuous Maintenance (CM) with the goal to eliminate the need to put a ship out of commission for maintenance. [Email, AMS, Inc. representative (1999)] Still, no system has evolved to keep an historical record of the work performed in the Phased Maintenance or Continuous Maintenance programs aside from the individual records of the Port Engineers.

1. Basic Work Item Index Reports

The Port Engineers maintain these data as personal working documents and as historical records of past availabilities. However, the Port Engineers hold no records that span the life of a ship. These data were difficult to analyze because of the inconsistency between Port Engineers. Also, in some cases, if cover letters did not describe what jobs had been deferred from an availability, deferred maintenance would have been impossible to determine from the existing data. All of these data were provided in hard copy, and it is not known how many, if any of them, are stored in a database. The limitations of the Basic Work Item Index Reports were the key factor in the inability to determine the total cost of deferred maintenance by SWLIN category.

The process of keeping historical data may be improving. Port Engineers are beginning to use the Maintenance Support Tool (MST) to assist them in preparing availability work packages. These portable computers have the ability to import and export work item information and download that information to the CSMP. MST is also capable of storing historical information. [Email, AMS, Inc. Representative (1999)]

The most comprehensive maintenance tool currently used by Port Engineers is the Regional Maintenance Automated Industrial System (RMAIS). All jobs entered in the ship's CSMP are reviewed daily by the Port Engineers using the RMAIS. Every job accomplished, whether done by ship's force, IMAs or depot level facilities, is contained in the CSMP. [Meeting, Port Engineers (1999)] The downfall of this system is that once a job is completed, it is simply deleted, and no historical record is kept. [Telephone Conversation, AMS, Inc. Representative (1999)]

2. SARP Data

The SARP data began to appear in database form in 1992 and remained until SARPs were discontinued in 1996 at COMNAVSURFLANT and 1997 at COMNAVSURFPAC. [Email, AMS, Inc. Representative (1999)] [Telephone Conversation, AMS, Inc. Representative (1999)] Still, SARPs were prepared inconsistently and only for certain classes of ships during those years. This limitation in SARP data was the key factor in defining the scope of this thesis. Table 4.35 shows the type of SARP data available. Additional SARPs may exist, but can no longer be retrieved since the SARP server has been shut down and is no longer used. [Email, AMS, Inc. Representative (1999)]

SHIP TYPE	SARP TYPE
AO	Authorized or completed, but not both
CG	Authorized or completed, but not both
FFG	Authorized or completed, but not both
DD	Authorized or completed, but not both
DDG	Authorized or completed, but not both
LPD	Authorized and completed for earlier data, then sporadic
LHA	Authorized and completed for earlier data, then sporadic
LHD	Authorized and completed for earlier data, then sporadic
LSD	Authorized and completed for earlier data, then sporadic
MHC	Unknown
MCM	Unknown
PC	Unknown

Table 4.35 **SARP Data by Ship Type**
[Telephone Conversation, AMS, Inc. Representative (1999)]

Some SARP data used in this study contained anomalies. For example, it could not be determined how a completed SARP would coincide exactly with an authorized SARP. This would suggest that no jobs were deferred, or that the authorized SARPs were adjusted to match the completed work. In this case, no record would be preserved for the deferred items. Additionally, some SARPs had no items marked as growth work. This would be inconsistent with the Port Engineer's practice of reserving 21 percent of funds up front for growth. [Meeting, Port Engineers (1999)] It could not be explained

why every work item in the SARP data under the Habitability data field was marked false. This would suggest that no jobs were related to habitability. Even work items within the 64000 SWLIN category were marked false. This category pertains to living spaces, clearly, a habitability item.

There are no historical data sources that specifically address deferred maintenance. However, commencing in fiscal year 1999, COMNAVSURFPAC has initiated a requirement for the SWRMC Port Engineers to submit a weekly report. This report provides the total dollar amount for unfunded maintenance for every ship homeported in San Diego. [Telephone Conversation, SWRMC Representative (1999)] Presumably, those work items will be deferred unless they are funded.

K. SUMMARY OF DATA ANALYSIS

The data suggest that SWLIN category 6XXXX has had 31 percent of its required work items deferred from 1993 to 1998. This is the most in any SWLIN category. SWLIN 6XXXX contains all habitability items as well as working spaces, work shops, issue and store rooms. This SWLIN was also the second most deferred category of total number of jobs. This is consistent with the SWRMC unfunded maintenance list which contains jobs for troop spaces and other living spaces. [Unfunded Maintenance List, SWRMC Representative (1999)]

Category 7XXXX, miscellaneous armament and weapons stowage, also had a significant portion of its work deferred. This is not surprising considering that the LPD's weapons consist of two Vulcan Phalanx Close in Weapons Systems (CIWS), various

machine guns and other small arms. Still, of the total 2996 completed jobs that were analyzed, only 20 jobs were from this category. This is also consistent with the SWRMC unfunded maintenance list which contains troop armory and rifle racks work items. [Unfunded Maintenance List, SWRMC Representative (1999)]

The third most deferred SWLIN category was 4XXXX. This category contains all command and surveillance systems including such items as communications equipment, fathometers and tank level indicators (TLI) systems.

SWLIN 5XXXX had 17.9 percent of its jobs deferred, and it ranked the highest among most deferred from the total jobs. But this category also had the most jobs completed with 30.4 percent of total jobs. It also accounted for 29.03 percent of the total cost, the highest among all categories. This is probably due to the fact that SWLIN 5XXXX contains major systems that are found throughout the ship. All damage control items, ballasting systems, deck equipment and numerous ship service systems are listed in this category.

SWLIN categories 1XXXX (Miscellaneous Hull Structure), 8XXXX (Integrated Engineering) and 9XXXX (Ship Assembly/Support Services) had deferred rates between 12.8 and 13.3 percent. SWLIN 8XXXX has items like production scheduling and program management. Temporary utilities/services and crane rigging/services are items found in category 9XXXX. What was interesting here was that category 9XXXX accounted for 15.96 percent of total cost, the third highest for total cost of all jobs completed. Category 1XXXX contains all hull structure items. Watertight doors, decks, the superstructure, voids and fuel/water tanks are listed here.

Category 3XXXX had 13 of 128 jobs deferred. It consistently ranked eighth in the SWLIN jobs analysis and all parts of the total jobs analysis. Category 3XXXX contains all the electric plant items.

Category 2XXXX ranked second in most jobs completed of total jobs and within SWLIN categories. It also accounted for 18.05 percent of total cost, the second highest. This category covers all main propulsion work items.

The category with the least amount of jobs deferred was 0XXXX. This cannot be considered significant since only five jobs of the total 2996 completed were in this category. SWLIN 0XXXX refers to general guidance and administration. The majority of items in this category appear to cover work items dealing mainly with new construction.

Analysis of these data showed that the job accomplishment rate was less than 90 percent for nine of the ten SWLIN categories. The average rate of job completion was 85.57 percent. The reasons for this are beyond the scope of this thesis, but may be related to any combination of insufficient funding, time or material.

V. CONCLUSIONS AND RECOMMENDATIONS

A. SUMMARY

Historically, the maintenance and modernization of surface ships have been crucial to meeting operational requirements and extending the life of these platforms.

This analysis has concluded that data support the idea that trends are evident in the type of work that is not completed during depot-level maintenance availabilities. Specifically, a significant portion of work items pertaining to general categories of habitability, weapons systems and electronics have been deferred for LPD availabilities between 1993 and 1998. Additionally, the smallest percentage of total cost has been expended in the area of weapons systems which includes such "mundane" items as rifle racks.

Work items for main propulsion and the electric plant are the least deferred during availabilities. Main propulsion jobs also comprise 18.05 percent of the total cost. This is a significant portion, second only to the 29.03 percent used for the category of miscellaneous auxiliaries, a general category that includes items like air conditioning and damage control.

The cost of jobs specifically related to the ship's presence in the depot repair facility, like staging, docking/undocking and temporary services, comprised 15.96 percent of the total. This is the third highest, yet less than six percent of total jobs were completed in this area. This category also falls directly behind main propulsion and electric plant items for the jobs least deferred.

The data available to analyze surface ship maintenance are inconsistent and sporadic. The most descriptive data were found in the SARP database, which was discontinued in 1997. Still, authorized and completed SARPs only exist for some amphibious ships. The author was unable to identify any place where historical data for surface ship maintenance availabilities are in place.

The RMAIS should be configured to store historical data. All the maintenance required on surface ships is reviewed by the Port Engineers on the RMAIS. Ship's force, IMA and depot repairs are all tracked with this system, but the information for these jobs is lost when the work item is completed. Maintaining this database would provide a wealth of information for future analysis and planning of all levels of surface ship maintenance.

B. RESEARCH QUESTIONS

1. Is there consistency in the type of work that is not being completed during regularly scheduled surface ship depot-level maintenance availabilities? Research and analysis of the data indicate that jobs under the category of Miscellaneous Outfit/Furnishings are most likely to be deferred. Habitability items comprise a significant portion of this category. A complete list of the items in this category is contained in Appendix D.

2. What is the estimated cost of the required work that is not being completed? The data were insufficient to determine the cost of deferred maintenance analyzed in this study. However, the unfunded maintenance list prepared by SWRMC

suggests that LPDs in San Diego require an additional $8,301,000 to complete all the work currently required for those ships. Of this total, $5,135,000 (61.86 percent) pertains to habitability items.

3. What is the distribution of the type of work completed based on category and cost? Over 50 percent of the total work completed was in main propulsion and miscellaneous auxiliary systems. These categories also comprised 47.08 percent of the total cost. The distribution of total jobs completed and the percent of total cost are shown in Table 5.1. This is graphically displayed in Figure 5.1

SWLIN CATEGORY	% OF TOTAL COMPLETE	% OF TOTAL COST
0XXXX	0.17	0.91
1XXXX	14.45	10.87
2XXXX	21.36	18.05
3XXXX	3.84	1.71
4XXXX	5.74	3.54
5XXXX	30.41	29.03
6XXXX	12.68	13.30
7XXXX	0.67	0.63
8XXXX	5.01	6.00
9XXXX	5.67	15.96
TOTAL	100.0	100.00

Table 5.1 **Percent of Jobs and Cost for all Work Completed**

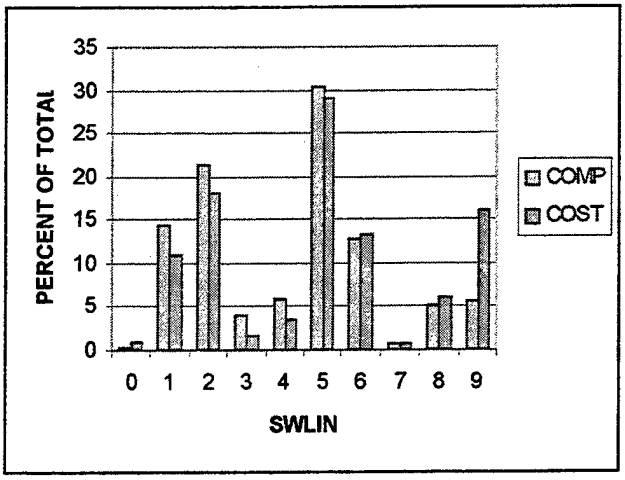

Figure 5.1 **Distribution of Total Jobs Completed and Their Percent of Cost**

4. What data exist for surface ship availabilities? The data that exist varies from ship to ship and year to year. No data exist to document the maintenance life of any single ship. Research found authorized and completed SARP data for some amphibious ships. Limited SARP data also exist for some other surface platforms. Port Engineers have the most current data. These data are locally prepared and the amount and type vary among individuals.

5. Can this analysis be conducted on any ship class in the fleet? This analysis was wholly dependent on the data available. Theoretically, this analysis can be conducted for any ship class using the methodology described.

C. SUGGESTIONS FOR FURTHER RESEARCH

Based on the facts presented in this study, the following recommendations are offered to provide the managers of surface ship maintenance a better method for planning and documenting required work packages.

1. This thesis has shown the limitations of data available for surface ship maintenance. Can the RMAIS be used in conjunction with MST to store and retrieve historical data for all levels of surface ship maintenance?

2. The data suggest a job completion rate of less than 90 percent in nine of the ten categories presented. Is this true for other classes of ships? Can this completion rate be tied to funding levels, time or material?

3. LPDs carry significantly more people than smaller combatants, yet habitability work items were the most deferred. Has habitability work been deferred in other ship classes as well? What impact has this had on quality of life and retention?

4. In the maintenance availabilities studied, a significant percentage of funds were used for shipyard services. Has the move toward Continuous Maintenance reduced this percentage? Are there other ways to reduce the cost of being in a depot-level facility?

APPENDIX A

ACRONYMS AND DEFINITIONS

ALRE	Aircraft Launch and Recovery System.
AMS	American Management Systems, Inc.
AVAIL	Availability. Period assigned a ship for accomplishing work at a repair activity.
CMP	Class Maintenance Plan. A detailed comprehensive document for implementing the maintenance plan for an entire ship class.
CNO	Chief of Naval Operations.
CSMP	Current Ship's Maintenance Project. Primary repository of information concerning the material condition of a ship.
DPMA	Docking Phased Maintenance Availability. A PMA expanded in scope to include maintenance and modernization that require dry docking.
FLTCINCS	Fleet Commanders in Chief.
FMP	Fleet Modernization Program. Component of the ship maintenance program designed to maintain integrity of ship configuration as changes are authorized.
HSC	Hardware Systems Command.
IMA	Intermediate Maintenance Activity. Maintenance facility for work beyond the capability of ship's force. May be a tender, repair ship, aircraft carrier or Shore IMA (SIMA).
LCEM	Life Cycle Engineering Manager.
LPD	Landing Platform, Dock.
MDS	Maintenance Data System
MJC	Master Job Catalog.
MRMS	Maintenance resource management system.

MRS	Maintenance Requirement System.
MST	Maintenance Support Tool.
OPNAV	Office of the Chief of Naval Operations.
OVERHAUL	A major availability, normally exceeding six months duration, for the accomplishment of maintenance and modernization.
PMA	Phased Maintenance Availability. A short, labor intensive availability for ships in a Phased Maintenance Program for the accomplishment of maintenance and modernization. Ships assigned to Phased Maintenance Programs are maintained through PMAs in lieu of overhauls.
PRAV	Phased Restricted Availability. A RAV for ships assigned to the phased maintenance program.
RAV	Restricted Availability. An availability assigned to an industrial activity for the accomplishment of specific items of work while the ship is present and rendered incapable of fully performing her assigned missions and tasks.
RMAIS	Regional Maintenance Automated Industrial System.
SARP	Ship Alteration and Repair Package. Method of recording authorized and completed maintenance on surface ships. Used from 1968 to 1997.
SHIPALT	Ship Alteration. Any change in hull, machinery, equipment or fittings which involves change in design, material, quantity, location, or relationship of the component parts of an assembly
SIMA	Shore Intermediate Maintenance Activity. A shore based maintenance facility for work beyond the capability of ship's force.
SIMA NRMF	Shore Intermediate Maintenance Activity Naval Reserve Maintenance Facility. A shore based naval reserve maintenance facility.
SPALTS	Strategic Systems Program Alterations.

SPM	Ship Program Managers.
SWLIN	System Work List Item Number. A five digit number used to designate the area or equipment affected by a work item.
SWRMC	South West Regional Maintenance center. Regional office for San Diego based Port Engineers.
TYCOM	Type Commander. The flag officer commanding all units of a certain type in the fleet. (e.g., The Commander, Naval Surface Force, Pacific Fleet, or SURFPAC)

APPENDIX B

SARP DATA FIELDS

Field Name	Field Description
ACTION	Action taken from 3M/2K (FINAL ACT. If available or ACT. TKN)
ADDED	Flag indicating that the record was added by the user.
AER	True if Alteration Equivalent to Repair.
ALT_NUM	Alteration number and type.
APL	Allowance Parts List number (1st APL from SARP).
APL_QTY	Quantity of the 1st part in Allowance Parts List (APL) from the SARP.
ARCHIVE	True when this reference number is considered too old for normal use. Filter this record as Archived when true.
AUTOSPEC	AutoSpec Number.
BATTLE_DMG	True if related to Battle Damage.
CAUSE_CD	Cause Code
CERT	A flag indicating the degree of certification (i.e., primary, secondary, or both) required.
CMP_NUM	The number of the class maintenance plan item for the task.
COMP_STAT	True indicates a completed 2k/ false indicated a deferred one.
COND_STMT	Condition Statement (Note: May include Repair Statements on some 2 kilos)
CONTRACTOR	Sub-contractor dollars.

CORR_NOTES	Correlation Notes.
CSMP_SUM	CSMP Summary.
CUST_CODE	SARP Line Item Customer Code (identification of organization funding the repair).
DEF_CODE	Deferral Reason Code.
DEF_STATUS	An entry made in preliminary and/or proposed Line Item Deferral Status or final Status.
DESIGN_SER	A flag indicating if D/S (design services) should be printed on the SARP.
DLOE	A flag indicating if DLOE (diesel light off examination) should be printed on the SARP.
DRY_DOCK	A yes/no field used to indicate whether the task requires dry-docking of the ship.
EMI	A flag indicating if EMI (electromagnetic interference) should be printed on the SARP.
EQUIP_ID	Equipment ID/Serial Number.
EQUIP_LOC	Equipment Location.
EQUIP_NAME	Equipment Name.
FCN	Shipyard Financial Control Number.
GFM	Government Furnished Material Cost.
GROWTH	Records whether this SWLIN Line Item contained any growth.
HAB	True if related to Habitability.
HEAT	True if related to Heat Stress.
HULL_NUM	Ship Hull Number.

JCN	Work Center and Job Sequence Number.
LINE_40	Related information about an item.
LINO_DATE	Date imported data line last modified.
LINO_KEY	Unique identifier of a line item within a SWLIN.
LOE	True if related to Light Off Examination.
MAN_DAYS	Mandays.
MATERIAL	Material and misc. dollar costs.
MD_DOLLARS	Labor Cost (used to calculate Orig_MD when Orig_MD not provided).
MJC_NUM	Master Job Catalogue Number.
MRS_LINO	MRS Line Item Number.
NEW_WORK	Records whether this SWLIN Line Item contains any new work.
NON_RECOV	True if mandays or material expended, but work not completed.
NUM_REP	Number repaired of the 1st part in the Allowance Parts List (APL) from the SARP.
ORIG_MATL	Original Material dollars.
ORIG_MD	Original Mandays as listed in import data source.
ORIG_SWLIN	Original SWLIN.
PEB	True if related to Propulsion Examination Board.
PEID	ID Number of Planner/Estimator.
PERA_SCRN	PERA or IUC Assignment/Screening Code.
POST_WDC	True if a change is made after Work Definition

	Conference.
PRIORITY	Priority of deferred maintenance.
RECORD19	Records whether this SWLIN Line Item includes data from a SARP 19 record.
REC_TYPE	Records the type of SARP record this SWLIN Line Item set was imported from.
REF_NUM	Ref number of availability leading zeros (e.g. 0001).
REPR_STMT	Repair Statement (Note: May include Condition Statement on some SARPs).
REP_ACT	Abbreviated roll-up of the screening code (YFIG).
RFG	Reserve for Growth cost.
RNW	Reserve for New Work cost.
RTN_TOTAL	Total return cost (labor and material).
SAFETY	Safety Code.
SARP_LINO	SARP Line Item Number.
SARP_TYPE	A-Authorized, C-Complete.
SF_MH	Completed Ship Force Manhours.
SHIP_CLASS	Ship Class.
STA	Status.
STD_SWLIN	Standard SWLIN.
SWLIN	System Work List Item Number.
TOT_DOL	Cost source total dollars.
TSTR	True if part of Total Ship Test Requirement.

TYCOM_SCRN	TYCOM Assignment/Screening Code.
UIC	Unit Identification Code.
USER_EDIT	True when the Man_day or material fields have been changed by a user edit (and therefore not replaced by calculated values).
WHEN_DIS	When Discovered Code.

APPENDIX C

COMPLETED SARP RECORD

SARP_TYPE	HULL_NUM	GROWTH	HAB	REP_ACT	SWLIN	TOT_DOL
C	LPD 4	FALSE	FALSE	Y	12314	16261
C	LPD 4	FALSE	FALSE	G	86031	0
C	LPD 4	FALSE	FALSE	Y	85711	12000
C	LPD 4	FALSE	FALSE	Y	99211	285
C	LPD 4	FALSE	FALSE	Y	85341	2852
C	LPD 4	FALSE	FALSE	Y	99411	2852
C	LPD 4	FALSE	FALSE	Y	84431	6204
C	LPD 4	FALSE	FALSE	Y	53511	7631
C	LPD 4	FALSE	FALSE	Y	98221	31522
C	LPD 4	FALSE	FALSE	Y	98241	33522
C	LPD 4	FALSE	FALSE	Y	89711	38522
C	LPD 4	FALSE	FALSE	Y	81311	148773
C	LPD 4	FALSE	FALSE	Y	98631	114088
C	LPD 4	FALSE	FALSE	Y	98061	855660
C	LPD 4	FALSE	FALSE	Y	99231	0
C	LPD 4	FALSE	FALSE	Y	40711	5500
C	LPD 4	FALSE	FALSE	Y	81321	3423
C	LPD 4	FALSE	FALSE	Y	99321	49704
C	LPD 4	FALSE	FALSE	Y	84431	9631
C	LPD 4	FALSE	FALSE	Y	81311	54983
C	LPD 4	FALSE	FALSE	Y	58419	12289
C	LPD 4	FALSE	FALSE	Y	89711	71374
C	LPD 4	FALSE	FALSE	G	85341	0
C	LPD 4	FALSE	FALSE	Y	40711	2200
C	LPD 4	FALSE	FALSE	G	98241	3072
C	LPD 4	FALSE	FALSE	Y	81321	3423
C	LPD 4	FALSE	FALSE	Y	81311	143349
C	LPD 4	FALSE	FALSE	Y	81321	1711
C	LPD 4	FALSE	FALSE	G	85341	4578
C	LPD 4	FALSE	FALSE	Y	40711	7704
C	LPD 4	FALSE	FALSE	Y	81321	570
C	LPD 4	FALSE	FALSE	Y	81321	1426
C	LPD 4	FALSE	FALSE	Y	40711	1911
C	LPD 4	FALSE	FALSE	Y	81321	570
C	LPD 4	FALSE	FALSE	Y	40711	2482
C	LPD 4	FALSE	FALSE	Y	40711	6164
C	LPD 4	FALSE	FALSE	Y	58421	6204
C	LPD 4	FALSE	FALSE	Y	57361	956
C	LPD 4	FALSE	FALSE	Y	57361	956
C	LPD 4	FALSE	FALSE	Y	61111	3602
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APPENDIX D

LIST OF ITEMS IN SWLIN CATEGORY 6XXXX

SWLIN	DESCRIPTION
6XXXX	Miscellaneous Outfit/Furnishings
60010	General Outfit Specs
60011	General Outfit Specs
60211	Label Plates (Manufacture)
603XX	Draft Marks
61111	Hull Fittings
61211	Rails/Stanchions/Lifelines
61221	Safety Nets
61311	Rigging and Canvas (Standing)
62111	Non-Structural Bulkheads
62210	Floor Plates and Gratings
62211	Floor Plates and Gratings (in Machinery Spaces)
62212	Floor Plates and Gratings (outside Machinery Spaces)
6221X	Floor Plates and Gratings
62310	Ladders, other than Accom
62311	Ladders, other than Accom (in Machinery Spaces)
62312	Ladders, other than Accom (outside Mach Spaces)
6231X	Ladders, other than Accom

62321	Accommodation Ladders
62322	Accommodation Ladders
6232X	Accommodation Ladders
62411	Non-Struc Closures (Machinery Spaces)
62412	Non-Struc Closures (Non-Machinery Spaces)
6241X	Non-Struc Closures
62511	Fixed portlights, windows
630XX	Preservatives and Coverings
63110	Bilge Painting
63111	Bilge Painting
63112	Interior Painting, Machinery Spaces
63113	Interior Painting, Non-Machinery Spaces
6311X	Interior Painting
63121	Exterior Painting
63131	Painting/Blasting U/W Hull
63141	Painting/Blasting Freeboard
632XX	Zinc and Metallic Coatings
63222	Flame Spray Aluminum
63211	Zinc Coatings
63212	Galvanizing
63221	Flame Spray Aluminum

63231	Metallic Claddings
63232	Metallic Special Purpose Coatings
63311	Cathodic Protection, Sacrificial Anode
63321	Cathodic Protection, Impressed Current
63411	Deck Covering
63421	Flight/Hanger Deck Non-Skid
63511	Hull Insulation
63611	Hull Damping
63711	Sheathing/Covering
63811	Reefer Ship's Provision Spaces
63821	Cargo Refrigerated Spaces
63911	Radiation Shielding/Canning
64000	Living Spaces
64011	Living Spaces
64021	Living Spaces
640XX	Living Spaces
64111	Officer Berthing Spaces
64121	Officer Berthing Spaces
641XX	Officer Berth/Mess Spaces
64211	NCO Berthing Spaces
64221	NCO Messing Spaces

642XX	NCO Berth/Mess Spaces
64311	Enlisted Berth Spaces
64321	Enlisted Mess Spaces
643XX	Enlisted Berth/Mess Spaces
64411	Sanitary Spaces
644XX	Sanitary Spaces
64511	Leisure and Community Spaces
645XX	Leisure and Community Spaces
65111	Commissary Spaces
651XX	Commissary Spaces
65200	Medical Spaces
65211	Medical/Dental Spaces Equipment
652XX	Medical Spaces
65300	Dental Spaces
65311	Dental Spaces
653XX	Dental spaces
65400	Utility Spaces
65411	Utility Spaces
654XX	Utility Spaces
65511	Laundry/Dry Clean Spaces
655XX	Laundry/Dry Clean Spaces

65611	Trash/Paper Disposal Spaces
656XX	Trash/Paper Disposal Spaces
66000	Working Spaces
66011	Working Spaces
660XX	Working Spaces
66111	Offices
661XX	Offices
66211	Machinery Control Center Furnishings
662XX	Machinery Control Center Furnishings
66311	Elex Control Center Furnishings
663XX	Elex Control Center Furnishings
66411	DC Station Furnishings
664XX	DC Station Furnishings
66500	Workshops/Labs/Test Areas
66511	HM&E Workshops/Labs/Test Areas
66521	Elex Workshops/Labs/Test Areas
66531	Aviation Workshops/Labs/Test Areas
66541	Weapons Workshops/Labs/Test Areas
665XX	Workshops/Labs/Test Areas
66611	Working Spaces
666XX	Working Spaces

67011	Lockers and Special Stowage
670XX	Lockers and Special Stowage
67111	Lockers and Special stowage
671XX	Lockers and Special stowage
67211	Storerooms
67212	Issue Rooms
6721X	Store and Issue Rooms
672XX	Storerooms
67311	Cargo Stowage Furnishings
673XX	Cargo Stowage Furnishings

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5. Office of Budget.....1
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   1000 Navy Pentagon
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6. Mr. George LeBaron.....1
   FFG Port Engineer (Code N431E17)
   U. S. Naval Station 32nd Street
   3755 Brinser Street
   Bldg 3116
   San Diego, CA 92136-5205

7. Mr. Kim Sage.....1
   LPD Port Engineer (Code N431E)
   U. S. Naval Station 32nd Street
   3755 Brinser Street
   Bldg 3116
   San Diego, CA 92136-5205

8. Mr. Ken Jacobs.....1
Naval Sea Systems Command
2531 Jefferson Davis Highway
Bldg. NC3
Arlington, VA 22242-5160

9. Mr.. Robert Ceres.....1
AMS, 11th Floor
4114 Legato Rd.
Fairfax, VA 22033

10. LCDR Clifford A. Pish.....1
18714 Walden Forest Dr.
Humble, TX 77346