2002-06

Cost analysis of maintenance programs for pre-positioned war reserve material stock (PWRMS)

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THESIS

COST ANALYSIS OF MAINTENANCE PROGRAMS FOR PRE-POSITIONED WAR RESERVE MATERIAL STOCK (PWRMS)

by

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June 2002

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REPORT DOCUMENTATION PAGE | *Form Approved OMB No. 0704-0188*

1. AGENCY USE ONLY *(Leave blank)*	**2. REPORT DATE** June 2002	**3. REPORT TYPE AND DATES COVERED** Master's Thesis

4. TITLE AND SUBTITLE: Cost Analysis of Maintenance Programs for Pre-Positioned War Reserve Material Stock (PWRMS)

5. FUNDING NUMBERS

6. AUTHOR Phillip G. Cyr

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Naval Postgraduate School
Monterey, CA 93943-5000

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING /MONITORING AGENCY NAME(S) AND ADDRESS(ES)
N/A

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for Public Release; Distribution is Unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT *(maximum 200 words)*

This study analyzes the existing program for the maintenance of CESE (Civil Engineer Support Equipment) and CEEI (Civil Engineer End Items) that are stored as part of the Pre-positioned War Reserve Material Stock (PWRMS) and attempts to predict the required funding levels of Operations and Maintenance, Navy funding (OMN) for that maintenance.

The objective is to provide DOD, the Navy, and the Civil Engineer Corps a guideline and possible benchmark for maintenance costs required to maintain the CESE War Reserves in a C1 condition of readiness.

This research is important since the Naval Facilities Engineering Command (Seabee Readiness and Logistics, SRL) and Code N44, CBC Port Hueneme CESE Management Branch, need to determine the amount of funding required in order to adequately maintain CESE PWRMS in a Ready-For-Issue (RFI) condition. PWRMS is considered mission essential, but the Project Managers' ability to rapidly respond to a contingency and meet the scheduled mobilization dates are predicated on the ability to get the PWRMS out of storage, mobilized, and transported to the contingency. Therefore, this thesis has direct operational readiness implications.

The OMN funding required to maintain CESE PWRMS in a RFI condition was estimated using assumptions for cost of materials, estimates for labor expenditures, and frequency of use of equipment. Recommendations include modifications to the current program's objectives and improvements to issues noted in this study. Areas of further study are provided for improved budgetary decisions.

14. SUBJECT TERMS Cost Analysis, CESE, Civil Engineer Support Equipment, PWRMS, Pre-positioned War Reserve Material Stock, War Reserves, NCF, Naval Construction Force, CEEI, Civil Engineer End Items, Naval Facilities Engineering Command, NAVFAC, Civil Engineer Corps, CEC, Naval Mobil Construction Battalion, NMCB

15. NUMBER OF PAGES 59

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	**18. SECURITY CLASSIFICATION OF THIS PAGE**	**19. SECURITY CLASSIFICATION OF ABSTRACT**	**20. LIMITATION OF ABSTRACT**
Unclassified	Unclassified	Unclassified	UL

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18

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COST ANALYSIS OF MAINTENANCE PROGRAMS FOR PRE-POSITIONED WAR RESERVE MATERIAL STOCK (PWRMS)

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MASTER OF SCIENCE IN MANAGEMENT

from the

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ACKNOWLEDGMENTS

I would like to acknowledge all the fantastic people within the Naval Construction Force, Construction Equipment Divisions, and the CESE Management Branch for their patience, vast knowledge, and willingness to assist me in my endeavors. Without their experience and corporate knowledge, none of this research would have been possible.

I am particularly grateful to my thesis advisors, John Mutty, Captain, USN (Ret), and Professor Shu Liao. Their hours of counsel, encouragement, and editorial assistance enabled me to form and express concepts herein.

To my wife, Debbie for all of her love, patience and understanding while I locked myself away for countless hours in the search for knowledge.

Finally, a special acknowledgement of two late Presidents, who have the similar views as my own regarding war.

“It is an unfortunate fact that we can secure peace only by preparing for war.”
John F. Kennedy
Speech delivered while campaigning for the presidency in Seattle, Washington
September 6, 1960

“I have said not once but many times that I have seen war and that I hate war…”
Franklin D. Roosevelt
Public Address of Fireside Chat on War in Europe
September 3, 1939

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I. INTRODUCTION

A. PURPOSE OF THIS STUDY

This study analyzes the existing maintenance programs for Pre-positioned War Reserve Material Stock (PWRMS). The objective is to provide DOD, the Navy, and the Civil Engineer Corps a guideline and possible benchmark for maintenance costs required to maintain the CESE War Reserves in a C1 condition of readiness. This research is important since Naval Facilities Engineering Command (Seabee Readiness and Logistics Division, SRL) and Code N44, CBC Port Hueneme CESE Management Branch, need to determine the amount of funding required in order to adequately maintain CESE PWRMS in a Ready-For-Issue (RFI) condition. PWRMS is considered mission essential, but the Project Managers' ability to rapidly respond to a contingency and meet the scheduled mobilization dates are predicated on the ability to get the PWRMS out of storage, mobilized and transported to the contingency. In a recent mobilization exercise, the dates for mobilization could not be met in accordance with the Timed Phased Force Deployment Schedule (TPFDS), a shortcoming partially attributed to the poor material condition of the PWRMS. Therefore, this thesis has direct operational readiness implications.

The US Marine Corps is the nation's rapid response team in most contingencies and it is the primary mission of the Seabees to support the Marines. In order to complete their mission, it is essential that the CESE PWRMS is operational. It is Naval Facilities Engineering Command's (NAVFAC) responsibility to provide the proper funding requirements to the N80 Planning Office for the annual defense budget and the Program Objective Memorandum (POM).

B. MISSION REQUIREMENT

The War Reserve Material Policy, DOD Directive 3110.6, defines the Department of Defense (DOD) War Reserve Material (WRM) policy. It states that "War Reserve

Material Requirements shall be computed and war reserve materials shall be acquired in peacetime sufficient to attain operational objectives for scenarios and other stockage objectives approved for programming in the Secretary of Defense (SECDEF) planning guidance." SECDEF planning guidance prescribes requirements for the size of naval forces and for the capabilities of those forces.

OPNAV Instruction 3501.115C, "Projected Operational Environment (POE) and Required Operational Capabilities (ROC) for the Naval Construction Force (NCF)," further establishes the NCF mission, requirements, capabilities, as well as the types and locations of expected operations. These requirements and capabilities form the planning basis for the Navy WRM program. The NAVFAC Commander is identified in DOD Directive 3110.6 as being responsible for the management of the inventory and the maintenance programs for the CESE War Reserves. Civil Engineer End Items (CEEI) are also war reserve materials within the responsibility of NAVFAC. NAVFAC must ensure that CESE and CEEI war reserve material is in ready-for-issue condition and available for rapid deployment.

The NCF has a total of 32 required Table of Allowances (TOA), Figure 1, under Chief of Naval Operations resource sponsor N44. The Table of Allowance (TOA) is all the items that are allowed and authorized to be supported by a military unit. The 32 TOAs include the requirements for enough war reserves to outfit eight active Naval Mobile Construction Battalions (NMCB), twelve reserve Naval Mobile Construction Battalions, two active Underwater Construction Teams (UCT), two active and four reserve Naval Construction Regiments (NCR), two reserve Naval Construction Force Support Units (NCFSU), and two Construction Battalion Maintenance Units (CBMU).[1] There are 6462 pieces of CESE necessary to meet the requirements for the 32 TOA.[2] Examples of CESE are trucks, cranes, tractors, dozers and any other engine driven equipment. The quantity of CEEI is 1966 pieces, which include pumps, storage containers, tanks, refrigeration units, panel boards and other non-engine driven equipment.[3]

Naval Construction Force Table Of Allowance

Forward Deployed				Early Deployers				MPF Prepo			Logistics Overhaul			Trng		Late Deployers				Early Deployers				MPF Prepo			ILO	Special Mission			
NMCB	NMCB	NMCB	NMCB	NMCB	NMCB	NMCB	NMCB	NMCB	NMCB	NMCB	NMCB	NMCB	NMCB	NMCB	NMCB	NMCB	NMCB	NMCB	NMCB	UCT	UCT	22NCR	30NCR	NCR	NCR	NCR	NCR	NCFSU	NCFSU	CBMU	CBMU
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	1	2	1	2	3	4	5	6	1	2	1	2

Figure 1. NCF TOA[4]

All CESE and CEEI items are controlled through the CESE Management Branch of N-44 located at Construction Battalion Center (CBC), Port Hueneme, California. The primary CESE storage locations are on nine Maritime Prepositioning Force (MPF) ships and at CBC Port Hueneme and CBC Gulfport, Mississippi. However, since there is much CESE in use, it is located all around the world at forward deployment sites and training locations.

CESE inventory and registration is managed with the Construction, Automotive, and Specialized Equipment Management Information System (CASEMIS). The CASEMIS is a comprehensive equipment management information system developed by NAVFAC to assist in the management of the U.S. Navy's total inventory of construction, automotive, and special equipment. The CASEMIS is part of the Naval Facilities System (NFS) Automated Data Processing Systems (ADPS). It is jointly sponsored by the Deputy Commander for Military Readiness (Code 06) and the Assistant Commander for Public Works Centers and Departments (Code 16). The Inventory and Registration (I&R) User Manual provides the information required to exercise control of equipment through its entire life cycle, from the compilation of Navy equipment and budget requirements through acquisition, utilization, maintenance, and disposal. The I&R subsystem of CASEMIS is a Navy-wide system maintained in one master file containing information that includes identification, description and status, as well as location of each piece or USN numbered CESE, General Services Administrative (GSA) rental equipment, identification numbered CESE attachments, and various CEEI that require inventory by the Naval Construction Force.[5]

CESE is also maintained, managed, and operated at the user level in accordance with the Construction Equipment Department Management and Operations Manual, NAVFAC P-434. The P-434 includes the quality assurance inspection and surveillance procedures, labor classifications, operational test procedures, and equipment labor standards for the preservation actions required for CESE and CEEI equipment. Preservation is considered the application or use of adequate protective measures to prevent deterioration including, as applicable, the use of appropriate cleaning procedures, preservatives, protective wrappings, cushioning, interior containers, and complete identification marking, up to, but not including the exterior shipping container.

C. SCOPE AND METHODOLOGY

This research analyzes the PWRMS program from a financial standpoint, to evaluate the different methods for maintenance and inventory of Civil Engineering Support Equipment (CESE) War Reserve Material Stock. The cost of maintenance is not an exact determination as equipment breakdowns and overhauls cannot be predicted with 100% surety. Therefore, the maintenance costs must be predicted based on the historical data and assumed probabilities of maintenance actions.

The maintenance costs will be predicted for the CESE unit set portion of the reserve NMCB P25 TOA. The NMCB CESE TOA is identified by the code designation P25. Other Naval Construction Force TOA designations are identified in Table 1.[6] The reserve NMCB TOA will be analyzed since those pieces of equipment are primarily stored in warehouses and remain there unless reissued or there is a need to mobilize due to military conflict. This warehoused CESE requires a predictable, yet undetermined amount of maintenance in order to be considered ready to deploy. The active NMCB TOAs are in use with a constantly changing military mission. This causes the amount of material cost to fluctuate drastically from year to year.

Unit Type	**Unit Acronym**	**TOA Designator**
Naval Mobile Construction Battalion	NMCB	P25
Underwater Construction Team	UCT	P35
Naval Construction Regiment	NCR	P29
NCF Training Regiment, Gulfport	20th NCR	TA47
NCF Training Regiment, Port Hueneme	31st NCR	TA48
Construction Battalion Unit	CBU	TA10
Naval Construction Force Support Unit	NCFSU	P31
Construction Battalion Maintenance Unit	CBMU	P05
Naval Construction Training Center	NCTC	
NCTC Port Hueneme		TA14
NCTC Gulfport		TA16
Readiness Support Site	RSS	TA29

Table 1. Naval Construction Force Unit Designators

The total for one P25 TOA is valued at $39.6 Million and consists of 10,802 line items which include CESE and CEEI, as well as repair parts, computers, weapons, medical supplies, and other commodities etc. (beans, bullets and band aids). The CESE portion of the P25 TOA is 277 pieces valued at $24.5 Million.[7] The CESE accounts for only 2.6% of the total makeup of the P25 TOA, yet 61.9% of the procurement cost. The CEEI with Equipment Codes and USN stock numbers accounts for 55 pieces bringing the total required P25 unit set to 322 pieces.

A mathematical formula of the costs using historical values for manpower rates and parts costs was developed using statistical methods in order to estimate the annual total costs of maintenance per P25 CESE TOA. While the model developed is specific to

CESE, the methodology is applicable to other Advanced Based Functional Components (ABFC) War Reserve Materials such as the Fleet Hospital Programs.

The accuracy of the model developed hinges on the assumptions utilized in this study. The assumptions are based on known facts and evaluations of CESE maintenance records. The records for vehicle maintenance are maintained in the vehicle's history jacket, which remain with the vehicle. A central database of maintenance history records is not available. The collection of maintenance history information for a central database was cancelled in 1995 due to budget cutbacks and force reductions.

D. ORGANIZATION OF THIS THESIS

This thesis includes five chapters. Chapter I provides background information and defines the scope of study.

Chapter II includes in-depth background and defines the problem of study. Other information in this chapter will make the reader aware of goals and objectives for CESE management.

Chapter III defines the factors affecting the cost of maintenance and includes data used to establish projected maintenance costs.

Chapter IV presents the analysis of the data and as well as the assumptions made in generating the prediction formula for maintenance costs.

Chapter V contains conclusions on the cost of maintenance, which can be used to develop a budget for the Future Years Defense Plan. Recommendations include modifications to the current program's objectives. Some precautions for using the data are identified. Areas of further study are provided, and how documentation of expenditures might play a part in budgeting for the Navy in the 21st century.

II. OVERVIEW OF PRE-POSITIONED WAR RESERVE MATERIAL STOCK PROGRAM (PWRMS)

A. NCF TABLE OF ALLOWANCE UTILIZATION

This research analyzes the PWRMS program from a financial standpoint in order to evaluate Total Ownership Costs for maintenance and inventory of Civil Engineer Support Equipment. Analysis will be restricted to the Table of Allowances for the twenty Naval Mobile Construction Battalions. The NMCB TOAs numbered from 1 to 20, as shown in Figure 2, identify the TOA priorities for a Major Theater of War.

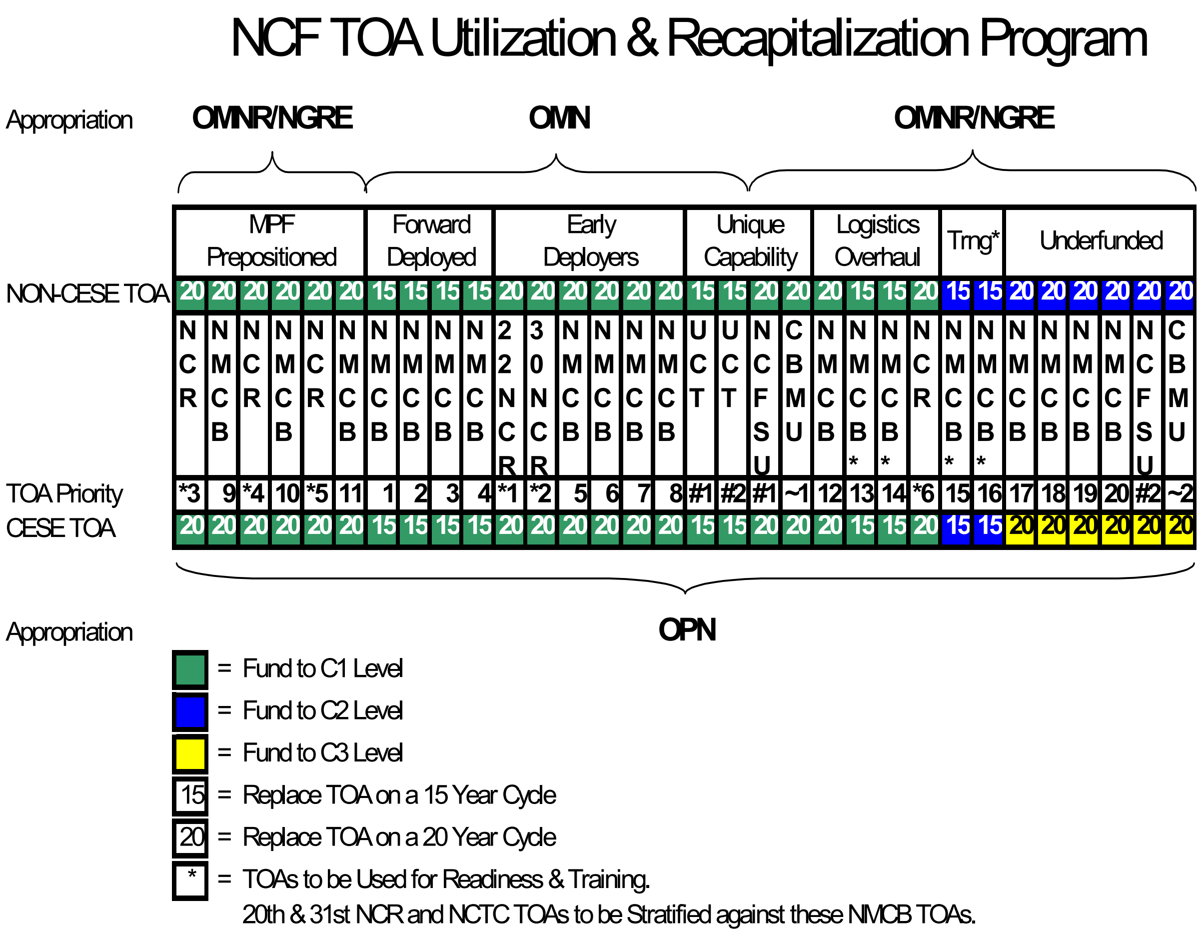

Figure 2. NCF Table of Allowance Utilization and Recapitalization Program[8]

The highest priority active P25 TOAs are located at the four NMCB forward deployment sites in Rota Spain, Puerto Rico, Guam, and Okinawa to allow for their rapid deployment in support of War Plans or OPLAN requirements. The CESE unit set for these active NMCB TOAs is used for construction and training at the main forward deployment sites and at the detail deployment sites. Maintenance efforts are conducted by the enlisted Construction Mechanics attached to the battalions. In case of mobilization to a conflict, the NMCB will take its TOA to the conflict.

The next priority active P25 TOAs are the four identified in Figure 2 as “Early Deployers”. These homeport unit sets are in most cases warehoused in a ready-for-issue condition at the Construction Battalion Centers in Gulfport and Port Hueneme. All equipment is preserved while in storage to include the loosening of engine belts, removing batteries, dunnage and blocking as necessary, and removing all fuel. The equipment is organized into core modules for ease of configuring to match mission requirements and mobilization plans.

There are three complete reserve P25 TOAs on board the Maritime Prepositioning Force with each TOA segregated on the ships of each MPF squadron. These TOAs are also modular and segregated the same as the early deployers above. There are three MPF Squadrons with five ships per squadron. The TOA unit sets for the NMCB are stored on three ships per squadron to allow for their rapid deployment in support of OPLAN requirements.

Three reserve P25 TOAs are undergoing Integrated Logistics Overhaul (ILO) at any one time and are rotated between the prepositioned MPF ships as directed by the CESE Management Division. This process is performed to maintain the equipment in a usable condition at the Depot maintenance level and to replace aging equipment in the system.

The active Naval Construction Regiments (NCR) at each CBC, 22nd and 30th, each maintain a reserve P25 TOA used for readiness and training. Not all NCF units are deployable units with a distinct Operations Planning Mission (OPLAN). Due to resource constraints, the policy of the NCF is to only procure TOA equipment that is required by OPLANs. The NCR TOA equipment and material requirements for training or daily operations will be met by rotating assets and utilizing the TOA assets of one of the later deploying NMCB TOAs.

The final four reserve P25 TOAs are only partially complete with two in Gulfport and two in Port Hueneme. The CESE for these TOAs has the lowest priority and is utilized to support and backfill the other TOAs with usable equipment. These TOAs have been short funded in the OPN and OMN appropriations in order to meet other budget shortfalls. Without additional OPN funding the TOAs will remain incomplete. Without OMN funding, the equipment that is in the stockpile will continue to rust, have flat tires, and remain predominately in an inoperable condition. Funding is currently insufficient for even the surveillance necessary in order to identify maintenance requirements.[9]

B. TRADITIONAL FUNDING SOURCES

The NMCB P25 Table of Allowance is comprised of 322 pieces of CESE and CEEI, which account for $24.5 Million of the total $39.6 Million P25 initial procurement cost. The initial procurement and the recapitalization of equipment are funded from OPN appropriations. The maintenance and upkeep of the non-operational equipment stored in reserve P25 unit sets is funded from OMN from one resource sponsor, Naval Facilities Engineering Command. The unified commanders fund the operational battalions that utilize the TOA equipment. Accordingly, maintenance costs for the four forward deployed NMCBs are funded by the Atlantic Fleet and the Pacific Fleet commanders. Currently, any maintenance costs for any equipment deployed to Afghanistan are funded from Special Operations Command, SOCOM, which is the supported operational commander.

N-44 and NAVFAC's primary maintenance budget for CESE is used to fund the Construction Equipment Divisions (CED) in Gulfport and Port Hueneme which perform the majority of the depot level and major maintenance.

Historical data have shown that OPN and OMN funding shortfalls in the past ten years have severely impacted maintenance of CESE. Due to resource constraints, the policy of the NCF is to only procure equipment for TOAs that are required by OPLANs.

The two CEDs operate independently in order to maintain their work force and to repair the equipment on their respective coasts. The major difference between the two CEDs is that Gulfport has supplemented their maintenance and repair work with other reimbursable work such as boats from the Beach Group.

The NCF TOA Recapitalization Plan, shown in figure 3 below, indicates the 15 and 20 year replacement schedule for both CESE and Non-CESE equipment. All recapitalization is funded from OPN appropriations. Due to funding shortfalls, the NCF has adopted the plan to procure CESE for the last four TOAs by contract and only when a major war would dictate the need for twenty NMCB TOAs. This Plan differs for the current program shown in Figure 2 in that it includes a maintenance contract for the last four TOAs. The Recapitalization Plan has not been finalized.

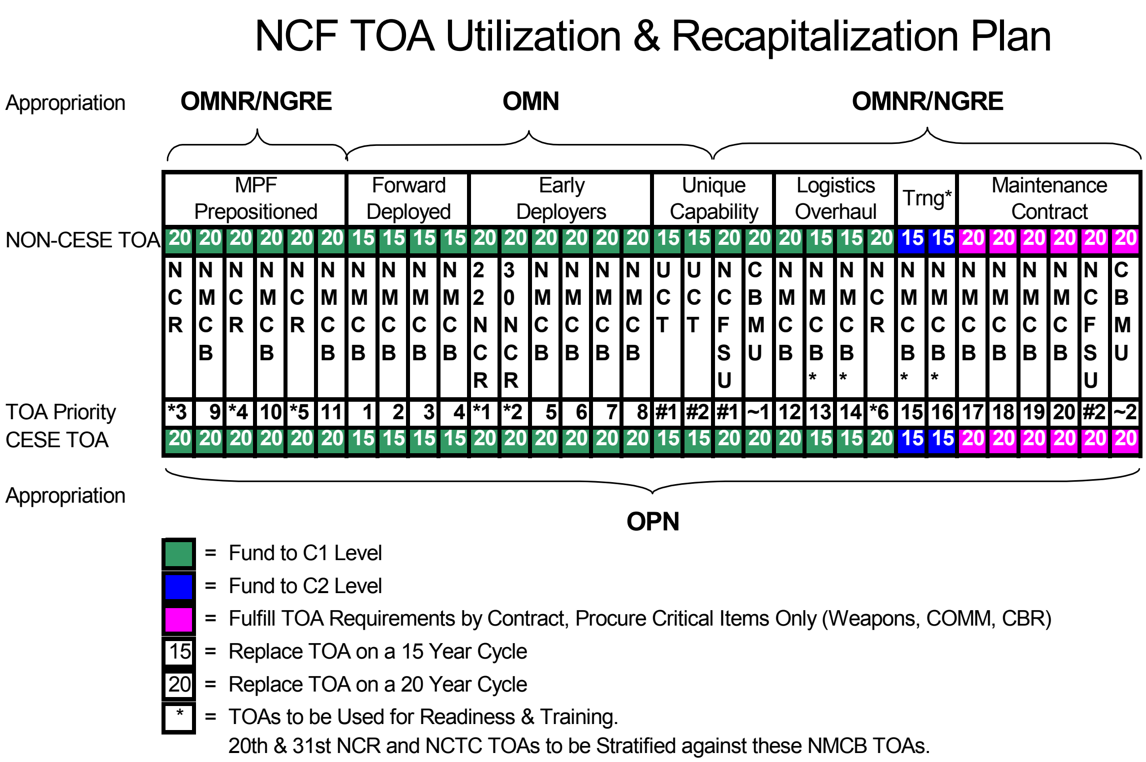

Figure 3. NCF TOA Utilization and Recapitalization Plan

The policy of the NCF is to resource its units in accordance with figure 4.[10] The intent of the NCF TOA Resourcing Plan is to ensure that the NCF has sufficient TOAs in a “C1” readiness condition, to respond to a single Major Theater of War while engaged in a simultaneous small-scale conflict. The readiness condition codes are described in the Problem section below. Maintenance costs are funded from Operations and Maintenance Navy, Operations and Maintenance Navy Reserve, and National Guard and Reserve Equipment appropriations as indicated in Figure 3. Resourcing allows the NCF to take equipment from lower priority TOAs to fill the need for equipment in Forward or Early Deployed units. As indicated by the Recapitalization Plan, any equipment that doesn't get repaired by OMN funding would be procured by contract.

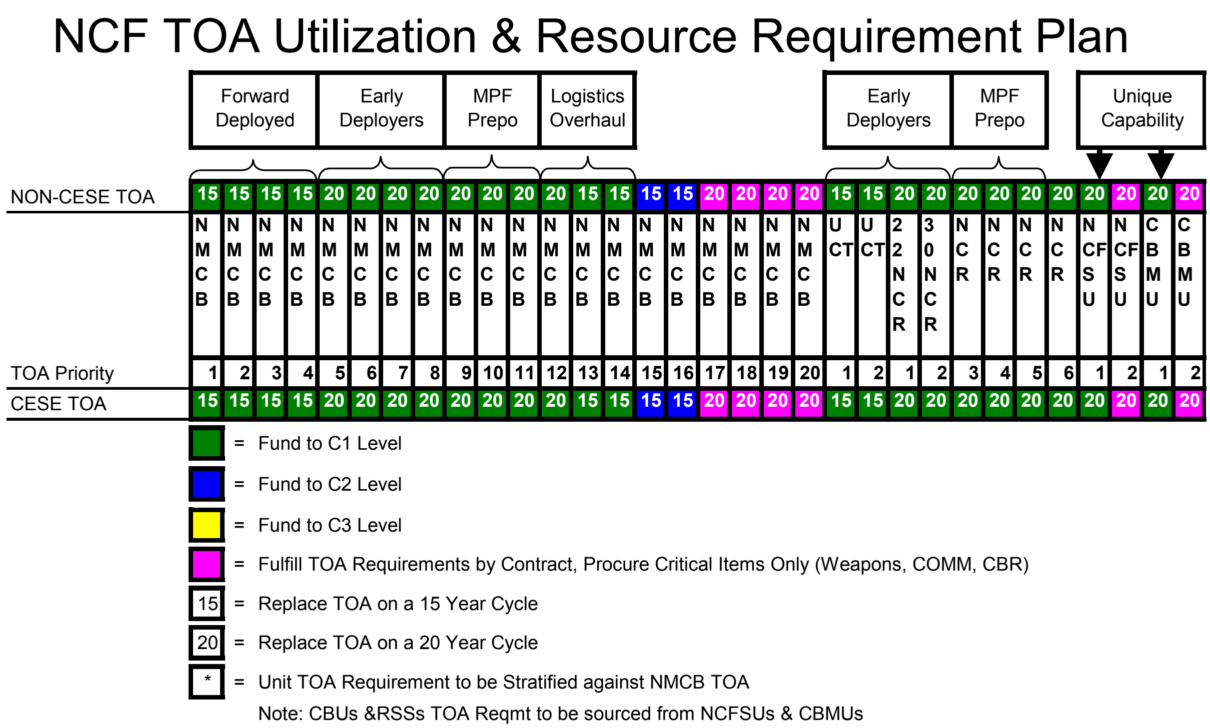

Figure 4. NCF TOA Utilization and Resource Requirements Plan

C. PROBLEM DEFINITION

The CESE War Reserves are in a mixed state of readiness. The current status of equipment is documented for Equipment Assigned, Combat Readiness, Recapitalization, and Modernization as shown in figures 5, 6, and 7. The major concern for NAVFAC is that the last four NMCB TOAs have an estimated readiness for the equipment assigned ranging from 64% to 81%, but their true condition is unknown since funding restrictions have only allowed minimal surveillance and maintenance for the last ten years.[11]

Accuracy of CASEMIS database is estimated at 60% correct.[12] Figures 5, 6, and 7 indicate the number of assets that are in condition "A5 or Better". These assets are all serviceable meaning that they are new, used, repaired, or reconditioned material that can be issued to all customers without limitation or restriction. The condition codes range from A1 – A3, which is unused and considered good, fair, and poor, to A4 – A6, which is used and considered good, fair, and poor. Code A5 is considered used property that is usable without repairs but is somewhat worn or deteriorated and may soon require repairs.

The equipment's condition of readiness is relative to its status and location. Readiness for equipment that is part of a deployed NMCB or active TOA is determined by comparing CESE allowance with equipment on hand and available for use. The rating is determined in terms of CESE that is on hand and combat ready. CESE will be counted as combat ready if it is on hand under main body operational control and can be returned within 48 hours, in condition A5 or better.

The Status of Resources and Training System (SORTS) uses a different code for the condition of readiness. The ratings are listed below and are the color code used in Figures 5, 6 and 7: Rating percent is calculated as the number of units on hand that are combat ready divided by the total number of units on hand.

C1 is considered 90% or better and is represented by the green,

C2 is considered 70% to 90% and is represented by the blue,

C3 is considered 60% to 70% and is represented by the yellow,

Less than 60% is considered C4 and is represented by the red.[13]

The lack of funding has meant that CESE PWRMS has not been maintained in a Ready-for-Issue (RFI) condition as dictated in the instructions for the Navy War Reserve Material Program. Therefore, NAVFAC has been searching for alternative solutions to solve the problem of funding shortages.

One possible method to maintain PWRMS in a RFI condition is indicated in Figure 3 with an improved Recapitalization Plan.[14] The current Utilization and Recapitalization Plan for the last four NMCB TOAs is to "do nothing" to improve the current inventory and to outsource to a private contractor to provide the equipment as necessary in time of conflict. The C1 equipment in the warehouses and yards for these TOAs will continue to be utilized as replacements for the other sixteen P25 TOAs and rotated in as warranted by the condition of the equipment into the operational TOAs. Any equipment that is rotated out of the operational commands will not be repaired or renovated which will save available OMN funds. This equipment will reduce the overall readiness of the lower priority TOAs. The equipment will eventually have to be maintained or replaced by the Recapitalization Plan.

	SECOND Naval Construction Brigade													
	P25 ROTA, NX6074	P25 PUERTO RICO, NX6073	P25 GP HP1, NX6070	P25 GP HP2, NX6071	P25 GP1 PWRMS, NX8140	P25 GP2 PWRMS, NX6162	P25 GP3 PWRMS, NX6157	P25 GP4 PRWMS, NX6158	NCR GP1, NX6181	CBMU 202, NX8147	NCFSU (TRUCKS) GP, NX8146	NCFSU (LESS TRUCKS) GP, NX8146	UCT 1 GP, NX6129	2ND NCB TOTALS
Allowance Requirements	274	274	274	274	274	274	274	274	16	90	45	282	26	2651
Assets on Hand	276	268	253	278	255	234	219	174	11	79	46	141	22	2256
Equipment Assigned	**101%**	**98%**	**92%**	**101%**	**93%**	**85%**	**80%**	**64%**	**69%**	**88%**	**102%**	**50%**	**85%**	**85%**
Assets A5 or Better	276	267	248	277	245	232	203	173	11	77	38	136	22	2205
Combat Readiness	**100%**	**100%**	**98%**	**100%**	**96%**	**99%**	**93%**	**99%**	**100%**	**97%**	**83%**	**96%**	**100%**	**98%**
Underage Assets	120	118	121	138	171	98	111	58	3	46	41	57	13	1095
Recapitalization	**43%**	**44%**	**48%**	**50%**	**67%**	**42%**	**51%**	**33%**	**27%**	**58%**	**89%**	**40%**	**59%**	**49%**
Assets Matching Current Allowance	121	120	126	130	134	72	100	75	2	44	17	88	10	1039
Modernization	**44%**	**45%**	**50%**	**47%**	**53%**	**31%**	**46%**	**43%**	**18%**	**56%**	**37%**	**62%**	**45%**	**46%**

Legend				
	C1	>90%	C3	69-60%
	C2	89-70%	C4	<60%

Figure 5. Second Naval Construction Brigade Readiness

	THIRD Naval Construction Brigade													
	P25 OKINAWA, NX6069	P25 GUAM, NX6068	P25 PH HP1, NX6057	P25 PH HP2, NX6058	P25 PH1 PWRMS, NX8141	P25 PH2 PWRMS, NX8142	P25 PH3 PWRMS, NX 8143	P25 PH4 PWRMS, NX6094	NCR PH1, NX8144	CBMU 303, NX8145	NCFSU (TRUCKS) PH, NX8145	NCFSU (LESS TRUCKS) PH, NX8145	UCT 2 PH, NX6130	3RD NCB TOTALS
Allowance Requirements	274	274	274	274	274	274	274	274	16	90	45	282	26	2651
Assets on Hand	266	273	262	249	249	229	221	178	15	68	42	230	28	2310
Equipment Assigned	97%	100%	96%	91%	91%	84%	81%	65%	94%	76%	93%	82%	108%	87%
Assets A5 or Better	250	255	259	237	232	224	207	158	12	65	41	221	27	2188
Combat Readiness	94%	93%	99%	95%	93%	98%	94%	89%	80%	96%	98%	96%	96%	95%
Underage Assets	141	147	170	132	183	99	121	86	4	31	38	130	10	1292
Recapitalization	53%	54%	65%	53%	73%	43%	55%	48%	27%	46%	90%	57%	36%	56%
Assets Matching Current Allowance	115	113	130	103	138	85	98	69	2	40	14	123	16	1046
Modernization	43%	41%	50%	41%	55%	37%	44%	39%	13%	59%	33%	53%	57%	45%

Legend				
	C1	>90%	C3	69-60%
	C2	89-70%	C4	<60%

Figure 6. Third Naval Construction Brigade Readiness

	MPF (E)										
	MPS1, P25, NX8131	MPS 1 P29, NX8131	MPS 2, P25, NX8132	MPS 2, P29, NX8132	MPS 3, P25, NX8133	MPS 3, P29, NX8133	MPS ILO, P25, NX8149	MPS ILO, P29, NX8149	MPS TOTALS		NCF TOTAL
Allowance Requirements	274	16	274	16	274	16	274	16	1160		6462
Assets on Hand	176	16	276	16	276	16	271	16	1163		5729
Equipment Assigned	101%	100%	101%	100%	101%	100%	99%	100%	100%		89%
Assets A5 or Better	276	16	275	16	274	16	264	16	1153		5546
Combat Readiness	100%	100%	100%	100%	99%	100%	97%	100%	99%		97%
Underage Assets	246	16	219	16	202	16	184	16	915		3302
Recapitalization	89%	100%	79%	100%	73%	100%	68%	100%	79%		58%
Assets Matching Current Allowance	172	5	173	12	175	9	166	8	720		2805
Modernization	62%	31%	63%	75%	63%	56%	61%	50%	62%		49%

Legend				
	C1	>90%	C3	69-60%
	C2	89-70%	C4	<60%

Figure 7. Enhanced Maritime Prepositioning Force Readiness

The NCF will stratify against mission requirements, or reassign, from the last four TOAs by allocating the existing assets against valid TOA requirements to determine the readiness posture of each TOA. The NCF, OPNAV N44 program policy will be to stratify CESE and CEEI TOA assets in the following Manner:

a. All existing NCF assets will be stratified against the TOA requirements of warfighting units with an OPLAN mission.

b. The priority for stratifying assets between units will be based on the Time Phased Force Deployment Plan (TPFDP) flow dates. The units with the earliest available load dates should be given priority over units with later load dates.

c. Until contracts are in place to fill the late deploying NMCB TOAs for the theater reserve battalions, NCF assets should be stratified against all 20 NMCB TOAs. Once contracts are in place, it will resource shortfall for commercial CESE and CEEI for two reserve P25, one CBMU, and one NCFSU theater Reserve TOAs.

d. TOA assets that are not required by war-fighting units will be available for stratification against the equipment requirements of non-warfighting units.[15]

The CESE Management Branch will track this stratification process and provide that information to each NCF unit on a monthly basis so that the readiness status of each NCF TOA can be determined for the Status of Readiness and Training System (SORTS) and Joint Monthly Readiness Review (JMRR) processes.

The recapitalization program shown in Figure 2 has the equipment in each NMCB TOA being replaced on either a 15 or 20 year schedule. This allows old and obsolete equipment to be phased out in order to maintain the TOAs with equipment that meets the current mission requirements.

D. CED OPERATIONS

N-44 and NAVFAC's primary maintenance budget for CESE is used to fund the Construction Equipment Divisions (CED) in Gulfport and Port Hueneme which perform the majority of the intermediate depot level and major maintenance.

Standard operating procedures for the CEDs include preservation, depreservation surveillance, inspection, maintenance and repair of the CESE. CED Gulfport additionally has reimbursable contracts with other Naval and Marine Corps entities in order to supplement their workload and to fully employ their staff and mechanics. This change took place in the early 1990s due to reduced funding.

The CEDs can be compared to a civilian automotive shop. They can perform electronic engine diagnosis and repair, complete engine and transmission rebuilding, powertrain and suspension work, bodywork, painting, and window replacement.

The CED mechanics are familiar with the unique equipment and requirements of the P25. This is useful for all Class II Inspections (see below), Functional Tests, and Operational Tests. Therefore, learning curve theory was not considered when these labor norms were developed and standard labor norms can be applied for all types of equipment with an Equipment Code, EC.[16]

A Class I inspection is a visual inspection of end items made to identify obvious defects. Disturbance of preservation, packaging and packing is held to a minimum during this inspection. The types of defects outlined in NAVFAC P-434, Tables A-5, A-6, and Appendix A, are sought in this inspection to the extent practical. Special attention must be directed to the following deficiency areas:

1. General condition of containers, including any deficiencies in preservation, packaging and packing, or marking.
2. Visible deficiencies in loading, bracing, or blocking.
3. Evidence of visible damage to the end item resulting from rough handling or from defects discovered in the above two procedures.
4. Evidence of pilferage or lost accessories.

5. Visible signs of physical deterioration.[17]

A Class II inspection requires disturbing preservation, packaging and packing and partial disassembly of an end item to identify defects and determine the probable cause of defects. A Class II inspection consists of detailed examination of an item to determine its acceptability and/or serviceability in accordance with specifications and other requirements, including the adequacy of the paint/preservation, packaging, packing or markings. Any partial disassemble shall be restricted to the removal of crankcase pan and inspection plates of an internal combustion engine, and to fiberscope checking of cylinder heads in lieu of definitions of components and classification of defects in NAVFAC P-434. Table A-5, Appendix A-4, and Appendix A, provides the definition of causes of defects to be used describing any defects found during inspection.[18]

Other tests that CED performs are functional tests and operational tests. A functional test is the assembly and operation of an end item, its attachments and accessories for a limited time to verify assemble of the unit and its ability to function. Functional tests are included in all Class II inspections. Operational tests are load tests and are usually restricted to complex equipment. The operational tests are performed under actual or simulated environmental conditions to determine if equipment is operating in accordance with specifications or requirements.

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III. COST OF MAINTENANCE

A. FACTORS AFFECTING COST

1. Recapitalization

The policy for the Naval Construction Force (NCF) is to procure new equipment on a 15 to 20 year basis as indicated in figure 2. The funding source is from Other Procurement Navy (OPN). The older a piece of equipment is, the higher the general and breakdown maintenance costs normally are.

The following amounts of OPN funding were executed or are planned to be executed for N44 Civil Engineer Support Equipment (CESE) procurements. There were no funds issued for FY98. FY01 and FY02 include congressional additions for Medium Tactical Vehicle Replacement (MTVR).[19]

FY96	$2,267,500
FY97	$524,000
FY98	0
FY99	$704,000
FY00	$4,013,500
FY01	$23,931,900
FY02	$36,846,700

2. Resourcing Plan

The policy of the NCF is to resource its units in accordance with the NCF Table of Allowance (TOA) Utilization and Resource Requirement Plan. The intent of the NCF TOA Resourcing Plan is to ensure that the NCF has sufficient TOAs in a C1 readiness condition to respond to a single Major Theater War while engaged in a simultaneous Small Scale Conflict by rotating better equipment to the higher priority TOAs.

Resourcing, like recapitalization, affects the total maintenance cost by either shortening or prolonging the time between major overhauls. The longer the delay before overhaul means that there will be higher general and breakdown maintenance that is funded by operational commands. Shorter times mean higher overhaul maintenance that is funded by N44 OMNR. As shown in Figure 8, the objective should be to resource equipment at the lowest overall cost. The typical resource schedule plan is every five years.

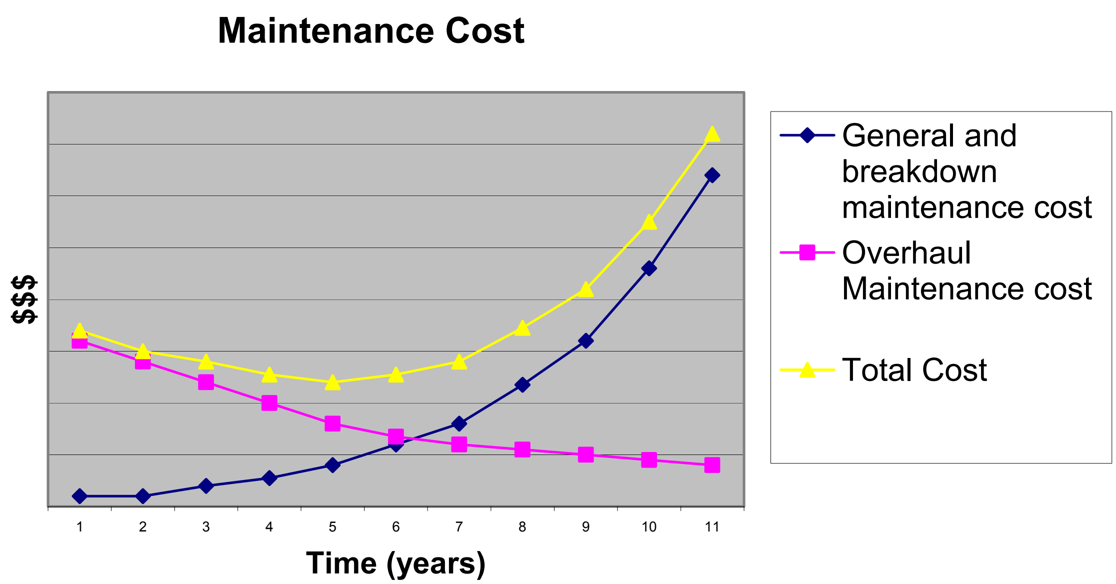

Figure 8. Typical Maintenance Cost Profile

3. Integrated Logistics Overhaul

The policy of the NCF is to conduct a systematic overhaul of its containerized TOAs on a regular, cyclical basis. The purpose of the Integrated Logistics Overhaul (ILO) is to keep the TOAs up to date and in good condition. This ILO process consists of unpacking, refreshing expired items, replacing deteriorated, obsolete, or damaged items, adding new items, and repacking, the TOA into the containers. The ILO process is not the same as recapitalization since the ILO process is not meant to replace every item in the TOA. The ILO process will replace the containerized portion of the on-site TOA with a recently overhauled complete containerized TOA. The ILO cycle is every five years.

4. Usage – Operations and Repair

The four forward deployed battalions have historical data for equipment hours versus maintenance costs. Therefore, general maintenance costs are predictable based on the anticipated workload.

The following data indicate the total material costs for a one-year period for two active Naval Mobile Construction Battalions.[20] The costs are only for the mainbody sites and not all inclusive since approximately 25% to 33% of the P25 CESE for the battalion is dispersed among the detail sites. These figures vary greatly depending on the amount of corrective maintenance required. Additionally, some of the equipment have hour meters to measure the time that the equipment has been running instead of odometers to measure the distance traveled. Therefore, material costs are averaged either by mile or by hour, but not both.

	Guam	Okinawa
Total Material Cost	$1,082,770	$438,702
Material Cost per mile	$2.71	$1.08
Material Cost per hour	$167.74	$74.26

5. Service Life Extension Program

The policy of the NCF is to conduct the Service Life Extension Program to extend the life of major pieces of equipment. The purpose of the SLEP program is to reduce equipment procurement costs by obtaining the maximum practical life out of the NCF's CESE. NAVFAC is responsible for developing and overseeing the SLEP Program plan.

The total NCF SLEP budget for FY02 was $3.781 million, which consists of $1.820 million from OMN and $1.961 million from OMNR.[21]

6. Maintenance and Repair

The Construction Engineering Division conducts general maintenance, repair and overhaul. Historical data can be used to predict the annual costs required to maintain CESE in a C1 condition. The accuracy of the prediction would vary due to the fluctuating levels of readiness just as total OMN funding has fluctuated over the last ten years. Unfortunately, historical data for the last ten years are not available.

Based on the required equipment in the P25, the reliability of the equipment, and the predictability for maintenance costs, a model can be developed for identifying annual funding thresholds necessary to maintain equipment ready for issue in a C1 status.

7. Storage Method

The equipment is normally stored in climate-controlled warehouses. When stored equipment is exposed to the environment, preservation, depreservation and general maintenance costs are higher.

B. EQUIPMENT LABOR NORMS

Equipment labor norms for common types of storage are listed in Table 2 from NAVFAC P-434. The operational test norms assume the equipment has been prepared for testing during the Class II inspection.

These norms are provided as a guide to measure the efficiency of the preservation and depreservation efforts. The majority of equipment is stored in warehouses. However, some equipment is stored in the open and is exposed to the environment. Therefore, there are two different norms for preservation of equipment depending on storage location.

ECC	Description	Direct Labor Man-Hours				
		Preservation				
		Open	Whse	Depres	Class II	Op. Test
010501	AUTO, SEDAN, 4 DOOR AUTO-XMSN	30	28	8	14	4
030701	TRK, UTILITY, 4x4, 1/4T, W/OW M151A2	26	24	8	14	4
031301	TRK, 1/2T, CARGO, PICKUP, 4x2, GED	29	27	8	14	4
033301	TRK, AMBU, VAN CONV, 4x2, GED 2 LTR	30	28	8	14	4
036001	TRK, CARGO, 4x4, 1-1/2T, W/OW XM705	29	27	10	16	4
036101	TRK, AMBU, 4x4, 1-1/4T, W/OW XM737	29	27	8	16	4
045611	TRK, DUMP, 4x4, 2T, 4 CU YD	32	30	9	20	8
053601	TRK, VAN 6x6, 19000 GVW, W/O WINCH	43	40	10	16	4
053901	TRK, CARGO DRP SD, 6x6, 2-1/T	42	40	12	18	4
057001	TRK, 5T AMPHIB, LIGHTER; LARC-5	54	50	16	50	16
058701	TRK, DUMP, 6x6, 5T, W/OW XM817	43	41	13	20	8
058801	TRK, CARGO, DROP SIDE, 6x6, 5T	43	41	13	18	4
060701	TRK, TRACTOR, 6x6, 5T, W/OW XM818+	43	41	13	18	8
064401	TRK, DUMP, 6x4, 20T, 10CYD, DED	51	48	12	24	8
061511	TRK, TRACTOR, 6x4, DED 85000 GVW	50	48	12	24	8
064900	TRK, TRACTOR, 6x4, 64000 GVW	50	48	12	20	8
071501	TRK, MAINT, P-LINE CONST, 6x6, 2-1/2T	46	44	14	20	12
071901	TRK, VAN FOOD WINDOW SERV, 4x2, GED	29	27	12	20	16
072211	TRK, MAINT TEL, 4x4M 1-1/2T, W/W M726	30	28	9	16	6
072311	TRK, MAINT, TEL, CONST, 6x6 2-1/2T	46	44	14	20	12
073011	TRK, WRECKER, 6x6, 5T W/W XM816	55	50	16	26	16
074301	TRK, TANK AVIA, 500 GAL 16000 GVW 4x2	39	36	16	20	16
074611	TRK, TANK FUEL 1200 GAL 6x6 2-1/2T	48	46	16	20	16
080101	TRL, CARGO 2-WHL, 1/4T M416	6	6	2	3	4
080201	TRL, CARGO 2-WHL, 3/4T, M-SERIES	6	6	2	3	4
080401	TRL, CARGO 2-WHL, 1-1/T M105A2	6	6	3	4	4
081211	SEMITRL, STAKE 4-WHL DT 12T M127A2C	16	14	5	7	6
081311	SEMITRL, VAN 2-AXLE 12T	17	14	5	7	6
082601	SEMITRL, LOW BED 6-WHL DT 3AX 50T	23	22	5	8	8
082711	SEMITRL, L-BED FLDNG GSNK XM524E2 60	36	34	6	8	8
082901	DOLLY TRL CONV 8T, 2-WHL DT M198	4	4	2	3	4
084201	TRL, BOLSTER SEMI P-P TDM WHL 16T	14	14	2	4	4
084301	TRL, BOLSTER CBL REEL 2-WHL 3-1/2T	6	6	2	4	4
084801	SEMITRL, BTM DUMP, 18 YD	20	16	4	6	16
085401	WATER PURIF UNIT 600 GPH	0	20	8	8	16
085601	SEMITRL, DENTAL	20	16	4	20	24
085701	BATH UNIT TRL-MTD, 24HD GED	20	18	6	12	16
086211	TRL, F-BED TILT, 12T, 4-WHL DT	16	14	3	4	6
088001	TRL, TANK 400 GAL, 2-SHL M149	7	6	3	4	4
088601	SEMITRL TANK, WATER, 2200	20	18	8	8	10
089001	SEMITRL TANK, 5M-GL, 4 COMPT	22	20	8	8	10

ECC	Description	Direct Labor Man-Hours				
		Preservation				
		Open	Whse	Depres	Class II	Op. Test
MATERIALS HANDLING EQUIPMENT						
130400	TRK FORKLIFT 4000 LBS CAP DED	26	24	8	36	4
130600	TRK FORKLIFT 6000 LBS CAP DED	28	26	8	36	4
134800	TRK FORKLIFT 20000 LBS CAP DED	30	28	10	36	4
182600	TRK FORKLIFT 6000 LBS CAP ROUGH TERR	30	28	10	36	6
220011	PLANT CRUSHING SCRNG 75TPH EMD CON	60	48	24	46	80
220031	PLANT CRUSHING SCRNG 320TPH CONE	72	60	40	48	120
230001	PAVER, ASPHALT 100TPH DED	40	32	16	32	8
231000	FINISH MACH, CONC & PAV SLIP-FORM	0				
231200	CURING MACH CONC 0-25"W, GED 4-WHL M	26	24	10	16	8
241031	PLANT ASPH BATCH 150 TPH EMD SELF-E	86	68	40	84	120
241701	MIXER SOIL STAB CWLR MTD SELF-PROP I	40	34	16	46	16
242001	MIXER CONC 8-lwCW 6x6 TRK MTD DED	60	52	16	28	16
241000	ASPHALT PLANT, BATCH TYPE	0		16		
243401	MIXER CONC TRL MTD 16CR GED	18	16	6	12	8
243611	PLANT CONC CEN MIX PORT 100TPH	38	32	18	60	80
247001	SAW ABRAS 12N" DISC SGL BLD	0	6	4	4	2
252021	DIST BITUM 2000 GAL HYD DRV	66	54	16	32	12
252111	DIST WTR 2000 GAL TRK MTD M40A2	54	48	16	32	12
252121	DIST WTR 8000 GAL WAGON MTD	42	40	6	16	16
253501	SPREADER AGGR 13F 4 CY SLF-PROP 4-W	35	32	8	20	12
254001	SPREADER AGGR 12F 1-1/2CY TOWED	6	6	4	4	2
254201	SPREADER CEMENT SLF-PROP DED, 4x4	26	24	16	32	12
261001	CONV PORT 24Nx60FT WHL MTD DED	24	24	8	18	16
262011	PUMP CONC 70CY TRK/SKID MTD DED	56	50	16	32	8
276011	KETTLE, HTR JTSLR, 120G GED	12	10	6	4	4
285500	MELTER, ASPHALT, 1200 GPH CAP	10	8	4	3	4
315511	COMPRESSOR, 365CFM 100PSI, TRL MTD D	16	16	6	18	8
316501	COMPRESSOR, 600CFM 100PSI, TRL MTD	16	16	6	18	8
353201	DRILL PNEU DRIFTER CWLR	8	6	4	6	8
363001	DRIVER, PILE W/BOX LEADS, DSL HAMMER	8	8	3	10	40
363011	DRIVER, PILE DSL 30100 FT LBS	8	6	3	10	40
371001	AUGER EARTH 9-12-16-24	18	16	6	18	16
372001	WELL DRILLING MACH ROT A/L	30	24	12	24	16
372011	WELL DRILLING MACH ROT TRL MTD	34	30	14	32	24
395000	TAMPER, PISTON-HAMMER TYPE PNEU 6N	2	2	0	2	4
424001	CRANE-SHOVEL 30T 1-1/2 YD CWLR MTD R	60	54	24	60	48
431001	DITCHER LADDER CRWLR 16-24x5 1/2 FT D	38	34	8	27	12
433001	EXCAVATOR MULTIPUR TRK MTD 6x6	55	50	16	68	32

ECC	Description	Direct Labor Man-Hours				
		Preservation				
		Open	Whse	Depres	Class II	Op. Test
442011	GRADER RD MTR 6x4 A/D	34	32	14	24	16
442031	GRADER RD MTR 6x4 ded	44	40	16	28	16
445000	SUBGRADER, TOWED, WHL MTD					
453011	LOADER SCOOP F/TRACK 4-1 BUCKET 2-1/	32	30	16	32	24
453021	LOADER SCOOP F/TRACK 4-1 BUCKET 2-1/	34	32	16	40	24
453111	LOADER SCOOP WHL 4x4 1-1/2 CY	44	40	16	40	32
453131	LOADER SCOOP WHL 4x4 2-1/4 CY 4-1 BKT	44	40	16	40	28
453141	LOADER SCOOP WHL 4x4 2-1/4 CY 4-1 BKT	44	40	16	40	20
453151	LOADER SCOOP WHL 4x4 5-1/2 CY DED	48	44	16	40	20
460000	WATER PURIF UNIT, FRAME MTD 25 GAL.M	4	4	4	4	8
461501	ROLLER OSCILLAT MTZ 9-WHL 15T DED	53	50	16	36	16
462101	ROLLER TOWED 2 DRUM	3	3	2	8	8
462201	ROLLER SEGMENTED, SELF-PROP DED	32	28	12	36	20
463501	ROLLER VIBRA SELF-PROP DED A/D	22	20	8	24	16
463521	ROLLER VIBRA SELF-PROP DED	32	28	12	40	20
464001	ROLLER MTR ROAD 3-WHL 10T DED	26	24	12	36	16
471001	SCRAPER TOWED W/DOLLY 4CY HYD A/D	8	6	3	8	12
473101	SCRAPER TOWED W/O DOLLY 14CY HYD	20	16	4	16	44
474001	DOLLY SCRAPER CONV 2-WHL 14 CY	0		2		
475001	SCRAPER, TRAC, SELF-PROP 4x4 24CY 2 I	60	54		68	32
475001	TRACTOR SCRAPER MRS SELF-PROP DED	58	52	20	48	32
475011	SCRAPER SELF-PROP 4x4 24 CY 2 ENG DE	60	54	24	68	32
476001	TRK DUMP 20T 13 CY OFF HIWAY DED	54	48	14	28	12
477001	WAGON OFF HIWAY SIDE CMP 30T 20YD 2	22	18	3	12	10
480501	TRACTOR SELF-PROP 4x2 30T 20YD 2WHL	48	44	20	32	40
482001	TRACTOR, F/TRACK A-DOZER R-HYD AUX C	40	34	16	10	20
485001	TRACTOR F/TRACK SEMI-U W/HYD TILT AU	46	40	16	40	20
485011	TRACTOR F/TRACK A-DOZER HYD R-WN-S	46	40	16	40	20
485021	TRACTOR F/TRACK SEMI-U DOZER HYD R-	46	40	16	40	20
485101	TRACTOR T11 HYD SEMI-U DOZR W/R-RIP	54	48	16	40	20
489301	TRACTOR WHL 4x4 R-HYD AUX CONN 24MD	50	44	18	58	32
511011	FLOODLIGHT 5KW DED TRL MTD 80500W F	0	5	4	8	16
512111	GENERATOR, 15KW BRUSHLESS SKID DE	0	10	8	12	16
512200	GENERATOR SET DED 30KW	0	12	8	12	16
512421	GENERATOR, 100KW DED	0	12	10	24	18
512700	GENERATOR SET DED SKID MTD 500KW	0	20	18	36	32
512801	GENERATOR 200KW BRUSHLESS SKID DE	0	12	16	24	20
516011	LUBRICATION UNIT F/DRUMS DED	0	16	6	10	16
517011	WELDER ARC 300A, 4-WHL TLR MTD DED	0	12	7	14	12
517021	WELDER ARC 300A INERT GAS TLR MTD	0	12	7	14	14

ECC	Description	Direct Labor Man-Hours				
		Preservation				
		Open	Whse	Depres	Class II	Op. Test
521011	PUMP DIAPH 100GPH 4x4 WHL MTD GED	4	4	4	6	8
522021	PUMP CENT TRASH 3N 200MGPH 2WHL GE	5	5	4	6	8
522031	PUMP WTR LDG STND MIN 1000GPH DED	9	8	6	10	14
524011	PUMPING ASSY DEEPWELL 50GPM 250' LI	0	3	4	2	8
541011	CLEANER STEAM 250GPH 4-WHL MTD EMI	13	12	6	6	10
541801	CLEANER WATER SANDBLSTR TLR MTD G	18	16	8	16	12
542001	DECONTAMINATING APPARATUS SKD GED	0	8	6	6	6
542109	SPRAYER-INSECTICIDE FOG GED	7	6	5	6	6
543503	MARKER TRAF LINE SELF-PROP WHL MTD	4	4	4	4	4
545011	DISTIL UNIT,WATER THERMCOMP 200GPH	0	12	6	14	24
545511	WTR PURIF UNIT BAST MTD 3000GPH	0	16	6	12	32
549811	LAUNDRY TLR MTD 120-LB-HR	16	14	8	8	16
549821	LAUNDRY UNIT 225 LB-SKID/TRLR MTD	18	16	10	24	24
550001	FUEL SERV UNIT, AIRCRAFT TRLR MTD	11	10	8	12	16
551501	TONG SET, PWRD PIPELINE CONST. SKD I	2	2		2	4
563501	SPRAYER SEED FIBER MULCH SKID MTD (	13	12	8	6	6
571011	SWEEPER MAGNET SELF-PROP 96-IN	18	16	8	16	16
574011	SWEEPER, TOWED 8FT WTR TLR MTD GEI	11	9	4	6	10
590001	SAW RADIAL OVRM 16nTLR MTD DED-ELE(	18	16	9	16	16
591011	SHOP EQUIP GENPURP SEMI-TRLR	34	32	24	32	40
610500	SWITCHBOARD PWR OUTDR 4KW F/600KV	0	6	2	2	1
717501	TRK FIRE FGHT AIRCRT & RESC 4x4 38000	50	45	16	38	16
734111	TRK FIRE 4x4 2T W/4-1/2 SUC HSE LDRS	50	45	14	32	16
821001	CRANE TRK MTD 6x6 25T DED	100	90	24	90	48
821801	CRANE TRK MTD 50T 8x4 2 ENG DED	105	95	24	110	32
824621	CRANE TRK MTD 8x4 HYD 25T DED	82	75	24	84	24
824901	CRANE TRK MTD 55THYD 8x4 2 ENG DED	90	82	26	110	24
825411	CRANE WHL 4x4 HYD 5T DED	64	58	14	60	20
8800	PROPELLING UNIT, INBOARD	14	12	8	24	16

Table 2. Equipment Labor Norms from P-434, Appendix D.

The standard times shown in Table 2 were developed assuming normal working conditions, in terms of weather, accessibility to the job site, etc. Unusual conditions, which could affect any given job, will normally cause a variance in a craftsman's performance as compared to the standard for that job. No time has been allowed for repair actions.

C. CESE DISTRIBUTION

The following matrix shows the CESE distribution for the P25 Table of Allowances sorted by Equipment Code and P25. The number of CESE per TOA and the average equipment per EC in the P25 is calculated in Table 3.

	Deployed P25 Rota	Deployed P25 Okinawa	Deployed P25 Guam	Deployed p25 Puerto Ri	Homeport P25 Hueneme 1	Homeport P25 Gulfport 1	Homeport P25 Hueneme 2	Homeport P25 Gulfport 2	MPS - 1	MPS - 2	MPS - 3	MPS - ILO	Backfill P25 Hueneme 1	Backfill P25 Gulfport 1	Backfill P25 Hueneme 2	Backfill P25 Gulfport 2	Backfill P25 Hueneme 3	Backfill P25 Gulfport 3	Backfill P25 Hueneme 4	Backfill P25 Gulfport 4	Required per P25 Assembly	Average
EC	1	2	3	4	9	10	11	12	13	14	15	20	21	22	23	24	25	26	27	28		
36053	8	8	8	8	8	8	4	8	8	8	8	8	0	8	2	4	0	1	0	0	8	5.4
36062	4	4	4	4	4	4	4	4	4	4	4	4	4	0	4	4	5	3	4	4	4	3.8
36063	16	16	16	16	16	6	8	16	16	16	16	18	16	15	15	16	16	15	15	16	16	15.0
36143	2	2	2	2	4	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	2.1
36361	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	4	3	0	4	0	4	3.6
58761	16	16	16	16	16	16	16	16	16	16	16	16	16	16	15	16	16	19	16	13	16	16.0
58861	14	14	14	14	14	14	14	14	14	14	14	16	14	14	15	14	14	14	11	14	14	14.0
60761	20	20	20	20	20	20	20	20	20	20	20	20	12	7	20	19	15	12	15	0	20	17.0
70961	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0	2	1.9
73061	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2.0
74661	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2.0
81611	10	10	10	10	11	7	9	10	10	10	10	10	7	9	3	9	0	0	0	0	10	7.3
82511	15	13	13	13	13	13	12	13	13	13	13	13	13	13	13	13	9	13	13	13	13	12.9
82902	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	3	5	5	5	4	5	4.9
84201	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	0	0	0	1	0.8
88002	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10.0
182004	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5.0
182012	7	7	7	7	7	7	7	7	7	7	7	7	7	7	4	6	5	7	7	7	7	6.7
182050	1	1	1	1	0	2	0	0	2	2	2	0	0	0	0	0	0	0	0	0	1	0.6
243301	3	2	2	3	2	1	2	3	3	3	3	3	3	1	1	3	0	0	0	0	3	1.9
252061	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1.0
252161	3	3	3	2	3	2	3	3	3	3	3	3	3	3	3	3	3	3	2	1	2	2.8
252322	5	2	2	4	2	6	1	6	2	2	2	2	2	2	2	0	0	2	1	0	4	2.3
313502	4	4	4	4	4	4	4	4	4	4	4	4	4	4	1	4	4	4	4	4	4	3.9
316502	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1.0
316511	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1.0
371061	2	2	2	2	1	2	2	1	2	2	2	2	2	2	2	1	2	2	2	1	2	1.8
372002	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1.0
372161	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	0	0	0	0	0	1	0.7
431001	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1.0
431002	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1.0
435001	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	2	2	2	1.9
442021	6	6	6	6	6	6	6	6	6	6	6	6	6	6	5	6	6	6	1	6	6	5.7
453041	4	4	4	4	4	4	5	4	4	4	4	4	4	4	4	3	4	4	3	4	4	4.0
453110	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3	3	3	3.0

	Deployed P25 Rota	Deployed P25 Okinawa	Deployed P25 Guam	Deployed p25 Puerto Ri	Homeport P25 Hueneme 1	Homeport P25 Gulfport 1	Homeport P25 Hueneme 2	Homeport P25 Gulfport 2	MPS - 1	MPS - 2	MPS - 3	MPS - ILO	Backfill P25 Hueneme 1	Backfill P25 Gulfport 1	Backfill P25 Hueneme 2	Backfill P25 Gulfport 2	Backfill P25 Hueneme 3	Backfill P25 Gulfport 3	Backfill P25 Hueneme 4	Backfill P25 Gulfport 4	Required per P25 Assembly	Average
ECC	1	2	3	4	9	10	11	12	13	14	15	20	21	22	23	24	25	26	27	28		
453130	3	3	3	3	3	3	3	3	3	3	3	4	3	3	1	3	3	3	1	1	3	2.8
461501	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0	0	2	0	1	2	1.7
463520	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3	2	3	3	3	2.9
475004	6	6	6	6	6	6	7	6	6	6	6	6	6	8	6	10	7	6	5	6	6	6.4
483010	3	2	2	3	2	3	3	3	3	3	3	3	3	0	2	4	0	1	3	3	3	2.5
485011	2	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	2	2	3	0	3	2.7
485021	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3.0
487503	1	1	1	1	0	1	0	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0.9
487510	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	1	2	2	1	1	2	1.9
511022	10	10	10	10	10	10	9	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10.0
512110	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2.0
512115	6	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	4	4	4	4	4	4.1
512230	7	3	3	7	3	7	3	7	7	7	7	7	6	7	4	7	0	3	0	1	7	4.8
512460	6	6	6	6	6	6	6	6	6	6	6	6	6	6	2	3	0	1	0	0	6	4.5
512460	6	6	6	6	6	6	6	6	6	6	6	6	6	6	2	3	0	1	0	0	6	4.5
516001	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1.0
517071	7	7	7	7	7	7	7	7	7	7	7	7	7	7	3	5	7	7	4	6	7	6.5
521011	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2.0
522019	3	2	2	3	2	3	2	3	3	3	3	3	3	3	2	1	3	3	3	3	3	2.7
522021	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	4	8	8	8	7	8	7.8
522031	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1.0
525010	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	2	6	5.8
525011	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26.0
525020	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3.0
525021	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	6	10	9.8
542001	3	2	2	3	2	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2.8
545501	3	2	2	3	2	3	2	3	3	3	3	3	3	3	3	1	3	3	0	1	3	2.5
549003	2	2	2	2	2	2	2	4	2	2	2	2	2	2	2	2	2	2	1	2	2	2.1
549801	3	2	2	3	2	2	2	3	3	3	3	3	4	3	1	1	3	3	0	0	3	2.3
571021	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0	2	3	2	2	2	2.0
590001	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	2	4	4	4	4	4	3.9
591011	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1.0
592001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
821501	3	2	3	3	2	2	2	3	3	3	3	3	3	3	3	3	3	2	2	1	3	2.6
	327	310	311	322	310	308	295	325	322	322	322	325	300	297	279	285	265	273	250	224	322	299

Table 3. CESE Distribution for P25 TOA.

IV. ANALYSIS AND RESULTS

A. CONTRIBUTING FACTORS

The preferred method for conducting this thesis would have been to collect maintenance history from a central database of information. Until 1995, some of these data were collected and stored centrally. It was not until late in the thesis process that it was discovered that the person responsible for collected the data retired and no one continued the task.

The preceding chapter identified potential factors that would impact the costs of maintaining CESE Pre-positioned War Reserve Material Stock. These factors that could be used to accurately determine maintenance cost include:

- Type of equipment sorted by Equipment Code
- Location of maintenance provider – CED or contractor
- Type of maintenance – corrective, breakdown, or preventive
- Type of inspection – preservation, depreservation, or Class II
- Date of maintenance and period between maintenance
- Cost of materials per type of maintenance and inspection
- Time to complete maintenance and inspection
- Cost of labor and labor rates for all work performed
- Time and cost for Supply department handling
- Purpose for maintenance – initial handling, Resourcing or ILO
- Funding source – OMN, OMNR, NGRE, or other
- Total Funding for the last ten years from OMN and OMNR appropriations

Using the distribution of historical data, forecasting analysis could be conducted using quantitative methods using Monte Carlo Simulation or the probabilistic Box-Jenkins Model.

An alternate method that could be used to determine annualized maintenance costs would be to gather some of the primary data for the current cost of maintaining CESE combined with probabilistic assumptions for other data such as the frequency of occurrence. Unfortunately, the current method for collecting data does not separate corrective from preventive maintenance or depreservation costs from Class II inspections, further analysis of the data would have been necessary. Furthermore, an ongoing A-76 study to determine if a Commercial Activity could perform the maintenance at less cost to the government prevented the release of the data due to the risk of releasing critical or compromising data. Therefore, this thesis could not proceed to develop a forecasting model as originally planned.

Another alternative method would be to collect the necessary data from each piece of equipment. The vehicle history jackets contain all maintenance records for that individual equipment. A review of the maintenance conducted and the time to complete the maintenance would allow for a calculation of the cost involved. With the collection of all data, the cost of materials and labor, and the frequency of occurrence, the same forecasting could be conducted using quantitative methods using Monte Carlo Simulation or the probabilistic Box-Jenkins Model.

This alternate method requires much more time than was available for this thesis research. Additionally, since the vehicle history jackets remain with the equipment, and since much of the equipment is in use, the history jackets are located at several locations around the world. Some jackets might be inaccessible and the cost for time and travel would be prohibitive.

A modification of the second alternative would be to perform a random sample of approximately ten percent of the equipment for every equipment code and extrapolate the data to allow for an accurate forecast of the annual maintenance cost. The data needed to complete this forecast would be the same as above and could be collected from two primary locations at CED Gulfport, Mississippi and CED Port Hueneme, California. It is suggested that future attempts to forecast maintenance costs use this sampling method.

B. MAINTENANCE AND REPAIR PREDICTIONS

With the limited amount of data that was available a further modification of the second alternative was conducted. The annual maintenance cost for CESE PWRMS is predicted in Table 4 below by using the equipment labor norms from Table 2 along with the average equipment in the P25 as calculated in Table 3. By combining the labor norms with the number of CESE in the TOA, the reliability of the equipment, and the predictability for maintenance costs, a total cost of maintenance can be predicted. This prediction could be used to identify, justify, and program annual funding thresholds necessary to maintain CESE PWRMS equipment in a C1 ready for issue status.

The data from the CASMIS database were tabulated in Table 3 in order to determine the average required CESE per P25 unit set. This average of 299 pieces compares with the required 322 pieces as identified in the P25 Facility Assembly Detail. The 299 piece average also verifies that the there is a shortage of equipment as indicated by the 89% of equipment assigned to equipment required from Figure 7. The average is used in order to base the budget on the current status of equipment and not the desired levels.

The equipment labor norms from Table 2 are multiplied by the estimated wage rate of $61.00 the labor cost necessary to complete each type of maintenance.[22]

The Annual Equipment Cost Worksheet in Table 4 gives the predicted annual funds required for only planned maintenance and repair of CESE PWRMS. The formula for the calculation is the probability of preservation times the sum of the preservation material and labor costs plus the probability of depreservation times the sum of the preservation material and labor costs, plus the probability of a Class II inspection times the sums of the Class II maintenance costs all times the number of pieces of CESE in that EC. The totals by EC are summed to achieve a bottom line figure of $557,129.00.

From Table 4, the Average Annual Cost = [probability preservation * (Preservation Material + Preservation manpower) + probability depreservation * (depreservation material + depreservation manpower) + probability CII*(CII material + CII manpower)] * number in TOA.

For example, the average annual cost for EC 0360-01 = [1*(50+1708)+1*(40+610)+0.25*(240+540+95+976)]*25=$71,766.

C. ASSUMPTIONS

The calculations in Table 4 that are used to predict the annual equipment cost only analyze the equipment codes that are included in the P25 TOA. As indicated in Figure 1 and Table 1, there are other TOA designators that include CESE. However, they were not part of this research.

The average number of pieces of equipment was calculated in Table 3, CESE Distribution of TOA, and used in Table 4 to predict the annual equipment cost. The average was used since the intent of the research is not to make the NCF whole, but to determine their requirements based on what is on hand now.

The probability of preservation, depreservation, and Class II inspections was estimated based on the frequency of use. A scraper, EC 4750-00, may be placed in storage and never rotated to an operational unit for ten years. Therefore the probability for depreservation within one year would be one of ten or 10 percent. A more frequently used item such as a loader, EC 4531-00, might be rotated in four years or 25 percent.

Preservation, depreservation, and Class II inspections are not mutually exclusive. Since the equipment assigned for the entire NCF is at 89%, Figure 7, there is very little new equipment that is added to a TOA. Therefore, for every preservation event, there will be a simultaneous depreservation event. Additionally, for every Class II inspection there must be a depreservation event. A portion of the cost for Class II inspection includes depreservation.

Every preservation event is different but includes a minimum amount of fluid additives, engine preservatives, and wood blocking and bracing. Since a history of costs was not determined, a standard and uniform cost for materials of $50.00 was used for every preservation event.

The material cost for depreservation was taken directly from the Gulfport CED equipment breakdown data.

The Class II inspection cost has several factors. First, the material cost includes the cost of depreservation as well as a standard cost of $200.00 for replacement of rubber items that deteriorate quickly over time such as gaskets, bushings, seals and hoses.

Secondly, the cost for replacement batteries is included. The standard battery does not last for more than five years due to the chemical reactions of lead. Therefore, equipment is not stored with batteries and new batteries have to be purchased in order to operate the equipment. Prices for the three standard batteries used, 4D, 8D, and 6TN, were obtained from a distributor in Bellingham, Washington.[23] The table includes only one battery per piece of equipment.

Thirdly, as mentioned above, tires like other rubber products break down over time and need to be replaced. The cost for new tires should be included in the estimate cost since much of the equipment has been in storage for greater than ten years. The cost for new tires was obtained from the Army Corps of Engineers pamphlet, EP 1110-1-8 (Vol.1) dated 31 Aug 01, Appendix F for their tire description and tire cost guide.[24]

Annual Equipment Cost Worksheet

ECC	ECC Cross Reference to current TOA	Probability of Maintenance			Average Cost of Maintenance								Number in TOA	Average Annual Cost
		Preserva	Deprese	Class II	Preservation		Depreservation		Class II					
		per year	per year	per year	Material	Manpow	Material	Manpow	Material	Tires	Battery	Manpowe		
0360-01	0360-53/62/63	1	1	0.25	50	1,708	40	610	240	540	95	976	25	71,766
0361-01	0361-43, 0363-6	1	1	0.25	50	1,708	40	488	240	540	95	976	7	19,240
0587-01	0587-61	1	1	0.25	50	2,562	68	793	268	2,964	95	1,220	16	73,754
0588-01	0588-61	1	1	0.25	50	2,562	68	793	268	2,964	95	1,098	14	64,108
0607-01	0607-61	0.2	0.2	0.21	50	2,562	68	793	268	2,964	95	1,098	17	27,604
0715-01	0709-61	0.2	0.2	0.21	50	2,745	65	854	265	810	95	1,220	2	2,489
0730-11	0730-61	0.2	0.2	0.21	50	3,203	406	976	606	810	95	1,586	2	3,154
0746-11	0746-61	0.2	0.2	0.21	50	2,867	406	976	606	810	95	1,220	2	2,866
0813-11	0816-611	0.2	0.2	0.21	50	946	20	305	220	5,064	95	427	8	11,866
0826-01	0825-11	0.2	0.2	0.21	50	1,373	20	305	220	5,064	95	488	13	20,559
0829-01	0829-02	0.1	0.1	0.21	50	244	20	122	220	844	0	183	5	1,527
0842-01	0842-01	0.1	0.1	0.21	50	854	20	122	220	1,688	0	244	1	557
0880-01	0880-02	0.1	0.1	0.2	50	397	30	183	230	844	0	244	10	3,296
182600	1820-04/12/50	0.5	0.5	0.25	50	1,769	120	610	320	4,428	140	2,196	13	39,592
243401	2433-01	0.1	0.1	0.2	50	1,037	40	366	240	4,940	140	732	2	2,719
252021	2520-61	0.1	0.1	0.2	50	3,660	90	976	290	4,220	140	1,952	1	1,798
252111	2521-61	0.5	0.5	0.21	50	3,111	56	976	256	2,532	95	1,952	3	9,335
252121	2523-22	0.2	0.2	0.2	50	2,501	56	366	256	3,376	95	976	3	4,605
315511	3135-02	0.1	0.1	0.2	50	976	40	366	240	270	90	1,098	4	1,931
316501	3165-02/11	0.1	0.1	0.2	50	976	40	366	240	270	90	1,098	2	966
371001	3710-61	0.2	0.2	0.21	50	1,037	50	366	250	1,688	95	1,098	2	1,916
372001	3720-02	0.2	0.2	0.21	50	1,647	50	732	250	1,688	95	1,464	1	1,230
372011	3721-61	0.2	0.2	0.21	50	1,952	50	854	250	844	95	1,952	1	1,241
431001	4310-01/02	0.2	0.2	0.21	50	2,196	70	488	270	3,192	140	1,647	2	3,326
433001	4350-01	0.2	0.2	0.2	50	3,203	70	976	270	4,428	140	4,148	2	5,314
442031	4420-21	0.5	0.5	0.2	50	2,562	50	976	250	3,192	140	1,708	6	17,262
453021	4530-41	0.5	0.5	0.25	50	2,013	100	976	300	0	140	2,440	4	9,158
453111	4531-10	0.5	0.5	0.25	50	2,562	98	976	298	3,324	140	2,440	3	10,181
453131	4531-30	0.5	0.5	0.25	50	2,562	98	976	298	4,428	140	2,440	3	11,009
461501	4615-01	0.1	0.1	0.2	50	3,142	145	976	345	11,232	140	2,196	2	6,428
463521	4635-20	0.1	0.1	0.2	50	1,830	100	732	300	0	140	2,440	3	2,542
475011	4750-04	0.2	0.2	0.2	50	3,477	100	1,464	300	18,932	140	4,148	7	40,055
482001	4830-10	0.2	0.2	0.21	50	2,257	100	976	300	0	140	610	3	2,691
485011	4850-11	0.2	0.2	0.21	50	2,623	105	976	305	0	140	2,440	3	4,070
485021	4850-21	0.2	0.2	0.21	50	2,623	105	976	305	0	140	2,440	3	4,070
489301	4875-03/10	0.1	0.1	0.2	50	2,867	100	1,098	300	4,428	140	3,538	3	6,278
511011	5110-22	0.1	0.1	0.21	50	153	30	244	230		90	488	10	2,174
512111	5121-10/15	0.5	0.5	0.25	50	305	30	488	230	0	90	732	7	4,897
512200	5122-30	0.2	0.2	0.21	50	366	40	488	240	0	90	732	5	2,059
512421	5124-60	0.1	0.1	0.2	50	366	40	610	240	0	90	1,464	5	2,327
516011	5160-01	0.1	0.1	0.2	50	488	45	366	245	540	95	610	1	393
517021	5170-71	0.1	0.1	0.2	50	366	30	427	230	270	90	854	7	2,633
521011	5210-11	0.1	0.1	0.2	50	244	10	244	210	540	90	366	2	592
522021	5220-19/21	0.1	0.1	0.2	50	305	10	244	210	270	90	366	11	2,730
522031	5220-31	0.1	0.1	0.2	50	519	10	366	210	0	90	610	1	277
524011	5250-10/11/20/2	0.1	0.1	0.2	50	92	10	244	210	0	90	122	45	5,580
542001	5420-01	0.1	0.1	0.2	50	244	100	366	300	3,376	95	366	3	2,710
545511	5455-01	0.5	0.5	0.21	50	488	100	366	300	540	90	732	3	2,553
549811	5490-03	0.2	0.2	0.21	50	915	100	488	300	540	90	488	3	1,825
549821	5498-01	0.2	0.2	0.21	50	1,037	100	610	300	3,376	95	1,464	3	4,376
571011	5710-21	0.5	0.5	0.21	50	1,037	30	488	230	540	90	976	2	2,376
590001	5900-01	0.1	0.1	0.2	50	1,037	30	549	230	270	90	976	4	1,919
591011	5910-11	0.1	0.1	0.2	50	2,013	75	1,464	275	3,376	95	1,952	1	1,500
821801	8215-01	0.5	0.5	0.21	50	6,100	110	1,464	310	15,248	140	6,710	3	25,703
													314	557,126

Table 4. Annual Equipment Cost Worksheet

D. ANALYSIS

The budget system for OMN and OMNR for CESE PWRMS provides funding necessary for the immediate maintenance of equipment. However, it is budgeting for maintenance within a preset spending allowance. The author could not find any discernable results from planning or programming that predict the future needs and maintenance requirements. In the mean time, the condition of equipment is still unknown and worsens as time and the environment take their toll on the mission readiness of the equipment.

Several assumptions were necessary in order to predict the annual cost of maintenance for CESE PWRMS. This predicted cost does not include:

- CESE that is not identified as PWRMS.
- CESE that is utilized by operational commands.
- Any cost associated with storage that would normally be considered a Supply Department function. This cost is reimbursed by N44
- Any cost of breakdown maintenance such as transmission or engine failure.
- Any cost of accident repair such as bodywork and painting.

The budget for Other Procurement Navy (OPN) was cut back to zero in Fiscal Year 1998. The data at that time indicated that the NCF was less than 89% of the equipment assigned to the equipment required. This shows obvious signs of budget shortfalls, however as the equipment gets older, the cost of maintenance goes up. Correspondingly, the CESE Combat Readiness has declined. Typically, a time lag should exist between the declining OPN funding and the increase in the cost of maintenance as equipment gets older and the extent of required maintenance increases. There is no indication that the OMN and OMNR budgets increased over the same time to compensate for the age of the equipment.

The only conclusions that could be made from the comparison of the PWRMS maintenance budget to the operational battalion's budget at Okinawa and Guam is that there could be a trend in typical costs for corrective and breakdown maintenance. So, if maintenance and repair costs were to consistently increase for the forward deployed locations, then it could be predicted that they would also increase for the CEDs. Additionally, if there are unusually high costs for maintenance year after year, then the CESE Management Branch should rotate more equipment from the backfill TOAs in order to replace degraded equipment in the operational commands. Since more equipment is rotated and mobilized, then the OMN and OMNR requirements for the PWRMS would also increase. Higher maintenance and repair cost would also trigger the need to program more OPN funding for replacement equipment and eventually, more OPN appropriations should mean less OMN funding. The data available for the forward deployed battalions did not lead to any conclusions.

A recent change in the Seabee deployment schedule from seven months deployed-seven months homeport to six months deployed and twelve months in homeport has offered the opportunity for Construction Mechanics and Equipment Operators to get essential training while assisting with the inventory and surveillance of the WRM. However, this is only a temporary and partial fix. The surveillance would only assist in identifying maintenance and repair requirements. The total cost of maintenance must still be identified in order to obtain proper funding.

V. CONCLUSIONS AND RECOMMENDATIONS

A. SUMMARY OF FINDINGS

This study attempted to model the programmed costs of maintenance for CESE Pre-positioned War Reserve Material Stock by using an equation with estimated probabilities for the type of maintenance and the probability of maintenance being performed per year. The importance of this information cannot be underestimated for projecting the budget necessary for maintaining CESE in a C1 condition of readiness.

Based on the alternate method for calculating the cost of maintenance for CESE PWRMS described in Chapter 4 using the assumed values with the exclusions as noted, the final predicted cost is $557,126 per year.

This predicted value only covers the cost for preservation, depreservation and Class II inspections of the Civil Engineer Support Equipment that is identified as P25 Pre-positioned War Reserve Material Stock portion of the total OMN and OMNR requirements. It does not include any equipment in other TOA designators (TA10, P35, etc.) or any other maintenance such as corrective, breakdown, bodywork, or SLEP. Further studies need to be completed to determine other aspects of the OMN and OMNR budget. Nonetheless, it does help to justify the funding based on the requirements for the equipment of DOD Directive 3110.6, War Reserve Material Policy.

B. LIMITATIONS

As alluded to above in the Contributing Factors section, the best way to complete this cost analysis would have been to review actual performance data from the Construction Equipment Division or from the CESE Management Branch. However, there is no central collection point for any data relating to periodicity for preservation, depreservation, or inspections. Costs are not documented and sorted by Equipment Code. The only way to find all of the data necessary to complete this research would have been to find every one of the over 6,000 individual Equipment History Jackets and collate the data. The collection of that data would have taken an enormous amount of time beyond the time available to conduct this thesis research and would only be part of the formula necessary for the prediction of maintenance costs.

Preservation and depreservation periodicity records are not maintained. Therefore the frequency of equipment turnover cannot be determined. Furthermore, the actual cost incurred for maintenance and labor is not separately tracked, adding to the uncertainty that surrounds the cost of work. For centrally funded work, this method might be acceptable, but for reimbursable work, the customer cannot be given an accurate estimated cost in advance.

The equipment labor norms posted in P-434, Appendix D are dated April 1982 with minor revisions in September 1983. Advances in technology have made these values obsolete, yet they are still being used. Their use is still limited further since the equipment that is in the Table of Allowance is not what is in the labor norm standards, meaning that estimators have to guess how the new equipment correlates to the old standards. The first two columns in Table 4 show how the ECs were cross-referenced.

Historical data are not available which would allow the actual OMN funding for CESE PWRMS maintenance to be identified and separated from other OMN funding. This limits the budgeting capabilities and ability to justify what funding is necessary and where that funding will be spent.

The labor norms only include time to complete maintenance. As explained earlier, they are set for the experienced worker and not prorated for the beginner or apprentice. Since the learning curve theory was not applied to the labor standard table, the standards can skew the estimates allowing for low initial estimates and high final bills. The labor norms also do not include any cost associated with the Supply Department, which can be sizable. For the Supply Department, this includes the cost for blocking, bracing, packaging of collateral equipment, boxing, crating, or marking as well as the lease and utilities for the building. Additionally, the labor norms only include minor spot painting. As with other costs, NAVFAC must be able to predict the cost of labor in order to accurately budget for them.

Breakdown or corrective maintenance cannot be predicted without historical data. Transmission and engine failures are rare on equipment that has been stored in the warehouse. Nevertheless, over time, the frequency and repair cost of these failures could be accurately predicted. Likewise, the more common failures of rubber products like bushings, seals, gaskets and tires should be tracked and included in the cost of doing business.

C. RECOMMENDATIONS

The shortfalls in funding will not change unless the NCF can better justify the need for additional funding. The best way to identify all associated program costs for all maintenance and repair would be to outsource an auditing contractor to determine an Activity Based Costing Model for all aspects of the CESE Management operations.

The ABC Model would allow management the opportunity to plan for future costs and program both the Resourcing and Recapitalization Plans with confidence knowing that the cost for future work will be closer to the estimate.

Once the maintenance costs can be identified the next logical step would be to perform a cost benefit analysis on contracting or leasing out CESE and other construction equipment for the entire TOA or to continue to maintain the equipment with the program that is currently in place.

A surveillance plan needs to be established that can identify and document maintenance requirements so that they can be properly programmed into the future year's OMN and OMNR budgets. This surveillance plan should provide the additional benefit of documenting the current condition of equipment, which will increase the reliability of the Status of Resources and Training System data (SORTS). The plan should include random testing of inactive reserve equipment to establish current condition and standards for repairs.

The current CESE Management Program objectives should be modified to provide consistency and doctrine for standard operational procedures, particularly between the Construction Equipment Divisions. A business manager should be an integral part of the CESE Management Branch to control the cost of doing business with consideration for today's typical funding shortfalls, proper allocation of funds, and stewardship of the American tax dollar.

Update the P-434 Labor Norms and Standards that incorporate the improved maintenance technology and digital repair equipment, variations in CESE, different workforce experience, and different management practices.

Historical data must be maintained for all manpower and material costs of maintenance in a database that can be sorted by time, EC, maintenance type, manpower cost, and material cost. The unique costs for tire and battery replacement must be included into the cost of doing business and not considered an exception. These data should be used to make accurate predictions for the maintenance budget and CED manning standards.

Additional studies should be conducted to quantify the effects of reduced OPN funding on the levels of OMN funding for CESE maintenance and to determine the effects of a Surveillance Plan that conforms to the Naval Construction Brigade guidelines as well as the reduced cost of utilizing enlisted personnel for surveillance inspections.

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