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THESIS

**UNITED STATES MARINE CORPS
PERFORMANCE PRICING MODEL**

by

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September 2009

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UNITED STATES MARINE CORPS PERFORMANCE PRICING MODEL

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ABSTRACT

The United States Marine Corps Installations & Logistics (I&L) Department, located at the Navy Annex in Washington, D.C., conducts the Sustainment Program Evaluation Board (PEB) as part of the Planning, Programming, Budgeting, and Execution Process (PPBE). One of the functions of this board is to estimate the future funds required to support equipment maintenance world-wide in the Marine Corps. Since these estimates compete with other USMC funding needs, they must be based on reliable data using defensible methodologies.

In support of I&L's priorities, the department needs to improve the defensibility of its estimates in the current budgetary environment. The Assistant Deputy Commandant, Installations & Logistics, Headquarters Marine Corps, located at the Navy Annex in Washington D.C., has requested this study to develop pricing models for Operating/Crew, Field levels, and Sustainment level of maintenance in order to predict maintenance funding requirements at the Marine Forces (MARFOR) level. The inputs will include historical inventory quantities for MARFOR equipment and corresponding cost data for each echelon of maintenance.

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LIST OF ACRONYMS/ABBREVIATIONS

AFTOC	Air Force Total Ownership Cost
ATLASS	Asset Tracking Logistics and Supply System
CNA	Center for Naval Analysis
COMMARFORCOM	Commander Marine Forces Command
DoD	Department of Defense
ERO	Equipment Repair Order
FY	Fiscal Year
GAO	Government Accounting Office
I	Intermediate
I&L	Installations and Logistics
MARFOR	Marine Forces
MARCORLOGCOM	Marine Corps Logistics Command
MARFORCOM	Marine Forces Command
MARFORPAC	Marine Forces Pacific
MARFORRES	Marine Forces Reserves
MARFORSOC	Marine Forces Special Operations Command

MCBUL 3000	Marine Corps Bulletin 3000
MEE	Mission Essential Equipment
MEF	Marine Expeditionary Forces
MERIT	Marine Corps Equipment Readiness Information Tool
MIMMS	Marine Corps Integrated Maintenance System
NCCA	Naval Center for Cost Analysis
O	Organizational
O&I	Organizational and Intermediate
O&S	Operating and Support
OSD, CAIG	Office of the Secretary of Defense Cost Analysis Improvement Group
OSMIS	Operating and Support Management Information System
PEB	Program Evaluation Board
PEI	Principal End Items
PPBE	Planning, Programming, Budgeting, and Execution
RAC	Regional Activity Code
R&D	Research and Development
RDT&E	Research, Development, Training, and Evaluation
SASSY	Supported Activity Supply System

TAMCN	Table of Authorized Material Control Number
USJFCOM	United States Joint Forces Command
USMC	United States Marine Corps
USPACOM	United States Pacific Command
VAMOSOC	Visibility and Management of Operating and Support Costs

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EXECUTIVE SUMMARY

The United States Marine Corps Installations & Logistics (I&L) Department, located at the Navy Annex in Washington D.C., conducts the Sustainment Program Evaluation Board (PEB) as part of the Planning, Programming, Budgeting, and Execution Process (PPBE). One of the functions of this board is to estimate the future funds required to support equipment maintenance world-wide in the Marine Corps. Since these estimates compete with other USMC funding needs, they must be based on reliable data, using defensible methodologies.

In support of I&L's priorities, the department needs to improve the defensibility of its estimates in the current budgetary environment. The Assistant Deputy Commandant, Installations & Logistics, Headquarters Marine Corps, located at the Navy Annex in Washington D.C., has requested this study to develop pricing models for Operating/Crew, Field levels, and Sustainment level of maintenance in order to predict maintenance funding requirements at the Marine Forces (MARFOR) level. The inputs will include historical inventory quantities for MARFOR equipment and corresponding cost data for each echelon of maintenance.

This study will produce an Excel-based desktop model that uses appropriate statistical methods to account for input averages, and a measure of the distribution around those averages, in predicting future USMC requirements. Desired output will be defensible funding requirements for the MARFOR's given estimated inventory levels. Additionally, some measure of the required funding's predicted variability will be provided to enable planners to make informed trade-off decisions in the event of funding reductions. The model will be used to determine how sustainment resources should be programmed and allocated per echelon of maintenance.

Analysis of the data set, provided by Marine Corps Logistics Command (MARCORLOGCOM), was conducted in two phases. Phase I aimed to assist planners in analyzing past Organizational and Intermediate (O&I) parts expenditures, and the MARFOR's annual budget requests. Phase II aimed to assist planners in predicting

future average costs per Table of Authorized Material Control Number (TAMCN) per year as inventory levels are adjusted over time.

The analysis of Phase I shows that the model is useful, but that further study is needed. In Phase I, we identified the 228 total TAMCNs listed in the FY09 MCBUL 3000. We were then able to determine which of these TAMCNs were driving the maintenance expenditures from the total MARFOR level, down to the individual MARFOR commands and further down to the echelon of maintenance level. Phase I also allowed the comptrollers a quick look at the historic means, and historic means plus one standard deviation, as a method to judge if the budget request by a MARFOR command was reasonable.

The analysis of Phase II shows that there were 20 TAMCNs identified in Phase I which accounted for 76.4 percent of the total maintenance expenditures during the four years. This model can also be used to predict the Average Unit Cost per TAMCN. The fluctuation of the inventory numbers, and total maintenance expenditures, over time helps us to predict future costs. Modeling efforts are currently underway in the follow-on study by Captains Romero and Elliott of the Naval Postgraduate School. Phase II will allow Installations and Logistics (I&L) personnel to question the MARFOR commands concerning why a certain TAMCN is increasing/decreasing in maintenance expenditures.

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I would like to thank Professor Daniel A. Nussbaum and Gregory Mislick, LtCol, USMC, (Ret) for their contributions to this thesis. Professor Nussbaum provided a wealth of cost estimating knowledge and direction on this project. LtCol. Mislick was the driving force in making sure the writing was concise and clear.

I would like to thank Steve Nolan at the Installations & Logistics Department for always being available to answer questions that have arisen during the research. I hope this thesis will provide insight into what requirements are needed at the maintenance levels for the United States Marine Corps.

Most importantly, I would like to thank my wife, Simeona, and our two children, Angelica, and Joseph, for their constant support. You have allowed me to focus on my naval career, and have given me the support I needed to finish my thesis. I am forever in your debt. Angelica and Joseph, you have shown me the importance of not taking everything so seriously, and the importance of being a father. Thank you all very much.

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I. INTRODUCTION

A. PROBLEM STATEMENT

The United States Marine Corps Installations & Logistics (I&L) Department, located at the Navy Annex in Washington D.C., conducts the Sustainment Program Evaluation Board (PEB) as part of the Planning, Programming, Budgeting, and Execution Process (PPBE). One of the functions of this board is to estimate the future funds required to support equipment maintenance world-wide in the Marine Corps. Since these estimates compete with other USMC funding needs, they must be based on reliable data using defensible methodologies (Steve Nolan, personal communication, February 17, 2009).

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¹ Installations & Logistics Department. (2009). *USMC Performance Pricing Model (PPM)*. Washington, D.C: Headquarters Marine Corps.1-4.

B. OVERVIEW OF OPERATING AND SUPPORT COSTS

There are three main phases to a program's life cycle: Research and Development (R&D), Procurement, and Operating and Support (O&S) costs. O&S is routinely the largest, in dollar value, of these three phases. Thus, understanding their origin is a must. The Office of the Secretary of Defense, Cost Analysis Improvement Group (OSD, CAIG) summarizes the O&S phase as:

Sustainment costs incurred from the initial system development through the end of systems operations. Includes all costs of operating, maintaining, and supporting fielded systems. Specifically, this consists of the costs (organic and contractor) of personnel, equipment, supplies, software, and services associated with operating, modifying, maintaining, supplying, training, and supporting a system in the Department of Defense (DoD) inventory.²

O&S costs are funded from Military Personnel; Operations and Maintenance; Procurement; and occasionally Research, Development, Training, and Evaluation (RDT&E) appropriations.

The OSD, CAIG O&S cost structure categorizes and defines cost elements that cover a full range of O&S costs that occur for a particular system. The cost structure identifies where specific type of costs appear in an estimate. The O&S cost element structure is divided into six major categories. These six categories are: Unit-Level Manpower, Unit Operations, Maintenance, Sustaining Support, Continuing Systems Improvements, and Indirect Support³. Maintenance, the third category, is the focus of this study.

C. SCOPE AND LIMITATIONS

1. Scope

The USMC is concerned with expenditures at the organizational and intermediate (O&I) levels of maintenance. In 2005, the Center for Naval Analysis (CNA) conducted a

² Office of the Secretary of Defense Cost Analysis Improvement Group. *Operating and Support Cost-Estimating Guide*. Washington, D.C.: United States Department of Defense. 2007 2-2.

³ Office of the Secretary of Defense Cost Analysis Improvement Group. *Operating and Support, Year*, 6-1-6-2.

quick-turnaround study that examined the relationship between annual sustainment costs and unit procurement costs. Using a three-pronged approach, the study concluded that a general ratio of the annual sustainment cost to unit procurement cost of 6 to 8 percent was suitable for planning purposes. In other words, for every \$100 million of systems procurement costs, the annual sustainment requirement would be \$6 million to \$8 million.⁴ In 2009, CNA conducted another quick look by refining the findings from the 2005 effort and by examining different commodity types and the effects of other variables. This study achieved the objectives of providing factors for different types of equipment as a ratio of sustainment costs to procurement costs, and was partially successful in considering the impact of other variables.⁵ Even with these two studies, the Marine Corps has yet to create a model aiding in forecasting future maintenance costs to assist in developing budgets.

a. Maintenance

Maintenance includes the cost of labor (outside the scope of O-level) and materials at all levels of maintenance in support of the primary system. The scope of this thesis consists of five cost criteria using Marine Corps Logistics Command (MARCORLOGCOM) data. The five criteria are: Organizational-Level Consumable Parts, Organizational-Level Repair Parts, Intermediate-Level Consumable Parts, Intermediate-Level Repair Parts, and Government Labor. The definitions for these five criteria are defined by OSD, CAIG as the following:

1. Organizational-Level Consumable Parts. Organizational consumable maintenance material includes the costs of material consumed in the maintenance and support of a primary system at the unit level.
2. Organizational-Level Repair Parts. Organizational repair parts include the costs of materials used to repair primary systems at the unit level. Items

⁴ Klein, Steven W. *Sustainment Cost Implications of the Supplemental Appropriations*, Military Application Report, Alexandria, VA.: Center for Naval Analysis, 2005,8.

⁵ Klein, Steven W. *A Quick Look at Estimating Sustainment Costs*, Military Application Report, Alexandria, VA.: Center for Naval Analysis, 2009,3.

may include circuit cards, transistors, capacitors, gaskets, fuses, filters, batteries, tires, and other materials that are not repaired.

3 Intermediate-Level Consumable Parts. The cost of government furnished consumable materials used in maintaining and repairing a primary system by intermediate-level maintenance activities.

4. Intermediate-Level Repair Parts. The cost of government furnished repair parts used in maintaining and repairing a primary system by intermediate-level maintenance activities.

5. Government Labor. The costs of military and government civilian manpower that performs intermediate maintenance on a primary system at intermediate-level maintenance activities.⁶

These five cost criteria will aid in the development of a model to help forecast future O&I funding requirements at the MARFOR level.

2. Limitations

The Marine Corps Bulletin 3000 (MCBul 3000) is a listing of Principal End Items (PEI) and Mission Essential Equipment (MEE) established by the Marine Corps to capture ground equipment readiness of all Marine Corps Units. The Principal End Items "...are those items that have been" nominated by the MARFORs.⁷ The items selected have a sufficient inventory to provide an adequate measure of overall equipment status or capability for the MARFORs. Mission Essential Equipment are "items of equipment whose availability is essential and indispensable for the execution of the mission essential tasks of the unit in support of a combatant commander."⁸ Mission Essential Equipment is a subgroup of the Principal End Items. The Marine Corps Bulletin 3000 (MCBul 3000) tries to capture ground equipment readiness of Marine Corps units accurately. Input for the MCBul 3000 for the Fiscal Year 2009 was received from the MARFORs.

⁶Office of the Secretary of Defense Cost Analysis Improvement Group. *Operating and Support Cost-Estimating Guide*. Washington, D.C.: United States Department of Defense. 2007, 6-8-6-10.

⁷ Headquarters Marine Corps. *Marine Corps Bulletin 3000: Marine Corps Automated Readiness Evaluation System (MARES) Equipment*. Washington, D.C.: United States Department of Navy. 2009, 1 – 2.

⁸ Headquarters Marine Corps. *Automated Readiness Evaluation System (MARES) Equipment, Year, 2*.

In order to obtain the best representative sample of Marine Corps ground equipment deemed to be mission critical, the number of Principal End Items was increased from one hundred sixteen (116) items in 2008, to two hundred twenty-eight (228), in 2009.⁹ With this increase, the historical data may be limited for the new Table of Authorized Material Control Number (TAMCN).

The initial study intended to focus on the four major MARFORs, which accounted for the majority of the USMC organizational and intermediate level maintenance expenditures. The four were: Marine Forces Command (MARFORCOM), Marine Forces Pacific (MARFORPAC), Marine Forces Special Operations Command (MARFORSOC), and Marine Forces Reserves (MARFORRES). During the initial data collection, however a problem with insufficient data existed for MARFORSOC. Since MARFORSOC was activated in February 2006, there was insufficient data to be confident that we could help accurately forecast a requirements budget. Thus, we deleted MARFORSOC from the analysis. Perhaps in five years, the data from MARFORSOC, at the O&I levels of maintenance, could help provide indicators as to what TAMCNs are driving maintenance costs at both the organizational and intermediate levels for that command.

We proceeded to collect data for the three MARFORs for the years FY1999 - 2008. Early analysis of the data showed a significant spike in (Total MARFOR level) expenditures, from \$1.1B in 2002 to \$3.6B in 2003. The spike was identified from the data collected from MARFORCOM. Further research found that MARFORCOM used the Asset Tracking Logistics and Supply System (ATLASS II), which is a deployable, microcomputer-based supply system that provides the ability to control, distribute, and replenish equipment and supplies in assigned areas of operations. It also helps to receive supply support from, and provide supply support to, other services. (James Jackson, personal communication, June 05, 2009) MARFORCOM was using ATLASS II from 1999 to 2004. During this time, the data had to be transferred to the Marine Corps Integrated Maintenance Management System (MIMMS), which will be discussed in Chapter II. Here a major problem was encountered. When the data was transferred, the

⁹ Headquarters Marine Corps. *Automated Readiness Evaluation System (MARES) Equipment, Year*, 1.

extended price, not the unit price, was entered into the unit price field. The extended price is calculated by taking the unit price of a part required and multiplying it by the quantity required. An example of this is: Four windshields are ordered in ATLASS II at a unit price of \$5 and a quantity of 4. The extended price will be \$20. When the data was transferred to MIMMS, the extended price from ATLASS II of \$20 was entered in the unit price field, and then multiplied by the quantity of four to get a new extended price of \$80. (Capt. Dustin Elliot, personal communication, August 18, 2009). With this data entry error discovered, data from 1999–2004 was deemed erroneous, and we have been unable to repair these data. Thus, this study had to disregard those six years of data, and shift its focus to only the years covering 2005–2008.

D. CONTENT OF THIS THESIS WORK

Chapter II discusses the methodology used for Phase I and Phase II of the model from the data set provided by MARCORLOGCOM. Chapter III contains the analysis of the data set used for both Phase I and Phase II. Observations and recommendations from the analysis of the data are included in Chapter IV. The Appendix includes the current MCBUL 3000 and a listing of the TAMCNs used for this thesis.

II. DATA AND METHODOLOGY

A. DATA OVERVIEW

USMC Logistics Command (MARCORLOGCOM), located in Albany, Georgia, provides life cycle management services for the USMC ground systems and equipment, including tracking maintenance and supply data for organizational and intermediate level maintenance. MARCORLOGCOM tracks this maintenance and supply information via three databases: the Marine Corps Integrated Maintenance System (MIMMS), Supported Activity Supply System (SASSY), and the Asset Tracking for Logistics Supply System II (ATLASS II), which are described as:

- MIMMS is a standardized system providing for effective maintenance management related to 1st, 2nd, 3rd, and 4th echelons of maintenance throughout the Marine Corps. Timely and accurate information on the equipment undergoing repair by the maintenance activities is provided. The system interfaces with SASSY, Marine Corps Equipment Information tool (MERIT), and other Department of Defense (DoD) systems as required.
- SASSY is the primary retail supply accounting system for the Marine Corps. It provides retail supply accounting functions such as stock replenishment, requirements determination, receipts, inventory, stock control, and asset visibility. It provides asset visibility to MERIT and other DoD systems.
- ATLASS II is a deployable, microcomputer-based supply system that provides the ability to control, distribute, and replenish equipment and supplies in assigned areas of operations. It also helps to receive supply support from, and provides supply support to, other services. (James Jackson, personal communication, June 05, 2009)

MIMMS/SASSY provides input into the Marine Corps Equipment Readiness Information Tool (MERIT), while ATLASS II does not. MERIT is a web-enabled tool that

graphically depicts the current readiness posture and detailed supply and maintenance information for all Marine Corps readiness reportable TAMCNs. MERIT transforms data into information that provides a view of equipment readiness by commodity and functional area. MERIT gives Force Commanders visibility of their readiness trends, problems, and associated causes.¹⁰ MARCORLOGCOM also reports inventory data by location for each TAMCN into MERIT.¹¹ This data collected by MARCORLOGCOM is maintained in its Master Data Repository. MERIT provides detailed O and I-level maintenance and supply data from MIMMS/SASSY/ATLASS II to provide input into the Navy Visibility and Management of Operating and Support Costs (VAMOSC), maintained by the Naval Center for Cost Analysis.¹²

VAMOSC began in the 1970s based on a General Accounting Office (GAO) recommendation, and later mandated by Congress, that the DoD should accurately determine weapon systems O&S costs. Under the guidance of the OSD CAIG's Cost Element Structure in DoD 5000.4, OSD authorized each service to develop its own general VAMOSC program.¹³ Currently VAMOSC includes the Navy's VAMOSC system and the Marine Corps VAMOSC system, both managed by NCCA; the Air Force VAMOSC system, known as Air Force Total Ownership Cost (AFTOC); and the Army's Operating and Support Management Information Systems (OSMIS). The Air Force and Army manage their own VAMOSC data systems.

¹⁰ Marine Corps Logistics Command. *Marine Corps Equipment Readiness Tool*. <https://merit.logcom.usmc.mil/>

¹¹ Naval Center for Cost Analysis. "Naval Visibility and Management of Operating and Support Costs (VAMOSC)," *USMC Ground Equipment User Manual*. Washington, D.C.: Naval Center for Cost Analysis. February 2009, 37.

¹² Marine Corps Logistics Command. *Marine Corps Equipment Readiness Tool*. <https://merit.logcom.usmc.mil/>

¹³ Naval Center for Cost Analysis. "Naval Visibility and Management of Operating and Support Costs (VAMOSC)," *USMC Ground Equipment User Manual*. Washington, D.C.: Naval Center for Cost Analysis. February 2009, 1.

An Equipment Repair Orders (ERO) is a standard document used to request and record maintenance on an item of equipment. O and I-level maintenance and supply data consists of records of these EROs opened during a fiscal year.¹⁴ The elements included in an ERO are shown in Table 1.

Maintenance Data	Supply Data
Fiscal Year	Fiscal Year
TAMCN	TAMCN
TAMCN Description	TAMCN Description
RAC	RAC
ERO	ERO
Maintenance Echelon	Maintenance Echelon
Date Received in Shop	Date Received/Cancelled
ERO Date Closed	NSN Required
Equipment Serial Number	SMR Code
Primary Meter Reading	Advise Code
Military Labor Hours	Unit Price
ID Number	Quantity Required
Hold UIC (RUC)	

Table 1. Raw Data Elements for all Equipment Repair Orders

The initial data for the O and I-level maintenance consists of tracked TAMCNs. The data is then separated by O and I-level first and second echelon of maintenance codes (O=1, 2, and I=3, 4).¹⁵ The echelon of maintenance provides flexibility and accuracy in defining the levels of maintenance operations in the Marine Corps. The echelon of maintenance is defined as the following:

1. First Echelon Organizational Maintenance (O=1)

First echelon organizational maintenance is that work performed by the user or operator of the equipment. It includes proper care, use, operation, cleaning, preservation,

¹⁴ Headquarters Marine Corps. *MIMMS AIS Field Maintenance Procedures Users Manual*. Washington, D.C.: United States Department of the Navy. July 1994, A-8.

¹⁵ Naval Center for Cost Analysis. "Naval Visibility and Management of Operating and Support Costs (VAMOSOC)," *USMC Ground Equipment User Manual*. Washington, D.C.: Naval Center for Cost Analysis. February 2009, 37.

and lubrication; and such adjustments as minor repairs, testing, and parts replacement as may be prescribed by technical publications.

2. Second Echelon Organizational Maintenance (O=2)

Second echelon organizational maintenance is that work performed by specially trained personnel with the organization. Appropriate publications authorize the second echelon of maintenance, additional tools and necessary parts, supplies, and skilled personnel to perform maintenance beyond the capabilities and facilities of the first echelon.

3. Third Echelon Intermediate Maintenance (I=3)

Third echelon intermediate maintenance is that work performed by specially trained units in direct support of one or more using organizations. Third echelon maintenance is authorized a larger allotment of tools and test equipment than is provided to using organizations.

4. Fourth Echelon Intermediate Maintenance (I=4)

Fourth echelon intermediate maintenance is that work performed by units organized as semi-fixed or permanent shops to serve lower maintenance echelons within a geographical area. The principal function of fourth echelon maintenance is to repair subassemblies, assemblies, and major items, for return to the lower echelons or the supply system.¹⁶

B. INPUT PARAMETERS

From Table 1, the input parameters used in this study will consist of the Fiscal Year; TAMCNs; Regional Activity Code (RAC); Maintenance Echelon; Unit Price; Quantity Required; and also Inventory Levels. The Fiscal Years used for the study will be from 2005 to 2008. The TAMCN's and TAMCN Description are given in Appendix A.

¹⁶ Headquarters Marine Corps. *MIMMS AIS Field Maintenance Procedures Users Manual*. Washington, D.C.: United States Department of the Navy. July 1994, A-1 – A-24.

The Regional Activity Code (RAC) is a means to identify and separate by region (or in most case's by Marine Expeditionary Forces (MEF's)). The part and labor costs are separated by the RAC assigned, the reporting information, and by Fiscal Year (FY). (James Jackson, personnel communication, August 12, 2009) The MIMMS/SASSY/ATLASS II reporting information categorizes seven RACs when separating the maintenance data:

- MIM001 Camp Pendleton, California
- MIM002 Camp Lejeune, North Carolina
- MIM003 Okinawa, Japan
- MIM004 Reserves, New Orleans, Louisiana
- MIMMPS Maritime Prepositioning Ships (MPS)/Maritime Prepositioning Forces (MPF)
- MIM007 Deployed
- MIM008 Bases/Posts/Stations

This study will focus on four of these RACs: MIM001, MIM002, MIM003, and MIM004. The other three were disregarded at the request of the sponsor, whose main interest is on the maintenance expenditures of the MARFORs. For organizational purposes, MIM001 and MIM003 report to Marine Forces Pacific Command (MARFORPAC), MIM002 reports to Marine Forces Command (MARFORCOM), and MIM004 reports to Marine Forces Reserve (MARFORRES). MARCORLOGCOM provides the Echelon of Maintenance; Unit price, Quantity required, and Inventory levels data for the four RACs.

C. METHODOLOGY

Analysis of the data set will be conducted in two phases.

1. Phase I

Phase I uses past maintenance expenditures to predict future annual MARFOR budget requests. The following tasks will be accomplished:

- Create a data worksheet for each Marine Corps Bulletin 3000 Table of Authorized Material Control Number, broken down by MARFOR and by year (2005–2008).
- Populate worksheets with annual Organizational and Intermediate (O and I) level part and labor costs, using constant dollars.
- Normalize all data to Fiscal Year 2008 dollars (FY08\$).
- Sum O and I level part and labor costs for each fiscal year, and calculate the means and standard deviations per TAMCN, per year.

The end result of Phase I will advise comptrollers to question budget requests that fall outside the historic range of one standard deviation around the historic mean. It also identifies which TAMCNs consume the majority of the maintenance budget.

2. Phase II

Phase II uses past inventory levels to predict future annual MARFOR budget requests per unit possessed by the MARFORs. The following task will be accomplished:

- Divide the total O and I level part and labor costs by the number of MARFOR possessed TAMCNs per year.
- Normalize all data to Fiscal Year 2008 dollars (FY08\$).
- Sum O and I level average unit costs for each TAMCN per fiscal year, and calculate the means and standard deviations per TAMCN, per year.

The end result of Phase II will advise comptrollers to question budget requests that fall outside the historic range of one standard deviation around the historic mean. It

also identifies which TAMCNs consume the majority of the maintenance budget. Phase II allows the comptrollers to predict future average unit cost per TAMCN per year as inventory levels are adjusted over time. It also identifies the average unit cost per TAMCN per year.

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III. ANALYSIS

This study's main research question concerning "sustainment requirements needed for the Marine Forces" is addressed using descriptive statistics. The analysis will be discussed in a top down approach, first showing the Total MARFOR maintenance expenditures of all 228 TAMCNs listed in the current FY09 MCBUL 3000 (See Appendix for complete list). These expenditures are for the years 2005–2008. Second, we then will analyze the data by MARFORs and discuss the results from the three individual MARFORs: Marine Forces Command (MARFORCOM), Marine Forces Pacific (MARFORPAC), and Marine Forces Reserve (MARFORRES), used in this study. The two phases of the study are:

1. Sum O and I level part and labor costs for each fiscal year, and calculate the means and standard deviations per TAMCN, per year.
2. Sum O and I level average unit costs for each TAMCN per fiscal year, and calculate the means and standard deviations per TAMCN, per year.

Observations for both phases are reported after the analysis. The observations for Phase I are in section 5, page 62. The observations for Phase II are in section 21, page 85.

A. PHASE I

In this Phase we will discuss MARFOR expenditures for both Organizational and Intermediate Level of maintenance. As previously discussed in Chapter 2, the analysis on the three MARFORs (MARFORCOM, MARFORPAC, and MARFORRES), will identify the following information:

1. The Total Maintenance Expenditures per MARFOR.
2. The TAMCNs that consume 80% of the expenditures per level of the maintenance echelon.
3. The percentage per year that the TAMCNs expend.

4. The delta between expenditures when there was an increase or decrease in total maintenance expenditures.

1. Total MARFOR O and I Maintenance Expenditures

Figure 1 shows the Total MARFOR O and I maintenance expenditures from 2005 to 2008. The MARFORs spent, on average, \$461.35M per year during the four years studied. From Figure 1 there is a major spike in expenditures from 2007 to 2008; this increase of 83.05 percent is driven by MARFORCOM and MARFORRES. Both of these commands will be discussed later in this chapter to establish what is driving their costs. With this spike, the total expenditures FY2008 are 1.5 standard deviations from the historic mean.

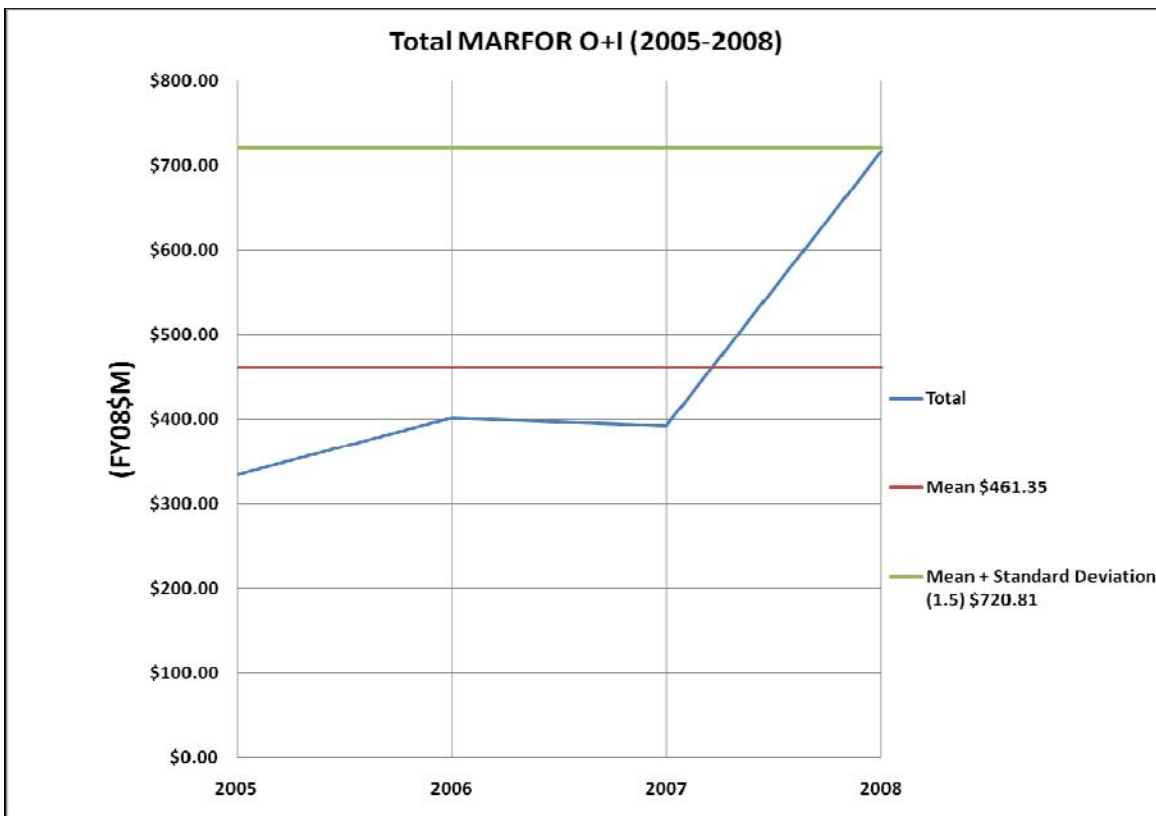


Figure 1. Total MARFOR O + I (2005–2008) with 1.5 Standard Deviations

The spike in 2008 was an increase from \$391.74M in 2007 to \$717.07M in 2008. This was mainly caused by 17 TAMCNs which accounted for 80 percent of the total

expenditures during that year. These 17 TAMCNs are described and listed by the total percentage expended during 2008 in Table 2.

TAMCN DESCRIPTION	TAMCNs	Percentage
Machine Gun, Cal .50, Browning, HB Flexible - M2	E0980	17.05%
Machine Gun, 40MM - MK19 MOD3	E0994	16.66%
Mortar, 81mm, M252	E1095	5.62%
Assault Amphibious Vehicle, Personnel, AAVP7A1	E0846	5.54%
Truck, Utility, Cargo, Troop Carrier, HMMWV, M1123	D1158	4.82%
Machine Gun, Medium, 7.62MM, Ground Version - M240B	E0989	4.59%
Truck, Cargo, 7 Ton, W/O Winch (MTVR) MK23/MK25	D0198	4.31%
Tank, Combat, Full-Tracked, 120mm Gun, M1A1	E1888	3.70%
Mortar, 60MM, M224	E1065	3.54%
Launcher, Tubular F/GM (TOW), M220E4	E0935	3.42%
Power Unit, Front, 4x4, MK 48, Mod 0	D0209	2.34%
Rifle, Sniper, 7.62MM, W/Equipment	E1460	2.15%
M14/Sniper Rifle, EMR	E0311	1.46%
Truck, Utility, TOW Carrier, HMMWV, M1045/M1046	D1125	1.41%
Light Armored Vehicle, 25mm, LAV-25	E0947	1.25%
AN/PRC-117F/Radio Set, Multiband, Falcon II	A2068	1.25%
Truck, Utility, Expanded Capacity, Enhanced, 11,500 GVW, 4x4, M1152 (2-Door)	D0022	1.20%
Total		80.29%

Table 2. Description of Top 17 Total MARFOR TAMCNs Accounting for 80.29% of Total Expenditures in 2008

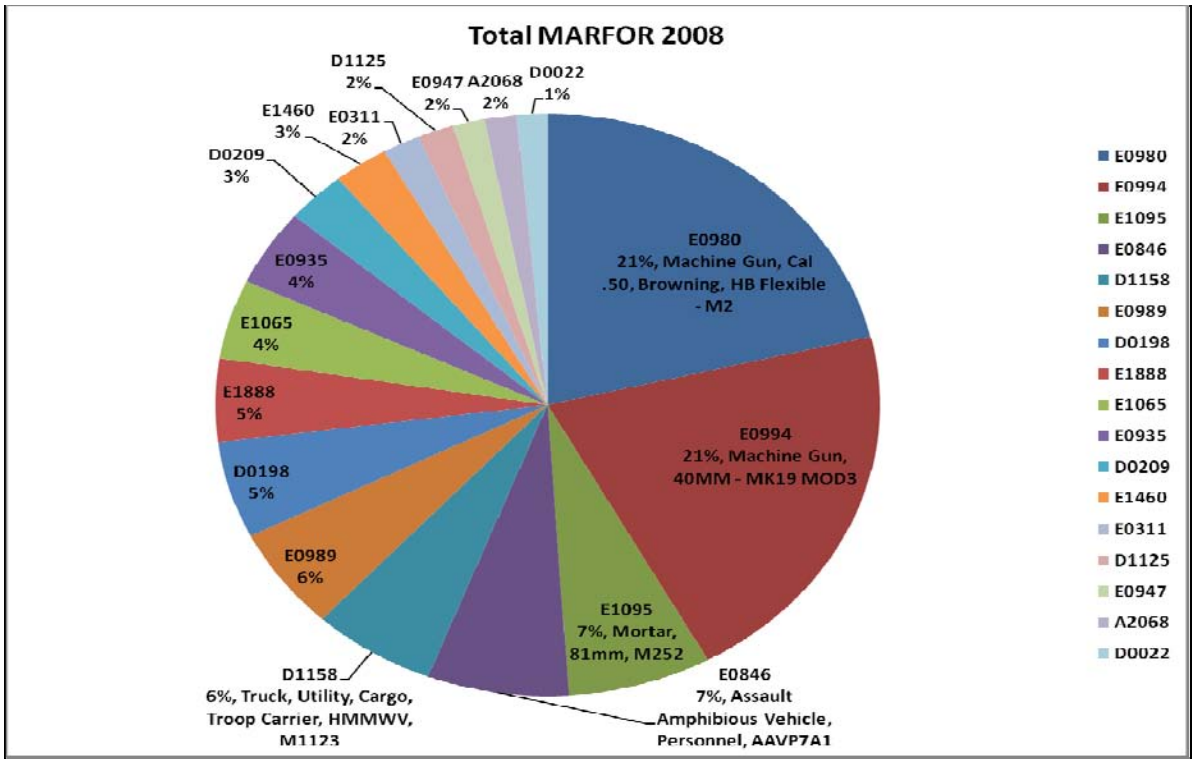


Figure 2. Top 17 TAMCNs

The four TAMCNs that expended the most maintenance dollars (“The Top Four”), as shown in Figure 2, accounted for 45 percent of the total maintenance expenditures in 2008. In Figure 3, these top four TAMCNs are shown as a percentage of the total spent during the four years, as an example. Figure 3 shows E0994, Machine Gun 40MM, was a low percentage of the total from 2005 to 2007, but, from 2007 to 2008, its percentage of the total expenditures increased dramatically from 1.63 percent to 21.13 percent. These top four TAMCNs: Machine Gun; .50 Cal, Machine Gun, 40MM; Mortar, 81MM; and Assault Amphibious Vehicle, Personnel, were the factors that led to a significant difference in expenditures from 2007 to 2008. This increase was \$210.17M or 64.6 percent of the total difference in expenditures from 2007 to 2008. Figure 4 graphically compares the expenditures from 2007 to 2008 for these four TAMCNs as well as the difference in expenditures between 2007 and 2008. The difference is significant because it increased the historic mean of the Total MARFORs expenditures and it shows the influence that a few TAMCNs can have on the total maintenance expenditures.

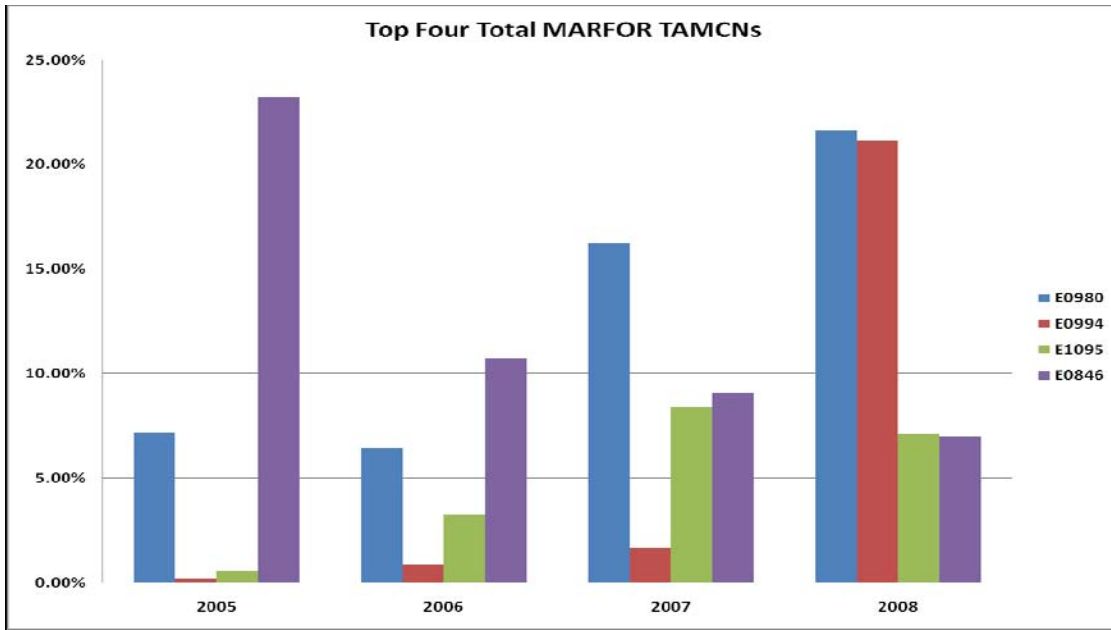


Figure 3. Top Four TAMCNs as a Percentage of the Total Spent per Year

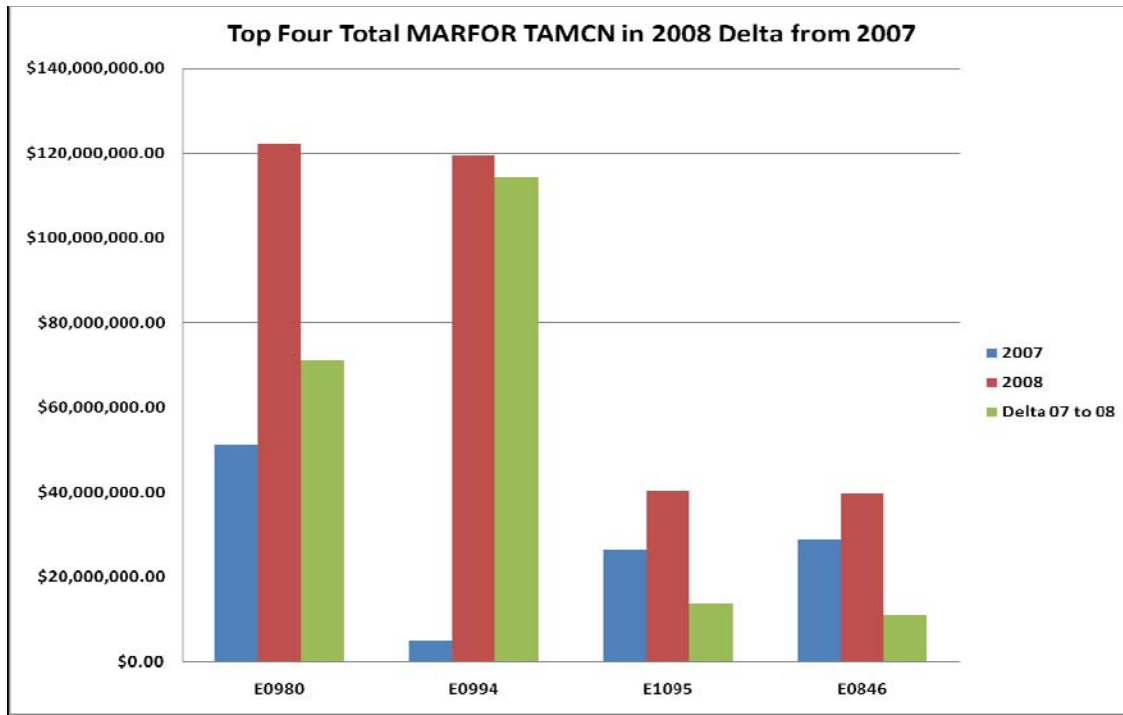


Figure 4. Change in Expenditures from 2007 to 2008 in the Four TAMCNs

In Figure 2, we showed the 17 TAMCNs which were driving the MARFOR costs in 2008. We then did further analysis of the Total MARFOR O and I expenditures focused on the top TAMCNS driving maintenance expenditures during 2005–2008.

From this, we determined the total number of TAMCNs during the four year period which remained at a steady interval. Figure 5 shows that the total numbers of TAMCNs per year accounting for 80 percent of the total maintenance expenditures are steady. In 2005, 19 TAMCNs comprised the top 80%, while only 15 comprised the top 80% in 2006.

Next, we added the percentages of total maintenance expenditures for each year and took the averages of all the 228 TAMCNs to find how many TAMCNs during the four year period were accounting for the highest percentage of the expenditures. Calculations revealed that twenty TAMCNs were responsible for 76.4 percent of the total maintenance expenditures spent by all the MARFORs during 2005–2008. These 20 TAMCNs are described and listed by the total percentage of expenditures in Table 3 and are graphically displayed in Figure 6.

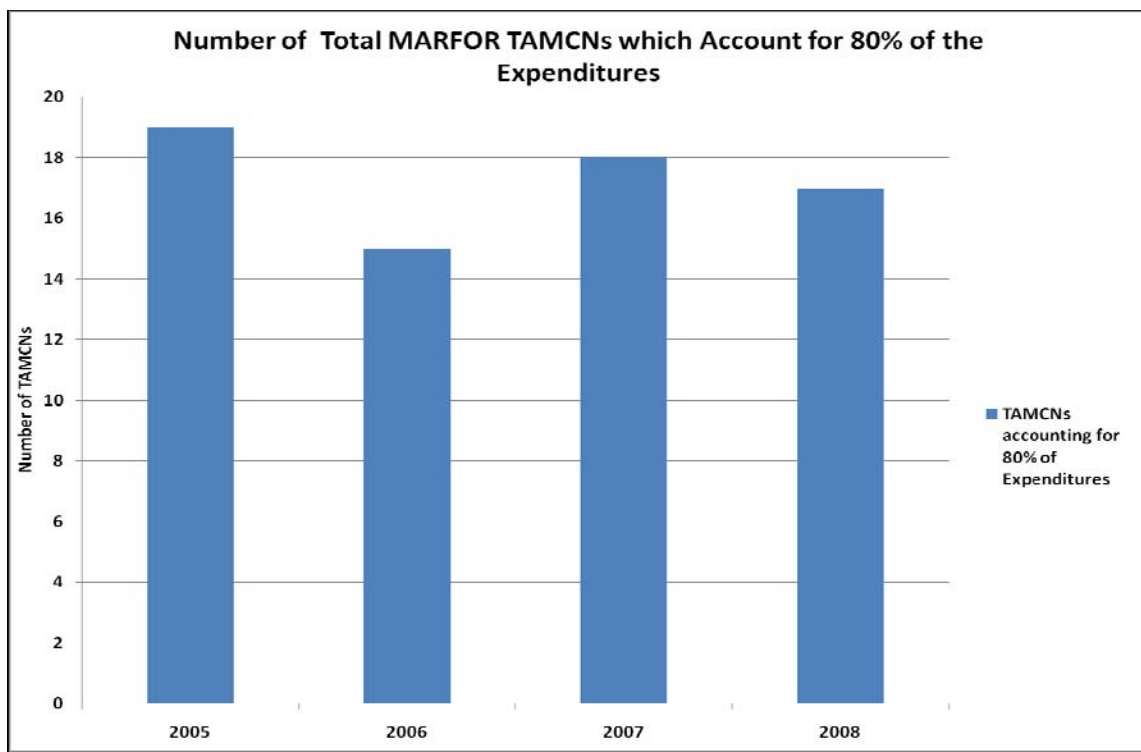


Figure 5. Number of TAMCNs Accounting for 80% of the Total Maintenance Expenditures

TAMCN DESCRIPTION	Top Twenty TAMCN's	Average percentage (2005-2008)
Launcher, Tubular F/GM (TOW), M220E4	E0935	10.24%
Machine Gun, Cal .50, Browning, HB Flexible - M2	E0980	10.23%
Assault Amphibious Vehicle, Personnel, AAVP7A1	E0846	9.88%
Tank, Combat, Full-Tracked, 120mm Gun, M1A1	E1888	6.82%
Truck, Utility, Cargo, Troop Carrier, HMMWV, M1123	D1158	6.51%
Machine Gun, 40MM - MK19 MOD3	E0994	4.49%
Mortar, 81mm, M252	E1095	3.77%
Howitzer, Medium, Towed 155MM, M198	E0665	3.50%
Light Armored Vehicle, 25mm, LAV-25	E0947	2.63%
Truck, Cargo, 7 Ton, W/O Winch (MTVR) MK23/MK25	D0198	2.39%
Mortar, 60MM, M224	E1065	2.18%
Power Unit, Front, 4x4, MK 48, Mod 0	D0209	2.05%
Radio Set, Manpack, AN/PRC-119A	A2070	2.04%
Radio Terminal Set, AN/MRC-142A	A1955	1.98%
Machine Gun, Medium, 7.62MM, Ground Version - M240B	E0989	1.72%
Sight, Thermal, AN/UAS-12C Hybrid	E0330	1.49%
Radio Set, AN/MRC-145A	A1957	1.45%
Rifle, Sniper, 7.62MM, W/Equipment	E1460	1.35%
Radar Set, LW3D, AN/TPS-59(V)3	A1503	1.11%
Secure Mobile Anti-Jam Reliable Tactical Terminal (SMART-T), AN/TSC-154	A3232	0.53%
Total		76.38%

Table 3. Description of the Top 20 TAMCNs Average Percentage from 2005–2008

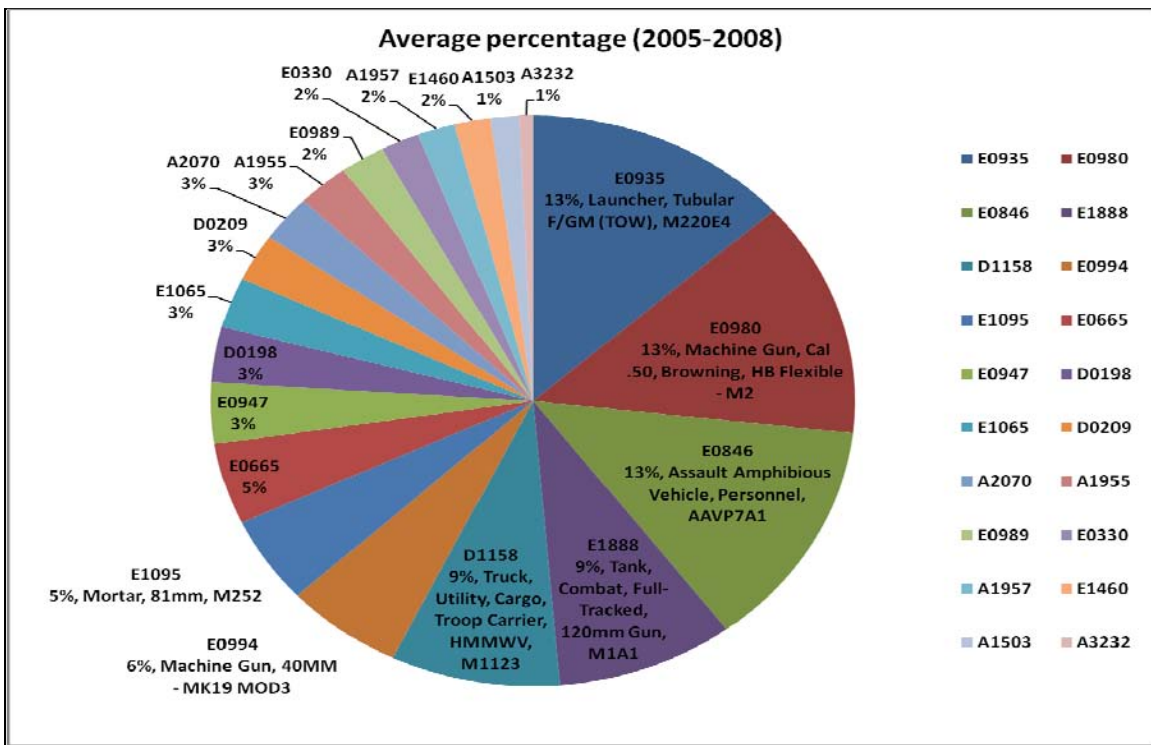


Figure 6. Top 20 TAMCNs from 2005–2008

2. MARFORCOM O and I Maintenance Expenditures

United States Marine Forces Command (MARFORCOM), headquartered at Naval Base Norfolk, VA, is the United States Marine Corps Service Component to the United States Joint Forces Command (USJFCOM). MARFORCOM is one of three major Marine Corps commands (along with MARFORPAC and MARFORRES) that provide operating forces to support Unified or Joint Task Force Commanders. The warfighting arm of MARFORCOM is the II Marine Expeditionary Force (II MEF). II MEF is composed of about 45,000 personnel, mostly from Camp Lejeune, North Carolina. Commander Marine Forces Command (COMMARFORCOM) serves in the following capacities: Commanding General, Fleet Marine Force Atlantic, and Commander, United States Marine Corps Bases, Atlantic.¹⁷

In Figure 1, in which there was a maintenance expenditure spike from 2007 to 2008 for the Total MARFORs, one of the factors for this increase was MARFORCOM's inputs to the total model. The Total MARFORCOM maintenance expenditures spiked from 2007 to 2008 by almost 113 percent, as shown in Figure 7. Figure 7 also shows MARFORCOM was below the historic expenditure mean from 2005 to 2007 until the spike to 2008. Prior to the spike, which will be explained later, MARFORCOM was below the historic expenditure mean plus one standard deviation. In 2008, MARFORCOM was 1.4 standard deviations above its 2005–2007 mean.

¹⁷ Marine Forces Command. <http://www.marforcom.usmc.mil/Background.html>

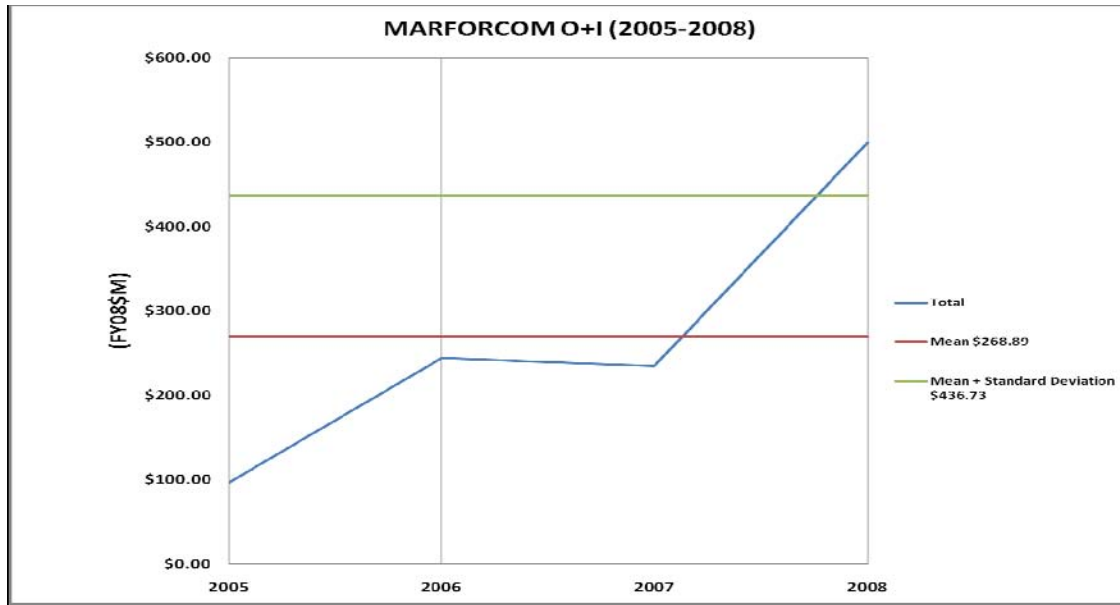


Figure 7. MARFORCOM O and I Maintenance Expenditures (2005–2008)

In 2008, MARFORCOM had total maintenance expenditures of \$499.43M; there were nine TAMCNs responsible for 81.6 percent of the total maintenance expenditures for that year. These nine TAMCNS are listed by the total percentage of expenditures in 2008 in Table 4 and graphically displayed in Figure 8. As was seen in Figure 2, the same top three TAMCNs were driving cost at the Total MARFORCOM level.

TAMCN Description	TAMCNs	Percentage
Machine Gun, Cal .50, Browning, HB Flexible - M2	E0980	24.31%
Machine Gun, 40MM - MK19 MOD3	E0994	23.66%
Mortar, 81mm, M252	E1095	7.92%
Machine Gun, Medium, 7.62MM, Ground Version - M240B	E0989	5.80%
Mortar, 60MM, M224	E1065	5.04%
Truck, Cargo, 7 Ton, W/O Winch (MTVR) MK23/MK25	D0198	4.75%
Launcher, Tubular F/GM (TOW), M220E4	E0935	4.64%
Rifle, Sniper, 7.62MM, W/Equipment	E1460	3.07%
Power Unit, Front, 4x4, MK 48, Mod 0	D0209	2.42%
Total		81.60%

Table 4. Description of the Nine MARFORCOM TAMCNs Accounting for 81.6% of the Total Expenditures in 2008

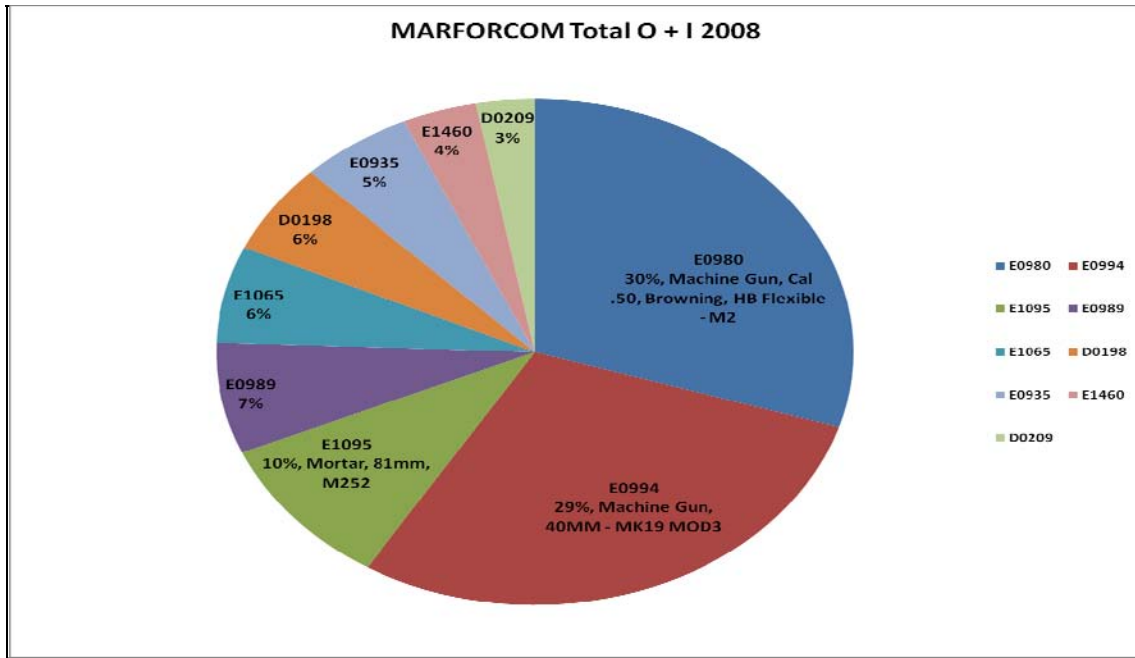


Figure 8. MARFORCOM 2008 Percentage of Total Expenditures of the 9 TAMCNs

E0994 and E0980 are the two dominant expenders of O&I costs. Table 5 highlights the dramatic increase in maintenance expenditures from 2007 to 2008 as well as the total percentage of expenditures during those years. The total increase of expenditures from 2007 to 2008 was \$264.73M for all 228 TAMCNs. Figure 9 graphically shows the total percentage of expenditures for the top three TAMCNs from 2007 to 2008, and Figure 10 shows the difference between the total expenditures.

There were two reasons for this increase in maintenance expenditures for E0994. First, more E0994 were required in support of combat operations in Iraq, driving the costs for rebuilds upwards which caused an increase in the quantity for the number of rebuilds. There was also a modification to an item that was required for all MK19s in the Marine Corps. This modification was to facilitate mounting a thermal sight on the receiver. (Major Brian Spooner, personal communication, September 1, 2009) Recent communication with MARCORLOGCOM has suggested that the modifications to E0994 occurred at the Depot Level. (Michael Brown, personnel communication, September 4, 2009) MARCORLOGCOM was unable to explain the reason for the increase at the I-level.

TAMCN	2007 (\$M)	2008 (\$M)	(+ or -) Delta 07 to 08 (\$M)	% of 2007	% of 2008	(+ or -) % Difference
E0980	\$50.74	\$121.43	\$70.69	21.62%	24.31%	2.70%
E0994	\$5.02	\$118.17	\$113.16	2.14%	23.66%	21.52%
E1095	\$26.32	\$39.54	\$13.22	11.21%	7.92%	-3.30%

Table 5. Total Expenditures and Total Percentage of Expenditures Differences from 2007 to 2008

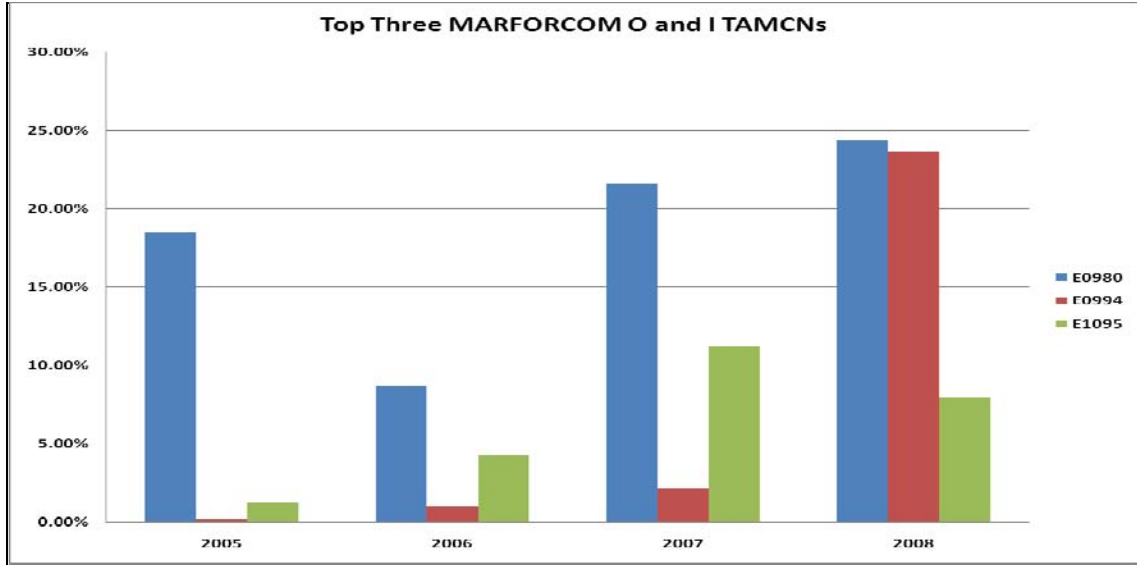


Figure 9. Top Three TAMCNs as a Percentage of the Total Spent per Year

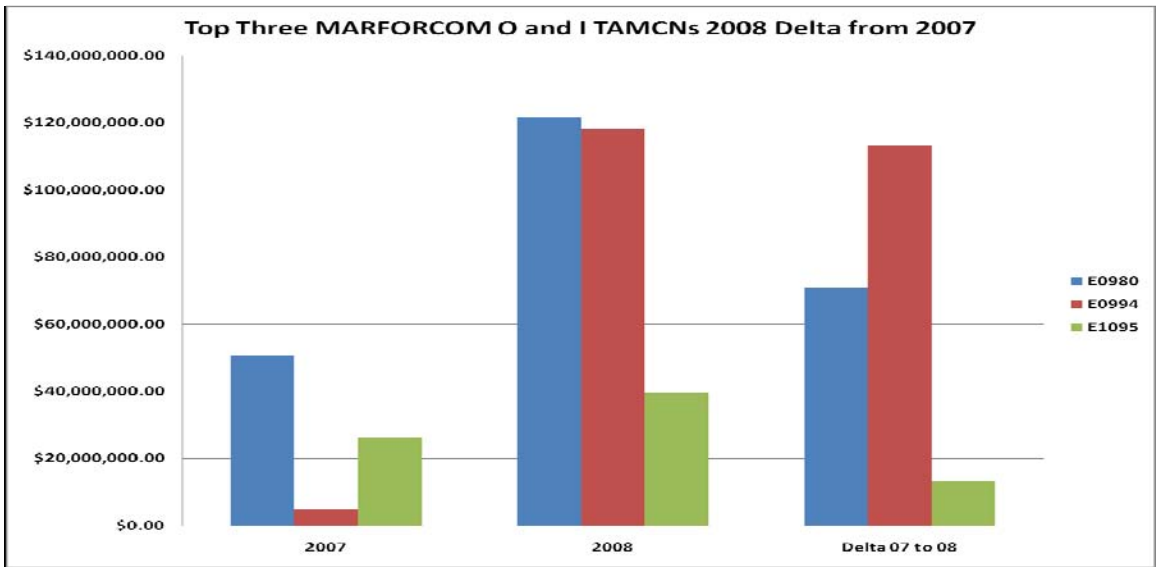


Figure 10. Change in Expenditures from 2007 to 2008 in the Three TAMCNs

Figure 11 shows that the total number of TAMCNs that account for 80 percent of the total MARFORCOM maintenance expenditures has decreased from 14 in 2005 to just nine in both 2007 and 2008. This decrease in the total number of TAMCNs means that fewer TAMCNs are expending more of the maintenance dollars. Operating efficiencies in these nine systems could save the Marine Corps significant maintenance dollars.

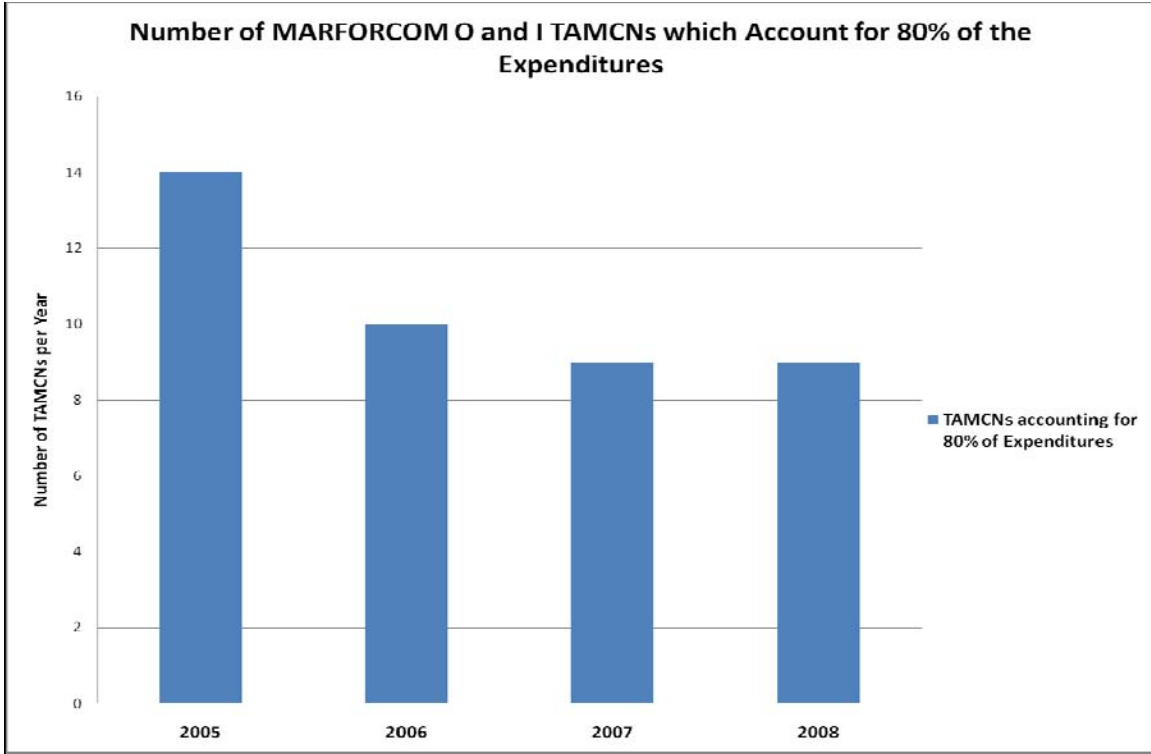


Figure 11. Number of TAMCNs accounting for 80% of Total MARFORCOM Maintenance Expenditures

a. MARFORCOM O-Level Expenditures

Of the total \$499.43M spent by MARFORCOM in maintenance in 2008, \$180.64M was spent at the organizational level. In Figure 7, the organization level for MARFORCOM showed fluctuation in the total maintenance expenditures from 2005 to 2008. Even with these fluctuations in total maintenance expenditures, expenditures at the organizational level at MARFORCOM still remained below one standard deviation of the historic mean.

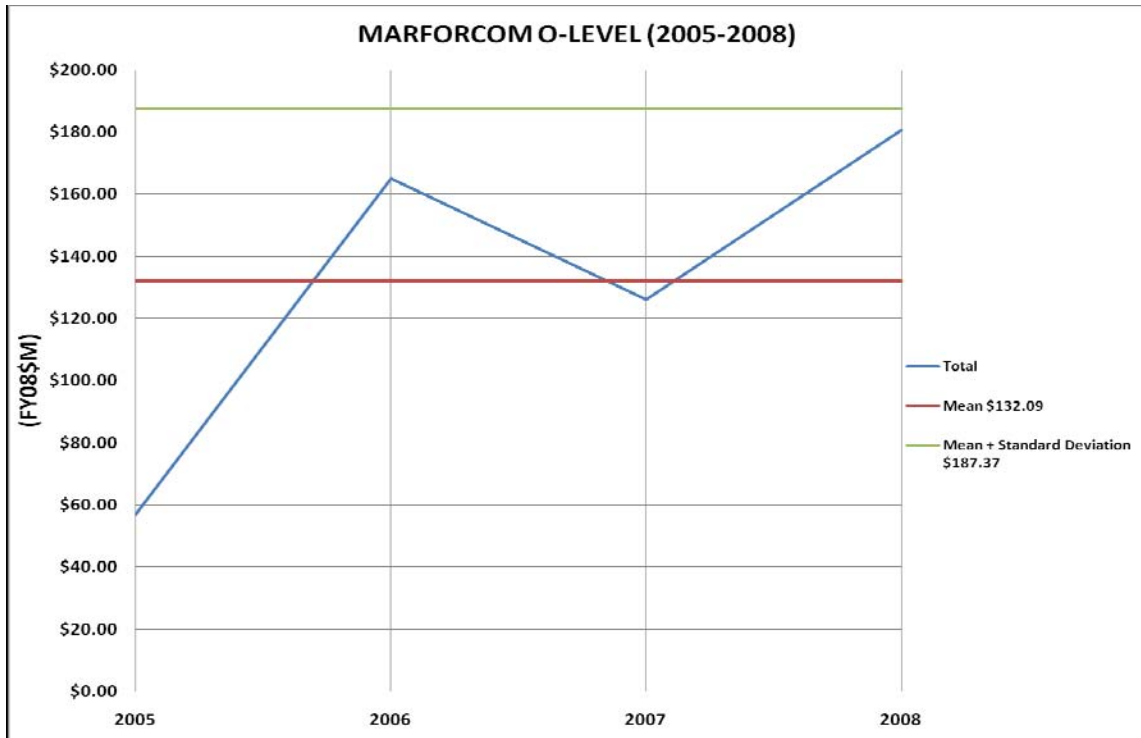


Figure 12. MARFORCOM O-Level Maintenance Expenditures (2005–2008)

The maintenance expenditures at the O-level for MARFORCOM were driven by 18 TAMCNs, listed by total percentage of expenditures in 2008 in Table 6. These 18 TAMCNs accounted for 80.29 percent of the total maintenance expenditures during 2008, as shown in Figure 13. There were four TAMCNs at the O-level accounting for 45 percent of the total maintenance expenditures in 2008, which are shown in Figure 14.

TAMCN DESCRIPTION	TAMCNs	Percentage
Truck, Cargo, 7 Ton, W/O Winch (MTRV) MK23/MK25	D0198	12.95%
Launcher, Tubular F/GM (TOW), M220E4	E0935	12.64%
Machine Gun, 40MM - MK19 MOD3	E0994	12.41%
Machine Gun, Cal .50, Browning, HB Flexible - M2	E0980	7.47%
Power Unit, Front, 4x4, MK 48, Mod 0	D0209	6.25%
Mortar, 60MM, M224	E1065	5.73%
Tank, Combat, Full-Tracked, 120mm Gun, M1A1	E1888	5.39%
Mortar, 81mm, M252	E1095	3.97%
AN/PRC-117F/Radio Set, Multiband, Falcon II	A2068	1.90%
Trailer, Powered, Container Hauler 4x4, MK14	D0876	1.47%
Radio Set, Manpack, AN/PRC-119A	A2070	1.47%
Sight, Thermal, AN/UAS-12C Hybrid	E0330	1.46%
Radio Terminal Set, AN/MRC-142A	A1955	1.44%
Truck Wrecker, MTRV, MK-36,	D1213	1.34%
Truck, Utility, Expanded Capacity, Enhanced, 11,500 GVW, 4x4, M1152 (2-Door)	D0022	1.17%
Assault Amphibious Vehicle, Personnel, AAVP7A1	E0846	1.16%
Radio Set, Vehicle, Dual VAA, AN/VRC-111	A0069	1.06%
Truck, Armored, 7 ton Cargo, AMK23	D0003	1.03%
Total		80.29%

Table 6. Description of the 18 MARFORCOM O-Level TAMCNs Accounting for 80.29% of the Total Expenditures in 2008

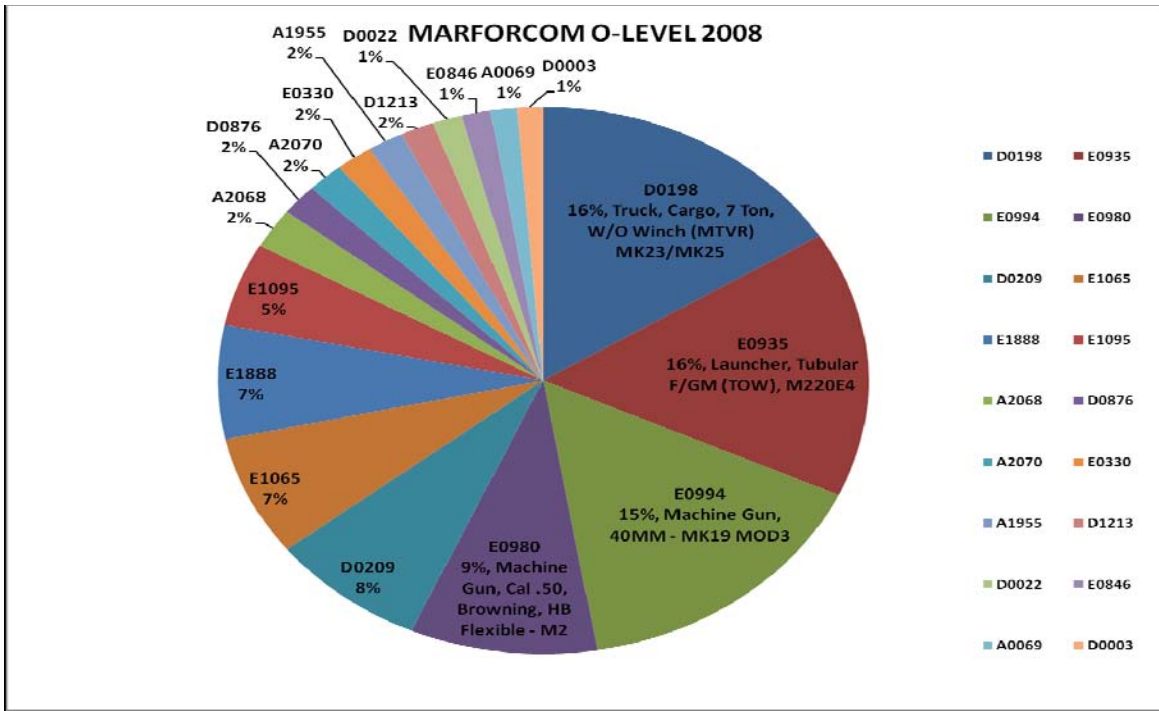


Figure 13. Top 18 TAMCNs in 2008

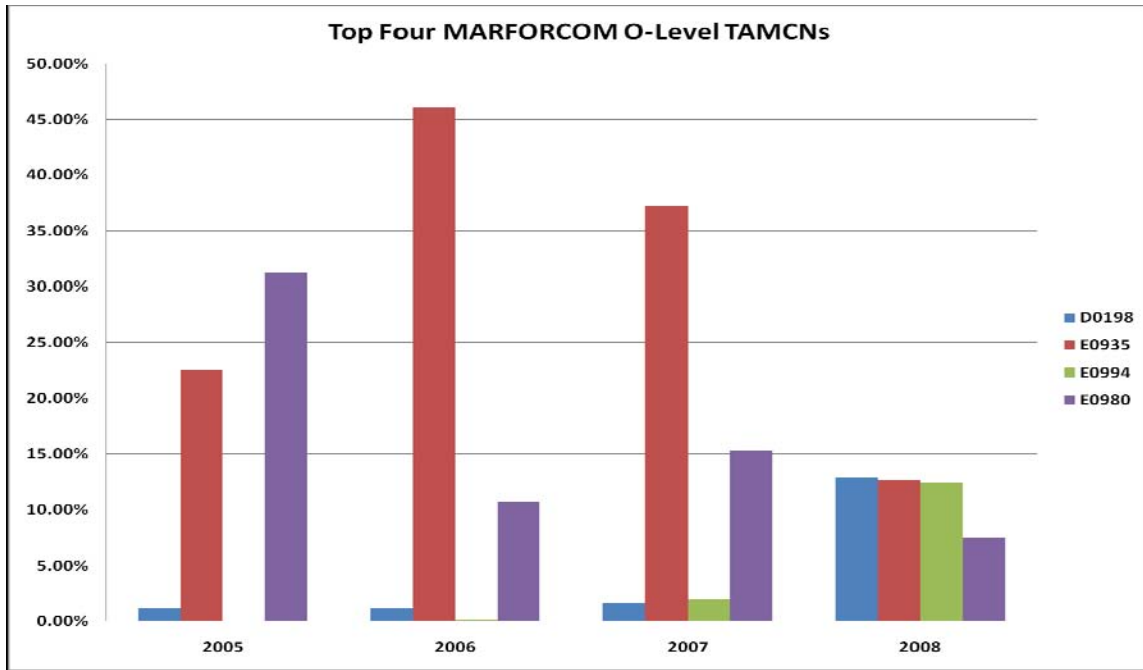


Figure 14. Top Four TAMCNs as a Percentage of the Total Spent per Year

Table 7 shows the difference of the total expenditures and total percentage of expenditures from 2007 to 2008 of the top four TAMCNs. These four TAMCNs, however, were not a major influence of the spike at the Total MARFOR level. Of the four TAMCNs, only two had an increase in expenditures from 2007 to 2008: these were D0198 and E0994, as shown in Figure 15.

TAMCN	2007 (\$M)	2008 (\$M)	(+ or -) Delta 07 to 08 (\$M)	% of 2007	% of 2008	(+ or -) % Difference
D0198	\$2.07	\$23.40	\$21.33	1.64%	12.95%	11.31%
E0935	\$46.97	\$22.83	-\$24.14	37.25%	12.64%	-24.61%
E0994	\$2.43	\$22.41	\$19.98	1.92%	12.41%	10.48%
E0980	\$19.33	\$13.49	-\$5.84	15.33%	7.47%	-7.86%

Table 7. Total Expenditures and Total Percentage of Expenditures Differences from 2007 to 2008

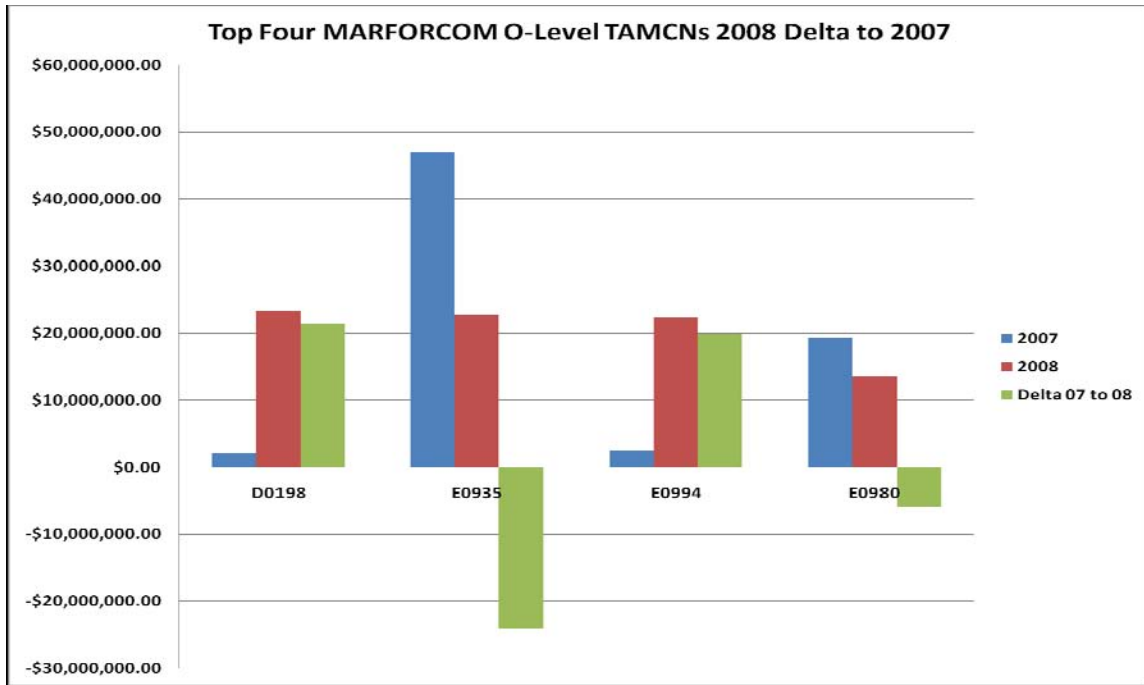


Figure 15. Change in Expenditures from 2007 to 2008 in the Four TAMCNs

The number of TAMCNs that were accounting for 80 percent of the total maintenance expenditures also changed at the O-Level from 2005 to 2008. Figure 16 shows that from 2005 to 2007, the number of TAMCNs remained between eight to ten TAMCNs, but in 2008 this number rose to 18.

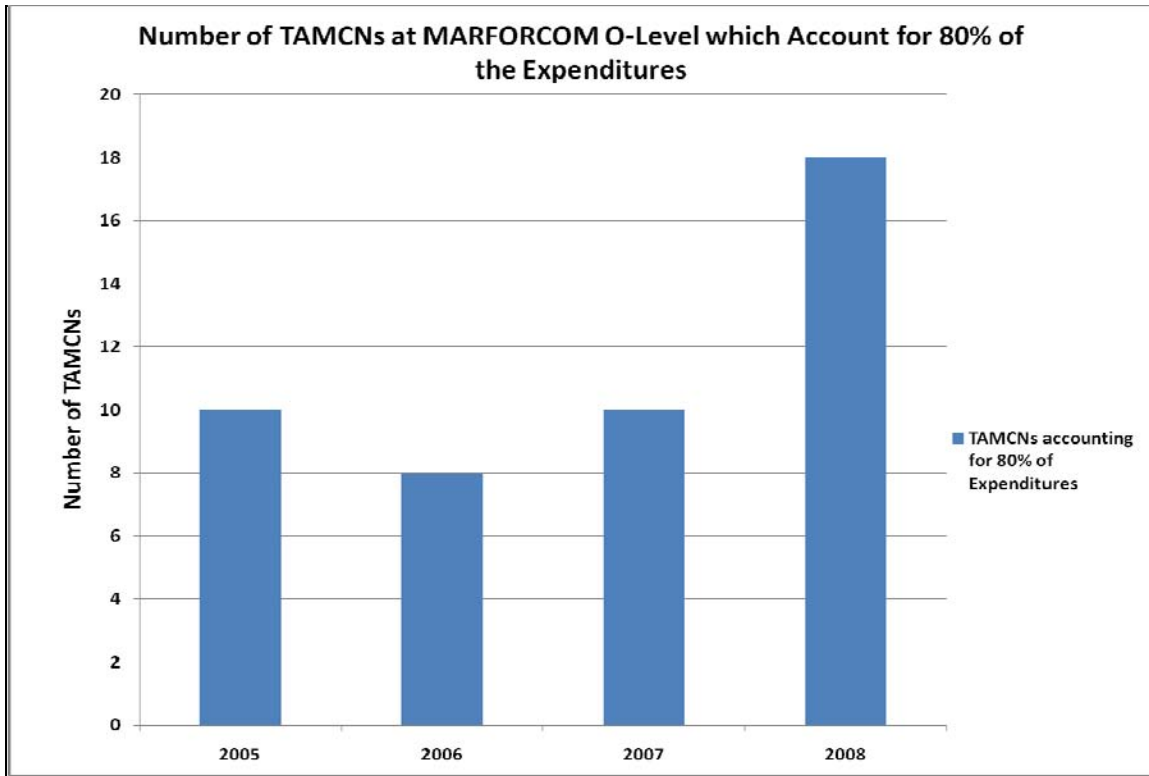


Figure 16. Number of TAMCNs accounting for 80% of MARFORCOM O-Level Maintenance Expenditures

b. MARFORCOM I-Level Expenditures

Shown in Figure 17, MARFORCOM I-level spent \$318.79M in 2008, or 64 percent of the total maintenance expenditures at the total MARFORCOM level. Since 2005, the MARFORCOM I-level has had increasing maintenance expenditures. The biggest increase, 293 percent, occurred from 2007 to 2008, and was driven by the four TAMCNs shown in Figure 18. These four TAMCNs accounted for 83.03 percent of the total maintenance expenditures at the I-level for MARFORCOM, as shown in Table 8.

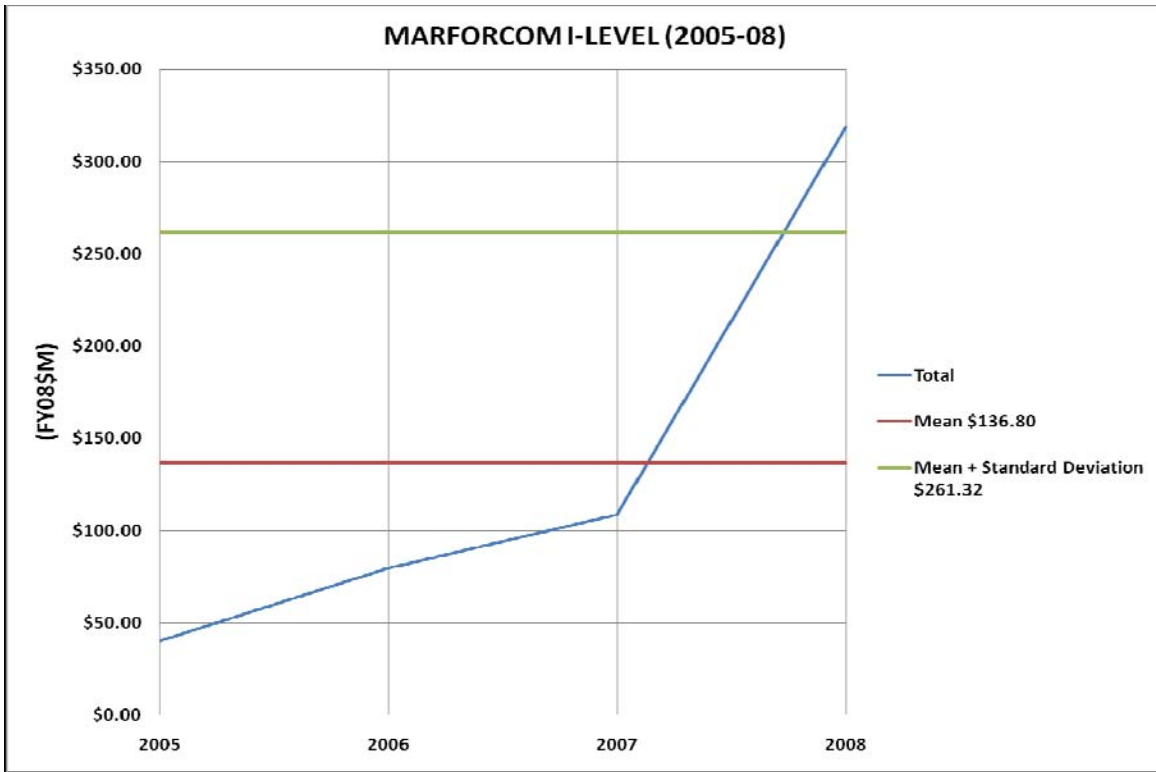


Figure 17. MARFORCOM I-Level Maintenance Expenditures (2005–2008)

TAMCN Description	TAMCNs	Percentage
Machine Gun, Cal .50, Browning, HB Flexible - M2	E0980	33.86%
Machine Gun, 40MM - MK19 MOD3	E0994	30.04%
Mortar, 81mm, M252	E1095	10.15%
Machine Gun, Medium, 7.62MM, Ground Version - M240B	E0989	8.98%
Total		83.03%

Table 8. Description of the Four MARFORCOM I-Level TAMCNs Accounting for 83.03% of the Total Expenditures in 2008

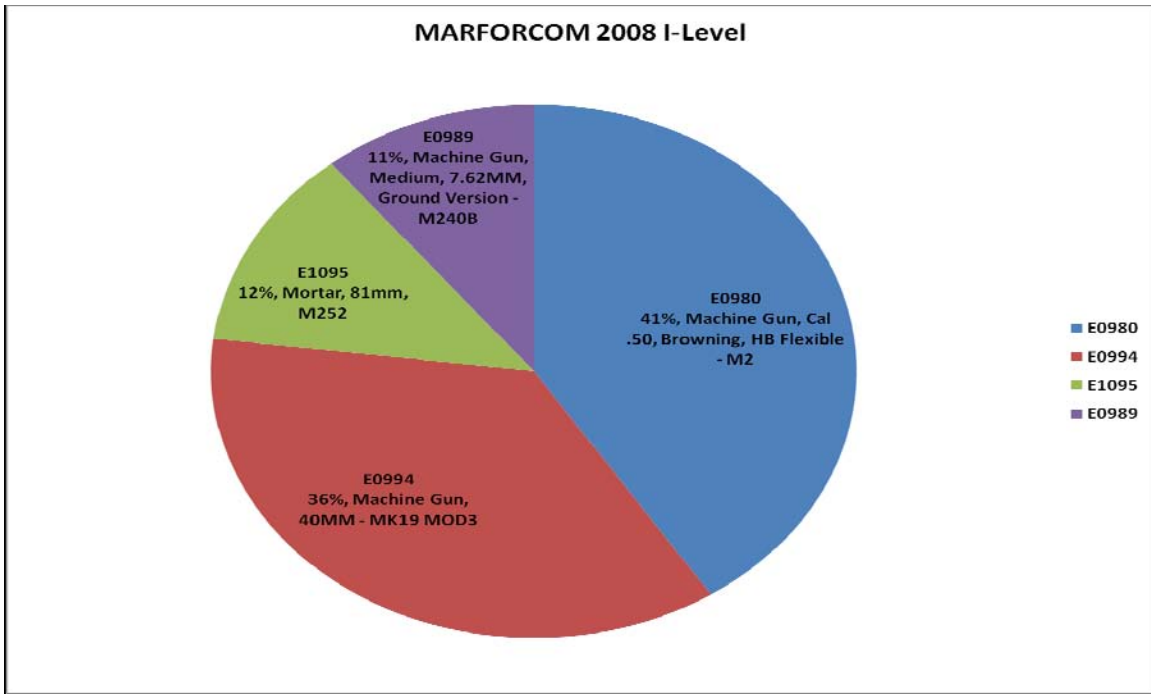


Figure 18. Top Four TAMCNs in 2008

These four TAMCNs, as a percentage of the total maintenance expenditures shown in Figure 19, were a small percentage in 2005 and 2006. Starting in 2007, all four TAMCNs then had an increasing impact on the total expenditures during that year. Table 9 shows the difference of total expenditures and total percentage of expenditures from 2007 to 2008. Figure 20 graphically displays the differences in total expenditures from 2007 to 2008. The differences between the expenditures for these four TAMCNs greatly contributed to the spike that occurred from 2007 to 2008.

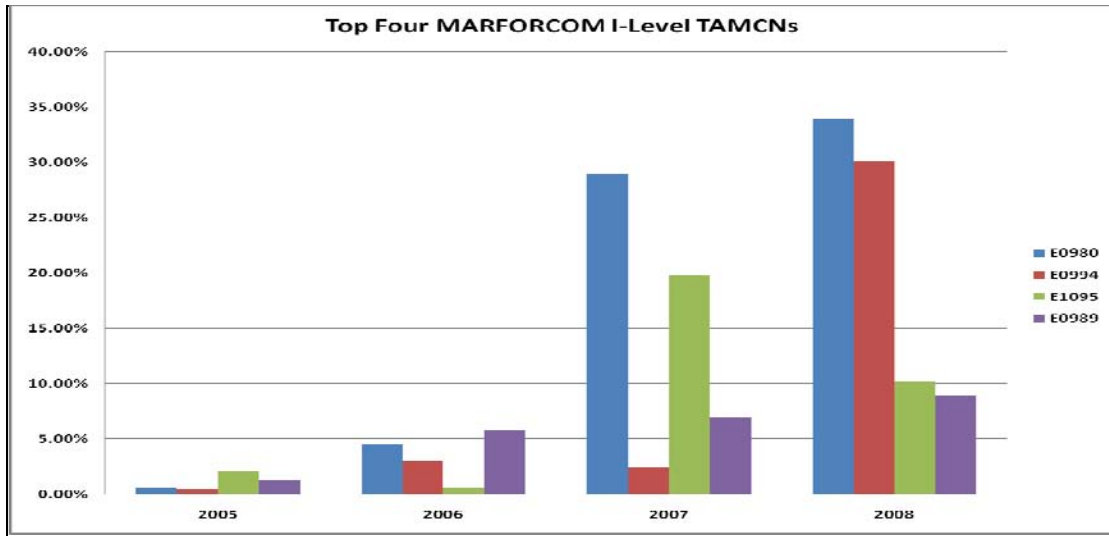


Figure 19. Top Four TAMCNs as a Percentage of the Total Spent per Year

TAMCN	2007 (\$M)	2008 (\$M)	(+ or -) Delta 07 to 08 (\$M)	% of 2007	% of 2008	(+ or -) % Difference
E0980	\$31.41	\$107.94	\$76.53	28.92%	33.86%	4.94%
E0994	\$2.59	\$95.76	\$93.17	2.38%	30.04%	27.66%
E1095	\$21.42	\$32.37	\$10.94	19.73%	10.15%	-9.58%
E0989	\$7.56	\$28.63	\$21.06	6.97%	8.98%	2.01%

Table 9. Total Expenditures and Total Percentage of Expenditures Differences from 2007 to 2008

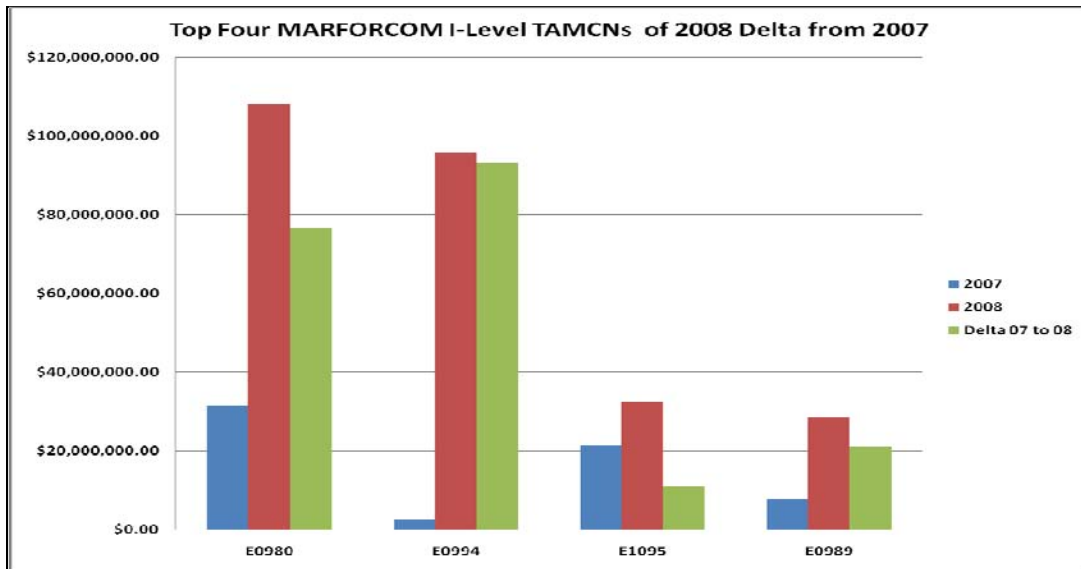


Figure 20. Change in Expenditures from 2007 to 2008 in the Four TAMCNs

The number of TAMCNs at the I-Level accounting for 80 percent of the expenditures during a year has been steadily decreasing. In 2005, the I-Level had nine TAMCNs spending 80 percent. By 2008 the number of TAMCNs had decreased to four, shown in Figure 21.

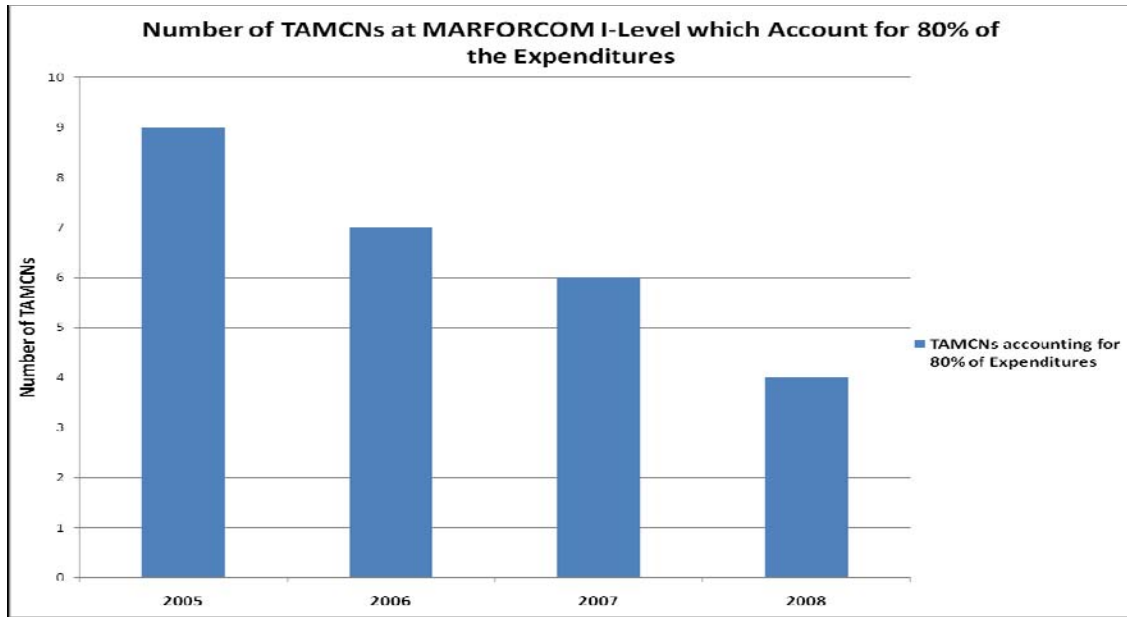


Figure 21. Number of TAMCNs accounting for 80% of MARFORCOM I-Level Maintenance Expenditures

3. MARFORPAC O and I Maintenance Expenditures

Commander, U.S. Marine Corp Forces, Pacific, headquartered at Camp H.M Smith, Hawaii, as the U.S. Marine Corps Service Component Commander for the Commander, U.S. Pacific Command (USPACOM), commands all the U.S. Marine Corps forces assigned to the USPACOM, accomplishes assigned operational missions, advises USPACOM on proper employment, capabilities and support of USMC forces. MARFORPAC is the largest field command in the U.S. Marine Corps. Forward deployed forces both ashore and afloat, and forces stationed in the United States, are led by the Force Commander. Peacetime combat forces and supporting installation Marines and Sailors total approximately 74,000.¹⁸

¹⁸ United States Marine Corps. <http://www.marines.mil/units/marforpac/Pages/main.aspx>

Unlike MARFORCOM and MARFORRES, this command accounted for only 23.87 percent of input into the Total MARFOR maintenance expenditures in 2008. MARFORPAC total maintenance expenditures, shown in Figure 22, decreased by 63 percent from 2005 to 2006. The total maintenance expenditures for the years 2006 to 2008 stayed below the historic expenditure mean as well as below the historic mean plus one standard deviation. This decrease in 2005 had little effect on the total MARFOR expenditures shown in Figure 1, but further analysis was needed to determine the reason for the decrease. In 2005, the Total MARFORPAC maintenance expenditures were consumed by 16 TAMCNs, shown in Figure 23. These 16 TAMCNs are described and listed by total percentage of expenditures in Table 10.

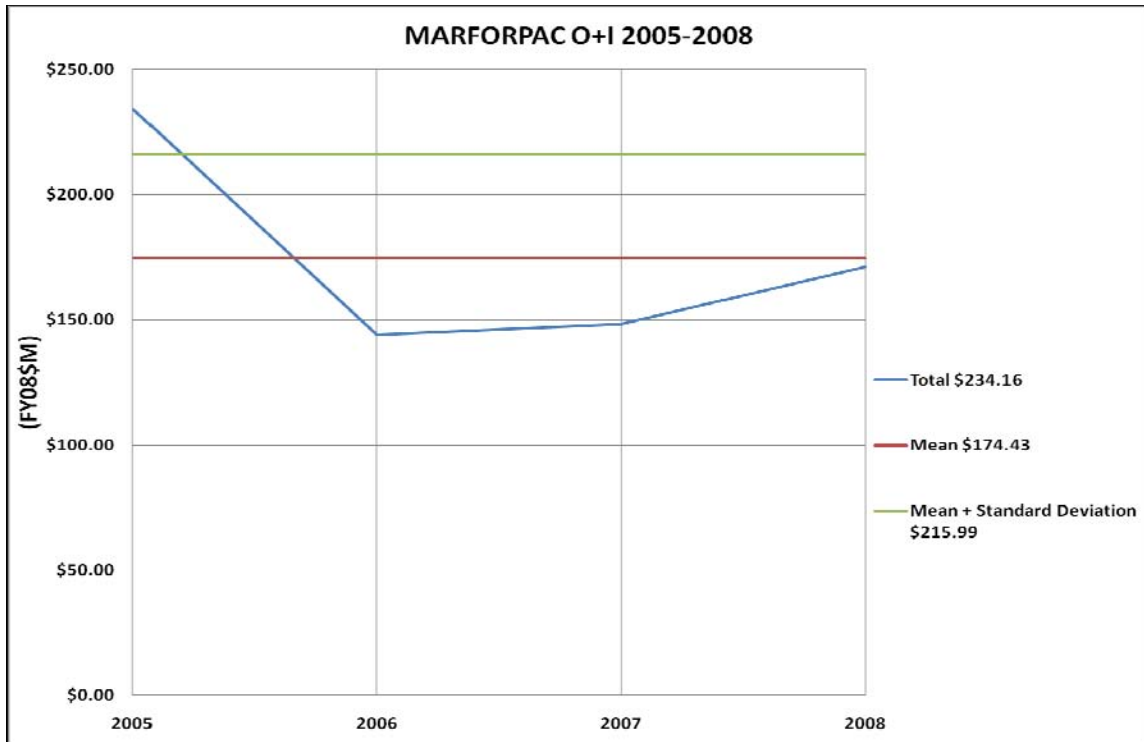


Figure 22. MARFORPAC O and I Maintenance Expenditures (2005–2008)

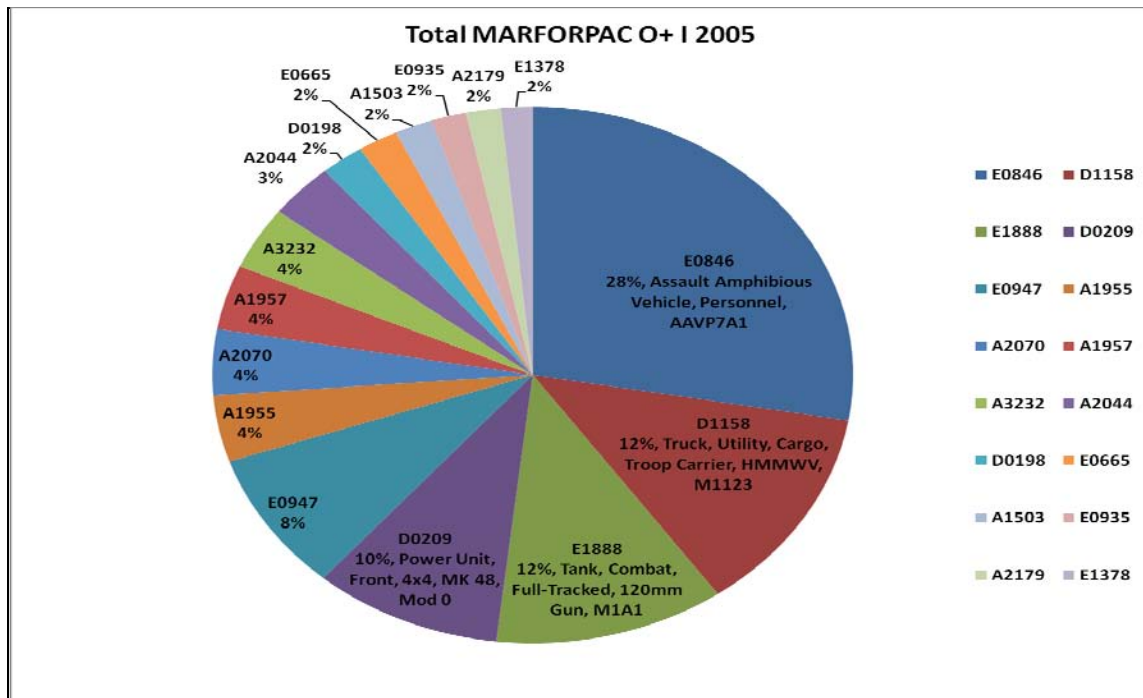


Figure 23. Top 16 TAMCNs

TAMCN Description	TAMCNs	Percentage
Light Armored Vehicle, Command/Control, LAV-C2	E0846	22.11%
Truck, Utility, Cargo, Troop Carrier, HMMWV, M1123	D1158	9.95%
Tank, Combat, Full-Track, 120mm Gun, M1A1	E1888	9.27%
Power Unit, Front, 4x4, MK 48, Mod 0	D0209	7.59%
Light Armored Vehicle, 25mm, LAV-25	E0947	6.73%
Radio Terminal Set, AN/MRC-142A	A1955	3.20%
Radio Set, Manpack, AN/PRC-119A	A2070	3.16%
Radio Set, AN/MRC-145A	A1957	3.10%
Secure Mobile Anti-Jam Reliable Tactical Terminal (SMART-T), AN/TSC-154	A3232	3.02%
Radio Set, Manpack, PRC-148(V)1	A2044	2.65%
Truck, Cargo, 7 Ton, W/O Winch (MTVR) MK23/MK25	D0198	1.75%
Howitzer, Medium, Towed 155MM, M198	E0665	1.62%
Radar Set, LW3D, AN/TPS-59(V)3	A1503	1.51%
Launcher, Tubular F/GM (TOW), M220E4	E0935	1.42%
Radio Terminal Digital, Troposcatter, AN/TRC-170	A2179	1.40%
Recovery Vehicle, Heavy, Full-Track, M88A2	E1378	1.27%
Total		79.77%

Table 10. Description of the 16 Total MARFORPAC TAMCNs Accounting for 79.77% of the Total Expenditures in 2008

Table 11 shows the total expenditures and total percentage of expenditures from 2005 to 2006. From 2005 to 2006, these five TAMCNs accounted for 73.42 percent of the total decrease in maintenance expenditures during those years. The top five TAMCNs as a percentage of the total maintenance expenditures are shown in Figure 24. As a total of all the MARFORS, these five TAMCNs are part of the top twenty TAMCNs driving maintenance costs. Figure 25 graphically displays the decreases in maintenance expenditures for these five TAMCNs from 2005 to 2006

TAMCN	2005 (\$M)	2006 (\$M)	(+ or -) Delta 05 to 06 (\$M)	% of 2005	% of 2006	(+ or -) % Difference
E0846	\$51.77	\$29.87	-\$21.90	22.11%	20.75%	-1.36%
D1158	\$23.31	\$8.33	-\$14.97	9.95%	5.79%	-4.17%
E1888	\$21.70	\$16.95	-\$4.76	9.27%	11.77%	2.50%
D0209	\$17.78	\$1.48	-\$16.30	7.59%	1.03%	-6.57%
E0947	\$15.76	\$7.47	-\$8.29	6.73%	5.19%	-1.54%

Table 11. Total Expenditures and Total Percentage of Expenditures Differences from 2005 to 2006

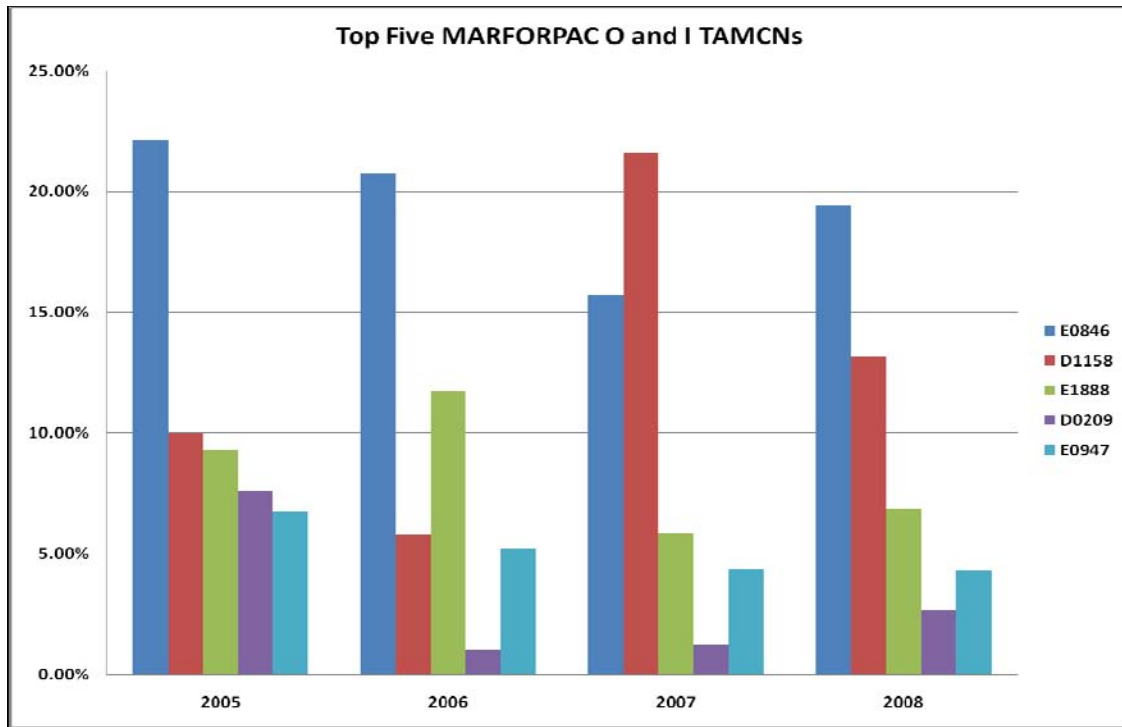


Figure 24. Top Five TAMCNs as a Percentage of the Total Spent per Year

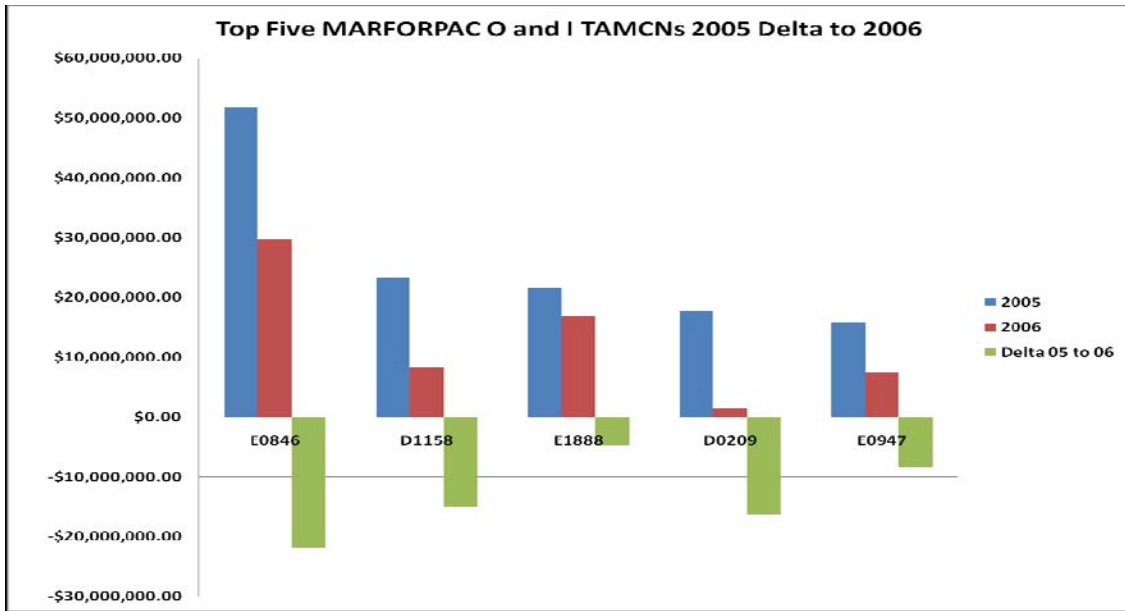


Figure 25. Change in Expenditures from 2005 to 2006 in the Five TAMCNs

MARFORPAC has also seen an increase in the number of TAMCNs that are expending 80 percent of the total maintenance expenditures per year, shown in Figure 26. In 2005, MARFORPAC had 16 TAMCNs; this number increased to 25 by 2008.

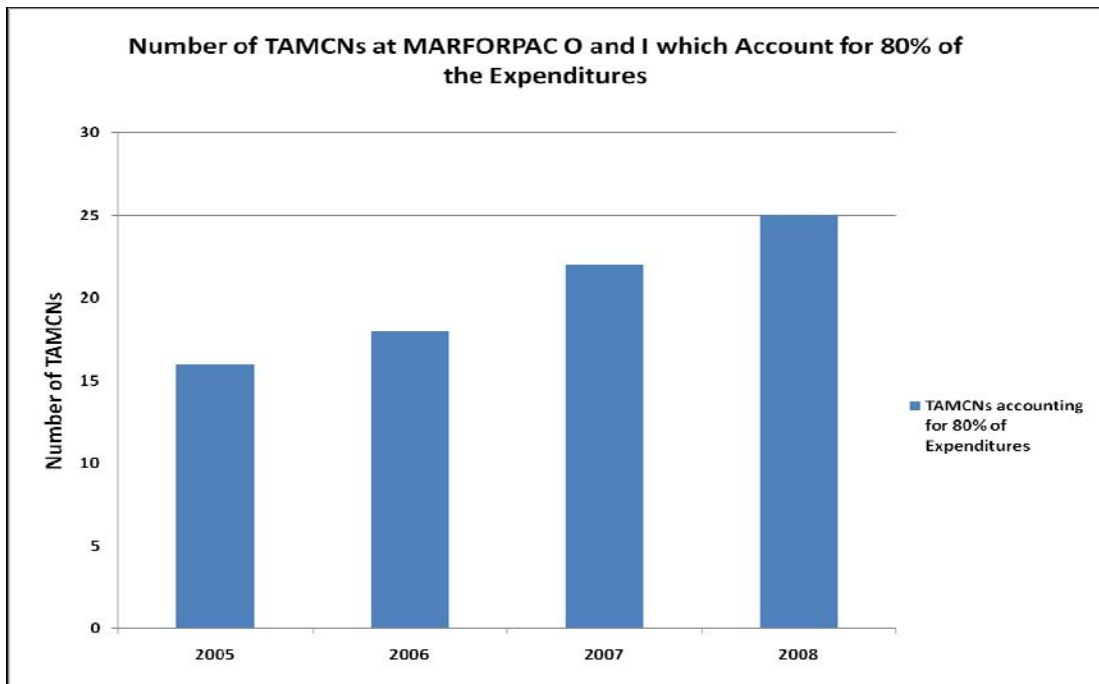


Figure 26. Number of TAMCNs accounting for 80% of MARFORPAC Maintenance Expenditures

a. MARFORPAC O-Level Expenditures

At the MARFORPAC O-level, the total maintenance expenditures decreased from 2005 to 2007, shown in Figure 27. During the four years of this study, MARFORPACs O-level was below the historic mean as well as the historic mean plus one standard deviation. This decrease in maintenance expenditures was driven by 18 TAMCNs, listed by total percentage of expenditures in 2005 in Table 12, and shown in Figure 28. Of these 18, the top five were the driving force for the decrease at the O-Level.

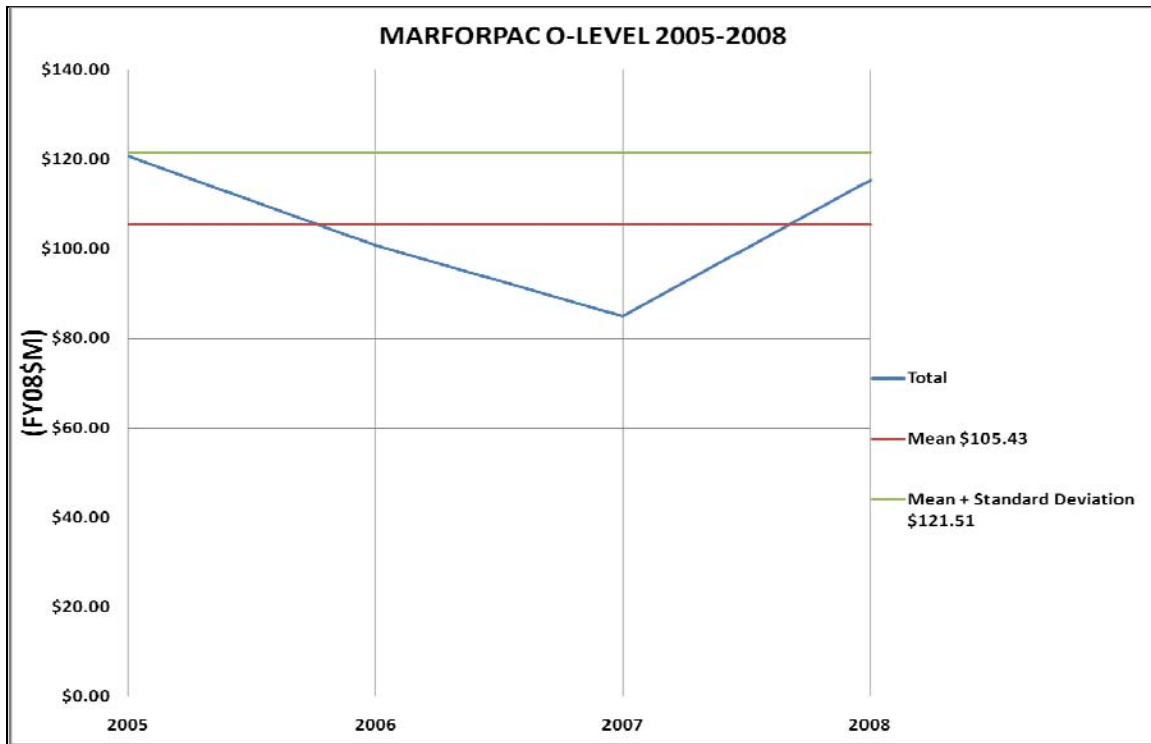


Figure 27. MARFORPAC O-Level Maintenance Expenditures (2005–2008)

TAMCN Description	TAMCNs	Percentage
Light Armored Vehicle, Command/Control, LAV-C2	E0846	17.20%
Radio Terminal Set, AN/MRC-142A	A1955	6.17%
Light Armored Vehicle, 25mm, LAV-25	E0947	6.11%
Radio Set, Manpack, AN/PRC-119A	A2070	6.05%
Truck, Utility, Cargo, Troop Carrier, HMMWV, M1123	D1158	6.05%
Radio Set, AN/MRC-145A	A1957	5.85%
Secure Mobile Anti-Jam Reliable Tactical Terminal (SMART-T), AN/TSC-154	A3232	5.84%
Radio Set, Manpack, PRC-148(V)1	A2044	5.11%
Radar Set, LW3D, AN/TPS-59(V)3	A1503	2.93%
Radio Terminal Digital, Troposcatter, AN/TRC-170	A2179	2.70%
Truck, Cargo, 7 Ton, W/O Winch (MTVR) MK23/MK25	D0198	2.66%
Power Unit, Front, 4x4, MK 48, Mod 0	D0209	2.50%
Tactical Air Operations Module, (TAOM), AN/TYQ-23(V)4	A2525	2.38%
Radio Set, Manpack, AN/PRC-119F	A2079	2.01%
Launcher, Tubular F/GM (TOW), M220E4	E0935	2.00%
Communications Terminal, AN/TSC-93C (V)1	A0814	1.61%
Tank, Combat, Full-Track, 120mm Gun, M1A1	E1888	1.53%
Howitzer, Medium, Towed 155MM, M198	E0665	1.52%
Total		80.22%

Table 12. Description of the 18 MARFORPAC O-Level TAMCNs Accounting for 80.22% of the Total Expenditures in 2005

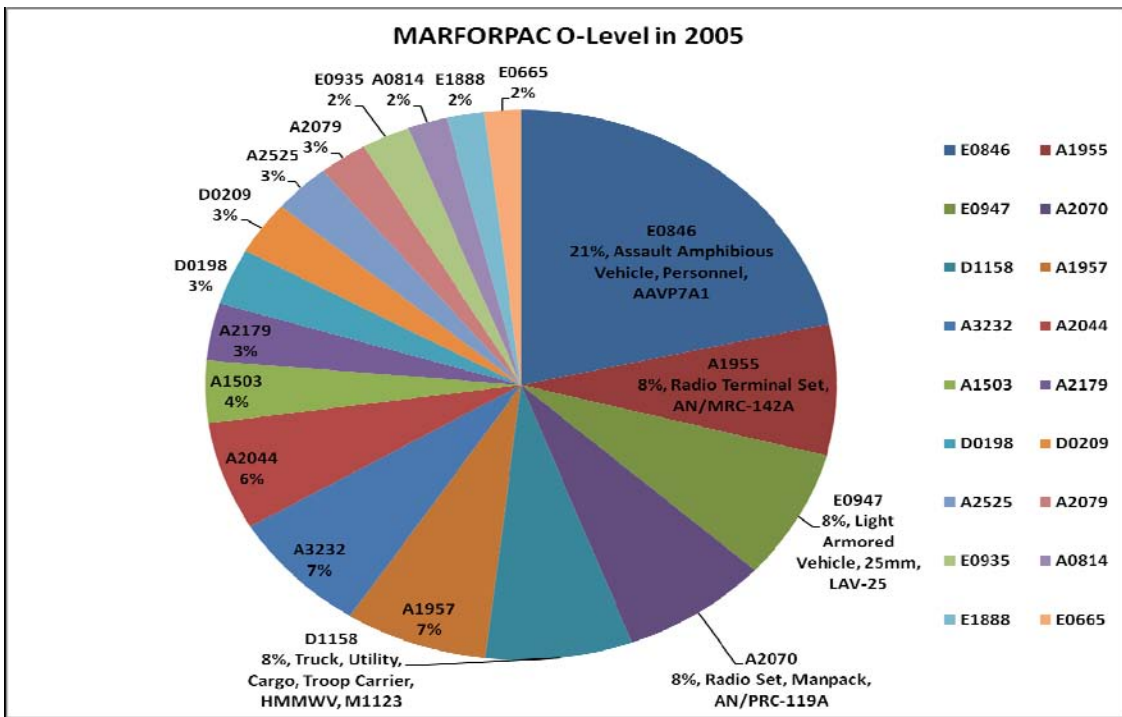


Figure 28. Top 18 TAMCNs

Unlike the Total MARFORPAC difference from 2005 to 2006, the differences from 2005 to 2007 are small. Table 13 shows the total expenditure difference from 2005 to 2007 for the top five TAMCNs as well as showing the difference in total percentage of expenditures during those years. The top five TAMCNs as a percentage of the total maintenance expenditures (Figure 29) show that E0846 has been the highest spender of maintenance dollars throughout the four year period, increasing every year from 2005 to 2008. In 2005, MARFORPAC O-Level spent \$120.79M on maintenance compared to spending \$84.90M in 2007; this was a decrease of \$35.88M during those two years. The differences from 2005 to 2007 are graphically shown in Figure 30.

TAMCN	2005 (\$M)	2007 (\$M)	(+ or -) Delta 05 to 07 (\$M)	% of 2005	% of 2007	(+ or -) % Difference
E0846	\$20.77	\$18.11	-\$2.66	17.20%	21.33%	4.14%
A1955	\$7.46	\$3.85	-\$3.60	6.17%	4.54%	-1.64%
E0947	\$7.38	\$4.57	-\$2.81	6.11%	5.38%	-0.73%
A2070	\$7.31	\$5.82	-\$1.49	6.05%	6.86%	0.81%
D1158	\$7.30	\$4.13	-\$3.17	6.05%	4.87%	-1.18%

Table 13. Total Expenditures and Total Percentage of Expenditures Differences from 2005 to 2007

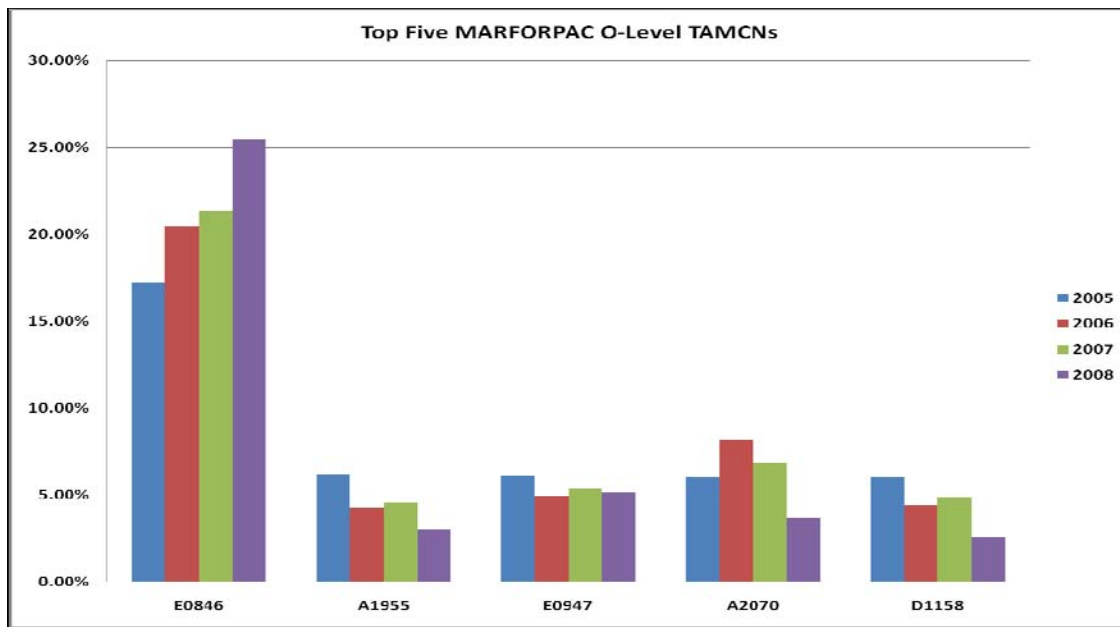


Figure 29. Top Five TAMCNs as a Percentage of the Total Spent per Year

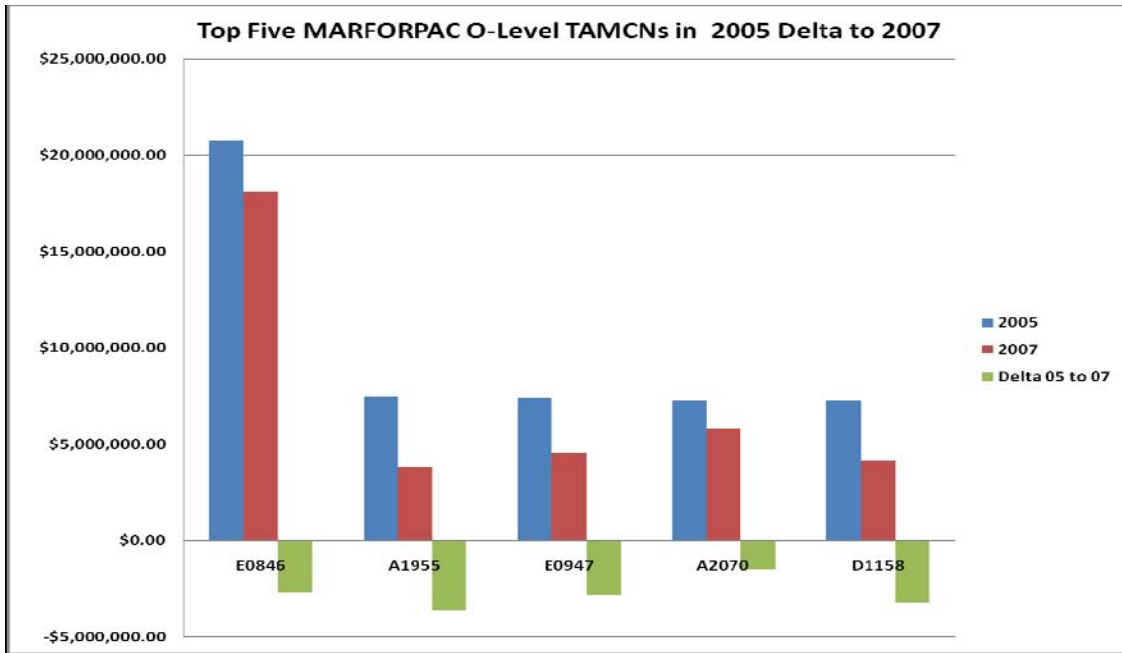


Figure 30. Change in Expenditures from 2005 to 2007 in the Five TAMCNs

MARFORPAC O-Level has also seen an increase in the number of TAMCNs that are expending 80 percent of the total maintenance dollars per year, shown in Figure 31. In 2005, MARFORPAC O-Level had 16 TAMCNs. This number increased to 26 in both 2007 and 2008.

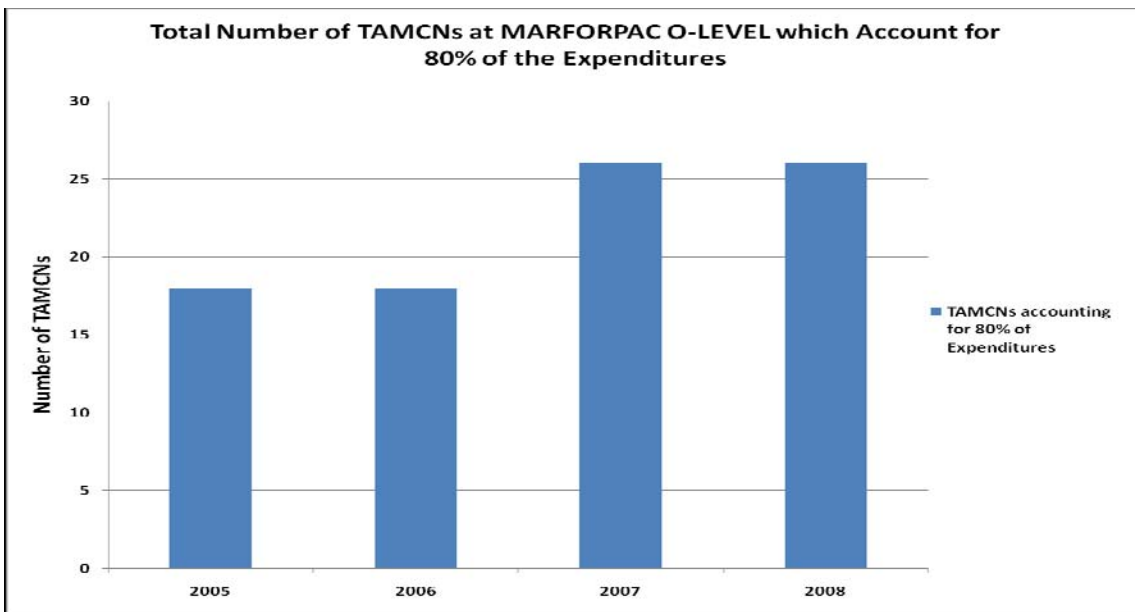


Figure 31. Number of TAMCNs accounting for 80% of MARFORPAC O-Level Maintenance Expenditures

b. MARFORPAC I-Level Expenditures

The MARFORPAC I-Level had a substantial decrease in maintenance expenditures from 2005 to 2006; this decrease was approximately 262 percent going from spending \$113.36M in 2005 to spending only \$43.19M in 2006, shown in Figure 32. Since 2006, the I-Level remained below the historic mean as well as below the mean plus one standard deviation. The decrease from 2005 to 2006 was also the contributing factor for the Total MARFORPAC decrease from 2005 to 2006, previously shown in Figure 22. The same five TAMCNs at the Total MARFORPAC in Figure 24 show up at the I-Level, shown in Figure 33 and described in Table 14.

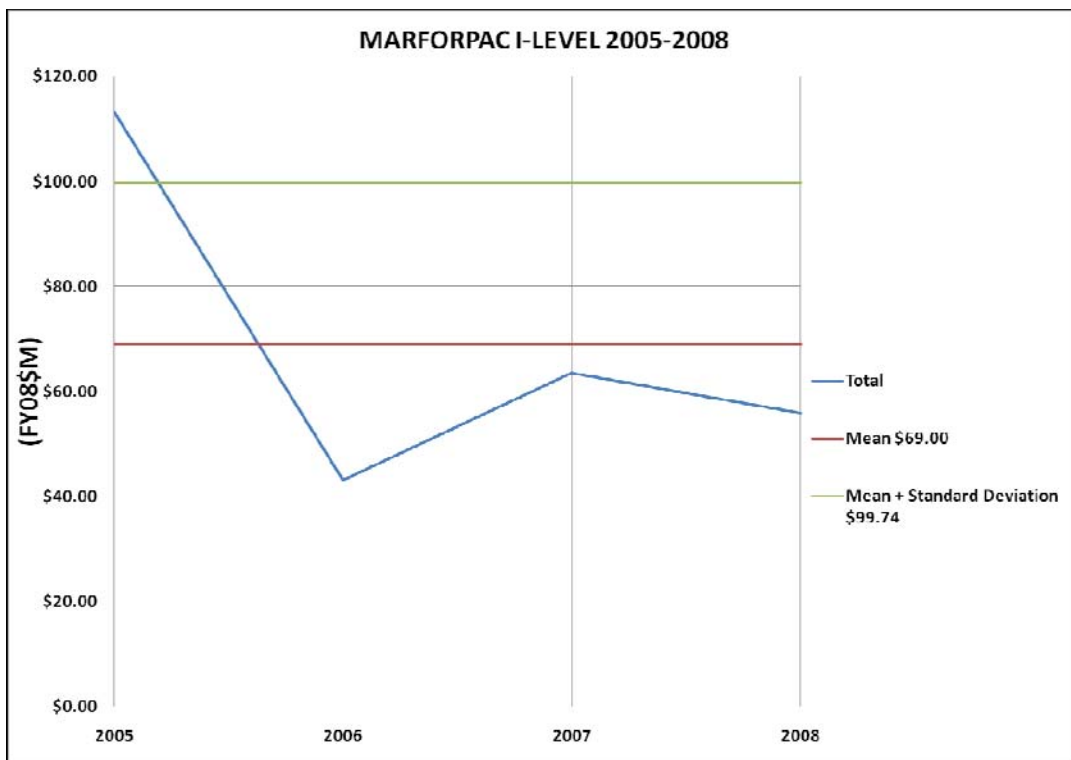


Figure 32. MARFORPAC I-Level Maintenance Expenditures (2005–2008)

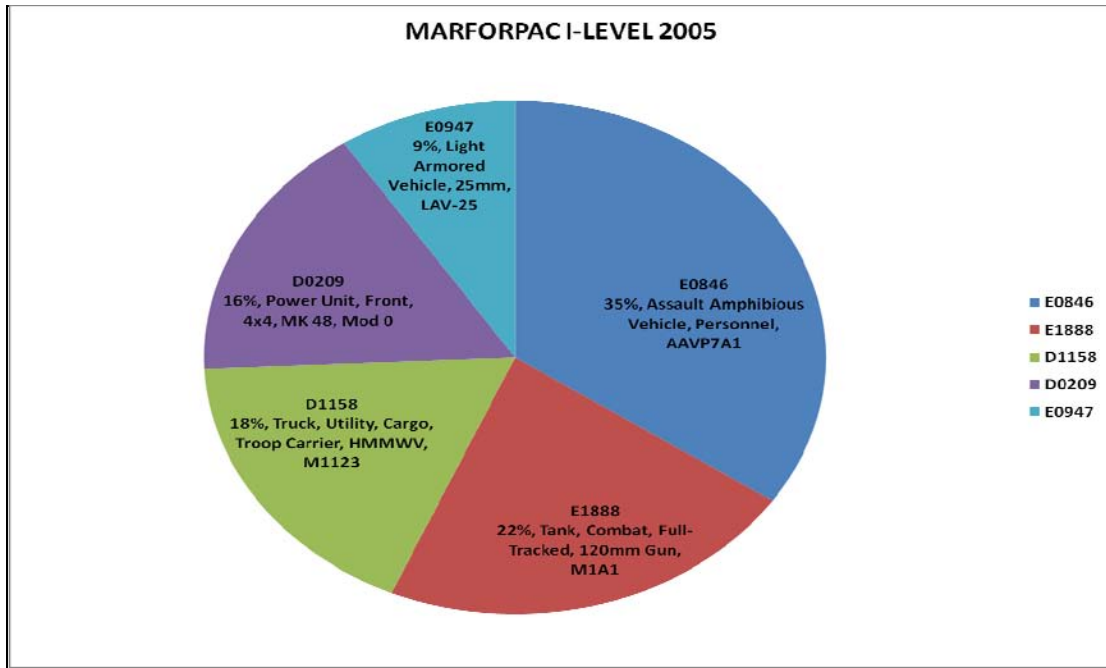


Figure 33. Top Five TAMCNs

TAMCN Description	TAMCN	Percentage
Light Armored Vehicle, Command/Control, LAV-C2	E0846	27.35%
Tank, Combat, Full-Tracked, 120mm Gun, M1A1	E1888	17.51%
Truck, Utility, Cargo, Troop Carrier, HMMWV, M1123	D1158	14.12%
Power Unit, Front, 4x4, MK 48, Mod 0	D0209	13.02%
Light Armored Vehicle, 25mm, LAV-25	E0947	7.39%
Total		79.38%

Table 14. Description of the Five MARFORPAC I-Level TAMCNs Accounting for 79.38% of the Total Expenditures in 2005

Table 15 displays the total maintenance expenditures and the total percentage of total expenditures from 2005 to 2006 for the top five TAMCNs at the I-level. The differences are shown for the total expenditures as well as the total percentage of expenditures during these years. Figure 34 shows the fluctuation of their percentage of the total expenditures during the four year period. The total maintenance expenditures for the four years of this study are shown in Figure 35.

TAMCN	2005 (\$M)	2006 (\$M)	(+ or -) Delta 05 to 06 (\$M)	% of 2005	% of 2006	(+ or -) % Difference
E0846	\$31.00	\$9.27	-\$21.73	27.35%	21.47%	-5.88%
E1888	\$19.85	\$14.05	-\$5.80	17.51%	32.53%	15.02%
D1158	\$16.00	\$3.87	-\$12.14	14.12%	8.95%	-5.16%
D0209	\$14.76	\$0.59	-\$14.17	13.02%	1.37%	-11.65%
E0947	\$8.37	\$2.50	-\$5.87	7.39%	5.79%	-1.59%

Table 15. Total Expenditures and Total Percentage of Expenditures Differences from 2005 to 2006

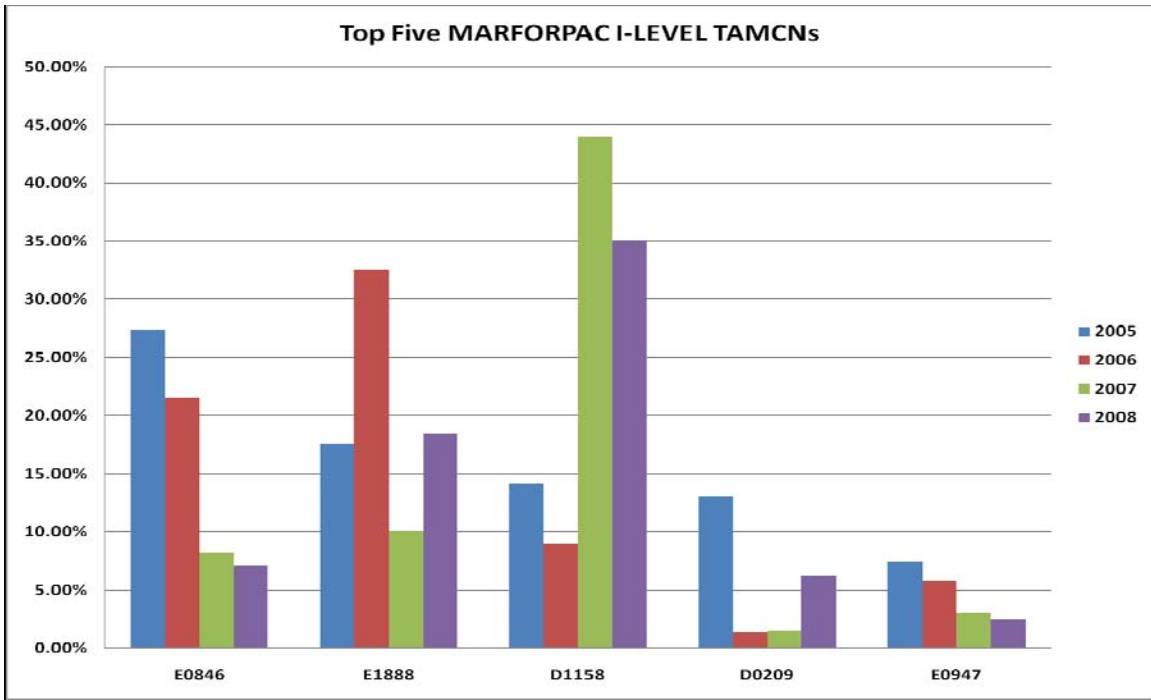


Figure 34. Top Five TAMCNs as a Percentage of the Total Spent per Year

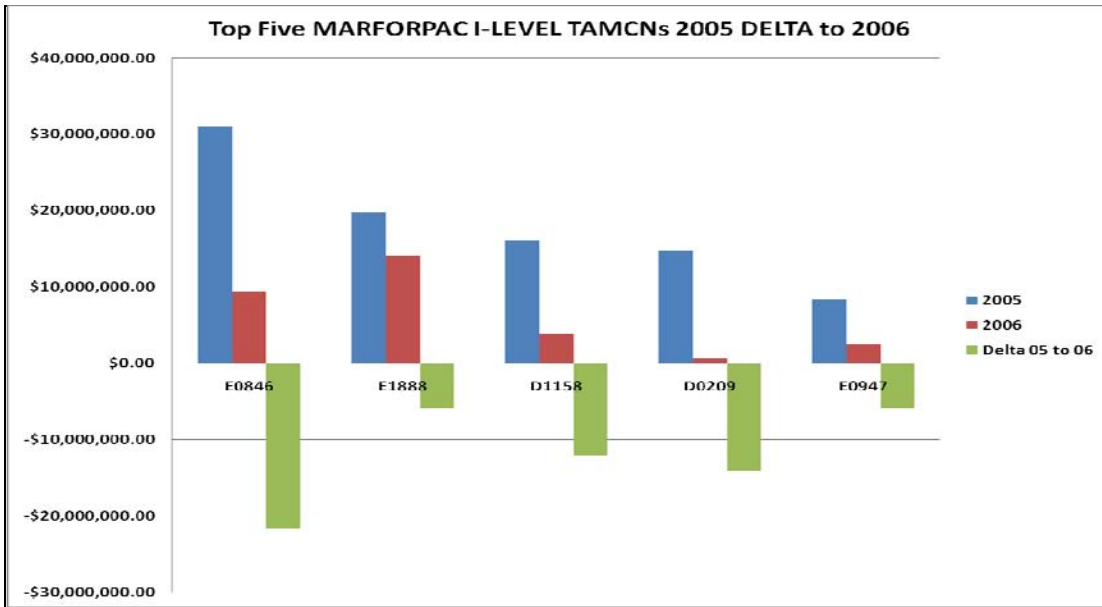


Figure 35. Change in Expenditures from 2005 to 2006 in the Five TAMCNs

The number of TAMCNs, accounting for 80 percent of the total maintenance expenditures per year at the I-Level, remained fairly steady throughout the four years, as shown in Figure 36. In 2005 the I-Level had five TAMCNs expending 80 percent of the maintenance expenditures. The number of TAMCNs climbed slightly in 2006 to seven, but has leveled out at six TAMCNs from 2007 and 2008.

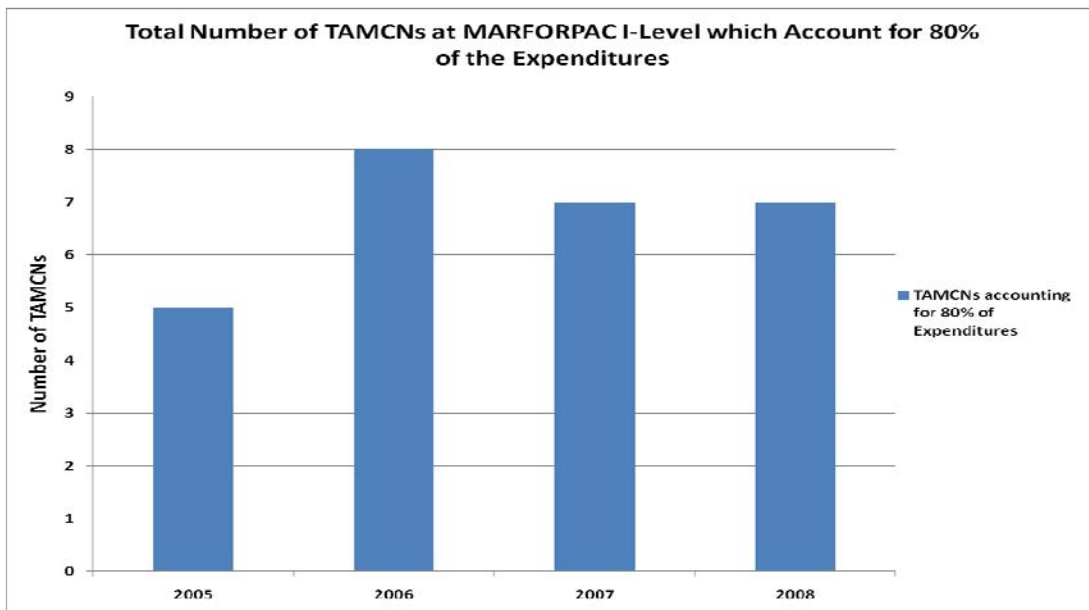


Figure 36. Number of TAMCNs accounting for 80% of MARFORPAC I-Level Maintenance Expenditures

4. MARFORRES O and I Maintenance Expenditures

Marine Forces Reserve, located in New Orleans, Louisiana, is the Headquarters command for all the Marine Reservists and Reserve units located throughout the United States. The mission of Marine Forces Reserve (MARFORRES) is to augment and reinforce active Marine forces in time of war, national emergency or contingency operations, provide personnel and operational tempo relief for the active forces in peacetime, and provide service to the community. The largest command in the Marine Corps, Marine Forces Reserve is the headquarters command for approximately 100,000 Reserve Marines.¹⁹

In Figure 1, there was a significant maintenance expenditure spike from 2007 to 2008. The first factor for the spike occurred at the Total MARFORCOM level, discussed earlier in section 3. The second factor for this spike was the maintenance expenditures at MARFORRES. In 2007, MARFORRES expended \$8.61M which increased to \$46.48M in 2008, an increase of \$37.87M and approximately 540 percent, shown in Figure 37. Unlike the total for MARFORCOM, there are four different TAMCNs which have caused this spike. Figure 38 shows the nine TAMCNs that expended 80 percent of the total maintenance expenditures in 2008. These nine TAMCNs are listed by total percentage of 2008 maintenance expenditures in Table 16. The top four TAMCNs expended 54.24 percent of the total maintenance expenditures in 2008.

¹⁹ United States Marine Corps Reserves. <http://www.mfr.usmc.mil/HQ/PAO/>

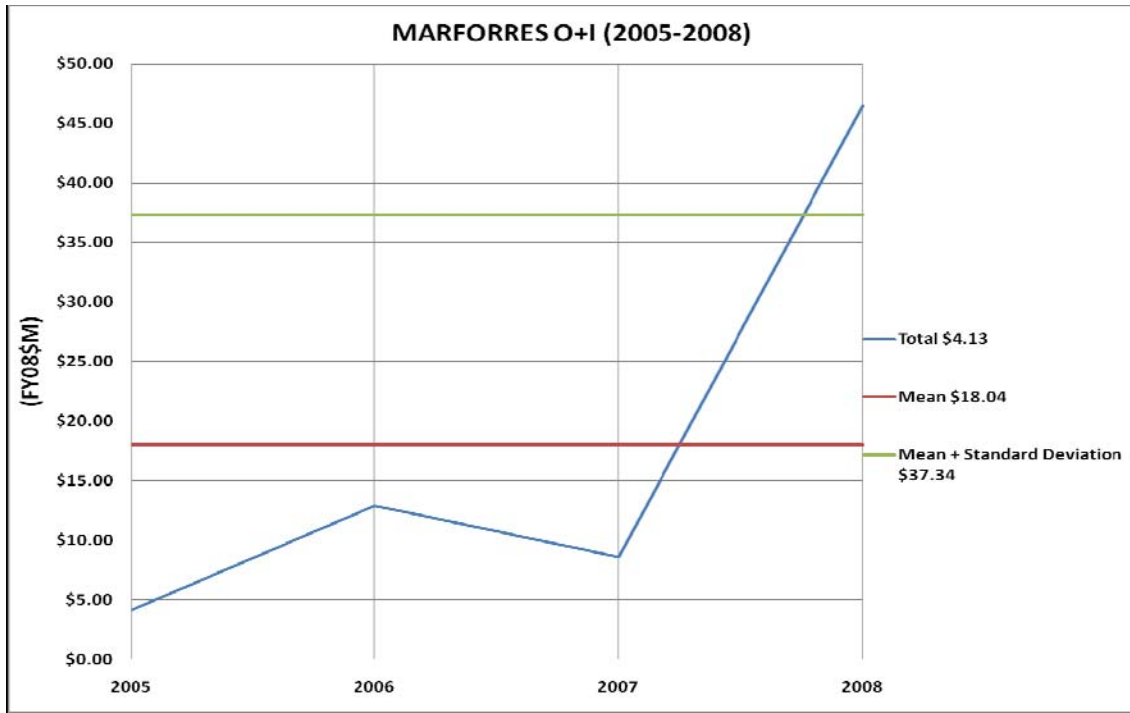


Figure 37. MARFORRES O and I Maintenance Expenditures (2005–2008)

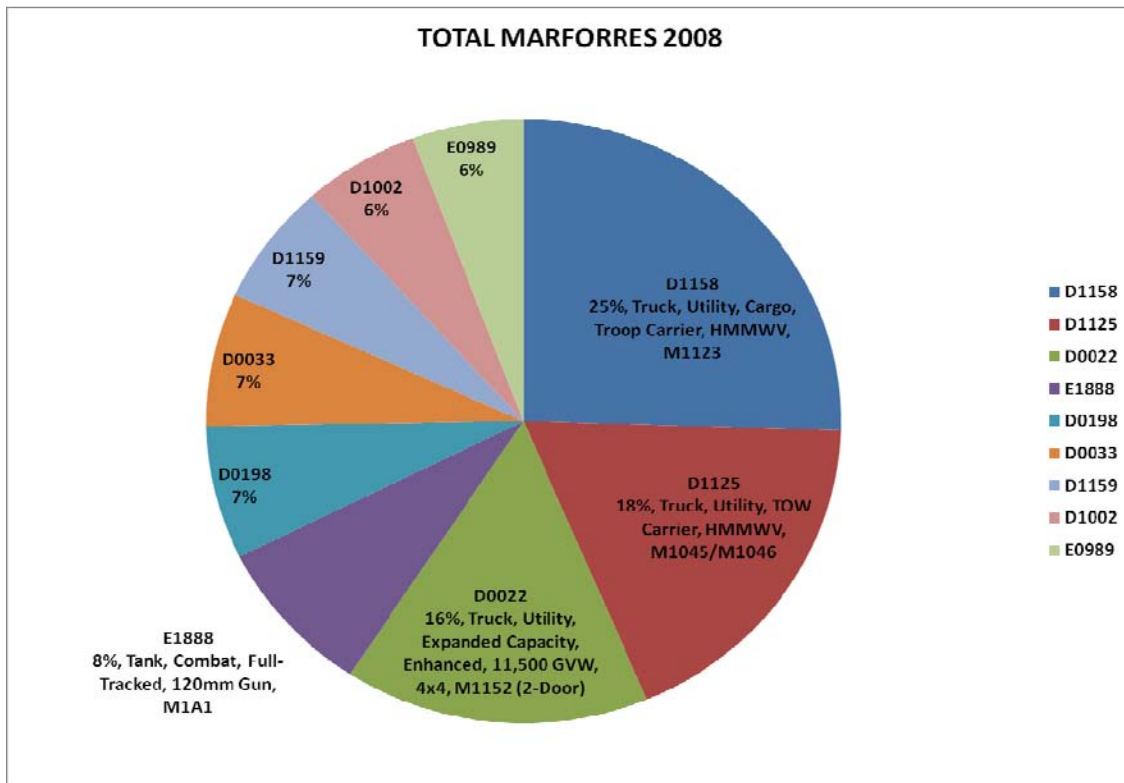


Figure 38. Top Nine TAMCNs in 2008

TAMCN Description	TAMCNs	Percentage
Truck, Utility, Cargo, Troop Carrier, HMMWV, M1123	D1158	20.43%
Truck, Utility, TOW Carrier, HMMWV, M1045/M1046	D1125	14.57%
Truck, Utility, Expanded Capacity, Enhanced, 11,500 GVW, 4x4, M1152 (2-Door)	D0022	12.49%
Tank, Combat, Full-Tracked, 120mm Gun, M1A1	E1888	6.75%
Truck, Cargo, 7 Ton, W/O Winch (MTVR) MK23/MK25	D0198	5.72%
Truck, Utility, Expanded Capacity, Enhanced, Armored, 2-Door	D0033	5.71%
Truck, Utility, Armored Carrier, W/SA, 2 ¼ Ton, HMMWV	D1159	5.22%
Truck, Ambulance, 2 Litter, Soft Top, 1 ¼ Ton, HMMWV, M1035	D1002	4.77%
Machine Gun, Medium, 7.62MM, Ground Version - M240B	E0989	4.55%
Total		80.21%

Table 16. Description of the Nine Total MARFORRES TAMCNs Accounting for 80.21% of the Total Expenditures in 2008

The differences between the total maintenance expenditures and the percentage of the total expenditures per year due to the top four TAMCNs are shown in Table 17. Figure 39 shows the fluctuation of the total percentages of the expenditures per year for the top four TAMCNs. The differences in maintenance expenditures of these four TAMCNs accounted for 59.3 percent of the \$37.86M increase at the I-level. These differences of the top four TAMCNs are graphically shown in Figure 40.

TAMCN	2007 (\$M)	2008 (\$M)	(+ or -) Delta 07 to 08 (\$M)	% of 2007	% of 2008	(+ or -) % Difference
D1158	\$0.72	\$9.50	\$8.78	8.35%	20.43%	12.08%
D1125	\$0.04	\$6.77	\$6.73	0.50%	14.57%	14.07%
D0022	\$0.01	\$5.81	\$5.79	0.16%	12.49%	12.33%
E1888	\$1.99	\$3.14	\$1.15	23.08%	6.75%	-16.34%

Table 17. Total Expenditures and Total Percentage of Expenditures Differences from 2007 to 2008

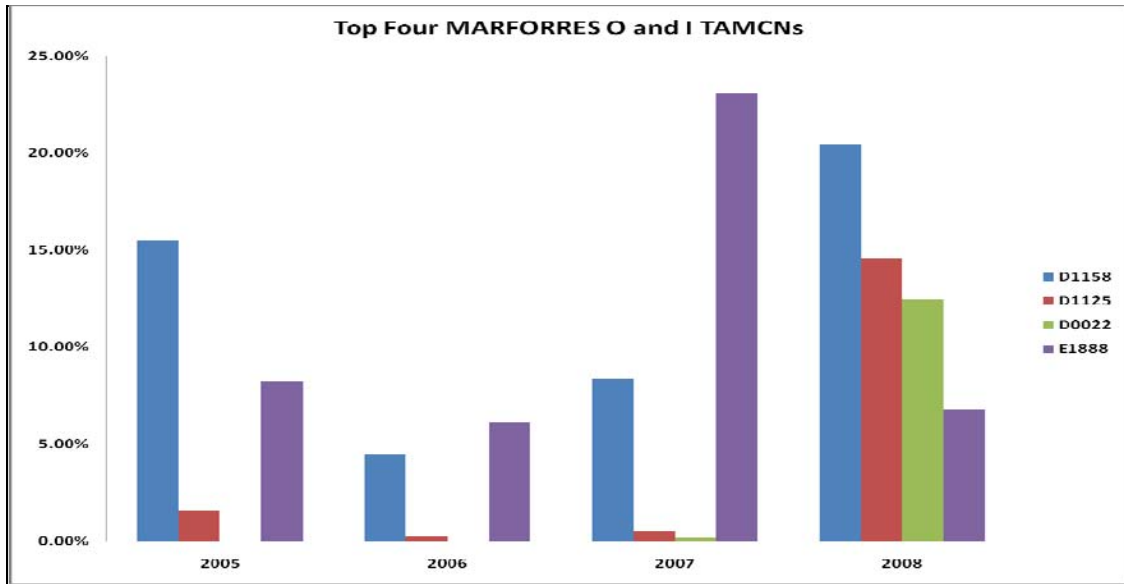


Figure 39. Top Four TAMCNs as a Percentage of the Total Spent per Year

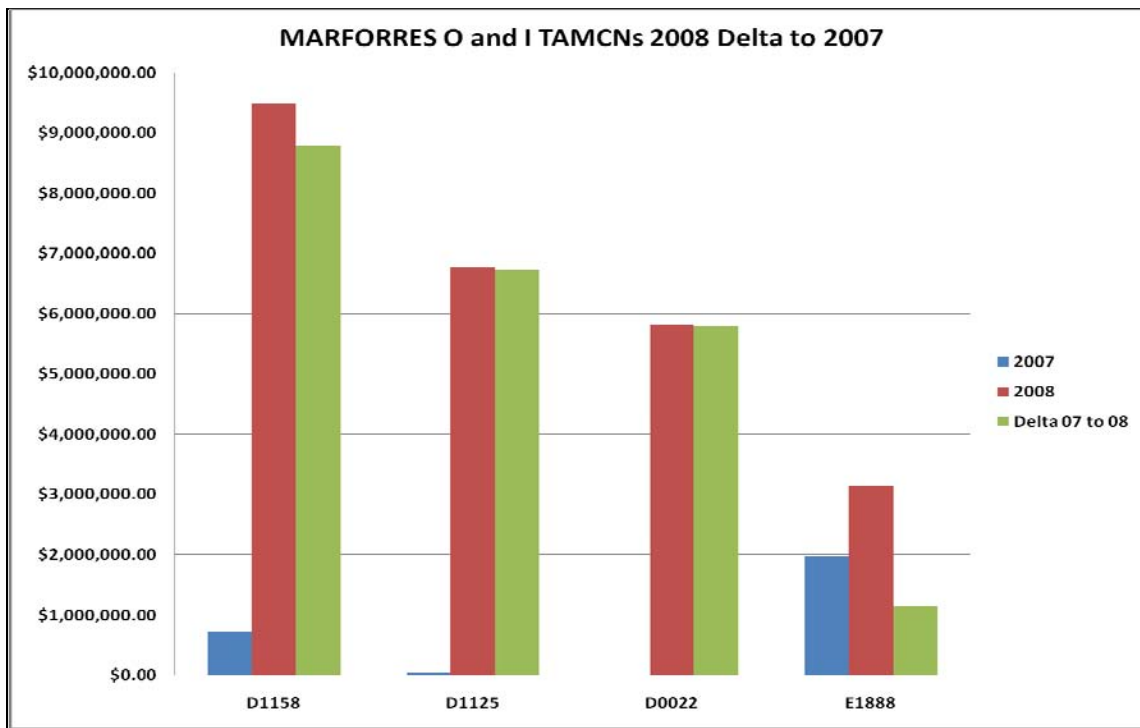


Figure 40. Change in Expenditures from 2007 to 2008 in the Top Four TAMCNs

At the Total MARFORRES level, the total number of TAMCNs accounting for 80 percent of the total maintenance expenditures fluctuated up and down from 2005 to 2008. These numbers are shown in Figure 41.

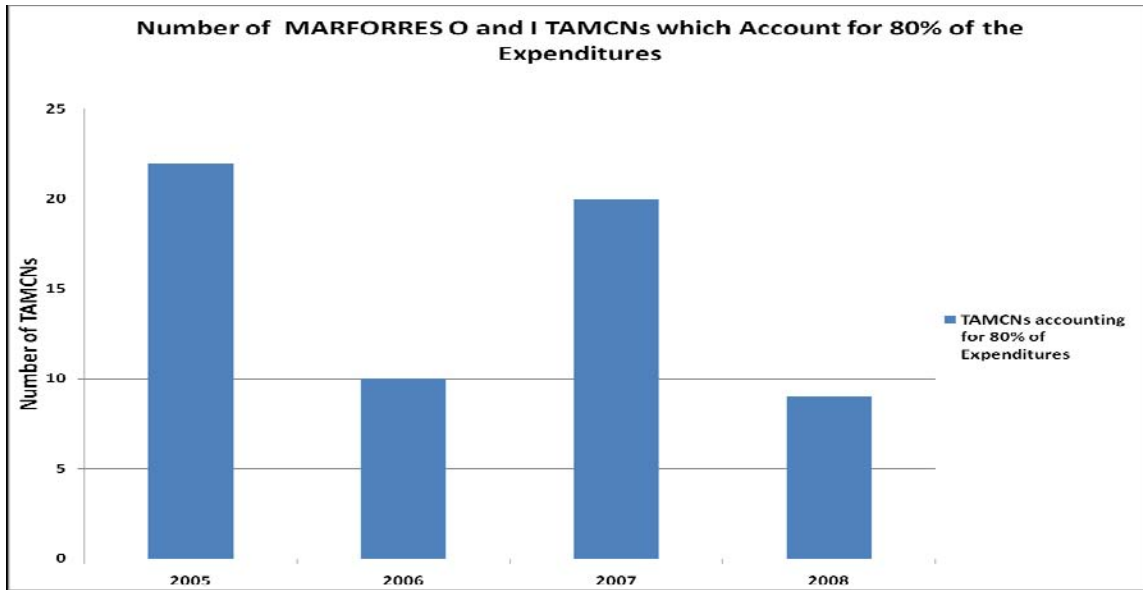


Figure 41. Number of TAMCNs accounting for 80% of Total MARFORRES Maintenance Expenditures

a. MARFORRES O-Level Expenditures

The spike at the Total MARFORRES level occurred at the MARFORRES O-Level, shown in Figure 42. In 2007 the O-level expended \$8.26M and increased dramatically to \$46.24M in 2008, an increase of \$37.98M accounting for all of the increase at the Total MARFORRES expenditures shown in Figure 37. This difference is greater than the Total MARFORRES total because there was a decrease in maintenance expenditure at the MARFORRES I-level, which will be shown later in the chapter.

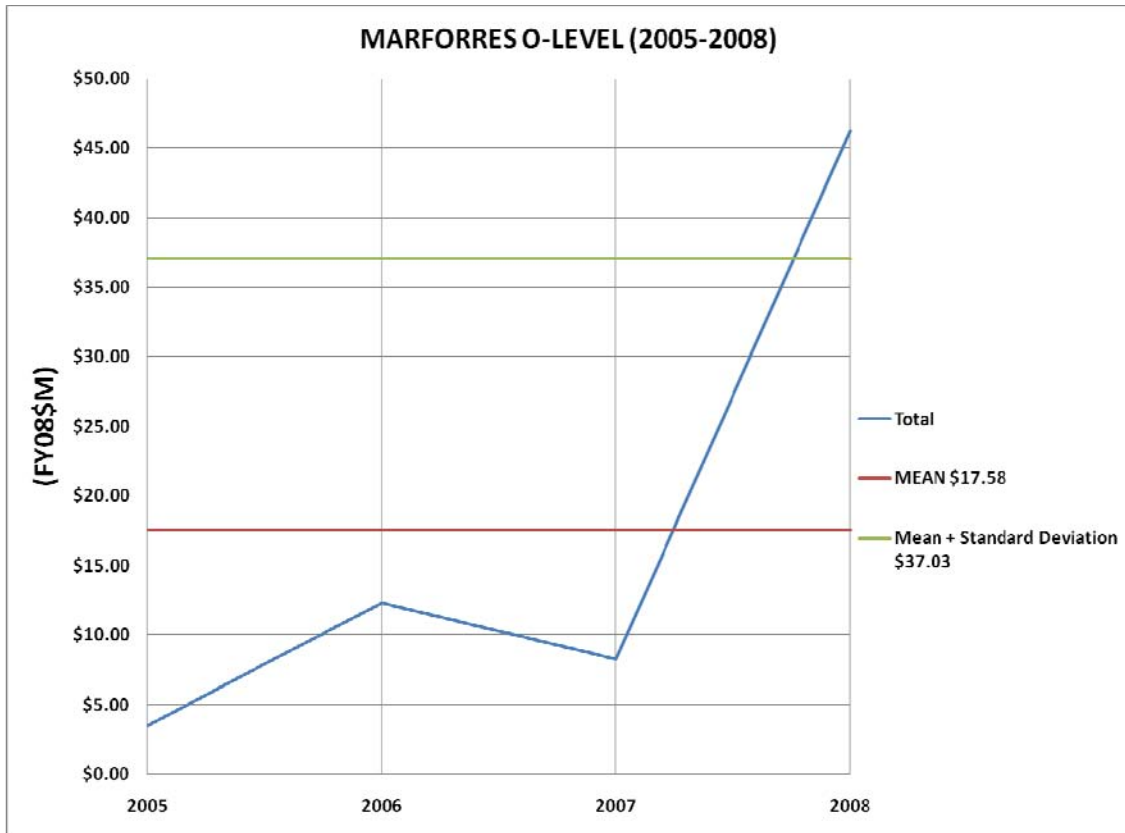


Figure 42. MARFORRES O-Level Maintenance Expenditures (2005–2008)

At the MARFORRES O-level, there were nine TAMCNs accounting 80.4 percent of the total maintenance expenditures in 2008, shown in Figure 43. Table 18 lists the nine TAMCNs by total percentage of expenditures. As was the case with the Total MARFORRES level, the same top four TAMCNs were the reason for the spike in expenditures from 2007 to 2008.

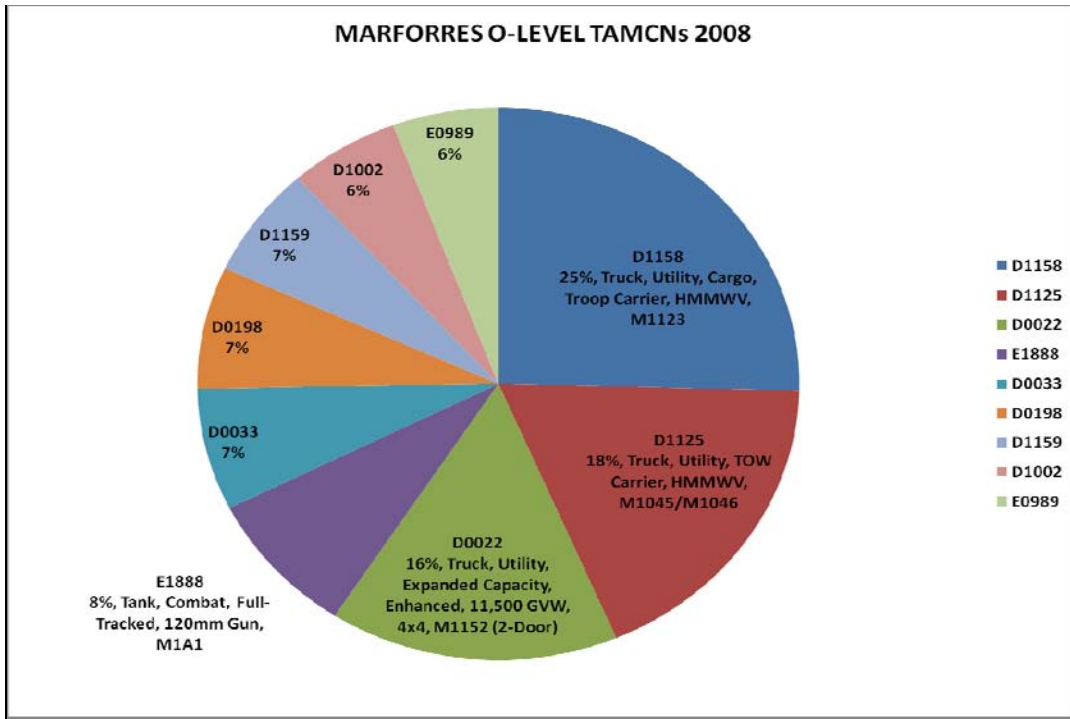


Figure 43. Top Nine TAMCNs

TAMCN Description	TAMCNs	Percentage
Truck, Utility, Cargo, Troop Carrier, HMMWV, M1123	D1158	20.41%
Truck, Utility, TOW Carrier, HMMWV, M1045/M1046	D1125	14.64%
Truck, Utility, Expanded Capacity, Enhanced, 11,500 GVW, 4x4, M1152 (2-Door)	D0022	12.50%
Tank, Combat, Full-Tracked, 120mm Gun, M1A1	E1888	6.78%
Truck, Utility, Expanded Capacity, Enhanced, Armored, 2-Door	D0033	5.74%
Truck, Cargo, 7 Ton, W/O Winch (MTVR) MK23/MK25	D0198	5.74%
Truck, Utility, Armored Carrier, W/SA, 2 ¼ Ton, HMMWV	D1159	5.24%
Truck, Ambulance, 2 Litter, Soft Top, 1 ¼ Ton, HMMWV, M1035	D1002	4.77%
Machine Gun, Medium, 7.62MM, Ground Version - M240B	E0989	4.57%
Total		80.40%

Table 18. Description of the Nine MARFORRES O-Level TAMCNs Accounting for 80.4% of the Total Expenditures in 2008

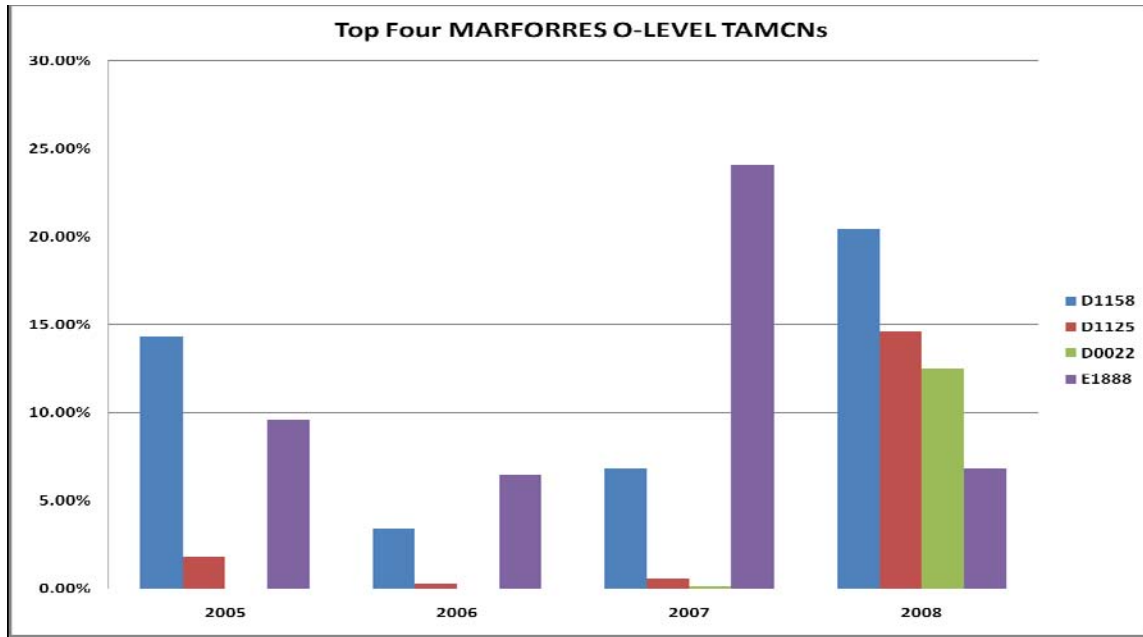


Figure 44. Top Four TAMCNs as a Percentage of the Total Spent per Year

TAMCN	2007 (\$M)	2008 (\$M)	(+ or -) Delta 07 to 08 (\$M)	% of 2007	% of 2008	(+ or -) % Difference
D1158	\$0.56	\$9.44	\$8.88	6.81%	20.41%	13.60%
D1125	\$0.04	\$6.77	\$6.73	0.53%	14.64%	14.12%
D0022	\$0.01	\$5.78	\$5.77	0.16%	12.50%	12.34%
E1888	\$1.99	\$3.14	\$1.15	24.07%	6.78%	-17.29%

Table 19. Total Expenditures and Total Percentage of Expenditures Differences from 2007 to 2008

Figure 44 displays the top four TAMCNs total percentage of expenditures during the four year period. During these years there was significant fluctuation in the total percentages. The differences between the total expenditures and total percentage of expenditures from 2007 to 2008 are shown in Table 19. The difference expended by these four TAMCNs was just as large as was shown at the Total MARFORRES level. The total difference from 2007 to 2008 at the O-level was \$37.98M; of this total, the top four TAMCNs accounted for 59.29 percent of this increase. Figure 45 graphically shows the dramatic increase in maintenance expenditures from 2007 to 2008. The total number of TAMCNs accounting for 80 percent of the total expenditures per year is shown in

Figure 46. The figure shows the increases and decreases of the number of TAMCNs which are expending the most maintenance dollars from year to year.

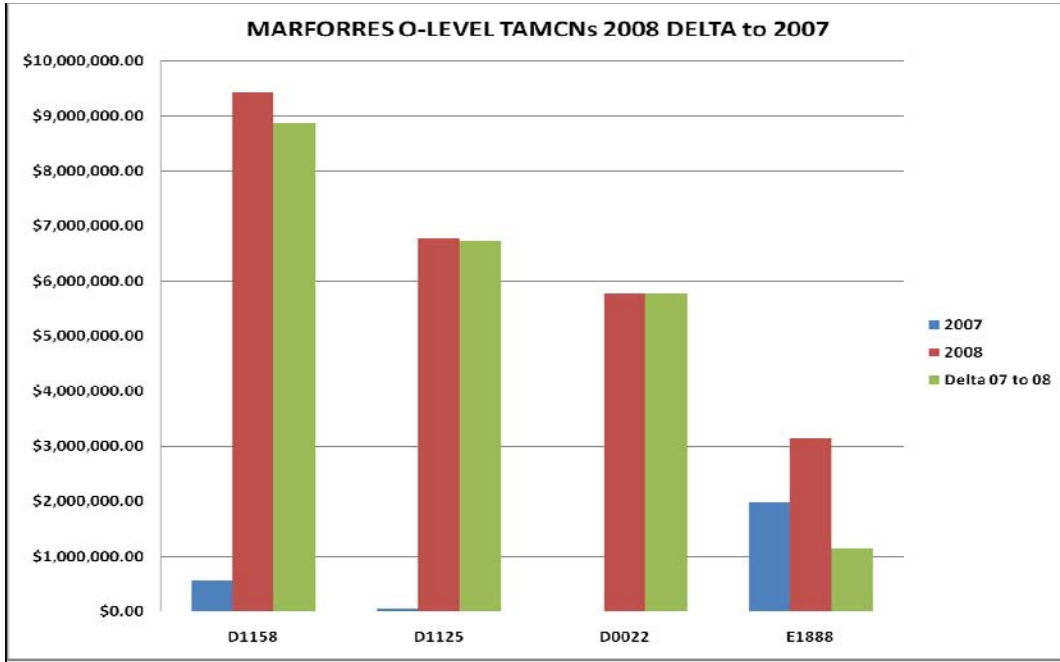


Figure 45. Change in Expenditures from 2007 to 2008 in the Four TAMCNs

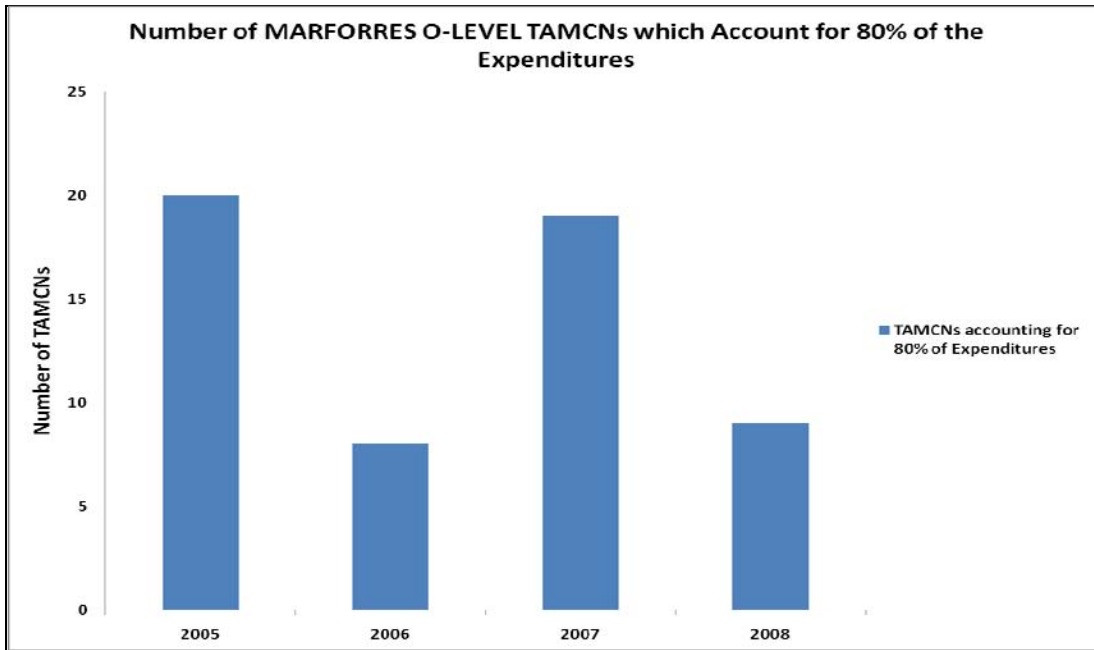


Figure 46. Number of TAMCNs accounting for 80% of MARFORRES O-Level Maintenance Expenditures

b. MARFORRES I-Level Expenditures

Unlike the MARFORRES O-level, the I-level showed a decrease in expenditures from 2006 to 2008. In 2006, the I-level expended \$.64M but decreased to \$.23M in 2008, a decrease of \$.40M. The MARFORRES I-level was above the historic mean in 2005 and 2006, but with the decrease in expenditures from 2007 to 2008, it dipped below the historic mean plus one standard deviation, shown in Figure 47. The decrease in expenditures at the I-level was due to D1158 and E0935.

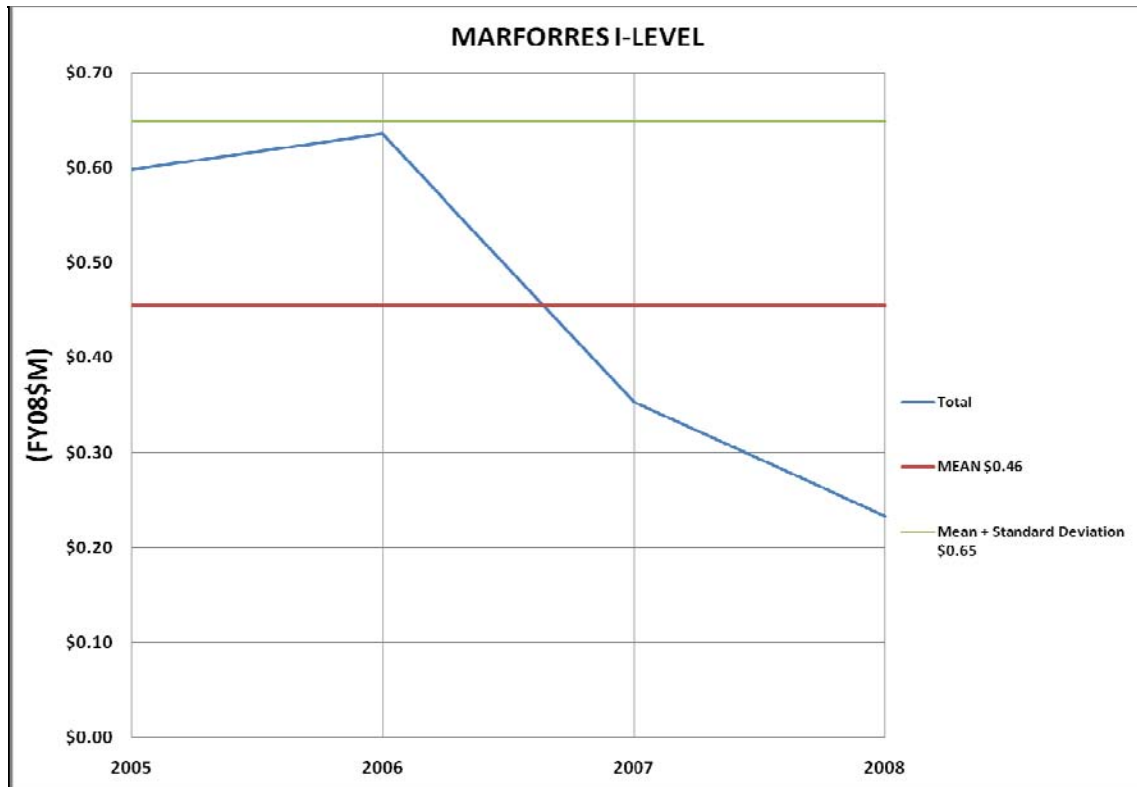


Figure 47. MARFORRES I-Level Maintenance Expenditures (2005–2008)

In Figure 48, there are five TAMCNs expending 80 percent of the total maintenance expenditures in 2006. Table 20 lists these five TAMCNs by the total percentage of expenditures in 2006. Out of these five, only two TAMCNs (D1158 and E0935) remained in 2008 of the seven TAMCNs accounting for 80 percent of the total maintenance expenditures shown in Figure 49. The seven TAMCNs in 2008 are listed in Table 21 by the total percentage of expenditures.

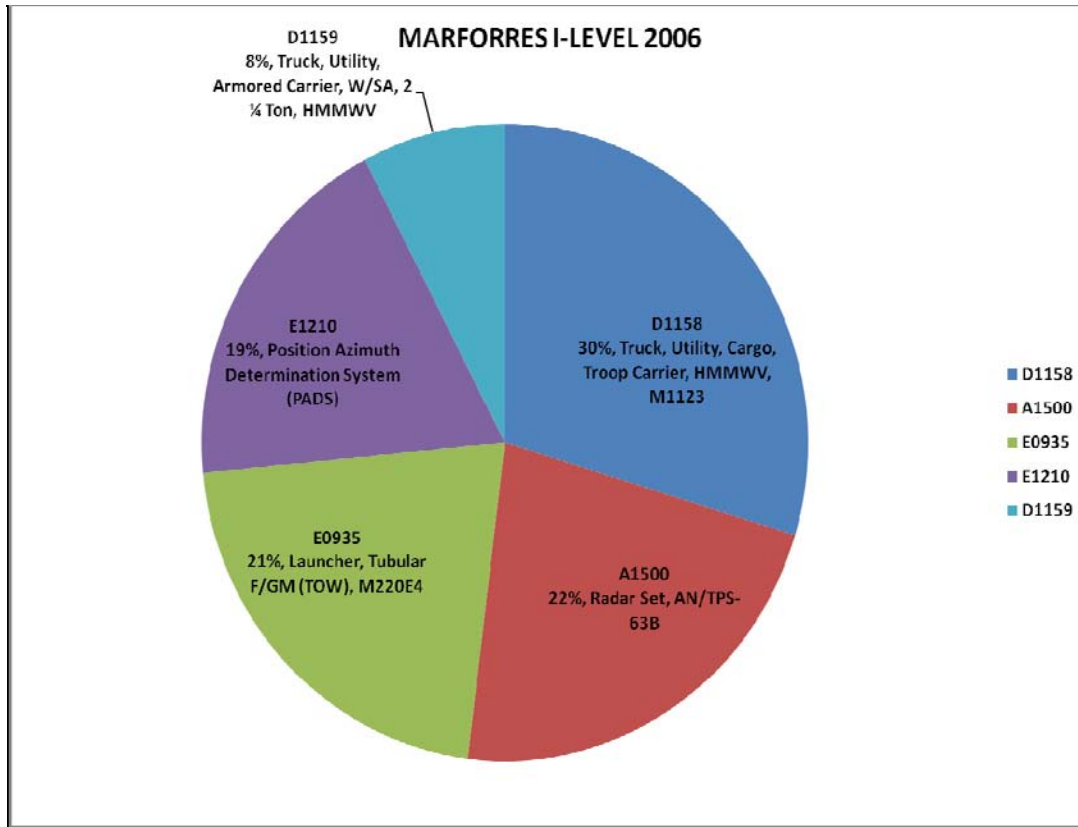


Figure 48. Top Five TAMCNs

TAMCN Description	TAMCN	Percentage
Truck, Utility, Cargo, Troop Carrier, HMMWV, M1123	D1158	25.07%
Radar Set, AN/TPS-63B	A1500	18.81%
Launcher, Tubular F/GM (TOW), M220E4	E0935	18.17%
Position Azimuth Determination System (PADS)	E1210	15.94%
Truck, Utility, Armored Carrier, W/SA, 2 ¼ Ton, HMMWV	D1159	6.45%
Total		84.43%

Table 20. Description of the Five MARFORRES I-Level TAMCNs Accounting for 84.43% of the Total Expenditures in 2006

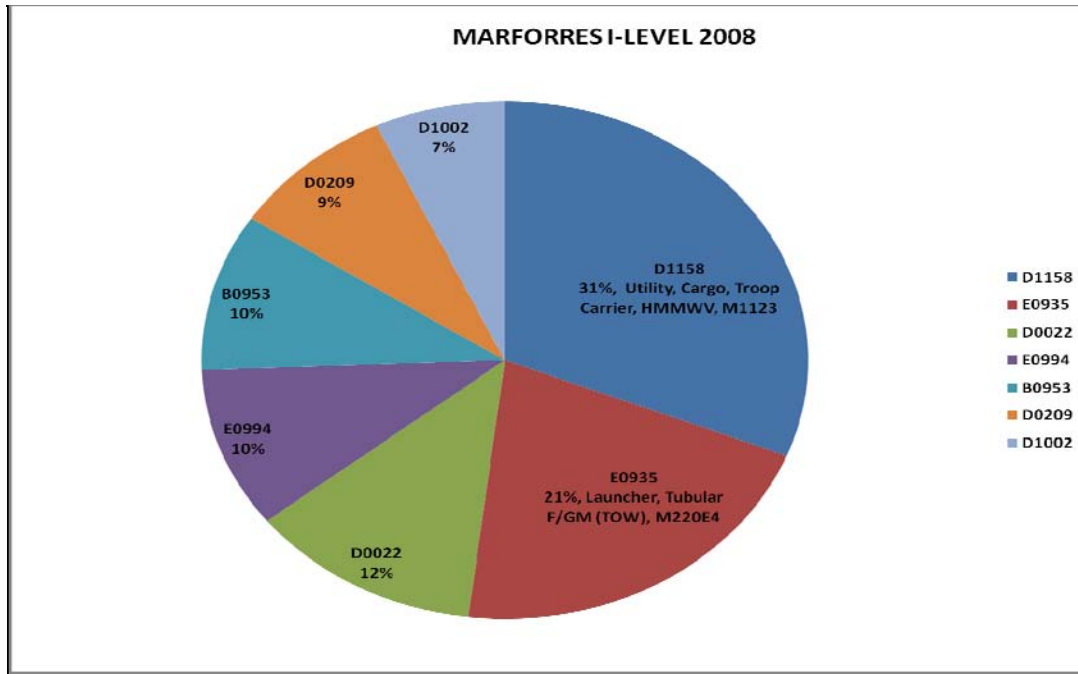


Figure 49. Top Seven TAMCNs

TAMCN Description	TAMCN	Percentage
Truck, Utility, Cargo, Troop Carrier, HMMWV, M1123	D1158	24.52%
Launcher, Tubular F/GM (TOW), M220E4	E0935	16.54%
Truck, Utility, Expanded Capacity, Enhanced, 11,500 GVW, 4x4, M1152 (2-Door)	D0022	9.82%
Machine Gun, 40MM - MK19 MOD3	E0994	7.94%
Generator Set, 30KW, 60 HZ, Skid Mtd, MEP-005A/805A/B	B0953	7.77%
Power Unit, Front, 4x4, MK 48, Mod 0	D0209	6.97%
Truck, Ambulance, 2 Litter, Soft Top, 1 ¼ Ton, HMMWV, M1035	D1002	5.50%
Total		79.07%

Table 21. Description of the Seven MARFORRES I-Level TAMCNs Accounting for 79.07% of the Total Expenditures in 2008

Table 22 displays the differences of the total maintenance expenditures and total percentage of expenditures for the top two TAMCNs from 2006 to 2008. Figure 50 graphically shows the total percentage of expenditures for the four years of this study. The figure displays the fluctuation of the total percentage for the top two TAMCNs.

TAMCN	2006 (\$M)	2008 (\$M)	(+ or -) Delta 06 to 08 (\$M)	% of 2006	% of 2008	(+ or -) % Difference
D1158	\$0.16	\$0.06	-\$0.10	25.07%	24.52%	-0.54%
E0935	\$0.12	\$0.04	-\$0.08	18.17%	16.54%	-1.63%

Table 22. Total Expenditures and Total Percentage of Expenditures Differences from 2006 to 2008

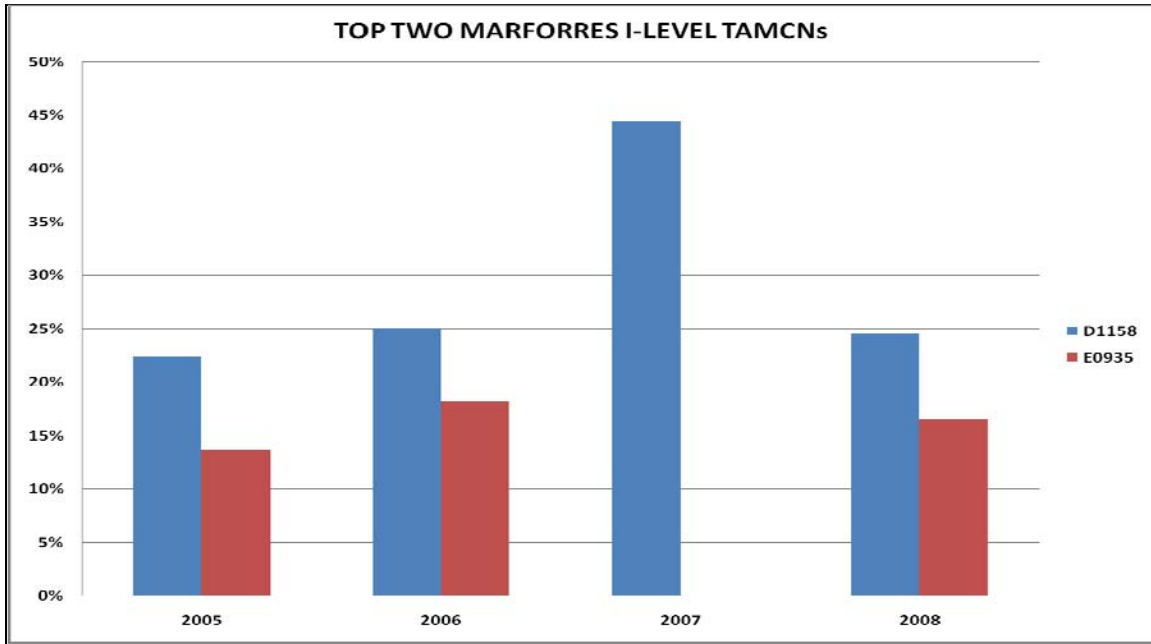


Figure 50. Top Two TAMCNs as a Percentage of the Total Spent per Year

Of the total difference at the I-level, \$.40M, the top two TAMCNs decreased \$.18M from 2006 to 2008, a 44.5 percent decrease. Figure 51 shows D1158 expending \$.16M in 2007, but in 2008, D1158 decreased to \$.06M, a difference of \$.10M. E0935 had expenditures of \$.12M in 2006 that decreased in 2008 to \$.04M. The number of TAMCNs expending 80 percent of the total maintenance expenditures, at the I-level, was low as well but was displayed an increase every year from 2005 to 2008. In 2005 there were 4 TAMCNs. The number of TAMCNs increased by one each year from 2005 to 2008, as shown in Figure 52.

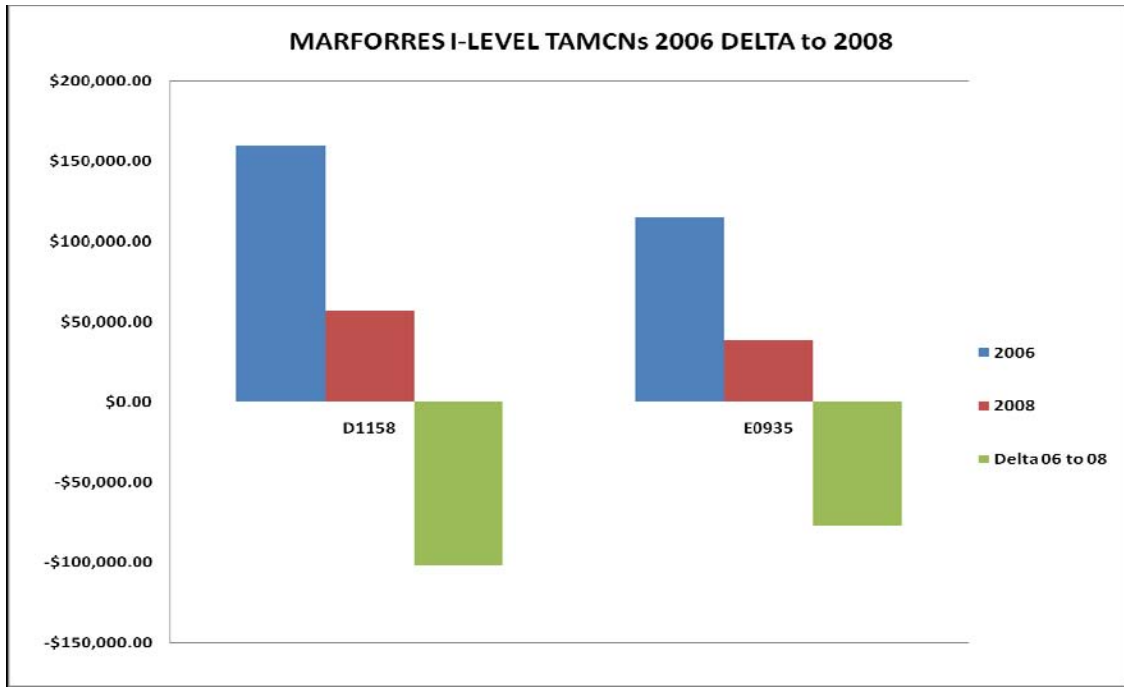


Figure 51. Change in Expenditures from 2006 to 2008 in the Top Two TAMCNs

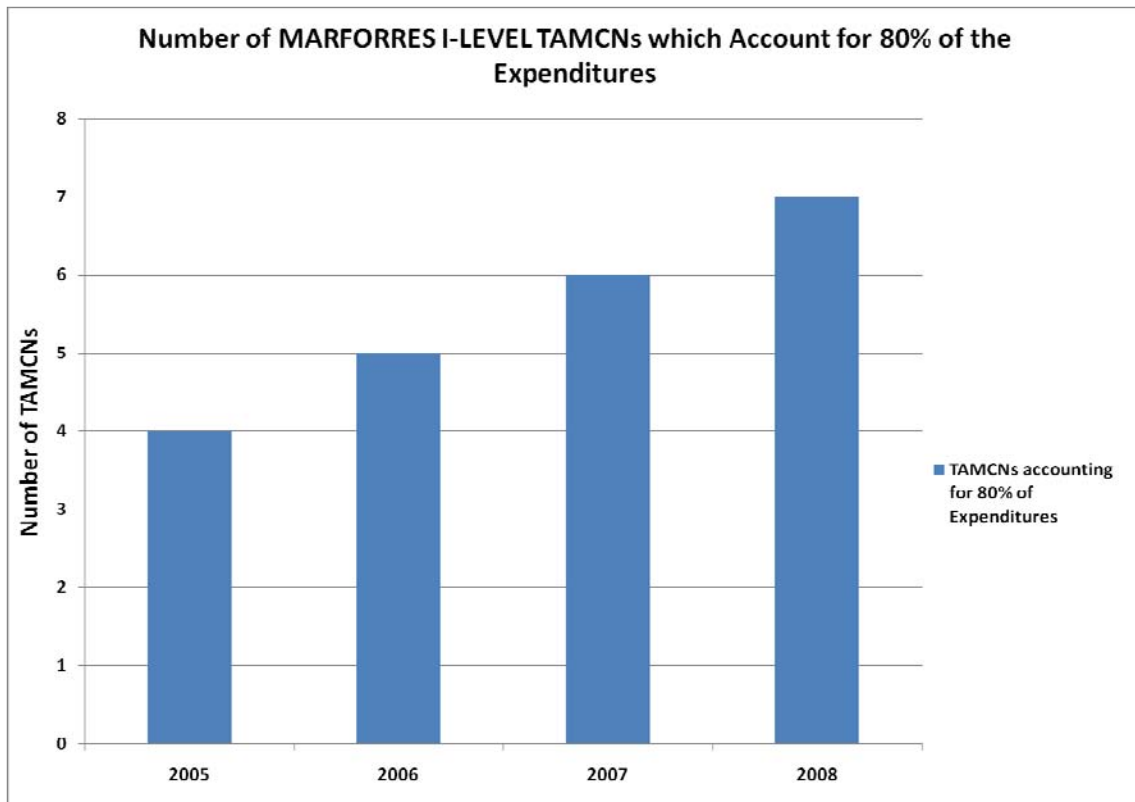


Figure 52. Number of TAMCNs accounting for 80% of MARFORRES I-Level Maintenance Expenditures

5. Observations from Phase I

There are three observations from Phase I. The first observation was that the number of total TAMCNs (out of the 228 total) expending approximately 80 percent of the total maintenance expenditures fluctuated at all echelon levels of maintenance. Second, at the total MARFOR level, there were four TAMCNs which accounted for 45 percent of the total maintenance expenditures in 2008. Finally, the total maintenance expenditures increased and decreased at the three major commands during different years. For example, both MARFORCOM and MARFORRES saw a significant increase in expenditures from 2007 to 2008, while MARFORPAC displayed a decrease in expenditures from 2005 to 2006.

B. PHASE II

The purpose of Phase II is to calculate an “average cost per unit” measure. This cost was calculated by the total O & I maintenance expenditures divided by the number of MARFOR-possessed TAMCNs per year. Of the total 228 TAMCNs listed in the MCBUL 3000, the analysis will focus on the top 20 TAMCNs because these twenty TAMCNs expended approximately 80 percent of the total maintenance expenditures, as shown in Figure 6. The percent total for the top 20 TAMCNs was calculated merely by adding the percentages for each year; as shown in Table 23. For each of the top twenty TAMCNs, we will calculate the Total Cost per Year, Average Unit Cost (AUC), the Average Unit Cost Mean, and the Average Unit Cost Mean plus one Standard Deviation. In each figure, except for A1503 and A3232 which were kept in whole dollars, the Total Cost per Year was divided by 1000, to keep the Total Cost per Year and the Average Unit Cost in the same dollars, which is FY08\$. Observations from this phase are reported in section 21, page 85.

TAMCN DESCRIPTION	Top Twenty TAMCN's	Average percentage (2005-2008)
Launcher, Tubular F/GM (TOW), M220E4	E0935	10.24%
Machine Gun, Cal .50, Browning, HB Flexible - M2	E0980	10.23%
Assault Amphibious Vehicle, Personnel, AAVP7A1	E0846	9.88%
Tank, Combat, Full-Track, 120mm Gun, M1A1	E1888	6.82%
Truck, Utility, Cargo, Troop Carrier, HMMWV, M1123	D1158	6.51%
Machine Gun, 40MM - MK19 MOD3	E0994	4.49%
Mortar, 81mm, M252	E1095	3.77%
Howitzer, Medium, Towed 155MM, M198	E0665	3.50%
Light Armored Vehicle, 25mm, LAV-25	E0947	2.63%
Truck, Cargo, 7 Ton, W/O Winch (MTVR) MK23/MK25	D0198	2.39%
Mortar, 60MM, M224	E1065	2.18%
Power Unit, Front, 4x4, MK 48, Mod 0	D0209	2.05%
Radio Set, Manpack, AN/PRC-119A	A2070	2.04%
Radio Terminal Set, AN/MRC-142A	A1955	1.98%
Machine Gun, Medium, 7.62MM, Ground Version - M240B	E0989	1.72%
Sight, Thermal, AN/UAS-12C Hybrid	E0330	1.49%
Radio Set, AN/MRC-145A	A1957	1.45%
Rifle, Sniper, 7.62MM, W/Equipment	E1460	1.35%
Radar Set, LW3D, AN/TPS-59(V)3	A1503	1.11%
Secure Mobile Anti-Jam Reliable Tactical Terminal (SMART-T), AN/TSC-154	A3232	0.53%
Total		76.38%

Table 23. Top Twenty TAMCNs Average Percentage (2005–2008) for Total MARFOR

1. E0935, Launcher, Tubular F/GM (TOW), M220E4

E0935, Launcher, Tubular F/GM (TOW), M220E4, was the top TAMCN, accounting for the most expenditures in the four year period, averaging 10.24 percent of the total maintenance expenditures, as shown in Table 23. There is a significant spike in the AUC from 2005 to 2006, but this steadily decreased from 2006 to 2008. The increase from 2005 to 2006 occurred at the MARFORCOM O-Level. In 2005, the O-level expended \$12.74M and increased to \$75.99M in 2006. This increase accounted for 99.84 percent of the increase at the total MARFOR level. The total inventory for E0935 also declined from 2005 to 2008. In 2005, the MARFORs had a total of 599 items which decreased to 457 items in 2008, a decrease of 142 total items, and 23.71%. With the steady decline in both AUC and inventory, E0935 has fallen well below the AUC mean and the AUC mean plus one standard deviation. The fluctuation of the inventory levels for this TAMCN, as well as for the other TAMCNs to be discussed, occurs when a piece of equipment is moved from either the O or I level of maintenance into the depot level maintenance. The MARFOR will remove it from their maintenance books while it is at

the depot until it is returned, or they have received a replacement. Possible explanations for the increase in expenditures were the increased number of items sent to conduct operations in Iraq during the increase of forces from 2005 to 2006.



Figure 53. E0935 Total Cost versus Average Unit Cost (2005–2008)

2. E0980, Machine Gun, Cal .50, Browning, HB Flexible-M2

E0980, Machine Gun, Cal .50, Browning, HB Flexible-M2, is the second highest TAMCN, on average accounting for 10.23 percent of the total maintenance expenditures. As shown in Figure 54, the Total Cost and AUC have been steadily increasing from 2006 to 2007. Until 2008, the AUC had remained below the AUC mean and the AUC mean plus one standard deviation. As discussed in Phase I, E0980 was one of the top four TAMCNs whose maintenance expenditures led the spike in the total cost from 2007 to 2008. One explanation for this increase is the total number of items in the inventory. In 2005, there were 1738 E0980s in the MARFOR inventory; this increased to 2208 in 2008, an increase of 470 items, or over 25 percent. Another possible explanation for increase in maintenance expenditures, which occurred at the MARFORCOM I-level, was the number of government labor dollars spent at the I-level.

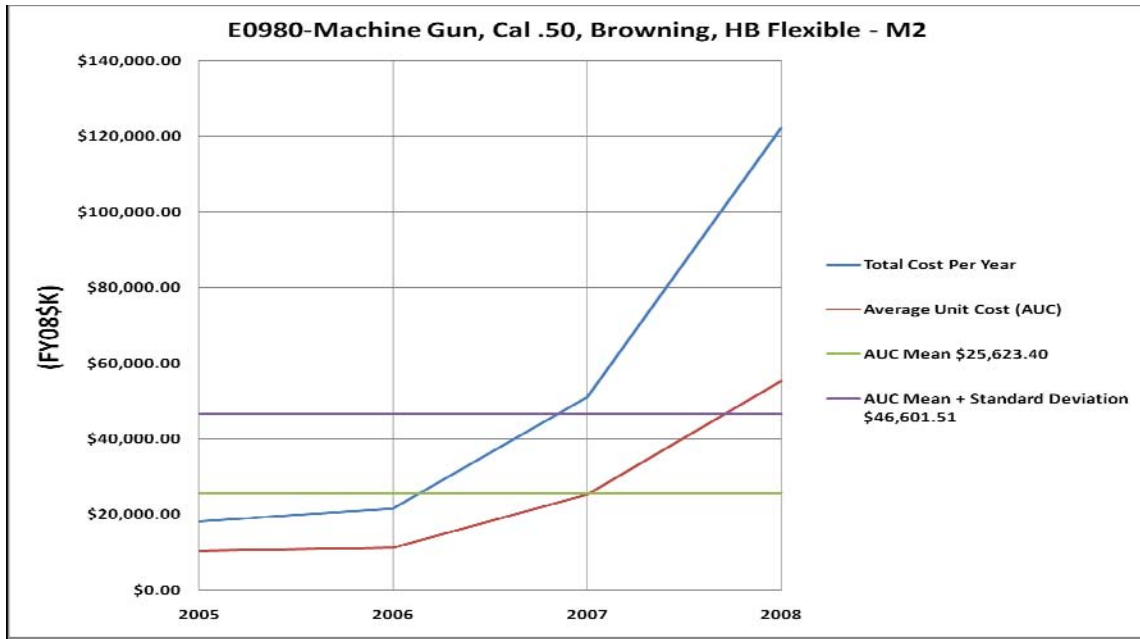


Figure 54. E0980 Total Cost versus Average Unit Cost (2005–2008)

3. E0846, Assault Amphibious Vehicle, Personnel, AAVP7A1

The third TAMCN is E0846, Assault Amphibious Vehicle, Personnel, AAVP7A1, which accounted for 9.88 percent of the total maintenance expenditures. Since 2006, the AUC has been below the AUC mean, as well as below the AUC mean plus standard deviation, as shown in Figure 55. The MARFORs have had a fluctuation in the number of E0846 accounted for in their inventory, as shown in Table 24. E0846 was the leading TAMCN in maintenance expenditures at the total MARFORPAC level. The decrease of \$21.9M from 2005 to 2007 also had a significant impact on the AUC. This decrease in expenditures occurred at the MARFORPAC I-level. An explanation for the decrease was that as more E0846 were used in combat operations but required less I-level maintenance at MARFORPAC.

Year	2005	2006	2007	2008
Number of items	571	508	522	618

Table 24. Number of Items at Total MARFOR level of E0846

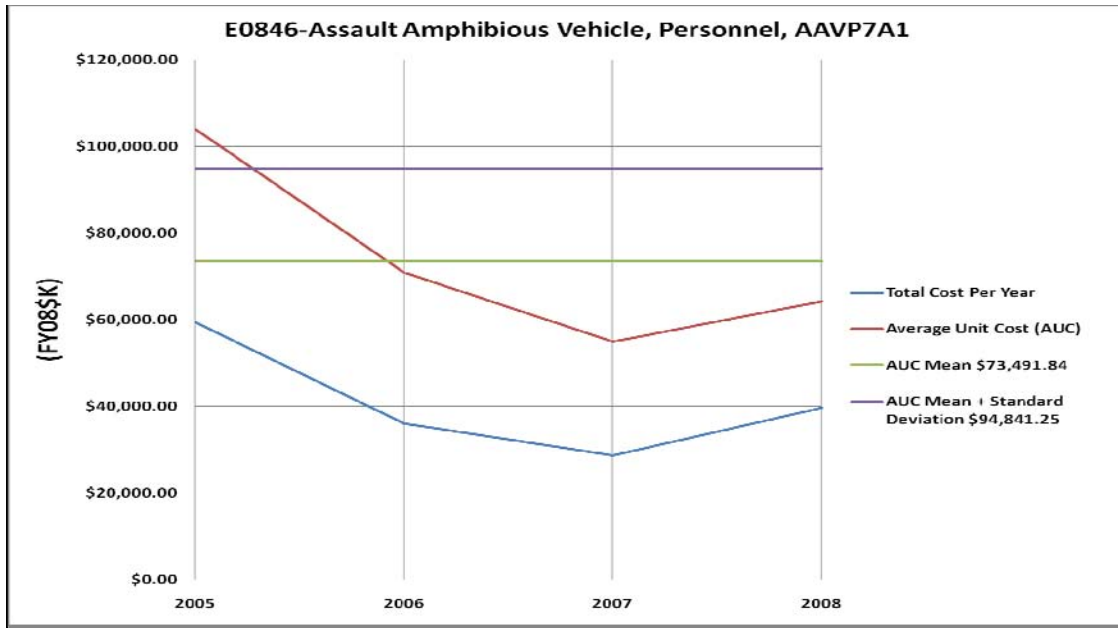


Figure 55. E0846 Total Cost versus Average Unit Cost (2005–2008)

4. E1888, Tank, Combat, Full-Track, 120MM Gun, M1A1

E1888, Tank, Combat, Full-Track, 120MM Gun, M1A1, is the fourth TAMCN of the top twenty but is a significant 3% drop from #3, E0846. E1888 averaged 6.82 percent of the total maintenance expenditures. Figure 56 shows that the total cost per year is almost steady for the four years, but the AUC had an increase from 2005 to 2006, then a decrease in 2007. Like E0846, E1888 had a decrease in expenditures from 2005 to 2006 at the total MARFORPAC level. Specifically this decrease occurred at the MARFORPAC I-level. This decrease could be attributed to moving a number of items into operations in Iraq. Even though the total maintenance expenditures decreased, so did the total number of items at the total MARFORs level. Table 25 displays the increase and decrease of the number items possessed at the total MARFOR level. From 2007 to 2008, the AUC for E1888 has remained below the AUC mean and the AUC mean plus standard deviation, and even with the increase in 2006 the AUC is just above the AUC mean plus standard deviation.

Year	2005	2006	2007	2008
Number of items	173	141	162	173

Table 25. Number of Items at Total MARFOR level of E1888

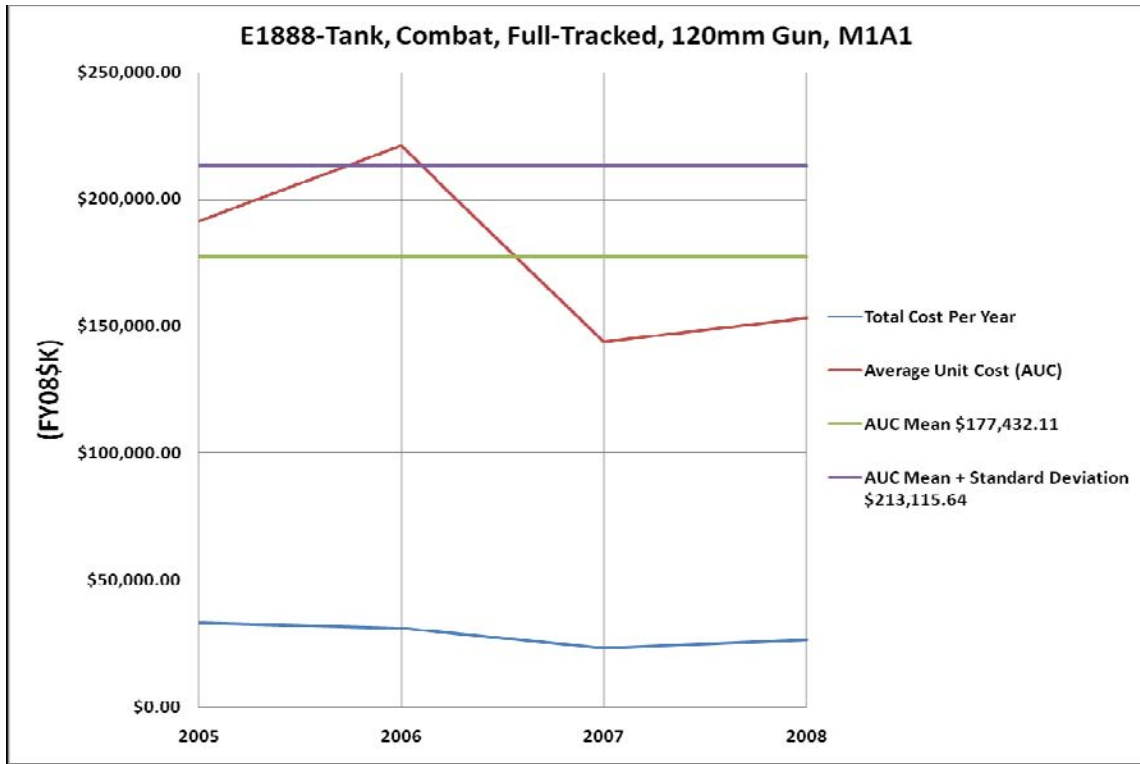


Figure 56. E1888 Total Cost versus Average Unit Cost (2005–2008)

5. D1158, Truck, Utility, Cargo, Troop Carrier, HMMWV, M1123

D1158 accounted for 6.51 percent of the total maintenance expenditures. Figure 57 shows the total cost per year had a decrease from 2005 to 2006 followed by an increase to 2007. These fluctuations were found at the MARFORPAC I-level. In 2007, D1158 accounted for 43 percent of the total maintenance expenditures. From 2006 to 2007, D1158 increased in expenditures by \$24.04M. The AUC cost for D1158 has had some fluctuation between the AUC mean and the AUC mean plus standard deviation, but has yet to move above these costs. The reason for this trend is the high amount of inventory kept by the MARFORs. The total number of items possessed by the MARFORs is shown in Table 26, which shows the large increases and decreases of the numbers in the inventory. Figure 57 shows the AUC mean is \$4.84K, while the AUC mean plus standard deviation is \$6.87K. This is a tight bound between the AUC mean and AUC mean plus standard deviation. Operations in Iraq, from 2006 to 2007, with increase in forces are a possible explanation for the increase.

Year	2005	2006	2007	2008
Number of items	6297	6424	6121	5161

Table 26. Number of Items at Total MARFOR level of D1158

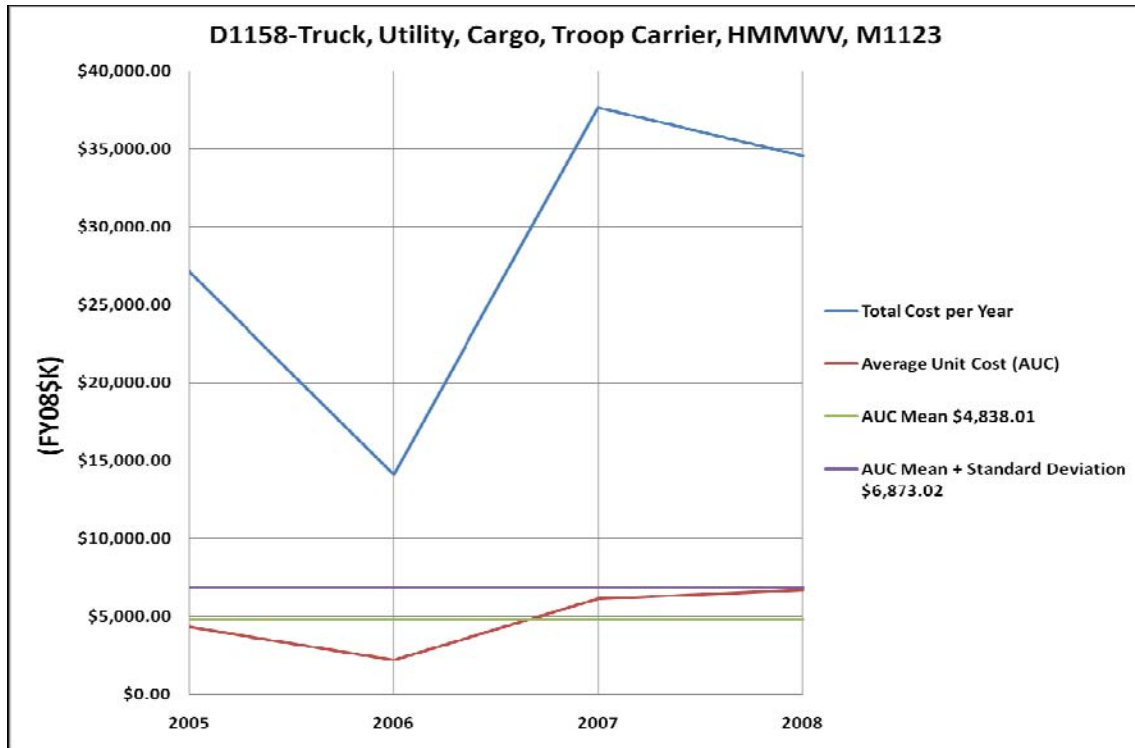


Figure 57. D1158 Total Cost versus Average Unit Cost (2005–2008)

6. E0994, Machine Gun, 40MM–MK19 MOD 3

E0994, which had the largest increase of maintenance expenditures from 2007 to 2008, is also shown in Figure 58. From 2005 to 2007, the total cost and the average unit costs were low but then from 2007 to 2008 the maintenance expenditure spike occurred. The total increase from 2007 to 2008 was \$114.31M. As discussed on page 24, paragraph one, there were two reasons for this increase in maintenance expenditures for E0994. First, more E0994 were required in support of combat operations which drove up the costs for rebuilds, which caused an increase in quantity for the number of rebuilds. Second, there was a modification to the item that was required for all MK19s in the Marine Corps. This modification was to facilitate mounting a thermal sight on the receiver. (Major Brian Spooner, personal communication, September 1, 2009). Recent

communication with MARCORLOGCOM has suggested that the modifications to E0994 occurred at the Depot Level, thus reducing costs at the I-level. (Michael Brown, personnel communication, September 4, 2009). MARCORLOGCOM were unable to give further reason for the rise in maintenance expenditures. Table 27 shows the increase in the number of items by the MARFORs (even with the modification occurring at the depot level), rising 547 items from 2005 to 2007. This rise is attributed to the increase in maintenance expenditures from 2007 to 2008.

Year	2005	2006	2007	2008
Number of items	1661	1937	2036	2208

Table 27. Number of Items at Total MARFOR level of E0994

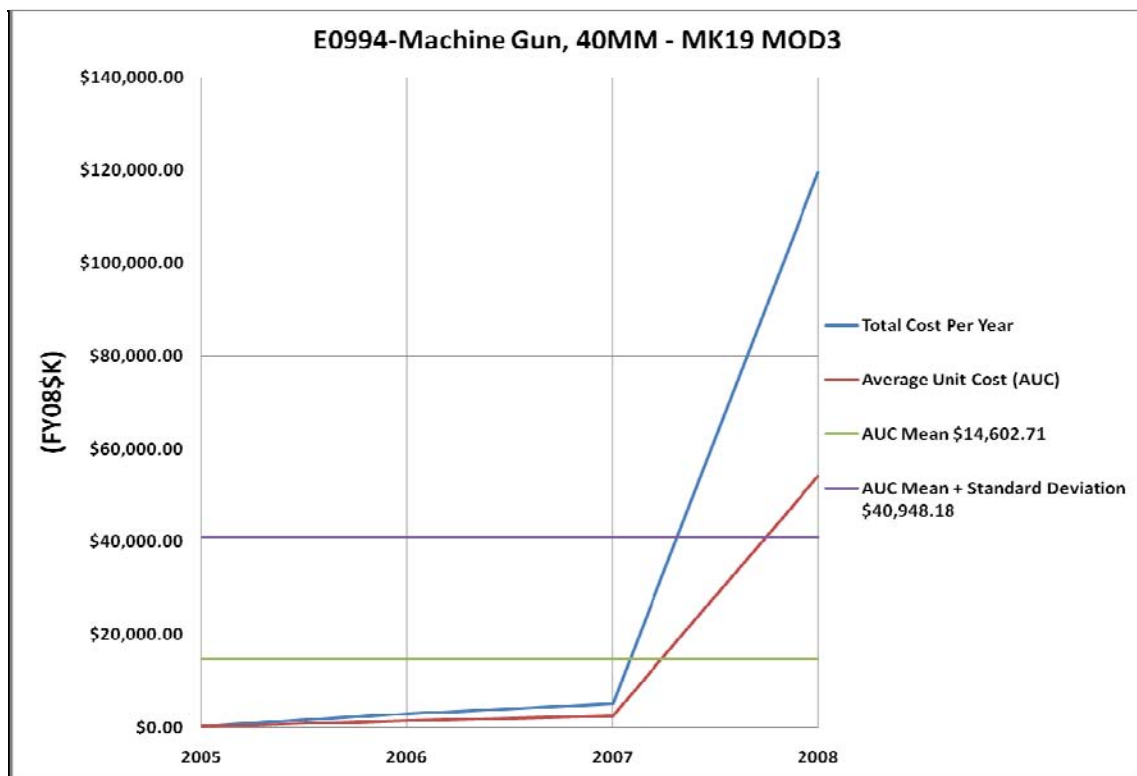


Figure 58. E0994 Total Cost versus Average Unit Cost (2005–2008)

7. E1095, Mortar, 81MM, M252

The E1095 average over the four years is 3.77 percent of the total maintenance expenditures. E1095 has seen an increase in maintenance expenditures from 2005 to 2008, as shown in Figure 59. At the total MARFOR level, E1095 total expenditures were

\$1.43M, in 2005. This increased to \$40.27M by 2008, an increase of \$38.83M. 98.6 percent of this increase is accounted for at the total MARFORCOM level. In 2005, MARFORCOM expended \$1.23M and rose to \$39.54M in 2008, a difference of \$38.30M. The AUC has also been impacted by this rise in maintenance expenditures. The AUC has risen from \$3.78K per item in 2005 to \$95.43K in 2008. E1095 inventory in 2005 was 380 items which increased to 422 items by 2008. The inventory levels are shown in Table 28. The reason for this increase is unknown at this time.

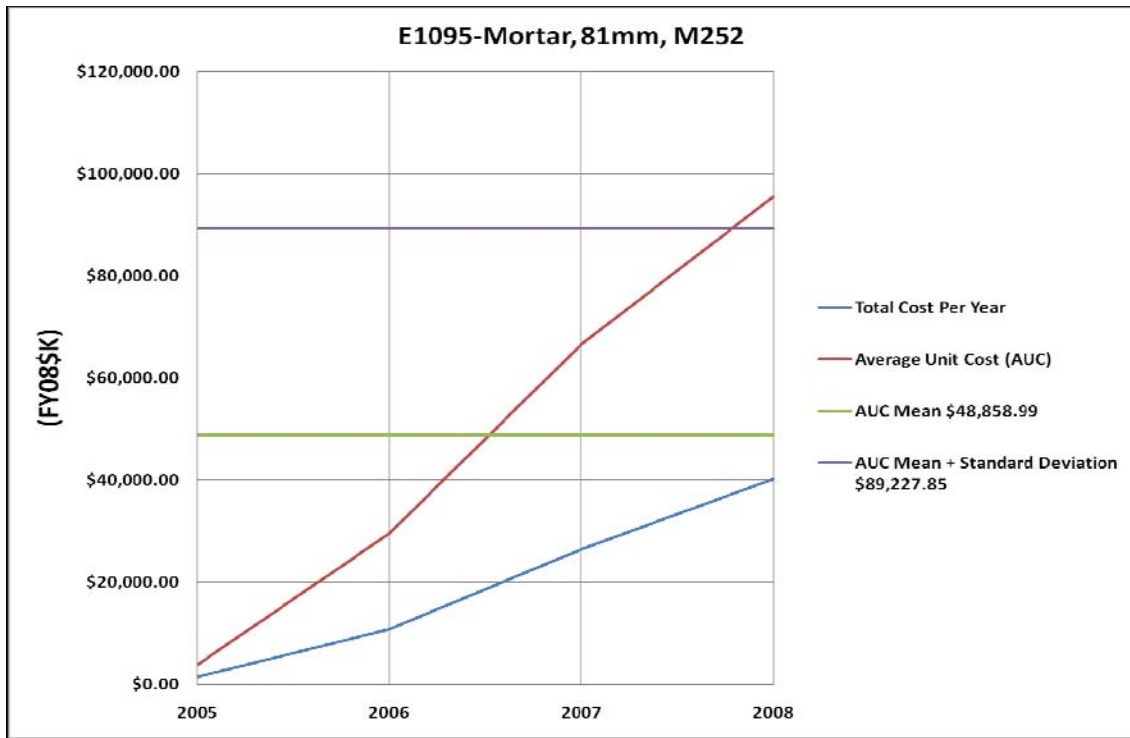


Figure 59. E1095 Total Cost versus Average Unit Cost (2005–2008)

Year	2005	2006	2007	2008
Number of items	380	366	398	422

Table 28. Number of Items at Total MARFOR level of E1095

8. E0665, Howitzer, Medium Towed 155MM, M198

E0665, Howitzer, Medium Towed 155MM, M198, which had an average of 3.5 percent of the total maintenance expenditures, saw an increase of the AUC from \$36.09K in 2005 to \$153.86K in 2006, a difference of \$117.77K. This was followed by a huge

decrease to \$19.24K in 2007. Table 29 shows the steady decreases in the number of items in the inventory at the MARFORs. Figure 60 displays two major spikes which occurred for E0665. The first was an increase in maintenance expenditures and AUC from 2005 to 2006. The second was a huge decrease in both maintenance expenditures and AUC from 2006 to 2007. The increase and decrease in maintenance expenditures occurred at the MARFORCOM I-level. In 2005, the I-level expended \$7.04M and rose to \$38.63M, an increase of \$31.59M, or 99.31 percent of the total increase at the Total MARFOR level. In 2007, the maintenance expenditures at the I-level significantly decreased to \$2.00M. Even with the decrease of inventory numbers from 2005 to 2008, the spikes which occurred were driven by the major fluctuations of maintenance expenditures from the I-level.

Year	2005	2006	2007	2008
Number of items	308	279	225	161

Table 29. Number of Items at Total MARFOR level of E0665

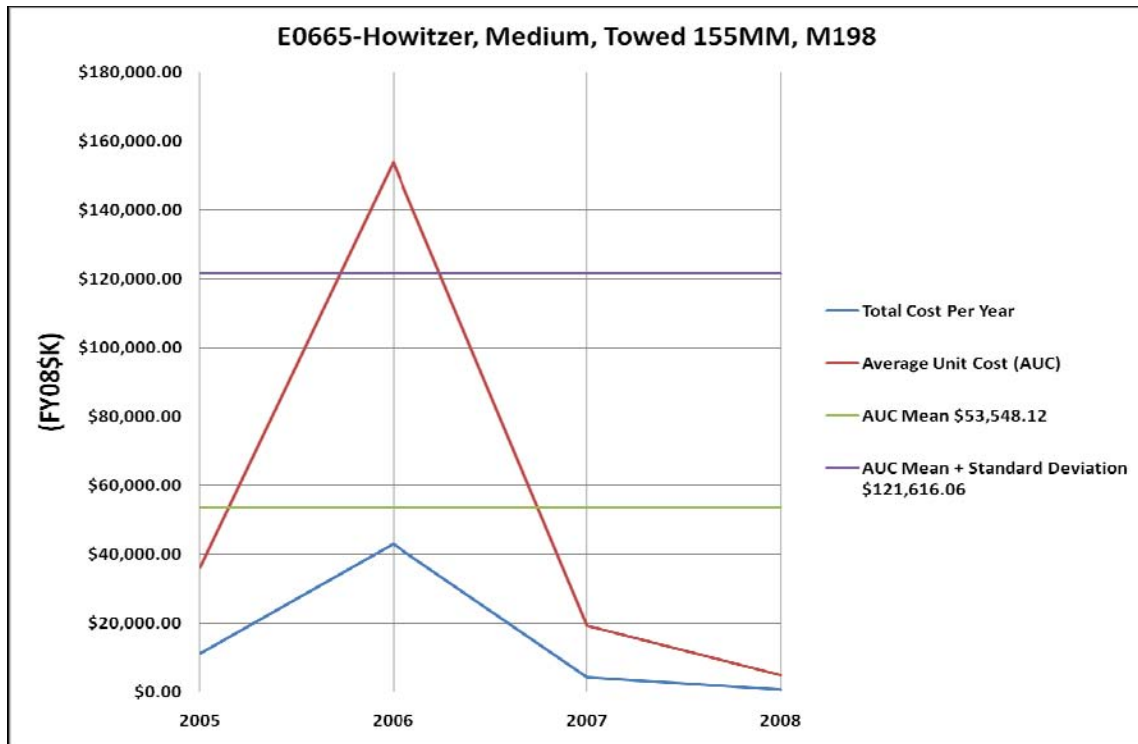


Figure 60. E0665 Total Cost versus Average Unit Cost (2005–2008)

9. E0947, Light Armored Vehicle, 25MM, LAV - 25

E0947, the Light Armored Vehicle, averaged 2.63 percent of the total maintenance expenditures from 2005 to 2008, and saw a decrease in AUC from 2005 to 2006, as shown in Figure 61. In 2005, the AUC was \$72.42K which decreased to \$47.53K, a difference of \$24.89K. This decrease can be explained by looking at the total cost at the MARFORPAC O&I levels of maintenance. At both levels the total cost showed a decrease in expenditures. The O-level had a decrease of \$2.81M and the I-level had a decrease of \$5.87M at the I-level. The number of items in the inventory decreased from 2005 to 2007, but increased in 2008, as shown in Table 30. This increase in the number of items as well as the total maintenance expenditures remaining steady led to the AUC to decrease from 2005 to 2006.

Year	2005	2006	2007	2008
Number of items	253	235	195	222

Table 30. Number of Items at Total MARFOR level of E0947

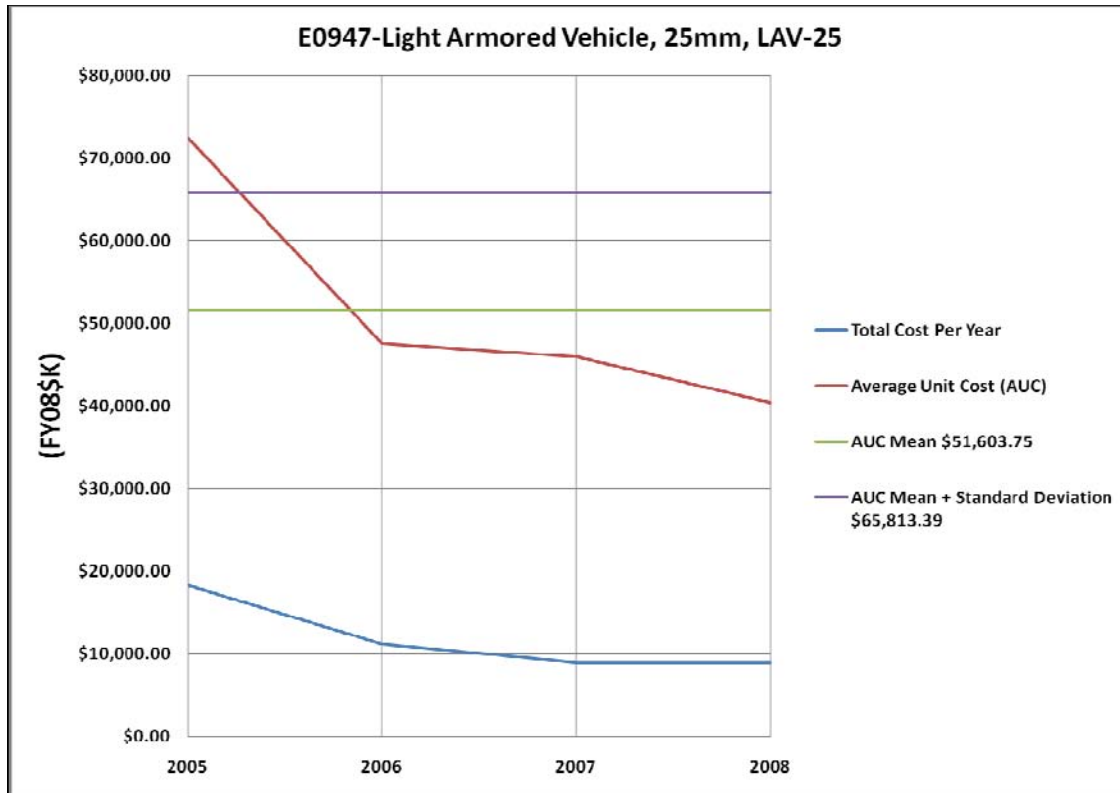


Figure 61. E0947 Total Cost versus Average Unit Cost (2005–2008)

10. D0198, Truck Cargo, 7 Ton W/O Winch (MTVR) MK23/MK25

In Figure 62, D0198 shows an increase in both Total Cost and AUC from 2007 to 2008. The increase in Total Cost occurred at the MARFORCOM O-Level. In 2007 D0198 expended \$2.07M and accounted for 1.64 percent of the total maintenance expenditures at the O-level. In 2008, D0198 accounted for 12.95 percent of the total expenditures and expended \$23.40M, a difference of \$21.33M. This increase in total maintenance expenditures led to the rise in the AUC. Table 31 shows the increases and decreases of the number of items in the inventory. This decrease in inventory numbers and the increase in total cost led to the AUC rising from 2007 to 2008. The AUC, in 2008, is above the AUC mean plus one standard deviation; this increase, though, is only a .5 standard deviations plus the AUC mean.

Year	2005	2006	2007	2008
Number of items	3055	3273	3040	2952

Table 31. Number of Items at Total MARFOR level of D0198

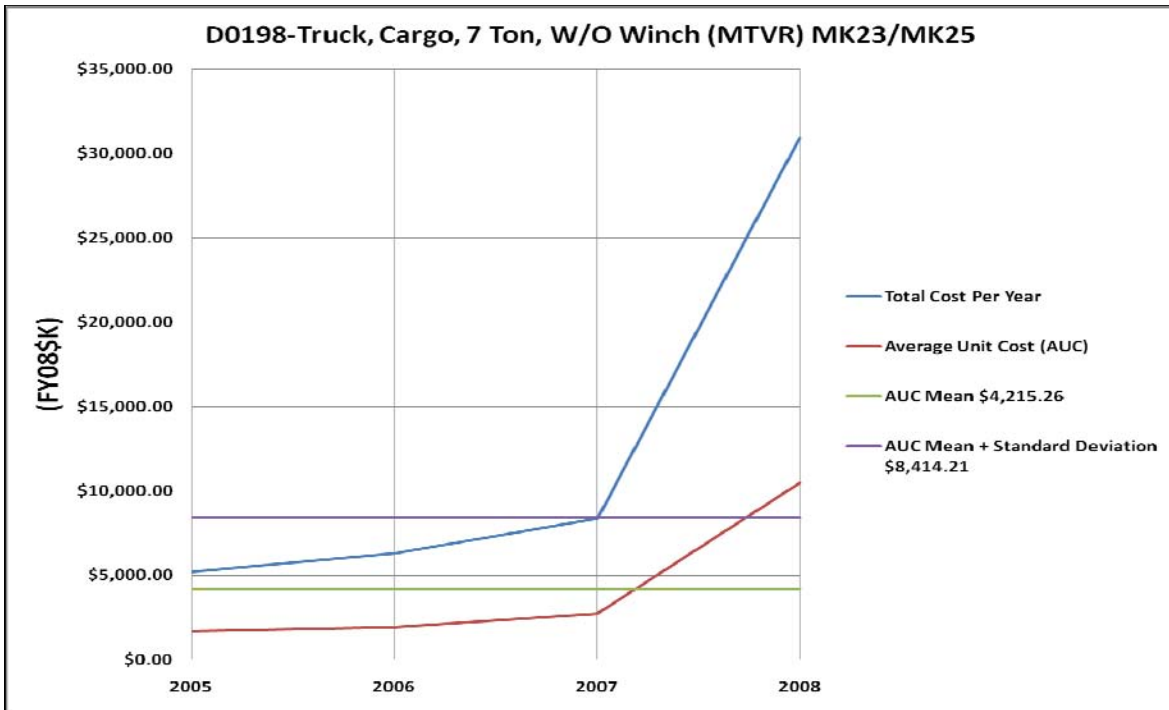


Figure 62. D0198 Total Cost versus Average Unit Cost (2005–2008)

11. E1065, Mortar, 60MM, M224

From 2005 to 2008, E1065, Mortar, 60MM, M224, has seen an increase in total cost and AUC. In 2005, E1065 expended \$1.35M and rose to \$25.37M in 2008, at the total MARFOR level. Table 32 displays the increases and decreases in the inventory numbers for the MARFORs. This fluctuation of inventory numbers, as well as the maintenance expenditures, can be seen in Figure 63. From 2006 to 2007, there was a slight increase in AUC and total cost which was due to the rise in the inventory. But the decrease from 2007 to 2008 also affected the AUC, since there was a rise in maintenance expenditures.

Year	2005	2006	2007	2008
Number of items	410	389	424	407

Table 32. Number of Items at Total MARFOR level of E1065

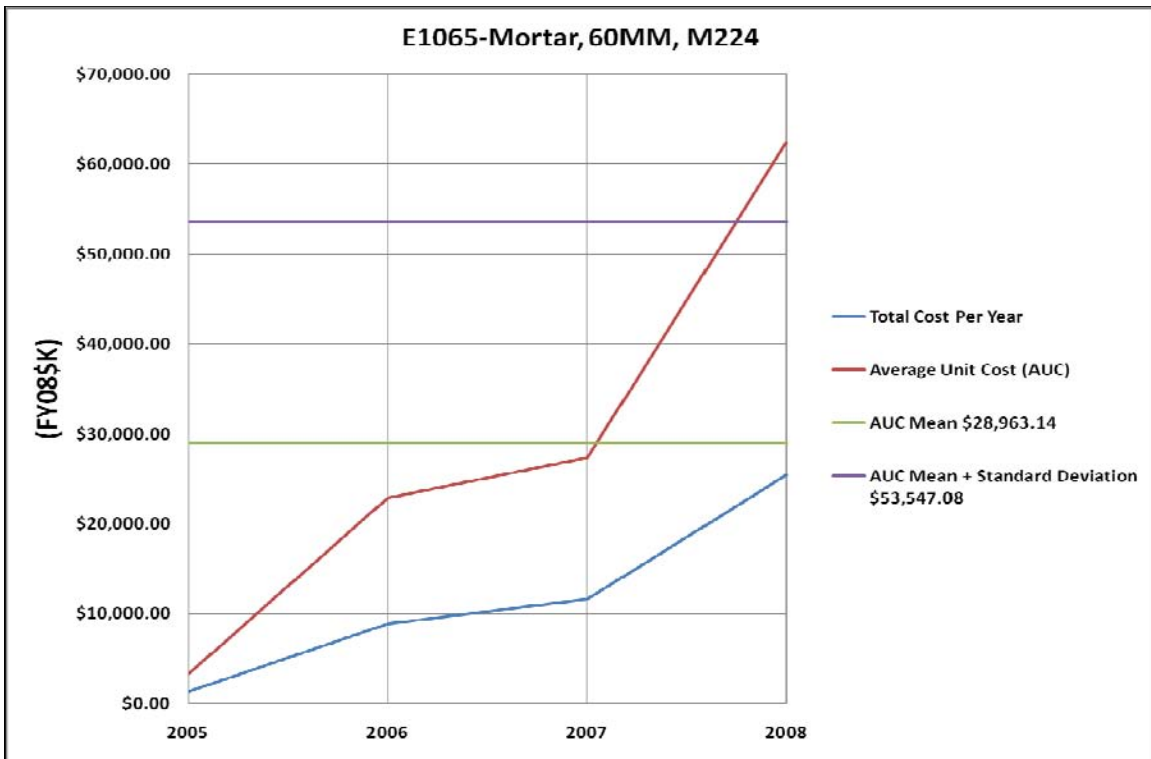


Figure 63. E1065 Total Cost versus Average Unit Cost (2005–2008)

12. D0209, Power Unit, Front, 4X4, MK48, Mod 0

D0209 averaged 2.05 percent of the total maintenance expenditures from 2005 to 2008, as shown in Figure 64. From 2005 to 2006, D0209 had a decrease in both the Total Cost and AUC. In 2005, D0209 expended \$14.76M but expended only \$.59M in 2006, a decrease of \$14.17M, yet during the same time the number of items increased by 333 items, as shown in Table 33. There was an increase in both Total Cost and AUC, in 2007. D0209 expended \$.96M and increased to \$3.44M, a difference of \$2.47M. The source of the differences in the expenditures from 2005 to 2006 and 2007 to 2008 came from the MARFORPAC I-Level. As a total percentage of expenditures during the four years at the I-level, D0209 was expending 13.02 percent in 2005. In 2006, that percentage decreased to 1.37 percent of the total. From 2007 to 2008 the percentage went from 1.52 percent to 6.52 percent.

Year	2005	2006	2007	2008
Number of items	882	1215	1054	1101

Table 33. Number of Items at Total MARFOR level of D0209

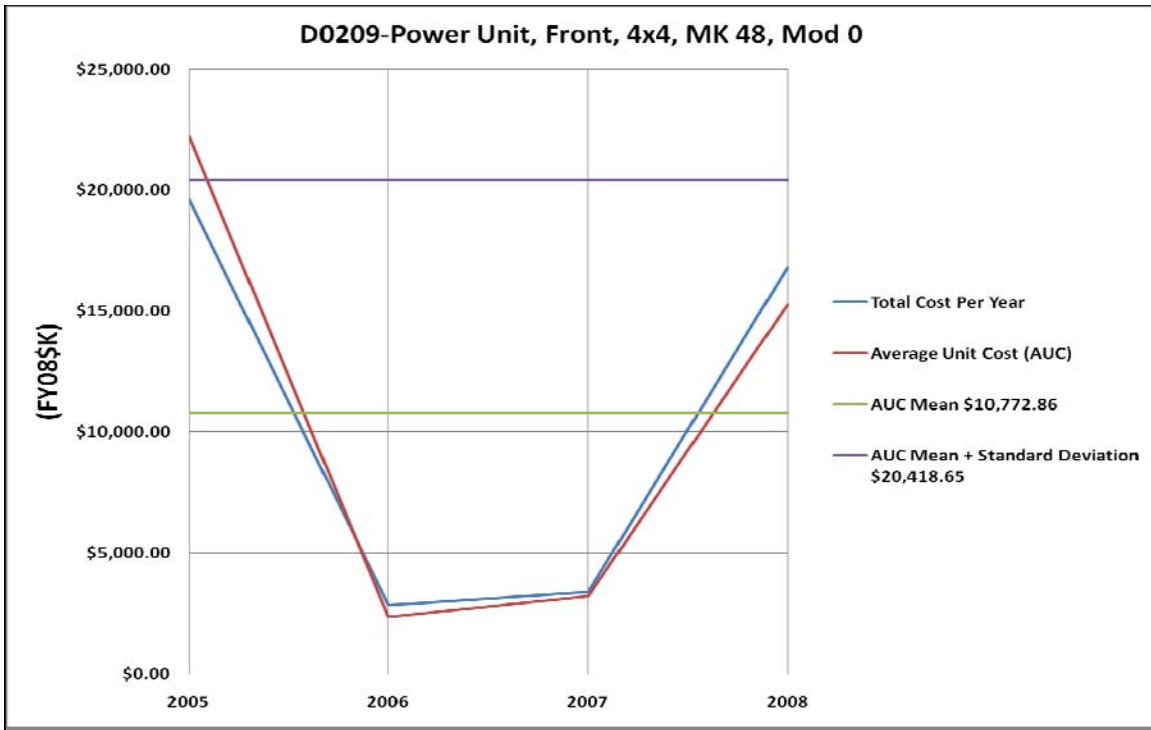


Figure 64. D0209 Total Cost versus Average Unit Cost (2005–2008)

13. A2070, Radio Set, Manpack, AN/PRC-119A

Figure 65 shows that the AUC for A2070 has tended to be below the AUC mean plus one standard deviation from 2005 to 2008. The total cost increased from 2005 to 2006 followed by decreasing expenditures from 2006 to 2008. A2070 was one of the top four TAMCNs at the MARFORPAC O-Level. From 2005 to 2006, A2070 saw an increase in expenditures and inventory numbers. The expenditures increased from \$7.31M in 2005 to \$8.26M in 2006 and the inventory numbers increased from 2005 to 2006, as shown in Table 34. A2070 averaged 2.04 percent of the total maintenance expenditures during the four years.

Year	2005	2006	2007	2008
Number of items	2818	2987	3022	2941

Table 34. Number of Items at MARFORPAC O-level of A2070

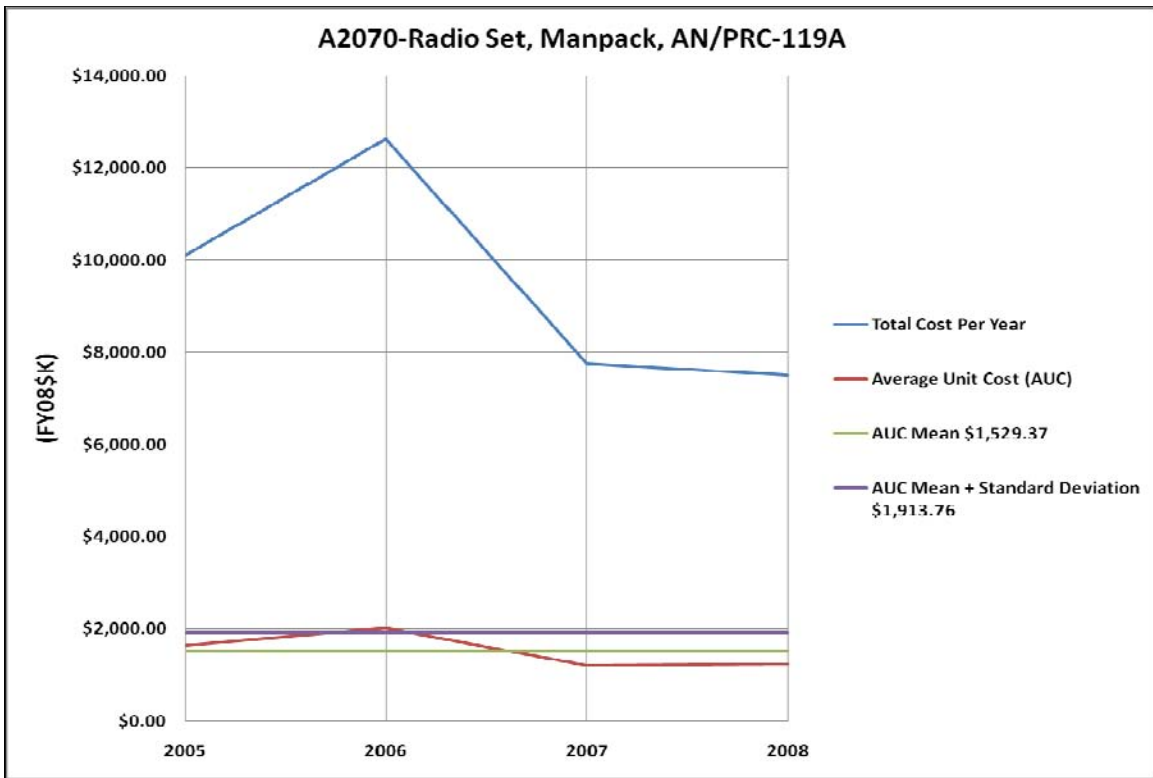


Figure 65. A2070 Total Cost versus Average Unit Cost (2005–2008)

14. A1955, Radio Terminal Set, AN/MRC - 142A

A1955 averaged 1.98 percent of the total maintenance expenditures from 2005 to 2008. A1955 experienced an increase in the total cost and AUC from 2005 to 2006 followed by a decrease from 2006 to 2007, as shown in Figure 66. The rise in expenditures occurred at two different commands. The first occurred at the MARFORCOM I-level where in 2005, A1955 expended \$14.18K but increased to \$800.20K in 2006. The second increase occurred at the MARFORRES O-level, where in 2005 it expended only \$.09M and rose to expending \$6.16M in 2006. Followed by the increases at both commands, there was a decrease from 2006 to 2007. MARFORCOM I-level decreased to \$34.64K, and MARFORRES O-level decreased to \$211.05K, in 2007. These increases and decreases are the explanations for the AUC spiking up and down from 2005 to 2007. Interestingly, the inventory levels for A1955 were steady throughout the four years, as shown in Table 35.

Year	2005	2006	2007	2008
Number of items	241	245	248	248

Table 35. Number of Items at Total MARFOR level of A1955

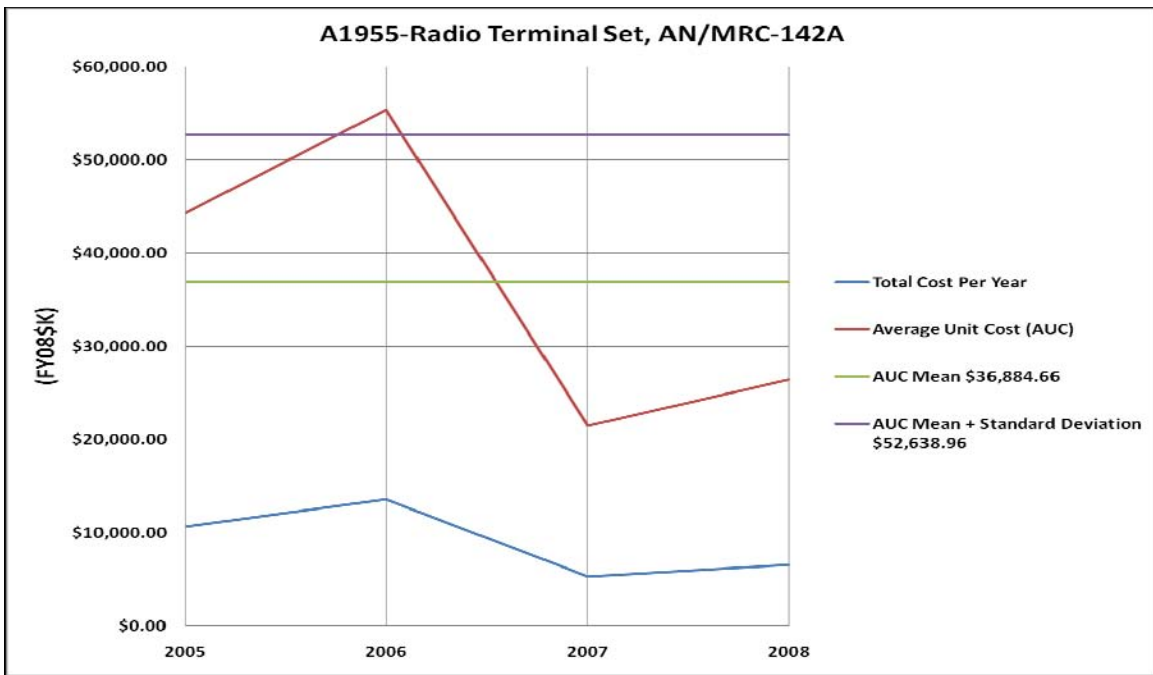


Figure 66. A1955 Total Cost versus Average Unit Cost (2005–2008)

15. E0989, Machine Gun, Medium, 7.62MM, Ground Version–M240B

E0989 averaged 1.72 percent of the total maintenance expenditures from 2005 to 2008. As shown in Figure 67, E0989 total cost and AUC increased during the four year period, with a noticeable spike from 2007 to 2008. One explanation for the spike is that E0989 expended \$8.97 M in 2007 and rose to \$32.89 M in 2008, an increase of \$23.92 M at the total MARFOR level. Of this increase, 88 percent of the increase occurred at the MARFORCOM I-level. In 2007 at the I-level, E0989 expended \$7.56M and increased to \$28.63M in 2008, a difference of \$21.06M. A second possible explanation for this spike from 2007 to 2008 is the number of items in the inventory. Table 36 shows the inventory number increased and decreased during the four year period, with the biggest increase in the inventory numbers occurring from 2007 to 2008. There were 3876 items in 2007 which rose to 4857 in 2008, an increase of 981 items. Even with the increase in maintenance inventory, the AUC rose above the AUC mean plus one standard deviation. The AUC mean is low as well, averaging only \$2.79K on maintenance expenditures during the four year period.

Year	2005	2006	2007	2008
Number of items	3734	3673	3876	4857

Table 36. Number of Items at Total MARFOR level of E0989

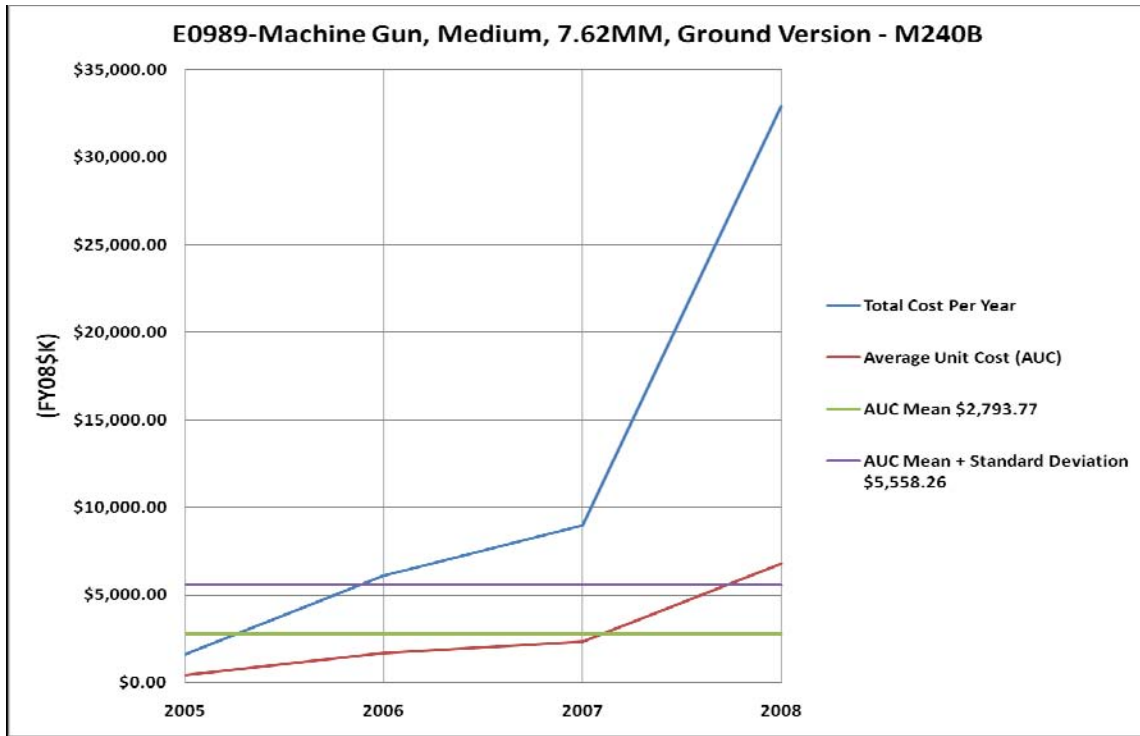


Figure 67. E0989 Total Cost versus Average Unit Cost (2005–2008)

16. E0330, Sight, Thermal, AN/UAS–12C Hybrid

E0330 averaged 1.49 percent of the total maintenance expenditures from 2005 to 2008. Figure 68 displays the total cost versus the AUC from 2005 to 2008. Even with the increase and decrease, the AUC was still below the AUC mean plus one standard deviation for the four year period. In the display we see from 2005 to 2006 that there was an increase in both total cost and AUC. There was also a decrease in both as well from 2007 to 2008. The cause for the increase and decrease occurred at the MARFORCOM O-level. In 2005, E0330 expenditures were \$.03M and significantly rose to \$11.52M in 2006, a difference of \$11.49M. This difference accounted for 99.6 percent of the increase at the total MARFOR level as well. In 2007, E0330 expenditures were \$10.79M and decreased to \$2.63M in 2008, a difference of \$8.16M. At the total MARFOR level, this accounted for 95.2 percent of the decrease. The inventory numbers have decreased steadily from 2005 to 2008 as shown in Table 37.

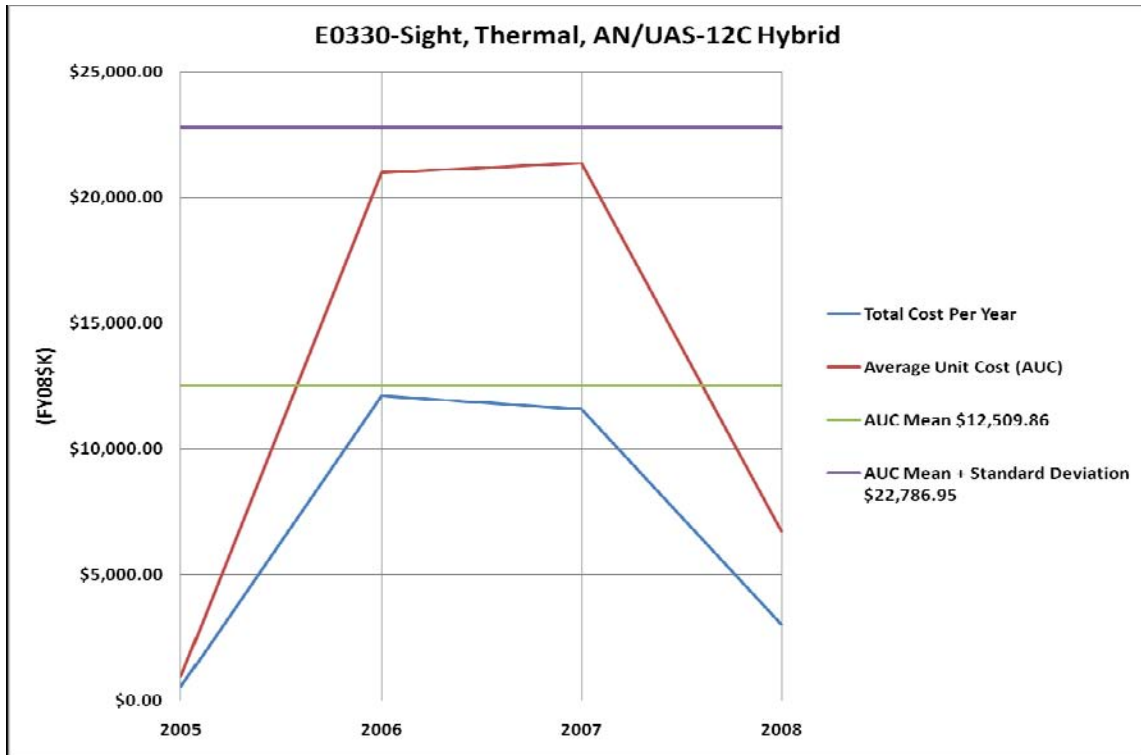


Figure 68. E0330 Total Cost versus Average Unit Cost (2005–2008)

Year	2005	2006	2007	2008
Number of items	582	577	542	447

Table 37. Number of Items at Total MARFOR level of E0330

17. A1957, Radio Set, AN/MRC-145A

A1957 averaged 1.45 percent of the total maintenance expenditures from 2005 to 2008. The total cost and AUC decreased from 2005 to 2008, as shown in Figure 69. There was a noticeable decrease from 2006 to 2007, where the expenditures decreased from \$8.18M to \$4.68M, a difference of \$3.50M. 86.9 percent of this total decrease can be explained at two different locations. The first significant decrease occurred at the MARFORCOM O-level. In 2006, the O-level expended \$3.04M and decreased its expenditures to \$1.39M in 2007, a delta of \$1.65M. The second decrease happened at the MARFORPAC O-level, where in 2006 it expended \$4.03M and decreased to \$2.63M in 2007, a difference of \$1.39M. A factor for the decrease in the AUC was also the inventory levels for the total MARFOR. Since 2005 the number of items in the inventory

has been increasing. The most significant increase in inventory occurred from 2006 to 2007 as shown in Table 38.

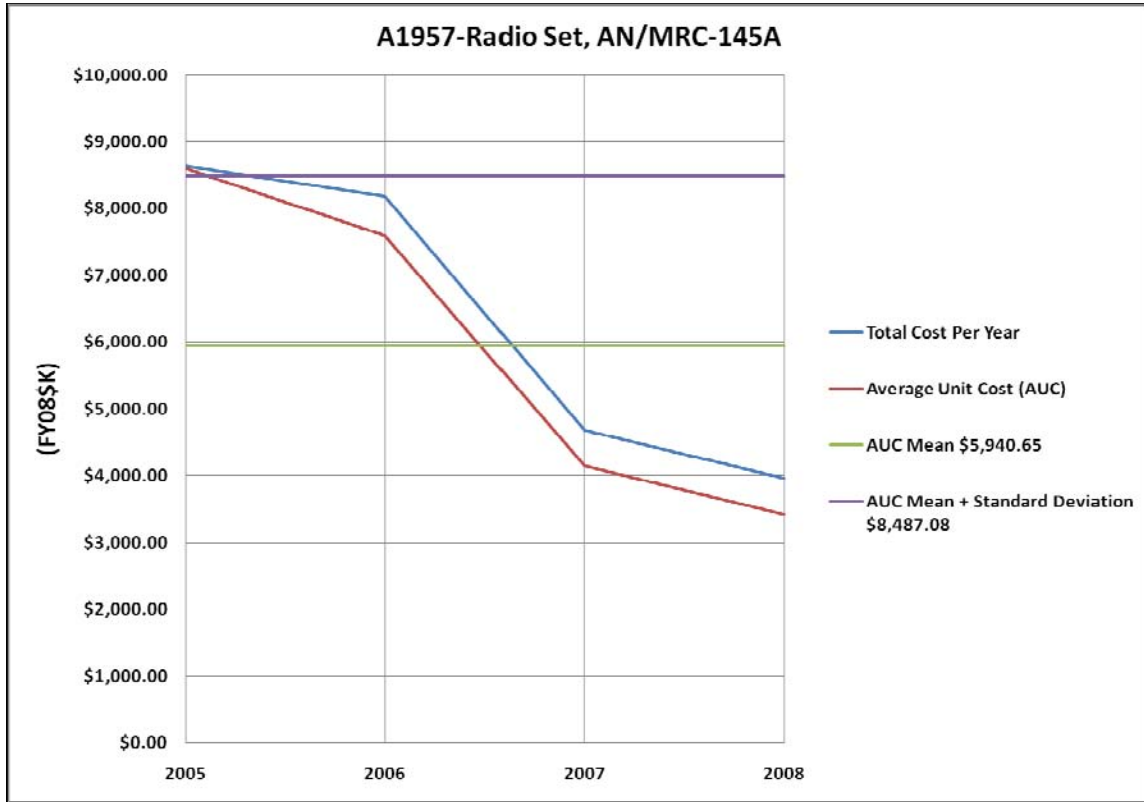


Figure 69. A1957 Total Cost versus Average Unit Cost (2005–2008)

Year	2005	2006	2007	2008
Number of items	1004	1077	1129	1160

Table 38. Number of Items at Total MARFOR level of A1957

18. E1460, Rifle, Sniper, 7.62MM, W/Equipment

E1460 averaged 1.35 percent of the total maintenance expenditures from 2005 to 2008. Since 2005 the total cost and AUC for E1460 has been increasing in maintenance expenditures with a noticeable spike in expenditures from 2006 to 2007, as shown in Figure 70. The total MARFOR level saw an increase in expenditures of \$11.29M from 2006 to 2007. The MARFORCOM I-level was the leading command who had the most significant increase in expenditures during this time. In 2006, the I-level expended \$1.39M and rose to \$12.53M in 2007, an increase of \$11.13M. Of the total difference at

the MARFOR level, the I-level accounted for 98.6 percent of the increase in expenditures. The AUC rose again from 2007 to 2008, even with the slight increase in total maintenance expenditures. This rise was due more in fact to the inventory numbers, as shown in Table 39.



Figure 70. E1460 Total Cost versus Average Unit Cost (2005–2008)

Year	2005	2006	2007	2008
Number of items	452	488	559	481

Table 39. Number of Items at Total MARFOR level of E1460

19. A1503, Radar Set, LW3D, AN/TPS–59(V) 3

A1503 averaged 1.11 percent of the total maintenance expenditures from 2005 to 2008. Figure 71 shows A1503 in whole dollars. This display graphically shows the fluctuation for the total cost of the item from 2005 to 2008. We see the AUC rose from 2005 to 2006, but has stayed below the AUC mean for the other years. This rise from 2005 to 2006 is not due to the inventory levels. Table 40 shows that the inventory numbers remained steady from 2005 to 2008. The increase in maintenance expenditures from 2005 to 2006 and the decrease of expenditures from 2006 to 2007 were the reasons

for the rise and fall of the AUC. The total MARFOR level saw an increase in expenditures of \$7.29M from 2005 to 2006 and a decrease in expenditures of \$8.44M from 2006 to 2007. The MARFORPAC O-level was the leading command for both the increase and decrease of the maintenance expenditures. The O-level in 2005 expended \$3.54M and rose to \$11.54M in 2006, a difference of \$8.00M. This difference accounted for 100 percent of the increase at the total MARFOR level. The decrease at the O-level occurred from 2006 to 2007 where the expenditures went from \$11.54M to \$3.14M respectively, a difference of \$8.40M. This decrease accounted for 99.5 percent of the total MARFOR decrease during those years.

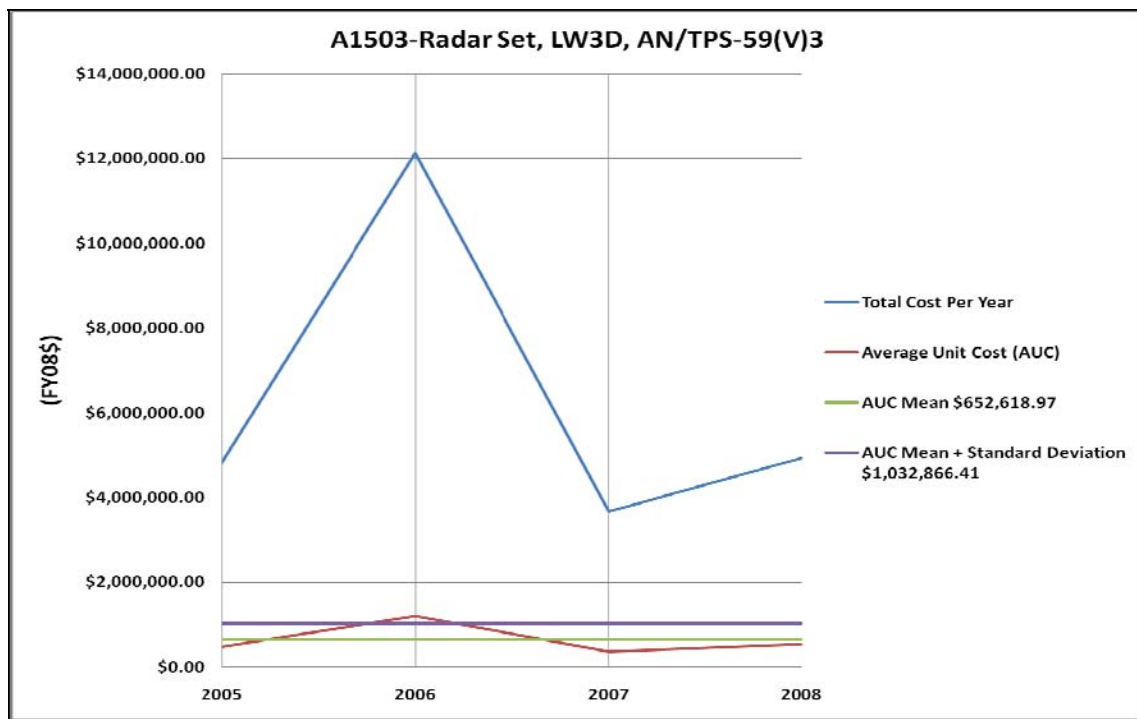


Figure 71. A1503 Total Cost versus Average Unit Cost (2005–2008)

Year	2005	2006	2007	2008
Number of items	10	10	10	9

Table 40. Number of Items at Total MARFOR level of A1503

20. A3232, Secure Mobile Anti-Jam Reliable Tactical Terminal (SMART-T), AN/TSC-154

A3232 averaged 0.53 percent of the total maintenance expenditures from 2005 to 2008. A3232, as shown in Figure 72, had a significant decrease in expenditures from 2005 to 2006. Since this decrease, the AUC has remained steadily below the AUC mean from 2006 to 2008. At the total MARFOR level, A3232 expended \$7.09M in 2005 and had a significant decrease in 2006 to \$.41M, a difference of \$6.68M. The command which had the most significant input for this decrease was the MARFORPAC O-level. Accounting for 99.5 percent of the decrease at the O-level, the expenditures in 2005 were \$7.05M, which declined to only \$.40M in 2006, a delta of \$6.65M. Table 41 displays the number of items in the inventory. From 2005 to 2008 there was little change in the number of items. This means the total maintenance expenditures per year are driving the AUC per item.

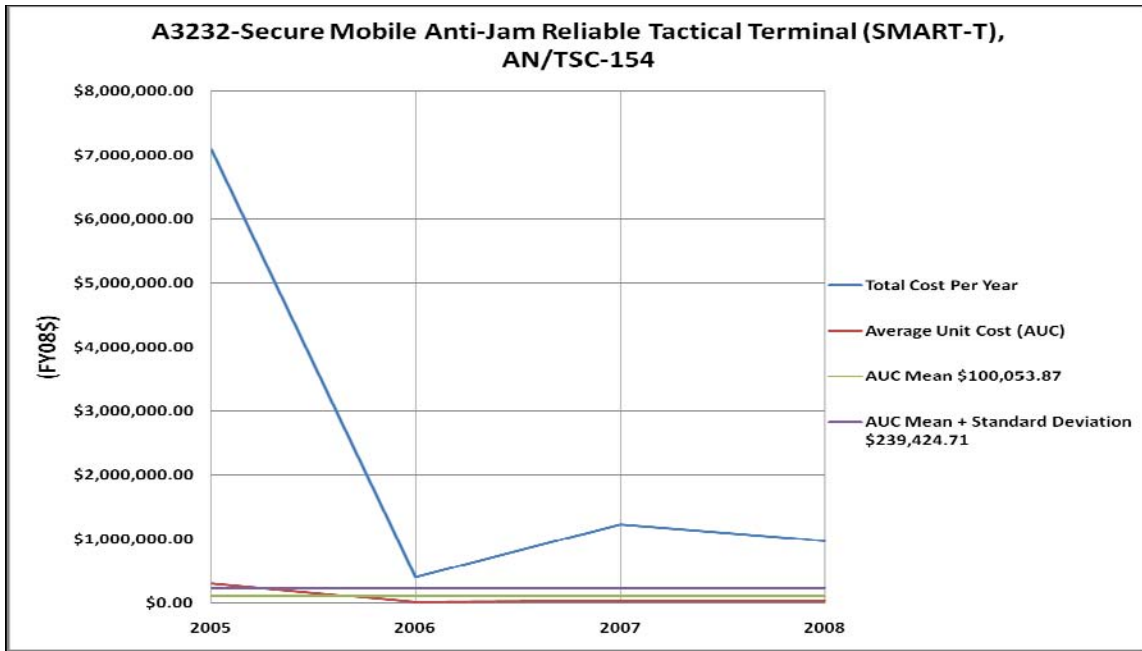


Figure 72. A3232 Total Cost versus Average Unit Cost (2005–2008)

Year	2005	2006	2007	2008
Number of items	23	28	31	26

Table 41. Number of Items at Total MARFOR level of A3232

21. Observations from Phase II

Phase II identified the twenty TAMCNs (out of the 228) which consumed the majority of the maintenance budget, accounting for 76.4% of overall expenditures. We observed that the number of items in the inventory fluctuated over time, and this variability led to fluctuating AUCs from 2005 to 2008. The increase and decrease in AUC was also driven by the total maintenance expenditures during the four year period. The increase and decrease of both the inventory numbers and total maintenance expenditures allows for predicting future costs for each item. The known inventory numbers and the historic maintenance costs will be used to extrapolate the future expenditures.

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IV CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

The analysis of Phase I show that the model is useful but that further study is needed. In Phase I we identified the 228 total TAMCNs listed in the FY09 MCBUL 3000. We then were able to determine which of these TAMCN's were driving the maintenance expenditures from the total MARFOR level down to the individual MARFOR commands and to the echelons of maintenance level. Phase I also allows the comptrollers a quick look at the historic means, and historic means plus one standard deviation, as a means to judge if the budget request by a MARFOR command was reasonable. As discussed in the analysis, it will be problematic to explain which TAMCNs are driving the costs in the future, since the number of TAMCNs requiring maintenance at all MARFOR maintenance echelons fluctuates from year to year. But with the increase and decrease of inventory levels, the future costs can be predicted by extrapolating from historic maintenance costs.

The analysis of Phase II shows that there were 20 TAMCNs identified in Phase I that accounted for 76.4 percent of the total maintenance expenditures during the four years. This model can be used to predict the Average Unit Cost per TAMCN. The fluctuation of the inventory numbers and of total maintenance expenditures over time helps us to predict future costs. Phase II will allow Installations and Logistics (I&L) personnel to question the MARFOR commands why a certain TAMCN is increasing or decreasing in maintenance expenditures. As an example, E0994 40MM machine gun, had a significant increase from 2007 to 2008. Phase II identifies that this was due to an increase in the number of rebuilds plus a modification to all the items in the inventory. Modeling efforts are currently underway in the follow-on study by Captains Romero and Elliott of the Naval Postgraduate School.

B. RECOMMENDATIONS FOR FURTHER STUDY

1. Construct Phase III

A Phase III is needed to continue this study and is presently underway. This phase should aim at identifying and explaining the maintenance cost drivers, and developing regression models to forecast maintenance costs per quantity of each TAMCN possessed. Currently, Capt. Alfredo Romero II, USMC, and Capt. Dustin Elliott, USMC are working on Phase III of this model at the Graduate School of Business and Public Policy at the Naval Postgraduate School, Monterey, CA.

2. Research the Top 20 TAMCNs

The top 20 TAMCNs identified in this study should be examined more closely. Since they, on average, account for approximately 80 percent of the USMC annual maintenance budget, this research may be able to model the maintenance expenditures fluctuations. This could allow I&L personnel to predict future cost variations from year to year, determining if the increase or decrease is due to inventory adjustments, or if they are due to modifications performed on the equipment.

3. Fix Erroneous Data

As discussed in Chapter 2, the original data from 1999–2004 was deemed erroneous, and we have been unable to repair this data. This data, once fixed by MARCORLOGCOM, should be added to the model. This addition of six years worth of data should greatly benefit the comptrollers at I&L to better analyze all budget requests received from the MARFORs.

APPENDIX. LISTING OF TAMCNS

Table of Marine Corps Readiness Evaluation System (MARES) Equipment

TAMCN	FA CODE	WSC	Nomenclature	MEE
A0013	13	8S	Theater Battle Management Core System AN/TYY-2	AN/TYY-2
A0020	13	AB	Direct Air Support Central, Airborne System (DASC, AS)	
A0021	13	6A	Communications Data Link System, TYQ-101A	TYQ-101A
A0025	13	5T	Communications Platform, Air Defense (ADCP)	AN/MSQ-124
A0060	19	AE	Joint Services Workstation, AN/TSQ-220 (V)	AN/TSQ-220
A0067	9	DL	Radio Set, AN/MRC-148	
A0068	10	IY	Radio Set, Tactical Long Haul Digital Link-11, AN/GRC-256	AN/GRC-256
A0069	9	0G	Radio Set, Vehicle, Dual VAA, AN/VRC-111	
A0075	9	VM	AN/VRC-104	
A0116	16	OJ	I PADS	
A0122	16	9Y	PHOENIX	PHOENIX
A0124	6	2Y	Remote Subscriber Access Module (RSAM) AN/TTC-63	
A0125	6	1Y	Deployable End Office Suite	
A0126	9	VM	Multiband Frequency, Vehicle Mounted, Radio System AN/VRC-103 (V)2	
A0132	6	UY	Deployable Integrated Transport Suite (DITS)	
A0138	19	AE	Tactical Exploitation Group - Remote Workstation	TEG-RWS
A0139	10	C9	Radio Set, AN/TRC-209	
A0149	9	E3	Antenna COMM TRL Mounted AS-4429D	AS-4429D
A0153	9	--	Radio Set, AN/MRC-142C	
A0170	19	--	AN/TSQ 226 (V)3 Trojan Spirit	AN/TSQ 226
A0172	7	HZ	DDS-R/M PWR Module (PM)	
A0173	7	HZ	DDS-R/M COMM Security Module (CSM)	
A0174	7	HZ	DDS-R/M LAN Service Module (LSM)	
A0175	7	HZ	DDS-R/M Configuration Module (CM) Laptop IBM	
A0176	7	HZ	DDS-R/M LAN Extension Module ON-704/TYC	
A0177	7	HZ	DDS-R/M APP SVR Module (ASM) AN/TYQ-147	
A0180	13	8A	AN/TYQ-145 Beyond Line of Sight Gateway	
A0182	19	--	Tactical One Roof	
A0197	7	6J	DDS-R/M Data Storage Module (DSM)	DSM
A0234	7	IT	SWAN D (V)1	SWAN D (V)1
A0241	7	3G	SWAN D (V)2	SWAN D (V)2
A0242	7	3J	Satellite Communication Subsystem	SCS
A0243	7	3N	SWAN D Network Package	SWAN D
A0244	7	3O	Network Management System	NMS
A0254	10	OL	Combat Ops Center, Set III - AN/TSQ-239(V)3	
A0255	10	OM	Combat Ops Center, Set IV - AN/TSQ-239(V)4	
A0273	9	6K	Radio Set, Vehicular, DVA, AN/VRC-110	
A0282	7	3Y	Team Portable Collection System Multi-Platform Capable	TPCSMPC
A0425	7	8N	AN/GSC-68(V)1/Mounted Digital Automated Communications Terminal (MDACT)	
A0499	7	Y3	Digital Technical Control (DTC), Facility, AN/TSQ-227	
A0806	5	B9	Lightweight Multiband Satellite Terminal (LMST) HUB AN/USC-65(V)1	
A0807	5	B9	Lightweight Multiband Satellite Terminal (LMST) Mini-HUB AN/USC-65(V)2	
A0814	5	BH	Communications Terminal, AN/TSC-93C (V)1	
A0873	13	U3	Server, INTEL OPS (IOS OPS)	

TAMCN	FA CODE	WSC	Nomenclature	MEE
A0880	14	EN	AN/UPX-37 Interrogator Set	AN/UPX-37
A0882	10	36	Joint Tactical Information Distribution System (JTIDS) AN/URC107(V)10	AN/URC-107(V)10
A0886	7	85	JT Enhanced Core COMM SYS (JECCS)	
A0921	19	G4	AN/TSQ 226 (V)1 Trojan Spirit Lite	AN/TSQ 226 (V)1
A0932	19	ID	IOW	
A0940	7	4X	PFED	
A0966	19	5J	Mobile EW Support System, AN/MLQ-36	
A1225	10	BN	AN/TSQ-158A/EPLRS Network Manager (ENM)	
A1260	5	4A	GPSS-DAGR	GPSS-DAGR
A1380	5	8H	Antenna, Lightweight High Gain X-Band (LHGXA), AS-4429	
A1440	43	BP	Radar Set, Fire Finder, AN/TPQ-36/AN/TPQ-46	TPQ-46
A1500	14	GS	Radar Set, AN/TPS-63B	
A1503	14	BQ	Radar Set, LW3D, AN/TPS-59(V)3	AN/TPS-59(V)3
A1520	19	AE	Radar System Attack Target JT, AN/TSQ-179(V)1, JSWS/JSTARS CGS	AN/TSQ-179B JSTARS
A1818	10	56	Radio Set, AN/GRC-171B(V)4	
A1954	8	5D	Radio Terminal Set ,AN/MRC-142B	
A1955	8	SD	Radio Terminal Set, AN/MRC-142A	
A1957	9	4R	Radio Set, AN/MRC-145A	
A2042	10	8T	High Frequency Manpack Radio, AN/PRC-150	
A2044	10	E3	Radio Set, Manpack, PRC-148(V)1	
A2068	10	8T	AN/PRC-117F/Radio Set, Multiband, Falcon II	
A2070	10	2Z	Radio Set, Manpack, AN/PRC-119A	
A2075	9	2Z	Radio Set, Vehicular AN/VRC-89D	
A2076	9	2Z	Radio Set, Vehicular AN/VRC-90D	
A2077	9	2Z	Radio Set, Vehicular AN/VRC-91D	
A2078	9	2Z	Radio Set, Vehicular - AN/VRC92D	
A2079	10	2Z	Radio Set, Manpack, AN/PRC-119F	
A2152	10	Z4	AN/VSQ2C/Enhanced Position Location Reporting System (EPLRS)	
A2179	8	FW	Radio Terminal Digital, Troposcatter, AN/TRC-170	
A2390	13	8A	Sector Anti-Air Warfare FAC, AN/TYQ-87	
A2525	13	BY	Tactical Air Operations Module, (TAOM), AN/TYQ-23(V)4	AN/TSQ-23(V)4
A2533	7	HZ	Data Distribution System, AN/TSQ-228 (V)3	
A2534	7	6G	Data Distribution System, AN/TSQ-228 (V)2	AN/TSQ-228 (V)2
A2535	7	7U	Tactical (Gateway) Data NetworkAN/TSQ-222	
A2538	7	7U	AN/TSQ-228(V)1/Data Distribution System, Tactical Server (DDS)	
A2551	19	2J	Tactical Command System, AN/USC-55A	
A2555	13	51	AFATDS	
A2560	13	4X	Target Loc, Desig & Hand-Off Sys (TLDHS)(BLK II) - AN/PSQ19A	
A2628	19	7G	Tactical Control and Analysis Center, Transportable	TCAC TW
A2634	19	6P	Tactical Control and Analysis Center, (TCAC-RAWS)	
A3232	5	7K	Secure Mobile Anti-Jam Reliable Tactical Terminal (SMART-T), AN/TSC-154	AN/TSC-154

TAMCN	FA CODE	WSC	Nomenclature	MEE
A3252	19	IE	UAV System, Dragon Eye	
A3270	13	6A	Communications Interface System, AN/MRQ-12(V)3	AN/MRQ-12(V)3
A8018	97	HE	Interrogator Computer, TSEC/KIR-1C	
A8019	97	HK	Transponder Computer, TSEC/Kit-1C	
A8038	97	HL	Electronic Key Generator, TSEC/KG-40A/P	
A8072	97	6H	Remote Rekey Equipment	
A9001	97	8N	Computer Set, Digital (Blue Force Tracker)	
B0001	21	MU	Air Conditioner, MCS Horizontal, 60HZ, 9K BTU	
B0003	21	JB	AC, 1.5 Ton, 60HZ	
B0004	21	JC	AC, 1.5 Ton, 400HZ	
B0006	21	JE	AC, 3 Ton, 400HZ	
B0008	21	JH	AC, 5T, 60K	
B0012	21	2U	Environmental Control Unit (Air Conditioner) 18K BTU/HR, 400HZ	
B0014	21	IZ	Environmental Control Unit (Air Conditioner)	
B0018	21	53	Integrated Trailer ECU	
B0025	29	0Y	Hydroseeder, Trailer Mounted	
B0026	29	N1	Hydroseeder, Skid Mounted	
B0035	29	3T	Hardened Engineer Vehicle (BUFFALO)	
B0038	29	B1	All Terrain Crain (ATC) MAC-50	
B0039	29	1Z	Airfield Damage Repair (ADR) Kit-GBE Runway REP	
B0063	29	0D	624K TRAM	
B0074	21	4O	AC, .75 Ton	
B0114	24	MK	Boat, Bridge Erection, USCSBMK3	USCSBMK3
B0152	24	JT	Bridge, Medium Girder (MGB), Dry Gap	MGB2
B0155	24	2K	Bridge, Floating Ribbon, 70-Ton	FBR-70
B0160	29	3W	Assault Breacher Vehicle	ABV
B0392	29	JV	Container Handler, RT, KALMAR	
B0476	29	IG	Detecting Set, Mine, AN/PSS-14	PSS14
B0589	23	3Q	Excavator Combat, M9 ACE	M9 ACE
B0675	25	KF	Fuel Dispensing System, Tactical, Airfield, M1966	TAFDS
B0685	25	KG	Fuel System Amphibious Assault, M69HC	AAFS
B0730	20	KH	Generator Set, 3KW, 60HZ, Skid-Mtd MEP831A	
B0891	20	KK	Generator Set, Skid Mtd, 10KW/60HZ, TQG MEP803A	
B0921	20	KL	Generator Set, Skid Mtd, 10KW/400HZ, TQG MEP 813	
B0930	20	OZ	Generator Set, 60HZ, MMG 25	
B0953	20	7M	Generator Set, 30KW, 60 HZ, Skid Mtd, MEP-005A/805A/B	
B0971	20	7N	Generator Set, 400HZ, 60KW, 400HZ, Skid Mtd, TQG 815	
B0980	20	YY	Generator Set, 60HZ, MEP 513A	
B1016	20	KN	Generator Set, 60KW, 400HZ, Skid Mounted, MEP-816A	
B1021	20	KP	Generator Set, 60 KW, 60 Hz, Skid Mounted, MEP-006A/806B	
B1045	20	KM	Generator Set, 100KW, 60HZ, SKID-MTD, TQG-MEP-807A	
B1082	23	FU	Grader, Road, Motorized-130G	
B1135	25	KQ	Refueling System, Expedient, HELO-81A5013A0000	
B1315	29	J8	Mine Clearing Launcher, MK-154, MOD 0	MK-154
B1580	25	KU	Fuel Pump Module (SIXCON)	
B1785	23	LZ	Roller, Compactor, Vibratory, Self-Propelled-CS563D	

TAMCN	FA CODE	WSC	Nomenclature	MEE
B2085	25	MT	Storage, Tank, Module, Fuel (SIXCON)	
B2086	25	M3	Storage, Tank, Module, Water (SIXCON) MWT166	
B2127	33	8P	Sweeper, Rotary, Vehicle Mounting	
B2462	23	7E	Tractor, Medium, Full-Trackd D7G, Caterpillar	D7G
B2483	23	2	Loader, Backhoe (BHL)	
B2561	26	MC	Forklift, Extended Boom	
B2566	26	KV	Light Capacity, Rough Terrain Forklift	
B2567	23	Z2	Tractor, Rubber Tire, Articulated Steer, MP (TRAM)-644E	TRAM 644E
B2605	29	IH	Tactical Water Purification System (TWPS)	TWPS
C2278	98	--	Oxygen Mask	
C2282	99	7V	NBC Reconnaissance System (FOX) M93	FOX
C2286	98	--	Oxygen System, Portable	
C2288	98	--	Re-Breather Unit, Oxygen, Portable - Phaos, Oxcon	
C4185	98	1J	Breathing Apparatus, Underwater-MK25 MOD2	
C4549	98	IK	Device Propulsion, Diver	
C5649	98	IM	Parachute Personnel, Maneuverable (MMPS)	
C5901	98	4V	Raiding Craft, Cmbt, Rubber, Inflatable, (CRRC) F470 Full up	
D0001	30	SR	Truck Utility, Up-Armored HMMWV (UAH) M1114	
D0003	31	I1	Truck, Armored, 7 ton Cargo, AMK23	
D0004	31	Z1	Truck, Armored, 7 Ton Cargo w/ Winch, AMK25	
D0005	31	Y1	Truck, Armored, 7 Ton Ext L WHLB, AMK27	
D0006	31	X1	Truck, Armored, 7 Ton Ext L WHLB w/ Winch, AMK28	
D0007	31	X1	Truck, Armored, Dump, 7 Ton, AMK29	
D0008	31	F2	Truck, Armored, Dump, 7 Ton w/ Winch, AMK30	
D0009	31	U1	Truck, Tractor, 7T, w/o Winch - MK31	
D0013	31	F2	Tractor, MTRV, w/o Winch, Armored - AMK31	
D0015	31	F2	Truck, Armored, Wrecker, 7 Ton w/ Winch, AMK36	AMK36
D0022	29	IN	Truck, Utility, Expanded Capacity, Enhanced, 11,500 GVW, 4x4, M1152 (2-Door)	
D0025	29	IQ	MRAP JERRV, 4X4	
D0027	29	IR	MRAP JERRV, 6X6	
D0030	30	OQ	Truck, Utility, Expanded Capacity, Armored Carrier, M1151	
D0031	29	5A	Truck, Utility, Expanded Capacity, G2/GP Vehicle	
D0033	30	5G	Truck, Utility, Expanded Capacity, Enhanced, Armored, 2-Door	
D0034	29	5E	Truck, Utility, Expanded Capacity, CMD&CNTRL GP	
D0081	26	--	Trailer, General Purpose, 4 Ton, 4 Wheel, MK18A1	
D0198	31	F2	Truck, Cargo, 7 Ton, W/O Winch (MTRV) MK23/MK25	
D0209	32	QE	Power Unit, Front, 4x4, MK 48, Mod 0	MK48A1
D0215	32	RY	Semi-Trailer, Refueler, 5000 GAL-MK970A	MK970A
D0235	32	RZ	Semi-Trailer, 40-Ton Low-Bed, 12- Wheel, M870	M870A2
D0861	32	QE	Trailer, Cargo, Resupply F/HIMARS, MK38	
D0876	32	QE	Trailer, Powered, Container Hauler 4x4, MK14	
D0877	32	QE	Trailer, Powered, Wrecker/Recovery, 4x4-MK15A1 Mod 0	MK15A1 Mod 0
D0878	32	QE	Trailer, Powered, 5th Wheel 4x4, MK16, Mod 0	MK16
D0880	31	Q6	Trailer, Tank, Water, 400 Gal, M149A2	
D0881	32	QE	Trailer, Ribbon Bridge-MK18A1	MK18A1

TAMCN	FA CODE	WSC	Nomenclature	MEE
D1001	30	QP	Truck, Ambulance, 4 Litter, Armored, 1 ¼ Ton, HMMWV, M997	
D1002	30	QQ	Truck, Ambulance, 2 Litter, Soft Top, 1 ¼ Ton, HMMWV, M1035	
D1062	31	F2	Truck, Cargo, 7 Ton, XLWB, MK27/MK28	
D1063	43	F2	MTVR, MK37 (MK27 w/ crane)	
D1064	33	SG	Trk, Fire Fighting, Aircraft and Structure, A/S32P-19A	A/S32P-19A
D1073	31	F2	Truck, RTAA, Dump, 7 Ton w/Winch	
D1125	48	QR	Truck, Utility, TOW Carrier, HMMWV, M1045/M1046	TOW Carrier
D1158	30	SF	Truck, Utility, Cargo, Troop Carrier, HMMWV, M1123	
D1159	30	QS	Truck, Utility, Armored Carrier, W/SA, 2 ¼ Ton, HMMWV	
D1160	30	8V	Interim Fast Attack Vehicle (IFAV), 04751E	
D1213	31	F2	Truck Wrecker, MTVR, MK-36,	MK-36
E0006	43	4C	Illuminator, Infrared (IZLID 1000P)	
E0020	47	4D	Scout Sniper Medium Range Night Sight	
E0055	48	76	Launcher, Tubular F/GM(TOW), M41A1 SABER	
E0149	40	UG	Bridge, Scissor for AVLB	
E0150	40	UJ	Launcher, Bridge, Armored Vehicle, M60A1	
E0180	43	UH	Circle, Aiming	
E0207	48	4D	Command Launch Unit, Javelin M98A1	M98A1
E0311	47	--	M14/Sniper Rifle, EMR	
E0330	48	UP	Sight, Thermal, AN/UAS-12C Hybrid	
E0665	43	U7	Howitzer, Medium, Towed 155MM, M198	M198
E0671	43	6F	Howitzer, Light Weight Medium, Towed, M777	M777
E0796	41	X2	Assault Amphibious Vehicle, Command/Communications, AAVC7A1	AAVC7A1
E0846	41	X3	Assault Amphibious Vehicle, Personnel, AAVP7A1	AAVP7A1
E0856	41	X4	Assault Amphibious Vehicle, Recovery, AAVR7A1	AAVR7A1
E0915	48	UA	Launcher, Assault Rocket, 83mm, MK153, Mod 0	
E0935	48	XR	Launcher, Tubular F/GM (TOW), M220E4	M220E4
E0942	42	VM	Light Armored Vehicle, Anti-Tank, LAV-AT	LAV-AT
E0946	42	VM	Light Armored Vehicle, Command/Control, LAV-C2	LAV-C2
E0947	42	VM	Light Armored Vehicle, 25mm, LAV-25	LAV-25
E0948	42	VM	Light Armored Vehicle, Logistics, LAV-L	LAV-L
E0949	42	VM	Light Armored Vehicle, Mortar, LAV-M	LAV-M
E0950	42	VM	Light Armored Vehicle, Maint/Recovery, LAV-R	LAV-R
E0980	45	VD	Machine Gun, Cal .50, Browning, HB Flexible - M2	
E0984	45	8X	Machine Gun, Cal .50	
E0989	45	58	Machine Gun, Medium, 7.62MM, Ground Version - M240B	
E0994	45	UB	Machine Gun, 40MM - MK19 MOD3	
E1030	48	TB	GLTD II Target Designator	
E1048	48	--	Vector 21	
E1065	46	V9	Mortar, 60MM, M224	
E1095	46	B3	Mortar, 81mm, M252	M252
E1145	43	8F	Velocity System, Muzzle (MVS)	
E1210	43	KD	Position Azimuth Determination System (PADS)	
E1378	40	XY	Recovery Vehicle, Heavy, Full-Track, M88A2	M88A2

TAMCN	FA CODE	WSC	Nomenclature	MEE
E1460	47	WC	Rifle, Sniper, 7.62MM, W/Equipment	
E1475	47	4J	Rifle, Scoped, Special Application, .50 CAL	
E1500	43	8Y	High Mobility Artillery Rocket System	HIMARS
E1839	49	G1	Advanced Man Portable Air Defense System	
E1888	40	UK	Tank, Combat, Full-Tracked, 120mm Gun, M1A1	M1A1
E1906	40	8B	Direct Support Electrical System Test Set (DSETS), AN/USM-615	
E1975	48	7C	Sight, Weapon, Thermal, Medium (MTWS)	
E1976	48	7C	Sight, Weapon, Thermal, Heavy ((HTWS)	

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