# Determination of cost drivers for Ship Operations (1B1B) consumable (SO) operations target accounts for Amphibious Assault ships

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# NAVAL POSTGRADUATE SCHOOL

**MONTEREY, CALIFORNIA**

# THESIS

**DETERMINATION OF COST DRIVERS FOR SHIP OPERATIONS (1B1B) CONSUMABLE (SO) OPERATIONS TARGET ACCOUNTS FOR AMPHIBIOUS ASSAULT SHIPS**

by

Brett M. Sullivan

December 2008

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The thesis also analyzed past obligation data (by Julian dated document number) for the period of 01 October 2005 through April 2006 which included the same demographic information previously described. This portion of the analysis determined no quarterly spending cycles, but did identify large spikes in obligations at the end of each fiscal year, an expected result.

Results of the analyses are that the regression analyses do not indicate a strong statistical relationship between monthly disbursements (by FSG) and demographic or figure of merit scores. Recommendation for further study include analysis of the distribution of available funds and what was purchased and analysis of ship's unfunded and phased replacement listing and end of year obligations.


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# DETERMINATION OF COST DRIVERS FOR SHIP OPERATIONS (1B1B) CONSUMABLE (SO) OPERATIONS TARGET ACCOUNTS FOR AMPHIBIOUS ASSAULT SHIPS

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Submitted in partial fulfillment of the
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# EXECUTIVE SUMMARY

This thesis addresses a request from the Deputy Comptroller, Commander Naval Surface Forces, to: Conduct an analysis and prepare a brief on cost drivers and the feasibility of applying alternate budget prediction tools to the Ship Operations (1B1B) accounts.

This request was addressed through an analysis of past obligation data for Amphibious Assault ships from 01 October 2005 to 30 April 2008. The purpose was to take this historical data, ship's demographic information and monthly training and maintenance figure of merit scores (TFOM and MFOM) and determine if there was any statistically significant relationship between these factors. Although the regression analyses produced no statistically significant results, the analysis determined:

- That funding, particularly in disbursements for Medical/Dental (FSG 65), Paint & Brushes (FSG 80) and Damage Control/Firefighting (FSG 42) were highly sensitive to increased funding at the end of each fiscal year (FY).
- Disbursements appear to be highly sensitive to the shelf life of particular items including Aqueous Film Forming Foam (AFFF) and medical vaccines such as influenza vaccine.
- Disbursements against National Stock Numbered (NSN) items account for only 45 percent of total annual disbursements, with the remaining 55 percent being disbursed against continuing services, credit card purchases, including prime-vendor contracts and other non-NSN identified material.

This data, as described above, consisted of individual document numbers and was aggregated into monthly disbursements made in each Federal Supply Group (FSG) code. This aggregation was used to determine the FSG codes which accounted for the largest proportion of total annual spending in this case greater than 3 percent. This data was also used to explore for any relationship between ship's demographics information and

monthly disbursements made by FSG code. Examples of ship's demographics include: homeport, ship's Class, FRP employment, age at launch, inspection cycle and maintenance availability schedule.

The regression analysis was performed using financial data from 01 July 2007 to 30 April 2008 and included monthly TFOM and MFOM scores. This narrow range of data was used because TFOM data could only be obtained from 01 July 2007 to present. Regression analysis did not result in any statistically significant results. Regression analysis was performed only on the top three FSG codes: Medical/Dental (FSG 65), Paint & Brushes (FSG 80) and Damage Control/Firefighting (FSG 42).

However, there are three recommendations for further study of annual disbursements made in consumable OPTAR.

- First, it is recommended that disbursements made against non-NSN items be made the focus of further studies. These disbursements historically account for 55 percent of total annual disbursements. Particular attention should be given to credit card spending and items purchased against Navy Prime Vendor Contracts such as Medical/Dental items.
- Second, it is recommended that a study be conducted between the relationships of availability of funding to the allocation of this funding. Disbursements in the top three FSG codes appear to be highly correlated to increases in available funding, particularly at the end of a FY. The loss of the COW supplemental should result in an increase of disbursements in these FSG codes during the last month of a FY.
- Finally, it is recommended, that monthly spending be compared to the validity of a ship's phased replacement and unfunded listings. End of FY spending is normally earmarked for the purchase of phase/unfunded material, particularly Medical/Dental (FSG 65) Allowance Equipage List (AEL) items, Damage Control/Firefighting (FSG 42) and Safety (FSG 42) AEL items. If this is true, it is imperative that the right gear be purchased with these increased funds.

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# I. INTRODUCTION

## A. PROBLEM STATEMENT

CNSF and staff expend a considerable amount of time and staff work briefing and monitoring the potential impact that a reduction in funding has had or will have on force readiness and mission accomplishment. As a result, Deputy Comptroller Commander Naval Surface Forces requested a study of the consumable ships Operations Target (OPTAR) to explore the existence of cost drivers for these accounts and if these drivers can be used to derive a better OPTAR allocation tool.

This reduction in funding is the result of both an ongoing 20 percent annual reduction (FY 2008 through the next few FYs) to CNSF repairable, consumable and ship's administration OPTAR accounts and the lost of the Cost of War (COW) supplemental. The 20 percent reduction is against the baseline funding for forecasted requirements and does not include the COW supplemental and will mean a $26M reduction to this years consumable OPTAR accounts. Currently, COW reimbursements account for approximately 25 percent of total annual expenditures and the loss of these funds will mean a reduction of $44M from the total repairable, consumable and ship administration forecasted budgets. Together, these two reductions create a $70M total shortfall to the total annual consumable budget. However, it is possible that a portion of the money for COW supplemental will be added to the baseline funding. If this were to occur, the reduction would only be about $33M a year.

## B. OVERVIEW OF CONSUMABLE OPTAR

Consumable OPTAR funding has been largely discretionary with expenditure priorities and guidance provided from their Type Commanders (TYCOM). In recent FYs, OPTAR has been at levels sufficient to support operations. Items such as continuing services (cranes, vehicles), office supplies, and Allowance Equipage List (AEL) items (flight deck equipment, damage control equipment and medical supplies) are just a few examples of what can be purchased with these funds. Essentially, consumable

OPTAR provides the means to purchase material and equipment in support of all shipboard operations that are not classified as repairable, counter-terrorism/force protection, ship's pier-side utilities or travel expenses. Note that repairable and consumable OPTAR account for 83 percent (55 percent for repair and 28 percent for consumable) of the total annual surface ship allocation, so a 20 percent reduction to the baseline combined with the loss of the COW supplemental will make a considerable impact to total amount of funds received each FY.

## C. SCOPE OF THIS THESIS WORK

This thesis focused on the relationship between monthly disbursements for Amphibious Assault ships consumable OPTAR accounts and ship's demographics and monthly performance measures. This study is restricted to disbursements for the approximately 30 Amphibious Assault ship platforms assigned to CNSF, primarily because these ships are the largest expenders of consumable OPTAR. A breakdown of these Amphibious Assault ships by class and homeport is provided in Table 1.

Monthly disbursements are represented by the aggregation of individual Julian dated document numbers by Federal Supply Group (FSG) for each ship and each month of the Fiscal Year (FY). This aggregation ensured that monthly figures accounted for a significant proportion of total monthly disbursements, while retaining the best description of the material that was purchased that particular month. Although data can be as detailed as the specific item and quantity purchased, the purpose of this thesis is to provide a better understanding of where consumable funds are spent and use this information to develop a better monthly/quarterly allocation tool. FSG and FSC codes are further described in Chapter II.C and Appendix C.

Demographics used include ship's class, homeport, Fleet Response Plan (FRP) employment and age. Monthly performance measures include Maintenance Figure of Merit (MFOM) and Training Figure of Merit (TFOM). The demographics of class and homeport were the best classifiers of individual ships. FRP employment is the best description of a ship's activity during that month. Additionally, class, homeport and FRP

employment are already factors in how funds are allocated to individual units. Age of a ship was included as a potential contributor to monthly disbursements in a particular FSG (for example paint)

MFOM and TFOM scores were included in the analysis because they provide an additional way to distinguish between two ships of the same class that are stationed in the same homeport and have similar FPR schedules. Monthly figure of merit scores were included in the analysis because a significantly significant relationship between monthly FSG disbursements and monthly figure of merit scores would provide an excellent measure of return on investment or aid in determine an appropriate range of spending to maintain desired figure of merit scores.

| Ship Class | Homeport | | | | |
|---|---|---|---|---|---|
| | Little Creek | Norfolk | San Diego | Sasebo | Total |
| LCC 19 | | | | 1 | 1 |
| LHA 1 | | 1 | 2 | | 3 |
| LHD 1 | | 4 | 2 | 1 | 7 |
| LPD 17 | | 2 | 1 | | 3 |
| LPD 4 | | 2 | 3 | 1 | 6 |
| LSD 41 | 4 | | 3 | 1 | 8 |
| LSD 49 | 2 | | 2 | | 4 |
| Total | 6 | 9 | 13 | 4 | 32 |

Table 1. Amphibious Assault Ship Classes by Homeport

## D. CONTENT OF THIS THESIS WORK

The thesis is composed of two main sections, not including this introduction section, conclusion and three appendices.

Chapter II analyzes various data components to include financial data, ship's demographics and maintenance figure of merit (MFOM), Training figure of merit (TFOM) scores.

Chapter III contains the analytical portion of the study. This section provides a macro level analysis of the various data elements (financial, demographic and figure of merit) and a description of how the final data set was constructed.

Conclusions from the analysis and recommendations are included in the Chapter IV.

Appendix A includes a description of how funds are distributed with the Department of Defense (DoD) and how the Ship Operations Model generates the estimated requirements which in turn determine funding levels. This section will also provide a brief description of the Surface Warfare Enterprise (SWE) and past thesis work that may contribute some valuable insight and analysis techniques that may be applied to this particular problem.

Appendix B contains a description of the mission areas measured by the weekly TFOM score.

Appendix C is a listing of Federal Supply Groups (FSG) and Federal Supply Classes (FSC) within each FSG.

## E. HYPOTHESIS AND ADDITIONAL RESEARCH QUESTIONS

The initial request from the Deputy Comptroller, Commander Naval Surface Forces was to conduct an analysis and prepare a brief on cost drivers and the feasibility of applying alternate budget prediction tools (such as Activity Based costing, etc.) to these Ship Operations (1B1B) accounts.

To satisfy the above request, a regression analysis of historical monthly consumable spending was modeled against several ships' demographic and performance measures was used to answer the hypothesis and additional research questions listed below. If this approach yields a statistically significant result, then the results of the regression analysis can be used to predict future spending requirements and develop a tool in which to best allocate available funds on a monthly or quarterly basis. Additional research questions were developed through further discussions with the Deputy Comptroller, Commander Naval Surface Forces and also let to the selection of independent variables such as demographics and figure of merit scores.

**Hypothesis:** Future obligations for specific Federal Supply Group (FSG) and Federal Supply Class (FSC) can be determined by analyzing past disbursement data against several ship's demographic information and monthly Figure of Merit scores.

**Research Question 1:** Are ships with consistently high Figure of Merit scores across all mission area more likely to invest a similar amount in complementary FSG/FSC coded material as other ships with the same figure of merit scores? For example, are two ships of the same class with the same homeport and similar FPR employment spending certain amounts on Damage Control Equipment FSG 42 given their Training figure of merit scores for Damage Control Drills and Training figure of merit scores for other mission areas?

**Research Question 2:** Is there a range of spending that maintains Training Figure of Merit scores at 80 or greater, or 90 and greater?

**Research Question 3:** Do demographics (i.e., class, homeport and FRP employment) contribute to the amount invested in particular FSG/FSC codes and/or do they contribute to the MFOM and TFOM scores?

**Research Question 4:** Are disbursements cyclical, or is there an increase in disbursements during the beginning, middle or end of a quarterly spending cycle?

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# II. DATA AND METHODOLOGY

## A. METHODOLOGY

Analysis of the final data set will be conducted in three parts.

- Determine the FSG codes with the highest percent of total annual spending and scale the analysis to these codes with the highest impact on annual spending.
- Determine if Class, Homeport, age or FRP cycle, have any discernable influence on total monthly spending or if disbursements are made in any discernable cycle (i.e., quarterly).
- Perform a regression analysis of the top FSG codes to find the best predictors of total monthly FSG/FSC investment against other performance measures (i.e., MOBD TFOM greater than 90).

The overall intent is to break the data into logical groupings that can be used in a regression analysis to determine if there is in fact a strong statistical relationship between individual ships' spending by FSG/FSC code and that ship's demographics and figure of merit scores.

### 1. Motivation for Factors Used

The factors used in the analysis were determined to be the best way to group the ships and also distinguish between individual ships. Class, Homeport, age and FRP cycle are easy ways to classify ships into similar groups and are also how the CNSF and the CLASSRONs allocate funding over the course of the year. However, as the analysis portion will show, ships of the same class in the same FRP employment do not have identical average monthly spending in a particular FSG/FSC code. MFOM and TFOM are the next best option to distinguish between ships of a similar Class, Homeport and FRP employment.

## 2. Pitfalls to the Analysis

Using past obligation data created two pitfalls for the analysis:

The first pitfall is that individual units do not have responsibility for compliance with the Anti-Deficiency Act 1517, but they must not obligate funds in excess of what they have been granted through their annual grants. Individual units are also responsible to make necessary adjustments between their obligations and actual expenditures monthly as well to as ensure that they have a 100% obligation rate at the end of each quarter and fiscal year. The 100% obligation rate presents a potential problem in the analysis because this policy may create quarterly and end of fiscal year skews in the financial data and will skew any potential correlation between demographics, FRP employment, inspections and the Figure of Merit Scores.

The second pitfall is that obligations do not necessarily reflect requirements as much as they represent the availability of funds. Obligations and expenditures stored in the STARS-FL system are a good source of historical information, but, they only represent what we bought. They do not measure what we did not buy or existing resources that we consumed and did not replenish or as what was erroneously purchased, or purchased and not used. These two components would represent total "cost," but is in reality unavailable. The danger is that obligations are a better indicator of availability of funds first and need or requirements second. Obligations do not reflect a true requirement, but possibly a requirement to obligate funds.

## 3. Regression Analysis Overview

Regression analysis is a technique which mathematically "fits" expected average observations through the existing data while minimizing the sum of squares error between the observed value and the expected or mean value given the same parameters. Specifically, the least-squares method measures the distance between the predicted response and the actual observations. Squaring this distance gives a better measure of the degree of error that the model is producing. Low sum of squares error values indicate a

well fitting model, where higher measures indicate that there is more noise in the data and responses will have a high degree of variability.

### *a. Classical Assumptions for Regression Analysis*

1) The sample must be representative of the population for the inference prediction.

2) The error is assumed to be a normal random variable with a mean of zero conditional on the explanatory variables.

3) The independent variables are error-free. If this is not so, modeling may be done using errors-in-variables model techniques.

4) The predictors must be linearly independent, i.e., it must not be possible to express any predictor as a linear combination of the others.

5) The errors are uncorrelated, that is, the variance-covariance matrix of the errors is diagonal and each non-zero element is the variance of the error.

6) The variance of the error is constant across observations (homoscedasticity). If not, weighted least squares or other methods might be used.

These are sufficient (but not all necessary) conditions for the least-squares estimator to possess desirable properties; in particular, these assumptions imply that the parameter estimates will be unbiased, consistent, and efficient in the class of linear unbiased estimators. Many of these assumptions may be relaxed in more advanced treatments.[1,2]

## 4. Regression Diagnostics

How well the "least-squares" method fits the data is determined through several regression diagnostics such as the R-Squared Value, Hypothesis Testing (t and F-Statistics) and the contribution or slope that each of the predictors contributes to the final output. The R-Squared value measures how much of the data's variability is accounted

[1] Regression Analysis: A Constructive Critique, Sage Publications (2004).

[2] Statistical Models: Theory and Practice, Cambridge University Press (2005).

for in the model and aids in determining if the model is a better predictor than just using the data's average. This measure depends strongly upon the variability contained in the data.

There are two measures that determine the significance of a regression analysis, the t-Statistic and F-Statistic. These values test the null hypothesis that the individual factor (t-Statistic) or the model as a whole (F-Statistic) contributes to predicting the response variable. This test is accomplished by comparing a p-Value, which is derived from the t and F-Statistics, against a predetermined level of confidence, for example 0.05. The level of confidence is the probability that the null hypothesis is true or how likely it is to observe this same value given similar values for the prediction variables. For example, a null hypothesis that Class has no effect on the monthly disbursements in FSG code 42 (Damage Control and Firefighting Equipment). In this case, we want to reject the null hypothesis, meaning that Class does determine the monthly disbursements in FSG code 42. If the p-Value produced in the Regression table is lower than 0.05, the null hypothesis is rejected. In this case, rejecting the null hypothesis would say that the relationship between the individual factor (T-Statistic) or the model (F-Statistic) and the response variables. If the value is greater than 0.05, then the null hypothesis is accepted. The 0.05 value indicates that we expect to obtain a response as unique as the observed value at least 95 percent of the time. The null hypothesis is:

$H_o$: There is no statistically significant relationship between past FSG/FSC obligations and therefore, future obligations cannot be determined by analyzing past disbursement data against several ship's demographic information and monthly Figure of Merit scores depends.

Ha: There is a statistically significant relationship between past obligations of monthly Disbursements by FSG/FSC and Ship's demographic information and monthly Figure of Merit scores. Therefore, future obligations can be made using the regression model.

### 5. Measures and Plots of Variability

In addition to numerical measures of goodness of fit, there are several graphical representations that provide insight about the variation that the data has about its mean. These graphical representations verify that the initial assumptions for regression analysis (listed above) have been met.

For instance, histograms and QQ Normal plots can be used to visually suggest that the data for dependent variables (in this case monthly FSG obligations) are normally distributed, meaning errors (variations) between observations are random variables normally distributed about the mean. Box-plots split the data among groupings, for example disbursements across ship class, and outline the spread of the data in terms of the mean, median as well as plotting outliers in the dataset. Box-plots are essential in determining the existence of homoscedasticity across observations. Homoscedasticity means that the variance in each category is equal across all observations. The absence of homoscedasticity usually results in low R-Squared values as well as not rejecting a null hypothesis due to a high p-Value. Scatter-plots provide insight into possible groupings of data when the prediction variable is non-categorical (Disbursements against TFOM score).

## B. DATA OVERVIEW

The data set consists of total monthly disbursements by Federal Supply Group (FSG) or Federal Supply Class (FSC) for each ship. Each monthly ship's FSG or FSC sum will also contain information about the ship's class, homeport, and Fleet Response Plan (FRP) employment, age at launch, average monthly Maintenance Figure of Merit (MFOM) and Training Figure of Merit (TFOM) scores.

Data was provided from various sources and activities. Financial data was provided by the Comptroller Officer, Commander Naval Surface Force. MFOM data will be provided by Commander Naval Surface Forces code N43. TFOM data was provided

by Commander Afloat Training Group, Atlantic, who is also the lead for the SWE Personal Readiness Team. FRP employment, age at launch and homeport was compiled using the Naval Vessel Registry Website.[3]

## C. DESCRIPTION OF FINANCIAL DATA

The financial data obtained from CNSF contained the requisition history of each ship (by Julian date and document #) from 01 October 2005 to April 2008 and also contained information about the ship's class, age of ship from delivery, age of ship from launch, homeport and Fleet Response Plan Employment. Financial Data for each ship was broken down in the total monthly expenditures by both FSC and FSG code. This data reflects both the Julian date the original requisition for the material was made and the amount that was ultimately disbursed against that document number. This is useful because it accurately records the date the material was ordered. A brief description of FSC and FSG codes is provided below.[4]

> The Federal Supply Classification (FSC) is a set of codes designed to help the federal government in supply operations. It was developed by the Office of the Secretary of Defense and is primarily used by the DoD.
>
> The FSC is broken down into 78 Federal Supply Groups (FSGs), each of which is assigned a 2-digit number. Some numbers don't currently have FSGs assigned to make room for future codes. This 2-digit code (or a letter A through Z for service categories) makes up the first half of an item's Federal Supply Code. The FSGs are in turn subdivided into 646 individual item classes; the last 2 digits in the FSC identify the class within the large group.[6]

Documents with no FSG codes consist primarily of purchase card expenses, continuing services (i.e., cranes, vehicles) and open purchased material for port visits. Documents with either no FSG code or are blank will not be considered for this study. However, analysis of purchase card disbursements and continuing services is recommended as a follow on to this study.

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[3] *Naval Vessel Registry* website at http://www.nvr.navy.mil [May 2008].

[4] *ONIVIA company website*. http://government.onvia.com [May 2008].

## D. DESCRIPTION OF MAINTENANCE FIGURE OF MERIT

There are two types of Maintenance Figure of Merit Scores (MFOM). MFOM 1.0 is an unclassified data set and was originally developed as part of the SHIPMAIN initiative "To allow a consistent comparative measure of maintenance requirements across platforms and regions". The MFOM formula was designed around existing maintenance database information stored in the Open Architecture Retrieval System (OARS). Each job in a ship's Consolidated Ship's Maintenance Plan (CSMP) given as a number ranging from 1-100, 100 being the most critical and is derived from information obtained from two static data tables and four dynamic inputs form 2K (job requests) inputs. Figure 1 provided the source of the inputs and the formula used to compute the MFOM score for each job in the ship's CSMP.[5]

MFOM 2.0 is a classified measure and is more subjective than MFOM 1.0 because it calculates material condition against operational requirements and information from Subject Matter Experts. MFOM 2.0 provides a better measure of capability, but because of MFOM 2.0s classification and subjectivity, MFOM 2.0 data will not be included in this study.

| (MCC/PRI) * (SEVERITY/100) * (Equip STATUS modified) * (SF SCR modified) * 12.5<br>*The 12.5 is a "spread factor" used to provide low end granularity to the MFOM score. | |
|---|---|
| Static Data Tables | |
| Mission Criticality Code (MCC) | Table from Ship Configuration & Logistic Information System (SCLSIS ) |
| Severity(S/100) | Table from the Maintenance Requirements System (MRS) |
| Dynamic 2K Inputs | |
| Priority | Block 41 from the 2K |
| Equip/System Status Code-modified | Block 7 from the 2K |
| SF Screening Code- modified TA Code | Block 42 from the 2K |
| Ship Work Line Item Number (SWLIN) | Block 14 from the 2K (used to access the static data tables) |

Figure 1. Dynamic Inputs for Maintenance Figure of Merit Score (MFOM). From 2007 CNSF N43 MFOM PowerPoint Presentation

While each job is given its own MFOM rating, the data is usually compiled as mean and median values for Force, Class (i.e., DDG) and hull number. Vessels with an

[5] 2007 CNSF N43 MFOM PowerPoint Presentation, [May 2007].

average MFOM rating of greater than 55 are not considered to be ready for tasking. The data used for this analysis was the average monthly MFOM score for each ship from October 2005 to June 2008.

## E. DESCRIPTION OF TRAINING FIGURE OF MERIT:

Available TFOM data is from the period of July 2007 to June 2008. This data contains the weekly TFOM scores for all mission areas. For the purpose of analysis, only one monthly Training Figure of Merit Score will be used for each ship. This score will be the end of month TFOM score or in the case of missing data, the previous weeks score. Missing TFOM data is defined as a zero in all mission areas and pillars for each ship for that week. For example, if the USS ASHLAND's observation during the last week of October 2007 contains zeros across all missions, the prior week's TFOM Score will be used. If a ship has zeros for observations during the entire month, then the zero score will be used. This ensures that the last best monthly observation is used for each ship each month and that missing observation in not confused with non-reported data. However, if a ship has no score for that month, it should be reflected in the data and will be assumed as a non-submission by that ship.

Figure of merit scores for Ballistic Missile Defense (BMD), Mine Warfare (MIW) and Cruise Missile (CM) will not be utilized because these mission areas are not evaluated for Amphibious Ships. Descriptions of the other 18 mission areas are in Appendix B of this thesis.

### 1. Pillars

A Training Figure of Merit rating is a score given to a total of 21 mission areas containing four pillars (Proficiency, Personnel, Management, and Material) which are aligned with the Continuous Certification Requirements (CCR) found in the Surface Force Training Manual. Training Figure of Merit Data is compiled in the Training and Operational Readiness information Services (TORIS V3.0.2) system. Because of updates to the system, only TFOM data form July 2007 to June 2008 will be used for this analysis. Each of the four pillars receives their own TFOM score and is also weighted to provide a rolled up TFOM score for that mission area. This data is intended to be a tool

for a ship's Commanding Officer to aid in their assessment of their ship's training proficiency and assist in his or her decision making. This data is also used by the Commander Afloat Training Group to measure the overall performance of on ship compared to other ships in the same CLASSRON, ISIC or homeport. TFOM scores can also be further rolled up into an overall TFOM rating for each ship at that point in time.

The score given to the Proficiency pillar for a ship is a measure of how well a ship performs that particular war fighting task and receives the highest weight in the roll-up for each mission area. Consequently, analysis will focus on the relationship between FSG disbursements and the proficiency pillar for any mission area. The Personnel pillar measures the manning levels, Naval Enlisted Classification (NEC requirements for that mission area, training team Personal Qualification Standards (PQS) and watch team turnover since the previous certification. The Management pillar is a measure of how well the ship documents their certification and training through (ASA) checklist items, CM doctrine, battle orders, watch bills and their PQS programs. The final pillar for Material measures all required hardware and equipment necessary to support operations and training. In the future, the Material pillar will consist of information from MFOM 2.0 and may be of benefit to future studies because it will be more readily obtainable and UNCLASSIFIED when provide through a TFOM rating.

### 2. TFOM Calculations

TFOM scores are produced using a 90 day rolling window, which is intended to reduce the impact of extreme variations ("bad day") in the data and produces a more stable indication of a ship's overall readiness. TFOM scores are also broken down into four T-ranges. T1 ratings result form a TFOM score of 100-90, T2 89.9-80, T3 79.9-70 and T4 69.9-0.

The below excerpt from the TORIS User's Guide: provides a further explanation of how TFOM calculations are derived:

1) Within the mission area pillar.

2) For the Proficiency pillar:

a. All Data Points for the 90-day (based on cage date) window are obtained for the particular ship.

3) The Data Points that are identical are averaged to obtain the average FOM.

4) For the Personnel, Management, Material pillars:

5) The most recent Data Point completed is found within the individual Data Point's periodicity. This Data Points FOM is used for the remainder of the TFOM calculation.

6) The Data Points within a group (CCR) are rolled up to calculate the FOM for the group.

7) The Group FOM is rolled up to calculate the FOM for the Mission Area Pillar

8) The Mission Area Pillar FOMs are rolled up to calculate the Mission Area FOM.

9) All Mission Area Pillar FOMs are rolled up to calculate the Pillar FOM.

10) The Pillar FOMs are rolled up to calculate the Ship FOM.

# III. ANALYSIS

## A. RESEARCH QUESTIONS AND ANALYSIS APPROACH

Below is a recap of the hypothesis and research questions. The analysis will consist of three parts.

The first part breaks down the annual obligation data by FSG to determine which FSG codes accounted for the largest percentage of total annual obligation.

The second part focuses on individual FSG codes and produces various plots of obligation by Class, Homeport, and FRP schedule, Age, MFOM and TFOM.

The third part takes the factors listed above and displays the results from multiple variable regressions performed on annual monthly obligations, by FSG, against the various factors discussed previously.

**Hypothesis:** Future obligations for specific Federal Supply Group (FSG) and Federal Supply Class (FSC) can be determined by analyzing past disbursement data against several ship's demographic information and monthly Figure of Merit scores.

**Research Question 1:** Are ships with consistently high Figure of Merit scores across all mission area more likely to invest a similar amount in complementary FSG/FSC coded material as other ships with the same figure of merit scores? For example, are two ships of the same class with the same homeport and similar FPR employment spending certain amounts on Damage Control Equipment FSG 42 given their Training figure of merit scores for Damage Control Drills and Training figure of merit scores for other mission areas?

**Research Question 2:** Is there a range of spending that maintains Training Figure of Merit scores at 80 or greater, or 90 and greater?

**Research Question 3:** Do demographics (i.e., class, homeport and FRP employment) contribute to the amount invested in particular FSG/FSC codes and/or do they contribute to the MFOM and TFOM scores?

**Research Question 4:** Are disbursements cyclical, or is there an increase in disbursements during the beginning, middle or end of a quarterly spending cycle?

## B. FEDERAL SUPPLY GROUP SELECTION

The purpose of this section is to confirm that aggregation by FSG is in fact the best representation of material purchased and identify the top FSG codes (e.g., FSG codes that represent greater than 3 percent of annual disbursements). Table 2 displays a breakdown of annual spending for the top twenty FSG codes for the period of October 2005 to April 2008.

The breakdown of disbursements shows that total annual obligations are spread over 76 separate FSG codes and non-NSN items. Non-NSN items include continuing service, disbursements associated with port visits and obligations made against the ship's credit card. As Table 3 shows, 55 percent of the obligations are made against non-NSN items, with the remaining 45 percent of obligations being made against NSN items. This 45 percent of the data is spread across 76 different FSG codes described in appendix A. However, what is most significant is that 38 percent of the total annual obligations are made against 20 different FSG codes with 7 percent being spread over the remaining 56 FSG codes. This study does not analysis any spending of non-NSN items. Further study into the breakdown of non-NSN items to include credit card purchases to items which may be tied to an NSN, FSC or FSG code is recommended.

The analysis focuses on the top FSG codes accounting for greater than 3 percent of total annual expenditures. Analysis of items with less than 3 percent of total annual disbursements will deal with dollar values too low to produce any benefit to the overall allocation scheme. FSG codes with greater than 3 percent of annual disbursements are: FSG 65 (Medical, Dental and Veterinary Equipment and Supplies), FSG 80 (Brushes, Paints, Sealers, and Adhesives), FSG 42 (Fire Fighting, Rescue, and Safety Equipment) and account for 5.69 percent, 4.83 percent and 3.82 percent respectively of the total annual expenditures.

| Breakdown of Total Annual Expenditures by Federal Supply Group (FSG) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rank | FSG Code | FY06 | FY06 | FY07 | FY07 | FY08 | FY08 | Grand Total | % Total | % Cum | | |
| 1 | NO FSC | $ | 19,959 | 52.58% | $ | 26,670 | 51.14% | $ | 4,558 | 47.91% | $ | 51,187 | 51.38% | 51.38% |
| 2 | 65 | $ | 2,068 | 5.45% | $ | 3,019 | 5.79% | $ | 586 | 6.16% | $ | 5,673 | 5.69% | 57.07% |
| 3 | 80 | $ | 1,728 | 4.55% | $ | 2,388 | 4.58% | $ | 696 | 7.32% | $ | 4,812 | 4.83% | 61.90% |
| 4 | (blank) | $ | 2,022 | 5.33% | $ | 2,031 | 3.89% | $ | 155 | 1.63% | $ | 4,208 | 4.22% | 66.13% |
| 5 | 42 | $ | 1,412 | 3.72% | $ | 2,149 | 4.12% | $ | 248 | 2.61% | $ | 3,809 | 3.82% | 69.95% |
| 6 | 84 | $ | 1,057 | 2.79% | $ | 1,603 | 3.07% | $ | 223 | 2.35% | $ | 2,884 | 2.89% | 72.84% |
| 7 | 81 | $ | 884 | 2.33% | $ | 1,173 | 2.25% | $ | 369 | 3.88% | $ | 2,427 | 2.44% | 75.28% |
| 8 | 79 | $ | 886 | 2.33% | $ | 1,221 | 2.34% | $ | 314 | 3.30% | $ | 2,421 | 2.43% | 77.71% |
| 9 | 72 | $ | 734 | 1.93% | $ | 1,425 | 2.73% | $ | 151 | 1.58% | $ | 2,310 | 2.32% | 80.03% |
| 10 | 75 | $ | 671 | 1.77% | $ | 940 | 1.80% | $ | 247 | 2.60% | $ | 1,858 | 1.87% | 81.89% |
| 11 | 73 | $ | 544 | 1.43% | $ | 919 | 1.76% | $ | 228 | 2.40% | $ | 1,691 | 1.70% | 83.59% |
| 12 | 51 | $ | 542 | 1.43% | $ | 985 | 1.89% | $ | 124 | 1.31% | $ | 1,650 | 1.66% | 85.25% |
| 13 | 85 | $ | 578 | 1.52% | $ | 755 | 1.45% | $ | 196 | 2.06% | $ | 1,529 | 1.54% | 86.78% |
| 14 | 40 | $ | 675 | 1.78% | $ | 816 | 1.56% | $ | - | 0.00% | $ | 1,490 | 1.50% | 88.28% |
| 15 | 91 | $ | 368 | 0.97% | $ | 493 | 0.95% | $ | 234 | 2.45% | $ | 1,094 | 1.10% | 89.38% |
| 16 | 66 | $ | 404 | 1.07% | $ | 514 | 0.99% | $ | 130 | 1.36% | $ | 1,048 | 1.05% | 90.43% |
| 17 | 68 | $ | 377 | 0.99% | $ | 520 | 1.00% | $ | 132 | 1.39% | $ | 1,030 | 1.03% | 91.46% |
| 18 | 47 | $ | 217 | 0.57% | $ | 199 | 0.38% | $ | 91 | 0.95% | $ | 506 | 0.51% | 91.97% |
| 19 | 62 | $ | 171 | 0.45% | $ | 246 | 0.47% | $ | 71 | 0.74% | $ | 488 | 0.49% | 92.46% |
| 20 | 70 | $ | 183 | 0.48% | $ | 229 | 0.44% | $ | 74 | 0.78% | $ | 487 | 0.49% | 92.95% |
| 21 | 53 | $ | 134 | 0.35% | $ | 153 | 0.29% | $ | 86 | 0.90% | $ | 373 | 0.37% | 93.32% |
| 22 | 20 | $ | - | 0.00% | $ | 215 | 0.41% | $ | 44 | 0.46% | $ | 259 | 0.26% | 93.58% |
| | Sub Total | $ | 35,614 | 93.82% | $ | 48,663 | 93.31% | $ | 8,957 | 94.15% | $ | 93,235 | 93.58% | |
| | | $ | - | | $ | - | | $ | - | | $ | - | | |
| | Total Sp | $ | 37,960 | | $ | 52,155 | | $ | 9,514 | | $ | 99,628 | | |

Table 2. Total Annual Expenditures by Federal Supply Group (FSG). Data from the 01 October 2005 to 30 April 2008 financial dataset. Financial figures are in $1000.00.

## C. RELATIONSHIP BETWEEN DISBURSEMENTS, FRP EMPLOYMENT, SHIP'S CLASS AND HOMEPORT

This section takes the same October 2005 to April 2008 dataset as the previous section, and explores the nature of disbursements through various plots of the monthly disbursements against ship's demographic information. The intent is to use the 31 months of financial data to draw any conclusions about the data which might be overlooked in the July 2007 to April 2008 dataset, particularly quarterly cycles. The financial data includes two complete fiscal year, plus 7 months of the current fiscal year. Another benefit of using this dataset ensures that almost two complete FRP cycles are represented for each ship. This section addresses research question number 4: Are disbursements cyclical, or is there an increase in disbursements during the beginning, middle or end of a quarterly spending cycle?

### 1. Are Disbursements Cyclical?

This section addresses research question number 4: Are disbursements cyclical, or is there an increase in disbursements during the beginning, middle or end of a quarterly spending cycle? Figure 2 plots cumulative monthly expenditures for the period of 01

September 2005 through April 2008 by Amphibious Assault Ship Class. The purpose of this plot is to display cumulative spending across the entire data set and includes both NSN and non-NSN items. We observe a nearly constant rate of increase throughout the year except for sharp increases at the end of each fiscal year and during the first month of a new fiscal year. Because the plot does not display any distinguishing "stair casing" pattern consistent with sharp increases with spending, it is concluded that there are no quarterly spending cycles for monthly consumable spending.

The increase in disbursements at the beginning of a fiscal year are the result of documents created at the beginning of a fiscal year to hold obligations for continuing services (crane services, vehicles, etc) and the ship's purchase card. The increased spending at the beginning of the year represents a onetime disbursement against those document numbers at the end of a fiscal year. This disbursement represents the total end-of-year disbursement of funds against a document number initially created as a "dummy" document. While the document is created at the beginning of the year, disbursement of funds does not occur until the end of the year when the document is closed out and no further obligations are made against that document.

Increases in disbursements at the end of fiscal years 2006 and 2007 are the result of a distribution of excess funds distributed during the last month of each fiscal year. This is confirmed by an increase of disbursements at the ends of fiscal year 2006 and 2007, but not during the beginning of the current 2008 fiscal year. Consequently, the only clearly identifiable cycles occur at the beginning and end of a fiscal year. Otherwise, Figure 2 shows a nearly constant rate of spending from month to month by ship class and therefore no quarterly spending cycles.

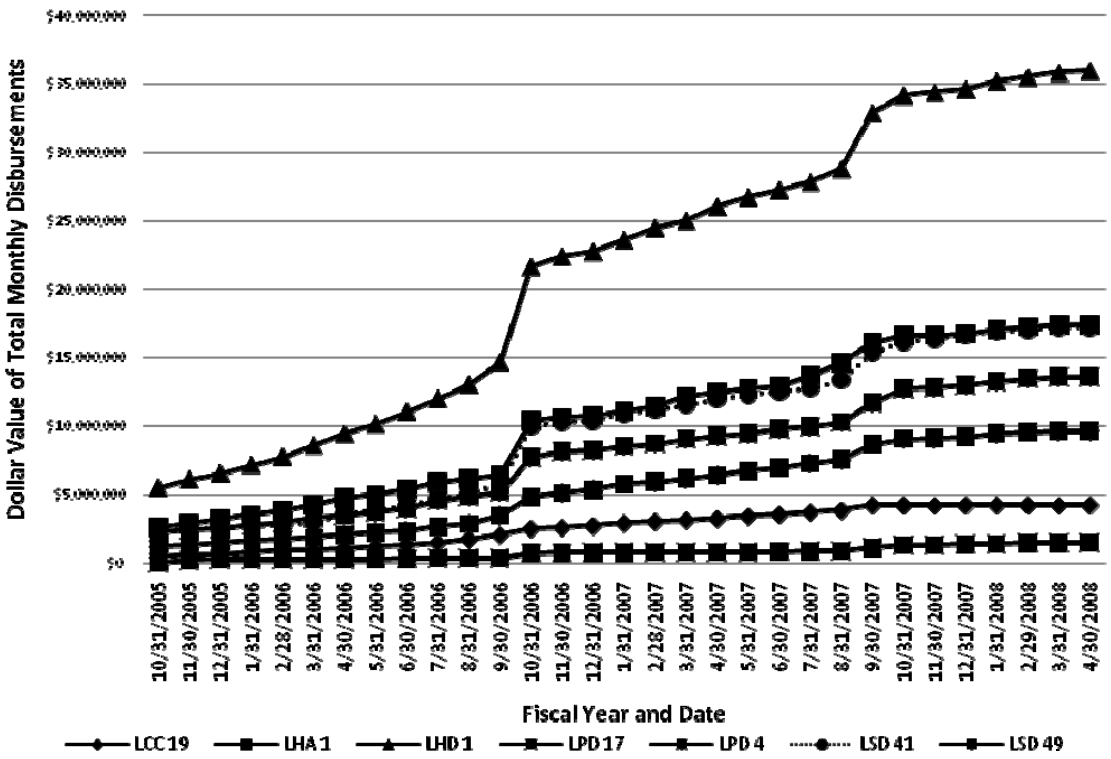


Figure 2. Total average cumulative expenditures for the period of 1 September 2005 through April 2008 by Amphibious Assault Ship Class. Observe that LHA1 and LSD 41 have identical disbursement histories. Data from the 01 October 2005 to 30 April 2008 financial dataset

As previously discussed, Figure 2 does not support any claim that total monthly disbursements occur in quarterly cycles. A second question is: are monthly disbursements for Damage Control/Firefighting (FSG 42), Medical and Dental (FSG 65) and Paint & Brushes (FSG 80) material made in quarterly cycles?

Figure 3 displays a plot of total monthly disbursements for Damage Control/Firefighting (FSG 42), Medical and Dental (FSG 65) and Paint and Brushes (FSG 80) and outlines three periods of increased disbursements which require further investigation. These periods are July, August and September 2006 and March 2007 and September 2007.

The series representing Damage Control/Firefighting (FSG 42) shows a noticeable increase in spending at the end of a fiscal year, but otherwise disbursements do not vary from month to month in any repeating pattern. Similar end of year patterns can also be found for Medical/Dental (FSG 65), however, clear increases in monthly

spending can be found during the months of July 2006 and March 2007. Paint & Brushes (FSG 80) shows an increase in spending during July 2007 and January 2008, but only an end-of-fiscal year increase during 2007.

In terms of annual spending, disbursements in September in both FY 2006 and 2007 account for significant portions of annual spending for each FSG code studied. For Medical/Dental (FSG 65), disbursements in September account for 16.33 percent in FY 06 and 24.83 percent in FY 2007 of their total annual disbursements. Section III.C.2 of this analysis shows that Medical/Dental (FSG 65) disbursements are also prone to spikes over the course of the FY due to large vaccine purchases. It is expected that outside of vaccine purchases, increases in Medical/Dental (FSG 65) disbursements will more likely be made at the end of a FY as a result of the loss of the COW supplemental.

September disbursements for Paint & Brushes (FSG 80) account for 8.68 percent in FY 2006 and 21.86 percent in FY 2007 of that year's total annual Paint & Brushes (FSG 80) disbursements. However, for FY 2006, the percentage of disbursements for Paint & Brushes (FSG 80) increases to 17.73 percent during the month of July 2006. This increase coincides with a similar spending spike for Medical/Dental (FSG 65) and a small but noticeable increase in Damage Control/Firefighting (FSG 42) disbursements during the same month. This leads to the conclusion that increased disbursements in July 2006 may be the result of increased funds be distributed. Otherwise, proportional disbursements made for Paint & Brushes (FSG 42) remain constant between 4 percent and 6 percent over the course of the FY. However, small increases can be seen in this FSG code when funding increases.

The largest proportional September spending is made in Damage Control/Firefighting (FSG 42). In FY 2006, disbursements made in Damage Control/Firefighting (FSG 42) account for 43.84 percent of total annual Damage Control/Firefighting (FSG 42) disbursements and 52.32 percent in FY 2007 where over the course of the year, proportional monthly disbursements deviate between 3 and 7%. It is concluded that Damage Control/Firefighting (FSG 42) disbursements are heavily dependent upon end of FY funding.

Overall, disbursements made against the top three FSG codes seem to be highly responsive to increases in available funds, particularly at the end of a FY. Further study into the possible relationship between mid and end of year increases in disbursements and the availability of addition funds be conducted for the FSG codes discussed in this thesis is recommended.

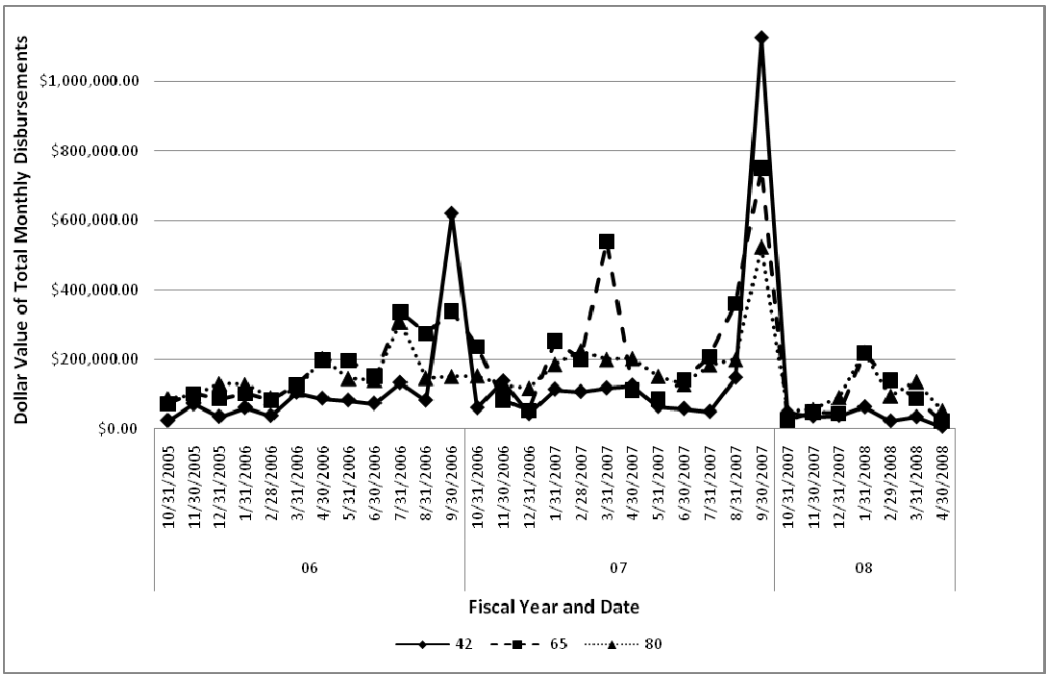


Figure 3. Total Monthly Disbursements for Control/Firefighting (FSG 42), Medical and Dental (FSG 65) and Paint and Brushes (FSG 80). Observe spikes in spending during months of July 2006, March 2007 and September 2007. Data from the 01 October 2005 to 30 April 2008 financial dataset

The next three subsections include a more in-depth analysis of monthly disbursements in Damage Control/Firefighting (FSG 42), Medical and Dental (FSG 65) and Paint & Brushes (FSG 80) that investigates the increases in spending during the three periods mentioned above. The next three sections explore the possible annual cycles as well as any correlation between ship's class, FRP employment and homeport. These three subsections depend heavily on graphical representation of the October 2005 to April 2008 financial data to determine if there are any strong relationships between disbursements and various factors to include: calendar time of year, FRP employment, ship's Class and homeport.

### *a. Medical, Dental and Veterinary Equipment*

Disbursements made against Medical/Dental (FSG 65) do not support cyclical spending patterns. Table 3 highlights total annual and proportion of annual spending for Medical/Dental (FSG 65), Paint & Brushes (FSG 80) and Damage Control/Safety/Rescue (FSG 42). Though total annual disbursements for Medical (FSG 65) vary from fiscal year to fiscal year, proportional spending remains constant over the first two fiscal years and for disbursements through April 2008, which does not include any end-of-fiscal year figures. The increase of $1 million in disbursements between fiscal years 2006 and fiscal years 2007 (Table 3) includes $538 and $749 thousand ($1.87 million) in disbursements made during the months of March and September 2007 (see Figure 4). Forecasted disbursements for Medical/Dental (FSG 65) during fiscal year 2008 total $1 million. However, these figures do not include mid or end-of-year disbursements of supplemental funds.

| FSG Code | FY06 | FY06 | FY07 | FY07 | FY08 | FY08 |
|---|---|---|---|---|---|---|
| 65 | $ 2,068 | 5.45% | $ 3,019 | 5.79% | $ 586 | 6.16% |
| 80 | $ 1,728 | 4.55% | $ 2,388 | 4.58% | $ 696 | 7.32% |
| 42 | $ 1,412 | 3.72% | $ 2,149 | 4.12% | $ 248 | 2.61% |

Table 3. Top Three Federal Supply Groups for Fiscal Years 2006, 2007 and 2008 through April (in Thousands of Dollars). Data from the 01 October 2005 to 30 April 2008 financial dataset

Monthly and average disbursements for Medical/Dental (FSG 65) for fiscal years 2006, 2007 and 2008 (through April 2008) are displayed in Figure 4. Average monthly disbursements appear to follow the same disbursement pattern as total disbursements and shows that disbursements made against Medical (FSG 65) do not appear to occur in distinct quarterly cycles, however, there are three distinct increases in disbursements during this period which require further investigation. These periods are July, August and September 2006 and March 2007 and September 2007.

An annual breakdown of disbursements for Medical/Dental (FSG 65) shows that National Stock Number (NSN) 6505 015393595 accounts for $277 thousand (13%) of fiscal year 2006 Medical/Dental (FSG 65) disbursements, $5 thousand (0.16%) in fiscal year 2007, but there is no investment during fiscal year 2008 through April 2008 for this item. However, during the month of July 2006, NSN 6505 015393595 accounts

for 63 percent of disbursements (see Table 4), but during the month of September 2007, total disbursements do not total for more than 2% of that month's disbursements. NSN 6505 015393595 is vaccine for the Influenza Virus.

Disbursements during the month of March includes a one-time purchase of NSN 6505 013806465 for $347 thousand dollars on 02 March 2007 by the USS PELELIU LHA 5. This purchase represents the only time that this particular NSN was purchased during the period of 1 October 2005 through April 2008 and accounts for a large percentage (9 percent) of total fiscal year 2007 Medical/Dental (FSG 65) disbursements and 64 percent of Medical/Dental (FSG 65) disbursements for that day. NSN 6505 013806465 is vaccine for Japanese Encephalitis. During this period, USS Peleliu (LHA 5) was assigned to humanitarian assistance support in the South Pacific and Southeast Asia.

It is concluded that spending spikes at the end of a FY are the result of an increase in available funds that are spread across a wide range of Medical/Dental (FSG 65) items by individual ships. However, vaccines such as Influenza tend to drive mid-year spikes. It is quite possible, that these spikes may represent the replacement of large batches of expired vaccines, with the exception of the Japanese Encephalitis disbursement which is most likely tied to operational requirements. Additionally, vaccines shelf life items, and it should be ensured that disbursements are made due to increases in vaccine requirements and not to replenish large batches of expired material. Further analysis of non-NSN disbursements should also be made to identify Medical/Dental (FSG 65) purchased through the prime vendor program.

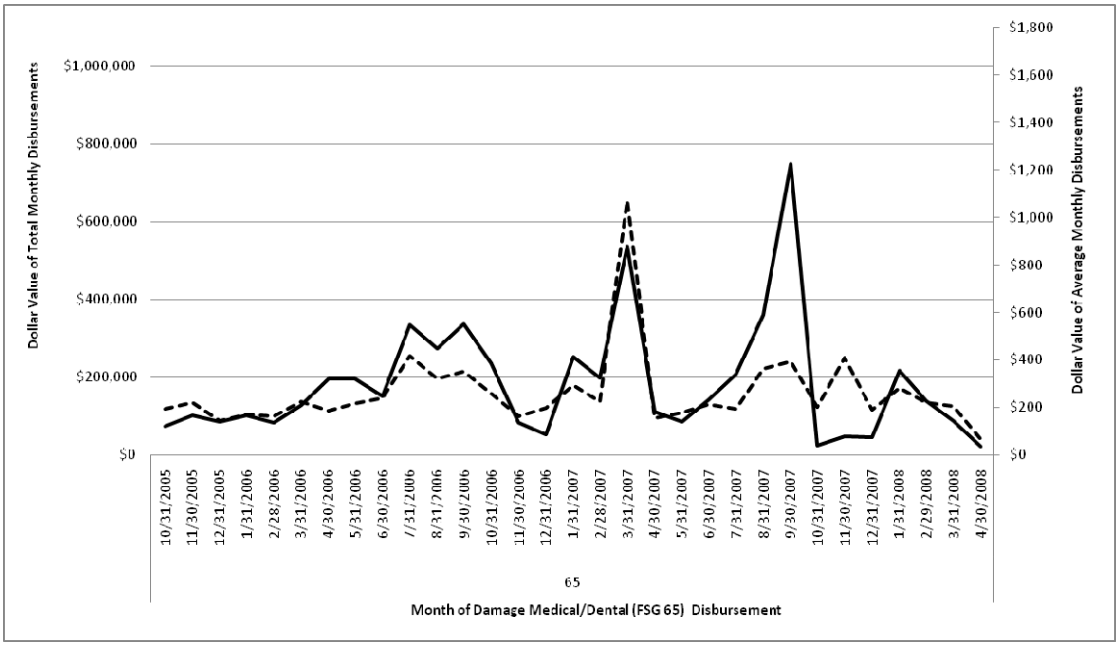


Figure 4. Total (Solid Line) and Average (---) Monthly Disbursements for Medical/Dental (FSG 65). Data from the 01 October 2005 to 30 April 2008 financial dataset.

| Jul-06 | | Total |
|---|---|---|
| NIIN | Disbursement | $336,220.45 |
| **015393595** | **$210,728** | **63%** |
| 013856328 | $15,295 | 5% |
| 013386091 | $5,759 | 2% |
| | | |
| Mar-07 | | Total |
| NIIN | Disbursement | $538,383.92 |
| **013806465** | **$346,962** | **64%** |
| 015273994 | $37,596 | 7% |
| 014568888 | $22,148 | 4% |
| 000095063 | $9,528 | 2% |
| | | |
| Sep-07 | | Total |
| NIIN | Disbursement | $749,710.63 |
| 015508039 | $129,681 | 17% |
| 015161519 | $33,339 | 4% |
| 013856328 | $24,448 | 3% |
| 013299842 | $23,719 | 3% |
| 011787903 | $18,411 | 2% |
| 001376345 | $17,438 | 2% |
| 013334154 | $14,829 | 2% |
| 013343232 | $14,625 | 2% |
| 012036289 | $14,115 | 2% |
| 014322707 | $13,653 | 2% |

Table 4. Summary of Disbursements greater than 2 percent for Medical and Dental Items (FSG 65) in July 2006, March 2006 and September 2007. Influenza Virus 6505 015393595 & Japanese Encephalitis 6505 013806465. Data from the 01 October 2005 to 30 April 2008 financial dataset.

The following graphical representations of total Monthly disbursements by FRP employment and ship's Class (Figures 5) and total Monthly disbursements by FRP employment and Homeport (Figures 6) show that there appears to be no correlation between average Monthly disbursements and FRP employment and Class or FRP employment and Homeport. Each observation in both plots represents the same average disbursement for a specific ship and is plotted in the same FRP employment. What changes is that the ships are grouped within each FRP employment cycle by ship's Class or homeport. A strong correlation would show that ships with the same FRP employment would have the same average spending if their Class or homeport were strong predictors of levels of disbursements.

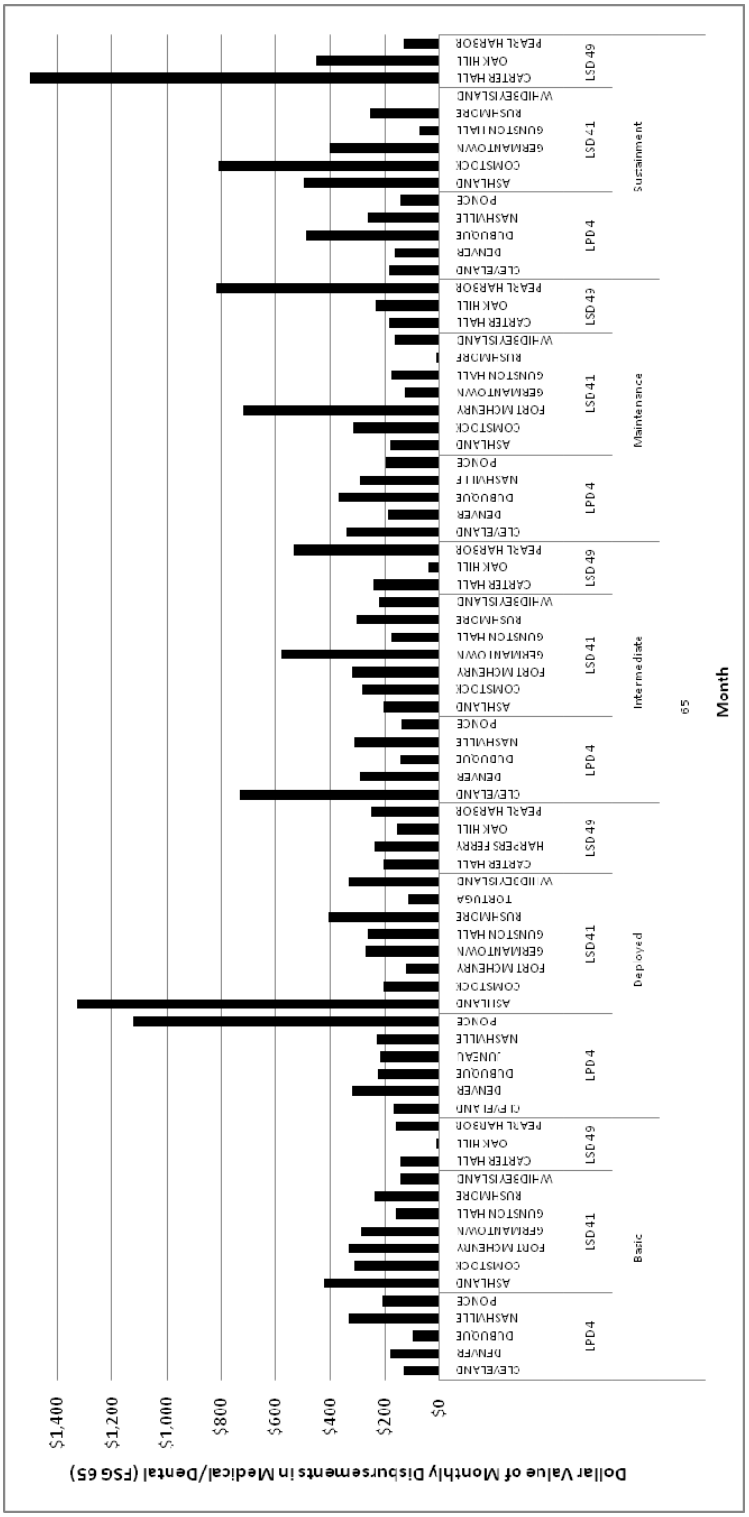


Figure 5. Average Monthly Disbursements for Medical/Dental (FSG 65) by FRP employment and ship's Class for Amphibious Assault ships. Data from the 01 October 2005 to 30 April 2008 financial dataset.

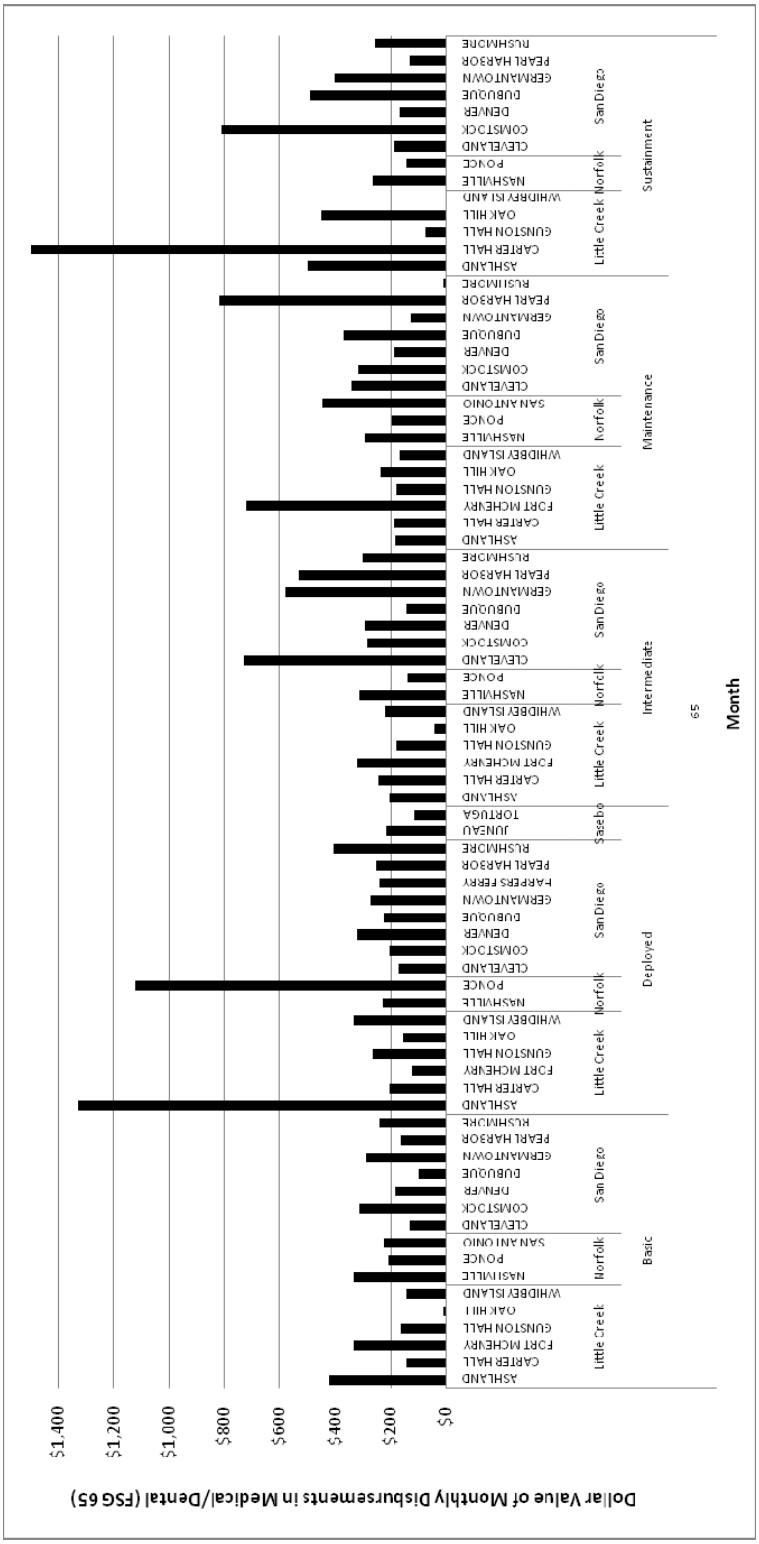


Figure 6. Average Monthly Disbursements for Medical/Dental (FSG 65) by FRP employment and Homeports for Amphibious Assault ships. Data from the 01 October 2005 to 30 April 2008 financial dataset.

### *b. Brushes, Paints, Sealers, and Adhesives (FSG 80)*

The analysis of Paint & Brushes (FSG 80) also does not support any quarterly spending cycles or relationship between FRP employment, ship's Class or homeport. Table 5 displays a breakdown of annual spending for the top three FSG codes for fiscal years 2006, 2007 and 2008 through April 2008. Total annual disbursements for Paint & Brushes (FSG 80) are estimated to be $1.2 million, but again, these figures do not include any end-of-fiscal year disbursements. Average monthly disbursements follow the same pattern as total monthly disbursements.

| FSG Code | FY06 | FY06 | FY07 | FY07 | FY08 | FY08 |
|---|---|---|---|---|---|---|
| 65 | $ 2,068 | 5.45% | $ 3,019 | 5.79% | $ 586 | 6.16% |
| 80 | $ 1,728 | 4.55% | $ 2,388 | 4.58% | $ 696 | 7.32% |
| 42 | $ 1,412 | 3.72% | $ 2,149 | 4.12% | $ 248 | 2.61% |

Table 5. Top Three Federal Supply Groups for Fiscal Years 2006, 2007 and 2008 through April 2008

Brushes & Paint (FSG 80) have total and proportional disbursement patterns similar to those made against Medical/Dental (FSG 65) material, but with approximately 3 percent more being spent in the first half of fiscal year 2008 than in fiscal years 2006 and 2007. This is most likely due to a spike in spending during the month of January 2008 shown if Figure 7. This increase implies a surge in distributed funds most likely a result in a delay in the allocation for the 2008 fiscal year or excess funds from the additional quarter and a need to replenish paint stocks purchased at the end of fiscal year 2007.

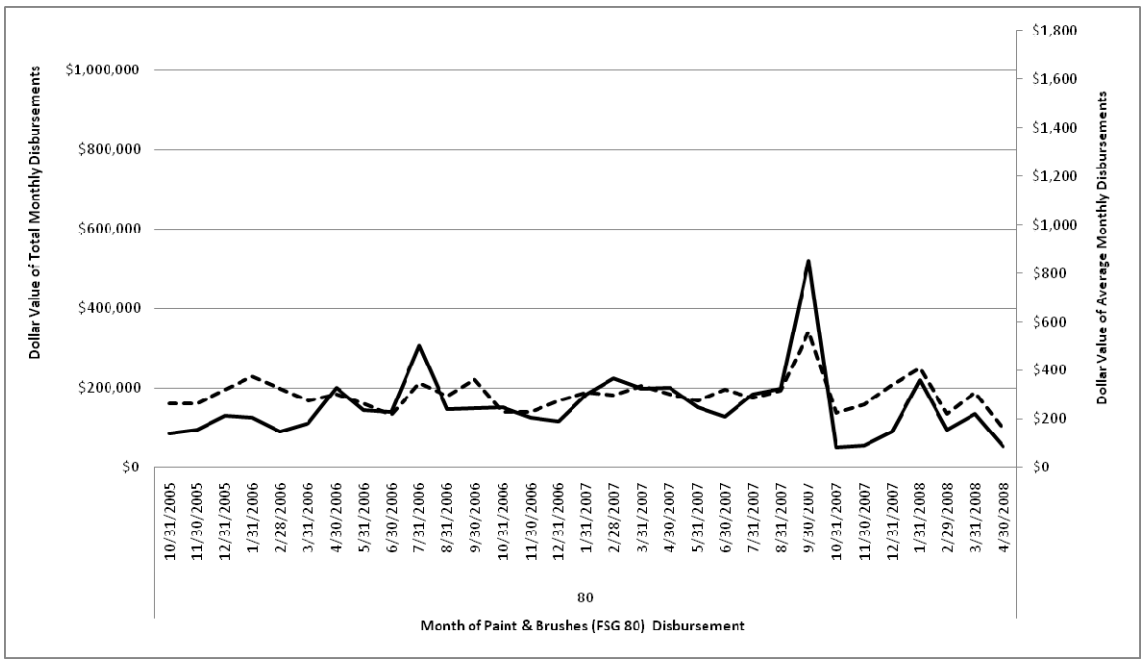


Figure 7. Total (Solid Line) and Average (---) Monthly Disbursements for Paint & Brushes (FSG 80). Data from the 01 October 2005 to 30 April 2008 financial dataset.

Contrary to Medical/Dental (FSG 65) NSN investment, proportional monthly disbursements for Paint & Brushes (FSG 80) remains constant across three NSNs 8010 014416147 (Haze Gray Enamel), 8010 013445322 (White Enamel), 8010 013504727 (Deck Gray Enamel) from fiscal year to fiscal year. These items are various enamel paints, such as white, haze grey and deck grey. In addition, Figure 7 shows two disbursement spikes during the months of March 2006 and September 2007. Disbursements in these two months remain proportional to annual disbursements for the top annual NSNs. Table 6 displays the breakdown these 3 NSNs.

| Annual Disbursements | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| NIIN | Fiscal Year 2006 | | | Fiscal Year 2007 | | | Fiscal Year 2008 | |
| Grand Total | $ 1,727,632 | | | $ 2,388,301 | | | $ 696,481 | |
| **014416147** | **$ 306,255** | **18%** | | **$ 516,969** | **22%** | | **$ 129,073** | **19%** |
| **013445322** | **$ 279,198** | **16%** | | **$ 385,417** | **16%** | | **$ 98,717** | **14%** |
| **013504727** | **$ 198,648** | **11%** | | **$ 289,727** | **12%** | | **$ 72,040** | **10%** |

| Monthly NIIN Breakdown | | |
|---|---|---|
| Jul-06 | | Total |
| NIIN | Disbursement | $ 306,256 |
| **014416147** | **$ 54,976** | **18%** |
| **013504727** | **$ 42,039** | **14%** |
| **013445322** | **$ 39,303** | **13%** |
| 013023608 | $ 17,055 | 6% |
| 013504742 | $ 14,489 | 5% |
| 013539055 | $ 14,243 | 5% |
| 013023607 | $ 12,924 | 4% |
| 013445100 | $ 12,602 | 4% |
| 014416151 | $ 7,660 | 3% |
| 013446700 | $ 6,790 | 2% |
| 013966798 | $ 4,679 | 2% |

| Sep-07 | | Total |
|---|---|---|
| NIIN | Disbursement | $ 522,142 |
| **014416147** | **$ 106,195** | **20%** |
| **013445322** | **$ 103,956** | **20%** |
| **013504727** | **$ 45,493** | **9%** |
| 013023608 | $ 33,275 | 6% |
| 013446703 | $ 24,010 | 5% |
| 013446700 | $ 22,194 | 4% |
| 005587026 | $ 15,435 | 3% |
| 014416151 | $ 12,422 | 2% |
| 013539055 | $ 10,187 | 2% |

Table 6. Summary of Disbursements greater than 2 percent for Paint & Brushes (FSG 80) in July 2006 and September 2007. Data from the 01 October 2005 to 30 April 2008 financial dataset.

Figures 8 and 9 plot the relationship of average monthly disbursements for Paint & Brushes (FSG 80) against FRP employment by ship's Class and homeport by ship's Class identical to the plots for Medical/Dental (FSG 65). Again, the plots do not visually support any claim that disbursements depend upon FRP employment, ship's Class or homeport. Increases in spending for these items appear to more closely tie to the availability of additional funds than to FRP employment or other ship's demographics. Furthermore, regression analysis for this item will be tied to the ship's overall monthly TFOM score as there is no mission area that appears to be directly related to Paint & Brushes (FSG 80) disbursements.

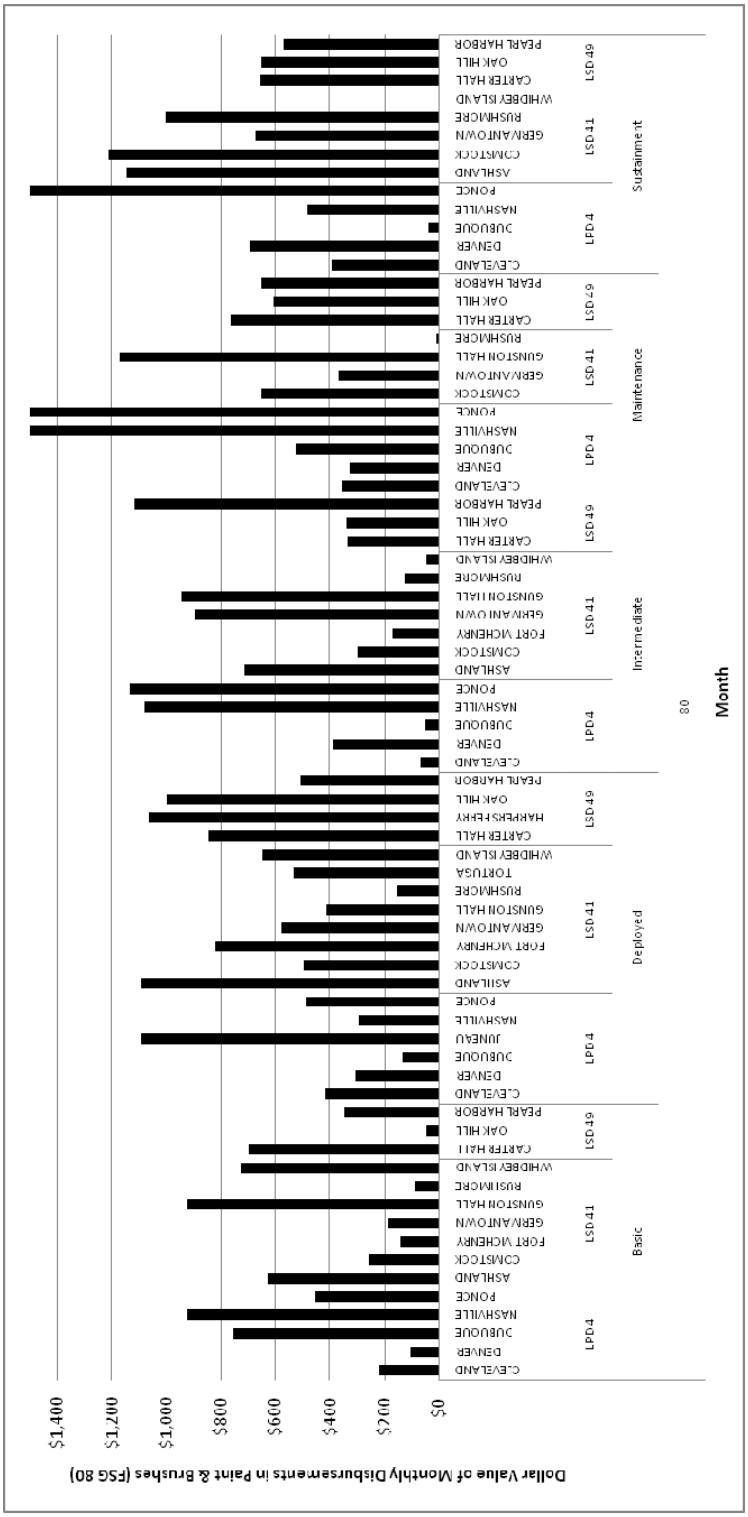


Figure 8. Average Monthly Disbursements for Paint & Brushes (FSG 80) by FRP employment and ship's Class for Amphibious Assault ships. Data from the 01 October 2005 to 30 April 2008 financial dataset.

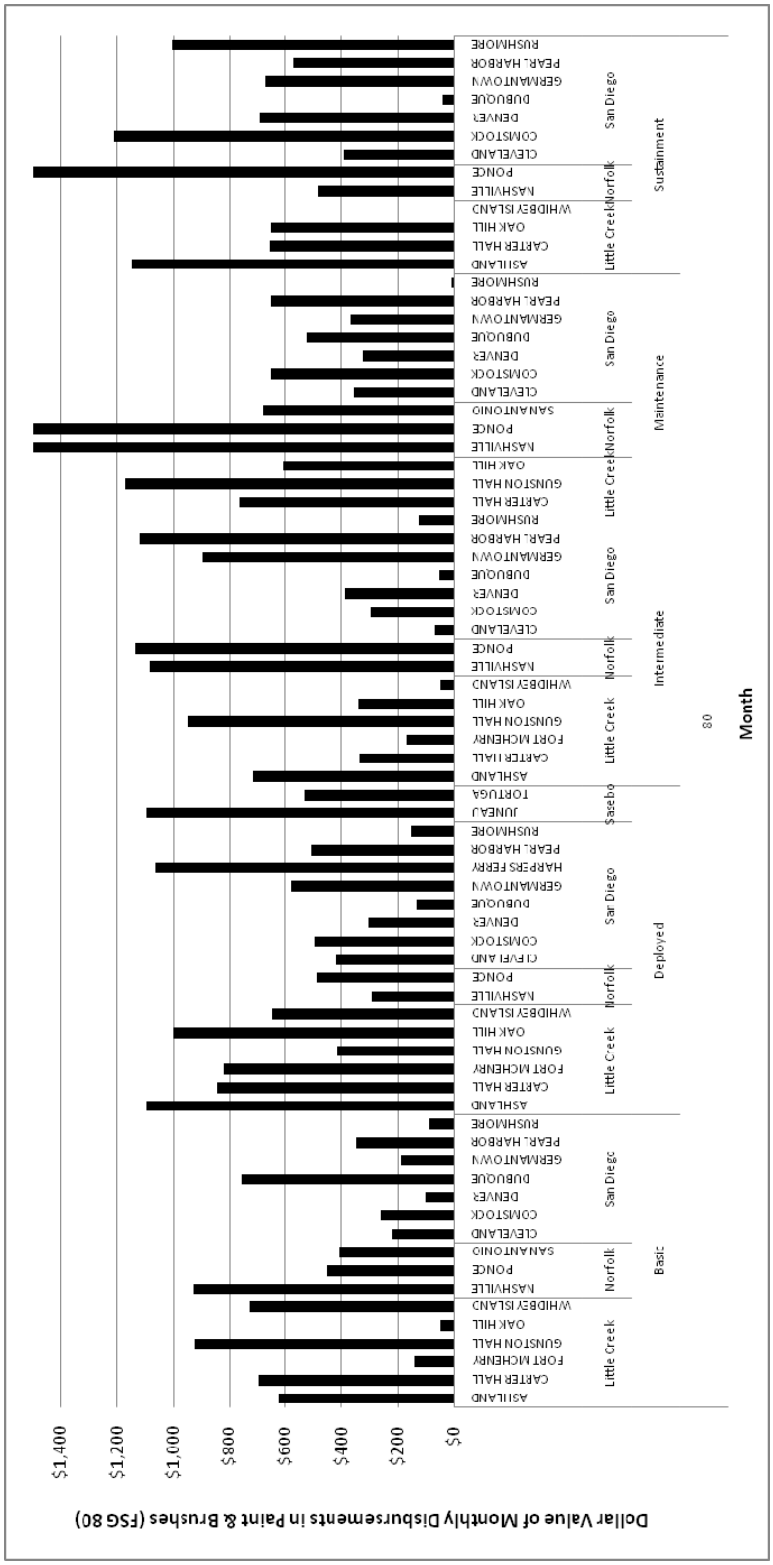


Figure 9. Average Monthly Disbursements for Paint & Brushes (FSG 80) by FRP employment and ship's Homeport for Amphibious Assault ships. Data from the 01 October 2005 to 30 April 2008 financial dataset.

### *c. Fire Fighting, Rescue, and Safety Equipment*

The data for Damage Control/Firefighting (FSG 42) also does not support any relationship to FRP employment, ship's Class or homeport. Figure 10 does show dramatic increases in disbursements at the end of each completed fiscal year. Table 7 displays a breakdown of annual spending for the top three FSG codes for fiscal years 2006, 2007 and 2008 through April 2008. Total annual disbursements for Damage Control/Firefighting (FSG 42) are estimated to be $425 thousand, but again, these figures do not include any end-of-fiscal year disbursements. Investigation of the relationship of Damage Control/Firefighting (FSG 42) to cyclical spending, FRP employment, ship's Class and homeport will be identical to the analysis for Medical/Dental (FSG 65).

| FSG Code | FY06 | FY06 | FY07 | FY07 | FY08 | FY08 |
|---|---|---|---|---|---|---|
| 65 | $ 2,068 | 5.45% | $ 3,019 | 5.79% | $ 586 | 6.16% |
| 80 | $ 1,728 | 4.55% | $ 2,388 | 4.58% | $ 696 | 7.32% |
| 42 | $ 1,412 | 3.72% | $ 2,149 | 4.12% | $ 248 | 2.61% |

Table 7. Top Three Federal Supply Groups for Fiscal Years 2006, 2007 and 2008 through April (in Thousands of Dollars)

As shown in Figure 10, monthly investment for Damage Control/Firefighting (FSG 42) remains consistent from month to month, except for the end of the fiscal year. Contrary to the findings for Medical/Dental (FSG 65) and Paint & Brushes (FSG 80), Damage Control/Firefighting (FSG 42) sees fewer distinct spending spikes over the course of the year, except, when during the last month of each FY monthly disbursements increase to 6 or 7 times that of the average monthly disbursement. In line with the findings for Medical/Dental (FSG 65) and Paint & Brushes (FSG 80), Figures 11 and 12 confirms there appears to be no strong relationship between disbursements and FRP employment, ship's Class or homeport.

Consistently top end of year NSN items are: 4240 014395937 Breathing Apparatus, Oxygen Generating (OBA) and 4220 014872932 Life Preserver, Vest. Historically, OBA's have account for 12 percent of Damage Control/Firefighting total annual disbursements, with the bulk being made during the last month of a FY. While OBA are being replaced and should no longer be expected to be a large contributor to end

of FY disbursements, Life Preserver Vests will continue to be a factor both throughout and at the end of a FY. These items have accounted for 5% and 10% of total annual Damage Control/Firefighting disbursements in FY 06 and FY 07, but 0.0% during the partial 2008 FY. This indicates that Life Preserver Vests are usually purchased with mostly end of year funds and are not part of a quarterly phase replacement list.

Additionally, NSN 4210 010560883 Foam Liquid, Fire Extinguishing (AFFF) account for 4 percent, 7 percent and 10 percent for FY 06, 07 and 2008. This would indicate that AFFF is purchased continually throughout the year. This makes intuitive sense because AFFF is a shelf life item where OBAs and Life Preserver Vests are not. NSN, 4210 014934694 Hood, Anti-Flash, Firemen's, has been a consistently high spender over FYs. For instance, NSN has consistently accounted for 3-5% of total annual Damage Control/Firefighting (FSG 42) disbursements.

The four items listed above consistently account for 25-30 percent of total annual Damage Control/Firefighting (FSG 42) disbursements. These items, excluding OBAs would be appropriate for further study. Particularly, if life vests should be mandated as quarterly phased replacement items or changed to a pushed issue item.

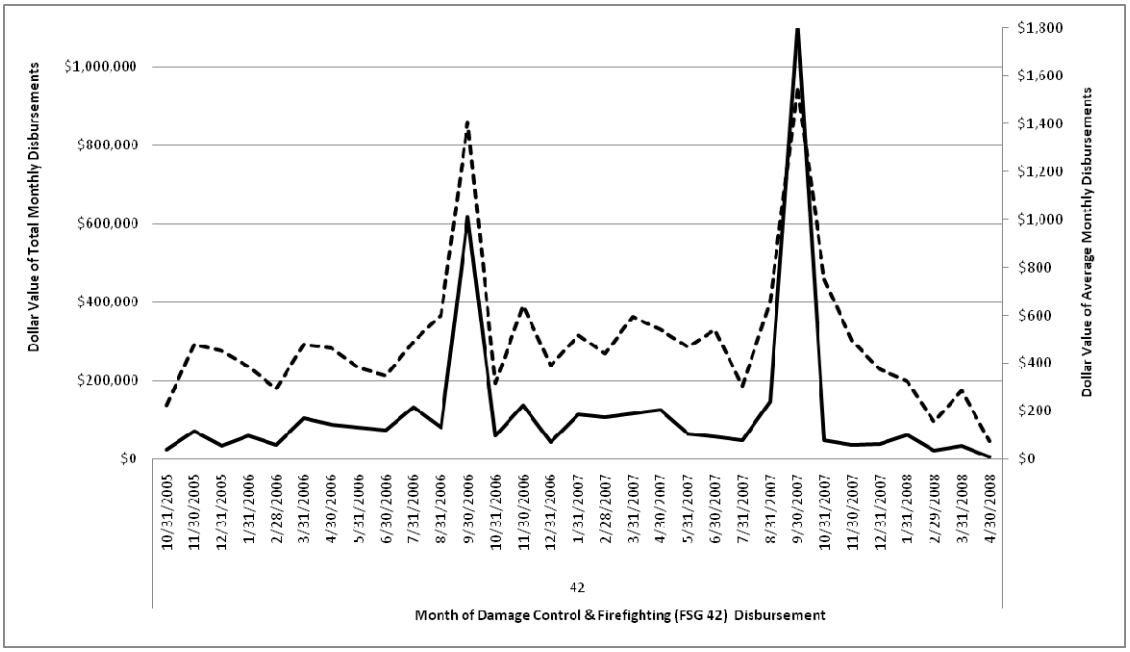


Figure 10. Total and Average Monthly Disbursements for Damage Control/Fire Fighting (FSG 42). Data from the 01 October 2005 to 30 April 2008 financial dataset.

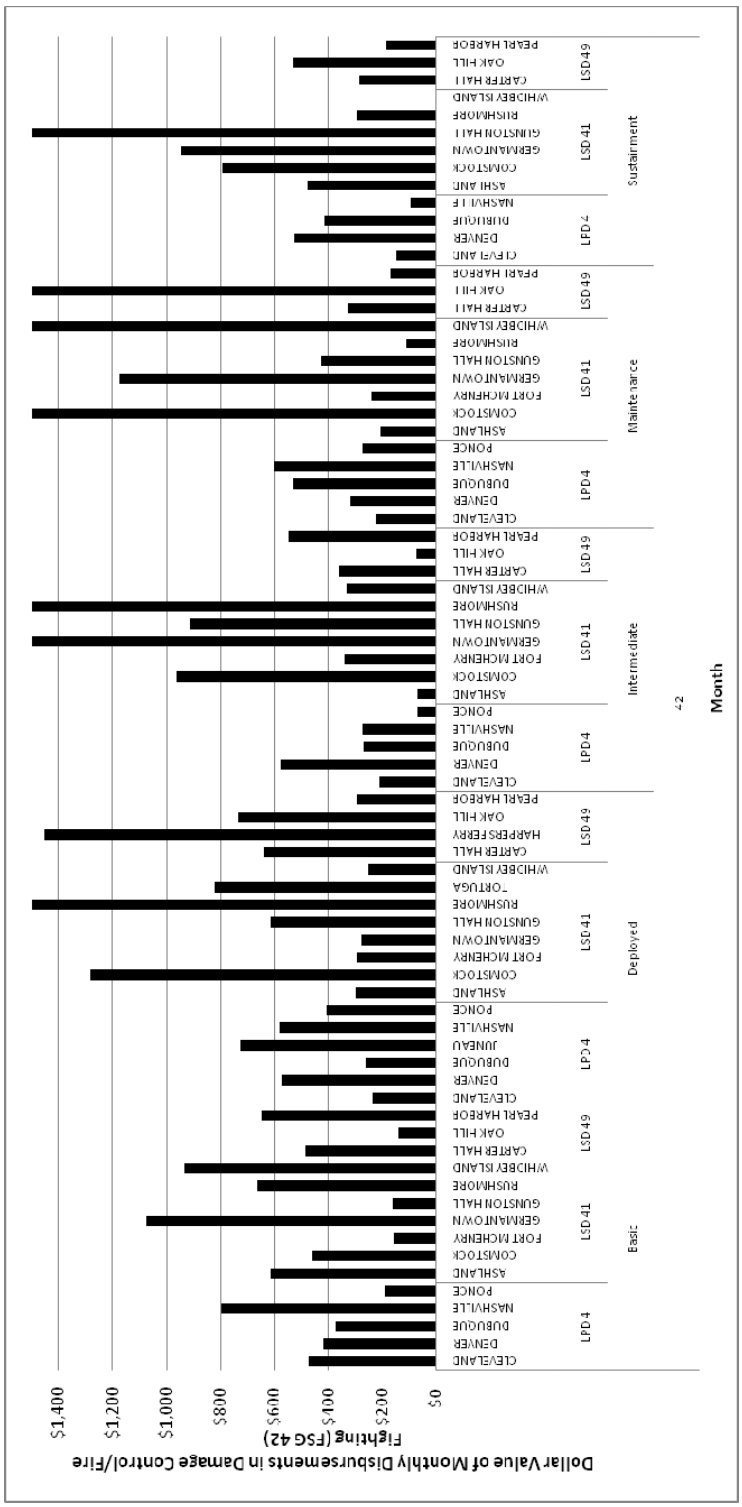


Figure 11. Average Monthly Disbursements for Damage Control/Firefighting (FSG 42) by FRP employment and ship's Class for Amphibious Assault ships. Data from the 01 October 2005 to 30 April 2008 financial dataset.

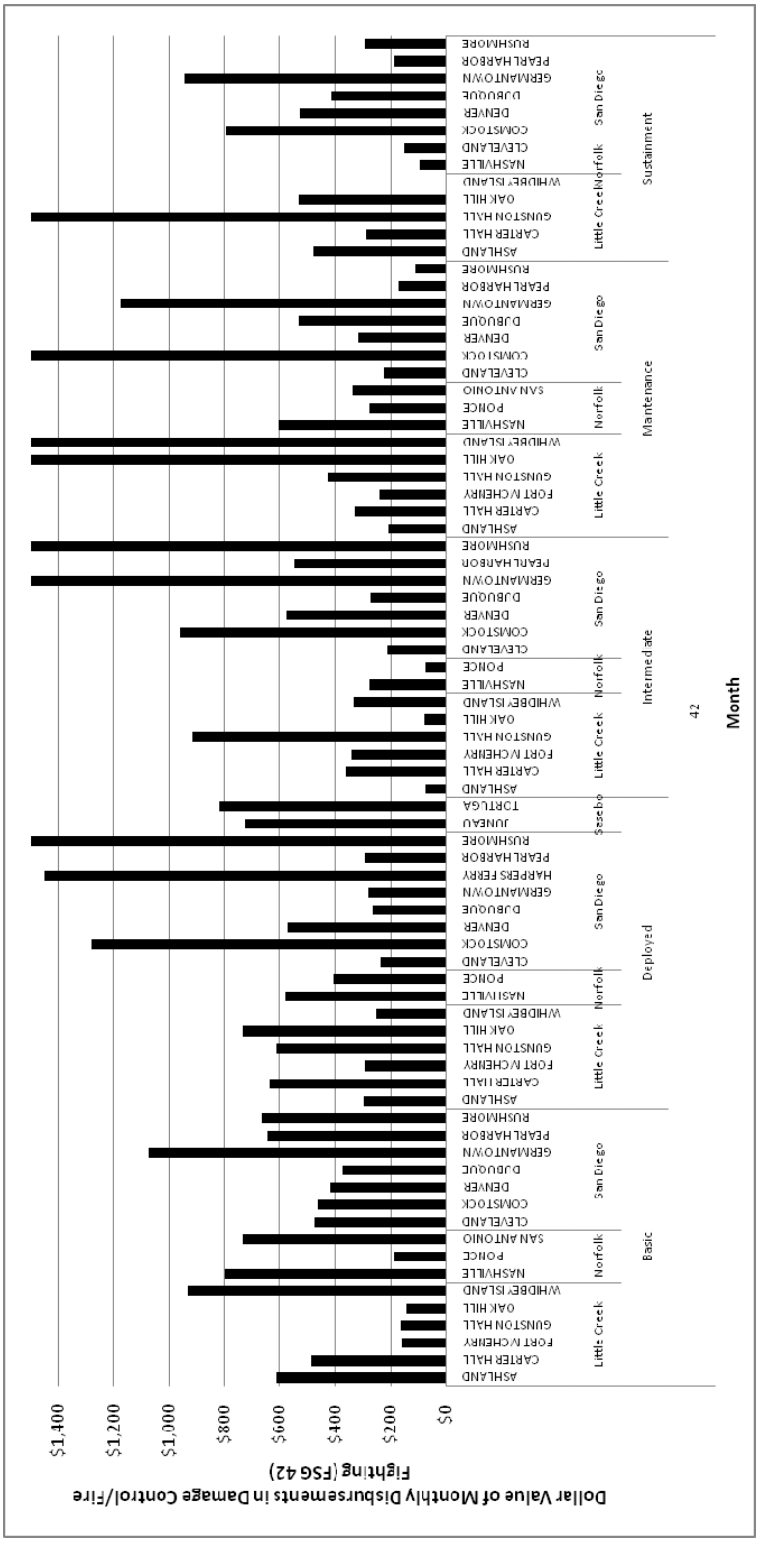


Figure 12. Average Monthly Disbursements for Damage Control/Firefighting (FSG 42) by FRP employment and ship's Homeport for Amphibious Assault ships. Data from the 01 October 2005 to 30 April 2008 financial dataset.

### *d. Conclusions*

This portion of the analysis supports a relationship between monthly disbursements made against Medical/Dental (FSG 65), Paint & Brushes (FSG 80) and Damage Control/Safety/Rescue (FSG 42) and the end of fiscal years. However, it does not support quarterly disbursement cycles or relationship to FRP employment, ship's Class or homeport. Monthly increases in disbursements during the course of the year are most likely due to increased funds received through an augment, a distribution of supplemental funds or, in the case of the Japanese Encephalitis vaccine, operational requirements. Increased disbursements at the end of a fiscal year are most likely due to a redistribution of excess funds as part of each fiscal years financial closeout.

Increases in Medical/Dental (FSG 65) and Damage Control/Firefighting (FSG 42) disbursements most likely represent purchases of phased replacement items which were deferred earlier in the FY. Further study into the allocation of available funds and the validity of each ship's phased replacement and unfunded listed is recommended. Particular attention should be given to the management of shelf life items to minimize expiration of large batches of material.

The next section includes a figure of merit scores for TFOM in a regression analysis with total monthly disbursements by FSG. The regression analysis includes TFOM scores relevant to that particular FSG code. The benefit of including these factors in the regression analysis is that it will provide additional plots and mathematically test the hypothesis that these factors and demographics do not add any improvement to predicting levels of disbursement other than using the average.

## D. REGRESSION ANALYSIS

Regression analysis was performed on monthly disbursements in the top three FSG codes modeled by FRP employment, ship's class, homeport and appropriate TFOM score. For example the most appropriate TFOM scores to model Medical/Dental (FSG 65) would be the monthly FSOM figure of merit, particularly, the Proficiency Pillar score. This figure of merit measures a ship's ability to perform its medical functions as

well as the status of certification, i.e., the last time they have conducted a medical drill and how well they performed the drill. Ship's overall TFOM score (Proficiency Pillar) will be used to model Paint & Brushes (FSG 80), and the MOB-D (Proficiency Pillar) will be used in the Damage Control/Fire Fighting (FSG 42) model. Other ship's demographic factors such as age of ship's at launch, inspection schedule, maintenance availability schedule and MFOM score will not be included in the regression analysis. A discussion of why these factors were omitted is included in the last portion of the analysis section.

### 1. Development of Regression Dataset

The final regression analysis dataset was constructed from financial data for the period of July 2007 through April 2008. The dataset contains monthly disbursements by FSG code and demographic information for the ship's class, homeport, FRP employment, monthly events (inspections and maintenance availabilities), average monthly MFOM score and the last best TFOM score for the ship that month. The analysis will focus on FSG codes with aggregated annual disbursements in excess of 3% of total annual disbursements. The FSG aggregation and selection process is described below as well as preliminary investigation for cyclical spending cycles and/or correlation to homeport, ship's class or FRP employment.

### 2. FSG 65: Medical, Dental and Veterinary Equipment

Regression analysis of monthly Medical/Dental (FSG 65) disbursements against FSOM TFOM scores, Class, Homeport and FRP Cycle yields no strong statistical significance and therefore no relationship between monthly obligations and the factors listed above. Although several regressions were ran, only the most significant and descriptive results will be displayed. For example, Table 9 shows the regression output for the logarithm of (1 + Sum of Monthly Disbursements for Medical/Dental) modeled by monthly FSOM TFOM score, Class, FRP employment and homeport. The log of disbursements was used because if yields a nearly normal distribution of the observations about the mean of monthly disbursements.

Figure 13 is a QQ plot of the logarithm of (1 + Sum of Monthly Disbursements for Medical/Dental). The purpose of a QQ plot is to test whether or not the variations or error in the dependant variable is normally distributed about the mean. This plot shows the variance of the data in relationship to the mean. A strait line implies a normal distributions and equal variance about the mean. Normally distributed data with equal variance is one of the requirements for using the sum-of-least squares regression. As Figure 13 shows, the plot indicates a nearly linear relationship and that the observations for the logarithm of monthly disbursements are normally distributed about the mean. A histogram (Figure 14) of the logarithm of (1 + Sum of Monthly Disbursements for Medical/Dental) also shows a nearly normal distribution of observations about the mean. Regression analysis using the sum-of-least squares method requires that the dependent variables have a standard normal distribution. So, the logarithm of (1 + Sum of Monthly Disbursements for Medical/Dental) is an appropriate independent variable for regression analysis.

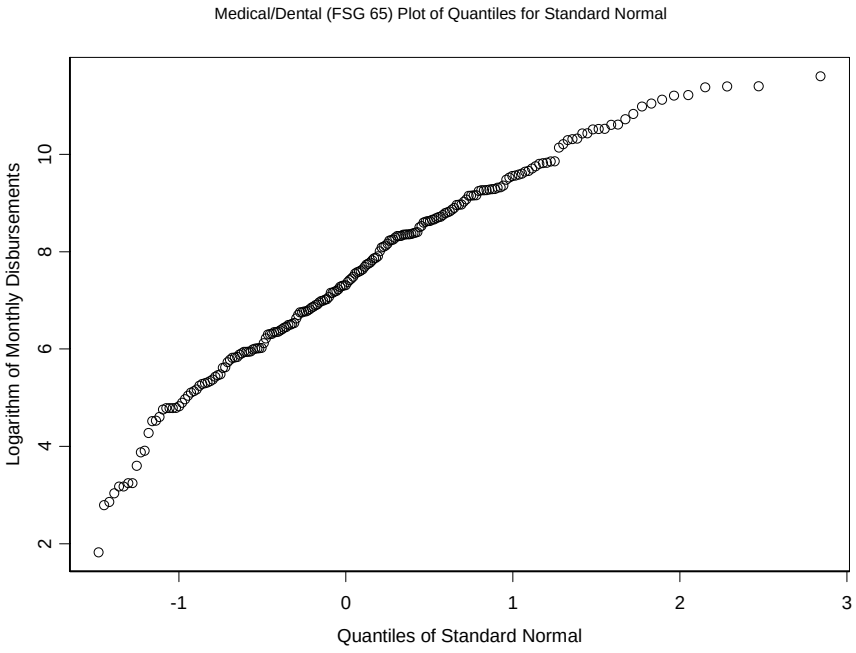


Figure 13. Plot of Standard Normal Quintiles for Logarithm of (1+ Sum of Monthly Medical/Dental (FSG 65) Disbursements). From the 01 July 2007 to 30 April 2008 Dataset.

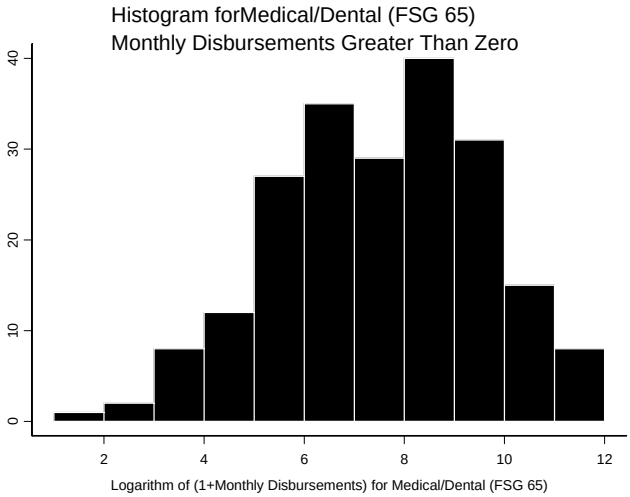


Figure 14. Histogram of for Logarithm of (1+ Sum of Monthly Medical/Dental (FSG 65) Disbursements). From the 01 July 2007 to 30 April 2008 Dataset.

This regression tests the null hypothesis shown below, using a p-Value of 0.10. Although the individual t and F-Statistics are less than our p-Value of .10 and results in rejecting the null hypothesis, the model has a low R-Squared value of 14.15 percent. This means that 14 percent of the variation in the data is accounted for in the model. As the regression in Table 8 shows, this model is not much better than using a historical average to estimate future disbursements for Medical/Dental (FSG 65).

$H_o$: FSG/FSC Future obligations cannot be determined by analyzing past disbursement data against several ship's demographic information and monthly Figure of Merit scores depends.

Ha: Ship's demographic information and monthly Figure of Merit scores do provide strong predictors of monthly Disbursements by FSG/FSC.

```
Call: lm(formula = log(1 + DISB) ~ FSOM.PROFICIENCY.FOM + Class + FRP + Hmpt,
data = FSG.65, na.action = na.exclude)
Residuals:
   Min     1Q Median    3Q   Max
 -7.17 -1.455 0.2764 1.802 4.981

Coefficients:
                       Value Std. Error t value Pr(>|t|)
         (Intercept)  1.0147  3.3845     0.2998  0.7646
FSOM.PROFICIENCY.FOM  0.0163  0.0080     2.0305  0.0436
          ClassLHA 1 -1.7558  1.7418    -1.0080  0.3147
          ClassLHD 1 -1.8245  1.6540    -1.1031  0.2713
         ClassLPD 17  2.2115  3.1822     0.6950  0.4879
          ClassLPD 4 -3.2087  1.6474    -1.9478  0.0529
         ClassLSD 41 -3.1168  1.6706    -1.8657  0.0636
         ClassLSD 49 -2.6445  1.7367    -1.5228  0.1294
            FRPBasic  6.8861  2.8943     2.3792  0.0183
             FRPDepl  7.5419  2.8793     2.6194  0.0095
              FRPInt  7.7028  2.9008     2.6555  0.0086
            FRPMaint  7.2946  2.8143     2.5919  0.0103
             FRPSust  7.0159  2.9024     2.4172  0.0165
           HmptNORVA -0.2173  0.7963    -0.2729  0.7852
             HmptSAS -0.2126  0.8628    -0.2464  0.8057
              HmptSD  0.3358  0.6299     0.5332  0.5945

Residual standard error: 2.652 on 198 degrees of freedom
Multiple R-Squared: 0.1415
F-statistic: 2.176 on 15 and 198 degrees of freedom, the p-value is 0.008291
9 observations deleted due to missing values
```

Table 8. S-Plus regression table for the logarithm of (1 + Sum of Monthly Disbursements for Medical/Dental (FSG 65)) modeled by monthly FSOM TFOM score, Class, FRP employment and homeport. From the 1 July 2007 – 30 April 2008.

Since the regression has some t-Statistics that would indicate a statistical significance between monthly Medical/Dental (FSG65) disbursements and FRP employment and ship's Class, an analysis of variance (ANOVA) is necessary to determine whether or not the model is improved by adding these factors. Table 9 is the results of an analysis of variance for the independent variables in the previous regression analysis. This function essentially tests the regression model over and over by removing each of the factors. This tests the contribution of each of the independent variables for predicting the expected amount of Medical/Dental (FSG 65) disbursements and produces a t-Statistic which tests whether or not the factor contributes to the fit of the model. Using

the same null hypothesis and p-Value of 0.10 shows that homeport and FRP cycle do not contribute to the model, but the Monthly FSOM TFOM score and ship's Class do contribute to the model.

```
Model:
log(1 + DISB) ~ FSOM.PROFICIENCY.FOM + Class + FRP + Hmpt
                     Df Sum of Sq      RSS      AIC  F Value     Pr(F)
               Hmpt   3   12.0822 1404.232 428.5918 0.572803 0.6335368
                FRP   5   62.7543 1454.904 432.1779 1.785058 0.1174968
             <none>               1392.150 432.7425
FSOM.PROFICIENCY.FOM   1   28.9879 1421.138 435.1527 4.122829 0.0436456
              Class   6  103.7508 1495.901 436.1247 2.459344 0.0257213
```

Table 9. Analysis of Variance (ANOVA) for regression of the logarithm of (1 + Sum of Monthly Disbursements for Medical/Dental) modeled by monthly FSOM TFOM score, Class, FRP employment and homeport. From 1 July 2007 – 30 April 2008.

Even though FSOM yields a low t-Statistic (0.0436) in the regression and analysis of variance, a scatter-plot of monthly disbursements for Medical/Dental (FSG 65) against monthly FSOM TFOM scores shows that the data produces no discernable level of spending for a given TFOM score. If monthly FSOM scores where a good predictor of monthly disbursements, the data would have clustered into groups. However, as the scatter-plot in Figure 15 shows, the data is widely disbursed and yields no distinctive clusters.

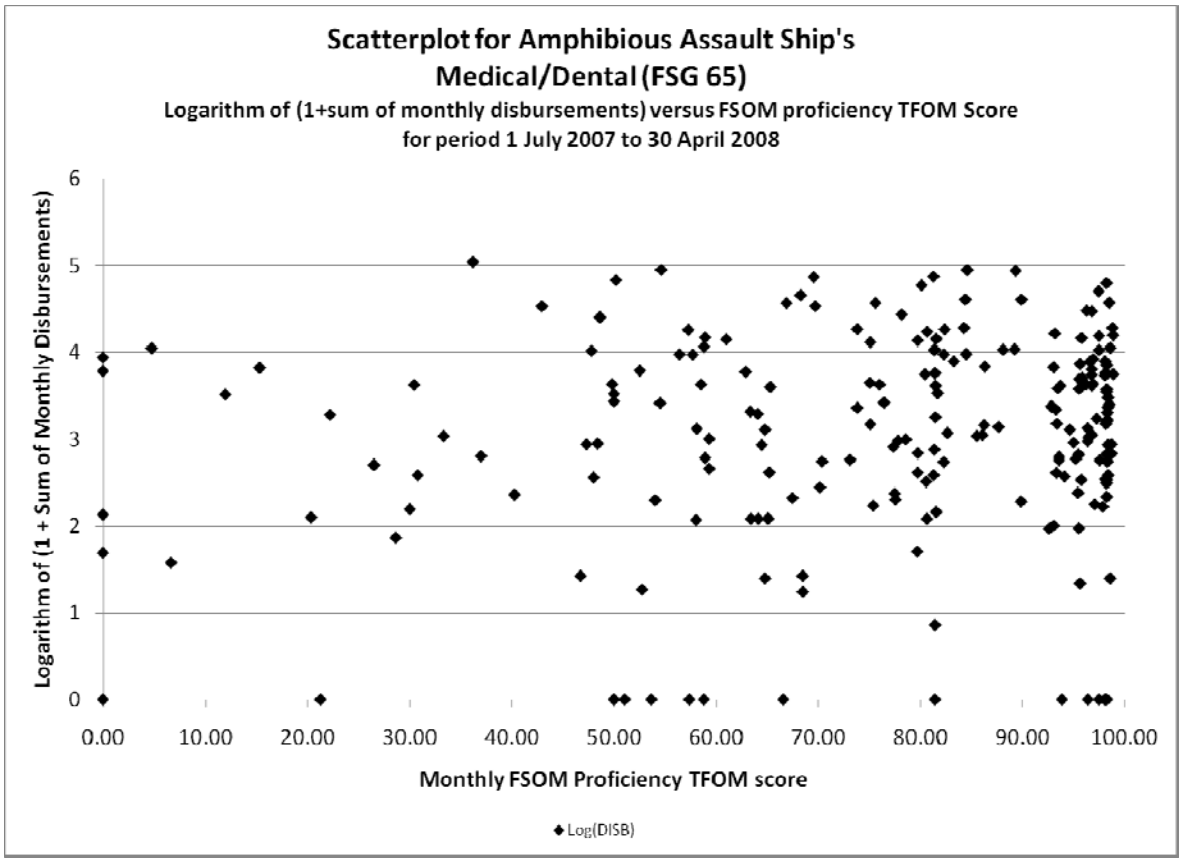


Figure 15. Scatter-plot of Total Monthly Disbursements for Medical/Dental (FSG 65) against monthly FSOM TFOM scores for Amphibious Assault ships. From 1 July 2007 – 30 April 2008.

Another graphical tool for examining data dispersion is the box-plot. This plot simultaneously displays six different summaries of data. The highest and lowest observations, median score, mean score and the upper and lower quartiles. The main purpose is to show whether or not the data is similarly distributed about their means. If this is true, we would expect to find a statistically significant relationship between the factors in the box-plot. As shown in Figure 16, the box-plot of the sum of monthly Medical/Dental (FSG 65) disbursements against the ship's class shows that there is a wide degree of variation in the data. Particularly, the data is heavily influenced by a large number of outliers, particularly in the LHD-1 and LSD-41 classes. Although the regression table and ANOVA table indicate a possible relationship between monthly disbursements and ship's Class, Figure 16 shows that there is too much dispersion in the data to draw any reliable conclusions or to use the ship's class as a predictor of future

disbursements. Figure 17 is included to demonstrate that there appears to be no relationship between monthly FSOM Proficiency TFOM score and the ship's class. Similar to the relationship between monthly disbursements and ship's Class, there is too much variation in the data and many outliers which contribute to the noise.

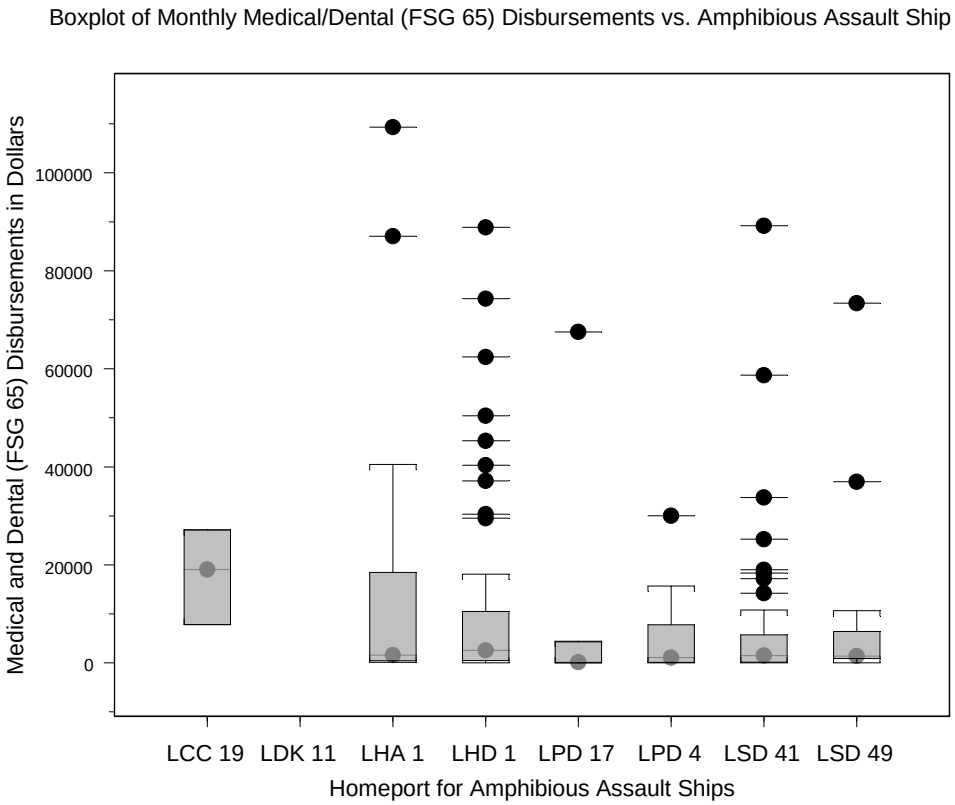


Figure 16. Box-plot of Monthly Medical/Dental Disbursements against ship's Class. From 1 July 2007 – 30 April 2008.

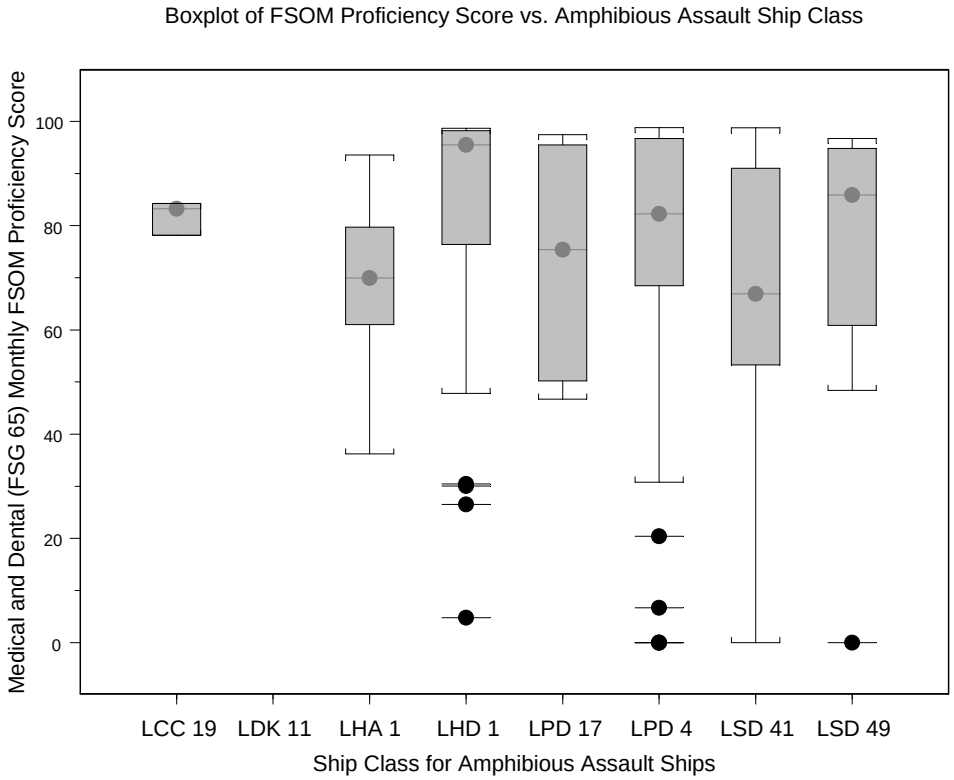


Figure 17. Box-plot of Monthly FSOM Proficiency TFOM scores against ship's Class. From 1 July 2007 – 30 April 2008.

### 3. FSG 80: Brushes, Paints, Sealers, and Adhesives

The previous methodology was performed on monthly disbursements for Paint & Brushes (FSG 80), except the ship's overall monthly TFOM score was used in place of the MOB-D. The ship's overall TFOM score was used, because there is no monthly TFOM score for an evolution that would be logically tied to paint. The regression analysis (Table 10) does not produce a significantly statistical relationship. Although the F-Statistic shows that the overall model is significant, the t-Statistics for the independent variables do not meet the criteria (less than 0.10) for rejecting the null hypothesis. Since none of the t-Statistics meet the criteria for rejecting the null hypothesis, an analysis of variance is not necessary. Additionally, the model does not produce a high R-Squared value that demonstrates the model accounts for much of the variability. In this case, the R-Squared value is 15 percent, so this model is not much better than using the average.

QQ Normal and a histogram (Figures 18 and 19 respectively) show that in monthly disbursements for Paint & Brushes (FSG 80) do not have a normal distribution. However, a regression analysis was still performed and is shown in Table 10.

```
lm(formula=log(1+DISB)~Ship.OVERALL.FOM+Class+FRP+Hmpt,data=FSG.80,na.a
ction=na.exclude)
> summary(FSG80.DISB.log)

Call: lm(formula = log(1 + DISB) ~ Ship.OVERALL.FOM + Class + FRP +
Hmpt, data = FSG.80, na.action = na.exclude)
Residuals:
    Min     1Q Median    3Q   Max
 -7.811 -1.024 0.5351 1.492 5.258

Coefficients:
                  Value Std. Error t value Pr(>|t|)
     (Intercept)  5.5325  3.2664     1.6938  0.0918
Ship.OVERALL.FOM -0.0021  0.0094    -0.2181  0.8275
      ClassLHA 1  0.6429  1.6294     0.3946  0.6936
      ClassLHD 1  0.1094  1.5505     0.0706  0.9438
     ClassLPD 17  1.2912  2.9978     0.4307  0.6671
      ClassLPD 4 -1.8599  1.5379    -1.2093  0.2279
     ClassLSD 41 -2.1136  1.5443    -1.3686  0.1726
     ClassLSD 49 -0.7665  1.6049    -0.4776  0.6334
        FRPBasic  2.3579  2.7401     0.8605  0.3905
         FRPDepl  3.2016  2.7147     1.1794  0.2396
          FRPInt  2.4254  2.7434     0.8841  0.3776
        FRPMaint  3.2207  2.6830     1.2004  0.2313
         FRPSust  2.9909  2.7392     1.0919  0.2761
       HmptNORVA -0.5165  0.7190    -0.7184  0.4733
         HmptSAS  0.4490  0.7434     0.6040  0.5465
          HmptSD -0.0003  0.5563    -0.0006  0.9995

Residual standard error: 2.488 on 212 degrees of freedom
Multiple R-Squared: 0.156
F-statistic: 2.612 on 15 and 212 degrees of freedom, the p-value is
0.001254
9 observations deleted due to missing values
```

Table 10. S-Plus regression table for the logarithm of (1 + Sum of Monthly Disbursements for Paint & Brushes (FSG 80)) modeled by monthly Overall TFOM score, Class, FRP employment and homeport. From the 1 July 2007 – 30 April 2008.

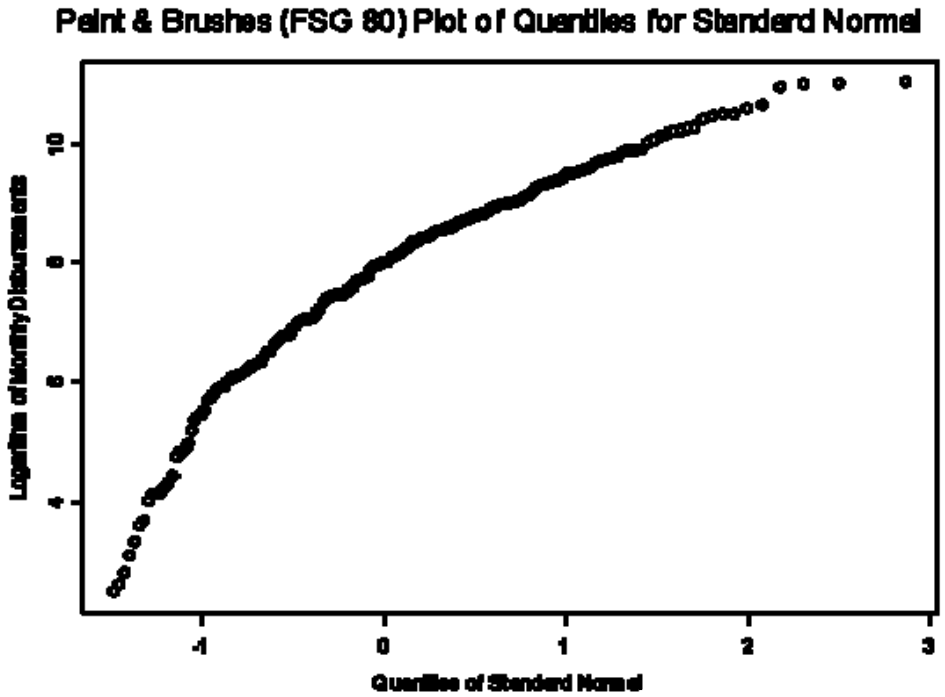


Figure 18. Plot of Standard Normal Quintiles for the Logarithm of (1+ Sum of Monthly Paint & Brushes (FSG 80) Disbursements). From 1 July 2007 – 30 April 2008.

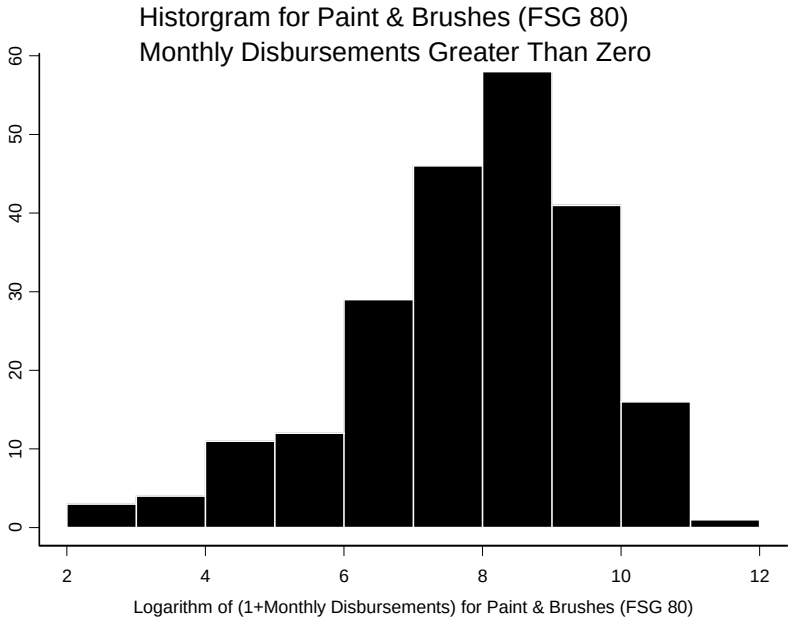


Figure 19. Histogram for the Logarithm of (1+ Sum of Monthly Paint & Brushes (FSG 80) Disbursements). From 1 July 2007 – 30 April 2008.

Figure 20 is the scatter-plot of logarithm of (1+ Sum of Monthly Paint & Brushes (FSG 80) disbursements) versus the ship's overall TFOM score. As the plot shows, the data does not cluster in any noticeable pattern that would indicate a specific level of spending. Since Paint & Brushes (FSG 80) does not have a logical relationship to other TFOM scores, the average monthly MFOM score was used to determine if this measure could provide a good indicator of monthly spending. Figure 21 is a scatter-plot of logarithm of (1+ Sum of Monthly Paint & Brushes (FSG 80) disbursements) against average monthly MFOM score. Similar to the scatter-plot for the ship's overall TFOM score, there is no clear clustering of data within any range of average monthly MFOM score to indicate further regression analysis, using average monthly MFOM as a factor.

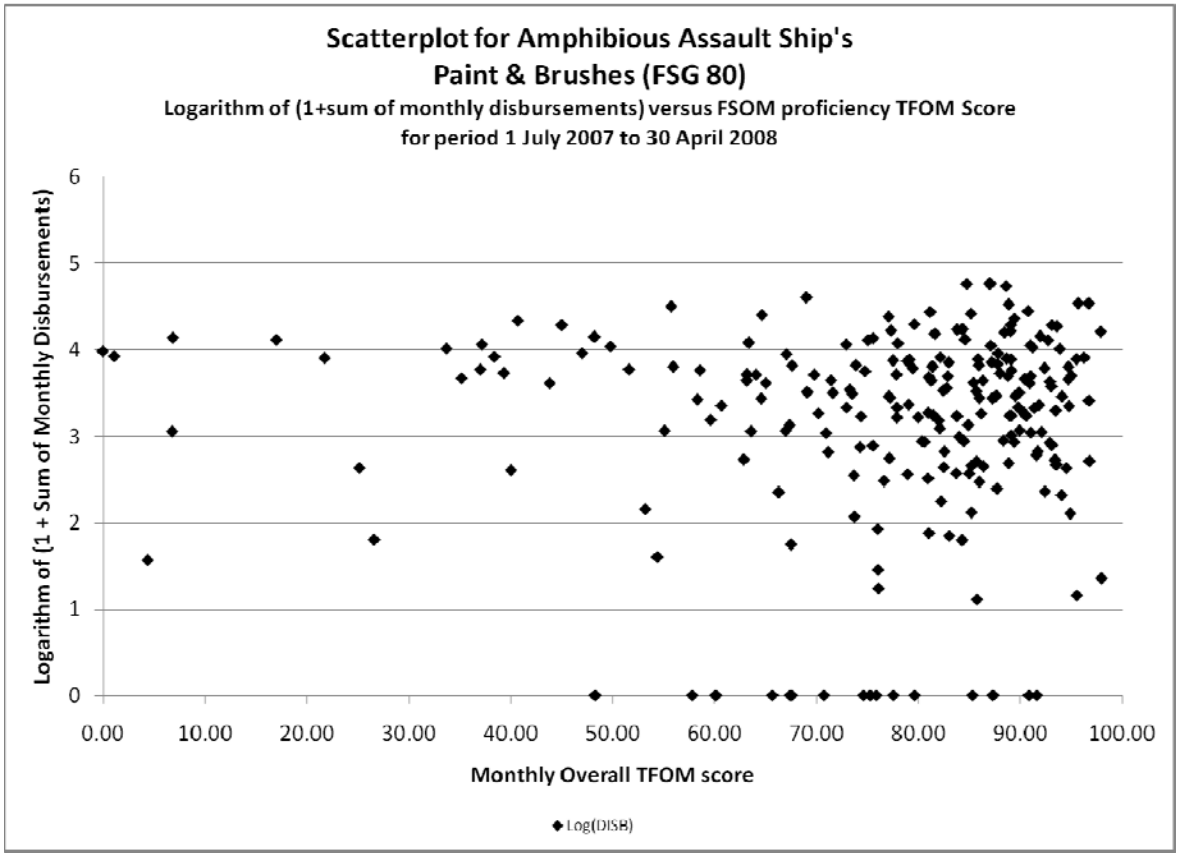


Figure 20. Scatter-plot of Total Monthly Disbursements for Paint & Brushes (FSG 80) against monthly ship's overall TFOM scores for Amphibious Assault ships. From 1 July 2007 – 30 April 2008.

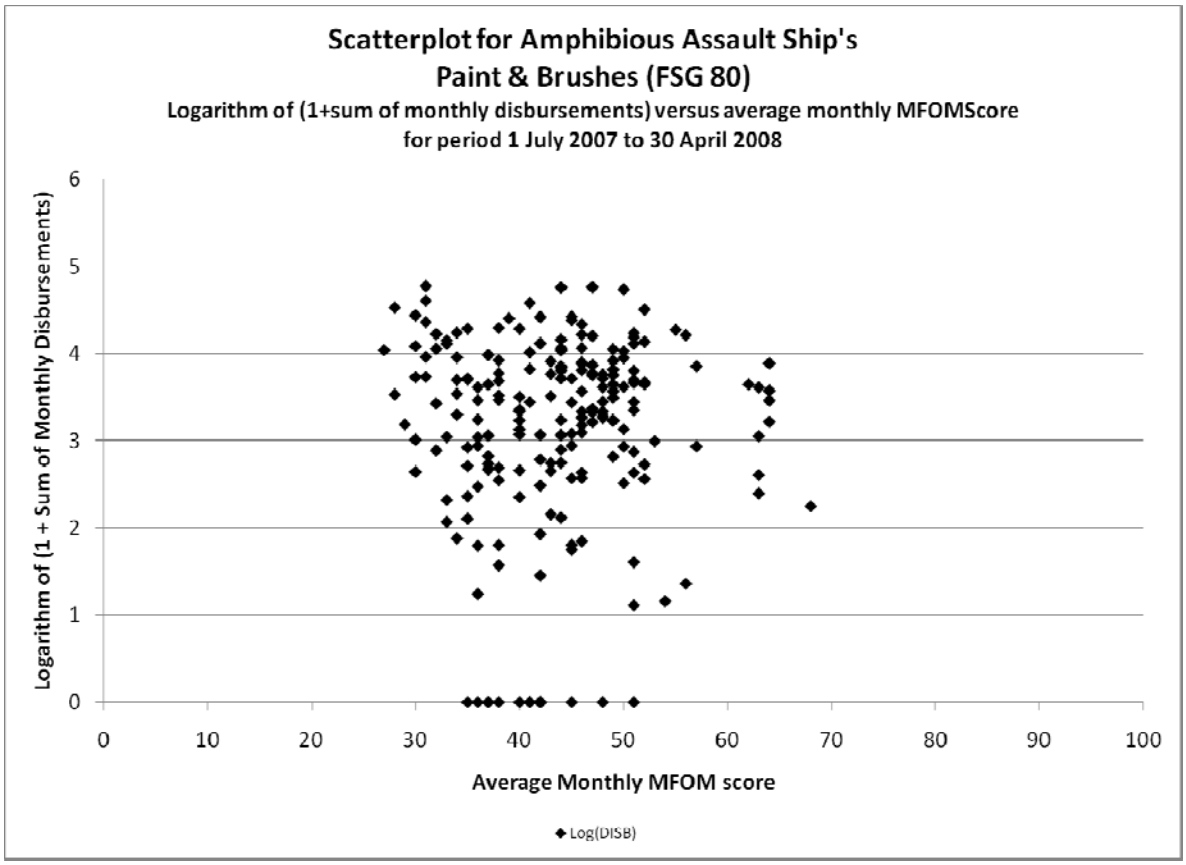


Figure 21. Scatter-Plot of the Logarithm of (1+ Sum of Monthly Disbursements) for Paint & Brushes (FSG 80) against the age of Amphibious Assault ships. From 1 July 2007 – 30 April 2008.

### 4. FSG 42: Fire Fighting, Rescue, and Safety Equipment

The regression for Fire Fighting/Safety (FSG 42) determined there is no relationship between monthly disbursements in this category, compared to the monthly MOB-D TFOM score, Class, Homeport and FRP employment for that month. Table 11 displays the S-Plus regression table for logarithm of monthly Firefighting and Damage Control Disbursements modeled by MOB-D TFOM score, Ship Class, FRP Employment and homeport and tests the null hypothesis that.

$H_o$: Monthly MOB-D TFOM score, Ship Class, FRP Employment and Homeport are not good predictors of monthly disbursement (or natural logarithm of monthly disbursements) levels for FSG 42.

Ha: MOB-D TFOM score, Ship Class, FRP Employment and Homeport are in fact good predictors.

Plots for the QQ Normal and histogram (Figures 22 and 23) for the logarithm of (1+ Sum of Monthly Damage Control/Firefighting (FSG 42) Disbursements) do indicate a slightly normal distribution about the mean. This indicates that the monthly disbursements for Damage Control/Firefighting (FSG 42) are a good candidate for regression analysis.

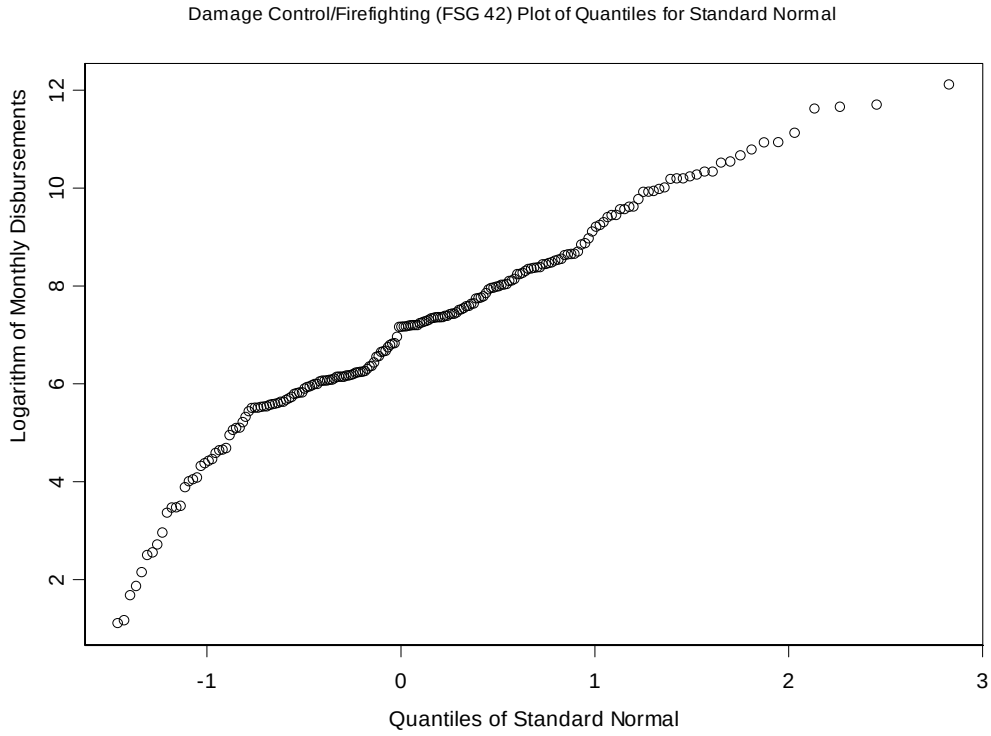


Figure 22. Plot of Standard Normal Quintiles for logarithm (1+ Sum of Monthly Damage Control/Firefighting (FSG 42) Disbursements). From 1 July 2007 – 30 April 2008.

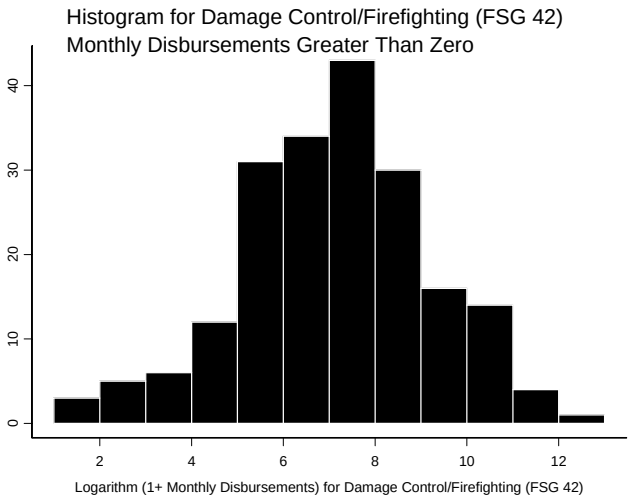


Figure 23. Histogram for the Logarithm of (1+ Sum of Monthly Paint & Brushes (FSG 80) Disbursements). From the 1 July 2007 – 30 April 2008.

This model initially indicates that it poorly accounts for the variability in the model (about 4.2 percent). P-Values for the F-Statistic is 0.8961, much larger than the 0.05 threshold to reject the hypothesis that ship's class, homeport and FRP employment contribute to the monthly disbursement. P-Values for each independent variable in the model indicate that the independent variables do not contribute to the model. Overall, this model does not lead to rejecting the null hypothesis and that this would not be better than using the average. Additionally, the R-Squared value indicates that this model accounts for less than 4.2 percent of the variability in the model.

```
Call: lm(formula = log(1 + DISB) ~ MOBD.PROFICIENCY.FOM + Class + FRP +
Hmpt, data
       = FSG.42, na.action = na.exclude)
Residuals:
    Min     1Q Median    3Q   Max
 -7.372 -1.067 0.3177 1.659 5.408

Coefficients:
                      Value Std. Error t value Pr(>|t|)
        (Intercept)  6.0776  3.1705     1.9169  0.0567
MOBD.PROFICIENCY.FOM -0.0089  0.0098    -0.9068  0.3657
          ClassLHA 1 -1.2254  1.8168    -0.6745  0.5008
          ClassLHD 1 -0.6989  1.7142    -0.4077  0.6839
         ClassLPD 17 -0.3936  2.6885    -0.1464  0.8838
          ClassLPD 4 -1.5814  1.7027    -0.9287  0.3542
         ClassLSD 41 -1.0081  1.7147    -0.5879  0.5573
         ClassLSD 49 -0.6686  1.7913    -0.3732  0.7094
            FRPBasic  1.7246  2.5071     0.6879  0.4924
             FRPDepl  1.7939  2.4782     0.7239  0.4700
              FRPInt  1.1671  2.5176     0.4636  0.6435
            FRPMaint  2.1278  2.4411     0.8717  0.3845
             FRPSust  1.7261  2.5105     0.6876  0.4926
           HmptNORVA  0.3805  0.8660     0.4394  0.6608
             HmptSAS  0.6643  0.8616     0.7710  0.4417
              HmptSD  0.6246  0.6347     0.9841  0.3263

Residual standard error: 2.75 on 192 degrees of freedom
Multiple R-Squared: 0.04256
F-statistic: 0.569 on 15 and 192 degrees of freedom, the p-value is
0.8961
6 observations deleted due to missing values
```

Table 11. S-Plus regression table for Natural Logarithm of Monthly Firefighting and Damage Control Disbursements Modeled by MOB-D TFOM score, Ship Class, FRP Employment and Homeport. From the 1 July 2007 – 30 April 2008.

The scatter-plot and box-plot shown in Figures 24 and 25 again show that there is too much variation in the monthly disbursement data to indicate that it can be modeled through regression analysis using monthly MOB-D Proficiency TFOM score and ship's Class. These plots are included as examples of the multiple plots that were made during the analysis. Redundant plots are not included in this thesis.

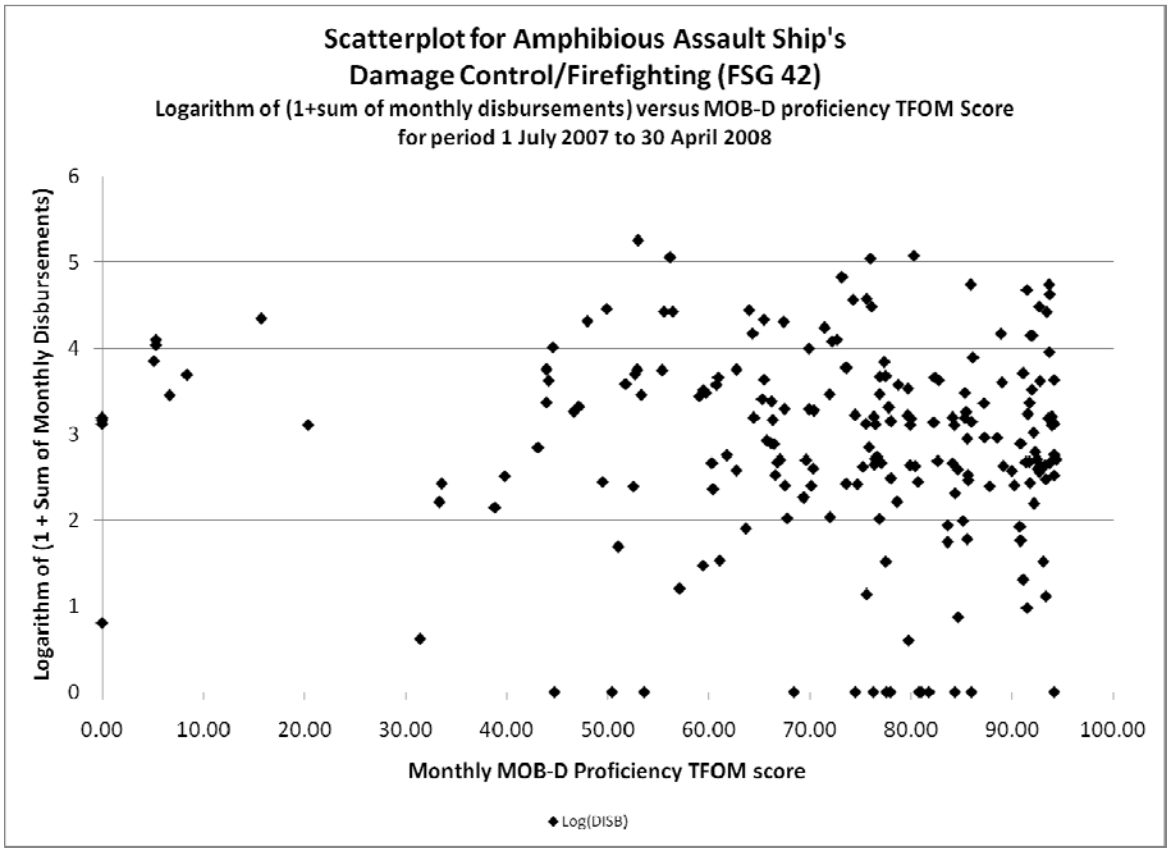


Figure 24. Scatter-plot of Total Monthly Disbursements for Damage Control/Firefighting (FSG 42) against monthly MOB-D TFOM proficiency scores for Amphibious Assault ships. From 1 July 2007 – 30 April 2008.

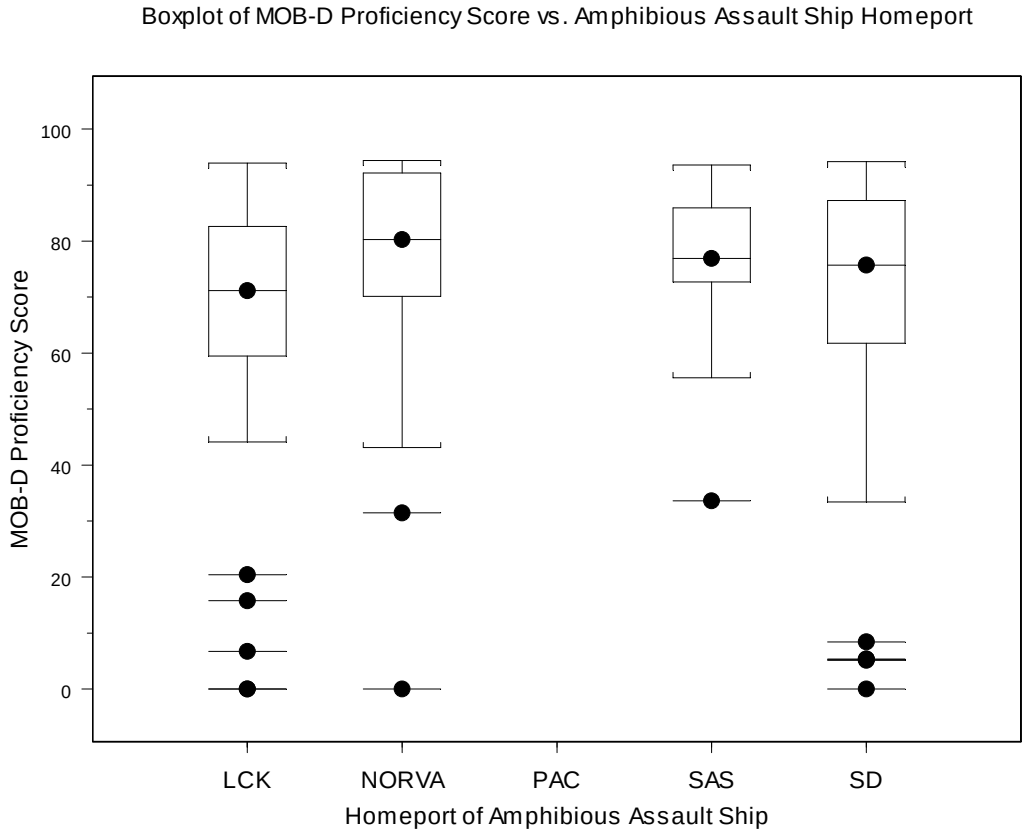


Figure 25. Box-plot of MOB-D Proficiency Scores against ship's Homeport. From 1 July 2007 – 30 April 2008. Homeports are Little Creek, VA (LCK), Norfolk, VA (NORVA), Sasebo, Japan (SAS) and San Diego, CA (SD). PAC is a dummy variable used in the regression.

## E. ADDITIONAL DEMOGRAPHICS NOT INCLUDED IN REGRESSION ANALYSIS

### 1. Time Lag between Disbursement and Return in Figure of Merit

The following two Figures (26 and 27) show plots of total monthly disbursements for Damage Control/Firefighting (FSG 42) as well as all four pillars (Proficiency, Personnel, Management and Material) for the MOB-D TFOM score. These plots were performed for a number of different ship's within the data set to explore the possibility of a lag between monthly disbursements and a noticeable drop or improvement in the figure of merit score. The analysis determined no discernable lag or delay in disbursements and changes figure of merit scores. The same methodology applied to the Medical/Dental

(FSG 65) and Paint & Brushes (FSG 80) data and yielded similar negative results. Further plots are redundant and do not contribute to the regression analysis.

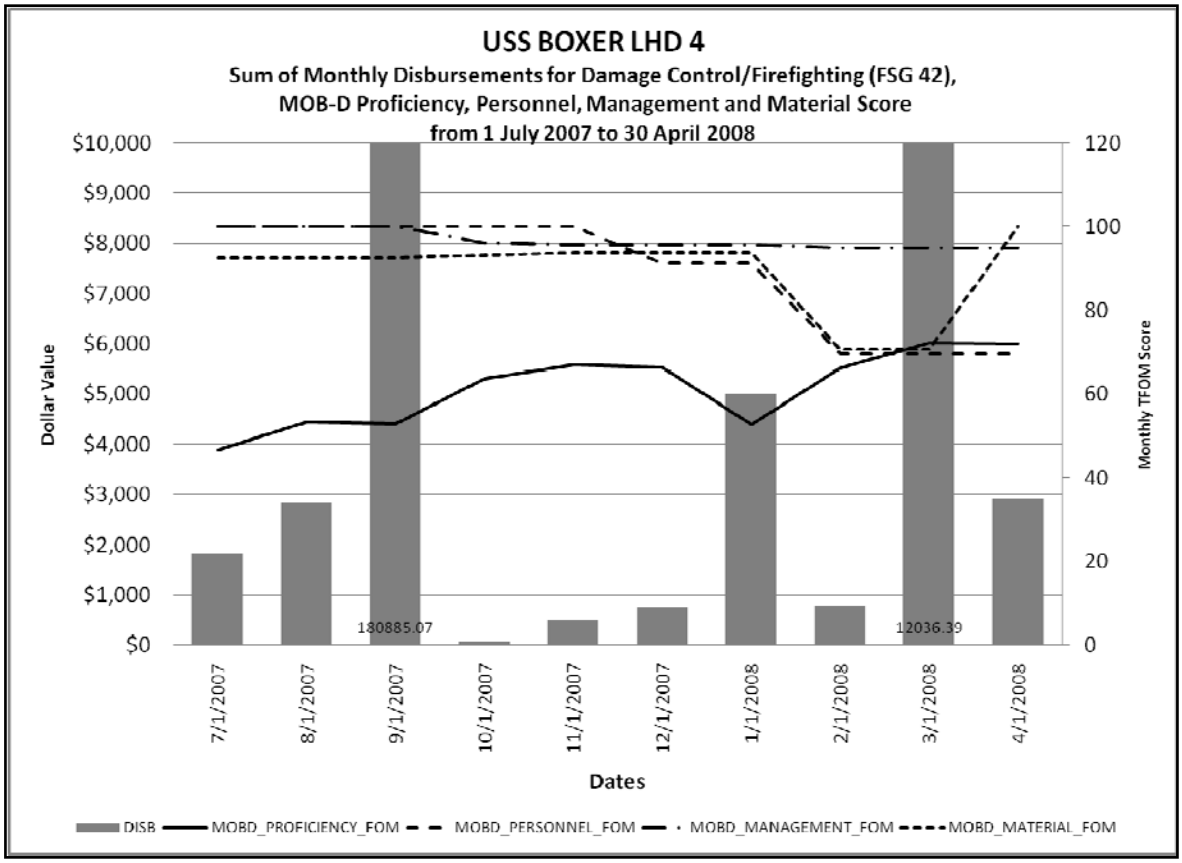


Figure 26. Plot of USS BOXER's LHD 4 Sum of Monthly Disbursements for Damage Control/Firefighting (FSG 42), Monthly MOB-D Proficiency, Personnel, Management and Material TFOM score. Scale for Sum of Monthly Disbursements has been increased to show lower dollar values against the monthly TFOM scores. September and March have noticeably larger monthly disbursements. $180K for September and $12K March. From 1 July 2007 – 30 April 2008.

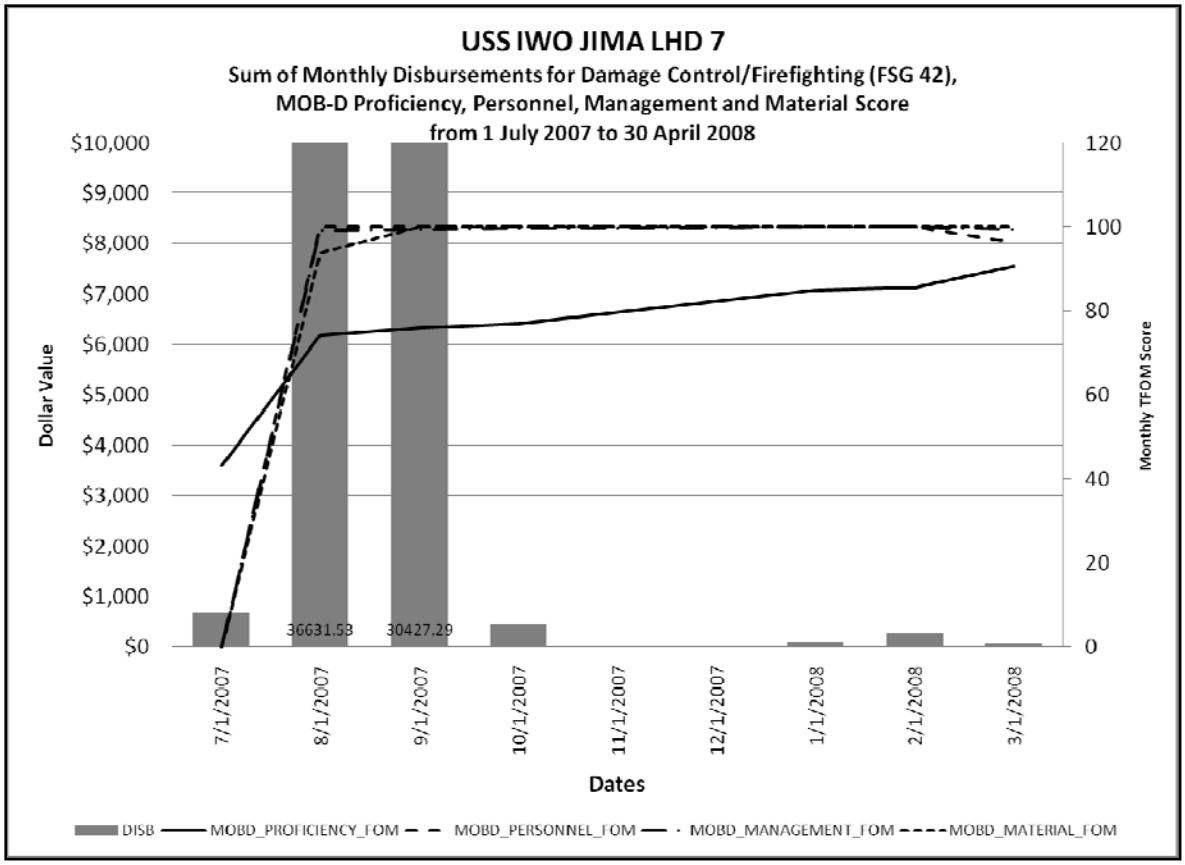


Figure 27. Plot of USS IWO JIMA's LHD 7 Sum of Monthly Disbursements for Damage Control/Firefighting (FSG 42), Monthly MOB-D Proficiency, Personnel, Management and Material TFOM score. Scale for Sum of Monthly Disbursements has been increased to show lower dollar values against the monthly TFOM scores. August and September have noticeably larger monthly disbursements. $36K for August and $30K for September. From 1 July 2007 – 30 April 2008.

### 2. Additional Factors not Used as Dependant Variable in the Regression Analysis

Age, average monthly MFOM score, inspections and maintenance availabilities were not used in the regression analysis. These items were intended to be included if the regression analysis yielded statistically significant results, with these factors being included to possible improve a good model. However, there was no significant correlation between inspection cycles or maintenance availabilities that would indicate that they would aid in any regression analysis. For instance, plots of total monthly

disbursements for various Amphibious Assault ships showed no conclusive increase in spending either before or after inspections, such as INSURV and C5RA or Periodic Maintenance Availabilities (PMAV). No graphical representations of these plots are included in this analysis because they do not contribute to the final regression analysis.

Two other likely contributors to the regression analysis were age of vessel and average monthly MFOM scores. Sample scatter-plots of the Logarithm of (1 + Sum of Monthly Disbursements) against age and average monthly MFOM score are shown in Figures 28 and 29. Both figures do not indicate any clear range of spending which would indicate lead to there being a strong statistical relationship between monthly disbursements and age or average monthly MFOM score.

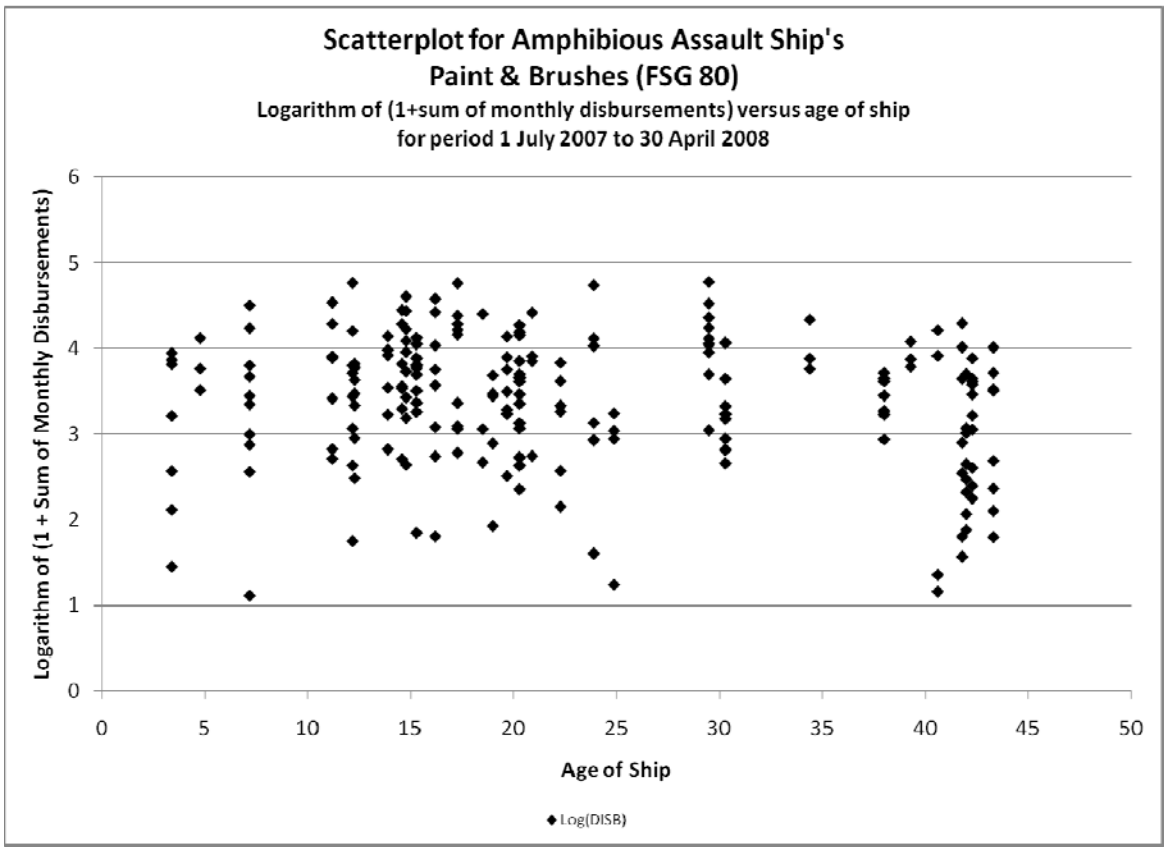


Figure 28. Scatter-plot of the Logarithm of (1 + Sum of Monthly Disbursements) for Paint & Brushes (FSG 80) against age of Amphibious Assault Ship. From 1 July 2007 – 30 April 2008.

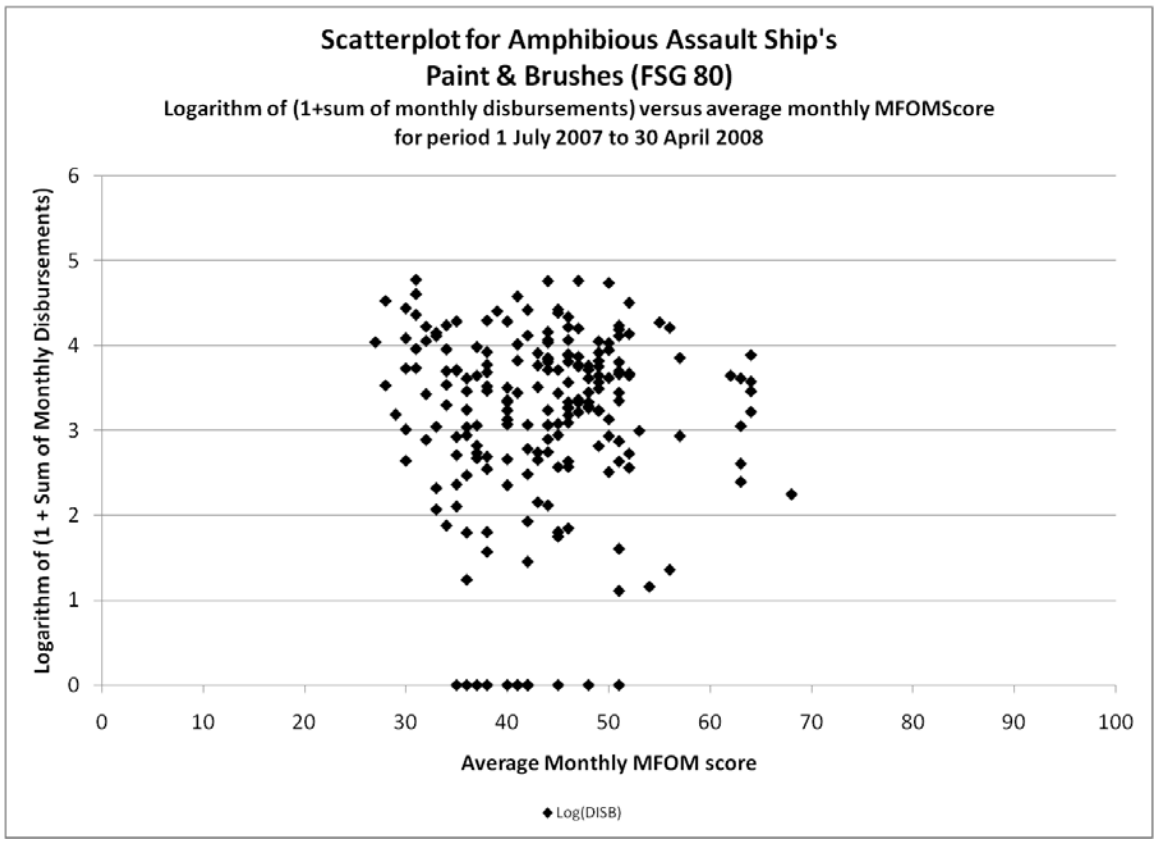


Figure 29. Scatter-Plot of the Logarithm of (1+ Sum of Monthly Disbursements) for Paint & Brushes (FSG 80) against the average Monthly MFOM scores for Amphibious Assault ships. From 1 July 2007 – 30 April 2008.

Because there is no any indication that age, average monthly MFOM score, inspection cycle or maintenance availabilities, these factors will not be included in the regression analysis. Although this portion of the analysis consisted of numerous plots for each ship in the dataset, they were not included because they did not yield positive results and did not contribute to the final regression analysis, which is the main focus of this study.

## F. CONCLUSIONS FOR THE REGRESSION ANALYSIS

As shown above, the regression analyses did not yield statistically significant results to indicate a relationship between monthly disbursements and ship's demographic information or figure of merit scores. The results presented above represent only the most pertinent and descriptive regressions performed during this analysis. Multiple regressions were run, comparing disbursements to all available TFOM scores across all

mission areas (and pillars) as well as all available ship's demographic information and MFOM scores. However, these regressions yield similar results to those presented above. The results are redundant and are not included in this analysis because they do not contribute to the final conclusions. Overall, ship's monthly disbursements, by FSG code, do not have any statistically significant relationship between ship's demographic information and monthly TFOM or MFOM scores.

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# IV. CONCLUSIONS

This analysis has not found any statistical significant results between monthly disbursements by FSG Code and monthly TFOM score, Class, homeport and FRP employment. Although the top three FSG codes account for a greater proportion of total annual consumable disbursements, there is too much variation within the disbursements. However, disbursements do appear to be highly influenced by the availability of additional funds, for example at the end of each FY. As the plots sections IV have shown, there is not any graphical representation or plot which produces noticeable patterns and therefore a relationship between monthly FSG disbursements and total spending. Regression analysis does not produce any better results. The below portion is a recap of the thesis hypothesis and research questions followed by a brief explanation of the finding of this analysis.

## A. FINDINGS

**Hypothesis:** Future obligations for specific Federal Supply Group (FSG) and Federal Supply Class (FSC) can be determined by analyzing past disbursement data against several ship's demographic information and monthly Figure of Merit scores.

**Conclusions:** The regression analysis showed no statistical significance between monthly disbursements in FSG codes for Medical/Dental (FSG 65), Paint & Brushes (FSG 80) and Damage Control/Firefighting (FSG 42) and ship's demographics or monthly TFOM and MFOM scores. Although some ship's demographics yielded good t-Statistics and would indicate that there is a relationship between monthly disbursements and those factors, these models produced low R-Squared values or resulted in an Analysis of Variance (ANOVA) that indicated that overall these factors do not contribute to predicting future monthly disbursements. However, the analysis has determined that disbursements made against Medical/Dental (FSG 65), Paint & Brushes (FSG 80) and Damage Control/Firefighting (FSG 42) are highly influence by the availability of increased funds, particularly at the end of a FY.

**Research Question 1:** Are ships with consistently high Figure of Merit scores across all mission area more likely to invest a similar amount in complementary FSG/FSC coded material as other ships with the same figure of merit scores? For example, are two ships of the same class with the same homeport and similar FPR employment spending certain amounts on Damage Control Equipment FSG 42 given their Training figure of merit scores for Damage Control Drills and Training figure of merit scores for other mission areas?

**Conclusions:** Average monthly MFOM and monthly TFOM scores do not indicate that there is any strong statistical relationship between these factors and monthly disbursements in FSG codes for Damage Control/Firefighting (FSG 42), Medical/Dental (FSG 65) and Paint & Brushes (FSG 80).

**Research Question 2:** Is there a range of spending that maintains Training Figure of Merit scores at 80 or greater, 90 or greater, etc.

**Conclusions:** Because the regression analysis yielded no statistically significant relationship, no appropriate range of spending could be determined. Disbursements appear to be more closely tied to increases in availably funds, especially at the end of a FY. Disbursements may also be driven by the shelf life of certain items, particularly AFFF and vaccines.

**Research Question 3:** Do demographics (i.e., class, homeport and FRP employment) contribute to the amount invested in particular FSG/FSC codes and/or do they contribute to the MFOM and TFOM scores?

**Conclusions:** Plots of monthly disbursements against ship's demographics do not produce any noticeable correlation. Additionally, the absence of any statistically significantly relationship between monthly disbursements and ship's demographics was confirmed though regression analysis.

**Research Question 4:** Are disbursements cyclical, or is there an increase in disbursements during the beginning, middle or end of a quarterly spending cycle?

**Conclusions:** Although there is an increase in disbursements in FSG codes for Damage Control/Firefighting (FSG 42), Medical/Dental (FSG 65) and Paint & Brushes (FSG 80) during the last month of a fiscal year, disbursements are not made in any monthly or quarterly cycle. Additionally, spending does not appear to follow any logical pattern according to inspection cycle or maintenance availability.

## B. RECOMMENDATIONS FOR FURTHER STUDY

This study did not find any statistically significant relationship between monthly disbursements in FSG codes for Damage Control/Firefighting (FSG 42), Medical/Dental (FSG 65) and Paint & Brushes (FSG 80). However, there are three recommendations for further study of annual disbursements made in consumable OPTAR.

First, it is recommended that disbursements made against non-NSN items be made the focus of further studies. These disbursements historically account for 55 percent of total annual disbursements. Particular attention should be given to credit card spending and items purchased against Navy Prime Vendor Contracts such as Medical/Dental items.

Second, it is recommended that a study be conducted between the relationships of availability of funding to the allocation of this funding. Disbursements in the top three FSG codes appear to be highly correlated to increases in available funding, particularly at the end of a FY. The loss of the COW supplemental should result in an increase of disbursements in these FSG codes during the last month of a FY.

Finally, it is recommended, that monthly spending be compared to the validity of a ship's phased replacement and unfunded listings. End of FY spending is normally earmarked for the purchase of phase/unfunded material, particularly Medical/Dental (FSG 65) Allowance Equipage List (AEL) items, Damage Control/Firefighting (FSG 42) and Safety (FSG 42) AEL items. If this is true, it is imperative that the right gear be purchased with these increased funds.

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# APPENDIX A. BACKGROUND AND FOUNDATION

## A. FLOW OF FUNDS

Figure 30 illustrates the flow of funds through Congress and the Department of Defense. After the Congress has appropriated funds and the President has signed the appropriation into law, funding is distributed to the Office of Management and Budget (OMB) via an appropriation warrant. OMB is responsible for regulating the expenditure rate and for assurance that public funds expenditures can be traced back to the appropriation and that it is within the dollar limitations in accordance with the appropriation bill. Generally, the annual funds will be apportioned by OMB on a quarterly basis.[6]

OMB then apportions funds to the various agencies (i.e., Assistant Secretary of the navy; financial management and Comptroller (ASN-FM&C) who then allocates these funds to the Responsible Officer (RO), which in this case is the Chief of Naval Operations (CNO). The CNO's Office then distributes these funds to the Navy's operating budget via an allotment. The Major Commands further subdivide the spending authority down to the end user level, in this case, CNSF. The CNSF Comptroller for moving money through the system, for example, to each CLASSRON who then adjudicates the distribution of these funds to the operational units under their control. It is important to note that the Major Command level is the last level to retain responsibility for compliance with the Anti-Deficiency Act (31 US Code 1517).

Beginning 1 October 2007, the funding for CNSF ships is adjudicated by their respective CLASSRONS. Previous to FY 07, adjudication was done at the TYCOM level. Each quarter, the CLASSRONs issue funds to each ship in the form of a quarterly grant. If additional funding is required during the quarter by a particular ship, that ship submits a request to its respective CLASSRON. Once the request is approved, the additional funds are provided in the form of a grant until a unit's annual forecasted

[6] Practical Financial Management; A Handbook for the Defense Department Financial Manager.

budget has been exhausted. After a vessel has exhausted its entire year's grants, additional funds are referred to as augments. At the end of the fiscal year, the comptroller may distribute additional funds that were originally obligated to other Fleet accounts (the fuels account) over the course of the year, or additional reimbursements from the Cost of War supplemental. Anti-Deficiency Act 1517 responsibility is retained at the Major Command level, which must ensure to sufficiently obligated funds to cover expected expenditures.

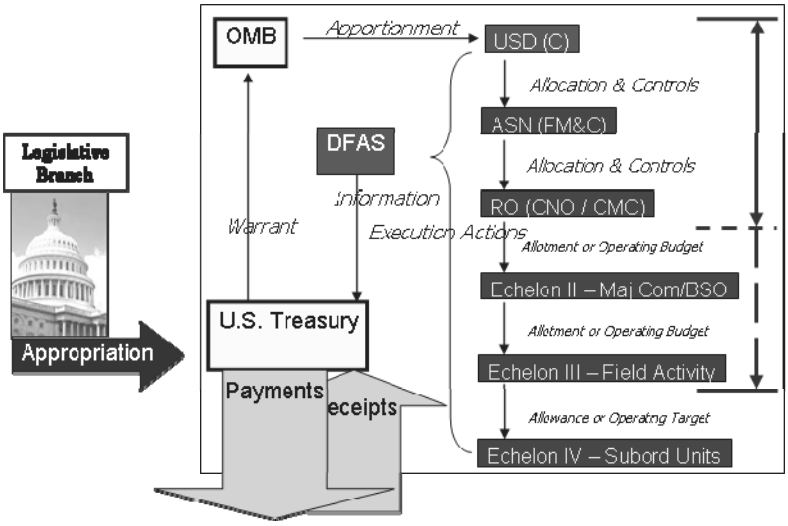


Figure 30. Flow of Funds from Congress through the Department of Defense. From: Practical Financial Management; A Handbook for the Defense Department Financial Manager

Obligations reduce funding from a ships account through a document number citing the appropriate line of account. However, it is an expenditure document that provides the historical amount spent on a specific requisition. Differences between total obligations and expenditures can occur for several reasons such as cancellations of an obligation before expenditure, or the expenditure can differ from the original obligation. These differences are accounted for and this information is provided to the ships in the form of a Summary Filled Order/Expenditure Difference Listing (SFOEDL) so that any

financial records for the current FY can be adjusted up or down. This financial data is stored in the Standardized Accounting & Reporting System – Field Level (STARS-FL).

## B. SHIP'S OPERATIONS MODEL AND COST OF WAR (COW)

Forecasting requirements for each fiscal year is accomplished through the Ship Operations Model which is managed by OPNAV N43. The model calculates an average obligation of the past three years of obligations by SIC code and by FRP cycle. This average is then used to forecast the next FY's requirements utilizing the next year's FRP cycle schedule obtained from the WebSked program. Each ship's monthly Fleet Response Plan employment is booked in WebSked and contains:

1) Each ship's monthly costs by SIC are then added to the FRP employment
2) Summarize the cost by number of FRP months and SIC
3) Summarize the costs by number of months and SIC
4) Allocate the SO TYCOM centrally funded value across the class
5) Summarize for a total class average per FRP Month

A drawback to this process is that requirements forecasting is made based upon the previous three years expenditures and that any reduction in funding will consequently result in lower and lower forecasted requirements which makes this a poor predictor of future requirements. A graphic illustration of the complexity of the Ship Operations Model is shown below in Figure 31.

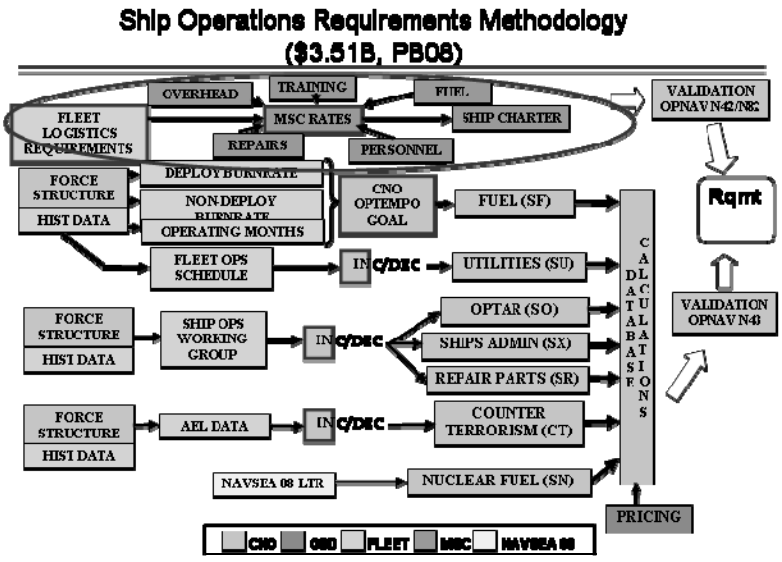


Figure 31. Methodology for the Ship Operations Requirements Model. From Deputy Comptroller CNSF Flow of Funds Brief 2008

A supplemental, such as the Cost of War supplemental, represents additional funding provided to the BSO by the Congress. The intent of a supplement is to fund a specific BSO for missions and operations conducted beyond its original tasking. These reimbursements are provided throughout the fiscal year and for the most part are transparent to the CLASSRON's and Operational Commands. The impacts of the loss of the COW supplemental are twofold:

- First, since the COW have historically represented 25% of the total annual expenditures and thus, a 25% reductions beginning FY09. Second, they have permitted funding of base requirements that were deferred earlier in the FY because of emergent mission requirements. Before COW supplemental, base requirements had been deferred in order to fund these increased mission requirements.

- For Amphibious Assault ship's, operational schedules and missions are expected to remain at current levels for the next few FYs. The impact of the loss of the COW supplemental is not only in the dollar value of funds lost, but that these funds are not included in the forecast of the next FY's requirement through the Ship Operations Model.

## C. SURFACE WARFARE ENTERPRISE

The Surface Warfare Enterprise (SWE) is an initiative that provides a common strategic vision for the Navy's Surface Fleet through the integration of all surface warfare stakeholders from the fleet, resource sponsors, and acquisition and maintenance communities. Established in November 2005, the SWE involves more than twenty flag officers and senior executives and consists of four cross functional teams: Sustainment and Modernization, Personnel Readiness, Strategic Financial Management, Over-Arching Metrics Team. The SWE is important to this study in that CNSF is the Chief Executive Officer for the enterprise as well as the Deputy Comptroller CNSF and Chief of Staff Afloat Training Group serving as key members in the cross functional teams.[7]

The focus of the Sustainment and Modernization team is enterprise-wide, end-to-end material, maintenance and modernization processes. Sustainment and Modernization team goals:

1) Achieve efficient and repeatable processes that enable continuous improvements
2) Enhance efficiencies in all sustainment and modernization processes
3) Absorb the SHIPMAIN program

The focus of the Personnel readiness Team (PRT) is to facilitate the integration of manpower initiatives with the Surface Force Total Force Strategy. Personnel readiness Team (PRT) goals:

1) Identify potential efficient gains in individual training
2) Supply Sailors ready to assume watch aboard ship

The focus of the Strategic Financial Management Team is to move the surface warfare stakeholders form a "consumption" mindset to an "output" mindset. The Strategic Financial Management Team goal is to:

1) Improve productivity to re-capitalize assets and help build tomorrow's fleet.

[7] *Surface Warfare Enterprise website* at www.swe.surfor.navy.mil [May 2008].

The overarching focus of the Metrics Team is to provide consistent, replicable, and integrated reports and forward-looking metrics across the first three cross-functional teams and present them in a standard format to support decision making by the SWE Board of Directors.

# APPENDIX B

Description of Each Training Figure of Merit (TFOM) Mission Areas Used in this Thesis.[8]

| | |
|---|---|
| Overall: | Aggregate of all Mission Areas (including weighted pillar scores) |
| AIR: | Aircraft Operations |
| AMW: | Amphibious Operations. e.g. Well Deck Operations, Flight Deck Operations, AAV Launch |
| ATFP: | Anti-Terrorism/Force Protection |
| AW: | Air Warfare |
| CCC: | Command, Control & Communication Drills. e.g. LINK 11, Flashing Light and Tactical Maneuver Drills |
| CRY: | Cryptology |
| EW: | Electronic Warfare Drill, Chaff and SLQ-32 |
| FSO-M: | Medical Emergency Drills |
| INT: | Intelligence Drills. e.g. Collection, Reporting, OPINTEL Plotting and Briefing, Area Threat Brief |
| MOB-D: | Damage Control Drills |
| MOB-E: | Engineering Casualty Control Drills |
| MOB-N: | Piloting and Navigation Drills |
| MOB-S: | Seamanship Drill. e.g. Astern Refueling, Moor to Buoy and Precision Anchoring |
| SAR | Search and Rescue |
| SW: | Surface Warfare |
| USW: | Undersea Warfare |
| VBSS: | Visit, Board, Search and Seizure |
| 3-M: | Preventative Maintenance Plan |

*Excludes Ballistic Missile Defense (BMD), Mine Warfare (MIW) and Cruise Missile (CM) Mission Areas. Amphibious Assault Ship's do not perform these missions.

[8] COMNAVSURFLANT/PACINST 3502.2E.

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# APPENDIX C

The Federal Supply Classification (FSC) is designed to permit the classification of all items of supply used by the Federal Government. Each item of supply will be included in one, and only one, FSC. The FSC is made up of 2 two digit numeric codes: the federal supply group and the federal supply class. The federal supply group identifies, by title, the commodity area covered by classes within the group. Each class covers a relatively homogeneous range of commodities. Federal supply groups and classes are defined in DLA Publication H-2. Federal supply groups are listed below:

| | | | |
|---|---|---|---|
| 10 | Weapons | 51 | Hand tools |
| 11 | Nuclear ordnance | 52 | Measuring tools |
| 12 | Fire control equipment | 53 | Hardware and abrasives |
| 13 | Ammunition and explosives | 54 | Prefabricated structures and scaffolding |
| 14 | Guided missiles | 55 | Lumber, millwork, plywood, and veneer |
| 15 | Aircraft and airframe structural components | 56 | Construction and building materials |
| 16 | Aircraft components and accessories | 57 | Unassigned |
| 17 | Aircraft launching, landing, and ground handling equipment | 58 | Communication, detection and coherent radiation equipment |
| 18 | Space vehicles | 59 | Electrical and electronic equipment components |
| 19 | Ships, small craft, pontoons, and floating docks | 60 | Fiber optics, materials and components |
| 20 | Ship and marine equipment | 61 | Electric wire, and power and distribution equipment |
| 21 | Unassigned | 62 | Lighting fixtures and lamps |
| 22 | Railway equipment | 63 | Alarm and signal security detection systems |
| 23 | Ground Effect vehicles, Motor vehicles, trailers, and cycles | 64 | Unassigned |
| 24 | Tractors | 65 | Medical, dental, and veterinary equipment and supplies |
| 25 | Vehicular equipment components | 66 | Instruments and laboratory equipment |
| 26 | Tires and tubes | 67 | Photographic equipment |
| 27 | Unassigned | 68 | Chemicals and chemical products |
| 28 | Engines, turbines, and components | 69 | Training aids and devices |
| 29 | Engine accessories | 70 | General purpose automatic data processing equipment (including firmware),software, supplies and support equipment |
| 30 | Mechanical power transmission equipment | 71 | Furniture |
| 31 | Bearings | 72 | Household and commercial furnishings and appliances |
| 32 | Woodworking machinery and equipment | 73 | Food preparation and serving equipment |
| 33 | Deleted | 74 | Office machines, data processing equipment and visible record equipment |
| 34 | Metalworking machinery | 75 | Office supplies and devices |
| 35 | Service and trade equipment | 76 | Books, maps, and other publications |
| 36 | Special industry machinery | 77 | Musical instruments, phonographs, and home-type radios |
| 37 | Agricultural machinery and equipment | 78 | Recreational and athletic equipment |
| 38 | Construction, mining, excavating, and highway maintenance equipment | 79 | Cleaning equipment and supplies |
| 39 | Materials handling equipment | 80 | Brushes, paints, sealers, and adhesives |
| 40 | Rope, cable, chain, and fittings | 81 | Containers, packaging, and packing supplies |
| 41 | Refrigeration, air conditioning and air circulating equipment | 82 | Unassigned |
| 42 | Fire fighting, rescue, and safety equipment | 83 | Textiles, leather, furs, apparel and shoe findings, tents and flags |
| 43 | Pumps and compressors | 84 | Clothing, individual equipment and insignia |
| 44 | Furnace, steam plant, and drying equipment, and nuclear reactors | 85 | Toiletries |
| 45 | Plumbing, heating, and sanitation equipment | 86 | Unassigned |
| 46 | Water purification and sewage treatment equipment | 87 | Agricultural supplies |
| 47 | Pipe, tubing, hose, and fittings | 88 | Live animals |
| 48 | Valves | 89 | Subsistence |
| 49 | Maintenance and repair shop equipment | 90 | Unassigned |
| 50 | Unassigned | 91 | Fuels, lubricants, oils, and waxes |
| | | 92 | Unassigned |
| | | 93 | Nonmetallic fabricated materials |
| | | 94 | Nonmetallic crude material |
| | | 95 | Metal bars, sheets, and shapes |
| | | 96 | Ores, minerals, and their primary products |
| | | 97 | Unassigned |
| | | 98 | Unassigned |
| | | 99 | Miscellaneous |

# LIST OF REFERENCES


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