A Linear Regression Model Identifying the Primary Factors Contributing to Maintenance Man Hours for the C-17 Globemaster III in the Air National Guard

GRADUATE RESEARCH PROJECT

James M. Nasman, Major, DCANG

AFIT/IMO/ENS/12-10

DEPARTMENT OF THE AIR FORCE

AIR UNIVERSITY

AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

AFIT/IMO/ENS/12-10

A LINEAR REGRESSION MODEL IDENTIFYING THE PRIMARY FACTORS CONTRIBUTING TO MAINTENANCE MAN HOURS FOR THE C-17 GLOBEMASTER III IN THE AIR NATIONAL GUARD

Presented to the Faculty

Department of Systems and Engineering Management

Graduate School of Engineering and Management

Air Force Institute of Technology

Air University

Air Education and Training Command

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Logistics

James M. Nasman, BBA, MS

Major, DCANG

June 2012

AFIT/IMO/ENS/12-10

A LINEAR REGRESSION MODEL IDENTIFYING THE PRIMARY FACTORS CONTRIBUTING TO MAINTENANCE MAN HOURS FOR THE C-17 GLOBEMASTER III IN THE AIR NATIONAL GUARD

James M. Nasman, BBA, MS

Major, DCANG

Approved:

//SIGNED/18 April 2012//

Lt Col Shay R. Capehart, PhD (Advisor)

AFIT/IMO/ENS/12-10

Abstract

The purpose of this research was to identify the primary correlating factors contributing to the amount of Maintenance Man Hours expended on maintaining the C-17 Globemaster III aircraft in the Air National Guard. The research question was answered through the use of statistical analysis comprised of multivariate linear regression modeling.

A literature review was performed with limited results as, though there is literature available that addresses linear regression modeling and the use of various metrics, there is no documentation that the researcher is aware of specific to the use of linear regression in this specific manner.

The results of the regression model showed that five independent variables were significant in predicting the number of Maintenance Man Hours that would be expended on the aircraft. These variables included four assigned versus authorized Air Force Specialty Code ratios and the Utilization rate of the individual aircraft.

To My Dearest Family,

Whose Love And Support Made This Possible

Acknowledgments

I would like to express my sincere appreciation to my research advisor, Lt Col Shay Capehart, for his guidance and support throughout the course of this Graduate Research Project effort. His advice, input and guidance were much appreciated. I would also like to thank my sponsor, Capt Mike Ogle, Director of Air National Guard Readiness Center A4 for his unwavering support and the access he provided me to his professional staff whose contributions to this effort were invaluable.

A very special thanks to Mr. Jim Guevara (ANGRC A1), Mr. Dennis Murray (ANGRC A4) and MSgt Brian Whitt (166 MOF, Delaware ANG) for their absolutely vital contributions to this project.

James M. Nasman

Table of Contents

List of Figures

Figure Page

List of Tables

I. Introduction

Background

Since its formal creation by the Militia Act of 1903 the United States National Guard has played an integral and vital role in the Nation's defense and supporting our national interests. The Air National Guard (ANG) came into being at essentially the same time as the creation of the regular Air Force from the Army Air Corps on September 18, 1947. As a part of the Reserve Component of the Air Force, the Air National Guard has continued this great tradition of supporting our regular forces in the defense of our freedoms and national interests. The critical role that the ANG plays becomes much more evident by the fact that over 60 percent of our nation's organic air lift capacity resides within the Reserve Component – the Air National Guard and the Air Force Reserve. The ANG provides the vast majority of this capability (Testimony, 03/21/96, GAO/T-NSIAD-96-130).

The Air National Guard air mobility capability is comprised of Airlift and Air Refueling Wings utilizing C-5, C-17, C-130, KC-10, and KC-135 aircraft in 54 U.S. states and territories. The primary mission of these units is to train during peacetime for both State and Federal missions.

The Guard is a unique animal in that Guardsmen are "dual-hatted", meaning that they typically have two potential roles to play in times of peace and war. The Guard falls under U.S. Title 32, which essentially means that Guardsmen serve at the pleasure of their respective State governors, not the President, unless activated into Title 10 status by Federal authority. This can be and, as we have seen in recent history, is often done by the President to supplement regular forces in time of war or national distress. When this is done, Guardsmen essentially become subject to all of the rules and regulations governing regular forces.

One of the key differences between regular and Guard forces is the stability and experience levels of the members. Guardsmen have an average longevity and experience level of 15 years as compared with 7 years for the average active duty airman (Options for Meeting the Maintenance Demands of Active Associate Flying Units, Rand Corp, 2008). It is also typical for E-7 personnel to be physically engaged in “wrench turning” rather than purely supervisory duties as is the case in the Regular forces. Many Guardsmen will also spend their entire careers in a single location, perhaps working on a single Mission Designed Series (MDS). (Howe, Theole, Pendley, Antoline, Golden, Air Force Journal of Logistics, vol. XXX1, number 4). This stability promotes an incredible amount of depth and experience in the typical Guardsman.

The C-17 Globemaster III was first introduced to the Air Force in 1993 and the first squadron became operational in 1995. The first ANG C-17’s were delivered to the 172nd Airwing in Jackson, Mississippi around the same time frame (C-17 Globemaster Fact Sheet, www.af.mil).

Currently the C-17 is operated by the Air Mobility Command at the 60th Airlift Wing and the 349th Air Mobility Wing (Associate Reserve) at Travis AFB, Calif.; 436th AW and 512th AW (Associate Reserve) at Dover AFB, Del.; 62nd AW and 446th AW (Associate Reserve) at McChord AFB, Wash.; 437th Airlift Wing and 315th AW

(Associate Reserve) at Charleston AFB, S.C.; the 305th AMW, McGuire AFB, N.J.; and the 172nd AW, Mississippi ANG. Additionally, Air Force Materiel Command operates two C-17s at Edwards AFB, Calif., and Pacific Air Forces operates eight aircraft each at Elmendorf AFB, Alaska and Hickam AFB, Hawaii (Associate Guard). The Air Force Reserve Command operates eight aircraft at March Air Reserve Base, Calif; and Air Education and Training Command has 12 aircraft at Altus AFB, Okla. (C-17 Globemaster Fact Sheet, www.af.mil)

Because of the sheer volume of capability that the Reserve Component brings to the fight, any perceived threat to that capability must be regarded with the most intense scrutiny. The purpose of this paper is to analyze the factors contributing to the number of maintenance man hours it takes to return a C-17 aircraft to an available status. This analysis is important because if the main factors that correlate to the number of man hours it takes to keep an aircraft flying can be identified, steps can more easily be taken to address those factors.

Problem Statement

The goal of any aircraft maintenance organization is to keep or return the aircraft it is responsible for to full operational capability so that those aircraft can accomplish the mission for which they were designed. The maintenance organizations within the United States Air National Guard are no different. This paper will attempt to identify the correlating factors contributing to the man hours required to return the C-17 aircraft to an available status.

According to the Air National Guard Readiness Center A4, there has been an expectation that as airframes mature the time to accomplish maintenance actions should decrease. This is due, largely in part, to the assumption that as maintenance personnel become more familiar with the airframe they will overcome the "learning curve" inherent with learning any new process. Unfortunately, preliminary data collected from a study done at Stewart Air National Guard Base does not support this assumption. As a result Air National Guard (ANG) leadership would like to indentify the factors that have resulted in this apparent contradiction to "common wisdom".

The desire to identify and understand these causal factors is readily understandable. Increased maintenance man hours can easily translate into increased downtime and unavailability of aircraft. Readiness levels of individual squadrons, the Air National Guard and the Air Force as a whole are adversely impacted, especially when one considers that 45% of the Air Force's organic strategic lift capability resides within the Air National Guard.

Research Question

This paper's main focus is to answer the Research Question, "What are the primary factors contributing to the man hours required to repair specific Work Unit Codes on the C-17 aircraft?"

Investigative Question

In order to properly direct the research and answer the research questions, the following investigative question will be explored.

1. What does a Multivariable Linear Regression Analysis of the following factors show regarding their correlation to the average Maintenance Man Hours required to repair the "top 25" WUC's?

a. Age of aircraft

c. Percentage of personnel assigned vs authorized for multiple maintenance Air Force Specialty Codes (AFSC's)

d. Usage Rate of aircraft

Scope

The scope of this paper is limited to observations of the aforementioned airframes within the Air National Guard. Observations were conducted on the C-17 airframe to identify factors that correlate to the Maintenance Man Hours expended to return aircraft to flight status.

Methodology

The research methodology employed in the writing of this paper consists of the collection and statistical analysis of data streams from the LIMS-EV database. These data are drawn from the Integrated Maintenance Data System (IMDS) and are representative of the Investigative Question listed above.

These data will be quantitatively analyzed through statistical means, specifically the formulation of a linear regression model to determine the correlating factors involved in predicting the Maintenance Man Hours (MMH) required to perform the most common maintenance actions on the C-17. The most common maintenance actions are defined as the “Top 25” drivers of maintenance as a function of total man hours invested in maintenance.

This statistical analysis will be accomplished using data taken from the last seven years of airframe service in the Air National Guard (2005 – 2011).

Assumptions and Limitations

This paper assumes the following:

A. The airframe discussed (C-17) will remain in the Air National Guard inventory and continue to be utilized in its current manner.

B. The Air National Guard will continue to use “Blue Suit” Maintenance to maintain these aircraft.

C. The Air National Guard manpower construct and policy will remain consistent.

D. The data collected from all sources is accurate and relevant to the Research Problem.

The research conducted in this study will be limited by the availability of the requisite data, the tools currently available to analyze it and the time allotted to the author to conduct the actual research.

Implications

The implications of this research to the Air National Guard and the Air Force as a whole are significant. The identification of factors that may be causal to increasing, or conversely decreasing, the number of man hours required to return an aircraft to service may pay significant dividends. This information could serve to more closely link adequate manning in specific maintenance areas, use rates and other factors to overall mission productivity.

II. Literature Review

The literature on this topic is sketchy at best. In fact, the author has been unable to find any literature specifically addressing this question. Most published articles related to this topic are framed around the use of metrics and the C-5 airframe.

AFLMA Total Non-Mission Capable Study

This research on the C-5 was conducted by the Air Force Logistics Management Agency (AFLMA) and was essentially a three part study related to Total Non-Mission Capable Maintenance (TNMCM) rates. Part I relates to TNMCM and unit manning level, Part II with the misalignment of the two metrics of Home Station Logistics Departure Reliability (HSLDR) and TNMCM, and Part III addresses the inconsistencies non-standardization present within the Air Force when applying TNMCM rates to individual units. In Part I of this study AFLMA developed a new metric, labeled "Net Effective Personnel" (NEP) to quantify how many "net" maintenance personnel a unit had on hand when taking into account the various non-hands-on maintenance demands placed upon those personnel.

This metric has the potential to be a valuable tool when and if it is utilized by the A1 to determine unit manning needs for a given historical workload. And it does address, at least partially, the manning aspect of this paper.

AFSO 21

Also addressed in the literature review were AFSO21 initiatives conducted by Air Force units. While AFSO21 does not have an immediate bearing upon the topic of this paper, it is important to note that Constant Process Improvement (CPI) efforts can have significant impact upon reducing required man hours for a variety of processes, including maintenance, when applied correctly.

Rand Studies

An additional study conducted by Rand Corporation related to Associate Units – units comprised of both active duty and reserve/Guard components – gave further insight into the differences inherent in the manning structures and experience levels of personnel in the different organizations.

A separate paper written for Rand by Matthew C. Dixon focuses on the maintenance costs of aging aircraft in the civilian world and its applicability to the military. Aircraft between 0 -20 years of age were studied.

The paper stipulates that maintenance costs in the civilian sector, as validated by research on Boeing fleets of aircraft, increase for aircraft between 6-12 years of age. This is mainly due to them transitioning out of their warranty periods and costs transferring to the owners, not as a result of increased maintenance requirements.

The study found that maintenance costs for the aircraft studied plateaued after the 12 year mark. It is difficult to determine whether this effect is likely to be mirrored in the Air Force due to the different mission sets and stresses placed upon military aircraft as opposed to the civilian sector.

The Usefulness of Linear Regression

Articles related to the usefulness of linear regression modeling were reviewed as well as a congressional report related to the future military airlift mission of the C-17. This literature gave perspective on the necessity and appropriateness of this research and the tools being used to quantify the solution.

The academic textbook supplied for the statistics course was of great help in the actual accomplishment of the Linear Regression. This procedure will be discussed in depth in the Methodology portion of this paper.

The Effect of Aircraft Age on Maintenance

A paper commissioned by the Center for Naval Analyses (CAN) that studied the effects of age and several other factors on naval aircraft, predominantly the F/A-18C, proved insightful. This study used a quite large data set, on the order of approximately 27,000 observations, over a period of 10 years. The study confirmed that age (and several other factors including deployments, etc.) has a statistically significant effect on the maintenance effort required. According to this paper the following was the average percentage increase in cost per year:

Organizational and Intermediate Spares – 4.38%

Aviation Depot Level Repairables – 5.3%

Scheduled Depot Level Maintenance – 7.94%

Petroleum, Oils, and Lubricants - .59%

Organizational and Intermediate Level Labor – 4.17%

This study, while not exhaustive, certainly provides further evidence to substantiate the claim that an airframe's age does contribute to the cost required to maintain that aircraft.

III. Methodology

Overview

This research project incorporates a multivariate linear regression analysis of maintenance data pertinent to the research question stated previously. The purpose of conducting linear regression is to construct a model, more commonly referred to as a regression equation, which will serve as a predictor of a given output. This equation is comprised of one or more inputs in the form $\hat{y} = \beta_0 + \beta x_1 + \ldots \beta x_i$ with β_o comprising a calculated regression constant, the x's comprising the input factors or variables, and the β's comprising the calculated regression coefficients.

The process of developing a regression model consists of five steps:

Step 1 – Hypothesizing the deterministic component of the model that relates the expected value of '*y*' to the independent variable(s) 'x_{1-n}'.

Step 2 – Use sample data to estimate unknown parameters in the model

Step 3 – Specify the probability distribution of the random error term and estimate the standard deviation.

Step 4 – Check that the assumptions on ε are satisfied and make model modifications as necessary.

Step 5 – Statistically evaluate the usefulness of the model

Step 6 – When satisfied that the model is useful, use it for prediction and estimation (Benson, McClave, Sincich, 2011).

Data Collection

Any analysis involves the collection of data. The data for this regression consists of the following subsets:

1. Maintenance Man Hours expended on “Top 25” maintenance drivers.

2. Age – the physical age of the airframes examined in the regression

3. USE Rate – defined as the number of hours flown divided by the number of Primary Assigned Aircraft (PAA) over a given time period.

4. Maintenance Specific AFSCs as outlined in Table 1 below.

Table 1. Maintenance AFSCs

2A0X1	Avionics Test Station and Components
2A3X3	Tactical Aircraft Maintenance
2A390	Quality Assurance Chief Inspector
2A5X1	Aerospace Maintenance
2A6X1	Aerospace Propulsion
2A6X2	Aerospace Ground Equipment
2A6X3	Aircrew Egress Systems
2A6X4	Aircraft Fuel Systems
2A6X5	Aircraft Hydraulic Systems
2A6X6	Aircraft Electrical and Environmental Systems
2A7X1	Aircraft Metals Technology
2A7X2	Nondestructive Inspection
2A7X3	Aircraft Structural Maintenance
2A7X4	Survival Equipment

The data was collected with the assistance of Maintenance Data Analysts and Personnel Specialists in the A4 and A1 Divisions, respectively, of the Air National Guard Readiness Center at Joint Base Andrews in Maryland. The data was collected from the Logistics Installations and Mission Support – Enterprise View (LIMS-EV) data base and Air National Guard Readiness Center Manning Data. The LIMS-EV data base is fed by a number of different sources. Among them is the Integrated Maintenance Data System

(IMDS) which is the central Air Force system for all maintenance actions. The Maintenance Man Hours portion of the data set was drawn from this source. The data set itself may be referenced in tabular form in Appendix A.

The data used in this analysis was drawn from maintenance performed over a seven year period from 2005 to 2011 on the eight C-17 aircraft assigned to the 172nd Airlift Wing of the Mississippi Air National Guard based in Jackson, Mississippi. The final compilation of pertinent data drawn from the data sets consists of n=60 separate observations.

The maintenance data consists of the man hours expended on the “Top 25” maintenance drivers for the air wing. The “Top 25” are those maintenance Work Unit Codes (WUCs) that the majority of the unit’s maintenance man hours are dedicated to repairing. This data is represented in the regression equation as the dependent variable. In other words, it is the output factor that is affected by the input factors.

The physical age of the aircraft was taken into consideration in an effort to see if this had any bearing on the research question. Unfortunately, the aircraft are all of a similar age and so it is unlikely that this factor played any significant differentiating role. That appears to be the case as will be seen in the final regression equation.

USE rate was a logical choice for evaluation as it would be beneficial for the purposes of this study to see if the rate at which an aircraft is utilized has an effect upon how much maintenance is performed on it.

Also used in the analysis is personnel data from the 172nd ALW, to wit a listing of authorized AFSC billets versus assigned personnel. The purpose of collecting the personnel data was to attempt to find a correlation between the number of Maintenance Man Hours expended and the ratio of personnel authorized for a specific AFSC and skill level and the number actually assigned to the unit. This data may also be referenced in Appendix A.

IV. Results and Analysis

The following chapter will follow the previously listed six step method for constructing a valid multivariate regression model. The results of each step are contained within the subheadings for each.

Step 1 - Formulating the Hypothesis

Formulation of the hypothesis for this regression model stemmed from the research question posed earlier. The hypotheses in this case would essentially state the following:

Null Hypothesis - Ho: There is no correlation between any of the following factors – age, USE rate, or assigned vs authorized ratios for maintenance AFSCs - and the number of Maintenance Man Hours required to repair the “Top 25” maintenance drivers for the specified aircraft.

Alternate Hypothesis – Ha: There is a correlation between one or more of the following factors - age, USE rate, or assigned vs authorized ratios for maintenance AFSCs - and the number of Maintenance Man Hours required to repair the “Top 25” maintenance drivers for the specified aircraft.

Step 2 - Parameter Estimation

Estimation of the parameters for the regression equation was accomplished with the use of IBM SPSS software. This software is a package of statistical analysis tools that greatly enhances the speed and ease with which one can create regression models and equations.

The process by which the regression model specified in this paper was constructed involved entering the pertinent data collected for analysis into the software package and allowing the software to run the regression calculations.

The calculations which the software goes through produces what is known as a "Least Squares Line". This is an equation in the form, $\hat{y} = \beta_0 + \beta x_1 + \ldots \beta x_i$. This equation is derived from the data points entered into the software and serves as a model to predict what the output (y) will be for given inputs (x's). This equation has two significant properties.

First, as the equation represents a function that *estimates* values, the actual values will be either above or below the Least Squares Line. The sum of these predictive errors will be equal to zero. This is essentially the definition of a "best fit" regression line.

Second, the sum of the squared errors (SSE) is smaller for this line than any other straight line model (Benson, McClave, Sincich, 2011).

There are three distinct ways in which one can perform stepwise multivariable linear regression such as the one accomplished in this study. They are Forward, Backward and Mixed Stepwise Regression.

Forward Regression adds one variable at a time to the model and accepts or rejects the variable as significant based upon criteria set by the modeler. This is typically a p-value parameter. The resulting model is comprised of those factors that have the most impact to the predictive equation.

Backward Regression starts with a full model, in other words with all of the possible variables in the model, and discards those that are progressively less useful in the prediction of the dependent variable. Again, using parameters set by the modeler.

Mixed Regression is essentially a combination of the two previous methods discussed. It “steps” forward and backward through the regression process until it arrives at an optimal solution (Stockburger, 2012).

The regression equation resulting from this analysis is as follows:

MMH = 19540.893 – 18487.684(2A652) + 17.418(USE rate) – 5280.275(2A654) – 1939.487(2A390) + 2756.975(2A653)

The most notable feature of this equation is the fact that three of the four AFSCs identified in the equation are negative values. The significance and possible reasons for this condition will be discussed in the discussion portion of this paper.

Step 3 – Specify the Probability Distribution of the Random Error Term and Estimate the Standard Deviation

The prime indicator of the potential usefulness of a regression model is the measure of Multiple Coefficient of Determination, or R^2. R^2 is represented in the regression data as a number between zero and one and is defined as the ratio of explained variability to total variability in the data. It is an indication of how much of the variation in the data can be accounted for in the regression model. In short, the closer the R^2 value is to one, the better the model fits the data. R^2 can also be interpreted as how accurate the model should be at predicting values of the dependent variable if the data set contains a significantly larger sample size than the number of variables being evaluated.

Typically researchers will use an adjusted R^2 value rather than the R^2 value itself. This adjusted value is typically more conservative than the unadjusted value and is used to compensate for data sets in which there may be a small sample size relative to the number of variables being evaluated (Benson, et al, 2011).

For this analysis a stepwise regression was performed with a resultant adjusted R^2 of .81 (Figure 1). While initially this would seem to be an excellent result, this value must be taken with the proverbial “grain of salt”. The data set utilized consisted of n=60 separate observations, but a total of 36 separate variables were evaluated. This is a large amount of variable input for the total number of observations. The result is promising, but caution is still advised when interpreting the significance of the R^2 value in these types of scenarios.

Model Summary[h]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.711[a]	.506	.497	614.4521355
2	.815[b]	.664	.653	510.6704276
3	.860[c]	.740	.726	453.7980291
4	.889[d]	.789	.774	411.7582115
5	.898[e]	.806	.788	398.5964298
6	.909[f]	.826	.807	380.9706016
7	.909[g]	.826	.810	377.6164140

Figure 1. SPSS Model Summary

The data analysis also includes an Analysis of Variance (ANOVA) F-test to test the usefulness of the model. The F-test is a hypothesis test that tests the following null and alternate hypotheses:

Ho: $\boldsymbol{\beta_1 = \beta_2 = \ldots \beta_k = 0}$

Ha: At least one of the coefficients is nonzero.

"…the F-statistic is the ratio of the explained variability divided by the model degrees of freedom to the unexplained variability divided by the error degrees of freedom. Thus, the larger the proportion of the total variability accounted for by the model, the larger the F-statistic." (Benson, et al, 2011)

The F-statistic for this regression was calculated as 51.315 with a significance (p-value) of ~.000 indicating that the model explains a high degree of the variability inherent in the data (Figure 2).

ANOVA[h]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.239E7	1	2.239E7	59.299	.000[a]
	Residual	2.190E7	58	377551.427		
	Total	4.429E7	59			
2	Regression	2.942E7	2	1.471E7	56.410	.000[b]
	Residual	1.486E7	57	260784.286		
	Total	4.429E7	59			
3	Regression	3.275E7	3	1.092E7	53.017	.000[c]
	Residual	1.153E7	56	205932.651		
	Total	4.429E7	59			
4	Regression	3.496E7	4	8740320.329	51.552	.000[d]
	Residual	9324965.359	55	169544.825		
	Total	4.429E7	59			
5	Regression	3.571E7	5	7141354.906	44.948	.000[e]
	Residual	8579472.146	54	158879.114		
	Total	4.429E7	59			
6	Regression	3.659E7	6	6098983.485	42.022	.000[f]
	Residual	7692345.761	53	145138.599		
	Total	4.429E7	59			
7	Regression	3.659E7	5	7317232.449	51.315	.000[g]
	Residual	7700084.429	54	142594.156		
	Total	4.429E7	59			

Figure 2. SPSS ANOVA Analysis

Step 4 – Check that the Assumptions on 'ε' are Satisfied and Make Model Modifications as Necessary

There are four assumptions for ε that must be satisfied in order for the regression model to be valid. These assumptions are:

1. The mean of the probability distribution of ε = 0.

2. The variance of the probability distribution of ε is constant

3. The probability distribution of ε is normal

4. The values of ε associated with any two observed values of ‘y’ are independent.

These assumptions can best be addressed graphically. The first two assumptions are addressed by scatter plots showing that the distribution of ε for each variable exhibits no discernable pattern, such as cones, parabolas, etc., about the zero line. These scatter plots can be seen as Figures 3 through 8 below. The SPSS residuals statistics showing the residual mean of zero are also provided in Figure 9.

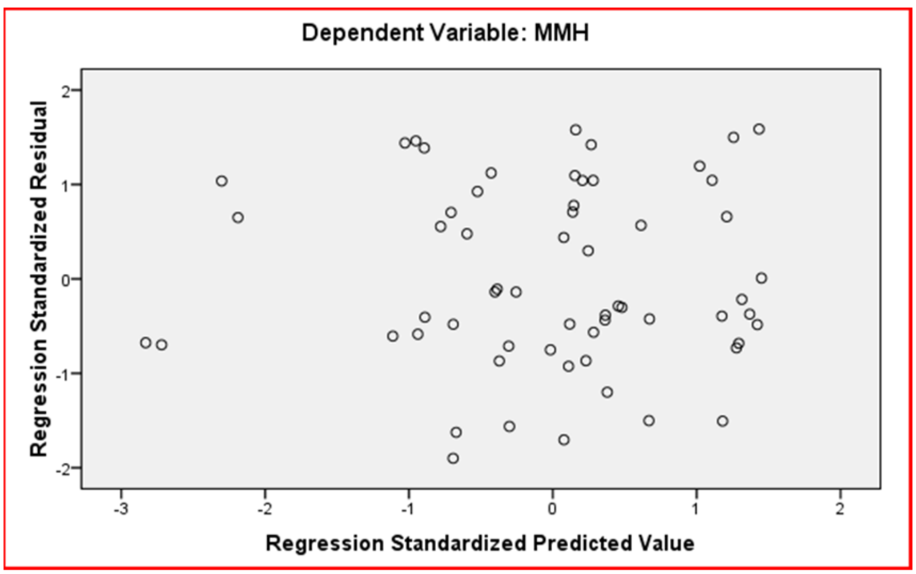


Figure 3. Residual Predicted vs Standardized Values

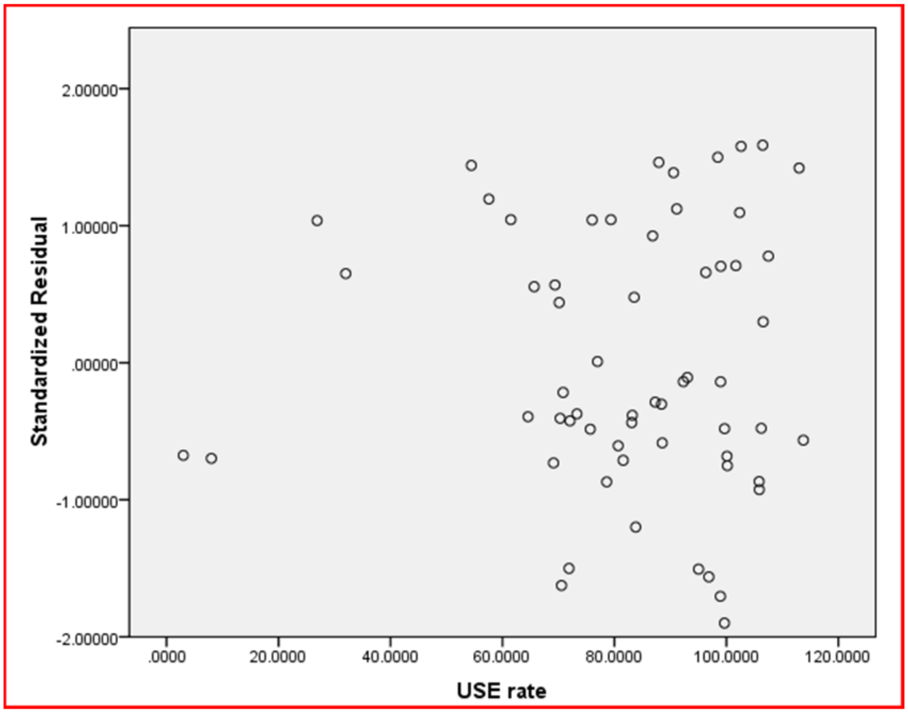


Figure 4. USE Rate and Standardized Residual Scatter Plot

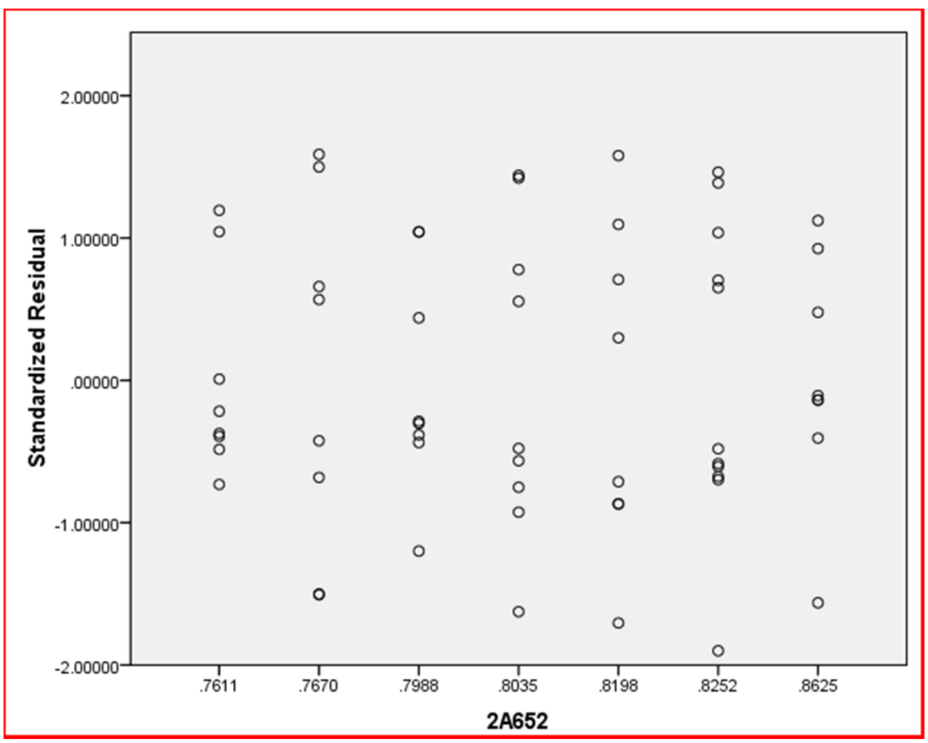


Figure 5. AFSC 2A652 and Standardized Residual Scatter Plot

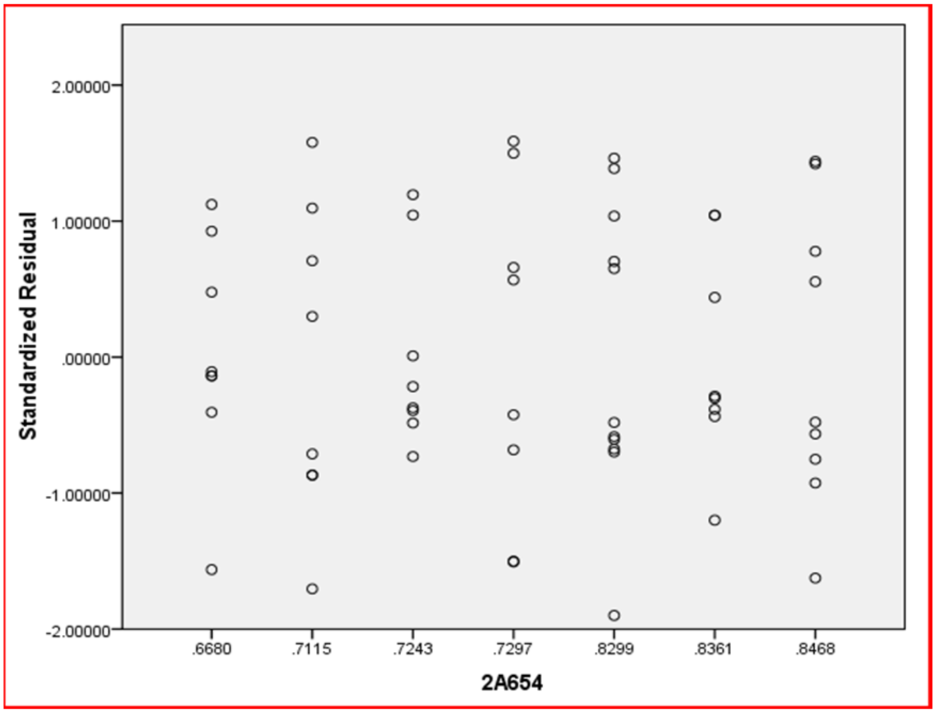


Figure 6. AFSC 2A654 and Standardized Residual Scatter Plot

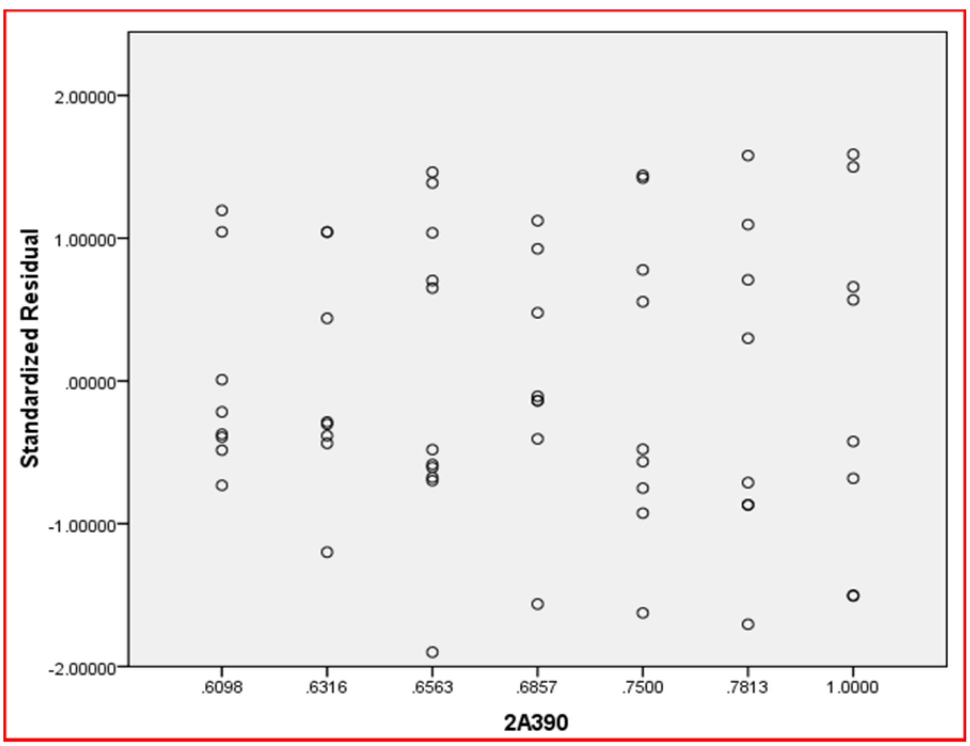


Figure 7. AFSC 2A390 and Standardized Residual Scatter Plot

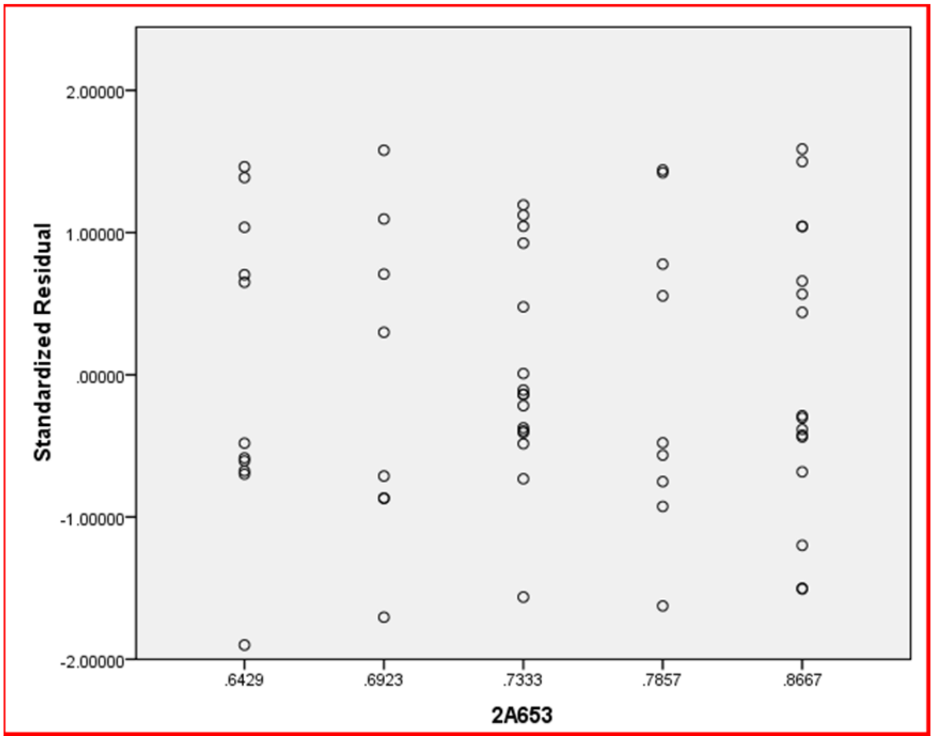


Figure 8. AFSC 2A653 and Standardized Residual Scatter Plot

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	455.158173	3825.964355	2684.010000	787.4671071	60
Residual	-717.4897461	599.2650757	.0000000	361.2615473	60
Std. Predicted Value	-2.830	1.450	.000	1.000	60
Std. Residual	-1.900	1.587	.000	.957	60

a. Dependent Variable: MMH

Figure 9. SPSS Regression Statistics

Assumption 3 is addressed with the histogram shown in Figure 10. This chart shows the approximately normal distribution of ε.

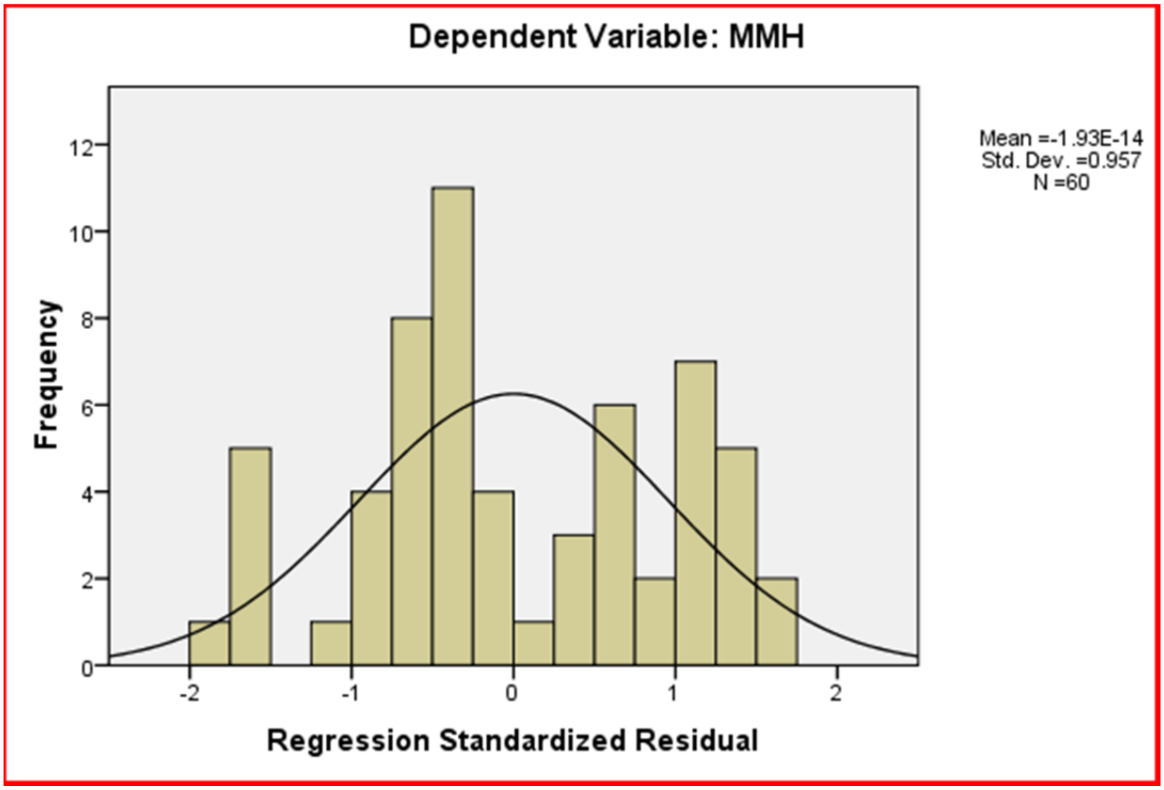


Figure 10. Histogram of ε Normal Distribution

The final assumption, Assumption 4, is addressed in Figure 11 with a graphic charting the standardized residuals against the flow of time. In this case they are plotted against each of the seven years the data was collected. Again, there is no discernable pattern that would indicate that the distribution of ε is nonrandom or nonnormal.

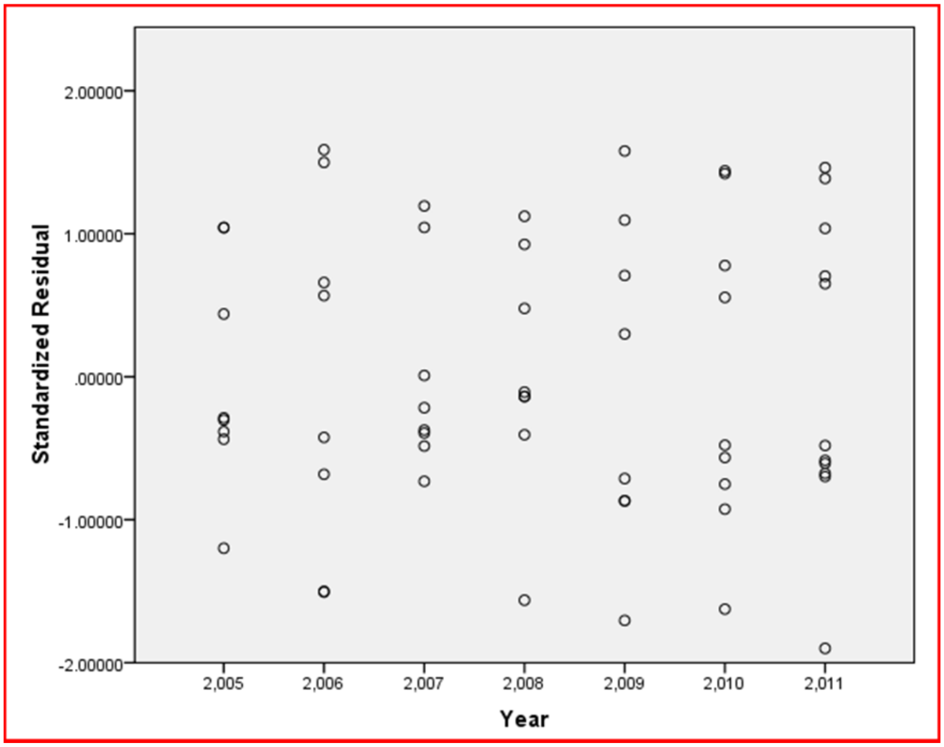


Figure 11. Standardized Residuals by Year

Step 5 – Statistically evaluate the usefulness of the model

The statistical usefulness of the model is an indication of whether the independent variables truly affect the dependent variable. In other words, is there a linear relationship between the dependent and independent variables? This is shown by conducting a t-test to test null and alternative hypotheses for each of the individual variables (Benson, et al, 2011). The hypotheses are as follows:

$$\textbf{Ho: } \beta_1 = 0$$

$$\textbf{Ha: } \beta_1 \neq 0$$

The resulting t-statistics and the corresponding p-values (p-values < .05 indicate statistical significance) from the SPSS analysis are shown in Figure 12. All variables are shown to have p-values (Sig column) less than .05. This result leads to the rejection of the null hypothesis and the conclusion that there is a linear relationship between each independent variable and the dependent variable.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
7	(Constant)	19540.893	1980.225		9.868	.000	15570.781	23511.005
	2A652	-18487.684	1849.330	-.680	-9.997	.000	-22195.367	-14780.000
	USE rate	17.418	2.324	.462	7.494	.000	12.758	22.078
	2A654	-5280.275	780.444	-.411	-6.766	.000	-6844.972	-3715.578
	2A390	-1939.487	486.683	-.273	-3.985	.000	-2915.227	-963.746
	2A653	2756.975	769.494	.257	3.583	.001	1214.234	4299.717

Figure 12. SPSS T-statistic Output

Step 6 – When satisfied that the model is useful, use it for prediction and estimation

This step will necessarily only be completed at the discretion of those persons responsible for the execution of the applicable programs in the Air National Guard and/or Air Force. While the model has proven statistically significant, there are many other considerations inherent in the decision making process for establishing how a unit will be manned and what the utilization of its aircraft will be. This model simply serves as another tool that a decision maker can use to enable them to make an informed decision.

Notes on Common Pitfalls

Care was taken during this analysis to watch for and avoid the common pitfalls of Estimability, Multicolinearity and Extrapolation (Benson, et al, 2011).

Problems with estimability occur when the parameters of the model cannot be estimated due to concentration of the parameter data around a single point. An example is a consistently recurring value for an independent variable. An infinite number of lines can be drawn through a single point, thus it would be impossible to establish a single regression line in the presence of such a condition.

Multicollinearity exists when two or more independent variables are correlated with each other. An indication of this condition is when the t-statistic for individual parameters is non-significant, yet the F-statistic for overall model adequacy is significant and the signs of the estimates (β coefficients) are the opposite of what is expected.

As has already been shown, all the parameter t-statistics are significant and the F-statistic for overall model adequacy is also significant for this model. A Pearson Correlation Matrix is included in Appendix A which details the correlations of the individual variables with each other in a one to one relationship.

Variance Inflation Factor (VIF) analysis was also conducted to further examine the individual variables for multicollinearity and to rule out any correlation between the independent variables that could affect the accuracy of the model.

VIF determines if the variances of the estimated coefficients in the regression model are inflated due to multicollinearity. This effect is explained by the following excerpt from Dr. Laura Simon's Penn State lecture:

Let's consider such a model with correlated predictors:

$$y_i = \beta_0 + \beta_1 x_{i1} + \cdots + \beta_k x_{ik} + \cdots + \beta_{p-1} x_{i,p-1} + \varepsilon_i$$

Now, again, if some of the predictors are correlated with the predictor x_k, then the variance of b_k is inflated. It can be shown that the variance of b_k is:

$$Var(b_k) = \frac{\sigma^2}{\sum_{i=1}^{n}(x_{ik} - \bar{x}_k)^2} \times \frac{1}{1 - R_k^2}$$

where R_k^2 is the R^2-value obtained by regressing the k^{th} predictor on the remaining predictors. Of course, the greater the linear dependence among the predictor x_k and the other predictors, the larger the R_k^2 value. And, as the above formula suggests, the larger the R_k^2 value, the larger the variance of b_k (Simon, 2004).

The VIF itself is comprised of the last portion of the equation:

$$\frac{1}{1 - R_k^2}$$

According to Dr. Simon, VIF values in excess of 4 warrant further investigation and values in excess of 10 are signs of serious multicollinearity (Simon, 2004). Table 2 lists the Variation Inflation Factors for each independent variable (predictor) as regressed against all of the other independent variables in the model. The highest VIF shown is

1.6, therefore there are no indications of multicollinearity in this model that require further attention.

Independent Variable	Variance Inflation Factor
USE Rate	1.182
2A390	1.456
2A652	1.439
2A653	1.6
2A654	1.143

Table 2.

Extrapolation occurs when the model is used to predict values beyond the scope of the data set used to construct the model. This type of error is not applicable to this study.

V. Discussion

Interpreting the Model

This study resulted in a multivariate regression model:

MMH = 19540.893 – 18487.684(2A652) + 17.418(USE rate) – 5280.275(2A654) – 1939.487(2A390) + 2756.975(2A653)

The literal interpretation of the model is that we can expect for every one percent increase in the manning level of 5-level Aerospace Ground Equipment (AGE) personnel (2A652) we will see a decrease in Maintenance Man Hours of approximately 185 hours over the course of a year. The calculation is similar for the other AFSCs included in the equation. MMH would drop by approximately 53 hours for each additional percent increase in 5-level Fuel Systems personnel (2A654), 19 hours for Quality Inspection Chief (2A390) and would actually increase by 27 and a half hours for each percentage increase in 5-level Aircrew Egress personnel.

The model also predicts an increase of just over 17 man hours per year for each point that the USE rate increases. It is important to note that the USE rate coefficient is not divided by 100 as the USE rate in the data set is expressed as a number representing the ratio of flight hours to Primary Assigned Aircraft (PAA) and not a percentage as are the AFSC figures.

Expectations

This model exhibits features that were generally expected with one aspect that may was a bit of a surprise. The features expected in the model are those that exhibit what one would perceive as "sensical" or logical results. For instance, the model predicts an increase in Maintenance Man Hours as the USE Rate of the aircraft increases. This is logical as the USE rate is a ratio that expresses how much an aircraft is flying. One would logically expect that the more an aircraft flies, the more maintenance will be required. No surprise there.

Similarly, we would expect to see a decrease in the number of man hours required as the level of manning in critical areas increased. This relationship is evident in the majority of the AFSC relationships expressed in the model above. The singular surprise was the positive relationship between the 5-level Aircrew Egress AFSC (2A653) and MMH expended. It is uncertain why this relationship exists. As has already been shown, there is no evidence of multicollinearity between the independent variables that could lead the model to assign the opposite sign than one would expect to a variable.

There is not enough data to make any conclusions regarding this portion of the model, so the author will refrain from doing so.

Significance of the Model

Statisticians (and economists, it seems) are fond of using the expression, "Some models are useful, but none are correct." One could make the same statement regarding this model. It is simply a tool that may be used to predict an outcome based upon certain inputs. The prediction will almost never be correct or exact. If the model is statistically valid, as this one is, the model's prediction should prove useful within the range specified by the data. Care must always be taken not to extrapolate beyond the limits of the data set specified. Models such as this one are fit to finite data sets and cannot be used to "crystal ball" scenarios outside their scope.

That being said, this model should prove useful in predicting effects of changes in manning and USE rates of aircraft within the bounds of the data provided. This is significant as it provides insight to decision makers into what areas within an organization may need to be addressed relative, in this case, to specific AFSC manning levels and utilization rates of aircraft.

Perhaps the greatest significance of this study, however, is not the model itself, but the validation that multivariate regression analysis can be applied to individual units as a decision making tool. This tool will help to provide insight to leadership as to what areas may be the most beneficial for a unit to address in the near and long term in order to maximize mission fulfillment as defined by the individual model.

We must remember that the model presented in this paper is specific to the dependent variable that the author desired to assess. Regression models may be applied to an infinite variety of effects or outcomes. Virtually anything that an individual would like to predict may be modeled given an adequate supply of data.

The Air Force collects massive amounts of data of all types, so the capacity to build regression models is enormous. We simply need to take advantage of the situation, analyze the data and then make sensible and practical decisions relative to what that analysis shows.

Conclusion

This paper has given background on the importance of the strategic airlift capability of the United States Air Force and the role that the Reserve Component, specifically the Air National Guard, play in that capability. Approximately 45 percent of the nation's organic airlift resides in the Air National Guard. For this reason alone, any perceived issues with mission accomplishment for those units providing this critical capability must be carefully considered. Additionally, any tools that can be used to analyze and help rectify these issues should be applied to the maximum extent possible.

This paper has shown that Multivariate Regression Modeling can be a potentially powerful tool to help decision makers in their quest to maximize mission accomplishment and promote an environment of continuous improvement throughout the Air Force.

Regression analysis is widely used throughout the business world to predict everything from absenteeism to a company's financial performance (Abilla, 2006). The whole of the Department of Defense, not just the Air Force or the Air National Guard, would do well to learn from best business practices. The military has relied on the axiom “We are not a business and cannot be run like a business” for far too long. The fact is that many of the tools that the business world utilizes to improve its processes are just as applicable to processes within the military.

In short, regression is a valuable tool that has proven results and utility and should be applied as aggressively in the military aviation maintenance sphere as it is in the business world external to the Department of Defense.

Appendix A. Data Set Used in the Analysis

USE rate	Age	2A090	2A300	2A373	2A390	2A571	2A590	2A602	2A652	2A653	2A654	2A655	2A656	2A672	2A673	2A674	2A675	2A676	2A690	2A691	2A692	2A751	2A752	2A753	2A771	2A772	2A773	2A790	2R000	2R051	2R071	2R090	2R151	2R171	MMH	Year
76.01	3	0.22	0.14	0.39	0.63	0.53	0.80	0.21	0.80	0.87	0.84	0.74	0.89	0.47	0.41	0.53	0.51	0.53	0.95	0.81	1.00	0.93	0.87	0.79	0.49	0.51	0.44	0.68	0.17	0.95	0.63	1.00	0.73	0.83	3239.9	2005
87.28	2	0.22	0.14	0.39	0.63	0.53	0.80	0.21	0.80	0.87	0.84	0.74	0.89	0.47	0.41	0.53	0.51	0.53	0.95	0.81	1.00	0.93	0.87	0.79	0.49	0.51	0.44	0.68	0.17	0.95	0.63	1.00	0.73	0.83	2933.9	2005
88.40	2	0.22	0.14	0.39	0.63	0.53	0.80	0.21	0.80	0.87	0.84	0.74	0.89	0.47	0.41	0.53	0.51	0.53	0.95	0.81	1.00	0.93	0.87	0.79	0.49	0.51	0.44	0.68	0.17	0.95	0.63	1.00	0.73	0.83	2947.9	2005
83.09	2	0.22	0.14	0.39	0.63	0.53	0.80	0.21	0.80	0.87	0.84	0.74	0.89	0.47	0.41	0.53	0.51	0.53	0.95	0.81	1.00	0.93	0.87	0.79	0.49	0.51	0.44	0.68	0.17	0.95	0.63	1.00	0.73	0.83	2804.8	2005
83.81	2	0.22	0.14	0.39	0.63	0.53	0.80	0.21	0.80	0.87	0.84	0.74	0.89	0.47	0.41	0.53	0.51	0.53	0.95	0.81	1.00	0.93	0.87	0.79	0.49	0.51	0.44	0.68	0.17	0.95	0.63	1.00	0.73	0.83	2529.2	2005
79.37	2	0.22	0.14	0.39	0.63	0.53	0.80	0.21	0.80	0.87	0.84	0.74	0.89	0.47	0.41	0.53	0.51	0.53	0.95	0.81	1.00	0.93	0.87	0.79	0.49	0.51	0.44	0.68	0.17	0.95	0.63	1.00	0.73	0.83	3298.9	2005

83.19	2	0.22	0.14	0.39	0.63	0.53	0.80	0.21	0.80	0.87	0.84	0.74	0.89	0.47	0.41	0.53	0.51	0.53	0.95	0.81	1.00	0.93	0.87	0.79	0.49	0.51	0.44	0.68	0.17	0.95	0.63	1.00	0.73	0.83	2826.6	2005
70.14	2	0.22	0.14	0.39	0.63	0.53	0.80	0.21	0.80	0.87	0.84	0.74	0.89	0.47	0.41	0.53	0.51	0.53	0.95	0.81	1.00	0.93	0.87	0.79	0.49	0.51	0.44	0.68	0.17	0.95	0.63	1.00	0.73	0.83	2909.8	2005
72.05	4.00	1.00	0.75	1.02	1.00	0.95	0.95	0.87	0.77	0.87	0.73	0.74	0.80	0.98	1.25	0.98	0.92	0.95	0.91	0.88	0.97	0.96	0.86	0.74	1.01	0.94	0.95	1.00	0.48	0.95	0.93	1.00	0.80	1.03	3053.10	2006
96.31	3.00	1.00	0.75	1.02	1.00	0.95	0.95	0.87	0.77	0.87	0.73	0.74	0.80	0.98	1.25	0.98	0.92	0.95	0.91	0.88	0.97	0.96	0.86	0.74	1.01	0.94	0.95	1.00	0.48	0.95	0.93	1.00	0.80	1.03	3884.70	2006
98.47	3.00	1.00	0.75	1.02	1.00	0.95	0.95	0.87	0.77	0.87	0.73	0.74	0.80	0.98	1.25	0.98	0.92	0.95	0.91	0.88	0.97	0.96	0.86	0.74	1.01	0.94	0.95	1.00	0.48	0.95	0.93	1.00	0.80	1.03	4239.40	2006
69.38	3.00	1.00	0.75	1.02	1.00	0.95	0.95	0.87	0.77	0.87	0.73	0.74	0.80	0.98	1.25	0.98	0.92	0.95	0.91	0.88	0.97	0.96	0.86	0.74	1.01	0.94	0.95	1.00	0.48	0.95	0.93	1.00	0.80	1.03	3381.00	2006
106.48	3.00	1.00	0.75	1.02	1.00	0.95	0.95	0.87	0.77	0.87	0.73	0.74	0.80	0.98	1.25	0.98	0.92	0.95	0.91	0.88	0.97	0.96	0.86	0.74	1.01	0.94	0.95	1.00	0.48	0.95	0.93	1.00	0.80	1.03	4412.2	2006

																																			0	
95.03	3.00	1.00	0.75	1.02	1.00	0.95	0.95	0.87	0.77	0.87	0.73	0.74	0.80	0.98	1.25	0.98	0.92	0.95	0.91	0.88	0.97	0.96	0.86	0.74	1.01	0.94	0.95	1.00	0.48	0.95	0.93	1.00	0.80	1.03	3044.80	2006
71.88	3.00	1.00	0.75	1.02	1.00	0.95	0.95	0.87	0.77	0.87	0.73	0.74	0.80	0.98	1.25	0.98	0.92	0.95	0.91	0.88	0.97	0.96	0.86	0.74	1.01	0.94	0.95	1.00	0.48	0.95	0.93	1.00	0.80	1.03	2643.50	2006
100.09	3.00	1.00	0.75	1.02	1.00	0.95	0.95	0.87	0.77	0.87	0.73	0.74	0.80	0.98	1.25	0.98	0.92	0.95	0.91	0.88	0.97	0.96	0.86	0.74	1.01	0.94	0.95	1.00	0.48	0.95	0.93	1.00	0.80	1.03	3444.10	2006
76.98	5	0.24	0.10	0.41	0.61	0.51	0.83	0.20	0.76	0.73	0.72	0.77	0.78	0.47	0.47	0.56	0.47	0.50	0.86	0.84	0.97	1.06	1.01	0.76	0.50	0.50	0.44	0.73	0.42	0.60	0.71	1.05	0.85	0.81	3829.2	2007
57.57	4	0.24	0.10	0.41	0.61	0.51	0.83	0.20	0.76	0.73	0.72	0.77	0.78	0.47	0.47	0.56	0.47	0.50	0.86	0.84	0.97	1.06	1.01	0.76	0.50	0.50	0.44	0.73	0.42	0.60	0.71	1.05	0.85	0.81	3938.9	2007
61.49	4	0.24	0.10	0.41	0.61	0.51	0.83	0.20	0.76	0.73	0.72	0.77	0.78	0.47	0.47	0.56	0.47	0.50	0.86	0.84	0.97	1.06	1.01	0.76	0.50	0.50	0.44	0.73	0.42	0.60	0.71	1.05	0.85	0.81	3950.4	2007
73.30	4	0.24	0.10	0.41	0.61	0.51	0.83	0.20	0.76	0.73	0.72	0.77	0.78	0.47	0.47	0.56	0.47	0.50	0.86	0.84	0.97	1.06	1.01	0.76	0.50	0.50	0.44	0.73	0.42	0.60	0.71	1.05	0.85	0.81	3620.9	2007

69.13	4	0.24	0.10	0.41	0.61	0.51	0.83	0.20	0.76	0.73	0.72	0.77	0.78	0.47	0.47	0.56	0.47	0.50	0.86	0.84	0.97	1.06	1.01	0.76	0.50	0.50	0.44	0.73	0.42	0.60	0.71	1.05	0.85	0.81	3413	2007
70.82	4	0.24	0.10	0.41	0.61	0.51	0.83	0.20	0.76	0.73	0.72	0.77	0.78	0.47	0.47	0.56	0.47	0.50	0.86	0.84	0.97	1.06	1.01	0.76	0.50	0.50	0.44	0.73	0.42	0.60	0.71	1.05	0.85	0.81	3636.9	2007
75.69	4	0.24	0.10	0.41	0.61	0.51	0.83	0.20	0.76	0.73	0.72	0.77	0.78	0.47	0.47	0.56	0.47	0.50	0.86	0.84	0.97	1.06	1.01	0.76	0.50	0.50	0.44	0.73	0.42	0.60	0.71	1.05	0.85	0.81	3620.5	2007
64.56	4	0.24	0.10	0.41	0.61	0.51	0.83	0.20	0.76	0.73	0.72	0.77	0.78	0.47	0.47	0.56	0.47	0.50	0.86	0.84	0.97	1.06	1.01	0.76	0.50	0.50	0.44	0.73	0.42	0.60	0.71	1.05	0.85	0.81	3460.8	2007
98.96	6	0.50	0.09	0.45	0.69	0.53	0.91	0.21	0.86	0.73	0.67	0.87	0.82	0.52	0.47	0.53	0.50	0.50	0.70	1.03	0.56	1.00	1.62	1.08	0.58	0.51	0.42	0.55	0.23	0.53	1.03	0.35	0.69	0.60	2430.5	2008
91.13	5	0.50	0.09	0.45	0.69	0.53	0.91	0.21	0.86	0.73	0.67	0.87	0.82	0.52	0.47	0.53	0.50	0.50	0.70	1.03	0.56	1.00	1.62	1.08	0.58	0.51	0.42	0.55	0.23	0.53	1.03	0.35	0.69	0.60	2770.3	2008
86.82	5	0.50	0.09	0.45	0.69	0.53	0.91	0.21	0.86	0.73	0.67	0.87	0.82	0.52	0.47	0.53	0.50	0.50	0.70	1.03	0.56	1.00	1.62	1.08	0.58	0.51	0.42	0.55	0.23	0.53	1.03	0.35	0.69	0.60	2621.1	2008
92.31	5	0.50	0.09	0.45	0.69	0.53	0.91	0.21	0.86	0.73	0.67	0.87	0.82	0.52	0.47	0.53	0.50	0.50	0.70	1.03	0.56	1.00	1.62	1.08	0.58	0.51	0.42	0.55	0.23	0.53	1.03	0.35	0.69	0.60	2315.1	2008

70.30	5	0.50	0.09	0.45	0.69	0.53	0.91	0.21	0.86	0.73	0.67	0.87	0.82	0.52	0.47	0.53	0.50	0.50	0.70	1.03	0.56	1.00	1.62	1.08	0.58	0.51	0.42	0.55	0.23	0.53	1.03	0.35	0.69	0.60	1830.5	2008
93.03	5	0.50	0.09	0.45	0.69	0.53	0.91	0.21	0.86	0.73	0.67	0.87	0.82	0.52	0.47	0.53	0.50	0.50	0.70	1.03	0.56	1.00	1.62	1.08	0.58	0.51	0.42	0.55	0.23	0.53	1.03	0.35	0.69	0.60	2339	2008
96.86	5	0.50	0.09	0.45	0.69	0.53	0.91	0.21	0.86	0.73	0.67	0.87	0.82	0.52	0.47	0.53	0.50	0.50	0.70	1.03	0.56	1.00	1.62	1.08	0.58	0.51	0.42	0.55	0.23	0.53	1.03	0.35	0.69	0.60	1856.3	2008
83.52	5	0.50	0.09	0.45	0.69	0.53	0.91	0.21	0.86	0.73	0.67	0.87	0.82	0.52	0.47	0.53	0.50	0.50	0.70	1.03	0.56	1.00	1.62	1.08	0.58	0.51	0.42	0.55	0.23	0.53	1.03	0.35	0.69	0.60	2394.4	2008
81.56	7	0.53	0.11	0.45	0.78	0.52	0.90	0.18	0.82	0.69	0.71	0.83	0.78	0.53	0.53	0.46	0.51	0.48	0.76	0.97	0.52	0.86	1.30	0.84	0.57	0.56	0.41	0.54	0.26	0.60	0.93	0.59	0.78	0.58	2173.4	2009
105.84	6	0.53	0.11	0.45	0.78	0.52	0.90	0.18	0.82	0.69	0.71	0.83	0.78	0.53	0.53	0.46	0.51	0.48	0.76	0.97	0.52	0.86	1.30	0.84	0.57	0.56	0.41	0.54	0.26	0.60	0.93	0.59	0.78	0.58	2537.9	2009
102.36	6	0.53	0.11	0.45	0.78	0.52	0.90	0.18	0.82	0.69	0.71	0.83	0.78	0.53	0.53	0.46	0.51	0.48	0.76	0.97	0.52	0.86	1.30	0.84	0.57	0.56	0.41	0.54	0.26	0.60	0.93	0.59	0.78	0.58	3218	2009
102.62	6	0.53	0.11	0.45	0.78	0.52	0.90	0.18	0.82	0.69	0.71	0.83	0.78	0.53	0.53	0.46	0.51	0.48	0.76	0.97	0.52	0.86	1.30	0.84	0.57	0.56	0.41	0.54	0.26	0.60	0.93	0.59	0.78	0.58	3405.4	2009

101.69	6	0.53	0.11	0.45	0.78	0.52	0.90	0.18	0.82	0.69	0.71	0.83	0.78	0.53	0.53	0.46	0.51	0.48	0.76	0.97	0.52	0.86	1.30	0.84	0.57	0.56	0.41	0.54	0.26	0.60	0.93	0.59	0.78	0.58	3060.1	2009
78.61	6	0.53	0.11	0.45	0.78	0.52	0.90	0.18	0.82	0.69	0.71	0.83	0.78	0.53	0.53	0.46	0.51	0.48	0.76	0.97	0.52	0.86	1.30	0.84	0.57	0.56	0.41	0.54	0.26	0.60	0.93	0.59	0.78	0.58	2062.7	2009
98.93	6	0.53	0.11	0.45	0.78	0.52	0.90	0.18	0.82	0.69	0.71	0.83	0.78	0.53	0.53	0.46	0.51	0.48	0.76	0.97	0.52	0.86	1.30	0.84	0.57	0.56	0.41	0.54	0.26	0.60	0.93	0.59	0.78	0.58	2101.1	2009
106.57	6	0.53	0.11	0.45	0.78	0.52	0.90	0.18	0.82	0.69	0.71	0.83	0.78	0.53	0.53	0.46	0.51	0.48	0.76	0.97	0.52	0.86	1.30	0.84	0.57	0.56	0.41	0.54	0.26	0.60	0.93	0.59	0.78	0.58	2990.6	2009
112.98	8	0.75	0.12	0.43	0.75	0.51	0.90	0.21	0.80	0.79	0.85	0.87	0.80	0.51	0.42	0.46	0.50	0.48	0.78	0.94	0.52	0.92	1.25	0.81	0.58	0.55	0.40	0.55	0.22	0.53	0.97	0.57	0.86	0.53	3430.5	2010
54.44	7	0.75	0.12	0.43	0.75	0.51	0.90	0.21	0.80	0.79	0.85	0.87	0.80	0.51	0.42	0.46	0.50	0.48	0.78	0.94	0.52	0.92	1.25	0.81	0.58	0.55	0.40	0.55	0.22	0.53	0.97	0.57	0.86	0.53	2417.9	2010
113.74	7	0.75	0.12	0.43	0.75	0.51	0.90	0.21	0.80	0.79	0.85	0.87	0.80	0.51	0.42	0.46	0.50	0.48	0.78	0.94	0.52	0.92	1.25	0.81	0.58	0.55	0.40	0.55	0.22	0.53	0.97	0.57	0.86	0.53	2693.8	2010
100.	7	0.75	0.12	0.43	0.75	0.51	0.90	0.21	0.80	0.79	0.85	0.87	0.80	0.51	0.42	0.46	0.50	0.48	0.78	0.94	0.52	0.92	1.25	0.81	0.58	0.55	0.40	0.55	0.22	0.53	0.97	0.57	0.86	0.53	2387	2010

18																																			.3	
105.87	7	0.75	0.12	0.43	0.75	0.51	0.90	0.21	0.80	0.79	0.85	0.87	0.80	0.51	0.42	0.46	0.50	0.48	0.78	0.94	0.52	0.92	1.25	0.81	0.58	0.55	0.40	0.55	0.22	0.53	0.97	0.57	0.86	0.53	2420.6	2010
106.23	7	0.75	0.12	0.43	0.75	0.51	0.90	0.21	0.80	0.79	0.85	0.87	0.80	0.51	0.42	0.46	0.50	0.48	0.78	0.94	0.52	0.92	1.25	0.81	0.58	0.55	0.40	0.55	0.22	0.53	0.97	0.57	0.86	0.53	2595.6	2010
70.54	7	0.75	0.12	0.43	0.75	0.51	0.90	0.21	0.80	0.79	0.85	0.87	0.80	0.51	0.42	0.46	0.50	0.48	0.78	0.94	0.52	0.92	1.25	0.81	0.58	0.55	0.40	0.55	0.22	0.53	0.97	0.57	0.86	0.53	1541.1	2010
107.50	7	0.75	0.12	0.43	0.75	0.51	0.90	0.21	0.80	0.79	0.85	0.87	0.80	0.51	0.42	0.46	0.50	0.48	0.78	0.94	0.52	0.92	1.25	0.81	0.58	0.55	0.40	0.55	0.22	0.53	0.97	0.57	0.86	0.53	3092.1	2010
65.67	14	0.75	0.12	0.43	0.75	0.51	0.90	0.21	0.80	0.79	0.85	0.87	0.80	0.51	0.42	0.46	0.50	0.48	0.78	0.94	0.52	0.92	1.25	0.81	0.58	0.55	0.40	0.55	0.22	0.53	0.97	0.57	0.86	0.53	2279.4	2010
90.55	9	0.57	0.12	0.53	0.66	0.47	0.79	0.25	0.83	0.64	0.83	0.84	0.80	0.50	0.52	0.47	0.46	0.48	0.90	0.75	0.51	0.91	1.12	0.93	0.55	0.54	0.42	0.50	0.25	0.69	0.89	0.46	0.92	0.50	2503.7	2011
99.66	8	0.57	0.12	0.53	0.66	0.47	0.79	0.25	0.83	0.64	0.83	0.84	0.80	0.50	0.52	0.47	0.46	0.48	0.90	0.75	0.51	0.91	1.12	0.93	0.55	0.54	0.42	0.50	0.25	0.69	0.89	0.46	0.92	0.50	1957.2	2011
32.	8	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	12	20

00		57	12	53	66	47	79	25	83	64	83	84	80	50	52	47	46	48	90	75	51	91	12	93	55	54	42	50	25	69	89	96	42	92	50	05.9	11
98.99	8	0.57	0.12	0.53	0.66	0.47	0.79	0.25	0.83	0.64	0.83	0.84	0.80	0.50	0.52	0.47	0.46	0.48	0.90	0.75	0.51	0.91	1.12	0.93	0.55	0.54	0.42	0.50	0.25	0.69	0.89	0.96	0.42	0.92	0.50	2392.7	2011
80.67	8	0.57	0.12	0.53	0.66	0.47	0.79	0.25	0.83	0.64	0.83	0.84	0.80	0.50	0.52	0.47	0.46	0.48	0.90	0.75	0.51	0.91	1.12	0.93	0.55	0.54	0.42	0.50	0.25	0.69	0.89	0.96	0.42	0.92	0.50	1579.2	2011
87.93	8	0.57	0.12	0.53	0.66	0.47	0.79	0.25	0.83	0.64	0.83	0.84	0.80	0.50	0.52	0.47	0.46	0.48	0.90	0.75	0.51	0.91	1.12	0.93	0.55	0.54	0.42	0.50	0.25	0.69	0.89	0.96	0.42	0.92	0.50	2486.5	2011
88.54	8	0.57	0.12	0.53	0.66	0.47	0.79	0.25	0.83	0.64	0.83	0.84	0.80	0.50	0.52	0.47	0.46	0.48	0.90	0.75	0.51	0.91	1.12	0.93	0.55	0.54	0.42	0.50	0.25	0.69	0.89	0.96	0.42	0.92	0.50	1724	2011
99.64	8	0.57	0.12	0.53	0.66	0.47	0.79	0.25	0.83	0.64	0.83	0.84	0.80	0.50	0.52	0.47	0.46	0.48	0.90	0.75	0.51	0.91	1.12	0.93	0.55	0.54	0.42	0.50	0.25	0.69	0.89	0.96	0.42	0.92	0.50	1421	2011
3.00	16	0.57	0.12	0.53	0.66	0.47	0.79	0.25	0.83	0.64	0.83	0.84	0.80	0.50	0.52	0.47	0.46	0.48	0.90	0.75	0.51	0.91	1.12	0.93	0.55	0.54	0.42	0.50	0.25	0.69	0.89	0.96	0.42	0.92	0.50	199.8	2011
8.00	16	0.57	0.12	0.53	0.66	0.47	0.79	0.25	0.83	0.64	0.83	0.84	0.80	0.50	0.52	0.47	0.46	0.48	0.90	0.75	0.51	0.91	1.12	0.93	0.55	0.54	0.42	0.50	0.25	0.69	0.89	0.96	0.42	0.92	0.50	278.7	2011
26.89	15	0.57	0.12	0.53	0.66	0.47	0.79	0.25	0.83	0.64	0.83	0.84	0.80	0.50	0.52	0.47	0.46	0.48	0.90	0.75	0.51	0.91	1.12	0.93	0.55	0.54	0.42	0.50	0.25	0.69	0.89	0.96	0.42	0.92	0.50	1262.8	2011

Top 25 Work Unit Codes for ANG C-17

03215	COMBINE PREFLIGHT/POSTFLIGHT INSPECTION
0373A	1ST 120 DAY HOME STATION CHECK INSPECTION
0373B	2ND 120 DAY HOME STATION CHECK INSPECTION
0373C	3RD 120 DAY HOME STATION CHECK INSPECTION
0373D	4TH 120 DAY HOME STATION CHECK INSPECTION
0373E	5TH 120 DAY HOME STATION CHECK INSPECTION
0373F	6TH 120 DAY HOME STATION CHECK INSPECTION
0373G	1ST 180 DAY HOME STATION CHECK INSPECTION
0373H	2ND 180 DAY HOME STATION CHECK INSPECTION
0373J	3RD 180 DAY HOME STATION CHECK INSPECTION
0373L	HARD POINT INSPECTION
0374A	1ST REFURBISHMENT INSPECTION
0413C	ENGINE AIR INLET INSPECTION
04199	SPECIAL INSPECTION, NOT OTHERWISE CODED
04MD4	MODE 4 IFF SPECIAL INSPECTION
07000	PREPARATION AND MAINTENANCE OF RECORDS
13EAA	SHOCK STRUT ASSY
13HA0	MAIN WHEEL AND TIRE ASSY
13HAA	WHEEL ASSY, MLG
13JCA	BRAKE, MULTIPLE DISK
23A00	ENGINE, BASIC (F117-PW)
42BA0	BATTERY, STORAGE (MXK-860/A24A-55)
57GC0	BATTERY UNIT, POWER SUPPLY - IRU
57KC0	DISPLAY UNIT, HEAD-UP (ID-2458/AYQ-33) - HUD
91AA0	LIFE RAFT ASSY AND CONTAINER - FEDS

Appendix B. SPSS Regression Data

Notes

Output Created		14-Feb-2012 14:11:54
Comments		
Input	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	60
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics are based on cases with no missing values for any variable used.

Syntax		REGRESSION /DESCRIPTIVES MEAN STDDEV CORR SIG N /MISSING LISTWISE /STATISTICS COEFF OUTS CI(95) R ANOVA /CRITERIA=PIN(.05) POUT(.10) /NOORIGIN /DEPENDENT MMH /METHOD=STEPWISE USErate Age @2A090 @2A300 @2A373 @2A390 @2A571 @2A590 @2A600 @2A652 @2A653 @2A654 @2A655 @2A656 @2A672 @2A673 @2A674 @2A675 @2A676 @2A690 @2A691 @2A692 @2A751 @2A752 @2A753 @2A771 @2A772 @2A773 @2A790 @2R000 @2R051 @2R071 @2R090 @2R151 @2R171 /SCATTERPLOT=(*ZRESID ,*ZPRED) /RESIDUALS HIST(ZRESID) /SAVE RESID ZRESID.
Resources	Processor Time	0:00:00.858
	Elapsed Time	0:00:00.857
	Memory Required	31060 bytes
	Additional Memory Required for Residual Plots	312 bytes

Variables Created or Modified	RES_1	Unstandardized Residual
	ZRE_1	Standardized Residual

[DataSet1]

Regression

Descriptive Statistics

	Mean	Std. Deviation	N
MMH	2684.010000	866.3800266	60
USE rate	82.576644	22.9906287	60
Age	5.80	3.230	60
2A090	.549666	.2480162	60
2A300	.198709	.2184526	60
2A373	.522587	.2029458	60
2A390	.727252	.1218530	60
2A571	.568016	.1512927	60

2A590	.864394	.0583004	60
2A600	.300384	.2244059	60
2A652	.806365	.0318764	60
2A653	.754689	.0808100	60
2A654	.768439	.0673547	60
2A655	.811724	.0539850	60
2A656	.807288	.0328789	60
2A672	.563291	.1668130	60
2A673	.575386	.2702283	60
2A674	.563130	.1693009	60
2A675	.546826	.1479718	60
2A676	.554861	.1560338	60
2A690	.839076	.0841558	60
2A691	.882449	.0928085	60
2A692	.705502	.2256840	60
2A751	.945550	.0613480	60
2A752	1.146813	.2414384	60
2A753	.843170	.0871762	60
2A771	.609741	.1638398	60
2A772	.584036	.1404711	60
2A773	.493271	.1827518	60

2A790	.641382	.1615985	60
2R000	.287394	.1042861	60
2R051	.690486	.1661381	60
2R071	.872674	.1320190	60
2R090	.694853	.2611129	60
2R151	.810240	.0749227	60
2R171	.684562	.1844828	60

Correlations

		MMH	USE rate	Age	2A090	2A300	2A373	2A390	2A571	2A590	2A600	2A652	2A653	2A654	2A655	2A656	2A672	2A673	2A674	2A675	2A676
Pearson Correlation	MMH	1.000	.441	-.711	-.043	.365	.235	.266	.434	.322	.332	-.634	.536	-.306	-.587	.010	.331	.325	.467	.407	.413
	USE rate	.441	1.000	-.443	.206	.100	.061	.286	.147	.409	.075	.088	.208	-.154	.077	.023	.146	.083	.061	.165	.099
	Age	-.711	-.443	1.000	.193	-.322	-.172	-.176	-.410	-.241	-.282	.371	-.666	.332	.649	-.421	-.283	-.259	-.446	-.383	-.394
	2A090	-.043	.206	.193	1.000	.718	.778	.872	.677	.685	.731	-.075	.180	-.001	.136	-.377	.775	.725	.568	.714	.656

2A300	.365	.100	-.322	.718	1.000	.975	.880	.988	.561	.997	-.498	.565	-.173	-.559	-.052	.988	.983	.970	.990	.994
2A373	.235	.061	-.172	.778	.975	1.000	.876	.946	.535	.986	-.384	.376	-.201	-.426	-.182	.980	.991	.927	.949	.957
2A390	.266	.286	-.176	.872	.880	.876	1.000	.887	.802	.866	-.287	.435	-.244	-.243	-.233	.928	.885	.782	.910	.851
2A571	.434	.147	-.410	.677	.988	.946	.887	1.000	.639	.980	-.485	.617	-.283	-.574	-.030	.985	.970	.979	.998	.995
2A590	.322	.409	-.241	.685	.561	.535	.802	.639	1.000	.547	-.044	.373	-.556	.067	-.315	.657	.571	.533	.652	.565
2A600	.332	.075	-.282	.731	.997	.986	.866	.980	.547	1.000	-.472	.517	-.182	-.523	-.088	.987	.986	.969	.979	.989
2A652	-.634	.088	.371	-.075	-.498	-.384	-.287	-.485	-.044	-.472	1.000	-.491	-.130	.751	.109	-.404	-.441	-.540	-.466	-.503
2A653	.536	.208	-.666	.180	.565	.376	.435	.617	.373	.517	-.491	1.000	.079	-.657	.577	.501	.419	.601	.620	.604
2A654	-.306	-.154	.332	-.001	-.173	-.201	-.244	-.283	-.556	-.182	-.130	.079	1.000	.021	.337	-.267	-.281	-.306	-.244	-.236
2A655	-.587	.077	.649	.136	-.559	-.426	-.243	-.574	.067	-.523	.751	-.657	.021	1.000	-.401	-.456	-.498	-.646	-.545	-.603

2A656	.010	.023	-.421	-.377	-.052	-.182	-.233	-.030	-.315	-.088	.109	.577	.337	-.401	1.000	-.132	-.180	-.015	-.027	-.008
2A672	.331	.146	-.283	.775	.988	.980	.928	.985	.657	.987	-.404	.501	-.267	-.456	-.132	1.000	.988	.949	.989	.980
2A673	.325	.083	-.259	.725	.983	.991	.885	.970	.571	.986	-.441	.419	-.281	-.498	-.180	.988	1.000	.953	.968	.974
2A674	.467	.061	-.446	.568	.970	.927	.782	.979	.533	.969	-.540	.601	-.306	-.646	-.015	.949	.953	1.000	.964	.988
2A675	.407	.165	-.383	.714	.990	.949	.910	.998	.652	.979	-.466	.620	-.244	-.545	-.027	.989	.968	.964	1.000	.990
2A676	.413	.099	-.394	.656	.994	.957	.851	.995	.565	.989	-.503	.604	-.236	-.603	-.008	.980	.974	.988	.990	1.000
2A690	.143	-.290	-.181	-.103	.362	.305	-.008	.279	-.528	.353	-.595	.347	.543	-.747	.418	.224	.292	.360	.269	.355
2A691	.139	.423	-.178	.184	-.071	-.099	.265	.050	.763	-.088	.386	.108	-.622	.410	-.167	.050	-.052	-.049	.058	-.041
2A692	.656	-.093	-.710	-.232	.469	.314	.115	.504	-.043	.440	-.752	.710	-.083	-.944	.408	.361	.389	.610	.465	.534
2A751	.424	-.180	-.350	-.266	.077	.028	-.205	.129	.051	.106	-.333	.168	-.427	-.249	-.116	.040	.070	.292	.071	.152

2A752	-.379	.183	.312	-.007	-.504	-.409	-.196	-.446	.284	-.479	.825	-.498	-.424	.856	-.276	-.376	-.429	-.503	-.437	-.498
2A753	-.656	-.062	.460	-.098	-.482	-.326	-.372	-.490	-.158	-.432	.936	-.652	-.177	.751	-.059	-.398	-.396	-.489	-.487	-.485
2A771	.297	.166	-.231	.830	.971	.972	.944	.968	.708	.973	-.356	.468	-.272	-.363	-.188	.994	.973	.923	.975	.958
2A772	.325	.139	-.257	.784	.989	.980	.934	.977	.623	.985	-.446	.496	-.199	-.473	-.139	.995	.987	.935	.984	.973
2A773	.405	.090	-.366	.670	.996	.967	.858	.993	.561	.993	-.513	.568	-.237	-.591	-.054	.983	.983	.986	.988	.999
2A790	.642	.045	-.595	.349	.875	.774	.644	.900	.430	.858	-.741	.720	-.255	-.814	.074	.823	.830	.943	.877	.909
2R000	.528	-.074	-.272	.368	.716	.718	.543	.721	.394	.731	-.694	.195	-.447	-.515	-.496	.704	.766	.790	.686	.731
2R051	.261	-.056	-.457	.114	.652	.565	.365	.624	-.097	.625	-.453	.647	.222	-.844	.593	.558	.578	.650	.621	.667
2R071	-.324	.243	.402	.706	.152	.280	.471	.156	.654	.184	.529	-.300	-.314	.712	-.524	.284	.225	.045	.187	.109
2R090	.687	-.054	-.637	-.154	.475	.315	.198	.497	-.023	.434	-.888	.688	.037	-.947	.286	.368	.395	.567	.470	.516

	2R151	-.250	-.296	.604	.200	-.056	.045	-.104	-.185	-.398	-.022	-.302	-.471	.554	.185	-.533	-.097	-.025	-.160	-.171	-.137
	2R171	.678	.028	-.717	.104	.743	.612	.472	.787	.289	.716	-.717	.769	-.258	-.913	.271	.675	.685	.848	.756	.798
Sig. (1-tailed)	MMH	.	.000	.000	.373	.002	.036	.020	.000	.006	.005	.000	.000	.009	.000	.468	.005	.006	.000	.001	.001
	USE rate	.000	.	.000	.057	.225	.322	.013	.131	.001	.286	.252	.055	.120	.278	.431	.133	.264	.321	.105	.225
	Age	.000	.000	.	.070	.006	.095	.090	.001	.032	.015	.002	.000	.005	.000	.000	.014	.023	.000	.001	.001
	2A090	.373	.057	.070	.	.000	.000	.000	.000	.000	.000	.285	.084	.498	.150	.001	.000	.000	.000	.000	.000
	2A300	.002	.225	.006	.000	.	.000	.000	.000	.000	.000	.000	.000	.093	.000	.346	.000	.000	.000	.000	.000
	2A373	.036	.322	.095	.000	.000	.	.000	.000	.000	.000	.001	.002	.062	.000	.082	.000	.000	.000	.000	.000
	2A390	.020	.013	.090	.000	.000	.000	.	.000	.000	.000	.013	.000	.030	.031	.037	.000	.000	.000	.000	.000
	2A571	.000	.131	.001	.000	.000	.000	.000	.	.000	.000	.000	.000	.014	.000	.409	.000	.000	.000	.000	.000
	2A590	.006	.001	.032	.000	.000	.000	.000	.000	.	.000	.370	.002	.000	.306	.007	.000	.000	.000	.000	.000
	2A600	.005	.286	.015	.000	.000	.000	.000	.000	.000	.	.000	.000	.083	.000	.252	.000	.000	.000	.000	.000

2A652	.000	.252	.002	.285	.000	.001	.013	.000	.370	.000	.	.000	.161	.000	.204	.001	.000	.000	.000	.000
2A653	.000	.055	.000	.084	.000	.002	.000	.000	.002	.000	.000	.	.274	.000	.000	.000	.000	.000	.000	.000
2A654	.009	.120	.005	.498	.093	.062	.030	.014	.000	.083	.161	.274	.	.438	.004	.020	.015	.009	.030	.034
2A655	.000	.278	.000	.150	.000	.000	.031	.000	.306	.000	.000	.000	.438	.	.001	.000	.000	.000	.000	.000
2A656	.468	.431	.000	.001	.346	.082	.037	.409	.007	.252	.204	.000	.004	.001	.	.158	.085	.454	.419	.475
2A672	.005	.133	.014	.000	.000	.000	.000	.000	.000	.000	.001	.000	.020	.000	.158	.	.000	.000	.000	.000
2A673	.006	.264	.023	.000	.000	.000	.000	.000	.000	.000	.000	.000	.015	.000	.085	.000	.	.000	.000	.000
2A674	.000	.321	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.009	.000	.454	.000	.000	.	.000	.000
2A675	.001	.105	.001	.000	.000	.000	.000	.000	.000	.000	.000	.000	.030	.000	.419	.000	.000	.000	.	.000
2A676	.001	.225	.001	.000	.000	.000	.000	.000	.000	.000	.000	.000	.034	.000	.475	.000	.000	.000	.000	.
2A690	.138	.012	.083	.216	.002	.009	.476	.016	.000	.003	.000	.003	.000	.000	.000	.042	.012	.002	.019	.003
2A691	.145	.000	.086	.080	.296	.225	.020	.352	.000	.251	.001	.206	.000	.001	.102	.353	.346	.356	.329	.379
2A692	.000	.239	.000	.038	.000	.007	.190	.000	.372	.000	.000	.000	.264	.000	.001	.002	.001	.000	.000	.000

	2A751	.000	.085	.003	.020	.280	.415	.058	.163	.350	.211	.005	.099	.000	.027	.189	.380	.299	.012	.294	.123
	2A752	.001	.081	.008	.478	.000	.001	.067	.000	.014	.000	.000	.000	.000	.000	.016	.002	.000	.000	.000	.000
	2A753	.000	.320	.000	.227	.000	.005	.002	.000	.114	.000	.000	.000	.089	.000	.326	.001	.001	.000	.000	.000
	2A771	.011	.103	.038	.000	.000	.000	.000	.000	.000	.000	.003	.000	.018	.002	.075	.000	.000	.000	.000	.000
	2A772	.006	.145	.024	.000	.000	.000	.000	.000	.000	.000	.000	.000	.064	.000	.145	.000	.000	.000	.000	.000
	2A773	.001	.248	.002	.000	.000	.000	.000	.000	.000	.000	.000	.000	.034	.000	.342	.000	.000	.000	.000	.000
	2A790	.000	.368	.000	.003	.000	.000	.000	.000	.000	.000	.000	.000	.025	.000	.286	.000	.000	.000	.000	.000
	2R000	.000	.286	.018	.002	.000	.000	.000	.000	.001	.000	.000	.067	.000	.000	.000	.000	.000	.000	.000	.000
	2R051	.022	.335	.000	.192	.000	.000	.002	.000	.232	.000	.000	.000	.044	.000	.000	.000	.000	.000	.000	.000
	2R071	.006	.031	.001	.000	.123	.015	.000	.117	.000	.079	.000	.010	.007	.000	.000	.014	.042	.366	.077	.204
	2R090	.000	.340	.000	.120	.000	.007	.065	.000	.430	.000	.000	.000	.390	.000	.013	.002	.001	.000	.000	.000
	2R151	.027	.011	.000	.063	.335	.368	.215	.078	.001	.435	.010	.000	.000	.078	.000	.229	.424	.111	.095	.149
	2R171	.000	.417	.000	.214	.000	.000	.000	.000	.012	.000	.000	.000	.023	.000	.018	.000	.000	.000	.000	.000

N	MMH	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	USE rate	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	Age	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	2A090	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	2A300	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	2A373	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	2A390	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	2A571	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	2A590	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	2A600	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	2A652	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	2A653	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	2A654	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60

2A655	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
2A656	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
2A672	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
2A673	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
2A674	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
2A675	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
2A676	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
2A690	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
2A691	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
2A692	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
2A751	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
2A752	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
2A753	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60

	2A771	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	2A772	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	2A773	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	2A790	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	2R000	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	2R051	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	2R071	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	2R090	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	2R151	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	2R171	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60

Correlations

		2A690	2A691	2A692	2A751	2A752	2A753	2A771	2A772	2A773	2A790	2R000	2R051	2R071	2R090	2R151	2R171
Pearson	MMH	.143	.139	.656	.424	-.379	-.656	.297	.325	.405	.642	.528	.261	-.324	.687	-.250	.678

Correlation	USE rate	-.290	.423	-.093	-.180	.183	-.062	.166	.139	.090	.045	-.074	-.056	.243	-.054	-.296	.028
	Age	-.181	-.178	-.710	-.350	.312	.460	-.231	-.257	-.366	-.595	-.272	-.457	.402	-.637	.604	-.717
	2A090	-.103	.184	-.232	-.266	-.007	-.098	.830	.784	.670	.349	.368	.114	.706	-.154	.200	.104
	2A300	.362	-.071	.469	.077	-.504	-.482	.971	.989	.996	.875	.716	.652	.152	.475	-.056	.743
	2A373	.305	-.099	.314	.028	-.409	-.326	.972	.980	.967	.774	.718	.565	.280	.315	.045	.612
	2A390	-.008	.265	.115	-.205	-.196	-.372	.944	.934	.858	.644	.543	.365	.471	.198	-.104	.472
	2A571	.279	.050	.504	.129	-.446	-.490	.968	.977	.993	.900	.721	.624	.156	.497	-.185	.787
	2A590	-.528	.763	-.043	.051	.284	-.158	.708	.623	.561	.430	.394	-.097	.654	-.023	-.398	.289
	2A600	.353	-.088	.440	.106	-.479	-.432	.973	.985	.993	.858	.731	.625	.184	.434	-.022	.716
	2A652	-.595	.386	-.752	-.333	.825	.936	-.356	-.446	-.513	-.741	-.694	-.453	.529	-.888	-.302	-.717
	2A653	.347	.108	.710	.168	-.498	-.652	.468	.496	.568	.720	.195	.647	-.300	.688	-.471	.769
	2A654	.543	-.622	-.083	-.427	-.424	-.177	-.272	-.199	-.237	-.255	-.447	.222	-.314	.037	.554	-.258
	2A655	-.747	.410	-.944	-.249	.856	.751	-.363	-.473	-.591	-.814	-.515	-.844	.712	-.947	.185	-.913

2A656	.418	-.167	.408	-.116	-.276	-.059	-.188	-.139	-.054	.074	-.496	.593	-.524	.286	-.533	.271
2A672	.224	.050	.361	.040	-.376	-.398	.994	.995	.983	.823	.704	.558	.284	.368	-.097	.675
2A673	.292	-.052	.389	.070	-.429	-.396	.973	.987	.983	.830	.766	.578	.225	.395	-.025	.685
2A674	.360	-.049	.610	.292	-.503	-.489	.923	.935	.986	.943	.790	.650	.045	.567	-.160	.848
2A675	.269	.058	.465	.071	-.437	-.487	.975	.984	.988	.877	.686	.621	.187	.470	-.171	.756
2A676	.355	-.041	.534	.152	-.498	-.485	.958	.973	.999	.909	.731	.667	.109	.516	-.137	.798
2A690	1.000	-.883	.642	-.009	-.932	-.521	.144	.275	.355	.458	.228	.819	-.718	.671	.326	.514
2A691	-.883	1.000	-.305	.052	.727	.220	.110	-.006	-.057	-.097	-.106	-.503	.597	-.342	-.631	-.120
2A692	.642	-.305	1.000	.518	-.754	-.720	.281	.359	.515	.813	.524	.707	-.720	.948	-.249	.923
2A751	-.009	.052	.518	1.000	-.037	-.116	.036	-.016	.145	.399	.523	-.097	-.216	.343	-.122	.426
2A752	-.932	.727	-.754	-.037	1.000	.788	-.298	-.432	-.501	-.650	-.428	-.804	.696	-.850	-.295	-.679
2A753	-.521	.220	-.720	-.116	.788	1.000	-.351	-.446	-.485	-.707	-.510	-.501	.512	-.892	-.112	-.711
2A771	.144	.110	.281	.036	-.298	-.351	1.000	.987	.963	.779	.686	.477	.377	.289	-.078	.610

	2A772	.275	-.006	.359	-.016	-.432	-.446	.987	1.000	.980	.817	.698	.581	.254	.392	-.034	.666
	2A773	.355	-.057	.515	.145	-.501	-.485	.963	.980	1.000	.903	.754	.650	.121	.507	-.095	.782
	2A790	.458	-.097	.813	.399	-.650	-.707	.779	.817	.903	1.000	.799	.683	-.226	.797	-.182	.962
	2R000	.228	-.106	.524	.523	-.428	-.510	.686	.698	.754	.799	1.000	.260	-.005	.542	.175	.681
	2R051	.819	-.503	.707	-.097	-.804	-.501	.477	.581	.650	.683	.260	1.000	-.500	.682	-.168	.744
	2R071	-.718	.597	-.720	-.216	.696	.512	.377	.254	.121	-.226	-.005	-.500	1.000	-.729	-.006	-.428
	2R090	.671	-.342	.948	.343	-.850	-.892	.289	.392	.507	.797	.542	.682	-.729	1.000	-.084	.880
	2R151	.326	-.631	-.249	-.122	-.295	-.112	-.078	-.034	-.095	-.182	.175	-.168	-.006	-.084	1.000	-.328
	2R171	.514	-.120	.923	.426	-.679	-.711	.610	.666	.782	.962	.681	.744	-.428	.880	-.328	1.000
Sig. (1-tailed)	MMH	.138	.145	.000	.000	.001	.000	.011	.006	.001	.000	.000	.022	.006	.000	.027	.000
	USE rate	.012	.000	.239	.085	.081	.320	.103	.145	.248	.368	.286	.335	.031	.340	.011	.417
	Age	.083	.086	.000	.003	.008	.000	.038	.024	.002	.000	.018	.000	.001	.000	.000	.000
	2A090	.216	.080	.038	.020	.478	.227	.000	.000	.000	.003	.002	.192	.000	.120	.063	.214
	2A300	.002	.296	.000	.280	.000	.000	.000	.000	.000	.000	.000	.000	.123	.000	.335	.000

2A373	.009	.225	.007	.415	.001	.005	.000	.000	.000	.000	.000	.000	.015	.007	.368	.000
2A390	.476	.020	.190	.058	.067	.002	.000	.000	.000	.000	.000	.002	.000	.065	.215	.000
2A571	.016	.352	.000	.163	.000	.000	.000	.000	.000	.000	.000	.000	.117	.000	.078	.000
2A590	.000	.000	.372	.350	.014	.114	.000	.000	.000	.000	.001	.232	.000	.430	.001	.012
2A600	.003	.251	.000	.211	.000	.000	.000	.000	.000	.000	.000	.000	.079	.000	.435	.000
2A652	.000	.001	.000	.005	.000	.000	.003	.000	.000	.000	.000	.000	.000	.000	.010	.000
2A653	.003	.206	.000	.099	.000	.000	.000	.000	.000	.000	.067	.000	.010	.000	.000	.000
2A654	.000	.000	.264	.000	.000	.089	.018	.064	.034	.025	.000	.044	.007	.390	.000	.023
2A655	.000	.001	.000	.027	.000	.000	.002	.000	.000	.000	.000	.000	.000	.000	.078	.000
2A656	.000	.102	.001	.189	.016	.326	.075	.145	.342	.286	.000	.000	.000	.013	.000	.018
2A672	.042	.353	.002	.380	.002	.001	.000	.000	.000	.000	.000	.000	.014	.002	.229	.000
2A673	.012	.346	.001	.299	.000	.001	.000	.000	.000	.000	.000	.000	.042	.001	.424	.000
2A674	.002	.356	.000	.012	.000	.000	.000	.000	.000	.000	.000	.000	.366	.000	.111	.000

2A675	.019	.329	.000	.294	.000	.000	.000	.000	.000	.000	.000	.000	.077	.000	.095	.000
2A676	.003	.379	.000	.123	.000	.000	.000	.000	.000	.000	.000	.000	.204	.000	.149	.000
2A690	.	.000	.000	.473	.000	.000	.137	.017	.003	.000	.040	.000	.000	.000	.006	.000
2A691	.000	.	.009	.347	.000	.046	.201	.483	.333	.230	.210	.000	.000	.004	.000	.180
2A692	.000	.009	.	.000	.000	.000	.015	.002	.000	.000	.000	.000	.000	.000	.027	.000
2A751	.473	.347	.000	.	.389	.189	.392	.451	.134	.001	.000	.229	.049	.004	.176	.000
2A752	.000	.000	.000	.389	.	.000	.010	.000	.000	.000	.000	.000	.000	.000	.011	.000
2A753	.000	.046	.000	.189	.000	.	.003	.000	.000	.000	.000	.000	.000	.000	.197	.000
2A771	.137	.201	.015	.392	.010	.003	.	.000	.000	.000	.000	.000	.001	.013	.277	.000
2A772	.017	.483	.002	.451	.000	.000	.000	.	.000	.000	.000	.000	.025	.001	.398	.000
2A773	.003	.333	.000	.134	.000	.000	.000	.000	.	.000	.000	.000	.178	.000	.236	.000
2A790	.000	.230	.000	.001	.000	.000	.000	.000	.000	.	.000	.000	.042	.000	.082	.000
2R000	.040	.210	.000	.000	.000	.000	.000	.000	.000	.000	.	.022	.485	.000	.090	.000

	2R051	.000	.000	.000	.229	.000	.000	.000	.000	.000	.000	.022	.	.000	.000	.100	.000
	2R071	.000	.000	.000	.049	.000	.000	.001	.025	.178	.042	.485	.000	.	.000	.481	.000
	2R090	.000	.004	.000	.004	.000	.000	.013	.001	.000	.000	.000	.000	.000	.	.261	.000
	2R151	.006	.000	.027	.176	.011	.197	.277	.398	.236	.082	.090	.100	.481	.261	.	.005
	2R171	.000	.180	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.005	.
N	MMH	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	USE rate	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	Age	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	2A090	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	2A300	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	2A373	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	2A390	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	2A571	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	2A590	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60

	2A600	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	2A652	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	2A653	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	2A654	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	2A655	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	2A656	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	2A672	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	2A673	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	2A674	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	2A675	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	2A676	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	2A690	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	2A691	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60

2A692	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
2A751	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
2A752	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
2A753	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
2A771	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
2A772	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
2A773	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
2A790	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
2R000	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
2R051	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
2R071	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
2R090	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
2R151	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60

	2R171	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Age	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
2	2A652	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
3	USE rate	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).

4	2A654	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
5	2A390	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
6	2A653	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
7	.	Age	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).

a. Dependent Variable: MMH

Model Summary[h]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.711[a]	.506	.497	614.4521355
2	.815[b]	.664	.653	510.6704276
3	.860[c]	.740	.726	453.7980291
4	.889[d]	.789	.774	411.7582115
5	.898[e]	.806	.788	398.5964298
6	.909[f]	.826	.807	380.9706016
7	.909[g]	.826	.810	377.6164140

a. Predictors: (Constant), Age

b. Predictors: (Constant), Age, 2A652

c. Predictors: (Constant), Age, 2A652, USE rate

d. Predictors: (Constant), Age, 2A652, USE rate, 2A654

e. Predictors: (Constant), Age, 2A652, USE rate, 2A654, 2A390

f. Predictors: (Constant), Age, 2A652, USE rate, 2A654, 2A390, 2A653

g. Predictors: (Constant), 2A652, USE rate, 2A654, 2A390, 2A653

h. Dependent Variable: MMH

ANOVA[h]

Model	Sum of Squares	df	Mean Square	F	Sig.

1	Regression	2.239E7	1	2.239E7	59.299	.000[a]
	Residual	2.190E7	58	377551.427		
	Total	4.429E7	59			
2	Regression	2.942E7	2	1.471E7	56.410	.000[b]
	Residual	1.486E7	57	260784.286		
	Total	4.429E7	59			
3	Regression	3.275E7	3	1.092E7	53.017	.000[c]
	Residual	1.153E7	56	205932.651		
	Total	4.429E7	59			
4	Regression	3.496E7	4	8740320.329	51.552	.000[d]
	Residual	9324965.359	55	169544.825		
	Total	4.429E7	59			
5	Regression	3.571E7	5	7141354.906	44.948	.000[e]
	Residual	8579472.146	54	158879.114		
	Total	4.429E7	59			
6	Regression	3.659E7	6	6098983.485	42.022	.000[f]
	Residual	7692345.761	53	145138.599		
	Total	4.429E7	59			
7	Regression	3.659E7	5	7317232.449	51.315	.000[g]
	Residual	7700084.429	54	142594.156		

	Total	4.429E7	59			

a. Predictors: (Constant), Age

b. Predictors: (Constant), Age, 2A652

c. Predictors: (Constant), Age, 2A652, USE rate

d. Predictors: (Constant), Age, 2A652, USE rate, 2A654

e. Predictors: (Constant), Age, 2A652, USE rate, 2A654, 2A390

f. Predictors: (Constant), Age, 2A652, USE rate, 2A654, 2A390, 2A653

g. Predictors: (Constant), 2A652, USE rate, 2A654, 2A390, 2A653

h. Dependent Variable: MMH

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3790.096	164.086		23.098	.000
	Age	-190.704	24.765	-.711	-7.701	.000
2	(Constant)	12949.232	1768.930		7.320	.000
	Age	-147.938	22.168	-.552	-6.673	.000
	2A652	-11666.164	2246.414	-.429	-5.193	.000
3	(Constant)	13735.109	1584.021		8.671	.000

	Age	-100.407	22.971	-.374	-4.371	.000
	2A652	-14221.842	2094.892	-.523	-6.789	.000
	USE rate	12.101	3.008	.321	4.023	.000
4	(Constant)	17672.389	1804.584		9.793	.000
	Age	-67.652	22.734	-.252	-2.976	.004
	2A652	-16386.550	1993.254	-.603	-8.221	.000
	USE rate	12.966	2.740	.344	4.732	.000
	2A654	-3192.347	884.760	-.248	-3.608	.001
5	(Constant)	20318.025	2131.518		9.532	.000
	Age	-55.552	22.706	-.207	-2.447	.018
	2A652	-18371.179	2136.013	-.676	-8.601	.000
	USE rate	15.312	2.865	.406	5.344	.000
	2A654	-3864.239	910.915	-.300	-4.242	.000
	2A390	-1090.295	503.333	-.153	-2.166	.035
6	(Constant)	19652.051	2054.994		9.563	.000
	Age	7.750	33.564	.029	.231	.818
	2A652	-18681.241	2045.407	-.687	-9.133	.000
	USE rate	17.820	2.920	.473	6.102	.000
	2A654	-5451.563	1081.769	-.424	-5.039	.000
	2A390	-2023.658	611.524	-.285	-3.309	.002
	2A653	2968.479	1200.695	.277	2.472	.017

7	(Constant)	19540.893	1980.225		9.868	.000
	2A652	-18487.684	1849.330	-.680	-9.997	.000
	USE rate	17.418	2.324	.462	7.494	.000
	2A654	-5280.275	780.444	-.411	-6.766	.000
	2A390	-1939.487	486.683	-.273	-3.985	.000
	2A653	2756.975	769.494	.257	3.583	.001

a. Dependent Variable: MMH

Coefficients[a]

Model		95.0% Confidence Interval for B	
		Lower Bound	Upper Bound
1	(Constant)	3461.643	4118.549
	Age	-240.277	-141.132
2	(Constant)	9407.010	16491.454
	Age	-192.330	-103.547
	2A652	-16164.531	-7167.797
3	(Constant)	10561.934	16908.285
	Age	-146.424	-54.390
	2A652	-18418.415	-10025.268
	USE rate	6.075	18.127
4	(Constant)	14055.922	21288.856

	Age	-113.213	-22.091
	2A652	-20381.121	-12391.979
	USE rate	7.475	18.457
	2A654	-4965.445	-1419.249
5	(Constant)	16044.589	24591.461
	Age	-101.074	-10.031
	2A652	-22653.627	-14088.732
	USE rate	9.568	21.056
	2A654	-5690.514	-2037.965
	2A390	-2099.417	-81.173
6	(Constant)	15530.254	23773.847
	Age	-59.571	75.072
	2A652	-22783.808	-14578.673
	USE rate	11.963	23.677
	2A654	-7621.316	-3281.810
	2A390	-3250.219	-797.096
	2A653	560.190	5376.768
7	(Constant)	15570.781	23511.005
	2A652	-22195.367	-14780.000
	USE rate	12.758	22.078
	2A654	-6844.972	-3715.578

	2A390	-2915.227	-963.746
	2A653	1214.234	4299.717

a. Dependent Variable: MMH

Excluded Variables[h]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics
						Tolerance
1	USE rate	.157[a]	1.540	.129	.200	.804
	2A090	.098[a]	1.041	.302	.137	.963
	2A300	.152[a]	1.583	.119	.205	.897
	2A373	.116[a]	1.242	.219	.162	.970
	2A390	.146[a]	1.577	.120	.204	.969
	2A571	.171[a]	1.714	.092	.221	.832
	2A590	.160[a]	1.715	.092	.221	.942
	2A600	.143[a]	1.502	.139	.195	.920
	2A652	-.429[a]	-5.193	.000	-.567	.862
	2A653	.112[a]	.907	.368	.119	.557
	2A654	-.079[a]	-.806	.423	-.106	.890
	2A655	-.217[a]	-1.820	.074	-.234	.579

2A656	-.351[a]	-3.833	.000	-.453	.823
2A672	.141[a]	1.480	.144	.192	.920
2A673	.150[a]	1.593	.117	.206	.933
2A674	.187[a]	1.852	.069	.238	.801
2A675	.158[a]	1.605	.114	.208	.853
2A676	.157[a]	1.581	.119	.205	.845
2A690	.015[a]	.156	.877	.021	.967
2A691	.013[a]	.133	.895	.018	.968
2A692	.306[a]	2.431	.018	.307	.496
2A751	.200[a]	2.084	.042	.266	.877
2A752	-.174[a]	-1.821	.074	-.235	.903
2A753	-.417[a]	-4.684	.000	-.527	.789
2A771	.141[a]	1.501	.139	.195	.947
2A772	.153[a]	1.619	.111	.210	.934
2A773	.167[a]	1.708	.093	.221	.866
2A790	.339[a]	3.170	.002	.387	.646
2R000	.361[a]	4.289	.000	.494	.926
2R051	-.081[a]	-.776	.441	-.102	.792
2R071	-.045[a]	-.442	.660	-.058	.838
2R090	.393[a]	3.611	.001	.432	.595

	2R151	.283[a]	2.559	.013	.321	.635
	2R171	.347[a]	2.765	.008	.344	.486
2	USE rate	.321[b]	4.023	.000	.473	.730
	2A090	.033[b]	.419	.677	.056	.938
	2A300	-.035[b]	-.391	.697	-.052	.730
	2A373	-.029[b]	-.349	.728	-.047	.852
	2A390	.051[b]	.630	.531	.084	.912
	2A571	-.001[b]	-.009	.993	-.001	.704
	2A590	.182[b]	2.388	.020	.304	.940
	2A600	-.034[b]	-.387	.700	-.052	.764
	2A653	-.086[b]	-.778	.440	-.103	.488
	2A654	-.220[b]	-2.728	.009	-.342	.815
	2A655	.336[b]	2.400	.020	.305	.278
	2A656	-.236[b]	-2.803	.007	-.351	.741
	2A672	.002[b]	.021	.983	.003	.816
	2A673	-.010[b]	-.113	.911	-.015	.795
	2A674	-.017[b]	-.172	.864	-.023	.638
	2A675	-.005[b]	-.057	.954	-.008	.732
	2A676	-.030[b]	-.320	.750	-.043	.697
	2A690	-.329[b]	-3.837	.000	-.456	.644
	2A691	.283[b]	3.432	.001	.417	.731

	2A692	-.264[b]	-1.636	.107	-.214	.219
	2A751	.106[b]	1.271	.209	.167	.830
	2A752	.462[b]	3.781	.000	.451	.319
	2A753	-.006[b]	-.024	.981	-.003	.109
	2A771	.020[b]	.239	.812	.032	.862
	2A772	-.010[b]	-.117	.907	-.016	.791
	2A773	-.025[b]	-.272	.786	-.036	.701
	2A790	-.013[b]	-.093	.926	-.012	.333
	2R000	.154[b]	1.459	.150	.191	.518
	2R051	-.266[b]	-3.109	.003	-.384	.698
	2R071	.187[b]	2.050	.045	.264	.671
	2R090	-.451[b]	-1.918	.060	-.248	.102
	2R151	-.146[b]	-1.067	.291	-.141	.314
	2R171	-.099[b]	-.645	.522	-.086	.251
3	2A090	-.097[c]	-1.264	.211	-.168	.785
	2A300	-.066[c]	-.818	.417	-.110	.724
	2A373	-.059[c]	-.797	.429	-.107	.843
	2A390	-.051[c]	-.671	.505	-.090	.810
	2A571	-.030[c]	-.359	.721	-.048	.698
	2A590	.094[c]	1.265	.211	.168	.825
	2A600	-.059[c]	-.746	.459	-.100	.759

2A653	-.075[c]	-.769	.445	-.103	.488
2A654	-.248[c]	-3.608	.001	-.437	.809
2A655	.112[c]	.758	.452	.102	.214
2A656	-.147[c]	-1.792	.079	-.235	.662
2A672	-.041[c]	-.540	.591	-.073	.800
2A673	-.038[c]	-.492	.625	-.066	.788
2A674	-.003[c]	-.037	.971	-.005	.637
2A675	-.045[c]	-.559	.578	-.075	.721
2A676	-.043[c]	-.524	.603	-.070	.696
2A690	-.246[c]	-2.931	.005	-.368	.581
2A691	.207[c]	2.606	.012	.332	.669
2A692	.219[c]	1.129	.264	.151	.123
2A751	.244[c]	3.301	.002	.407	.726
2A752	.368[c]	3.201	.002	.396	.302
2A753	.259[c]	1.203	.234	.160	.099
2A771	-.034[c]	-.457	.649	-.062	.834
2A772	-.064[c]	-.818	.417	-.110	.769
2A773	-.043[c]	-.520	.605	-.070	.699
2A790	.053[c]	.440	.662	.059	.327
2R000	.167[c]	1.801	.077	.236	.518
2R051	-.197[c]	-2.444	.018	-.313	.656

	2R071	.048[c]	.511	.612	.069	.539
	2R090	.013[c]	.050	.960	.007	.073
	2R151	-.294[c]	-2.435	.018	-.312	.293
	2R171	.119[c]	.811	.421	.109	.216
4	2A090	-.145[d]	-2.108	.040	-.276	.761
	2A300	-.137[d]	-1.866	.067	-.246	.682
	2A373	-.144[d]	-2.108	.040	-.276	.769
	2A390	-.153[d]	-2.166	.035	-.283	.716
	2A571	-.133[d]	-1.726	.090	-.229	.621
	2A590	-.082[d]	-.965	.339	-.130	.530
	2A600	-.133[d]	-1.853	.069	-.244	.709
	2A653	.048[d]	.502	.618	.068	.422
	2A655	.038[d]	.277	.783	.038	.209
	2A656	.182[d]	1.491	.142	.199	.250
	2A672	-.141[d]	-1.975	.053	-.260	.710
	2A673	-.156[d]	-2.134	.037	-.279	.675
	2A674	-.123[d]	-1.492	.142	-.199	.551
	2A675	-.132[d]	-1.768	.083	-.234	.661
	2A676	-.130[d]	-1.703	.094	-.226	.640
	2A690	-.086[d]	-.773	.443	-.105	.310
	2A691	.064[d]	.666	.508	.090	.419

	2A692	.289[d]	1.658	.103	.220	.122
	2A751	.158[d]	1.989	.052	.261	.579
	2A752	.175[d]	1.159	.252	.156	.167
	2A753	.020[d]	.097	.923	.013	.088
	2A771	-.137[d]	-1.941	.057	-.255	.731
	2A772	-.150[d]	-2.098	.041	-.275	.704
	2A773	-.137[d]	-1.800	.077	-.238	.634
	2A790	-.121[d]	-1.025	.310	-.138	.276
	2R000	-.260[d]	-1.778	.081	-.235	.172
	2R051	-.099[d]	-1.176	.245	-.158	.540
	2R071	-.172[d]	-1.736	.088	-.230	.375
	2R090	.276[d]	1.154	.254	.155	.066
	2R151	-.159[d]	-1.292	.202	-.173	.249
	2R171	-.044[d]	-.310	.758	-.042	.193
5	2A090	-.043[e]	-.208	.836	-.029	.084
	2A300	.041[e]	.226	.822	.031	.113
	2A373	-.063[e]	-.442	.661	-.061	.178
	2A571	.154[e]	.730	.468	.100	.082
	2A590	.177[e]	1.276	.207	.173	.185
	2A600	.016[e]	.103	.919	.014	.151
	2A653	.277[e]	2.472	.017	.322	.261

2A655	-.039[e]	-.285	.777	-.039	.195
2A656	.215[e]	1.819	.075	.242	.247
2A672	.026[e]	.126	.900	.017	.085
2A673	-.073[e]	-.444	.659	-.061	.136
2A674	.081[e]	.540	.592	.074	.162
2A675	.183[e]	.799	.428	.109	.069
2A676	.082[e]	.478	.634	.066	.125
2A690	-.055[e]	-.505	.615	-.069	.304
2A691	.112[e]	1.189	.240	.161	.400
2A692	.260[e]	1.529	.132	.205	.121
2A751	.095[e]	1.031	.307	.140	.424
2A752	.079[e]	.509	.613	.070	.149
2A753	-.172[e]	-.786	.436	-.107	.075
2A771	.055[e]	.258	.798	.035	.081
2A772	-.035[e]	-.156	.877	-.021	.072
2A773	.046[e]	.266	.791	.037	.125
2A790	.239[e]	1.221	.227	.165	.093
2R000	-.142[e]	-.855	.396	-.117	.131
2R051	.016[e]	.152	.880	.021	.336
2R071	-.022[e]	-.143	.887	-.020	.152
2R090	.268[e]	1.157	.252	.157	.066

	2R151	-.250[e]	-2.060	.044	-.272	.230
	2R171	.257[e]	1.446	.154	.195	.111
6	2A090	.010[f]	.050	.960	.007	.083
	2A300	.052[f]	.304	.762	.042	.113
	2A373	.043[f]	.302	.764	.042	.162
	2A571	.063[f]	.305	.762	.042	.079
	2A590	-.041[f]	-.239	.812	-.033	.115
	2A600	.044[f]	.298	.767	.041	.151
	2A655	-.025[f]	-.193	.848	-.027	.194
	2A656	.026[f]	.160	.874	.022	.123
	2A672	.060[f]	.301	.765	.042	.084
	2A673	.051[f]	.308	.760	.043	.123
	2A674	.043[f]	.299	.766	.041	.160
	2A675	.069[f]	.305	.761	.042	.065
	2A676	.050[f]	.305	.762	.042	.124
	2A690	.030[f]	.273	.786	.038	.273
	2A691	-.034[f]	-.296	.768	-.041	.257
	2A692	.056[f]	.283	.778	.039	.086
	2A751	.013[f]	.140	.889	.019	.362
	2A752	-.036[f]	-.228	.821	-.032	.135
	2A753	.055[f]	.238	.812	.033	.062

	2A771	.055[f]	.272	.786	.038	.081
	2A772	.067[f]	.307	.760	.042	.069
	2A773	.050[f]	.304	.762	.042	.125
	2A790	.063[f]	.306	.761	.042	.078
	2R000	.044[f]	.246	.806	.034	.104
	2R051	.024[f]	.237	.814	.033	.336
	2R071	-.015[f]	-.099	.922	-.014	.152
	2R090	.031[f]	.122	.903	.017	.053
	2R151	.023[f]	.096	.924	.013	.058
	2R171	.058[f]	.290	.773	.040	.083
7	2A090	.024[g]	.133	.895	.018	.097
	2A300	.033[g]	.207	.837	.028	.129
	2A373	.028[g]	.211	.834	.029	.182
	2A571	.039[g]	.205	.838	.028	.090
	2A590	-.010[g]	-.074	.942	-.010	.166
	2A600	.031[g]	.217	.829	.030	.165
	2A655	-.004[g]	-.034	.973	-.005	.280
	2A656	.001[g]	.009	.993	.001	.176
	2A672	.040[g]	.213	.832	.029	.094
	2A673	.030[g]	.198	.844	.027	.144
	2A674	.029[g]	.215	.831	.029	.178

2A675	.043[g]	.205	.838	.028	.075
2A676	.031[g]	.206	.838	.028	.142
2A690	.010[g]	.109	.914	.015	.382
2A691	-.014[g]	-.142	.887	-.020	.343
2A692	.020[g]	.122	.904	.017	.118
2A751	.017[g]	.188	.852	.026	.380
2A752	-.008[g]	-.063	.950	-.009	.196
2A753	.053[g]	.229	.820	.031	.062
2A771	.046[g]	.230	.819	.032	.083
2A772	.041[g]	.201	.842	.028	.080
2A773	.031[g]	.207	.837	.028	.142
2A790	.038[g]	.202	.841	.028	.090
2R000	.041[g]	.230	.819	.032	.105
2R051	.006[g]	.071	.943	.010	.484
2R071	.004[g]	.034	.973	.005	.208
2R090	-.004[g]	-.018	.985	-.003	.074
2R151	.037[g]	.162	.872	.022	.063
2R171	.023[g]	.132	.895	.018	.113
Age	.029[g]	.231	.818	.032	.209

a. Predictors in the Model: (Constant), Age

b. Predictors in the Model: (Constant), Age, 2A652

c. Predictors in the Model: (Constant), Age, 2A652, USE rate

d. Predictors in the Model: (Constant), Age, 2A652, USE rate, 2A654

e. Predictors in the Model: (Constant), Age, 2A652, USE rate, 2A654, 2A390

f. Predictors in the Model: (Constant), Age, 2A652, USE rate, 2A654, 2A390, 2A653

g. Predictors in the Model: (Constant), 2A652, USE rate, 2A654, 2A390, 2A653

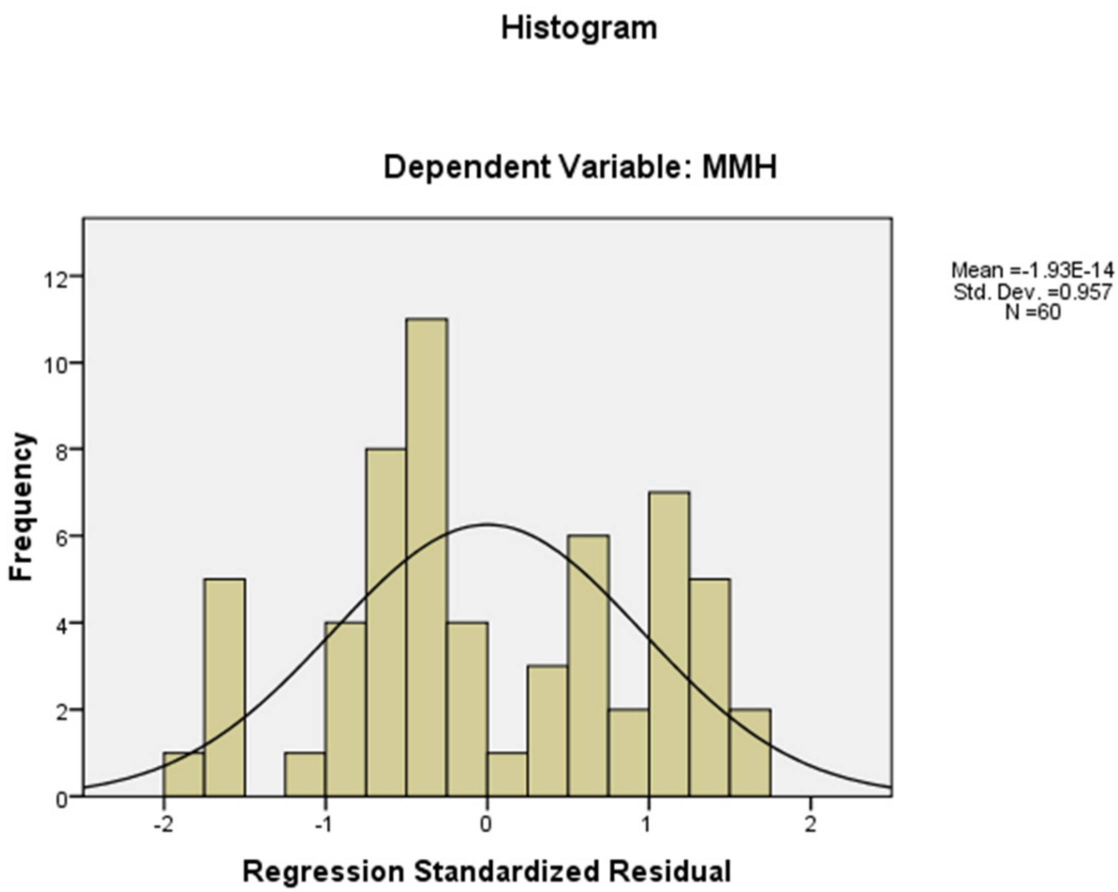
h. Dependent Variable: MMH

Residuals Statistics[a]

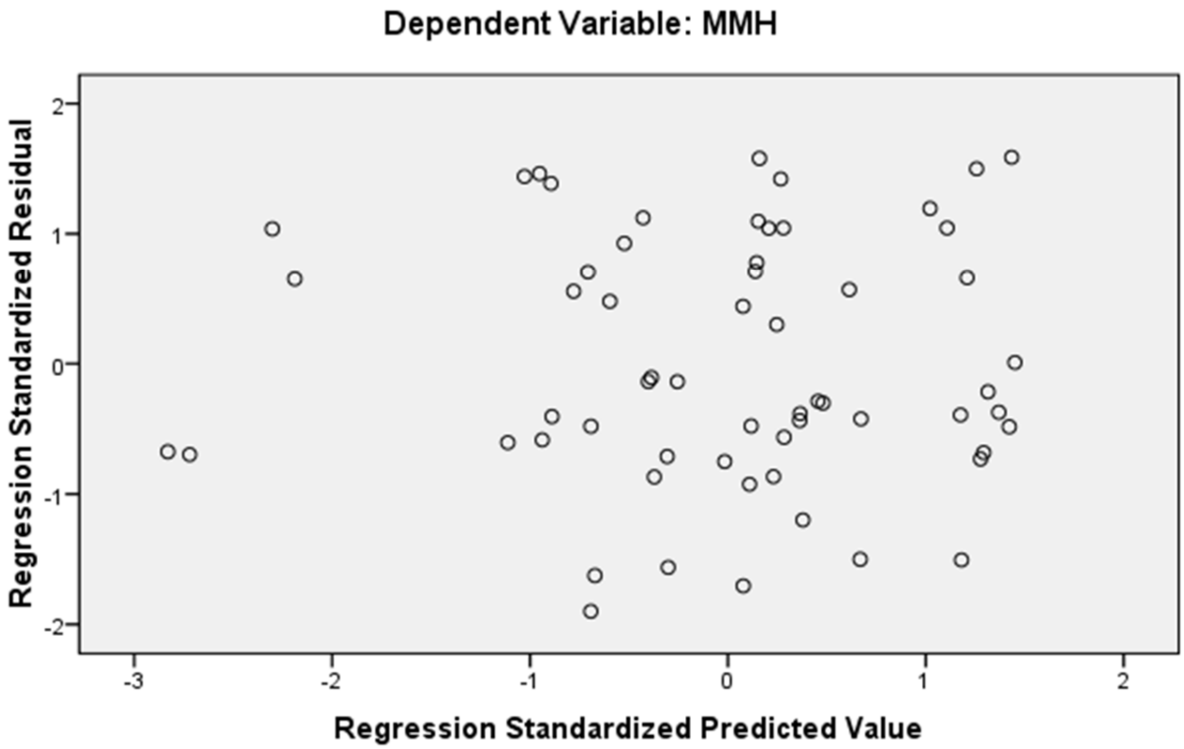
	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	455.158173	3825.964355	2684.010000	787.4671071	60
Residual	-717.4897461	599.2650757	.0000000	361.2615473	60
Std. Predicted Value	-2.830	1.450	.000	1.000	60
Std. Residual	-1.900	1.587	.000	.957	60

a. Dependent Variable: MMH

Charts


Histogram
Dependent Variable: MMH
Mean =-1.93E-14
Std. Dev. =0.957
N =60
Frequency
0
2
4
6
8
10
12
-2
-1
0
1
2
Regression Standardized Residual

Scatterplot



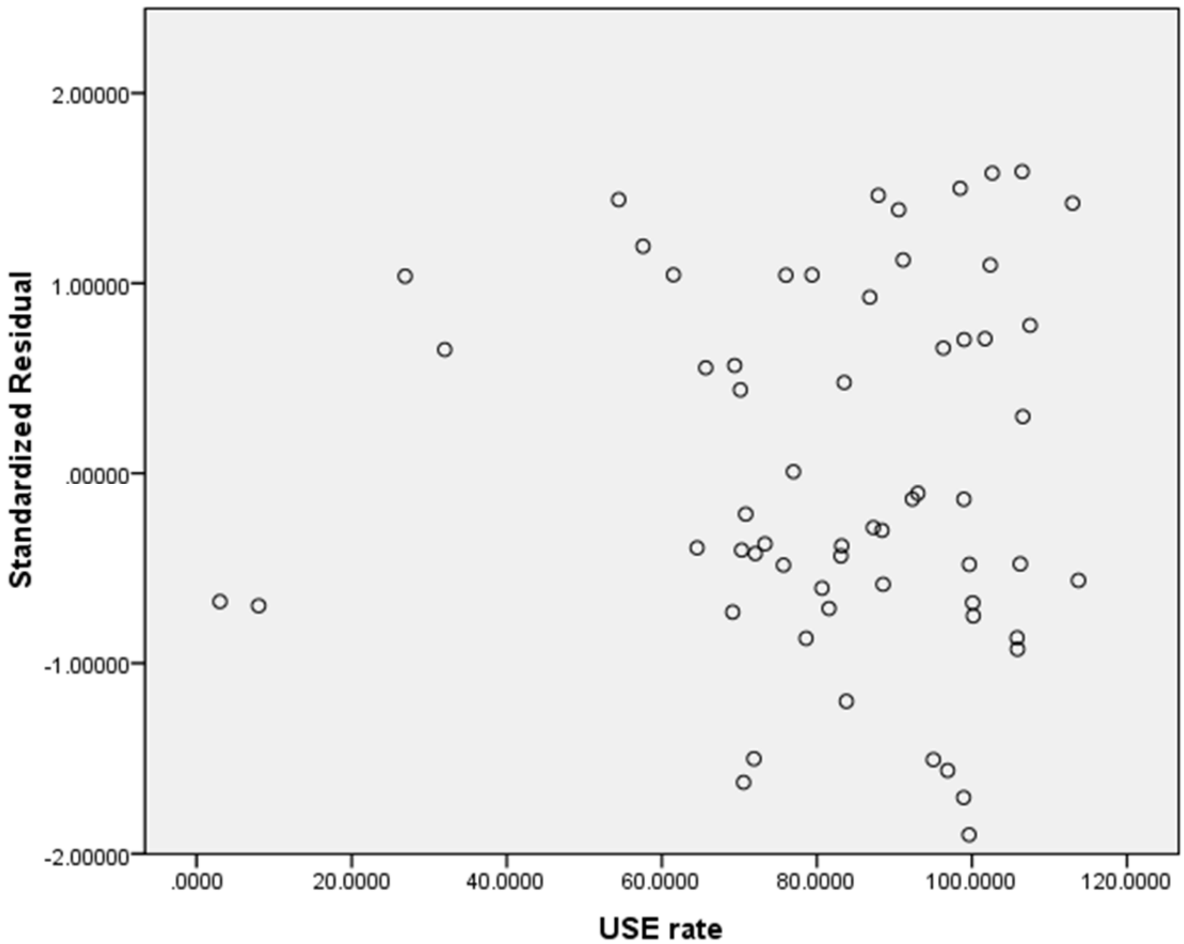
GGraph

Notes

Output Created		14-Feb-2012 14:33:45
Comments		
Input	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	60

Syntax		GGRAPH /GRAPHDATASET NAME="graphdataset" VARIABLES=USErate ZRE_1 MISSING=LISTWISE REPORTMISSING=NO /GRAPHSPEC SOURCE=INLINE. BEGIN GPL SOURCE: s=userSource(id("graphdataset")) DATA: USErate=col(source(s), name("USErate")) DATA: ZRE_1=col(source(s), name("ZRE_1")) GUIDE: axis(dim(1), label("USE rate")) GUIDE: axis(dim(2), label("Standardized Residual")) ELEMENT: point(position(USErate*ZRE_1)) END GPL.
Resources	Processor Time	0:00:00.437
	Elapsed Time	0:00:00.438

[DataSet1]


2.00000
1.00000
.00000
-1.00000
-2.00000
Standardized Residual
.0000
20.0000
40.0000
60.0000
80.0000
100.0000
120.0000
USE rate

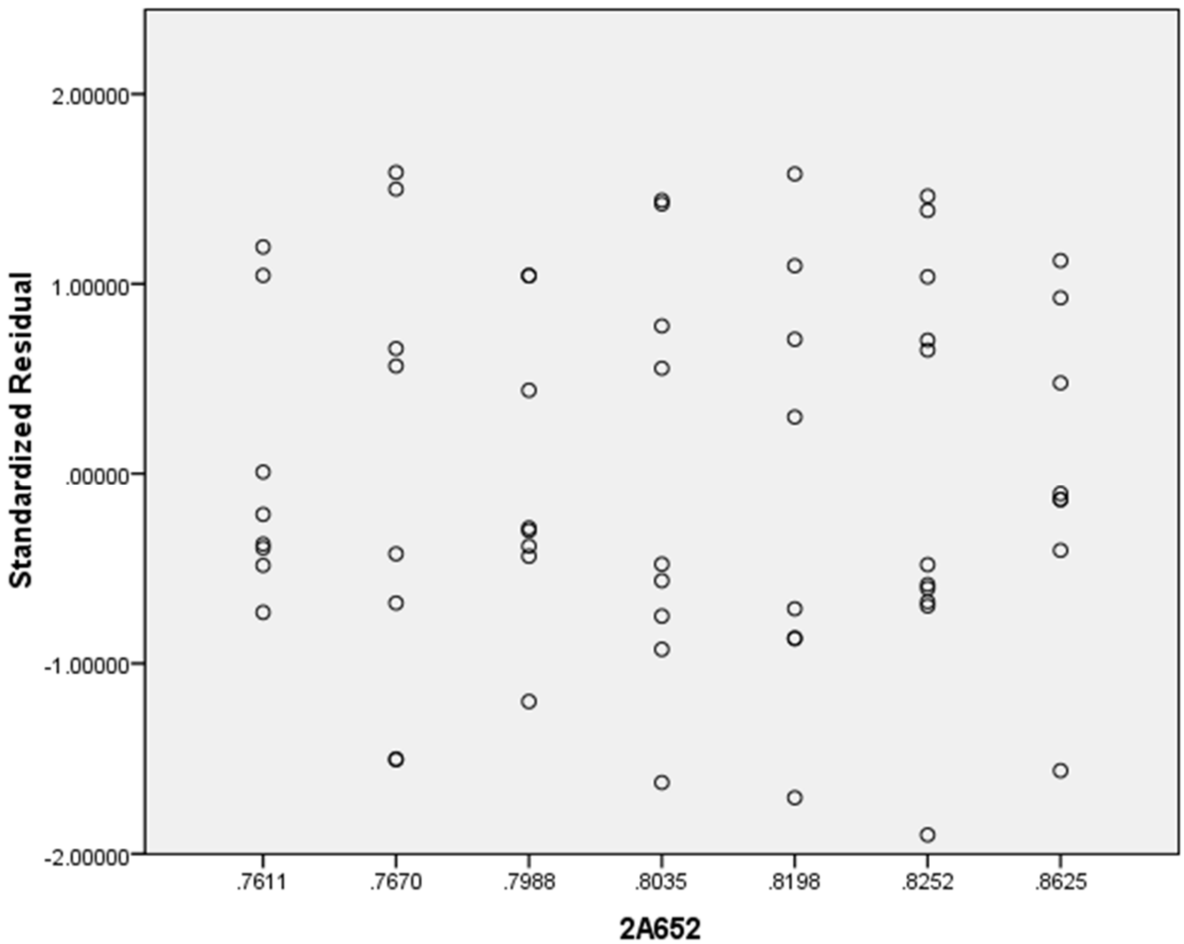
GGraph

Notes

Output Created		14-Feb-2012 14:38:07
Comments		
Input	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	60

Syntax		GGRAPH /GRAPHDATASET NAME="graphdataset" VARIABLES=@2A652[name="_2A652"] ZRE_1 MISSING=LISTWISE REPORTMISSING=NO /GRAPHSPEC SOURCE=INLINE. BEGIN GPL SOURCE: s=userSource(id("graphdataset")) DATA: A652=col(source(s), name("_2A652"), unit.category()) DATA: ZRE_1=col(source(s), name("ZRE_1")) GUIDE: axis(dim(1), label("2A652")) GUIDE: axis(dim(2), label("Standardized Residual")) SCALE: linear(dim(2), include(0)) ELEMENT: point(position(A652*ZRE_1)) END GPL.
Resources	Processor Time	0:00:00.358
	Elapsed Time	0:00:00.360

[DataSet1]


2.00000
1.00000
.00000
-1.00000
-2.00000
Standardized Residual
.7611
.7670
.7988
.8035
.8198
.8252
.8625
2A652

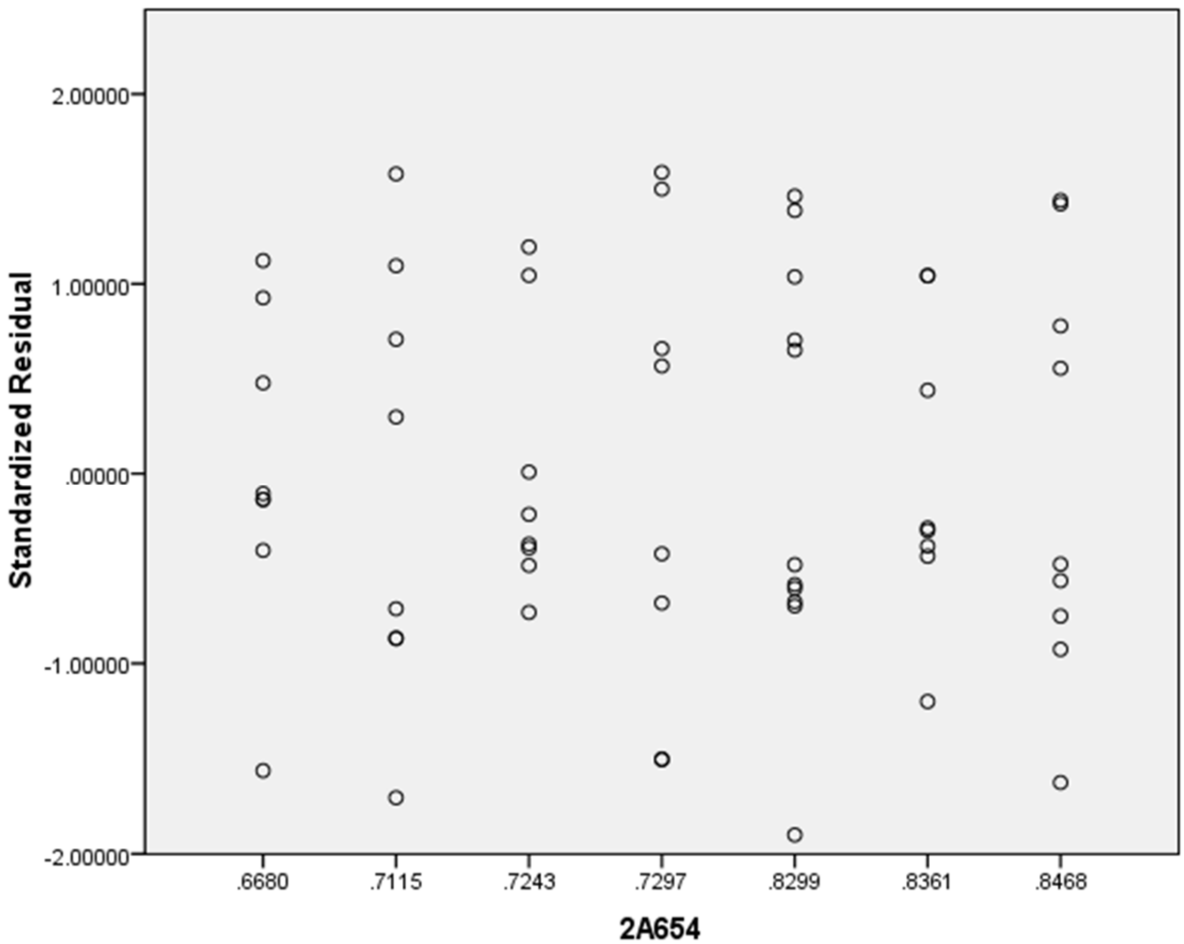
GGraph

Notes

Output Created		14-Feb-2012 14:47:33
Comments		
Input	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	60

Syntax		GGRAPH /GRAPHDATASET NAME="graphdataset" VARIABLES=@2A654[name="_2A654"] ZRE_1 MISSING=LISTWISE REPORTMISSING=NO /GRAPHSPEC SOURCE=INLINE. BEGIN GPL SOURCE: s=userSource(id("graphdataset")) DATA: A654=col(source(s), name("_2A654"), unit.category()) DATA: ZRE_1=col(source(s), name("ZRE_1")) GUIDE: axis(dim(1), label("2A654")) GUIDE: axis(dim(2), label("Standardized Residual")) SCALE: linear(dim(2), include(0)) ELEMENT: point(position(A654*ZRE_1)) END GPL.
Resources	Processor Time	0:00:00.327
	Elapsed Time	0:00:00.328

[DataSet1]


Standardized Residual
2.00000
1.00000
.00000
-1.00000
-2.00000
.6680
.7115
.7243
.7297
.8299
.8361
.8468
2A654

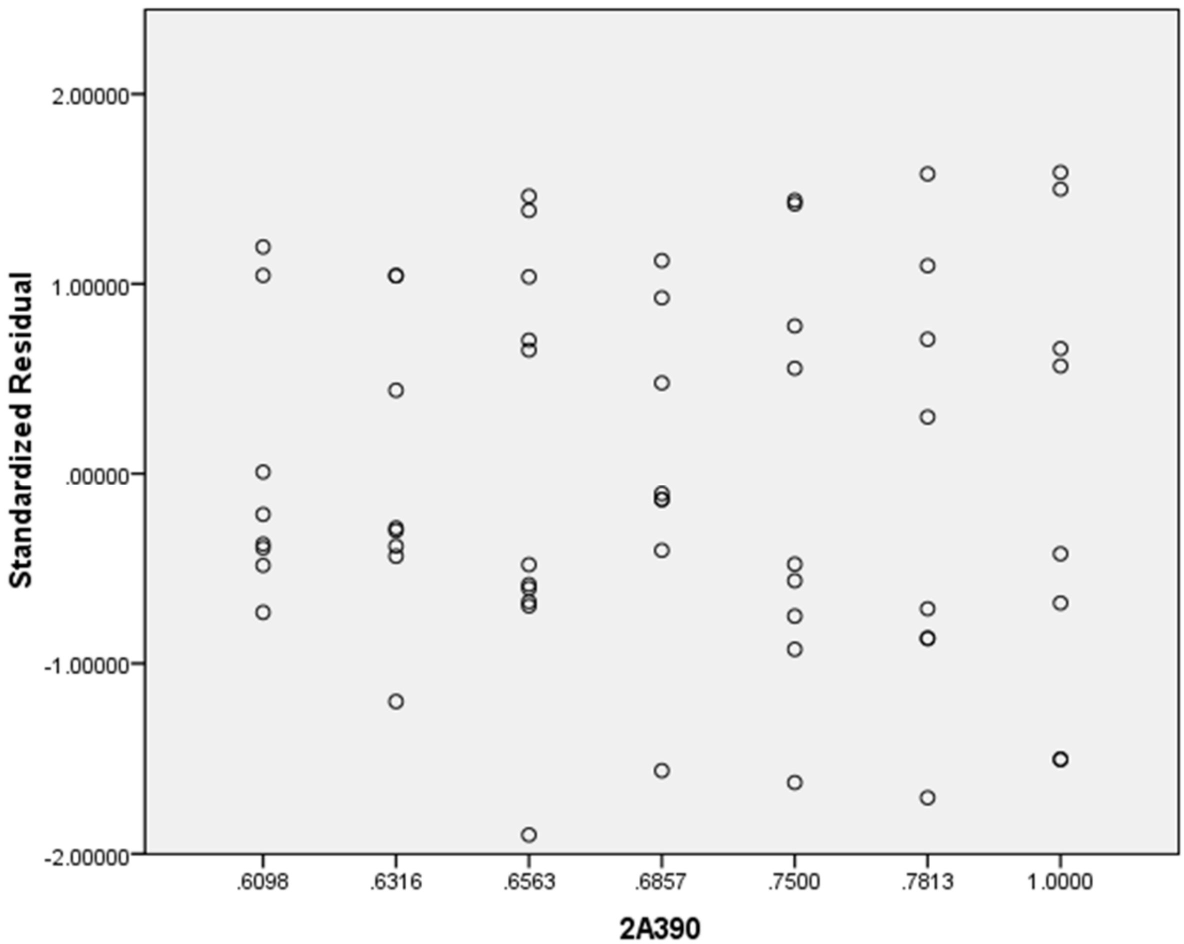
GGraph

Notes

Output Created		14-Feb-2012 14:48:06
Comments		
Input	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	60

Syntax		GGRAPH /GRAPHDATASET NAME="graphdataset" VARIABLES=@2A390[name="_2A390"] ZRE_1 MISSING=LISTWISE REPORTMISSING=NO /GRAPHSPEC SOURCE=INLINE. BEGIN GPL SOURCE: s=userSource(id("graphdataset")) DATA: A390=col(source(s), name("_2A390"), unit.category()) DATA: ZRE_1=col(source(s), name("ZRE_1")) GUIDE: axis(dim(1), label("2A390")) GUIDE: axis(dim(2), label("Standardized Residual")) SCALE: linear(dim(2), include(0)) ELEMENT: point(position(A390*ZRE_1)) END GPL.
Resources	Processor Time	0:00:00.390
	Elapsed Time	0:00:00.391

[DataSet1]



2.00000
1.00000
.00000
-1.00000
-2.00000
Standardized Residual
.6098
.6316
.6563
.6857
.7500
.7813
1.0000
2A390

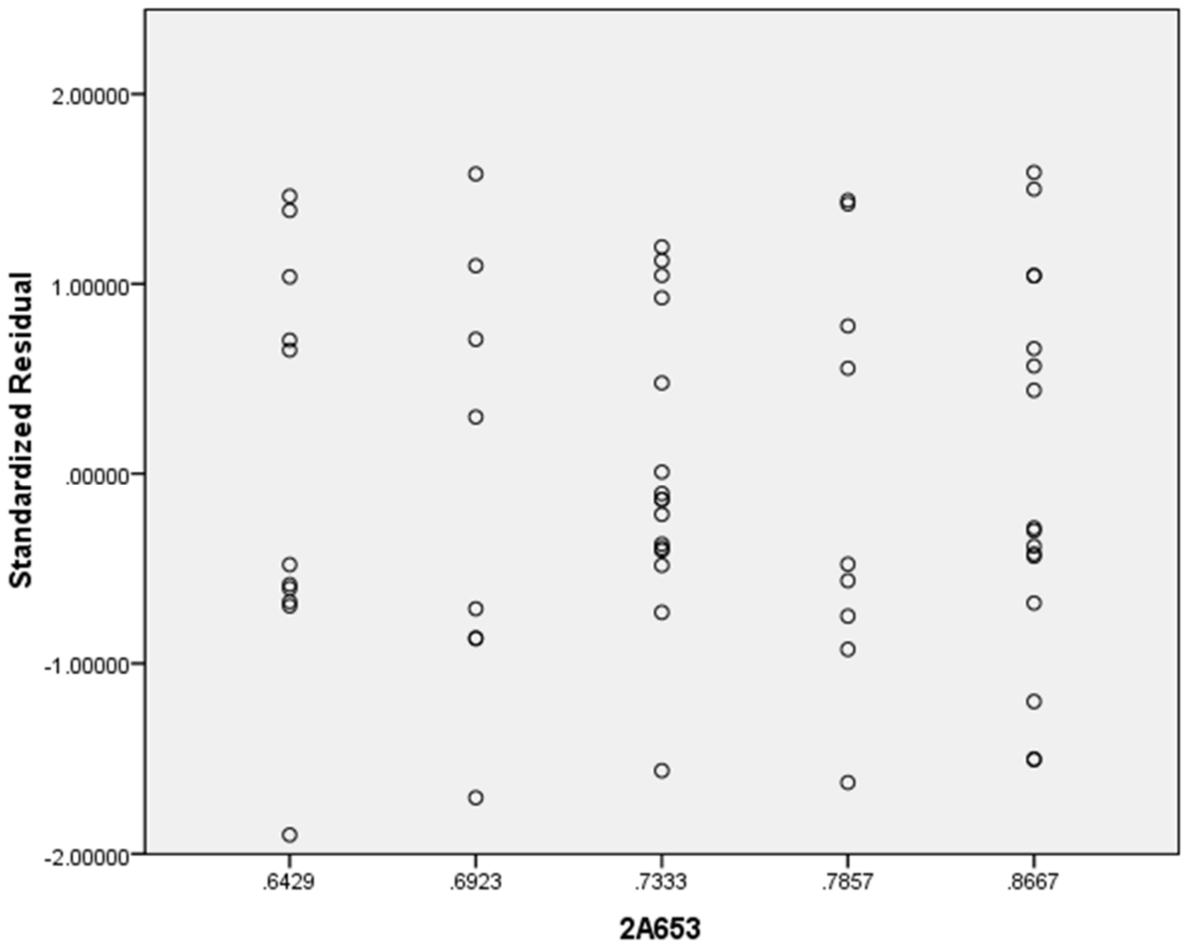
GGraph

Notes

Output Created		14-Feb-2012 14:49:05
Comments		
Input	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	60

Syntax		GGRAPH /GRAPHDATASET NAME="graphdataset" VARIABLES=@2A653[name="_2A653"] ZRE_1 MISSING=LISTWISE REPORTMISSING=NO /GRAPHSPEC SOURCE=INLINE. BEGIN GPL SOURCE: s=userSource(id("graphdataset")) DATA: A653=col(source(s), name("_2A653"), unit.category()) DATA: ZRE_1=col(source(s), name("ZRE_1")) GUIDE: axis(dim(1), label("2A653")) GUIDE: axis(dim(2), label("Standardized Residual")) SCALE: linear(dim(2), include(0)) ELEMENT: point(position(A653*ZRE_1)) END GPL.
Resources	Processor Time	0:00:00.328
	Elapsed Time	0:00:00.327

[DataSet1]


2.00000
1.00000
.00000
-1.00000
-2.00000
Standardized Residual
.6429
.6923
.7333
.7857
.8667
2A653

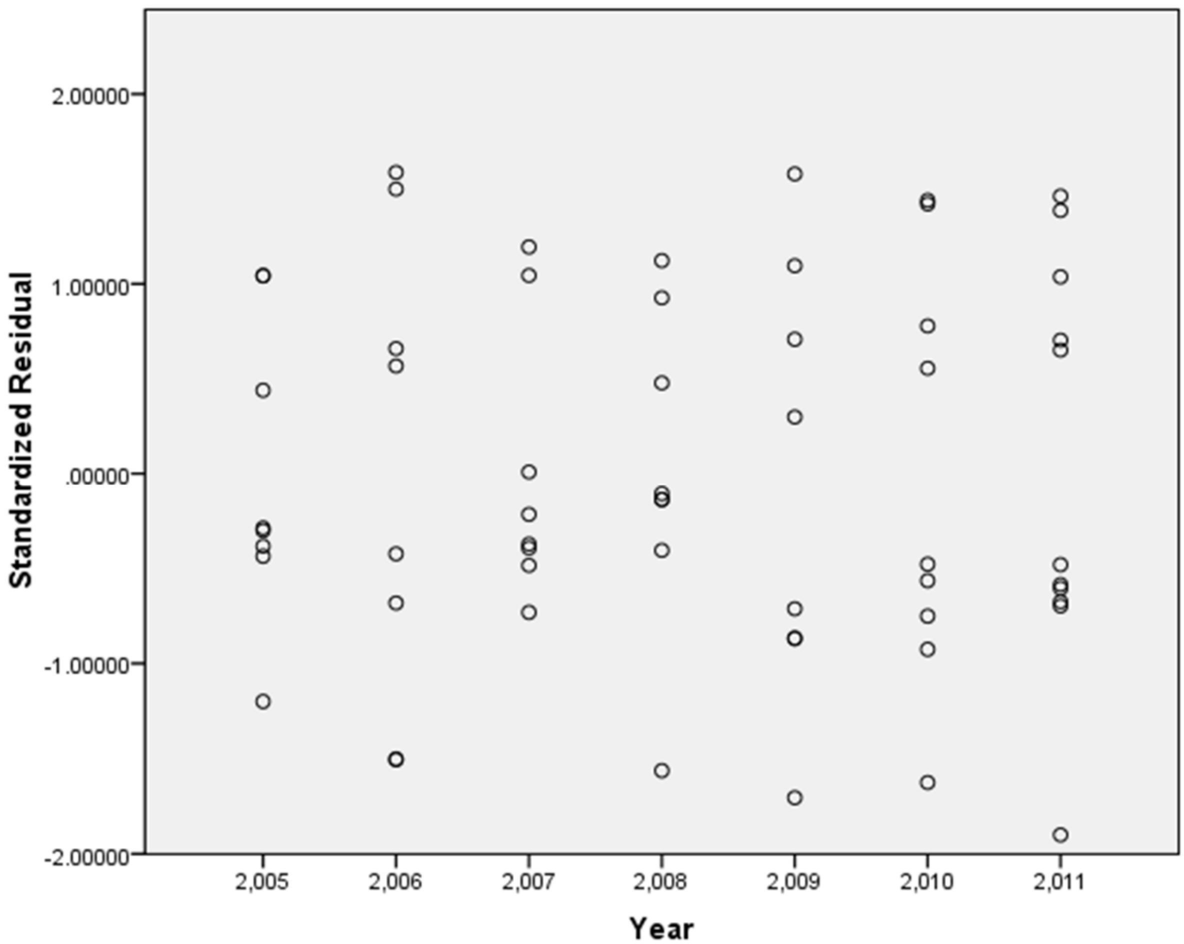
GGraph

Notes

Output Created		14-Feb-2012 15:11:24
Comments		
Input	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	61

Syntax		GGRAPH /GRAPHDATASET NAME="graphdataset" VARIABLES=Year ZRE_1 MISSING=LISTWISE REPORTMISSING=NO /GRAPHSPEC SOURCE=INLINE. BEGIN GPL SOURCE: s=userSource(id("graphdataset")) DATA: Year=col(source(s), name("Year"), unit.category()) DATA: ZRE_1=col(source(s), name("ZRE_1")) GUIDE: axis(dim(1), label("Year")) GUIDE: axis(dim(2), label("Standardized Residual")) SCALE: linear(dim(2), include(0)) ELEMENT: point(position(Year*ZRE_1)) END GPL.
Resources	Processor Time	0:00:00.312
	Elapsed Time	0:00:00.312

[DataSet1]


2.00000
1.00000
.00000
-1.00000
-2.00000
Standardized Residual
2,005
2,006
2,007
2,008
2,009
2,010
2,011
Year

Variability Inflation Factor Analysis

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.392[a]	.154	.092	21.9070191	.154	2.495	4	55	.053

a. Predictors: (Constant), 2A654, 2A653, 2A652, 2A390

USE Rate

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.559[a]	.313	.263	.1046221	.313	6.259	4	55	.000

a. Predictors: (Constant), 2A654, 2A653, USE rate, 2A652

2A390

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.552[a]	.305	.254	.0275331	.305	6.021	4	55	.000

a. Predictors: (Constant), 2A654, 2A653, USE rate, 2A390

2A652

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.612[a]	.375	.330	.0661705	.375	8.249	4	55	.000

a. Predictors: (Constant), 2A652, USE rate, 2A654, 2A390

2A653

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.354[a]	.125	.062	.0652420	.125	1.971	4	55	.112

a. Predictors: (Constant), 2A653, USE rate, 2A390, 2A652

2A654

Appendix C. Quad Chart

A LINEAR REGRESSION MODEL IDENTIFYING THE PRIMARY FACTORS CONTRIBUTING TO MAINTENANCE MAN HOURS FOR THE C-17 GLOBEMASTER III IN THE AIR NATIONAL GUARD

Maj James M. Nasman

Advisor: Lt Col Shay R. Capehart, PhD

Advanced Studies of Air Mobility (ENS)

Air Force Institute of Technology

Introduction

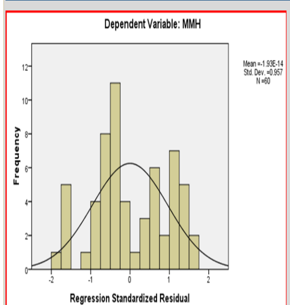
Because of the sheer volume of capability that the Reserve Component brings to the fight, any perceived threat to that capability must be regarded with the most intense scrutiny. The purpose of this research is to analyze the factors contributing to the number of maintenance man hours it takes to return a C-17 aircraft to an available status. This analysis is important because if these factors can be identified, Commanders and Maintenance Officers can more easily take steps to address those factors and potentially improve aircraft availability and mission success rates.

Research Goals

The goal of my research was to identify those factors that most directly contribute to aircraft maintenance man hours in an effort to provide commanders insight into areas for improvement within their organizations that can directly affect mission accomplishment.

The Regression Equation

MMH = 19540.893 – 18487.684(2A652) + 17.418(USE rate) – 5280.275(2A654) – 1939.487(2A390) + 2756.975(2A653)



Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
7	(Constant)	19540.893	1980.225		9.868	.000	15570.781	23511.005
	2A652	-18487.684	1849.330	-.680	-9.997	.000	-22195.367	-14780.000
	USE rate	17.418	2.324	.462	7.494	.000	12.758	22.078
	2A654	-5280.275	780.444	-.411	-6.766	.000	-6844.972	-3715.578
	2A390	-1939.487	486.683	-.273	-3.985	.000	-2915.227	-963.746
	2A653	2756.975	769.494	.257	3.583	.001	1214.234	4299.717

"Remembering the Forgotten Mechanic"

"Through the history of world aviation
many names have come to the fore—
Great deeds of the past in our memory will last,
as they're joined by more and more—

When man first started his labor in his quest to conquer the sky
he was designer, mechanic and pilot, and he built a machine that would fly—
But somehow the order got twisted, and then in the public's eye
the only man that could be seen was the man who knew how to fly—
The pilot was everyone's hero. He was brave, he was bold, he was grand,
as he stood by his battered old biplane with his goggles and helmet in hand—
To be sure, these pilots all earned it, to fly you have to have guts—
And they blazed their names in the hall of fame
on wings with bailing wire struts—

But for each of these flying heroes there were thousands of little renown,
and these were the men who worked on the planes
but kept their feet on the ground—
We all know the name of Lindbergh, and we've read of his flight to fame—
But think, if you can, of his maintenance man,
can you remember his name?

And think of our wartime heroes, Gabreski, Jabara, and Scott—
Can you tell me the names of their crew chiefs?
A thousand to one you cannot—

Now pilots are highly trained people, and wings are not easily won—
But without the work of the maintenance man
our pilots would march with a gun—
So when you see mighty jet aircraft as they mark their way through the air;
the grease-stained man with the wrench in his hand
is the man who put them there—"

Author unknown

Impact/Contributions

- Provides ANG leadership with quantifiable data identifying areas in manning and operations tempo that may require attention and/or adjustment
- Provides a valid, accurate quantitative analysis tool for focused improvement efforts

Collaboration

- ANG Readiness Center A4
- ANG Readiness Center A1
- Stewart ANG Base, New York

AIR FORCE INSTITUTE of TECHNOLOGY

Distribution Limited to U.S. Government Agencies; Administrative / Operational Use. June 2011. Other requests for this document must be referred to: AFIT/ENS, WPAFB OH 45433-7765

Bibliography

Abilla, P., *Applied Regression Analysis.* http://www.shmula.com/applied-regression-analysis/192/. 2006.

Benson, P., McClave, J., Sincich, T. *Statistics for Business and Economics.* Boston: Prentice Hall. 2011.

Davis, R. (1996, March 21). DOD Reserve Components: Issues Pertaining to Readiness (Testimony, 03/21/96, GAO/T-NSIAD-96-130).

Dixon, M. C. *The Maintenance Costs of Aging Aircraft: Insights from Commercial Aviation.* Rand. (2010).

Drew, J. G., Lynch, K. F., Masters, J. M., Tripp, R. S., Roll, Jr., C. R. (2008). *Options for Meeting the Maintenance Demands of Active Associate Flying Units*. Rand Corporation public report.

Francis, P. J., Shaw, G. B. *Effect of Aircraft Age on Maintenance Costs.* Center for Naval Analyses. 2000.

Goldberger, A. S., (1962, June). Best Linear Unbiased Prediction in the Generalized Linear Regression Model, *Journal of the American Statistical Association, 57, 369-375.*

Howe, J. A., Theole, B. A., Pendley, S. A., Antoline, A. F., Golden, R. D., Beyond Authorize versus Assigned: Aircraft Maintenance Personnel Capacity, *Air Force Journal of Logistics, 31, 16-26.*

Stockburger, D. *Multiple Regression with Many Predictor Variables.* http://www.psychstat.missouristate.edu/multibook/mlt07m.html

Simon, L. J., (2004). *Lesson #12: Multicollinearity*. The Pennsylvania State University. http://online.stat.psu.edu/online/development/stat501/12multicollinearity/05multico_vif.html.

USAF, n.d., C-17 Globemaster Fact Sheet, http://www.af.mil/information/factsheets/factsheet.asp?fsID=86

USAF, 105AW, 2011, C-17 Comparative Analysis

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

1. REPORT DATE *(DD-MM-YYYY)*	**2. REPORT TYPE**	**3. DATES COVERED** *(From - To)*
06/15/2012	Graduate Research Project	05/23/2011 - 06/15/2012

4. TITLE AND SUBTITLE	**5a. CONTRACT NUMBER**
A Linear Regression Model Identifying the Primary Factors Contributing to Maintenance Man Hours for the C-17 Globemaster III in the Air National Guard	
	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	**5d. PROJECT NUMBER**
Nasman, James M, Maj	
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)	**8. PERFORMING ORGANIZATION REPORT NUMBER**
Air Force Institute of Technology Graduate School of Engineering and Management (AFIT/EN) 2950 Hobson Way WPAFB OH 45433-7765	AFIT/IMO/ENS/12-10
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	**10. SPONSOR/MONITOR'S ACRONYM(S)**
Air National Guard Readiness Center A4 Col Mike Ogle, ANG Readiness FO/A4 Air National Guard Readiness Center Joint Base Andrews 20762	FO/A4
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
DISTRIBUTION STATEMENT A
APPROVED FOR PUBLIC RELEASE; DISTRIBUTION IS UNLIMITED.

13. SUPPLEMENTARY NOTES

14. ABSTRACT
The purpose of this research was to identify the primary correlating factors contributing to the amount of Maintenance Man Hours expended on maintaining the C-17 Globemaster III aircraft in the Air National Guard. The research question was answered through the use of statistical analysis comprised of multivariate linear regression modeling.
A literature review was performed with limited results as, though there is literature available that addresses linear regression modeling and the use of various metrics, there is no documentation that the researcher is aware of specific to the use of linear regression in this specific manner.

15. SUBJECT TERMS
C-17, Linear Regression, Air National Guard, Maintenance Man Hours

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			Dr. Shay Capehart, LtCol, USAF
					19b. TELEPHONE NUMBER *(Include area code)*
U	U	U	UU	124	DSN: 785-3636 x4516