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# THESIS

**AN ANALYTICAL COMPARISON OF HUMAN FACTOR MAINTENANCE RELATED PART FAILURES FOR NAVAL RESERVE FLEET LOGISTICS SUPPORT WING**

by


Daniel L. Allen


December 1999

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# AN ANALYTICAL COMPARISON OF HUMAN FACTOR MAINTENANCE RELATED PART FAILURES FOR NAVAL RESERVE FLEET LOGISTICS SUPPORT WING


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## LIST OF ACRONYMS

| | |
|---|---|
| CFLSW | Commander, Fleet Logistics Support Wing |
| DOD | Department of Defense |
| DON | Department of Navy |
| FLSW | Fleet Logistics Support Wing |
| HFACS | Human Factors Analysis and Classification System |
| HFQMB | Human Factors Quality Management Board |
| HR | Hazard Report |
| MF-HZ | Material Failure Hazard Report |
| MH-HZ | Mishap Hazard Report |
| MIR | Mishap Investigation Report |
| NON-VR | Naval Aviation C-130, C-9, C-20 Aircraft other than VR Wing |
| NSC | Navy Safety Center |
| NSCDB | Navy Safety Center Database |
| PAT | Process Action Team |
| PT FAIL | Human Factor Part Failure |
| SIMS | Safety Information Management System |
| TPF | Total Parts-related Failures |
| SQN | Squadron/Organization Personnel |
| VR | Naval Designation for Fleet Logistics Support Squadrons |

# EXECUTIVE SUMMARY

Naval Aviation like all DOD activities has experienced extensive change in recent years. Financial constraints, force reductions, and increasing OPTEMPO have impacted not only the material condition of Naval aircraft, but also the personnel who maintain them. In recent years the Naval Aviation Community has extensively studied the role of human factors, especially air crew error, in safety incident rates. One such effort, the Human Factors Quality Management Board (HFQMB), was chartered to analyze and improve each of the processes, programs and systems that impact human performance in aviation, with the purpose of dramatically reducing the annual flight mishap rate.

In order to foster future gains the scope of the HFQMB was expanded to include maintenance. The concern is for the aging of Naval aircraft, the slowing of replacement aircraft acquisitions, vertical cuts in aircraft types, force reductions, and sustaining of current OPTEMPO. Out of the HFQMB a Process Action Team (PAT) was formed to look into the role of human factors pertaining to maintenance in safety incidences. This led to the development of the Human Factor Analysis and Classification System-Maintenance Extension (HFACS-ME) as a model to identify and classify human causal factors.

Commander, Fleet Logistics Support (VR) Wing (CFLSW) has taken a proactive stance on maintenance safety. In support of this stance this study compares the parts-related safety incidences of the VR Wing to other similar Naval Aviation aircraft communities. As funding constraints tighten, the resources available to maintain VR Wing material readiness are impacted. Further straining financial resources, replacement parts for aircraft continue to rise in price. These constraints make it necessary to mitigate the unnecessary failure/destruction of piece parts in order to stretch every available dollar.

This study systematically examines the relationship between part failures and human factors in those failures. Of the 500 safety incident reports analyzed, 401 contained some form of parts-related failure. Those parts-related incidents are subdivided and categorized through data exploration process. Fiscal year tallies are generated, and a rate of incidents per flying hour is computed. The purpose of this data exploration is to obtain a quantitative baseline for regression analysis and hypothesis testing.

This research involves the analysis of Hazard, Mishap, and Material Failure Hazard Reports of C-130, C-9, and C-20 aircraft, maintained by the Naval Safety Center in the Safety Information Management System (SIMS) database. The

SIMS database is used because it links human factors to material failures. From this database 500 material related incidences ranging from fiscal year 1990 through 1999 are extracted and an exploratory data analysis is accomplished.

The results of this study provide Commander, Fleet Logistics Support Wing a baseline with which to raise maintainer awareness, both within and external to the VR Wing. The results show an increasing trend in parts-related failure. Eventhough the degree which human factors affect parts failures is not determined, one can infer from the analysis that human factors in maintenance are impacting readiness throughout the Naval Aviation community.

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# I. INTRODUCTION

## A. BACKGROUND

After the crash of an F14 fighter in Tennessee in 1996, which killed the aircrew members and civilians on the ground, an investigation of the crash pointed to human factors as the major cause (Nutwell & Sherman, 1997). This mishap, along with other similar human factors based mishaps, prompted immediate reaction by the Commander, Naval Air Force Pacific Fleet (COMNAVAIRPAC) to establish a Human Factors Quality Management Board (HFQMB). This HFQMB was chartered to analyze and improve each of the processes, programs and systems that impact human performance in aviation with the purpose of dramatically reducing the annual flight mishap rate.

The HFQMB used a three prong approach to get at human factor issues: Mishap Data Analysis, Benchmarking, and Climate Safety Assessment. Each provided a different perspective of the human factor problem. The insights gleaned by the HFQMB were briefed to the Navy's Air Board as well as the senior USMC leadership for consideration and support. This has led to several changes in Naval Aviation systems, programs, training, etc., which have notably served to reduce Class A mishap rate (Schmidt, 1999 personal communication).

In order to foster future gains the scope of the HFQMB was expanded to include maintenance. The same three-prong approach was adapted that was used for aircrew; it was determined that human factors in maintenance is an important area to address (Schmidt, Schmorrow, & Hardee, 1998). Underscoring this concern are those related to the aging of Naval aircraft, the slowing of replacement aircraft acquisitions, vertical cuts in aircraft types, and the sustaining of current operation tempo. The Commander, Naval Air Systems Command addressed his concerns to the general Naval Aviation community and emphasized the importance of effective and preventive maintenance as they relate to aviation safety (Lockhardt, 1997). His belief was that through an aggressive and proactive maintenance program, valuable air assets could be preserved.

The Commander, Fleet Logistics Support Wing (CFLSW), in order to take a proactive stance on maintenance safety, enlisted the help of the School of Aviation Safety at the Naval Postgraduate School, Monterey CA, to examine human factors in maintenance issues in his organization. This partnership resulted in two theses, Teeters (1999) and Goodrum (1999). Teeters, building on a previous effort by

Schmorrow (1998), analyzed and modeled all maintenance related mishaps in the Fleet Logistics Support (VR) Wing community using the Human Factors Analysis and Classification System-Maintenance Extension (HFACS-ME). He determined which error forms were most prevalent and developed a methodology for forecasting the relational benefit of intervention strategies. Goodrum, expanding an earlier effort by Baker (1998), employed a Maintenance Climate Assessment survey to assess the perception of safety within the same VR Wing squadrons that had experienced the mishaps analyzed by Teeters. Finally, Sciretta (1999) in an unpublished letter report analyzed the Naval Safety Center's Maintenance Survey findings of the last two years for 13 of the 14 squadrons in the VR Wing. He identified the more common maintenance program discrepancies that were prevalent throughout the wing.

To complete the missing component of the previous human factor research this thesis compares parts-related safety incidences of VR Wing aircraft with those of other similar Naval Aviation communities, (referred to throughout this theses as "Non-VR" i.e., other Navy and Marine Corps C-130, C-9, and C-20 aircraft). From the Naval Safety Center (NSC) Safety Information Management System (SIMS) database, elements of Hazard, Mishap, and Material Failure Reports, that were "parts related" for all VR Wing type aircraft (C-130, C-9, and C-20) were collected for analysis. The incident report information was classified by the degree human factors contributed to a part failure and whether the human factors were maintenance-related. Then, the HFACS-ME was used as a template to determine if the incident occurred as a result of Squadron or Non-Squadron maintenance practices. This study compares the findings to the Non-VR Naval Aviation community.

## B. PROBLEM STATEMENT

Recent Department of Defense (DOD) financial constraints have impacted the VR Community. The decrease in funding required to maintain VR Wing material readiness has also had an impact. As replacement parts for aircraft continue to rise in price, the need to mitigate the unnecessary failure/destruction of piece parts becomes an ever increasing priority. The present study addresses the following questions:

1. Is there a difference in the rate of parts-related safety incidences between VR and Non-VR?
    - Is there a trend in VR or Non-VR?
    - Is there a difference in human factor (HF) parts-related safety incidences between VR and Non-VR; and is there a trend in VR or Non-VR?

- Is there a difference pertaining to human factor in maintenance (HF-ME) parts-related safety incidences between VR and Non-VR; and is there a trend in VR or Non-VR?

2. Does human factors in the VR community contribute to a higher incidence of part failures than the rest of the C-130, C-9, and C-20 community (Non-VR)?

   - Is there a trend in human factors causing part failures in VR or Non-VR?

3. Is there a difference between Squadron (organizational level) and Non-Squadron (Depot, facilities, NAVAIR) human-factor in maintenance (HF-ME) parts related safety incidences for VR and Non-VR?

   - Is there a trend in Squadron human-factor in maintenance causing part failures in VR or Non-VR? Non-Squadron?

4. Does Squadron human factors in the VR community contribute to a higher incidence of part failures than the rest of the C-130, C-9, and C-20 community (Non-VR)? Non-Squadron?

   - Is there a trend in Squadron human factors causing part failures in VR or Non-VR? Non-Squadron?

## C. OBJECTIVE

The purpose of this research is to determine if there is a difference in the rate of parts related safety incidences between VR and Non-VR aircraft communities. By utilizing part failure safety incidences reported in VR community aircraft mishap, hazard, and material failure hazard reports, a determination can be made suggesting if the VR Wing is experiencing undue parts failures as a result of human factor actions. The association between material failures, human factors, and human factors in maintenance actions is examined to achieve a better understanding of VR Wing human factor involvement in parts failures as compared to the rest of Naval Aviation (Non-VR).

## D. SCOPE AND LIMITATIONS

This study examines the relationship between human factor maintenance-related errors and their impact on part failures for the VR Wing. Each of the three reports (i.e. Mishap, HAZREP, and Material Failure), contained in NSC's SIMS, are analyzed and classified based on the HFACS-ME. Once classified, those maintenance-related incidences requiring repair parts are further examined to determine if Human Factors contributed to the cause of the failure. The results achieved from the analysis of the NSC-derived database are statistically compared (VR vs. Non-VR) to determine if the VR community differs from similar Naval Aviation communities and if a trend exists indicating a rise or decline in incident rates.

In a subsequent analysis, these results are further broken down into Squadron and Non-Squadron related material failures. Squadron related failures are those actions performed by Squadron personnel (organizational level); Non-Squadron related failures are those actions, resulting in parts failures, performed by other than squadron personnel (i.e., depot, AIMD, facilities, etc.). This comparison provides the necessary validation to determine the extent human factors affect repair part failures and ultimately FSLW material and readiness posture.

Limitations inherent in the databases available include narrative data, absence of stock/part numbers, unreported incidences, cannibalizations, unrecorded maintenance, mislabeled or unidentified (bogus) parts, and possible duplication of reported incidences. SIMS Database reports from FY90 - FY99 are used in this study.

## E. ORGANIZATION OF THE THESIS

Chapter II, Literature Review, describes initiatives and analyses in this area of research, NSC reports and database utilized, and issues related to Human Factors and material requirements.

Chapter III describes the methodology utilized in this thesis, including data exploration, classification, data analysis, linear regression, and hypothesis test procedures.

Chapter IV contains the results of the data classification, analysis, and hypothesis test.

Chapter V summarizes the conclusions and recommendations.

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# II. LITERATURE REVIEW

## A. BACKGROUND

### 1. Naval Fleet Logistics Support Wing

The Naval Fleet Logistics Support (VR) Wing was founded in 1974 to provide rapid response, flexible and contingency air logistic support to U. S. Maritime Forces, anywhere and anytime. It is composed of 14 Reserve Force Squadrons consisting of 4,500 personnel and 51 aircraft. Three major aircraft types make up the VR Wing. The current types of aircraft are the C-9B/DC-9, the C130T, and the C-20G/D with 27, 18, and 6 each of the respective types in the VR Wing's inventory. Within each aircraft type are configuration and life cycle variances, which may differentiate one aircraft from another within each type. These differences are due to modifications, field changes, or phased component replacements. Additionally, aircraft are at varying ages or differing stages in their operational life-cycles. Aircraft require different levels of maintenance depending on the age and accumulated operating hours. Adding greater diversity to the VR Wing inventory is the pending arrival of the C-17 aircraft, which will be phased-in to support the growing worldwide medium and heavy lift requirements (Peniston, 1998).

The logistics support that the VR Wing provides ranges from Inter-theater (Strategic) to Intra-theater (Operational) to Carrier Onboard Deliver (COD) (Tactical). In this environment the VR aircraft have compiled over 60,000 flights hours a year, representing 53 percent of the Naval Reserve Force total program and a $1.7 billion capital investment. The VR Wing continues to exceed performance expectations in providing Global Logistics despite the increased operation tempo and the fact that the age of the VR aircraft ranges from 18 to 31 years. The ability to respond rapidly to contingency operations has ensured Fleet mobility and sustainability, while enabling Naval Forces to operate unencumbered through Maritime Air Logistics (NARA, 1999).

### 2. Human Factors Quality Management Board

The Human Factors Quality Management Board (HFQMB) was established to analyze human factor involvement in past Naval Aviation mishaps and in present Naval Aviation operations. In particular, it investigated Human Factor issues affecting tactical aircraft aircrew operations. Its approach (Figure 1), referred to as the "three-prong approach", uses information acquired from three areas, i.e., established practices benchmarking, mishap data analysis, and climate safety assessment. Its goal was to find ways to improve readiness and mission success through controlling safety related hazards (Nutwell & Sherman, 1997).

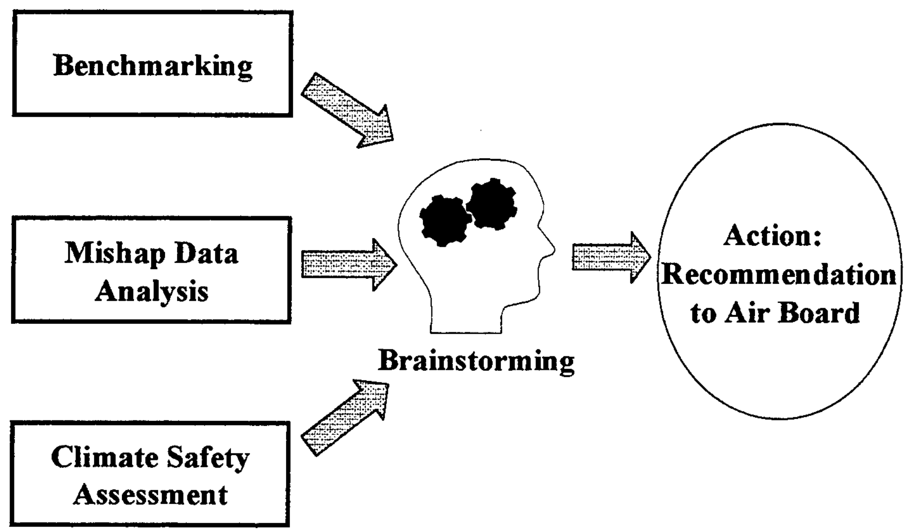


**Figure 1. HFQMB Methodology.**
**From "AIRPAC Brief," by CDR J. Schmidt, March 1998**

The HFQMB efforts yielded significant recommendations and results. It contributed to the Navy's safest year in Fiscal Year 1997. It directly contributed to the Marine Corps's safest year in Fiscal Year 1998 and the entire Naval Aviation community's safest year in Fiscal Year 1999. In light of the HFQMB's successful strategy of potentially reducing the number of mishaps attributed to aircrew operations error, the HFQMB broadened its focus to encompass maintenance operations using the same three-prong approach (Schmidt,1998/99 personal communication).

The HFQMB formed a new Process Action Team (PAT) which was tasked to assess human factors in maintenance and flight line operations using the three-prong approach since approximately one out of every five major mishaps involved maintenance error. Further, maintenance errors were even more prevalent in mishaps of lesser severity (Schmidt, Schmorrow, & Hardee, 1998).

### 3. Material Requirements

In a program, as demand for a part increases, its associated inventory model will respond by adding more safety level. This condition puts a stress on the organization's budget because inventory used to meet that demand will need to be acquired, in addition to the increased safety level. If maintenance-related human factors are a significant cause of this increase in demand, then identifying and reducing the causal factors will reduce the stress on the budget, which has the added feature of improving readiness.

The Naval Safety Center Data Base (NSCDB) SIMS, is the only resource which links human factor maintenance-related errors to material failures/part failures. A thorough comparison of FLSW parts related failures using the NSCDB with similar Navy parts related failures will indicate the impact human factors have on the VR Wing, whether a significant difference between the two communities (VR and Non-VR) exists, and if the incident rate is changing. These results infer the degree to which human factors affect the VR Wing's material readiness and inventory requirements.

## B. NAVAL AVIATION SAFETY PROGRAM

The Assistant Chief of Naval Operations (ACNO) Air Warfare has oversight responsibility for the Naval Aviation Safety Program. It includes all activities that may detect, contain, or eliminate hazards in Naval Aviation. It includes military and civilian personnel. It is based on the doctrine of necessitarianism and the belief that elimination of causal factors will inevitably reduce hazardous events [Department of the Navy (DON), 1991]. Based on this doctrine, it is through preventive measures that hazards can be eliminated thus preserving life and equipment (DON, 1991).

The Naval Aviation Safety Program was established to preserve human and material resources. It is monitored and tracked by the Naval Safety Center (NSC) (DON, 1991). NSC manages and retrieves aviation safety data which includes Mishap Investigation, Hazard, and Material Failure Hazard Reports.

## 1. Database

### *a) Mishap Investigation Reports*

A mishap is defined as an unplanned event or series of events directly involving naval aircraft, which results in $10,000 or greater cumulative damage to naval aircraft or personnel injury. The Mishap Investigation Report (MIR) is intended to report those hazards which are the cause of the reported mishap, damage and/or injury occurring during the mishap (DON, 1991). MIRs provide interested commands with notice of a mishap, preliminary information about the mishap, and mishap investigation progress.

### *b) Hazard Reports*

A hazard is defined as a potential cause of damage or injury. As described in section (B) above, the Naval Aviation Safety program operates on the belief that elimination of causal factors will eliminate hazards. Therefore, the Naval Aviation Safety Program is designed to identify and eliminate hazards before they result in a mishap. The Hazard Report is intended to eliminate hazards via three methods; 1) report a hazard and remedial action taken, allowing others to identify the hazard and take necessary action to eliminate it, 2) report the hazard and recommend corrective action to other organizations to eliminate the hazard, 3) report the hazard in order for another organization to determine corrective action to eliminate the hazard. An HR is submitted whenever a hazard (potential cause of damage or injury) is identified/detected (DON, 1991). The HR is used for hazard elimination information, while the MIR is used once a hazard results in a mishap. (DON, 1991).

#### *c) Material Failure Hazard Reports*

The Material Failure Hazard Report (MF-HR) is a subset of the HR data within SIMS. MF-HRs are identifiable as those hazard reports in which a material failure occurred or resulted from the incident/hazard. Submission requirements and purpose parallel that of the HR.

## C. THE HUMAN FACTORS ANALYSIS AND CLASSIFICATION SYSTEM-MAINTENANCE EXTENSION

Originally implemented to assist in the identification and classification of aircrew mishaps (Shappel & Wiegmann, 1997), the Human Factors Analysis and Classification System (HFACS) was adapted by Schmidt, Schmorrow, and Hardee (1998) as a tool to analyze maintenance related human conditions. The adapted model is illustrated in Table 1.

Table 1. **HFACS Maintenance Extension Categories**

| First Order | Second Order | Third Order |
|---|---|---|
| Supervisory Conditions | Unforeseen | Hazardous Operations<br>Inadequate Documentation<br>Inadequate Design |
| | Squadron | Inadequate Supervision<br>Inappropriate Operations<br>Failed to Correct Problem<br>Supervisory Violation |
| Maintainer Conditions | Medical | Mental State<br>Physical State<br>Physical/Mental Limitation |
| | Crew Coordination | Communication<br>Assertiveness<br>Adaptability/Flexibility |
| | Readiness | Preparation/Training<br>Qualification/Certification<br>Violation |
| Working Conditions | Environment | Lighting/Light<br>Exposure/Weather<br>Environmental Hazards |
| | Equipment | Damaged<br>Unavailable<br>Dated/Uncertified |
| | Workspace | Confining<br>Obstructed<br>Inaccessible |
| Maintainer Acts | Error | Attention<br>Memory<br>Rule/Knowledge<br>Skill |
| | Violation | Routine<br>Infraction<br>Exceptional |

HFACS-Maintenance Extension (ME), consists of a hierarchy of maintenance related orders which are broken down into three levels or orders. Simply defined as first, second, and third order conditions, they serve to identify causal factors within the HFACS-ME hierarchy. Table 1 summaries the HFACS-ME hierarchical structure from the broad to micro category.

The first order consists of four broad human error categories. The first three, Supervisory Conditions, Working Conditions, and Maintainer Conditions represent latent conditions that may influence or impact a maintainer's performance, and lead to an active failure or ultimately, a mishap. The fourth first order category is Maintainer Acts. This final category includes active failures in which the maintainer's action directly contributes to the maintenance error.

## D. PART FAILURE ANALYSIS

As is the case with most systematic analyses, many factors remain hidden in the details, never to surface until a tragedy or impromptu investigation discovers the anomaly. This section provides a detailed description of the studies, effort, and ongoing initiatives in the aviation arena. However, these initiatives do not include an analysis of part failures from a readiness perspective. This study examines the degree to which parts are failing as the result of maintenance actions.

If human factors are significantly affecting the expected life of repair parts, then it can be inferred that human factors are degrading the readiness of the VR wing and/or naval aviation as a whole. Comparing the rate of occurrence of human factor parts related incidents between VR and Non-VR is a first-step in identifying causal factors. This study determines statistically the correlation between human factors and parts failures. Further, it proves statistically whether the VR community is experiencing a greater human factor parts impact than Non-VR communities using similar aircraft types.

### E. SUMMARY

The evolution of the HFQMB and the maintenance PAT development have had a significant impact on the Naval Aviation Safety Program. This heightened awareness has influenced the VR Wing to institutionalize a proactive environment for the reduction of mishaps and elimination of hazards related to maintenance. The high OPTEMPO, when combined with dwindling financial resources and aging aircraft, has prompted the Commander of the VR Wing to request assistance from the Naval Postgraduate School's School of Aviation Safety. His belief is that an active analysis of maintenance practices and procedures will help eliminate causal factors, and in particular, those causal factors which are related to human factor conditions.

This study utilizes the HFACS-ME taxonomy to analyze the maintenance related mishap, hazard, and material failure hazard reports to evaluate if VR is causing substantial material failures due to Human Factors, and then to determine if these failure rates are equivalent Navy-wide. Derived from the HFACS, the maintenance extension is a proven tool to assist in the identification and classification of human error and the related causal factors.

This study focuses on incidences in which part failures occur in order to develop a baseline for the population. Once the population is established, it is tied to the first, second, and third order categories in the HFACS-ME, Table 1. By analyzing the trends relevant to these part failures one can statistically evaluate the degree Human Factors impacts the material readiness of the VR wing, and make a comparison between VR and Non-VR to determine if CFLSW has a significant human condition causing a degradation in the material readiness of the wing.

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# III. METHODOLOGY

## A. RESEARCH APPROACH

The intent of this study is to analyze data collected and maintained by the Naval Safety Center (NSC). The approach includes the extraction of material failure/deficiency related reports for the C-130, C-20, and C-9 aircraft from the Safety Information Management System (SIMS) database. This data consists of three types of reports, Material Failure Hazard (MF-HR), Mishap Hazard (MH-HR), and Mishap Investigation(MIR) Reports. These reports are formatted in accordance with OPNAV 3750.6 series. The format consists of a narrative section which describes the event and possible causal factors. A sample report is provided in Appendix A.

A review of 401 reports containing part failures is accomplished. These reports are segregated by VR and Non-VR. The reports are classified by causal factors using the Human Factors Analysis Classification System-Maintenance Extension (HFACS-ME) and evaluated using regression analysis and hypothesis testing techniques. The HFACS-ME is then expanded to determine which maintenance related human factor components are the result of squadron or non-squadron actions.

## B. DATABASE

The SIMS database, maintained by NSC, is a compilation of occupational and operational reports (i.e., Personnel Injury Reports (PIR) and Mishap Investigation Reports (MIR)) received from Navy and Marine Corps activities. The database is populated through manual entry in ASCII format (Sciretta, 1999). It was queried for reports containing material failures on Navy and Marine Corps C-130, C-20, and C-9 aircraft communities. A total of 500 material related failure reports were obtained. The resulting reports included Material Failure Hazard Reports (MF-HR), Mishap Investigation Reports (MIR), and Mishap Hazard Reports (MH-HR) from FY90 - FY99. Each report contains similar fields of data (Appendix A). Data includes the event number, date, hazard type (i.e., general, flight related or ground mishap, and class), aircraft model, controlling custodian (i.e., Naval Reserve, MARFORPAC, COMNAVAIRLANT), event summary, and causal factors.

## C. PROCEDURE

The resulting ASCII format output files from querying the SIMS database were saved in Microsoft Word format. Once in Word format each report is further formatted, extra spacing removed, text is "word-wrapped" and condensed through manual effort to facilitate the analysis. The narratives and causal factors are studied to determine if a part failure occurred, and a new subset of data is created. This data set is referred in this thesis as "Total Part Failures" (TPF). It includes those reports in which a part caused a reported safety incident or failed as a result of a reported safety incident. This TPF data set is further analyzed to determine if the part failure is related to the following (Figure 2 describes the data set relationship and the flow of the analysis):

- Human Factors
- Human Factors related to a maintenance action
- Maintenance action directly contributed to the part failure
- Caused further damage
- Squadron or Non-Squadron

As described in Figure 2, the initial query of the NSC SIMS database resulted in 500 MIR, MF-HR, and MH-HR Reports for C-130, C-9, and C-20 aircraft. Once formatted, the narratives are analyzed to determine which events contain part failures. This sub-classification produced 401 report narratives (80%) indicating some form of part failure (i.e., wear-out, breakage, shutdown). Using the 401 part failure occurrences, the next step separates those reports where human factors are involved.

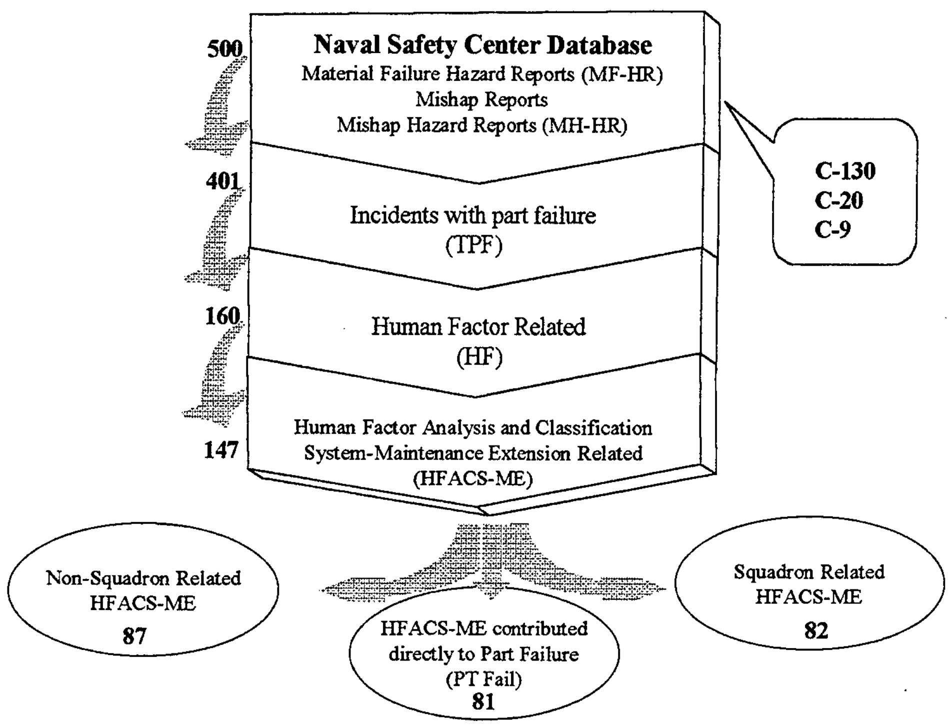


**Figure 2. Hierarchical Data Flow**

Of the 401 reports indicating a part failure, 160 indicate some form of human factor involvement (40%). These 160 are subjected to the HFACS-ME extension to determine which human factor events are maintenance related. 147 of the 160 human factor report occurrences (92%) contain some form of maintenance action, latent and/or active.

A running tally of each subset is maintained as the SIMS data set is subjected to further analysis. The next step determines which, if any, of the 147 HFACS-ME related part failures were caused directly or indirectly through maintenance error, or that the maintenance error contributed to the part failure. Of the 500 reports analyzed, 87 indicated a maintenance related human factor event contributed directly or indirectly to the part(s) failure (17%). The results of each step in the analysis are then subdivided into two groups. The first group is the VR Wing interest; the second is Non-VR Naval Aviation for the aircraft types C-130, C-9, and C-20.

A subsequent data analysis is conducted using the HFACS-ME subset (147 records). The HFACS-ME model is applied to this data set to determine which records indicate the part failure was the cause of an action on behalf of the squadron and/or of another facility, such as a depot, general facilities personnel, Naval Air Systems Command, etc. It is noted that multiple human factors may be involved (Appendix A), and an event may include both a squadron error as well as a non-squadron error. In this case, an event is tallied twice, one a squadron error, one a non-squadron error.

The same analysis is then applied to the HFACS-ME part failure subset (81 reports) to gain some insight into whether squadron or non-squadron activities are contributing to the failure of parts either directly or indirectly, and to what extent these failures are occurring. The resulting subset includes 51 squadron related (63%) and 43 non-squadron related part failures (53%) resulting from human factors in maintenance.

This information is entered into a Microsoft Access table, queries are run, and tallies are generated for each category/subcategory (i.e. HF, HFACS-ME, HFACS-ME part failure, Squadron, Non-Squadron). This tally information is entered into a Microsoft Excel workbook (Flying Hour Worksheet) described in Appendix B. Annual flying hour data provided by NSC is also entered into the worksheet. Yearly tallies are accumulated, and events per flying hour rates are calculated (Appendix B).

The event rate is derived by dividing the fiscal year tallies collected in the data analysis by the number of flying hours reported for each aircraft type, and command. For example, the total part failures for a given fiscal year are divided by the flying hours for that same fiscal year (i.e. tally/flying hours = event rate) for VR and then Non-VR. This step is repeated for each subset of data and for each aircraft type.

The resulting ratio forms the basis for the comparison. Appendix B contains the tally (count), flying hours, and the resulting ratios. A graphical representation of the ratios are include in Appendix C. This appendix provides a visual representation of the scope of differing ratios for each subset of data and/or aircraft type.

The ratio data are then input into another Excel work sheet. Using Excel statistical functions a regression analysis is run (Levine, Berenson, & Stephan, 1998). The regression analysis is chosen as a means of examining these ratios and their relationship. By using a linear regression one can determine if a correlation exists between VR and Non-VR, and the strength of the association between the fiscal year and the rate of parts-related incidents (Levine, et al, 1998).

The resulting regression lines are then subjected to two hypothesis tests using the two-tailed t-test with a significance level of alpha = .1 (Levine, et al, 1998). In the first test, the two-tailed t-test is utilized as a hypothesis testing tool to determine if the slopes of the VR Wing regression line (β1) differs from slope of the Non-VR regression line (γ1). The observed t-statistic is computed as,

$$t = \frac{\hat{\beta}_1 - \hat{\gamma}_1}{\hat{\sigma}\sqrt{\frac{1}{\sum\left(X_{1,i} - \overline{X_1}\right)^2 + \sum\left(X_{2,i} - \overline{X_2}\right)^2}}}$$

If the hypothesis test ($\beta1 = \gamma1$) cannot be rejected then the slopes of these lines are statistically the same. If the slopes are the same then one infers that the VR rate of parts-related incidents is not any different than the rest of Naval Aviation.

In the second test, the regression lines are subjected to an independent hypothesis test ($\beta1 = 0$) to determine if a trend exists between the tally/flying hour ratio and the fiscal year. If the hypothesis is rejected then one infers that there is a trend. The direction of the trend is determined by the sign of the slope (i.e. increasing trend for positive slope, decreasing trend for negative slope). Excel automatically computes the observed t-statistic for this test.

## D. DATA ANALYSIS

### 1. Data Tabulation VR vs Non-VR

Each report provided by NSC includes varying levels of detail. As each event is analyzed a tally is maintained for each general category. The tally results are subjective in nature as the report narratives do not necessarily state what causal factors are inherent in each incident. The tallies are categorized base on the author's assessment of the available information.

The following categories are described (Figure 2 refers):

1) reports in which a part failure occurred (TPF);
2) reports that had a part failure in which the narrative includes some form of human factor involvement;
3) the human factor included an activity, latent or active, addressed in the HFACS-ME model (Table 1 refers); and
4) the activity resulted in the part failure.

Each event is tallied according to the general category for VR and Non-VR aircraft and aircraft type.

### 2. Data Tabulation Squadron vs Non-Squadron

Subsequent to the tabulation conducted above, the data tally relating to the general category HFACS-ME is further subdivided. As an extension to the HFACS-ME matrix, the same criteria is applied as if the HFACS-ME act were the result of squadron (SQN) actions or non-squadron (Non-SQN) actions. Squadron causal factors are the result of squadron or organizational (O-level) personnel; non-squadron actions are the result of personnel not assigned to the squadron. Examples of non-squadron activities include depot maintenance facilities, non-squadron airport facilities personnel (i.e., fire/rescue and ground personnel).

### 3. Statistical Analysis

The number of parts related failures for each general category and aircraft type (C-130, C-9, C-20) are accumulated during the data tabulation phase and divided by the flying hours for the fiscal year in which the event occurred. The resulting tally-per-flying hour rates form the baseline for the statistical analysis. Each set of yearly rates describe a unique linear regression line which is compared against its counterpart (VR Vs Non-VR), and plotted (Appendix C). Microsoft Excel is used to process the regression analysis. Excel does this automatically with Tools/Data Analysis/Regression function.

For the purpose of this study the fiscal year is the independent (x) variable and the tally/flying hour ratio is the dependent (y) variable. Results are listed in Appendix D. The results of the regression analysis are then subjected to a hypothesis test to compare the slope of the regression line for VR against the slope of the regression line of Non-VR. This hypothesis test is conducted for each general category/subcategory containing adequate data points to warrant testing. The null hypothesis being tested is whether the VR slope ($\beta 1$) equals the slope of the Non-VR

($\gamma 1$) regression line ($\beta 1 = \gamma 1$). A t-statistic test for the null hypothesis is applied to each general category and to the C-130 aircraft type as a subcategory.

Each regression line is further analyzed to determine if a trend exists. The null hypothesis suggests that if the slope of the regression line equals zero ($\beta 1 = 0$), then there is no trend inherent in the data. A two-tailed t-test is conducted with $\alpha = 0.1$. If the p-value resulting from the regression analysis is less then $\alpha$ the null hypothesis is rejected suggesting an upward or downward trend does exist.

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# IV. RESULTS

## A. INTRODUCTION

Using simple linear regression as a tool to analyze data leads to many ethical considerations. Issues include data contamination, human error in data interpretation, inappropriate level of significance selection, test selection (one or two tailed), and data cleansing (Levine, et al, 1998). Throughout the data exploration phase every precaution is taken to attain the most accurate test results possible.

## B. HYPOTHESIS TESTING VR COMMUNITY

The resulting p-values of the hypothesis test $\beta 1 = 0$ for the VR community are displayed in Table 2. The column headings represent the HFACS classification while the row headings represent the total community and the subset of type of aircraft. Given a level of significance of .1 the data suggests rejecting the null hypothesis for each of the "total classifications." Rejecting the null hypothesis indicates that there is a statistical relationship between the independent variable (fiscal year) and the dependent variable (parts-related incidents per flight hour). For VR as a whole this suggests that the parts-related incidents per flight hour that are reported annually are increasing each year. It also indicates an increase in parts-related Human Factors incidents, and parts-related Human Factor Maintenance incidents. Most importantly, though, it indicates that there is an increasing trend in the rate of Human Factors causing material failure. In particular, this increase appears to be highly influenced from the VR C-9. It is worthy to note that the trend is based on 10 years of data. Fiscal year 1999 shows a significant drop in the parts-related incidents per flight hour. Although one data observation does not in itself signal a trend, in this case, due to the Navy's concerted effort to implement improved safety programs in the past two years, the significant decrease could be a signal of a downward trend.

**Table 2. VR Community Hypothesis Test (β1=0) p-values**

| | **TPF** | **Human Factors** | **HFACS-ME** | **PT Fail** |
|---|---|---|---|---|
| **Total** | .00016 | .03355 | .04182 | .00949 |
| **C-130** | .06386 | .12203 | .08517 | .42561 |
| **C-9** | .53018 | .23424 | .29773 | .06535 |
| **C-20** | .77672 | .92369 | .92369 | N/A |

Regression was not conducted in those areas where data did not exist and is represented by N/A in Tables 2 through 8.

## C. HYPOTHESIS TESTING NON-VR COMMUNITY

The resulting p-values of the hypothesis test $\beta 1 = 0$ for the Non-VR communities are displayed in Table 3. Column headings are exactly the same as those for the VR community. Given a level of significance of .1 the data suggests rejecting the null hypothesis for each of the "Total" classifications and for each of the "C-130" classifications. There was not enough data to generate regression lines for the "C-9" and "C-20" classifications. Rejecting the null hypothesis indicates that there is a significant relationship between the fiscal year and the parts-related incidents per flight hours. Also, as in the VR community, the data suggests an increasing trend in Human Factors causing parts failures. It is noted that, as in the VR community, fiscal year 1999 rate of Human Factors causing material failures dropped from fiscal year 1998. Based on the navy's efforts in implementing better safety programs this "drop" could be a signal of a downward trend. It is also noted that the C-130 community is influencing the increasing trend.

Table 3. Non-VR Hypothesis Test ($\beta1=0$) p-values

| | TPF | Human Factors | HFACS-ME | PT Fail |
|---|---|---|---|---|
| **Total** | .00998 | .03264 | .03696 | .00954 |
| **C-130** | .04654 | .06448 | .07885 | .06537 |
| **C-9** | N/A | N/A | N/A | N/A |
| **C-20** | N/A | N/A | N/A | N/A |

## D. HYPOTHESIS TESTING SQUADRON RELATED HFACS-ME

The resulting p-values of the hypothesis test $\beta1 = 0$ for the squadron related HFACS-ME are provided in Table 4. Given a level of significance of .1 the data suggests rejecting the null hypothesis for HFACS-ME for the VR community and HFACS-ME C-130 for the Non-VR communities.

Table 4. Squadron HFACS-ME Hypothesis Test ($\beta1=0$) p-values

| | VR | NON-VR |
|---|---|---|
| **Total** | .05587 | .44159 |
| **C-130** | .81390 | .09768 |
| **C-9** | .70052 | N/A |
| **C-20** | N/A | N/A |

Rejecting the null hypothesis suggests the slope of the regression line is not zero, which means a trend exists, in these two cases, increasing trend.

## E. HYPOTHESIS TESTING NON-SQUADRON RELATED HFACS-ME

The resulting p-values of the hypothesis test $\beta 1 = 0$ for the Non-squadron related HFACS-ME are provided in Table 5. Given a level of significance of .1 the data suggests ejecting the null hypothesis for HFACS-ME for the VR and Non-VR communities.

**Table 5. Non-Squadron HFACS-ME Hypothesis Test ($\beta 1=0$) p-values**

| | VR | NON-VR |
|---|---|---|
| **Total** | .03507 | .03751 |
| **C-130** | .70806 | .99069 |
| **C-9** | .65016 | N/A |
| **C-20** | .86085 | N/A |

## F. HYPOTHESIS TESTING SQUADRON AND NON-SQUADRON RELATED HFACS-ME PART FAILURES

The resulting p-values of the hypothesis test $\beta 1 = 0$ for the Squadron and Non-Squadron related HFACS-ME related part failures are provided in Table 6. As discussed in

Chapter III this data set consists of occurrences in which the human factors in maintenance caused, directly or indirectly, the part to fail. Given a level of significance of .1 the data suggests rejecting the null hypothesis for all but Squadron VR maintenance related part failures. This means that there appears to be no significant increase or decrease of Squadron human factors causing part failures in the VR community. The same cannot be statistically shown for Squadron human factors causing parts failures in the Non-VR community, nor can it be shown for Non-Squadron human factors causing parts failures within the Navy/Marine Corps combined logistics community. In other words, all non-squadron activities which maintain VR and Non-VR aircraft are showing an increased propensity to cause parts to fail. The same can be said for squadrons maintaining Non-VR aircraft.

**Table 6. Squadron and Non-Squadron HFACS-ME Part Failure Hypothesis Test ($\beta 1=0$) p-values**

| | SQN | NON-SQN |
|---|---|---|
| **VR** | .25865 | .00159 |
| **Non-VR** | .02727 | .08084 |

The VR squadron graph in Appendix C suggests this result may be skewed as fiscal years 92 through 94 data points remained constant with little to no variation. This is an anomaly when considering all the data analyzed in this research.

## G. HYPOTHESIS TEST VR VS NON-VR

The results of the hypothesis test comparing VR regression line slope ($\beta 1$) against Non-VR ($\gamma 1$) regression line are contained in Tables 7 and 8. The test can only be conducted for those data sets where both VR and Non-VR regression analysis could be conducted.

**Table 7. VR vs Non-VR Hypothesis Test ($\beta 1 = \gamma 1$) t-statistic**

| | TPF | Human Factors | HFACS-ME | PT Fail |
|---|---|---|---|---|
| **Total** | .24409 | -.58252 | -.60293 | -.86256 |
| **C-130** | .97110 | .22408 | .34882 | -.84114 |

Based on these results the null hypothesis ($\beta 1 = \gamma 1$) cannot be rejected for any category. The slopes of the corresponding regression lines are not statistically different and therefore indicate no difference in the failures per flight hour rates. Even though the rates are increasing, it appears that VR is not behaving any differently than the rest of the Navy.

**Table 8. Squadron and Non-Squadron VR vs Non-VR Hypothesis Test ($\beta 1 = \gamma 1$) t-statistic**

| | SQN | Non-SQN | SQN PT Fail | Non-SQN PT Fail |
|---|---|---|---|---|
| Total | -.14101 | -1.00433 | -.93707 | -.18079 |
| C-130 | -.83693 | .27211 | N/A | N/A |

## H. SUMMARY

The use of regression analysis is a valuable tool to draw conclusions about a given population. This study uses inferential statistics, including data collection, exploration, presentation, regression, and the analysis of the data through hypothesis testing. Limitations in the available data can affect the results.

Results from this analysis indicates increasing trends. However, are these trends the result of aging aircraft, increased OPTEMPO, or unqualified/trained personnel? Are the increasing trends the result of heighten awareness, and the belief within Naval Aviation that reporting these types of incidents/events will not damage one's career? Or, is this the result of more safety reports being initiated fleet-wide in an effort to mitigate the loss or life or property? The questions posed are not resolved here, but are left with the Naval Aviation Safety Program to shed some light.

Another issue potentially affecting the data is that during this time period the Navy was experiencing Base Realignment and Closure (BRAC), which resulted in numerous activity consolidations and disestablishments. This fleet wide activity may have influenced incident reporting during the time period.

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# V. CONCLUSIONS AND RECOMMENDATIONS

This study examines the relationship between part failures and human factors in maintenance involvement in those failures. Of the 500 safety incident reports analyzed, 401 contained some form of parts-related failure. Those parts-related incidents are subdivided in accordance with the data exploration process discussed in Chapter III. Fiscal year tallies are generated and divided by the total fiscal year flying hours to compute a rate of incidents per flying hour. The purpose of this data exploration was to obtain a quantitative baseline for regression analysis and comparison hypothesis testing.

The Naval Safety Center Safety Information Management System database is used because it links human factors to material failures. Consisting of narrative events, the data contained in this data base enables a subjective assessment of the role of human factors in the part failures. The foundation of this study is that if the slopes of the VR and Non-VR regression lines are equal than there is no difference between the VR community and the rest of similar Naval Aviation communities regardless of trend. This hypothesis is tested at the 10% significance level or 90% confidence level.

The results are presented in Chapter IV. The questions asked in this study are designed to solicit perceptions about the potential impact human factors have on part failures and ultimately material readiness. Data results form the basis for the following conclusions and recommendations regarding trend analysis, the impact of human factors on parts requirements, and potential differences between VR and Naval Aviation. Also discussed are additional recommendations for reporting material safety incidents and follow-on research.

## A. VR AND NON-VR PARTS RELATED SAFETY INCIDENTS

### 1. Conclusion

As shown in Chapter IV, statistically there is no difference in the rate of parts related, human factor, or human factor in maintenance safety incidences between VR and Non-VR communities. However, the results of this study do indicate an increasing trend of human factor involvement in parts failures for the VR community as well as Non-VR activities. One can infer from the analysis that human factors in maintenance may be impacting readiness in both VR and Non-VR squadrons. Although there may be many causes for the existence of an increasing trend, the presence of a positive trend suggests Mishap, Hazard, and Material Failure Reports support the conclusion that human factors, and particularly HFACS-ME, are present in the aviation maintenance system.

### 2. Recommendation

The primary research question of this study was to determine if VR was statistically different in terms of parts related incidents and human factor relationships than Non-VR. Quantitative findings support the conclusion that the VR Wing is no better or worse than the rest of the Naval Aviation logistics community. However considering the growing trend, continued attention must be placed in this area in order to reduce human factor influences.

## B. HUMAN FACTORS AND PARTS FAILURES IN THE VR AND NON-VR COMMUNITIES

### 1. Conclusion

Again, as shown in Chapter IV, statistically there is no difference between the human factor induced part failure rates for the VR community vs Non-VR communities. However, the results of this study do indicate an increasing trend in the human factors induced part failure rates for the VR and Non-VR communities. One can infer from the analysis that although there is no statistical difference between VR and Non-VR, human factors in maintenance are impacting parts requirements and that parts failures as a result of human causal factors is on the rise.

### 2. Recommendation

A primary objective of this research question is to determine if the Commander Fleet Logistics Support Wing should concentrate his limited resources in an effort to mitigate parts usage resulting from human error. Quantitative findings support the conclusion that the VR Wing is no different in this area than the rest of the Naval Aviation logistics community. However, a growing trend does exist and continued efforts are essential in order to eliminate unnecessary parts requirements and eliminate the wasting of valuable financial resources on piece parts damaged as a result of human error.

## C. SQUADRON AND NON-SQUADRON INFLUENCES ON VR AND NON-VR PARTS AND MAINTENANCE RELATED SAFETY INCIDENTS

### 1. Conclusion

Another purpose of this research question is to determine if squadron (organizational level) maintenance errors have a different impact on VR and Non-VR communities; and to determine if non-squadron (i.e. depot, facilities, SYSCOM) maintenance error is different. Again, the quantitative results in Chapter IV suggest that there is no difference between squadron or non-squadron related maintenance errors for the VR or Non-VR communities. In fact the occurrences of squadron and non-squadron incidents are similar. The results in Chapter IV also show a growing trend in both squadron and non-squadron human factor in maintenance safety incidents. This growing trend is also present when looking at the individual VR or Non-VR results.

### 2. Recommendation

The results in Chapter IV demonstrate that VR is not statistically different from Non-VR for squadron related maintenance errors or for non-squadron maintenance errors. However, a growing trend is present which suggests that both organizational maintainers and other maintainers (depots, airfield personnel) need to step-up their efforts and ensure compliance with maintenance standards and operating procedures. An improved effort by non-squadron personnel may help mitigate those errors caused by inadequate inspections prior to and following overhauls, and eliminate unnecessary incidents resulting from facilities personnel being unfamiliar with the aircraft they are servicing or the squadron's standard operating procedures. Squadron personnel must continue to eliminate hazards, and ensure proper procedures exist and are followed during maintenance procedures.

### D. SQUADRON AND NON-SQUADRON HUMAN FACTORS AND PARTS FAILURES IN THE VR AND NON-VR COMMUNITIES

#### 1. Conclusion

As shown in Chapter IV, statistically there is no difference between the human factor induced part failure rate for the VR community and non-VR communities based on squadron or non-squadron influences. As with previous findings, the results of this study indicate an increasing trend in the human factors induced part failure rates for VR non-squadron activities and at both the squadron and non-squadron level for the Non-VR communities. Human factors in maintenance activities are impacting parts requirements and that parts failures as a result of human causal factors is on the rise.

#### 2. Recommendation

A growing trend is present in the data which suggests that both organizational maintainers and other maintainers (depots, airfield personnel) need to reduce the impact their actions have on parts, and the material readiness of Naval Aviation squadrons. The growing trend supports the idea that progress can be made to eliminate the unnecessary use of spare parts both at squadron and at non-squadron activities.

## E. MISCELLANEOUS FINDINGS

### 1. Conclusion

The data utilized in this analysis (Material Failure, Mishap Investigation, and Hazard Reports) is in a format not conducive to an exploratory data analysis. The ASC II format enables a wide range of personnel to utilize the narratives, but categorical searches are not possible. The database is populated via manual entry by safety center personnel vice an automated method. This leads to key punch errors and omissions. Further, the database is a "stand-alone" system which does not interface with existing data repositories or financial information.

### 2. Recommendation

The Naval Safety Center plays a critical role in the mitigation of hazards throughout the fleet. Its purpose is to protect our sailors, marines, and civilian personnel and property of the U. S. Navy and Marine Corps. The data fields maintained in these reports should be linked and contain additional information such as a national stock number or part number when dealing with material issues. Also a data base which is accessible and can interface with other data repositories, and network systems will make it easier to conduct research and possibly identify additional areas of study or hazards hidden in the "weeds."

## F. FOLLOW-ON RESEARCH

Follow on analysis is needed to examine the relationship between depot maintenance activities resulting from consolidations and outsourcing, and human factor incidences. Utilizing these same aircraft types, an analysis of depot maintenance activities may lead to activities requiring an organizational climate assessment. The heightened awareness brought about by such an assessment may help mitigate the maintenance related part failure occurrences and ultimately eliminate potential hazards.

# APPENDIX A: SAMPLE NAVAL SAFETY CENTER HAZARD REPORT

EVENT DATA:

Event Serial: 00000 Date:
HAZARD - GENERAL

Responsible Aircraft Data:
Model: C009B Controlling Custodian: SAMPLE Ashore

AIRCRAFT DATA:

Model:

SUMMARY:

Event Summary:
ELECTRICAL SMOKE AND SPARKS IN COCKPIT DURING ACFT START.

DURING ROUTINE TRAINING, MAINTENANCE TECHNICIAN TURNED ON THE RIGHT APU BUS AND OBSERVED BLUE SPARKS AND SMOKE COMING FROM UNDER THE INSTRUMENT PANEL. AFTER SPARKS SEVERAL CIRCUIT BREAKERS POPPED BEFORE APU BUSES COULD BE SECURED. ALTHOUGH PROVIDED WITH A HAND-HELD RADIO FOR COMMUNICATIONS WITH MAINTENANCE CONTRO, THE BATTERIES WERE INOP. THE TECHNICIAN THEN SELECTED EMERGENCY POWER ON (ENERGIZING THREE ADDITIONAL BUSES) TO CALL MAINTENANCE CONTROL.

CAUSE FACTORS: (1) MAINTENANCE: (A) MAINT PERSONNEL: FAILED TO FOLLOW SAFETY PROCEDURES WHEN ALL ELECTRICAL POWER WAS NOT COMPLETELY SECURED. MAINTENANCE MAINTAINERS MUST BE REMINDED TO COMPLETE THEIR EMERGENCY PROCEDURES FIRST THEN WORRY ABOUT TELLING MAINTENANCE CONTROL. (2) MATERIAL: (A) CANNON PLUG WIRING: SHORTED/ARCED CAUSING BLUE SPARKS AND SMOKE AND BURNT BLACK CHARRED WIRES. AFTER ALL POWER WAS SECURED, MAINT DISCOVERED BURNT BLACK CHARRED WIRES ON THE BACK OF A CANNON PLUG NEAR THE COPILOT'S LEFT RUDDER PEDAL. CONCLUSIONS: BURNING WIRES CREATE TOXIC FUMES, THE POTENTIAL FOR ELECTROCUTION OF PERSONNEL AND COULD RESULT IN FIRES DAMAGING THE ACFT.

**Figure A-1. Sample Naval Safety Center Hazard Report**

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# APPENDIX B: TALLY/FLYING HOUR WORKSHEETS

**TOTAL PART FAILURES**

| **FISCAL YEAR** | | **90** | **91** | **92** | **93** | **94** | **95** | **96** | **97** | **98** | **99** | **TOTAL** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PART FAILURES** | | | | | | | | | | | | |
| | VR | 12 | 14 | 11 | 15 | 20 | 30 | 29 | 25 | 30 | 32 | 218 |
| | Non-VR | 14 | 20 | 15 | 13 | 15 | 16 | 17 | 26 | 28 | 19 | 183 |
| | TOTAL | 26 | 34 | 26 | 28 | 35 | 46 | 46 | 51 | 58 | 49 | 399 |
| **FLYING HOURS** | | | | | | | | | | | | |
| | VR | 49633 | 45573 | 44888 | 51546 | 56209 | 59964 | 61296 | 60023 | 53587 | 53899 | 536618 |
| | Non-VR | 62444 | 57049 | 47979 | 45773 | 43217 | 44016 | 44950 | 43727 | 40191 | 44134 | 473480 |
| | TOTAL | 112077 | 102622 | 92867 | 97319 | 99426 | 103980 | 106246 | 103750 | 93778 | 98033 | 1010098 |

**TOTAL PART FAILURES PER AIRCRAFT TYPE**

| **FISCAL YEAR** | | **90** | **91** | **92** | **93** | **94** | **95** | **96** | **97** | **98** | **99** | **TOTAL** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PART FAILURES** | | | | | | | | | | | | |
| | VR | | | | | | | | | | | |
| | C-130 | 0 | 0 | 0 | 6 | 5 | 12 | 15 | 13 | 19 | 18 | 88 |
| | C-9 | 12 | 14 | 11 | 9 | 14 | 16 | 13 | 10 | 7 | 13 | 119 |
| | C-20 | 0 | 0 | 0 | 0 | 1 | 2 | 1 | 2 | 4 | 1 | 11 |
| | Non-VR | | | | | | | | | | | |
| | C-130 | 14 | 20 | 15 | 10 | 15 | 16 | 14 | 22 | 26 | 19 | 171 |
| | C-9 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 1 | 0 | 4 |
| | C-20 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 4 | 1 | 0 | 8 |
| **FLYING HOURS** | | | | | | | | | | | | |
| | VR | | | | | | | | | | | |
| | C-130 | 22 | 396 | 2900 | 6426 | 10214 | 13199 | 13567 | 13891 | 13726 | 14723 | 89064 |
| | C-9 | 48174 | 44017 | 40527 | 43975 | 43710 | 41616 | 41232 | 38357 | 33135 | 34177 | 408920 |
| | C-20 | 1437 | 1160 | 1461 | 1145 | 2285 | 5149 | 6497 | 7775 | 6726 | 4999 | 38634 |
| | Non-VR | | | | | | | | | | | |
| | C-130 | 58921 | 53641 | 45069 | 42673 | 40431 | 41008 | 41555 | 40345 | 37980 | 41311 | 442934 |
| | C-9 | 3504 | 3394 | 2898 | 3063 | 2730 | 2647 | 2545 | 2188 | 1909 | 2823 | 27701 |
| | C-20 | 19 | 14 | 12 | 37 | 56 | 361 | 850 | 1194 | 302 | 0 | 2845 |

**RATIO**

| **FISCAL YEAR** | | **90** | **91** | **92** | **93** | **94** | **95** | **96** | **97** | **98** | **99** | **TOTAL** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | VR | 0.00024177 | 0.000307 | 0.000245 | 0.000291 | 0.000356 | 0.0005 | 0.000473 | 0.000417 | 0.00056 | 0.000594 | 0.0004062 |
| | Non-VR | 0.0002242 | 0.000351 | 0.000313 | 0.000284 | 0.000347 | 0.000364 | 0.000378 | 0.000595 | 0.000697 | 0.000431 | 0.0003865 |

**RATIO PER AIRCRAFT TYPE**

| **FISCAL YEAR** | | **90** | **91** | **92** | **93** | **94** | **95** | **96** | **97** | **98** | **99** | **TOTAL** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | VR | | | | | | | | | | | |
| | C-130 | 0 | 0 | 0 | 0.000934 | 0.00049 | 0.000909 | 0.001106 | 0.000936 | 0.001384 | 0.001223 | 0.0009881 |
| | C-9 | 0.0002491 | 0.000318 | 0.000271 | 0.000205 | 0.00032 | 0.000384 | 0.000315 | 0.000261 | 0.000211 | 0.00038 | 0.000291 |
| | C-20 | 0 | 0 | 0 | 0 | 0.000438 | 0.000388 | 0.000154 | 0.000257 | 0.000595 | 0.0002 | 0.0002847 |
| | Non-VR | | | | | | | | | | | |
| | C-130 | 0.00023761 | 0.000373 | 0.000333 | 0.000234 | 0.000371 | 0.00039 | 0.000337 | 0.000545 | 0.000685 | 0.00046 | 0.0003861 |
| | C-9 | 0 | 0 | 0 | 0.000979 | 0 | 0 | 0 | 0 | 0.000524 | 0 | 0.0001444 |
| | C-20 | 0 | 0 | 0 | 0 | 0 | 0 | 0.003529 | 0.00335 | 0.003311 | #DIV/0! | 0.002812 |

Figure B-1. Total Part Failure Tally/Flying Hour Worksheet

**TOTAL PART FAILURES, HF**

| FISCAL YEAR | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **PART FAILURES** | | | | | | | | | | | |
| VR | 6 | 8 | 4 | 1 | 4 | 9 | 14 | 15 | 11 | 14 | 86 |
| Non-VR | 5 | 8 | 3 | 7 | 4 | 1 | 7 | 15 | 14 | 10 | 74 |
| TOTAL | 11 | 16 | 7 | 8 | 8 | 10 | 21 | 30 | 25 | 24 | 160 |
| **FLYING HOURS** | | | | | | | | | | | |
| VR | 49633 | 45573 | 44888 | 51546 | 56209 | 59964 | 61296 | 60023 | 53587 | 53899 | 536618 |
| Non-VR | 62444 | 57049 | 47979 | 45773 | 43217 | 44016 | 44950 | 43727 | 40191 | 44134 | 473480 |
| TOTAL | 112077 | 102622 | 92867 | 97319 | 99426 | 103980 | 106246 | 103750 | 93778 | 98033 | 1010098 |

**TOTAL PART FAILURES, HF PER AIRCRAFT TYPE**

| FISCAL YEAR | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **PART FAILURES** | | | | | | | | | | | |
| VR | | | | | | | | | | | |
| C-130 | 0 | 0 | 0 | 0 | 1 | 2 | 7 | 4 | 6 | 6 | 26 |
| C-9 | 6 | 8 | 4 | 1 | 3 | 7 | 6 | 9 | 4 | 7 | 55 |
| C-20 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 1 | 1 | 5 |
| Non-VR | | | | | | | | | | | |
| C-130 | 5 | 8 | 3 | 6 | 4 | 1 | 7 | 12 | 14 | 10 | 70 |
| C-9 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| C-20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 3 |
| **FLYING HOURS** | | | | | | | | | | | |
| VR | | | | | | | | | | | |
| C-130 | 22 | 396 | 2900 | 6426 | 10214 | 13199 | 13567 | 13891 | 13726 | 14723 | 89064 |
| C-9 | 48174 | 44017 | 40527 | 43975 | 43710 | 41616 | 41232 | 38357 | 33135 | 34177 | 408920 |
| C-20 | 1437 | 1160 | 1461 | 1145 | 2285 | 5149 | 6497 | 7775 | 6726 | 4999 | 38634 |
| Non-VR | | | | | | | | | | | |
| C-130 | 58921 | 53641 | 45069 | 42673 | 40431 | 41008 | 41555 | 40345 | 37980 | 41311 | 442934 |
| C-9 | 3504 | 3394 | 2898 | 3063 | 2730 | 2647 | 2545 | 2188 | 1909 | 2823 | 27701 |
| C-20 | 19 | 14 | 12 | 37 | 56 | 361 | 850 | 1194 | 302 | 0 | 2845 |

**RATIO**

| FISCAL YEAR | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| VR | 0.00012089 | 0.000176 | 8.91E-05 | 1.94E-05 | 7.12E-05 | 0.00015 | 0.000228 | 0.00025 | 0.000205 | 0.00026 | 0.00016 |
| Non-VR | 8.0072E-05 | 0.00014 | 6.25E-05 | 0.000153 | 9.26E-05 | 2.27E-05 | 0.000156 | 0.000343 | 0.000348 | 0.000227 | 0.000156 |

**RATIO PER AIRCRAFT TYPE**

| FISCAL YEAR | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| VR | | | | | | | | | | | |
| C-130 | 0 | 0 | 0 | 0 | 9.79E-05 | 0.000152 | 0.000516 | 0.000288 | 0.000437 | 0.000408 | 0.000292 |
| C-9 | 0.00012455 | 0.000182 | 9.87E-05 | 2.27E-05 | 6.86E-05 | 0.000168 | 0.000146 | 0.000235 | 0.000121 | 0.000205 | 0.000135 |
| C-20 | 0 | 0 | 0 | 0 | 0 | 0 | 0.000154 | 0.000257 | 0.000149 | 0.0002 | 0.000129 |
| Non-VR | | | | | | | | | | | |
| C-130 | 8.4859E-05 | 0.000149 | 6.66E-05 | 0.000141 | 9.89E-05 | 2.44E-05 | 0.000168 | 0.000297 | 0.000369 | 0.000242 | 0.000158 |
| C-9 | 0 | 0 | 0 | 0.000326 | 0 | 0 | 0 | 0 | 0 | 0 | 3.61E-05 |
| C-20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.002513 | 0 | #DIV/0! | 0.001054 |

Figure B-2. TPF Human Factor Tally/Flying Hour Worksheet

**TOTAL PART FAILURES, HF,HF-ME**

| FISCAL YEAR | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **PART FAILURES** | | | | | | | | | | | |
| VR | 6 | 8 | 3 | 1 | 4 | 8 | 13 | 13 | 11 | 13 | 80 |
| Non-VR | 4 | 7 | 3 | 7 | 4 | 1 | 5 | 13 | 14 | 9 | 67 |
| TOTAL | 10 | 15 | 6 | 8 | 8 | 9 | 18 | 26 | 25 | 22 | 147 |
| **FLYING HOURS** | | | | | | | | | | | |
| VR | 49633 | 45573 | 44888 | 51546 | 56209 | 59964 | 61296 | 60023 | 53587 | 53899 | 536618 |
| Non-VR | 62444 | 57049 | 47979 | 45773 | 43217 | 44016 | 44950 | 43727 | 40191 | 44134 | 473480 |
| TOTAL | 112077 | 102622 | 92867 | 97319 | 99426 | 103980 | 106246 | 103750 | 93778 | 98033 | 1010098 |

**TOTAL PART FAILURES, HF, HF-ME PER AIRCRAFT TYPE**

| FISCAL YEAR | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **PART FAILURES** | | | | | | | | | | | |
| VR | | | | | | | | | | | |
| C-130 | 0 | 0 | 0 | 0 | 1 | 2 | 6 | 3 | 6 | 6 | 24 |
| C-9 | 6 | 8 | 3 | 1 | 3 | 6 | 6 | 8 | 4 | 6 | 51 |
| C-20 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 1 | 1 | 5 |
| Non-VR | | | | | | | | | | | |
| C-130 | 4 | 7 | 3 | 6 | 4 | 1 | 5 | 10 | 14 | 9 | 63 |
| C-9 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| C-20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 3 |
| **FLYING HOURS** | | | | | | | | | | | |
| VR | | | | | | | | | | | |
| C-130 | 22 | 396 | 2900 | 6426 | 10214 | 13199 | 13567 | 13891 | 13726 | 14723 | 89064 |
| C-9 | 48174 | 44017 | 40527 | 43975 | 43710 | 41616 | 41232 | 38357 | 33135 | 34177 | 408920 |
| C-20 | 1437 | 1160 | 1461 | 1145 | 2285 | 5149 | 6497 | 7775 | 6726 | 4999 | 38634 |
| Non-VR | | | | | | | | | | | |
| C-130 | 58921 | 53641 | 45069 | 42673 | 40431 | 41008 | 41555 | 40345 | 37980 | 41311 | 442934 |
| C-9 | 3504 | 3394 | 2898 | 3063 | 2730 | 2647 | 2545 | 2188 | 1909 | 2823 | 27701 |
| C-20 | 19 | 14 | 12 | 37 | 56 | 361 | 850 | 1194 | 302 | 0 | 2845 |

**RATIO**

| FISCAL YEAR | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| VR | 0.00012089 | 0.000176 | 6.68E-05 | 1.94E-05 | 7.12E-05 | 0.000133 | 0.000212 | 0.000217 | 0.000205 | 0.000241 | 0.000149 |
| Non-VR | 6.4057E-05 | 0.000123 | 6.25E-05 | 0.000153 | 9.26E-05 | 2.27E-05 | 0.000111 | 0.000297 | 0.000348 | 0.000204 | 0.000142 |

**RATIO PER AIRCRAFT TYPE**

| FISCAL YEAR | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| VR | | | | | | | | | | | |
| C-130 | 0 | 0 | 0 | 0 | 9.79E-05 | 0.000152 | 0.000442 | 0.000216 | 0.000437 | 0.000408 | 0.000269 |
| C-9 | 0.00012455 | 0.000182 | 7.4E-05 | 2.27E-05 | 6.86E-05 | 0.000144 | 0.000146 | 0.000209 | 0.000121 | 0.000176 | 0.000125 |
| C-20 | 0 | 0 | 0 | 0 | 0 | 0 | 0.000154 | 0.000257 | 0.000149 | 0.0002 | 0.000129 |
| Non-VR | | | | | | | | | | | |
| C-130 | 6.7888E-05 | 0.00013 | 6.66E-05 | 0.000141 | 9.89E-05 | 2.44E-05 | 0.00012 | 0.000248 | 0.000369 | 0.000218 | 0.000142 |
| C-9 | 0 | 0 | 0 | 0.000326 | 0 | 0 | 0 | 0 | 0 | 0 | 3.61E-05 |
| C-20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.002513 | 0 | #DIV/0! | 0.001054 |

Figure B-3. TPF, Human Factor, HFACS-ME Tally/Flying Hour Worksheet

**TOTAL PART FAILURES, HF,HF-ME, HF-ME PART FAILURE**

| FISCAL YEAR | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **PART FAILURES** | | | | | | | | | | | |
| VR | 3 | 3 | 2 | 1 | 4 | 8 | 7 | 9 | 8 | 6 | 51 |
| Non-VR | 0 | 2 | 2 | 2 | 1 | 1 | 3 | 5 | 9 | 5 | 30 |
| TOTAL | 3 | 5 | 4 | 3 | 5 | 9 | 10 | 14 | 17 | 11 | 81 |
| **FLYING HOURS** | | | | | | | | | | | |
| VR | 49633 | 45573 | 44888 | 51546 | 56209 | 59964 | 61296 | 60023 | 53587 | 53899 | 536618 |
| Non-VR | 62444 | 57049 | 47979 | 45773 | 43217 | 44016 | 44950 | 43727 | 40191 | 44134 | 473480 |
| TOTAL | 112077 | 102622 | 92867 | 97319 | 99426 | 103980 | 106246 | 103750 | 93778 | 98033 | 1010098 |

**TOTAL PART FAILURES, HF, HF-ME, HF-ME PART FAILURE PER AIRCRAFT TYPE**

| FISCAL YEAR | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **PART FAILURES** | | | | | | | | | | | |
| VR | | | | | | | | | | | |
| C-130 | 0 | 0 | 0 | 0 | 1 | 2 | 3 | 2 | 4 | 2 | 14 |
| C-9 | 3 | 3 | 2 | 1 | 3 | 6 | 4 | 7 | 4 | 3 | 36 |
| C-20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| Non-VR | | | | | | | | | | | |
| C-130 | 0 | 2 | 2 | 2 | 1 | 1 | 3 | 5 | 9 | 5 | 30 |
| C-9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C-20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **FLYING HOURS** | | | | | | | | | | | |
| VR | | | | | | | | | | | |
| C-130 | 22 | 396 | 2900 | 6426 | 10214 | 13199 | 13567 | 13891 | 13726 | 14723 | 89064 |
| C-9 | 48174 | 44017 | 40527 | 43975 | 43710 | 41616 | 41232 | 38357 | 33135 | 34177 | 408920 |
| C-20 | 1437 | 1160 | 1461 | 1145 | 2285 | 5149 | 6497 | 7775 | 6726 | 4999 | 38634 |
| Non-VR | | | | | | | | | | | |
| C-130 | 58921 | 53641 | 45069 | 42673 | 40431 | 41008 | 41555 | 40345 | 37980 | 41311 | 442934 |
| C-9 | 3504 | 3394 | 2898 | 3063 | 2730 | 2647 | 2545 | 2188 | 1909 | 2823 | 27701 |
| C-20 | 19 | 14 | 12 | 37 | 56 | 361 | 850 | 1194 | 302 | 0 | 2845 |

**RATIO**

| FISCAL YEAR | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| VR | 6.0444E-05 | 6.58E-05 | 4.46E-05 | 1.94E-05 | 7.12E-05 | 0.000133 | 0.000114 | 0.00015 | 0.000149 | 0.000111 | 9.5E-05 |
| OTHER | 0 | 3.51E-05 | 4.17E-05 | 4.37E-05 | 2.31E-05 | 2.27E-05 | 6.67E-05 | 0.000114 | 0.000224 | 0.000113 | 6.34E-05 |

**RATIO PER AIRCRAFT TYPE**

| FISCAL YEAR | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| VR | | | | | | | | | | | |
| C-130 | 0 | 0 | 0 | 0 | 9.79E-05 | 0.000152 | 0.000221 | 0.000144 | 0.000291 | 0.000136 | 0.000157 |
| C-9 | 6.2274E-05 | 6.82E-05 | 4.93E-05 | 2.27E-05 | 6.86E-05 | 0.000144 | 9.7E-05 | 0.000182 | 0.000121 | 8.78E-05 | 8.8E-05 |
| C-20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0002 | 2.59E-05 |
| Non-VR | | | | | | | | | | | |
| C-130 | 0 | 3.73E-05 | 4.44E-05 | 4.69E-05 | 2.47E-05 | 2.44E-05 | 7.22E-05 | 0.000124 | 0.000237 | 0.000121 | 6.77E-05 |
| C-9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C-20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | #DIV/0! | 0 |

Figure B-4. TPF, Human Factor, HFACS-ME, HFACS-ME Part Failure Tally/Flying Hour Worksheet

**TOTAL PART FAILURES, HF,HF-ME, SQUADRON**

| FISCAL YEAR | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **PART FAILURES** | | | | | | | | | | | |
| VR | 3 | 8 | 2 | 1 | 1 | 5 | 6 | 7 | 8 | 4 | 45 |
| Non-VR | 3 | 6 | 3 | 6 | 2 | 1 | 0 | 4 | 7 | 5 | 37 |
| TOTAL | 6 | 14 | 5 | 7 | 3 | 6 | 6 | 11 | 15 | 9 | 82 |
| **FLYING HOURS** | | | | | | | | | | | |
| VR | 49633 | 45573 | 44888 | 51546 | 56209 | 59964 | 61296 | 60023 | 53587 | 53899 | 536618 |
| Non-VR | 62444 | 57049 | 47979 | 45773 | 43217 | 44016 | 44950 | 43727 | 40191 | 44134 | 473480 |
| TOTAL | 112077 | 102622 | 92867 | 97319 | 99426 | 103980 | 106246 | 103750 | 93778 | 98033 | 1010098 |

**TOTAL PART FAILURES, HF, HF-ME, SQUADRON PER AIRCRAFT TYPE**

| FISCAL YEAR | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **PART FAILURES** | | | | | | | | | | | |
| VR | | | | | | | | | | | |
| C-130 | 0 | 0 | 0 | 0 | 1 | 2 | 2 | 1 | 4 | 1 | 11 |
| C-9 | 3 | 8 | 2 | 1 | 0 | 3 | 4 | 6 | 3 | 3 | 33 |
| C-20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| Non-VR | | | | | | | | | | | |
| C-130 | 3 | 6 | 3 | 6 | 2 | 1 | 0 | 4 | 7 | 5 | 37 |
| C-9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C-20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **FLYING HOURS** | | | | | | | | | | | |
| VR | | | | | | | | | | | |
| C-130 | 22 | 396 | 2900 | 6426 | 10214 | 13199 | 13567 | 13891 | 13726 | 14723 | 89064 |
| C-9 | 48174 | 44017 | 40527 | 43975 | 43710 | 41616 | 41232 | 38357 | 33135 | 34177 | 408920 |
| C-20 | 1437 | 1160 | 1461 | 1145 | 2285 | 5149 | 6497 | 7775 | 6726 | 4999 | 38634 |
| Non-VR | | | | | | | | | | | |
| C-130 | 58921 | 53641 | 45069 | 42673 | 40431 | 41008 | 41555 | 40345 | 37980 | 41311 | 442934 |
| C-9 | 3504 | 3394 | 2898 | 3063 | 2730 | 2647 | 2545 | 2188 | 1909 | 2823 | 27701 |
| C-20 | 19 | 14 | 12 | 37 | 56 | 361 | 850 | 1194 | 302 | 0 | 2845 |

**RATIO**

| FISCAL YEAR | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| VR | 6.0444E-05 | 0.000176 | 4.46E-05 | 1.94E-05 | 1.78E-05 | 8.34E-05 | 9.79E-05 | 0.000117 | 0.000149 | 7.42E-05 | 8.39E-05 |
| Non-VR | 4.8043E-05 | 0.000105 | 6.25E-05 | 0.000131 | 4.63E-05 | 2.27E-05 | 0 | 9.15E-05 | 0.000174 | 0.000113 | 7.81E-05 |

**RATIO PER AIRCRAFT TYPE**

| FISCAL YEAR | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| VR | | | | | | | | | | | |
| C-130 | 0 | 0 | 0 | 0 | 9.79E-05 | 0.000152 | 0.000147 | 7.2E-05 | 0.000291 | 6.79E-05 | 0.000124 |
| C-9 | 6.2274E-05 | 0.000182 | 4.93E-05 | 2.27E-05 | 0 | 7.21E-05 | 9.7E-05 | 0.000156 | 9.05E-05 | 8.78E-05 | 8.07E-05 |
| C-20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.000149 | 0 | 2.59E-05 |
| Non-VR | | | | | | | | | | | |
| C-130 | 5.0916E-05 | 0.000112 | 6.66E-05 | 0.000141 | 4.95E-05 | 2.44E-05 | 0 | 9.91E-05 | 0.000184 | 0.000121 | 8.35E-05 |
| C-9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C-20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | #DIV/0! | 0 |

Figure B-5. Squadron Related TPF, Human Factor, HFACS-ME Tally/Flying Hour Worksheet

**TOTAL PART FAILURES, HF,HF-ME, Non-SQUADRON**

| FISCAL YEAR | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **PART FAILURES** | | | | | | | | | | | |
| VR | 3 | 4 | 1 | 1 | 3 | 4 | 8 | 8 | 4 | 9 | 45 |
| Non-VR | 1 | 2 | 1 | 5 | 3 | 0 | 5 | 11 | 10 | 4 | 42 |
| TOTAL | 4 | 6 | 2 | 6 | 6 | 4 | 13 | 19 | 14 | 13 | 87 |
| **FLYING HOURS** | | | | | | | | | | | |
| VR | 49633 | 45573 | 44888 | 51546 | 56209 | 59964 | 61296 | 60023 | 53587 | 53899 | 536618 |
| Non-VR | 62444 | 57049 | 47979 | 45773 | 43217 | 44016 | 44950 | 43727 | 40191 | 44134 | 473480 |
| TOTAL | 112077 | 102622 | 92867 | 97319 | 99426 | 103980 | 106246 | 103750 | 93778 | 98033 | 1010098 |

**TOTAL PART FAILURES, HF, HF-ME, Non-SQUADRON PER AIRCRAFT TYPE**

| FISCAL YEAR | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **PART FAILURES** | | | | | | | | | | | |
| VR | | | | | | | | | | | |
| C-130 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 3 | 3 | 5 | 15 |
| C-9 | 3 | 4 | 1 | 1 | 3 | 4 | 3 | 3 | 1 | 3 | 26 |
| C-20 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 1 | 4 |
| Non-VR | | | | | | | | | | | |
| C-130 | 1 | 2 | 1 | 4 | 3 | 0 | 5 | 8 | 10 | 4 | 38 |
| C-9 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| C-20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 3 |
| **FLYING HOURS** | | | | | | | | | | | |
| VR | | | | | | | | | | | |
| C-130 | 22 | 396 | 2900 | 6426 | 10214 | 13199 | 13567 | 13891 | 13726 | 14723 | 89064 |
| C-9 | 48174 | 44017 | 40527 | 43975 | 43710 | 41616 | 41232 | 38357 | 33135 | 34177 | 408920 |
| C-20 | 1437 | 1160 | 1461 | 1145 | 2285 | 5149 | 6497 | 7775 | 6726 | 4999 | 38634 |
| Non-VR | | | | | | | | | | | |
| C-130 | 58921 | 53641 | 45069 | 42673 | 40431 | 41008 | 41555 | 40345 | 37980 | 41311 | 442934 |
| C-9 | 3504 | 3394 | 2898 | 3063 | 2730 | 2647 | 2545 | 2188 | 1909 | 2823 | 27701 |
| C-20 | 19 | 14 | 12 | 37 | 56 | 361 | 850 | 1194 | 302 | 0 | 2845 |

**RATIO**

| FISCAL YEAR | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| VR | 6.0444E-05 | 8.78E-05 | 2.23E-05 | 1.94E-05 | 5.34E-05 | 6.67E-05 | 0.000131 | 0.000133 | 7.46E-05 | 0.000167 | 8.39E-05 |
| Non-VR | 1.6014E-05 | 3.51E-05 | 2.08E-05 | 0.000109 | 6.94E-05 | 0 | 0.000111 | 0.000252 | 0.000249 | 9.06E-05 | 8.87E-05 |

**RATIO PER AIRCRAFT TYPE**

| FISCAL YEAR | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| VR | | | | | | | | | | | |
| C-130 | 0 | 0 | 0 | 0 | 0 | 0 | 0.000295 | 0.000216 | 0.000219 | 0.00034 | 0.000168 |
| C-9 | 6.2274E-05 | 9.09E-05 | 2.47E-05 | 2.27E-05 | 6.86E-05 | 9.61E-05 | 7.28E-05 | 7.82E-05 | 3.02E-05 | 8.78E-05 | 6.36E-05 |
| C-20 | 0 | 0 | 0 | 0 | 0 | 0 | 0.000154 | 0.000257 | 0 | 0.0002 | 0.000104 |
| Non-VR | | | | | | | | | | | |
| C-130 | 1.6972E-05 | 3.73E-05 | 2.22E-05 | 9.37E-05 | 7.42E-05 | 0 | 0.00012 | 0.000198 | 0.000263 | 9.68E-05 | 8.58E-05 |
| C-9 | 0 | 0 | 0 | 0.000326 | 0 | 0 | 0 | 0 | 0 | 0 | 3.61E-05 |
| C-20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.002513 | 0 | #DIV/0! | 0.001054 |

Figure B-6. Non-Squadron Related TPF, Human Factor, HFACS-ME Tally/Flying Hour Worksheet

TOTAL PART FAILURES, HF,HF-ME, HF-ME PART FAILURE, SQUADRON

| FISCAL YEAR | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PART FAILURES | | | | | | | | | | | |
| VR | 2 | 3 | 1 | 1 | 1 | 5 | 4 | 6 | 7 | 1 | 31 |
| Non-VR | 0 | 1 | 2 | 2 | 1 | 1 | 0 | 3 | 6 | 4 | 20 |
| TOTAL | 2 | 4 | 3 | 3 | 2 | 6 | 4 | 9 | 13 | 5 | 51 |
| FLYING HOURS | | | | | | | | | | | |
| VR | 49633 | 45573 | 44888 | 51546 | 56209 | 59964 | 61296 | 60023 | 53587 | 53899 | 536618 |
| Non-VR | 62444 | 57049 | 47979 | 45773 | 43217 | 44016 | 44950 | 43727 | 40191 | 44134 | 473480 |
| TOTAL | 112077 | 102622 | 92867 | 97319 | 99426 | 103980 | 106246 | 103750 | 93778 | 98033 | 1010098 |

TOTAL PART FAILURES, HF, HF-ME, HF-ME PART FAILURE, SQUADRON PER AIRCRAFT TYPE

| FISCAL YEAR | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PART FAILURES | | | | | | | | | | | |
| VR | | | | | | | | | | | |
| C-130 | 0 | 0 | 0 | 0 | 1 | 2 | 2 | 1 | 4 | 0 | 10 |
| C-9 | 2 | 3 | 1 | 1 | 0 | 3 | 2 | 5 | 3 | 1 | 21 |
| C-20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-VR | | | | | | | | | | | |
| C-130 | 0 | 1 | 2 | 2 | 1 | 1 | 0 | 3 | 6 | 4 | 20 |
| C-9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C-20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| FLYING HOURS | | | | | | | | | | | |
| VR | | | | | | | | | | | |
| C-130 | 22 | 396 | 2900 | 6426 | 10214 | 13199 | 13567 | 13891 | 13726 | 14723 | 89064 |
| C-9 | 48174 | 44017 | 40527 | 43975 | 43710 | 41616 | 41232 | 38357 | 33135 | 34177 | 408920 |
| C-20 | 1437 | 1160 | 1461 | 1145 | 2285 | 5149 | 6497 | 7775 | 6726 | 4999 | 38634 |
| Non-VR | | | | | | | | | | | |
| C-130 | 58921 | 53641 | 45069 | 42673 | 40431 | 41008 | 41555 | 40345 | 37980 | 41311 | 442934 |
| C-9 | 3504 | 3394 | 2898 | 3063 | 2730 | 2647 | 2545 | 2188 | 1909 | 2823 | 27701 |
| C-20 | 19 | 14 | 12 | 37 | 56 | 361 | 850 | 1194 | 302 | 0 | 2845 |

RATIO

| FISCAL YEAR | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| VR | 4E-05 | 6.6E-05 | 2.2E-05 | 1.9E-05 | 1.8E-05 | 8.3E-05 | 6.5E-05 | 1E-04 | 0.00013 | 1.9E-05 | 5.8E-05 |
| Non-VR | 0 | 1.8E-05 | 4.2E-05 | 4.4E-05 | 2.3E-05 | 2.3E-05 | 0 | 6.9E-05 | 0.00015 | 9.1E-05 | 4.2E-05 |

RATIO PER AIRCRAFT TYPE

| FISCAL YEAR | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| VR | | | | | | | | | | | |
| C-130 | 0 | 0 | 0 | 0 | 9.8E-05 | 0.00015 | 0.00015 | 7.2E-05 | 0.00029 | 0 | 0.00011 |
| C-9 | 4.2E-05 | 6.8E-05 | 2.5E-05 | 2.3E-05 | 0 | 7.2E-05 | 4.9E-05 | 0.00013 | 9.1E-05 | 2.9E-05 | 5.1E-05 |
| C-20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-VR | | | | | | | | | | | |
| C-130 | 0 | 1.9E-05 | 4.4E-05 | 4.7E-05 | 2.5E-05 | 2.4E-05 | 0 | 7.4E-05 | 0.00016 | 9.7E-05 | 4.5E-05 |
| C-9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C-20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | #DIV/0! | 0 |

Figure B-7. Squadron Related TPF, Human Factors, HFACS-ME, HFACS-ME Part Failure Tally/Flying Hour Worksheet

TOTAL PART FAILURES, HF,HF-ME, HF-ME PART FAILURE, NON-SQUADRON

| FISCAL YEAR | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PART FAILURES | | | | | | | | | | | |
| VR | 0 | 0 | 1 | 1 | 3 | 4 | 4 | 5 | 2 | 5 | 25 |
| Non-VR | 0 | 1 | 1 | 2 | 1 | 0 | 3 | 3 | 6 | 1 | 18 |
| TOTAL | 0 | 1 | 2 | 3 | 4 | 4 | 7 | 8 | 8 | 6 | 43 |
| FLYING HOURS | | | | | | | | | | | |
| VR | 49633 | 45573 | 44888 | 51546 | 56209 | 59964 | 61296 | 60023 | 53587 | 53899 | 536618 |
| Non-VR | 62444 | 57049 | 47979 | 45773 | 43217 | 44016 | 44950 | 43727 | 40191 | 44134 | 473480 |
| TOTAL | 112077 | 102622 | 92867 | 97319 | 99426 | 103980 | 106246 | 103750 | 93778 | 98033 | 1010098 |

TOTAL PART FAILURES, HF, HF-ME, HF-ME PART FAILURE, NON-SQUADRON PER AIRCRAFT TYPE

| FISCAL YEAR | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PART FAILURES | | | | | | | | | | | |
| VR | | | | | | | | | | | |
| C-130 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 1 | 2 | 6 |
| C-9 | 0 | 0 | 1 | 1 | 3 | 4 | 3 | 3 | 1 | 2 | 18 |
| C-20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| Non-VR | | | | | | | | | | | |
| C-130 | 0 | 1 | 1 | 2 | 1 | 0 | 3 | 3 | 6 | 1 | 18 |
| C-9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C-20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| FLYING HOURS | | | | | | | | | | | |
| VR | | | | | | | | | | | |
| C-130 | 22 | 396 | 2900 | 6426 | 10214 | 13199 | 13567 | 13891 | 13726 | 14723 | 89064 |
| C-9 | 48174 | 44017 | 40527 | 43975 | 43710 | 41616 | 41232 | 38357 | 33135 | 34177 | 408920 |
| C-20 | 1437 | 1160 | 1461 | 1145 | 2285 | 5149 | 6497 | 7775 | 6726 | 4999 | 38634 |
| Non-VR | | | | | | | | | | | |
| C-130 | 58921 | 53641 | 45069 | 42673 | 40431 | 41008 | 41555 | 40345 | 37980 | 41311 | 442934 |
| C-9 | 3504 | 3394 | 2898 | 3063 | 2730 | 2647 | 2545 | 2188 | 1909 | 2823 | 27701 |
| C-20 | 19 | 14 | 12 | 37 | 56 | 361 | 850 | 1194 | 302 | 0 | 2845 |

RATIO

| FISCAL YEAR | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| VR | 0 | 0 | 2.2E-05 | 1.9E-05 | 5.3E-05 | 6.7E-05 | 6.5E-05 | 8.3E-05 | 3.7E-05 | 9.3E-05 | 4.7E-05 |
| Non-VR | 0 | 1.8E-05 | 2.1E-05 | 4.4E-05 | 2.3E-05 | 0 | 6.7E-05 | 6.9E-05 | 0.00015 | 2.3E-05 | 3.8E-05 |

RATIO PER AIRCRAFT TYPE

| FISCAL YEAR | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| VR | | | | | | | | | | | |
| C-130 | 0 | 0 | 0 | 0 | 0 | 0 | 7.4E-05 | 0.00014 | 7.3E-05 | 0.00014 | 6.7E-05 |
| C-9 | 0 | 0 | 2.5E-05 | 2.3E-05 | 6.9E-05 | 9.6E-05 | 7.3E-05 | 7.8E-05 | 3E-05 | 5.9E-05 | 4.4E-05 |
| C-20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0002 | 2.6E-05 |
| Non-VR | | | | | | | | | | | |
| C-130 | 0 | 1.9E-05 | 2.2E-05 | 4.7E-05 | 2.5E-05 | 0 | 7.2E-05 | 7.4E-05 | 0.00016 | 2.4E-05 | 4.1E-05 |
| C-9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C-20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | #DIV/0! | 0 |

Figure B-8. Non-Squadron Related TPF, Human Factors, HFACS-ME, HFACS-ME Part Failure Tally/Flying Hour Worksheet

APPENDIX C: HIERACHICAL BREAKDOWN GRAPHICAL REPRESENTATION OF VR WING VS NON-VR

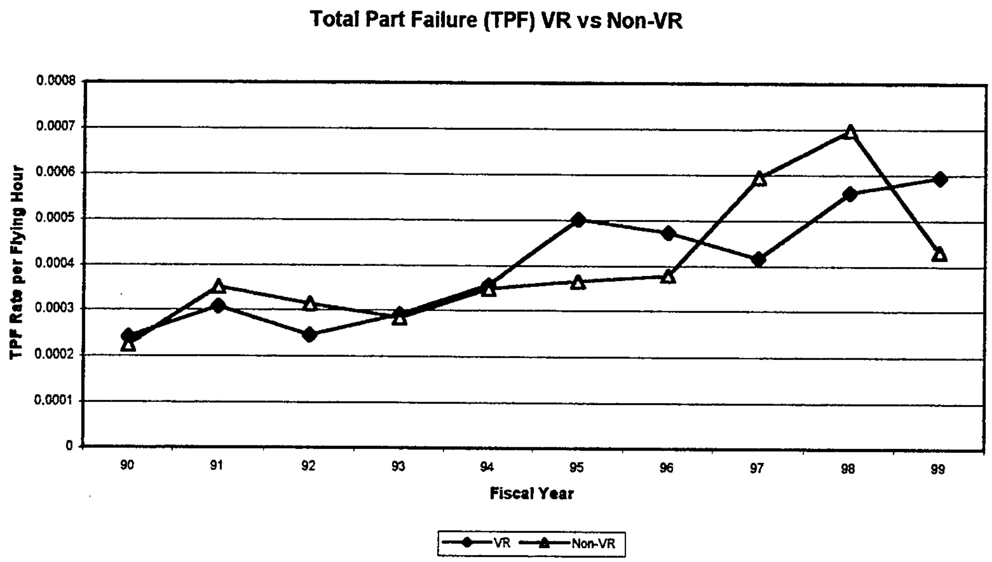


Figure C-1. Total part Failures VR vs Non-VR

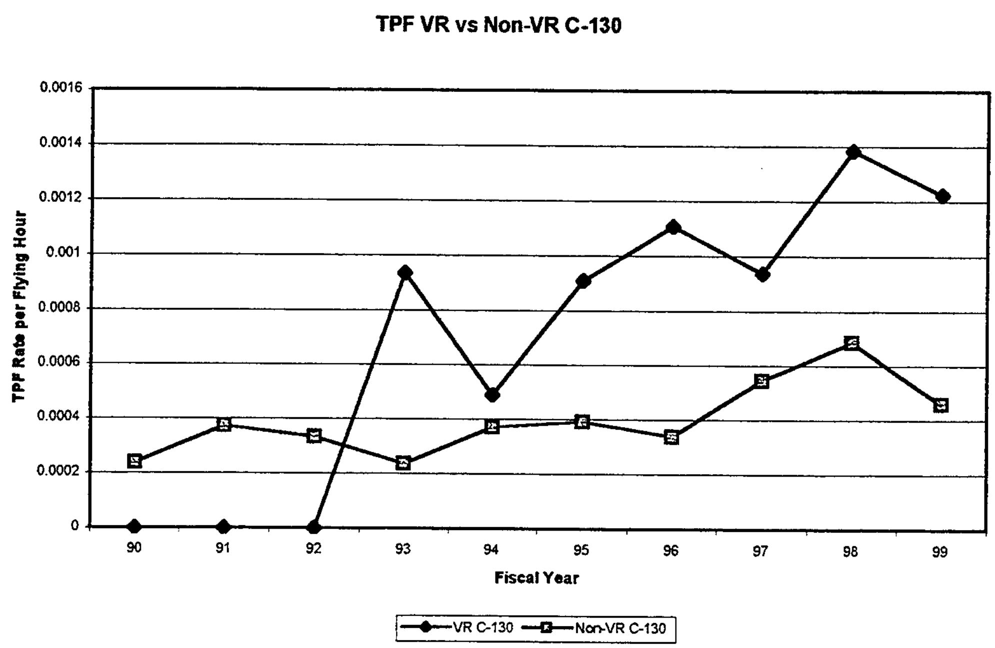


Figure C-2. C-130 Total Part Failures VR vs Non-VR

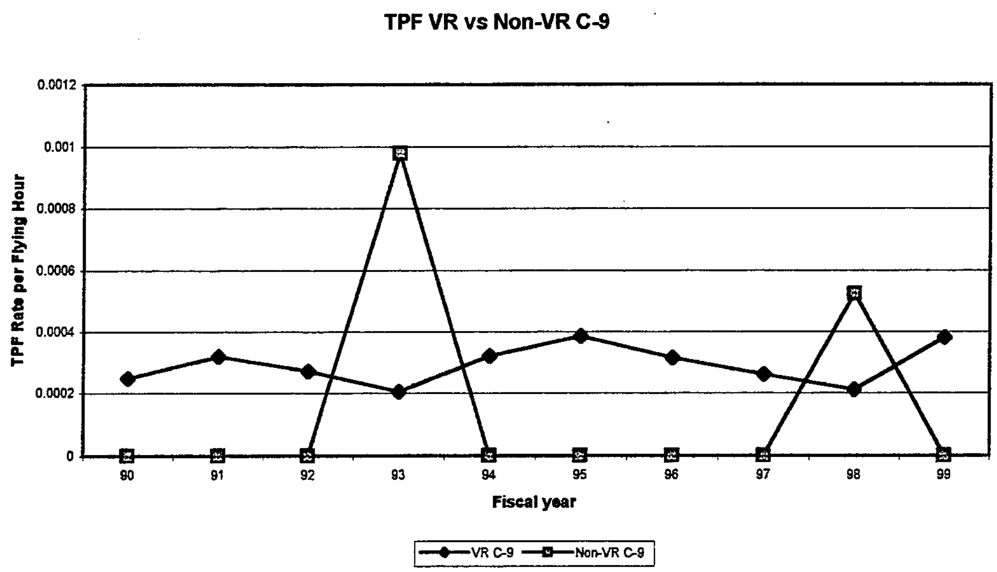


Figure C-3. C-9 Total Part Failures VR vs Non-VR

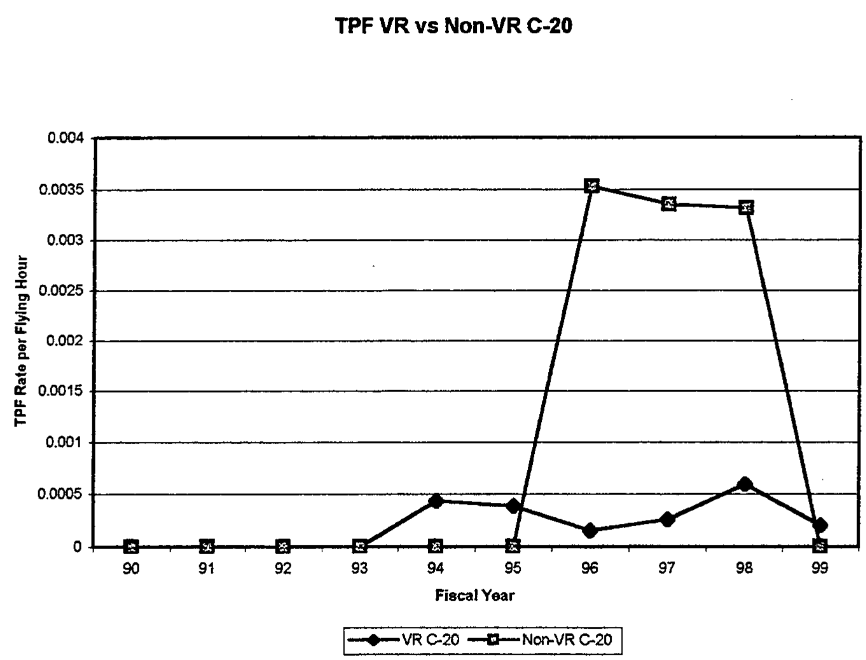


Figure C-4. C-20 Total Part Failures VR vs Non-VR

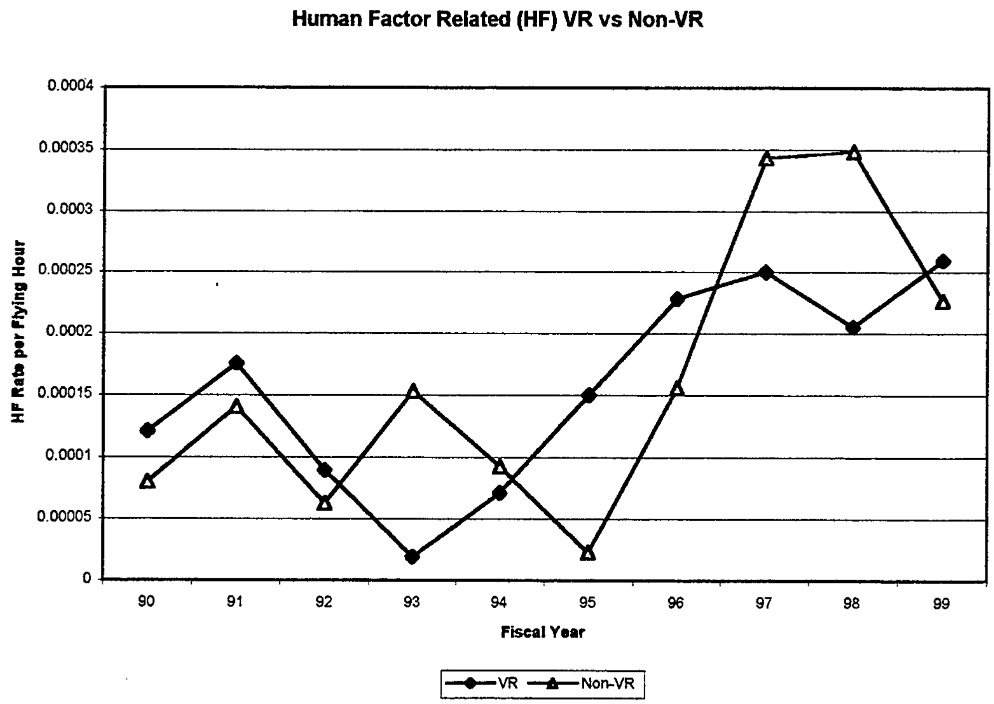


Figure C-5. Human Factor Related VR vs Non-VR

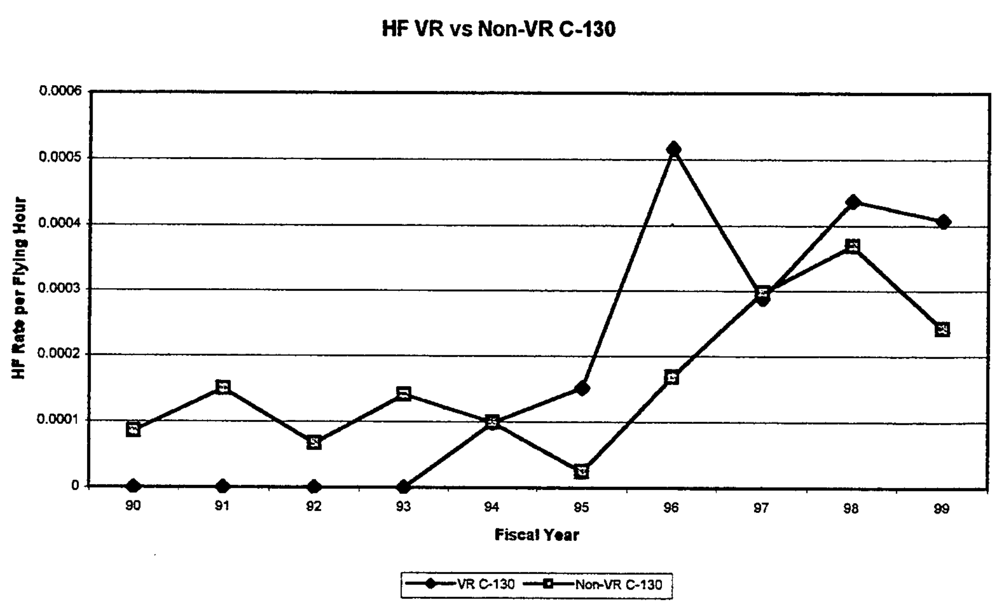


Figure C-6. C-130 Human Factor Related VR vs Non-VR

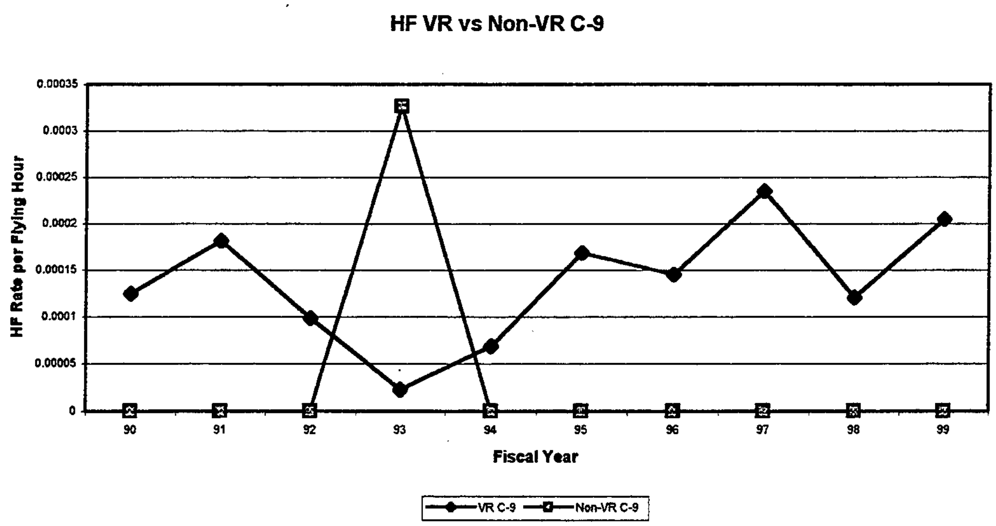


Figure C-7. C-9 Human Factor Related VR vs Non-VR

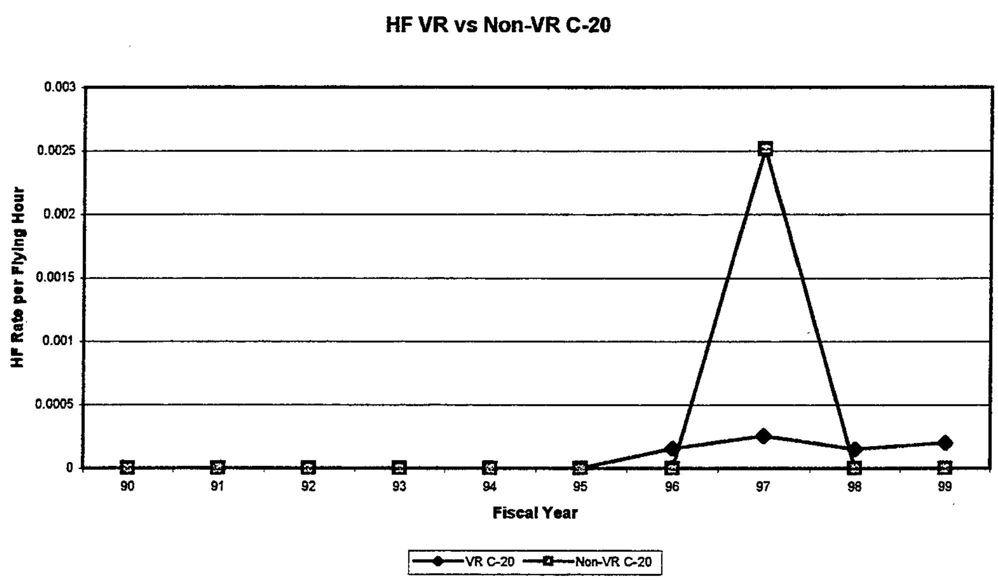


Figure C-8. C-20 Human Factor Related VR vs Non-VR

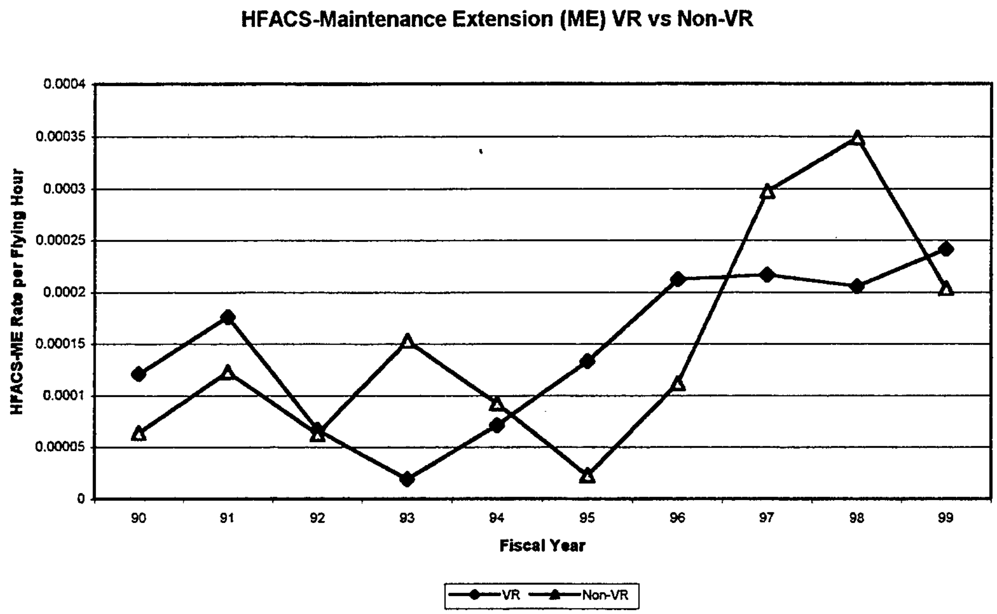


Figure C-9. HFACS-Maintenance Extension Related VR vs Non-VR

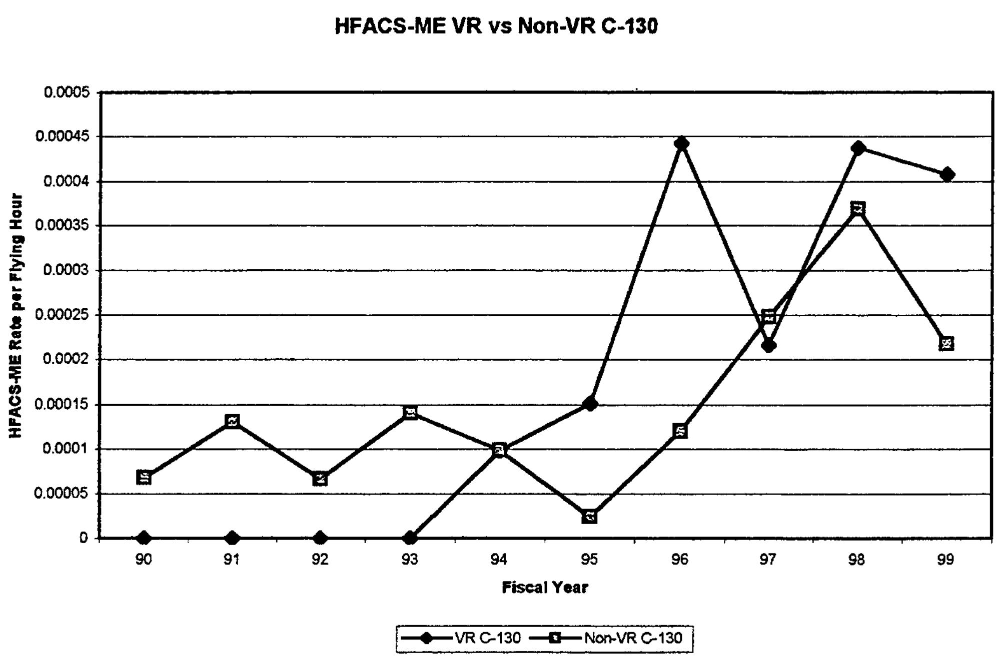


Figure C-10. C-130 HFACS-Maintenance Extension Related VR vs Non-VR

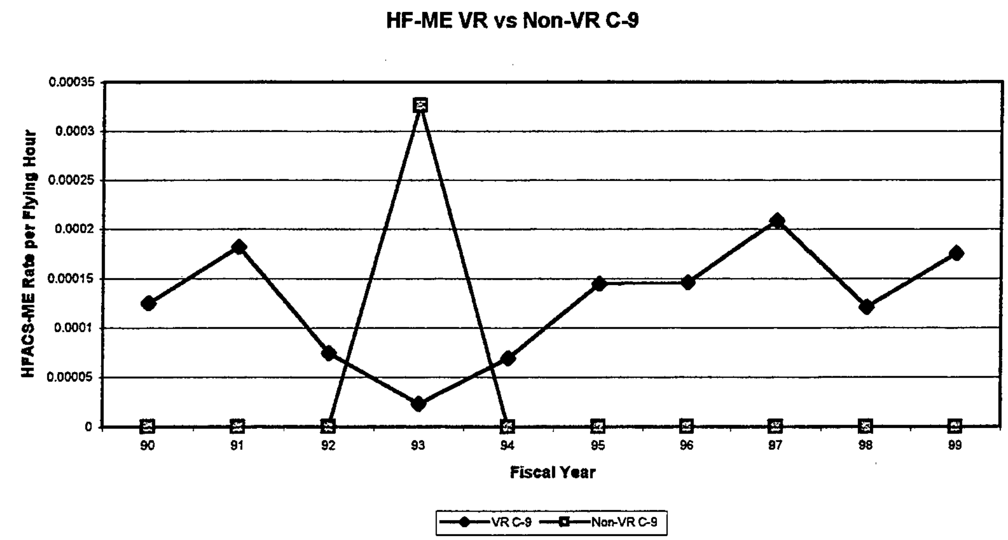


Figure C-11. C-9 HFACS-Maintenance Extension Related VR vs Non-VR

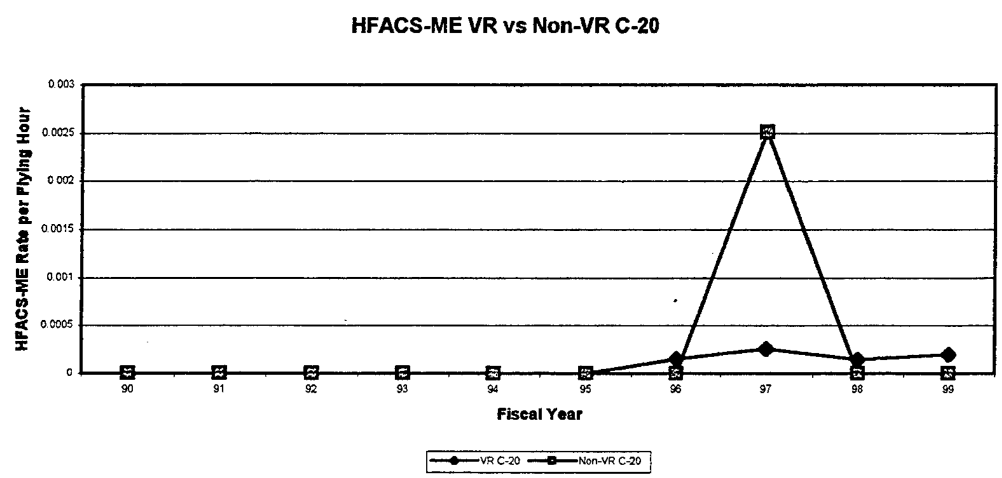


Figure C-12. C-20 HFACS-Maintenance Extension Related VR vs Non-VR

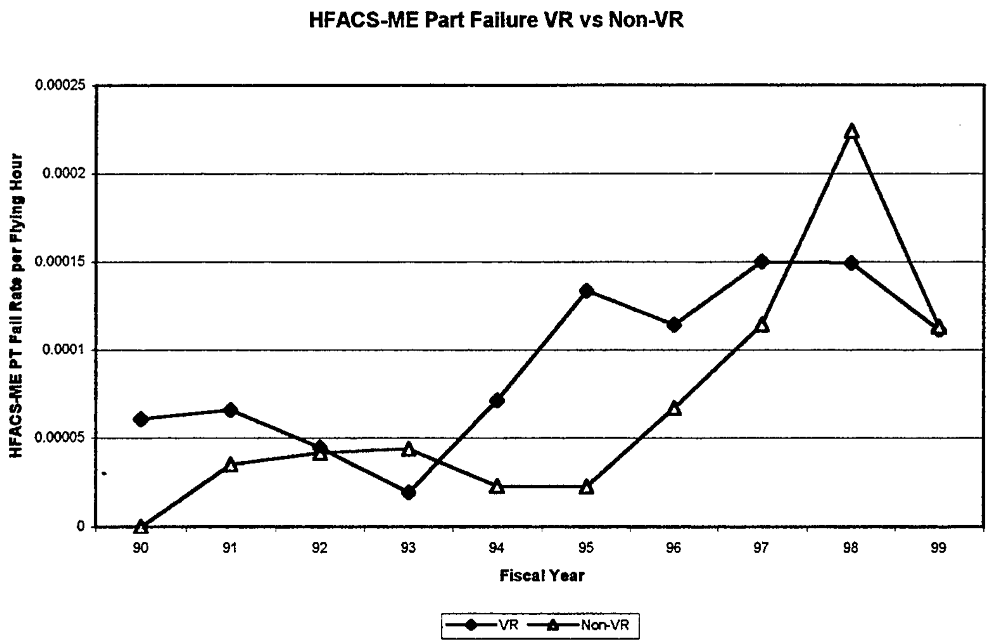


Figure C-13. HFACS-ME Part Failure Related VR vs Non-VR

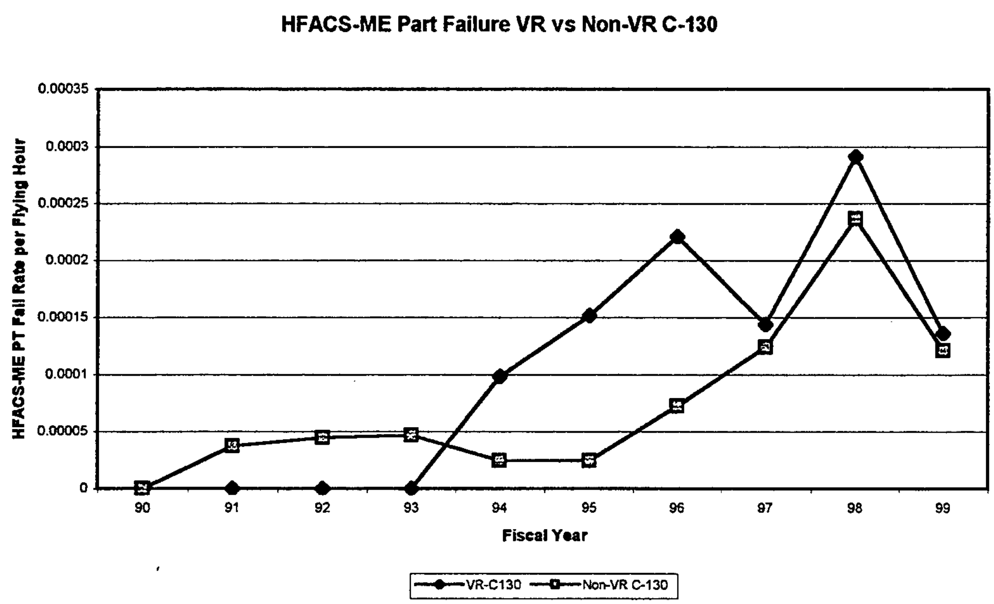


Figure C-14. C-130 HFACS-ME Part Failure Related VR vs Non-VR

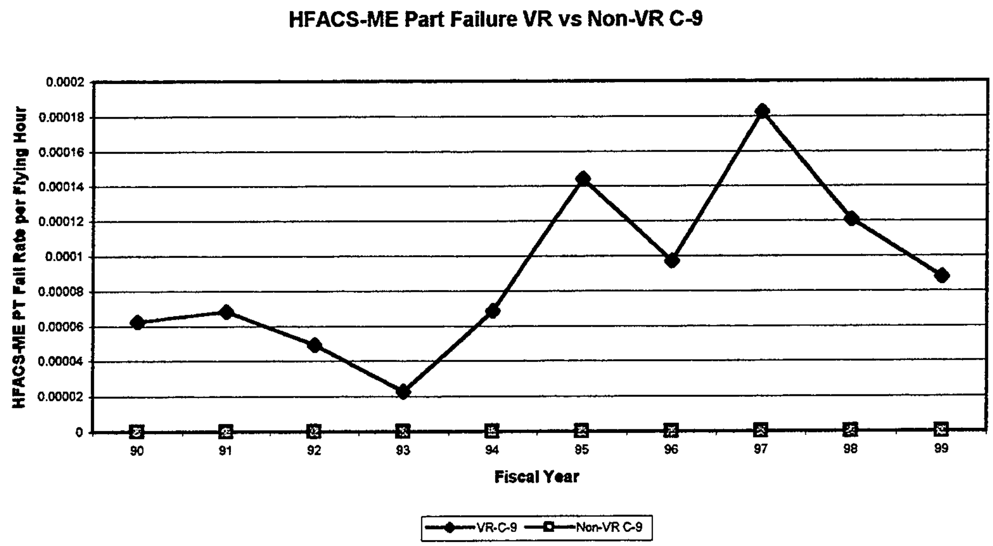


Figure C-15. C-9 HFACS-ME Part Failure Related VR vs Non-VR

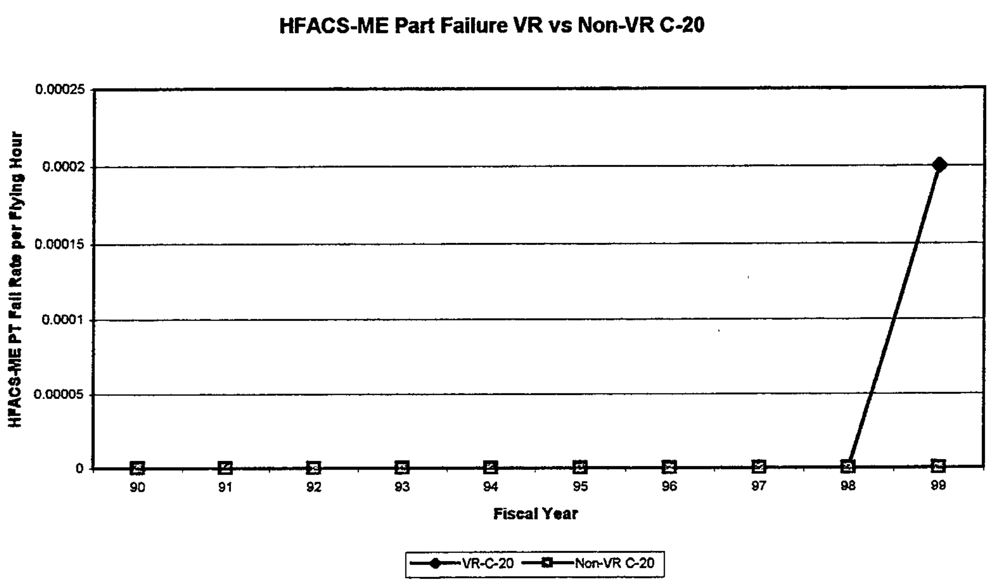


Figure C-16. C-20 HFACS-ME Part Failure Related VR vs Non-VR

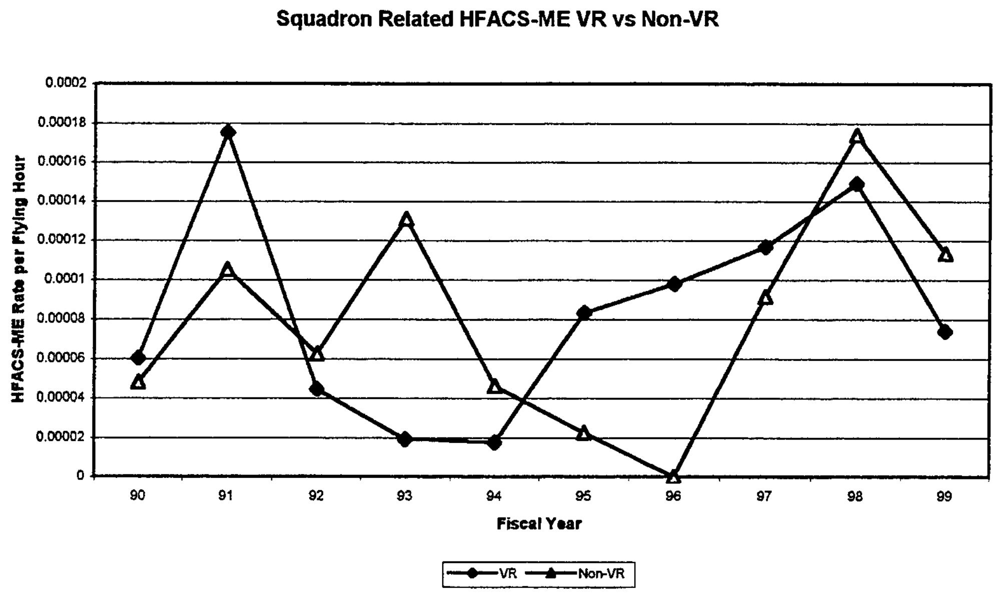


Figure C-17. Squadron Related HFACS-ME VR vs Non-VR

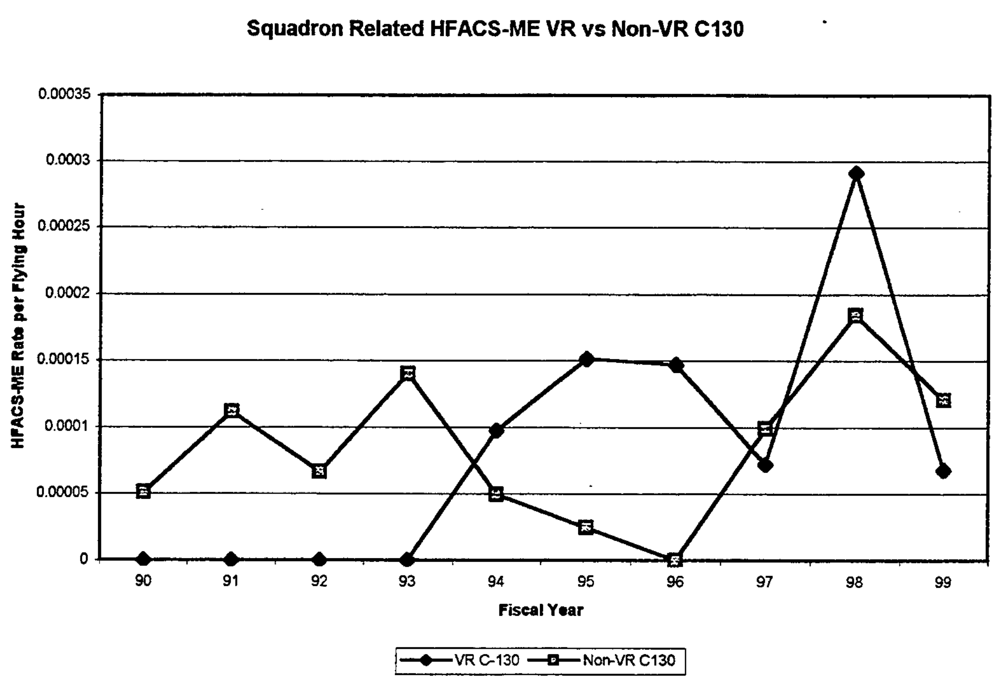


Figure C-18. C-130 Squadron Related HFACS-ME VR vs Non-VR

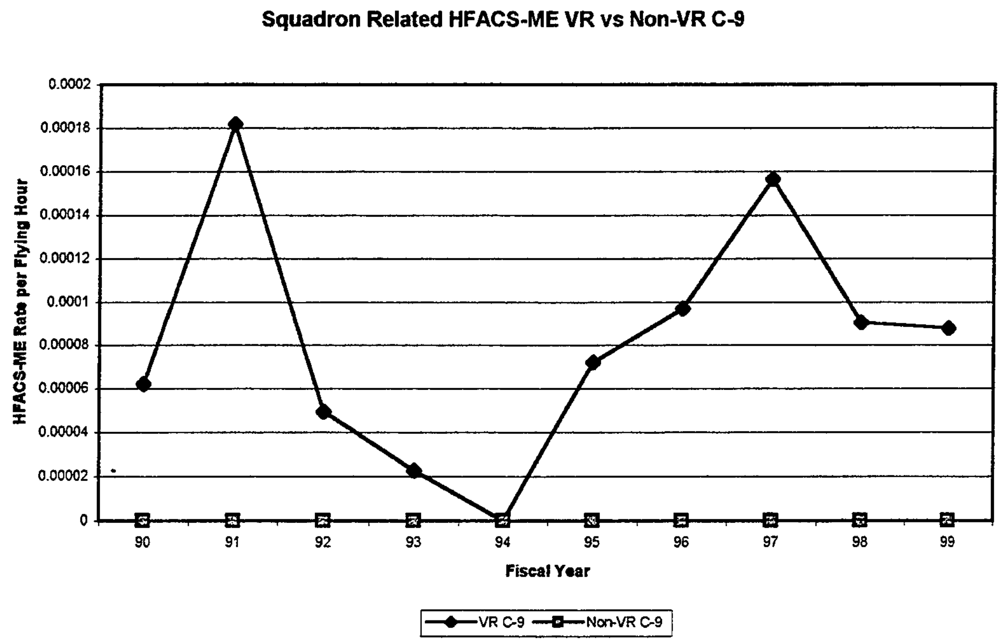


Figure C-19. C-9 Squadron Related HFACS-ME VR vs Non-VR

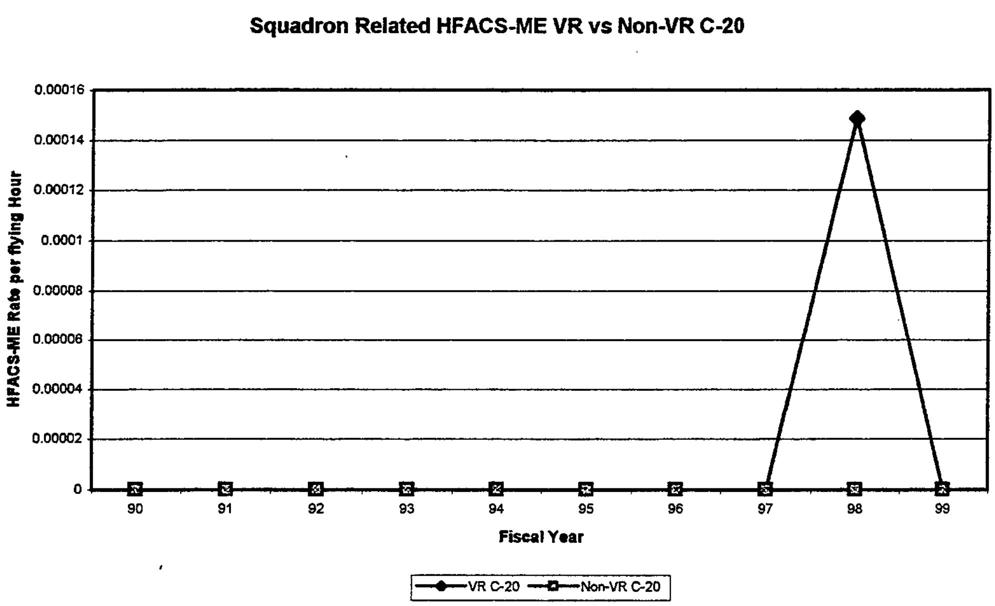


Figure C-20. C-20 Squadron Related HFACS-ME VR vs Non-VR

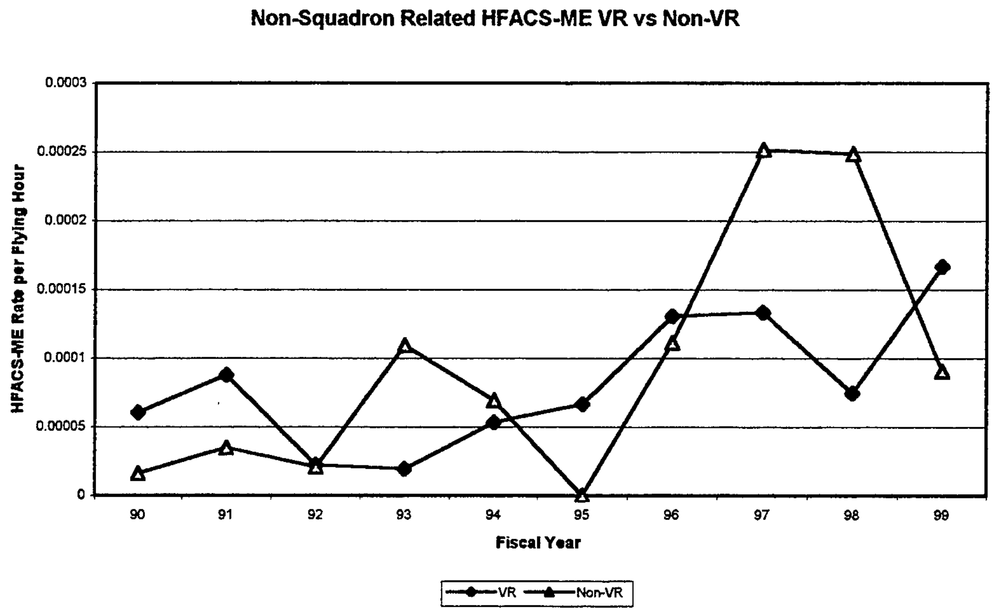


Figure C-21. Non-Squadron Related HFACS-ME VR vs Non-VR

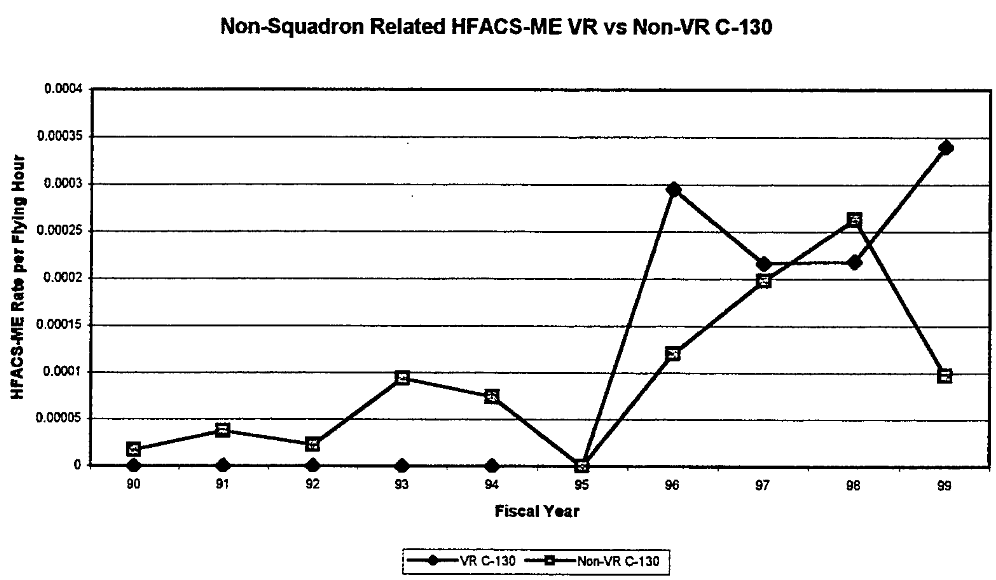


Figure C-22. C-130 Non-Squadron Related HFACS-ME VR vs Non-VR

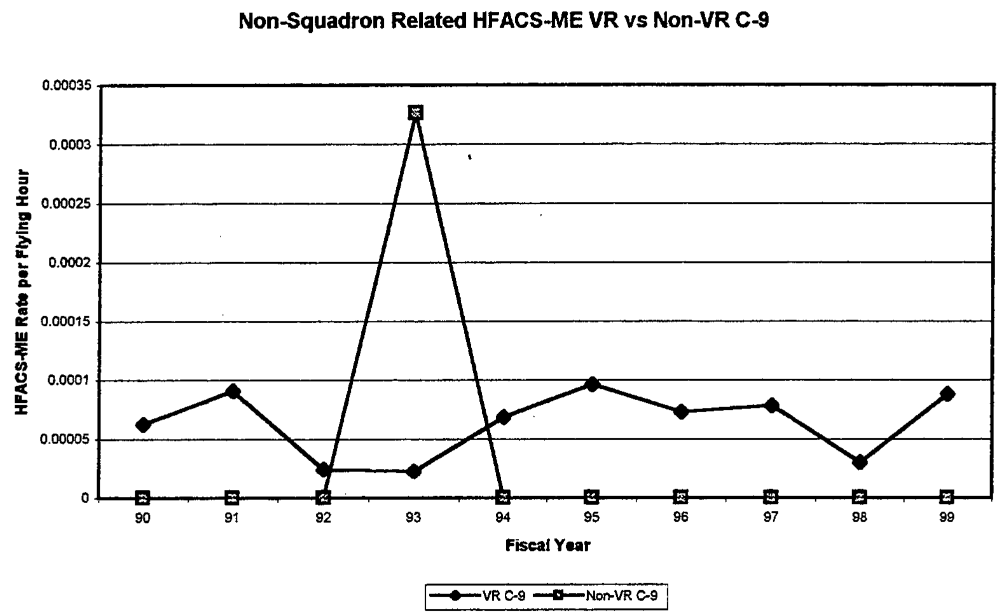


Figure C-23. C-9 Non-Squadron Related HFACS-ME VR vs Non-VR

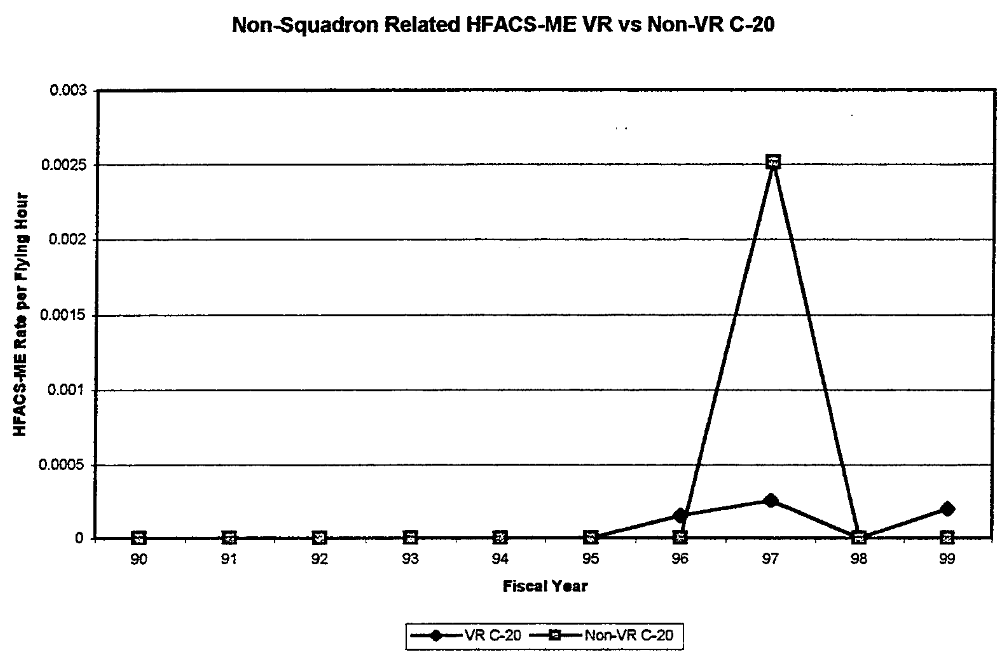


Figure C-24. C-20 Non-Squadron Related HFACS-ME VR vs Non-VR

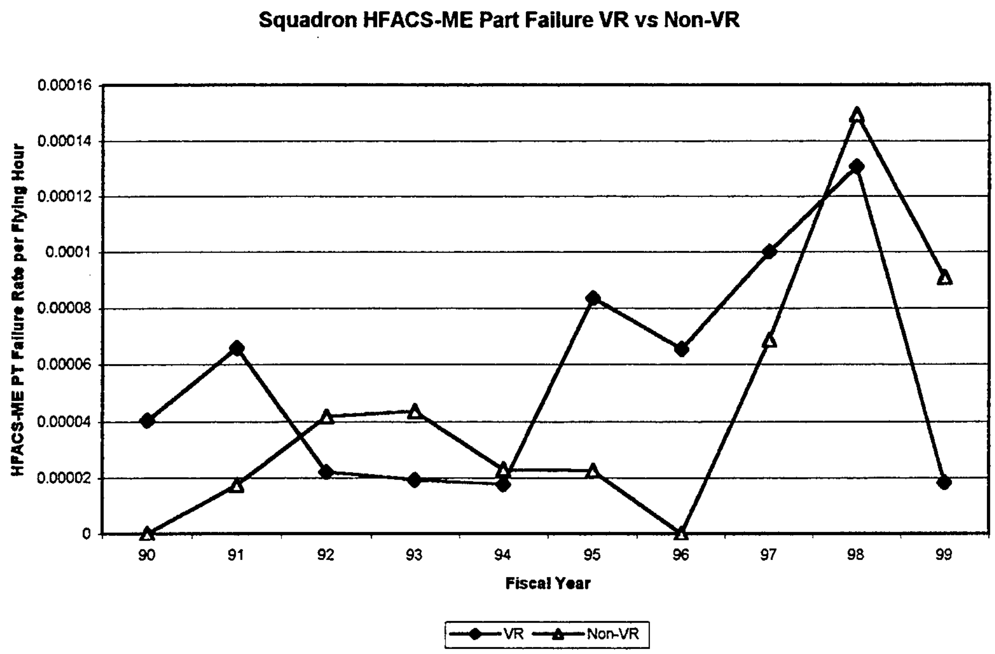


Figure C-25. Squadron Related HFACS-ME Part Failure VR vs Non-VR

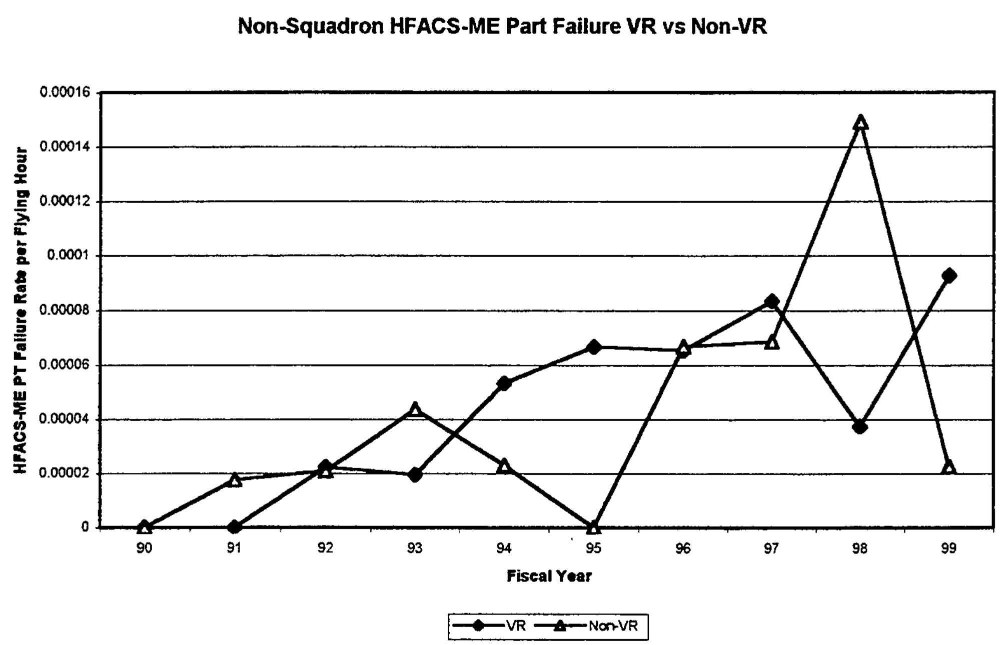


Figure C-26. Non-Squadron Related HFACS-ME Part Failure VR vs Non-VR

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# APPENDIX D: REGRESSION ANALYSIS

**Total Part Failure Regression**

| Fiscal Year | VR | Non-VR | FISCAL YEAR | VR | OTHER |
|---|---|---|---|---|---|
| 90 | 2.41774626 | 2.24200884 | 90 | 0.00024177 | 0.0002242 |
| 91 | 3.07199438 | 3.505758208 | 91 | 0.0003072 | 0.00035058 |
| 92 | 2.45054358 | 3.126367786 | 92 | 0.00024505 | 0.00031264 |
| 93 | 2.91002212 | 2.840102244 | 93 | 0.000291 | 0.00028401 |
| 94 | 3.55814905 | 3.470856376 | 94 | 0.00035581 | 0.00034709 |
| 95 | 5.0030018 | 3.635041803 | 95 | 0.0005003 | 0.0003635 |
| 96 | 4.73114069 | 3.781979978 | 96 | 0.00047311 | 0.0003782 |
| 97 | 4.16507006 | 5.945983031 | 97 | 0.00041651 | 0.0005946 |
| 98 | 5.59837274 | 6.966733846 | 98 | 0.00055984 | 0.00069667 |
| 99 | 5.93703037 | 4.30507092 | 99 | 0.0005937 | 0.00043051 |

**VR REGRESSION**

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.92093558 |
| R Square | 0.84812234 |
| Adjusted R Square | 0.82913763 |
| Standard Error | 0.53401365 |
| Observations | 10 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 12.73970285 | 12.7397 | 44.674 | 0.000155271 |
| Residual | 8 | 2.2813646 | 0.28517 | | |
| Total | 9 | 15.02106745 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* |
|---|---|---|---|---|
| Intercept | -33.150783 | 5.558501199 | -5.964 | 0.00034 |
| Fiscal Year | 0.39296392 | 0.058792968 | 6.68386 | 0.00016 |

**NON-VR REGRESSION**

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.7647008 |
| R Square | 0.58476732 |
| Adjusted R Square | 0.53286323 |
| Standard Error | 0.98208845 |
| Observations | 10 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 10.86632674 | 10.8663 | 11.2663 | 0.009983028 |
| Residual | 8 | 7.715981818 | 0.9645 | | |
| Total | 9 | 18.58230855 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* |
|---|---|---|---|---|
| Intercept | -30.314226 | 10.22247253 | -2.9654 | 0.018 |
| Fiscal Year | 0.36292293 | 0.10812438 | 3.35653 | 0.00998 |

Figure D-1. Total Part Failure Regression Output

**Total Part Failure Regression C-130**

| Fiscal Year | VR | Non-VR |
|---|---|---|
| 90 | 0 | 2.376062864 |
| 91 | 0 | 3.728491266 |
| 92 | 0 | 3.328230047 |
| 93 | 9.33706816 | 2.343402151 |
| 94 | 4.89524182 | 3.710024486 |
| 95 | 9.09159785 | 3.901677721 |
| 96 | 11.0562394 | 3.369028998 |
| 97 | 9.3585775 | 5.45296815 |
| 98 | 13.842343 | 6.845708268 |
| 99 | 12.2257692 | 4.599259277 |

| FISCAL YEAR | VR | OTHER |
|---|---|---|
| 90 | 0 | 0.0002376 |
| 91 | 0 | 0.0003728 |
| 92 | 0 | 0.0003328 |
| 93 | 0.000933707 | 0.0002343 |
| 94 | 0.000489524 | 0.000371 |
| 95 | 0.00090916 | 0.0003902 |
| 96 | 0.001105624 | 0.0003369 |
| 97 | 0.000935858 | 0.0005453 |
| 98 | 0.001384234 | 0.0006846 |
| 99 | 0.001222577 | 0.0004599 |

**VR REGRESSION**

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.72752294 |
| R Square | 0.52928963 |
| Adjusted R Squar | 0.43514755 |
| Standard Error | 2.13817328 |
| Observations | 7 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 25.70368669 | 25.7036867 | 5.622243 | 0.063863378 |
| Residual | 5 | 22.85892493 | 4.57178499 | | |
| Total | 6 | 48.56261162 | | | |

| | *Coefficients* | *Standard Erro* | *t Stat* | *P-value* |
|---|---|---|---|---|
| Intercept | -82.006858 | 38.79978717 | -2.1135904 | 0.088219 |
| Fiscal Year | 0.95811733 | 0.404076769 | 2.37112697 | 0.063863 |

**NON-VR REGRESSION**

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.76183733 |
| R Square | 0.58039612 |
| Adjusted R Squar | 0.49647535 |
| Standard Error | 1.04846901 |
| Observations | 7 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 7.60267118 | 7.60267118 | 6.916 | 0.046542855 |
| Residual | 5 | 5.496436273 | 1.09928725 | | |
| Total | 6 | 13.09910745 | | | |

| | *Coefficients* | *Standard Erro* | *t Stat* | *P-value* |
|---|---|---|---|---|
| Intercept | -45.706205 | 19.02576119 | -2.4023325 | 0.061443 |
| Fiscal Year | 0.52107962 | 0.198142017 | 2.62982898 | 0.046543 |

Figure D-2. Total Part Failure C-130 Regression Output

**Total Part Failure Regression C-9**

| Fiscal Year | VR | Non-VR |
|---|---|---|
| 90 | 2.49097023 | 0 |
| 91 | 3.18058932 | 0 |
| 92 | 2.71423989 | 0 |
| 93 | 2.0466174 | 9.794319295 |
| 94 | 3.20292839 | 0 |
| 95 | 3.84467512 | 0 |
| 96 | 3.15289096 | 0 |
| 97 | 2.60708606 | 0 |
| 98 | 2.11256979 | 5.238344683 |
| 99 | 3.80372765 | 0 |

| FISCAL YEAR | VR | OTHER |
|---|---|---|
| 90 | 0.000249097 | 0 |
| 91 | 0.000318059 | 0 |
| 92 | 0.000271424 | 0 |
| 93 | 0.000204662 | 0.0009794 |
| 94 | 0.000320293 | 0 |
| 95 | 0.000384468 | 0 |
| 96 | 0.000315289 | 0 |
| 97 | 0.000260709 | 0 |
| 98 | 0.000211257 | 0.0005238 |
| 99 | 0.000380373 | 0 |

**VR REGRESSION**

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.22596242 |
| R Square | 0.05105902 |
| Adjusted R Squa | -0.0675586 |
| Standard Error | 0.65138502 |
| Observations | 10 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 0.182641201 | 0.1826412 | 0.43045051 | 0.530181526 |
| Residual | 8 | 3.394419517 | 0.42430244 | | |
| Total | 9 | 3.577060717 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* |
|---|---|---|---|---|
| Intercept | -1.5307263 | 6.780209486 | -0.2257639 | 0.82704596 |
| Fiscal Year | 0.04705138 | 0.07171513 | 0.65608727 | 0.53018153 |

Figure D-3. Total Part Failure C-9 Regression Output

**Total Part Failure Regression C-20**

| Fiscal Year | VR | Non-VR |
|---|---|---|
| 90 | 0 | 0 |
| 91 | 0 | 0 |
| 92 | 0 | 0 |
| 93 | 0 | 0 |
| 94 | 4.37636761 | 0 |
| 95 | 3.88424937 | 0 |
| 96 | 1.53917193 | 35.29411765 |
| 97 | 2.57234727 | 33.50083752 |
| 98 | 5.94707107 | 33.11258278 |
| 99 | 2.00040008 | 10000 |

| FISCAL YEAR | VR | OTHER |
|---|---|---|
| 90 | 0 | 0 |
| 91 | 0 | 0 |
| 92 | 0 | 0 |
| 93 | 0 | 0 |
| 94 | 0.000437637 | 0 |
| 95 | 0.000388425 | 0 |
| 96 | 0.000153917 | 0.0035294 |
| 97 | 0.000257235 | 0.0033501 |
| 98 | 0.000594707 | 0.0033113 |
| 99 | 0.00020004 | #DIV/0! |

**VR REGRESSION**

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.14997911 |
| R Square | 0.02249373 |
| Adjusted R Squa | -0.2218828 |
| Standard Error | 1.83513434 |
| Observations | 6 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 0.309982879 | 0.30998 | 0.09204538 | 0.776718131 |
| Residual | 4 | 13.47087226 | 3.36772 | | |
| Total | 5 | 13.78085514 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* |
|---|---|---|---|---|
| Intercept | 16.2299165 | 42.33934682 | 0.38333 | 0.72097742 |
| Fiscal Year | -0.1330913 | 0.438681014 | -0.3034 | 0.77671813 |

Figure D-4. Total Part Failure C-20 Regression Output

**Human Factor Regression**

| Fiscal Year | VR | Non-VR |
|---|---|---|
| 90 | 1.20887313 | 0.800717443 |
| 91 | 1.75542536 | 1.402303283 |
| 92 | 0.89110675 | 0.625273557 |
| 93 | 0.19400147 | 1.529285824 |
| 94 | 0.71162981 | 0.9255617 |
| 95 | 1.50090054 | 0.227190113 |
| 96 | 2.28399896 | 1.557285873 |
| 97 | 2.49904203 | 3.430374826 |
| 98 | 2.05273667 | 3.483366923 |
| 99 | 2.59745079 | 2.2658268 |

| FISCAL YEAR | VR | OTHER |
|---|---|---|
| 90 | 0.000120887 | 8E-05 |
| 91 | 0.000175543 | 0.00014 |
| 92 | 8.91107E-05 | 6.3E-05 |
| 93 | 1.94001E-05 | 0.00015 |
| 94 | 7.1163E-05 | 9.3E-05 |
| 95 | 0.00015009 | 2.3E-05 |
| 96 | 0.0002284 | 0.00016 |
| 97 | 0.000249904 | 0.00034 |
| 98 | 0.000205274 | 0.00035 |
| 99 | 0.000259745 | 0.00023 |

**VR REGRESSION**

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.6713125 |
| R Square | 0.45066047 |
| Adjusted R Squa | 0.38199303 |
| Standard Error | 0.63770287 |
| Observations | 10 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 2.668918739 | 2.66891874 | 6.56294258 | 0.033551613 |
| Residual | 8 | 3.253319629 | 0.40666495 | | |
| Total | 9 | 5.922238368 | | | |

| | *Coefficients* | *Standard Erroi* | *t Stat* | *P-value* |
|---|---|---|---|---|
| Intercept | -15.427493 | 6.637793251 | -2.32419 | 0.0486005 |
| Fiscal Year | 0.17986253 | 0.070208776 | 2.56182407 | 0.03355161 |

**NON-VR REGRESSION**

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.67383979 |
| R Square | 0.45406007 |
| Adjusted R Squa | 0.38581757 |
| Standard Error | 0.87849105 |
| Observations | 10 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 5.134913268 | 5.13491327 | 6.65362673 | 0.032643593 |
| Residual | 8 | 6.173972154 | 0.77174652 | | |
| Total | 9 | 11.30888542 | | | |

| | *Coefficients* | *Standard Erroi* | *t Stat* | *P-value* |
|---|---|---|---|---|
| Intercept | -21.95135 | 9.144136232 | -2.4005931 | 0.04313679 |
| Fiscal Year | 0.24948221 | 0.096718681 | 2.57946249 | 0.03264359 |

Figure D-5. Human Factor Regression Output

**Human Factor Regression C-130**

| Fiscal Year | VR | Non-VR |
|---|---|---|
| 90 | 0 | 0.84859388 |
| 91 | 0 | 1.491396506 |
| 92 | 0 | 0.665646009 |
| 93 | 0 | 1.406041291 |
| 94 | 0.97905 | 0.989339863 |
| 95 | 1.51527 | 0.243854858 |
| 96 | 5.15958 | 1.684514499 |
| 97 | 2.87956 | 2.974346263 |
| 98 | 4.37127 | 3.686150606 |
| 99 | 4.07526 | 2.420662777 |

FISCAL YEAR

| | VR | OTHER |
|---|---|---|
| 90 | 0 | 8.4859E-05 |
| 91 | 0 | 0.00014914 |
| 92 | 0 | 6.6565E-05 |
| 93 | 0 | 0.0001406 |
| 94 | 9.79048E-05 | 9.8934E-05 |
| 95 | 0.000151527 | 2.4385E-05 |
| 96 | 0.000515958 | 0.00016845 |
| 97 | 0.000287956 | 0.00029743 |
| 98 | 0.000437127 | 0.00036862 |
| 99 | 0.000407526 | 0.00024207 |

**VR REGRESSION**

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.69931 |
| R Square | 0.48903 |
| Adjusted R Squa | 0.36129 |
| Standard Error | 1.32981 |
| Observations | 6 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 6.769862821 | 6.76986282 | 3.8282479 | 0.122030815 |
| Residual | 4 | 7.073588755 | 1.76839719 | | |
| Total | 5 | 13.84345158 | | | |

| | *Coefficient* | *Standard Error* | *t Stat* | *P-value* |
|---|---|---|---|---|
| Intercept | -56.857 | 30.68076601 | -1.8531799 | 0.13748204 |
| Fiscal Year | 0.62197 | 0.317885621 | 1.95659089 | 0.12203081 |

**NON-VR REGRESSION**

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.78481 |
| R Square | 0.61592 |
| Adjusted R Squa | 0.51991 |
| Standard Error | 0.88594 |
| Observations | 6 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 5.034829339 | 5.03482934 | 6.41462699 | 0.064478443 |
| Residual | 4 | 3.139592901 | 0.78489823 | | |
| Total | 5 | 8.17442224 | | | |

| | *Coefficient* | *Standard Error* | *t Stat* | *P-value* |
|---|---|---|---|---|
| Intercept | -49.761 | 20.44009755 | -2.4344772 | 0.07163391 |
| Fiscal Year | 0.53638 | 0.211781319 | 2.53271139 | 0.06447844 |

Figure D-6. Human Factor C-130 Regression Output

**Human Factor Regression C-9**

| Fiscal Year | VR | Non-VR |
|---|---|---|
| 90 | 1.24548512 | 0 |
| 91 | 1.81747961 | 0 |
| 92 | 0.98699632 | 0 |
| 93 | 0.22740193 | 3.264773098 |
| 94 | 0.6863418 | 0 |
| 95 | 1.68204537 | 0 |
| 96 | 1.45518044 | 0 |
| 97 | 2.34637745 | 0 |
| 98 | 1.20718274 | 0 |
| 99 | 2.04816104 | 0 |

| FISCAL YEAR | VR | OTHER |
|---|---|---|
| 90 | 0.000124549 | 0 |
| 91 | 0.000181748 | 0 |
| 92 | 9.86996E-05 | 0 |
| 93 | 2.27402E-05 | 0.0003265 |
| 94 | 6.86342E-05 | 0 |
| 95 | 0.000168205 | 0 |
| 96 | 0.000145518 | 0 |
| 97 | 0.000234638 | 0 |
| 98 | 0.000120718 | 0 |
| 99 | 0.000204816 | 0 |

**VR REGRESSION**

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.41403892 |
| R Square | 0.17142823 |
| Adjusted R Squa | 0.06785676 |
| Standard Error | 0.61734305 |
| Observations | 10 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 0.630805275 | 0.63080528 | 1.65516844 | 0.234235969 |
| Residual | 8 | 3.048899489 | 0.38111244 | | |
| Total | 9 | 3.679704765 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* |
|---|---|---|---|---|
| Intercept | -6.8930153 | 6.425869601 | -1.0726977 | 0.31469587 |
| Fiscal Year | 0.08744212 | 0.067967232 | 1.2865335 | 0.23423597 |

Figure D-7. Human Factor C-9 Regression Output

**Human Factor Regression C-20**

| Fiscal Year | VR | Non-VR |
|---|---|---|
| 90 | 0 | 0 |
| 91 | 0 | 0 |
| 92 | 0 | 0 |
| 93 | 0 | 0 |
| 94 | 0 | 0 |
| 95 | 0 | 0 |
| 96 | 1.53917193 | 0 |
| 97 | 2.57234727 | 25.12562814 |
| 98 | 1.48676777 | 0 |
| 99 | 2.00040008 | 10000 |

| FISCAL YEAR | VR | OTHER |
|---|---|---|
| 90 | 0 | 0 |
| 91 | 0 | 0 |
| 92 | 0 | 0 |
| 93 | 0 | 0 |
| 94 | 0 | 0 |
| 95 | 0 | 0 |
| 96 | 0.000153917 | 0 |
| 97 | 0.000257235 | 0.0025126 |
| 98 | 0.000148677 | 0 |
| 99 | 0.00020004 | #DIV/0! |

**VR REGRESSION**

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.07630742 |
| R Square | 0.00582282 |
| Adjusted R Squa | -0.4912658 |
| Standard Error | 0.61589165 |
| Observations | 4 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 0.004443328 | 0.00444333 | 0.01171385 | 0.923692576 |
| Residual | 2 | 0.758645042 | 0.37932252 | | |
| Total | 3 | 0.76308837 | | | |

| | *Coefficients* | *Standard Erroi* | *t Stat* | *P-value* |
|---|---|---|---|---|
| Intercept | -1.0068516 | 26.85668955 | -0.0374898 | 0.97350003 |
| Fiscal Year | 0.0298105 | 0.275435118 | 0.10823056 | 0.92369258 |

Figure D-8. Human Factor C-20 Regression Output

**Human Factor Manitenance Extension Regression**

| Fiscal Yea | VR | Non-VR |
|---|---|---|
| 90 | 1.208873 | 0.640574 |
| 91 | 1.755425 | 1.227015 |
| 92 | 0.66833 | 0.625274 |
| 93 | 0.194001 | 1.529286 |
| 94 | 0.71163 | 0.925562 |
| 95 | 1.334134 | 0.22719 |
| 96 | 2.120856 | 1.112347 |
| 97 | 2.165836 | 2.972992 |
| 98 | 2.052737 | 3.483367 |
| 99 | 2.411919 | 2.039244 |

| FISCAL YEAR | VR | OTHER |
|---|---|---|
| 90 | 0.000121 | 6.41E-05 |
| 91 | 0.000176 | 0.000123 |
| 92 | 6.68E-05 | 6.25E-05 |
| 93 | 1.94E-05 | 0.000153 |
| 94 | 7.12E-05 | 9.26E-05 |
| 95 | 0.000133 | 2.27E-05 |
| 96 | 0.000212 | 0.000111 |
| 97 | 0.000217 | 0.000297 |
| 98 | 0.000205 | 0.000348 |
| 99 | 0.000241 | 0.000204 |

**VR REGRESSION**

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.650191 |
| R Square | 0.422749 |
| Adjusted F | 0.350592 |
| Standard E | 0.609482 |
| Observatic | 10 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *ignificance F* |
|---|---|---|---|---|---|
| Regressior | 1 | 2.176353 | 2.176353 | 5.858784 | 0.041818 |
| Residual | 8 | 2.971747 | 0.371468 | | |
| Total | 9 | 5.1481 | | | |

| | *Coefficients* | *tandard Err* | *t Stat* | *P-value* |
|---|---|---|---|---|
| Intercept | -13.8863 | 6.344045 | -2.18886 | 0.060027 |
| Fiscal Yea | 0.162419 | 0.067102 | 2.420493 | 0.041818 |

**NON-VR REGRESSION**

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.662208 |
| R Square | 0.43852 |
| Adjusted F | 0.368335 |
| Standard E | 0.840649 |
| Observatic | 10 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *ignificance F* |
|---|---|---|---|---|---|
| Regressior | 1 | 4.415435 | 4.415435 | 6.248051 | 0.036964 |
| Residual | 8 | 5.653519 | 0.70669 | | |
| Total | 9 | 10.06895 | | | |

| | *Coefficients* | *tandard Err* | *t Stat* | *P-value* |
|---|---|---|---|---|
| Intercept | -20.3838 | 8.750236 | -2.32951 | 0.048198 |
| Fiscal Yea | 0.231345 | 0.092552 | 2.49961 | 0.036964 |

Figure D-9. HFACS-Maintenance Extension (ME) Regression Output

**Human Factor Manitenance Extension Regression C-130**

| Fiscal Year | VR | Non-VR |
|---|---|---|
| 90 | 0 | 0.678875104 |
| 91 | 0 | 1.304971943 |
| 92 | 0 | 0.665646009 |
| 93 | 0 | 1.406041291 |
| 94 | 0.97904836 | 0.989339863 |
| 95 | 1.51526631 | 0.243854858 |
| 96 | 4.42249576 | 1.203224642 |
| 97 | 2.15967173 | 2.478621886 |
| 98 | 4.37126621 | 3.686150606 |
| 99 | 4.0752564 | 2.1785965 |

| FISCAL YEAR | VR | OTHER |
|---|---|---|
| 90 | 0 | 6.8E-05 |
| 91 | 0 | 0.00013 |
| 92 | 0 | 6.7E-05 |
| 93 | 0 | 0.00014 |
| 94 | 9.79048E-05 | 9.9E-05 |
| 95 | 0.000151527 | 2.4E-05 |
| 96 | 0.00044225 | 0.00012 |
| 97 | 0.000215967 | 0.00025 |
| 98 | 0.000437127 | 0.00037 |
| 99 | 0.000407526 | 0.00022 |

**VR REGRESSION**

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.75116547 |
| R Square | 0.56424957 |
| Adjusted R Squa | 0.45531196 |
| Standard Error | 1.14415821 |
| Observations | 6 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 6.78056002 | 6.78056002 | 5.17956637 | 0.085174186 |
| Residual | 4 | 5.236392029 | 1.30909801 | | |
| Total | 5 | 12.01695205 | | | |

| | *Coefficients* | *Standard Erroi* | *t Stat* | *P-value* |
|---|---|---|---|---|
| Intercept | -57.147209 | 26.39747403 | -2.1648741 | 0.09636151 |
| Fiscal Year | 0.62246331 | 0.273506125 | 2.27586607 | 0.08517419 |

**NON-VR REGRESSION**

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.7610143 |
| R Square | 0.57914277 |
| Adjusted R Squa | 0.47392846 |
| Standard Error | 0.89399942 |
| Observations | 6 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 4.399317533 | 4.39931753 | 5.50441076 | 0.078846511 |
| Residual | 4 | 3.196939852 | 0.79923496 | | |
| Total | 5 | 7.596257386 | | | |

| | *Coefficients* | *Standard Erroi* | *t Stat* | *P-value* |
|---|---|---|---|---|
| Intercept | -46.587277 | 20.62592943 | -2.2586753 | 0.08680757 |
| Fiscal Year | 0.50138765 | 0.213706737 | 2.34614807 | 0.07884651 |

Figure D-10. HFACS-ME C-130 Regression Output

**Human Factor Manitenance Extension Regression C-9**

| Fiscal Year | VR | Non-VR |
|---|---|---|
| 90 | 1.24548512 | 0 |
| 91 | 1.81747961 | 0 |
| 92 | 0.74024724 | 0 |
| 93 | 0.22740193 | 3.264773098 |
| 94 | 0.6863418 | 0 |
| 95 | 1.44175317 | 0 |
| 96 | 1.45518044 | 0 |
| 97 | 2.08566885 | 0 |
| 98 | 1.20718274 | 0 |
| 99 | 1.75556661 | 0 |

| FISCAL YEAR | VR | OTHER |
|---|---|---|
| 90 | 0.000124549 | 0 |
| 91 | 0.000181748 | 0 |
| 92 | 7.40247E-05 | 0 |
| 93 | 2.27402E-05 | 0.0003265 |
| 94 | 6.86342E-05 | 0 |
| 95 | 0.000144175 | 0 |
| 96 | 0.000145518 | 0 |
| 97 | 0.000208567 | 0 |
| 98 | 0.000120718 | 0 |
| 99 | 0.000175557 | 0 |

**VR REGRESSION**

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.36638891 |
| R Square | 0.13424083 |
| Adjusted R Squa | 0.02602093 |
| Standard Error | 0.56763184 |
| Observations | 10 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 0.399678714 | 0.39967871 | 1.24044501 | 0.29772617 |
| Residual | 8 | 2.577647284 | 0.32220591 | | |
| Total | 9 | 2.977325999 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* |
|---|---|---|---|---|
| Intercept | -5.3112615 | 5.908430065 | -0.8989294 | 0.39494094 |
| Fiscal Year | 0.06960309 | 0.062494209 | 1.11375267 | 0.29772617 |

Figure D-11. HFACS-ME C-9 Regression Output

**Human Factor Manitenance Extension Regression C-20**

| Fiscal Year | VR | Non-VR |
|---|---|---|
| 90 | 0 | 0 |
| 91 | 0 | 0 |
| 92 | 0 | 0 |
| 93 | 0 | 0 |
| 94 | 0 | 0 |
| 95 | 0 | 0 |
| 96 | 1.53917193 | 0 |
| 97 | 2.57234727 | 25.12562814 |
| 98 | 1.48676777 | 0 |
| 99 | 2.00040008 | 10000 |

| FISCAL YEAR | VR | OTHER |
|---|---|---|
| 90 | 0 | 0 |
| 91 | 0 | 0 |
| 92 | 0 | 0 |
| 93 | 0 | 0 |
| 94 | 0 | 0 |
| 95 | 0 | 0 |
| 96 | 0.000153917 | 0 |
| 97 | 0.000257235 | 0.0025126 |
| 98 | 0.000148677 | 0 |
| 99 | 0.00020004 | #DIV/0! |

**VR REGRESSION**

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.07630742 |
| R Square | 0.00582282 |
| Adjusted R Squa | -0.4912658 |
| Standard Error | 0.61589165 |
| Observations | 4 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 0.004443328 | 0.00444333 | 0.01171385 | 0.923692576 |
| Residual | 2 | 0.758645042 | 0.37932252 | | |
| Total | 3 | 0.76308837 | | | |

| | *Coefficients* | *Standard Erroı* | *t Stat* | *P-value* | *Lower 95%* |
|---|---|---|---|---|---|
| Intercept | -1.0068516 | 26.85668955 | -0.0374898 | 0.97350003 | -116.561941 |
| Fiscal Year | 0.0298105 | 0.275435118 | 0.10823056 | 0.92369258 | -1.15529199 |

Figure D-12. HFACS-ME C-20 Regression Output

**HF-ME Part Failure Regression**

| Fiscal Year | VR | Non-VR |
|---|---|---|
| 90 | 0.604437 | 0 |
| 91 | 0.658285 | 0.350576 |
| 92 | 0.445553 | 0.416849 |
| 93 | 0.194001 | 0.436939 |
| 94 | 0.71163 | 0.23139 |
| 95 | 1.334134 | 0.22719 |
| 96 | 1.141999 | 0.667408 |
| 97 | 1.499425 | 1.143458 |
| 98 | 1.492899 | 2.239307 |
| 99 | 1.113193 | 1.132913 |

| FISCAL YEAR | VR | OTHER |
|---|---|---|
| 90 | 6.04E-05 | 0 |
| 91 | 6.58E-05 | 3.51E-05 |
| 92 | 4.46E-05 | 4.17E-05 |
| 93 | 1.94E-05 | 4.37E-05 |
| 94 | 7.12E-05 | 2.31E-05 |
| 95 | 0.000133 | 2.27E-05 |
| 96 | 0.000114 | 6.67E-05 |
| 97 | 0.00015 | 0.000114 |
| 98 | 0.000149 | 0.000224 |
| 99 | 0.000111 | 0.000113 |

**VR REGRESSION**

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.767946 |
| R Square | 0.589741 |
| Adjusted R | 0.538458 |
| Standard Ei | 0.310974 |
| Observatior | 10 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *ignificance F* |
|---|---|---|---|---|---|
| Regression | 1 | 1.11209 | 1.11209 | 11.49986 | 0.009484 |
| Residual | 8 | 0.773637 | 0.096705 | | |
| Total | 9 | 1.885726 | | | |

| | *Coefficients* | *tandard Err* | *t Stat* | *P-value* |
|---|---|---|---|---|
| Intercept | -10.0522 | 3.236897 | -3.10549 | 0.014544 |
| Fiscal Year | 0.116103 | 0.034237 | 3.391144 | 0.009484 |

**NON-VR REGRESSION**

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.767604 |
| R Square | 0.589216 |
| Adjusted R | 0.537868 |
| Standard Ei | 0.45075 |
| Observatior | 10 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *ignificance F* |
|---|---|---|---|---|---|
| Regression | 1 | 2.331437 | 2.331437 | 11.47496 | 0.009536 |
| Residual | 8 | 1.625408 | 0.203176 | | |
| Total | 9 | 3.956845 | | | |

| | *Coefficients* | *tandard Err* | *t Stat* | *P-value* |
|---|---|---|---|---|
| Intercept | -15.2015 | 4.691822 | -3.23999 | 0.011878 |
| Fiscal Year | 0.168107 | 0.049626 | 3.387471 | 0.009536 |

Figure D-13. HFACS-ME Part Failure Regression Output

**HF-ME Part Failure Regression C-130**

| Fiscal Year | VR | Non-VR |
|---|---|---|
| 90 | 0 | 0 |
| 91 | 0 | 0.372849127 |
| 92 | 0 | 0.443764006 |
| 93 | 0 | 0.46868043 |
| 94 | 0.97905 | 0.247334966 |
| 95 | 1.51527 | 0.243854858 |
| 96 | 2.21125 | 0.721934785 |
| 97 | 1.43978 | 1.239310943 |
| 98 | 2.91418 | 2.369668246 |
| 99 | 1.35842 | 1.210331389 |

| FISCAL YEAR | VR | OTHER |
|---|---|---|
| 90 | 0 | 0 |
| 91 | 0 | 3.7285E-05 |
| 92 | 0 | 4.4376E-05 |
| 93 | 0 | 4.6868E-05 |
| 94 | 9.79048E-05 | 2.4733E-05 |
| 95 | 0.000151527 | 2.4385E-05 |
| 96 | 0.000221125 | 7.2193E-05 |
| 97 | 0.000143978 | 0.00012393 |
| 98 | 0.000291418 | 0.00023697 |
| 99 | 0.000135842 | 0.00012103 |

**VR REGRESSION**

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.40508 |
| R Square | 0.16409 |
| Adjusted R Squa | -0.0449 |
| Standard Error | 0.71787 |
| Observations | 6 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 0.404642144 | 0.40464214 | 0.78520509 | 0.425614195 |
| Residual | 4 | 2.061332244 | 0.51533306 | | |
| Total | 5 | 2.465974388 | | | |

| | *Coefficient* | *Standard Erroi* | *t Stat* | *P-value* |
|---|---|---|---|---|
| Intercept | -12.938 | 16.56228651 | -0.7811433 | 0.47836491 |
| Fiscal Year | 0.15206 | 0.17160304 | 0.88611799 | 0.42561419 |

**NON-VR REGRESSION**

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.78326 |
| R Square | 0.6135 |
| Adjusted R Squa | 0.51688 |
| Standard Error | 0.55544 |
| Observations | 6 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 1.958848278 | 1.95884828 | 6.34929646 | 0.065372021 |
| Residual | 4 | 1.234056901 | 0.30851423 | | |
| Total | 5 | 3.19290518 | | | |

| | *Coefficient* | *Standard Erroi* | *t Stat* | *P-value* |
|---|---|---|---|---|
| Intercept | -31.28 | 12.81486063 | -2.4409303 | 0.07113703 |
| Fiscal Year | 0.33457 | 0.132775692 | 2.51978103 | 0.06537202 |

Figure D-14. HFACS-ME Part Failure C-130 Regression Output

**HF-ME Part Failure Regression C-9**

| Fiscal Year | VR | Non-VR |
|---|---|---|
| 90 | 0.62274256 | 0 |
| 91 | 0.68155485 | 0 |
| 92 | 0.49349816 | 0 |
| 93 | 0.22740193 | 0 |
| 94 | 0.6863418 | 0 |
| 95 | 1.44175317 | 0 |
| 96 | 0.97012029 | 0 |
| 97 | 1.82496024 | 0 |
| 98 | 1.20718274 | 0 |
| 99 | 0.8777833 | 0 |

| FISCAL YEAR | VR | OTHER |
|---|---|---|
| 90 | 6.22743E-05 | 0 |
| 91 | 6.81555E-05 | 0 |
| 92 | 4.93498E-05 | 0 |
| 93 | 2.27402E-05 | 0 |
| 94 | 6.86342E-05 | 0 |
| 95 | 0.000144175 | 0 |
| 96 | 9.7012E-05 | 0 |
| 97 | 0.000182496 | 0 |
| 98 | 0.000120718 | 0 |
| 99 | 8.77783E-05 | 0 |

**VR REGRESSION**

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.60235432 |
| R Square | 0.36283072 |
| Adjusted R Squa | 0.28318457 |
| Standard Error | 0.4027478 |
| Observations | 10 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 0.73893386 | 0.73893386 | 4.55553322 | 0.065346864 |
| Residual | 8 | 1.297646313 | 0.16220579 | | |
| Total | 9 | 2.036580173 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* |
|---|---|---|---|---|
| Intercept | -8.0401683 | 4.192166498 | -1.9179029 | 0.09141069 |
| Fiscal Year | 0.09464023 | 0.044341073 | 2.13436951 | 0.06534686 |

Figure D-15. HFACS-ME Part Failure C-9 Regression Output

**Squadron HF-ME Regression**

| Fiscal Year | VR | Non-VR |
|---|---|---|
| 90 | 0.60443656 | 0.480430466 |
| 91 | 1.75542536 | 1.051727462 |
| 92 | 0.44555338 | 0.625273557 |
| 93 | 0.19400147 | 1.31081642 |
| 94 | 0.17790745 | 0.46278085 |
| 95 | 0.83383363 | 0.227190113 |
| 96 | 0.9788567 | 0 |
| 97 | 1.16621962 | 0.91476662 |
| 98 | 1.4928994 | 1.741683461 |
| 99 | 0.7421288 | 1.1329134 |

| FISCAL YEAR | VR | OTHER |
|---|---|---|
| 90 | 6.04437E-05 | 4.8043E-05 |
| 91 | 0.000175543 | 0.00010517 |
| 92 | 4.45553E-05 | 6.2527E-05 |
| 93 | 1.94001E-05 | 0.00013108 |
| 94 | 1.77907E-05 | 4.6278E-05 |
| 95 | 8.33834E-05 | 2.2719E-05 |
| 96 | 9.78857E-05 | 0 |
| 97 | 0.000116622 | 9.1477E-05 |
| 98 | 0.00014929 | 0.00017417 |
| 99 | 7.42129E-05 | 0.00011329 |

**VR REGRESSION**

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.21085221 |
| R Square | 0.04445865 |
| Adjusted R Squa | -0.074984 |
| Standard Error | 0.54275905 |
| Observations | 10 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 0.109650584 | 0.10965058 | 0.37221751 | 0.558725661 |
| Residual | 8 | 2.35669912 | 0.29458739 | | |
| Total | 9 | 2.466349704 | | | |

| | *Coefficients* | *Standard Erroi* | *t Stat* | *P-value* |
|---|---|---|---|---|
| Intercept | -2.606041 | 5.649531367 | -0.4612845 | 0.65687707 |
| Fiscal Year | 0.0364568 | 0.059755805 | 0.61009631 | 0.55872566 |

**NON-VR REGRESSION**

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.27518008 |
| R Square | 0.07572408 |
| Adjusted R Squa | -0.0398104 |
| Standard Error | 0.54270573 |
| Observations | 10 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 0.193041706 | 0.19304171 | 0.655424 | 0.441592486 |
| Residual | 8 | 2.356236053 | 0.29452951 | | |
| Total | 9 | 2.549277759 | | | |

| | *Coefficients* | *Standard Erroi* | *t Stat* | *P-value* |
|---|---|---|---|---|
| Intercept | -3.7764437 | 5.648976303 | -0.6685182 | 0.52262043 |
| Fiscal Year | 0.04837251 | 0.059749934 | 0.80958261 | 0.44159249 |

Figure D-16. Squadron Related HFACS-ME Regression Output

**Squadron HF-ME Regression C-130**

| Fiscal Year | VR | Non-VR |
|---|---|---|
| 90 | 0 | 0.509156328 |
| 91 | 0 | 1.11854738 |
| 92 | 0 | 0.665646009 |
| 93 | 0 | 1.406041291 |
| 94 | 0.97904836 | 0.494669931 |
| 95 | 1.51526631 | 0.243854858 |
| 96 | 1.47416525 | 0 |
| 97 | 0.71989058 | 0.991448754 |
| 98 | 2.91417747 | 1.843075303 |
| 99 | 0.6792094 | 1.210331389 |

| FISCAL YEAR | VR | OTHER |
|---|---|---|
| 90 | 0 | 5.0916E-05 |
| 91 | 0 | 0.00011185 |
| 92 | 0 | 6.6565E-05 |
| 93 | 0 | 0.0001406 |
| 94 | 9.79048E-05 | 4.9467E-05 |
| 95 | 0.000151527 | 2.4385E-05 |
| 96 | 0.000147417 | 0 |
| 97 | 7.19891E-05 | 9.9145E-05 |
| 98 | 0.000291418 | 0.00018431 |
| 99 | 6.79209E-05 | 0.00012103 |

**VR REGRESSION**

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.12471345 |
| R Square | 0.01555345 |
| Adjusted R Squa | -0.2305582 |
| Standard Error | 0.92392254 |
| Observations | 6 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 0.053946785 | 0.05394679 | 0.06319671 | 0.813899684 |
| Residual | 4 | 3.414531418 | 0.85363285 | | |
| Total | 5 | 3.468478203 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* |
|---|---|---|---|---|
| Intercept | -3.9775635 | 21.31630136 | -0.1865973 | 0.86105802 |
| Fiscal Year | 0.05552183 | 0.22085973 | 0.25138955 | 0.81389968 |

**NON-VR REGRESSION**

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.7326223 |
| R Square | 0.53673544 |
| Adjusted R Squa | 0.4209193 |
| Standard Error | 0.52008612 |
| Observations | 6 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 1.253550119 | 1.25355012 | 4.63437508 | 0.097678723 |
| Residual | 4 | 1.081958277 | 0.27048957 | | |
| Total | 5 | 2.335508396 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* |
|---|---|---|---|---|
| Intercept | -25.030078 | 11.99917954 | -2.0859824 | 0.10530791 |
| Fiscal Year | 0.2676405 | 0.124324361 | 2.15275987 | 0.09767872 |

Figure D-17. Squadron Related HFACS-ME C-130 Regression Output

| Fiscal Year | VR | Non-VR |
|---|---|---|
| 90 | 0.62274256 | 0 |
| 91 | 1.81747961 | 0 |
| 92 | 0.49349816 | 0 |
| 93 | 0.22740193 | 0 |
| 94 | 0 | 0 |
| 95 | 0.72087659 | 0 |
| 96 | 0.97012029 | 0 |
| 97 | 1.56425164 | 0 |
| 98 | 0.90538705 | 0 |
| 99 | 0.8777833 | 0 |

| FISCAL YEAR | VR | OTHER |
|---|---|---|
| 90 | 6.22743E-05 | 0 |
| 91 | 0.000181748 | 0 |
| 92 | 4.93498E-05 | 0 |
| 93 | 2.27402E-05 | 0 |
| 94 | 0 | 0 |
| 95 | 7.20877E-05 | 0 |
| 96 | 9.7012E-05 | 0 |
| 97 | 0.000156425 | 0 |
| 98 | 9.05387E-05 | 0 |
| 99 | 8.77783E-05 | 0 |

**VR REGRESSION**

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.13959128 |
| R Square | 0.01948573 |
| Adjusted R Squa | -0.1030786 |
| Standard Error | 0.58171671 |
| Observations | 10 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 0.05379919 | 0.05379919 | 0.15898372 | 0.700524912 |
| Residual | 8 | 2.70715469 | 0.33839434 | | |
| Total | 9 | 2.76095388 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* |
|---|---|---|---|---|
| Intercept | -1.5932425 | 6.055038248 | -0.2631267 | 0.79910286 |
| Fiscal Year | 0.02553647 | 0.064044902 | 0.39872763 | 0.70052491 |

Figure D-18. Squadron Related HFACS-ME C-9 Regression Output

**Non-Squadron HF-ME Regression**

| Fiscal Year | VR | Non-VR |
|---|---|---|
| 90 | 0.60443656 | 0.160143489 |
| 91 | 0.87771268 | 0.350575821 |
| 92 | 0.22277669 | 0.208424519 |
| 93 | 0.19400147 | 1.092347017 |
| 94 | 0.53372236 | 0.694171275 |
| 95 | 0.66706691 | 0 |
| 96 | 1.30514226 | 1.112347052 |
| 97 | 1.33282242 | 2.515608205 |
| 98 | 0.7464497 | 2.488119231 |
| 99 | 1.66978979 | 0.90633072 |

| FISCAL YEAR | VR | OTHER |
|---|---|---|
| 90 | 6.04437E-05 | 1.6014E-05 |
| 91 | 8.77713E-05 | 3.5058E-05 |
| 92 | 2.22777E-05 | 2.0842E-05 |
| 93 | 1.94001E-05 | 0.00010923 |
| 94 | 5.33722E-05 | 6.9417E-05 |
| 95 | 6.67067E-05 | 0 |
| 96 | 0.000130514 | 0.00011123 |
| 97 | 0.000133282 | 0.00025156 |
| 98 | 7.4645E-05 | 0.00024881 |
| 99 | 0.000166979 | 9.0633E-05 |

VR REGRESSION

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.66719704 |
| R Square | 0.44515189 |
| Adjusted R Squa | 0.37579588 |
| Standard Error | 0.38429859 |
| Observations | 10 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 0.947898184 | 0.94789818 | 6.4183604 | 0.035066647 |
| Residual | 8 | 1.181483275 | 0.14768541 | | |
| Total | 9 | 2.129381459 | | | |

| | *Coefficients* | *Standard Erroi* | *t Stat* | *P-value* |
|---|---|---|---|---|
| Intercept | -9.3140536 | 4.00013035 | -2.3284375 | 0.04827931 |
| Fiscal Year | 0.1071899 | 0.042309883 | 2.53344832 | 0.03506665 |

**NON-VR REGRESSION**

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.660797 |
| R Square | 0.43665268 |
| Adjusted R Squa | 0.36623426 |
| Standard Error | 0.72023185 |
| Observations | 10 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 3.216581188 | 3.21658119 | 6.20083076 | 0.037513653 |
| Residual | 8 | 4.149871286 | 0.51873391 | | |
| Total | 9 | 7.366452473 | | | |

| | *Coefficients* | *Standard Erroi* | *t Stat* | *P-value* |
|---|---|---|---|---|
| Intercept | -17.706783 | 7.496830087 | -2.3619027 | 0.04582193 |
| Fiscal Year | 0.19745598 | 0.079294916 | 2.49014673 | 0.03751365 |

Figure D-19. Non-Squadron Related HFACS-ME Regression Output

**Non-Squadron HF-ME Regression C-130**

| Fiscal Year | VR | Non-VR |
|---|---|---|
| 90 | 0 | 0.169718776 |
| 91 | 0 | 0.372849127 |
| 92 | 0 | 0.221882003 |
| 93 | 0 | 0.93736086 |
| 94 | 0 | 0.742004897 |
| 95 | 0 | 0 |
| 96 | 2.94833051 | 1.203224642 |
| 97 | 2.15967173 | 1.982897509 |
| 98 | 2.18563311 | 2.632964718 |
| 99 | 3.396047 | 0.968265111 |

| FISCAL YEAR | VR | OTHER |
|---|---|---|
| 90 | 0 | 1.6972E-05 |
| 91 | 0 | 3.7285E-05 |
| 92 | 0 | 2.2188E-05 |
| 93 | 0 | 9.3736E-05 |
| 94 | 0 | 7.42E-05 |
| 95 | 0 | 0 |
| 96 | 0.000294833 | 0.00012032 |
| 97 | 0.000215967 | 0.00019829 |
| 98 | 0.000218563 | 0.0002633 |
| 99 | 0.000339605 | 9.6827E-05 |

**VR REGRESSION**

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.29194387 |
| R Square | 0.08523122 |
| Adjusted R Squa | -0.3721532 |
| Standard Error | 0.7091938 |
| Observations | 4 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 0.093723227 | 0.09372323 | 0.18634484 | 0.708056133 |
| Residual | 2 | 1.005911688 | 0.50295584 | | |
| Total | 3 | 1.099634915 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* |
|---|---|---|---|---|
| Intercept | -10.67641 | 30.92524111 | -0.3452329 | 0.76284753 |
| Fiscal Year | 0.13691109 | 0.317161109 | 0.43167678 | 0.70805613 |

**NON-VR REGRESSION**

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.00931112 |
| R Square | 8.6697E-05 |
| Adjusted R Squa | -0.49987 |
| Standard Error | 0.93072167 |
| Observations | 4 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 0.000150214 | 0.00015021 | 0.00017341 | 0.990688876 |
| Residual | 2 | 1.732485663 | 0.86624283 | | |
| Total | 3 | 1.732635877 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* |
|---|---|---|---|---|
| Intercept | 2.23124899 | 40.58522815 | 0.05497687 | 0.96115482 |
| Fiscal Year | -0.0054811 | 0.416231385 | -0.0131685 | 0.99068888 |

Figure D-20. Non-Squadron Related HFACS-ME C-130 Regression Output

**Non-Squadron HF-ME Regression C-9**

| Fiscal Year | VR | Non-VR |
|---|---|---|
| 90 | 0.62274256 | 0 |
| 91 | 0.90873981 | 0 |
| 92 | 0.24674908 | 0 |
| 93 | 0.22740193 | 3.264773098 |
| 94 | 0.6863418 | 0 |
| 95 | 0.96116878 | 0 |
| 96 | 0.72759022 | 0 |
| 97 | 0.78212582 | 0 |
| 98 | 0.30179568 | 0 |
| 99 | 0.8777833 | 0 |

| FISCAL YEAR | VR | OTHER |
|---|---|---|
| 90 | 6.22743E-05 | 0 |
| 91 | 9.0874E-05 | 0 |
| 92 | 2.46749E-05 | 0 |
| 93 | 2.27402E-05 | 0.0003265 |
| 94 | 6.86342E-05 | 0 |
| 95 | 9.61169E-05 | 0 |
| 96 | 7.2759E-05 | 0 |
| 97 | 7.82126E-05 | 0 |
| 98 | 3.01796E-05 | 0 |
| 99 | 8.77783E-05 | 0 |

**VR REGRESSION**

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.16428793 |
| R Square | 0.02699052 |
| Adjusted R Squa | -0.0946357 |
| Standard Error | 0.29202698 |
| Observations | 10 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 0.018924751 | 0.01892475 | 0.22191375 | 0.650163937 |
| Residual | 8 | 0.682238076 | 0.08527976 | | |
| Total | 9 | 0.701162828 | | | |

| | *Coefficients* | *Standard Erroi* | *t Stat* | *P-value* |
|---|---|---|---|---|
| Intercept | -0.7970207 | 3.039683259 | -0.2622052 | 0.79978858 |
| Fiscal Year | 0.01514566 | 0.032151113 | 0.47107722 | 0.65016394 |

Figure D-21. Non-Squadron Related HFACS-ME C-9 Regression Output

**Non-Squadron HF-ME Regression C-20**

| Fiscal Year | VR | Non-VR |
|---|---|---|
| 90 | 0 | 0 |
| 91 | 0 | 0 |
| 92 | 0 | 0 |
| 93 | 0 | 0 |
| 94 | 0 | 0 |
| 95 | 0 | 0 |
| 96 | 1.53917193 | 0 |
| 97 | 2.57234727 | 25.12562814 |
| 98 | 0 | 0 |
| 99 | 2.00040008 | 10000 |

| FISCAL YEAR | VR | OTHER |
|---|---|---|
| 90 | 0 | 0 |
| 91 | 0 | 0 |
| 92 | 0 | 0 |
| 93 | 0 | 0 |
| 94 | 0 | 0 |
| 95 | 0 | 0 |
| 96 | 0.000153917 | 0 |
| 97 | 0.000257235 | 0.0025126 |
| 98 | 0 | 0 |
| 99 | 0.00020004 | #DIV/0! |

**VR REGRESSION**

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.13914663 |
| R Square | 0.01936179 |
| Adjusted R Squa | -0.4709573 |
| Standard Error | 1.3375511 |
| Observations | 4 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 0.070645963 | 0.07064596 | 0.03948813 | 0.860853368 |
| Residual | 2 | 3.578085897 | 1.78904295 | | |
| Total | 3 | 3.64873186 | | | |

Figure D-22. Non-Squadron Related HFACS-ME C-20 Regression Output

**Squadron HF-ME Part Failure Regression**

| Fiscal Year | VR | Non-VR |
|---|---|---|
| 90 | 0.402958 | 0 |
| 91 | 0.658285 | 0.175288 |
| 92 | 0.222777 | 0.416849 |
| 93 | 0.194001 | 0.436939 |
| 94 | 0.177907 | 0.23139 |
| 95 | 0.833834 | 0.22719 |
| 96 | 0.652571 | 0 |
| 97 | 0.999617 | 0.686075 |
| 98 | 1.306287 | 1.492872 |
| 99 | 0.185532 | 0.906331 |

| FISCAL YEAR | VR | OTHER |
|---|---|---|
| 90 | 4.03E-05 | 0 |
| 91 | 6.58E-05 | 1.75E-05 |
| 92 | 2.23E-05 | 4.17E-05 |
| 93 | 1.94E-05 | 4.37E-05 |
| 94 | 1.78E-05 | 2.31E-05 |
| 95 | 8.34E-05 | 2.27E-05 |
| 96 | 6.53E-05 | 0 |
| 97 | 1E-04 | 6.86E-05 |
| 98 | 0.000131 | 0.000149 |
| 99 | 1.86E-05 | 9.06E-05 |

**VR REGRESSION**

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.394961 |
| R Square | 0.155994 |
| Adjusted R | 0.050494 |
| Standard Er | 0.384575 |
| Observatior | 10 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *ignificance F* |
|---|---|---|---|---|---|
| Regression | 1 | 0.218683 | 0.218683 | 1.47861 | 0.258652 |
| Residual | 8 | 1.183182 | 0.147898 | | |
| Total | 9 | 1.401865 | | | |

| | *Coefficients* | *tandard Err* | *t Stat* | *P-value* |
|---|---|---|---|---|
| Intercept | -4.30195 | 4.003005 | -1.07468 | 0.313859 |
| Fisca Year | 0.051485 | 0.04234 | 1.215981 | 0.258652 |

**NON-VR REGRESSION**

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.689876 |
| R Square | 0.475929 |
| Adjusted R | 0.41042 |
| Standard Er | 0.35559 |
| Observatior | 10 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *ignificance F* |
|---|---|---|---|---|---|
| Regression | 1 | 0.918633 | 0.918633 | 7.265114 | 0.027268 |
| Residual | 8 | 1.011556 | 0.126444 | | |
| Total | 9 | 1.930189 | | | |

| | *Coefficients* | *tandard Err* | *t Stat* | *P-value* |
|---|---|---|---|---|
| Intercept | -9.51456 | 3.701308 | -2.57059 | 0.033097 |
| Fiscal Year | 0.105522 | 0.039149 | 2.695388 | 0.027268 |

Figure D-23. Squadron Related HFACS-ME Part Failure Regression Output

**Non-Squadron HF-ME Part Failure Regression**

| Fiscal Yea | VR | Non-VR |
|---|---|---|
| 90 | 0 | 0 |
| 91 | 0 | 0.175288 |
| 92 | 0.222777 | 0.208425 |
| 93 | 0.194001 | 0.436939 |
| 94 | 0.533722 | 0.23139 |
| 95 | 0.667067 | 0 |
| 96 | 0.652571 | 0.667408 |
| 97 | 0.833014 | 0.686075 |
| 98 | 0.373225 | 1.492872 |
| 99 | 0.927661 | 0.226583 |

| FISCAL YEAR | VR | OTHER |
|---|---|---|
| 90 | 0 | 0 |
| 91 | 0 | 1.7529E-05 |
| 92 | 2.2278E-05 | 2.0842E-05 |
| 93 | 1.94E-05 | 4.3694E-05 |
| 94 | 5.3372E-05 | 2.3139E-05 |
| 95 | 6.6707E-05 | 0 |
| 96 | 6.5257E-05 | 6.6741E-05 |
| 97 | 8.3301E-05 | 6.8607E-05 |
| 98 | 3.7322E-05 | 0.00014929 |
| 99 | 9.2766E-05 | 2.2658E-05 |

**VR REGRESSION**

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.85566 |
| R Square | 0.732154 |
| Adjusted R | 0.698674 |
| Standard E | 0.182717 |
| Observatio | 10 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regressior | 1 | 0.730076 | 0.730076 | 21.86795 | 0.00158944 |
| Residual | 8 | 0.267085 | 0.033386 | | |
| Total | 9 | 0.997162 | | | |

| | *Coefficients* | *Standard Err* | *t Stat* | *P-value* |
|---|---|---|---|---|
| Intercept | -8.44933 | 1.90189 | -4.4426 | 0.00216 |
| Fiscal Yeai | 0.094071 | 0.020117 | 4.676318 | 0.001589 |

**NON-VR REGRESSION**

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.576851 |
| R Square | 0.332757 |
| Adjusted R | 0.249352 |
| Standard E | 0.388886 |
| Observatio | 10 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regressior | 1 | 0.603361 | 0.603361 | 3.989638 | 0.08084021 |
| Residual | 8 | 1.209856 | 0.151232 | | |
| Total | 9 | 1.813216 | | | |

| | *Coefficients* | *Standard Err* | *t Stat* | *P-value* |
|---|---|---|---|---|
| Intercept | -7.66903 | 4.047875 | -1.89458 | 0.094755 |
| Fiscal Yeai | 0.085519 | 0.042815 | 1.997408 | 0.08084 |

Figure D-24. Non-Squadron Related HFACS-ME Part Failure Regression Output

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