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Reset Aviation Maintenance Program Study of U.S. Army Aviation

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RESET AVIATION MAINTENANCE PROGRAM STUDY OF U.S. ARMY AVIATION

A Thesis
Presented to
The Faculty of the Department of Architecture and Manufacturing Sciences
Western Kentucky University
Bowling Green, Kentucky

In Partial Fulfillment
Of the Requirements for the Degree
Master of Science

By
Kristopher B. Williams

May 2011

RESET AVIATION MAINTENANCE PROGRAM STUDY OF U.S. ARMY AVIATION

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U.S. Army helicopter maintenance condition is affected by operation environment and high flight hours. Due to the environmental conditions and high operation tempo of Afghanistan and Iraq, U.S. Army Aviation created the RESET aviation maintenance program to provide restorative maintenance following deployments in theater. The RESET maintenance program was created in addition to the existing two-level maintenance programs. Following deployment, RESET is a thorough cleaning to remove contaminants, inspection of airframe and components, and repair cycle to restore the condition of the helicopter to acceptable condition.

Based on the original intent of RESET, it was projected that at the conclusion of military operations in Afghanistan and Iraq, the RESET maintenance program could be discontinued. Because of the presumed safety, reliability, and mission readiness created by RESET, this thesis appraised the RESET maintenance program as a permanent addition to U.S. Army Aviation maintenance programs.

The hypothesis was that RESET does improve safety, reliability, and mission readiness of the Army UH-60 Black Hawk fleet. The design was a quantitative survey of three variables: safety, reliability, and mission readiness. The survey featured Likert scale and open-ended questions of three groups: UH-60 maintenance test pilots, UH-60

AVUM/AVIM maintenance supervisory personnel, and ACE (Airframe Condition Evaluation) technical evaluators.

Data from each of the three survey groups verified the hypothesis that RESET improved safety, reliability, and mission readiness. Data from open-ended questions indicated that the additional disassembly and special inspections of RESET are more extensive than the aviation unit and intermediate Phased Maintenance Inspection (PMI). Therefore, given the disassembly and special inspections of RESET, and the verification that RESET improves safety, reliability, and mission readiness, it was concluded that RESET is a successful program that should be continued. Based on the effectiveness of RESET in discovering these deficiencies, RESET should be a permanent addition to the Army aviation maintenance programs.

CHAPTER 1- INTRODUCTION

Background

Due to the wars in Afghanistan and Iraq, U.S. Army Aviation created the RESET maintenance program to address necessary aviation maintenance following the unusually severe conditions encountered by helicopters operating in those regions. RESET is currently a temporary maintenance program that was added to the existing two-level maintenance programs. This survey study investigated the benefit of adding RESET as a permanent aviation maintenance program in the U.S. Army.

James Shamess of the U.S. Army Research, Development and Engineering Command (RDECOM) stated that the U.S. Army has named the conceptual future post-war aviation maintenance program, “Deep Cycle Maintenance.” (J. Shamess, personal communication, April 6, 2010). However, Deep Cycle Maintenance is not established or approved at this time. Throughout this research thesis, the existing program named “RESET” was used because it is the present established program of post-deployment aviation maintenance.

Following the establishment of RESET in 2003, there are three major maintenance programs for U.S. Army Aviation (Department of the Army, 2007, AR 750-1). These maintenance programs are level: 1) limited unit level (AVUM) and intermediate level (AVIM) field maintenance, 2) on-condition selective overhaul at depot maintenance facility (Department of the Army, 2007, AR 750-1), and 3) the RESET aviation maintenance program.

Annually, the Airframe Condition Evaluation (ACE) inspects all the available Army helicopters (Department of the Army, 1999). These evaluations generate a

composite profile index score for each helicopter (U.S. Army Aviation Systems Command, 1985). Point-based profile scores of ACE assist maintenance engineers to determine the selected aircraft threshold for on-condition overhaul at Corpus Christi Army Depot (Rees, 2001). An overhaul is rare in an aircraft's life cycle because overhaul candidates are determined by variables for those aircraft with the highest ACE profile score and the funding available.

The RESET aviation maintenance program was added in 2003. RESET is an aviation maintenance program developed to provide corrective maintenance following helicopter redeployments from desert environment operations. RESET is an AVIM category of maintenance meaning that it can be accomplished by Army aviation intermediate maintenance personnel (AVIM) if time was allotted. According to the RESET TB 1-1520-237-30-1 (2009), the time required is an average 3300 personnel hours using 9 personnel. RESET is thought to improve the maintenance condition of helicopters returning from Afghanistan and Iraq theaters. This perception is based on the fact that RESET maintenance is a special maintenance inspection of greater detail than the periodic Phased Maintenance Inspections 1 and 2 (PMI) (Department of the Army, TB 1-1520-237-30-1, 2009). PMI 1 and 2 are performed respectively every 360 and 720 flight hours as part of field maintenance (Department of Army, TM 1-1520-237-PMI, 2010). This is presented in greater detail in the Literature Review.

During service in Afghanistan and Iraq, there is a significant environmental impact to the helicopters' components and airframes. It is caused by weather, sand storms, and high-cycle high-time flight hours. RESET is thought to have been successful at increasing the safety, reliability, and mission readiness of aircraft fleets and thus it is

supplementary beneficial to the previous two-level maintenance system. Benefits to safety, reliability, and mission readiness are considerations for retaining RESET as a permanent aviation maintenance program.

Purpose

The purpose of this survey study was to verify or refute that the addition of the RESET maintenance program improves safety, reliability, and mission readiness of Army helicopters. The study surveyed maintenance test pilots, AVUM (unit level maintenance) and AVIM (intermediate level maintenance) supervisory personnel of Black Hawk helicopters, and Airframe Condition Evaluation (ACE) technical evaluators.

Maintenance test pilots are familiar with the condition of aircraft having flown them before RESET and after RESET maintenance. The AVUM/AVIM task supervisory personnel are familiar with aircraft of their unit having undergone RESET and aircraft that have returned from the Afghanistan or Iraq theaters, but are waiting to undergo RESET. ACE technical evaluators have an intimate knowledge of the aircraft defects that present a safety issue necessitating a high ACE profile score and subsequent depot-level maintenance.

With the advent of the Afghanistan and Iraq wars, the helicopters experience a significantly severe environment. Based on the perceptions of these three groups of personnel, this research intended to quantitatively assess the following: 1) Does the RESET maintenance program improve safety over the AVUM/AVIM maintenance programs? 2) Does the RESET maintenance program improve reliability over the AVUM/AVIM maintenance programs? and 3) Does the RESET maintenance program improve mission readiness over the AVUM/AVIM maintenance programs?

Significance

The significance of this survey study was that it assessed RESET as a permanent addition to the current Army aviation maintenance programs. The addition of such a program is expected to benefit the Army in maintaining its helicopter fleet. The survey study determined if program stakeholders agreed that the RESET program does indeed increase safety, reliability, and mission readiness. This equates to a safer, more reliable helicopter fleet with greater mission readiness for deployment. Safe, reliable aircraft are less susceptible to aviation mishaps like crashes and hard landings.

Based on the original intent of RESET, James Shamess of the U.S. Army Research Development, and Engineering Command (RDECOM) projected that after the wars in Afghanistan and Iraq and the helicopters complete maintenance through RESET, then RESET could be dissolved (J. Shamess, personal communication, September 4, 2008). Because of the presumed safety, reliability, and mission readiness created by RESET, this thesis appraised the RESET maintenance program as a permanent addition to U.S. Army Aviation maintenance programs.

Rationale

The design framework was quantitative and straightforward. The thesis was based on a survey study of maintenance test pilots, AVUM (unit level maintenance) and AVIM (intermediate level maintenance) supervisory personnel of Black Hawk helicopters, and Airframe Condition Evaluation (ACE) technical evaluators. Data analysis entailed statistical data analysis, reduction, and possibly correlation. This thesis conformed to the traditional category thesis with quantitative framework (Creswell, 2009). It adhered to a post-positivist worldview (Creswell, 2009). The scientific method was used to measure

the effectiveness of the RESET aviation maintenance program. The inquiry strategy was investigated by data survey research correlating to the purpose statement. The data survey resulted in statistical data. The survey was a questionnaire employing the Likert scale (Trochim, 2006) and contained some questions available for open written responses. The data was requested from the UH-60 Black Hawk maintenance test pilots, and AVUM/AVIM supervisory maintenance personnel owning RESET and non-RESET aircraft, and ACE technical evaluators. The data survey tested the impact of having RESET as a permanent addition to the current Army aviation maintenance programs.

Limitations

The following limitations were placed on this study:

1. This survey study focused on the analysis of the UH-60 Black Hawk model rather than encompassing all U.S. Army helicopter models.

2. This survey was limited by the years that the RESET aviation maintenance program has been activated.

3. This survey was limited to the sample size obtained for UH-60 Black Hawk maintenance test pilots, AVUM/AVIM supervisory maintenance personnel, and ACE technical evaluators.

Assumptions

The assumptions for this study were:

1. RESET is an on-going maintenance program. Aircraft periodically return from Afghanistan and Iraq for RESET maintenance. Following RESET maintenance, the assets are returned to owning units or reassigned to new units. At this point, the helicopters may

be sent back to Afghanistan or Iraq. After each completed deployment, RESET is conducted on helicopters.

2. RESET is currently a temporary maintenance program that is expected to expire following the end of the Afghanistan and Iraq wars signaling the subsequent performance of RESET on all remaining aviation helicopters.

3. If RESET was found to increase safety, reliability, and mission readiness of the UH-60 Black Hawk fleet, then it is likely that RESET will increase the safety, reliability, and mission readiness of the AH-64, CH-47, and OH-58 fleets.

4. U.S. Army UH-60 Black Hawk helicopters that belong to both the U.S. Army and Army National Guard have been deployed to combat. Helicopters from each organization equally undergo the same RESET maintenance program on their return from deployment.

5. Overhaul maintenance conducted at Corpus Christi Army Depot was considered a separate maintenance cycle with the differing goal of overhaul rather than field maintenance as defined in the Definition of Terms. Therefore, depot overhaul was not compared to RESET.

6. Recapitalization modernization maintenance program was considered a separate upgrade with the differing goal of modernization of the UH-60A rather than field maintenance as defined in the Definition of Terms. Recapitalization was conducted only at Corpus Christi Army Depot, thus is classified as depot maintenance as opposed to field maintenance such as RESET and AVUM/AVIM as defined in the Definition of Terms. Therefore, recapitalization was not compared to RESET.

Hypothesis

The hypothesis was that RESET does increase safety, reliability, and mission readiness of the Army UH-60 Black Hawk fleet. The RESET program should be a permanent addition to the Army aviation maintenance programs.

Definition of Terms

AMCOM: Acronym for Aviation and Missile Command (Department of the Army, 2007, AR 750-1).

AVIM: Acronym for Aviation Intermediate Maintenance (Department of Army, 2008).

AVUM: Acronym for Aviation Unit Maintenance (Department of Army, 2008).

Depot maintenance:

> Materiel maintenance requiring major overhaul or a complete rebuilding of parts, assemblies, subassemblies, and end items, including the manufacture of parts, modifications, testing, and reclamation as required. Depot maintenance serves to support lower categories of maintenance by providing technical assistance and performing that maintenance beyond their responsibility. Depot maintenance provides stocks of serviceable equipment because it has available more extensive facilities for repair than are available in lower maintenance activities. Depot maintenance includes all aspects of software maintenance (Department of the Army, 2007, AR 750-1, p. 176).

Field maintenance:

> Field maintenance is the first operation of the Army maintenance system. Field maintenance is characterized by the performance of maintenance tasks “on system” in a tactical environment using trained personnel, tools, and TMDE. Field maintenance is typically operator/crew maintenance and repair and return to user maintenance operations (Department of the Army, 2007, AR 750-1, p. 177).

Overhaul:

> Overhaul is maintenance that restores equipment or components to a completely serviceable condition with a measurable (expected) life. This process involves inspection and diagnosis according to the DMWRs, NMWRs, or similar technical directions that identify components exhibiting wear and directs the replacement or adjustment of those items in accordance with the applicable technical specifications (Department of the Army, 2007, AR 750-1, p. 182).

Unsafe Condition: “An occurrence of hazard severity category I or II of MIL–STD–882. This includes the conditions that cause loss or serious damage to the end item or major components, loss of control, death, serious injury, or illness.” (Department of the Army, 2007, AR 750-1, p. 187).

RDECOM: “U.S. Army Research, Development and Engineering Command” (United States Army, 2010).

Recapitalization: A refurbishment modernization maintenance activity in which a total of 300 UH-60A Black Hawk helicopters are refurbished for extended life to reach the future modification program conversion to L model configuration (Stingel & Componation, 2006).

Readiness: "The capability of a unit/formation, ship, weapon system, or equipment to perform the mission or functions for which it is organized or designed" (Department of the Army, 2007, AR 750-1, p. 183).

Repair: "Restoration or replacement of parts and/or units to maintain efficient operating conditions" (Department of the Army, 2007, AR 750-1, p. 184).

RESET: The aviation maintenance program that provides corrective maintenance from desert environment operations following helicopter deployments (Department of the Army, TB 1-1520-237-30-1, 2009).

CHAPTER 2- LITERATURE REVIEW

Field Perspective

In deployed operations, the measure of sand experienced by these helicopters and their pilots is staggering. There is an aviation brownout condition in which the sand and dust that is blown from the ground into air has blinded pilots causing landing damage (Warwick, 2008). Sandstorms are a significant impact on the aircraft. Sand abrades aviation components like flight controls and rotor blades. Sand is a significant cause of aircraft corrosion. Aircraft corrosion represents significant personnel-hours to perform sheet metal repairs to the airframe (Hahn & Newman, 2006). As was experienced in the first Gulf War in 1991, sand can cause sticking or binding of flight control bearings, disruption of wiring contact and corrosion in airframe mating surfaces (Department of the Army, 1992). This is equally important for operations in Afghanistan. Vigilant checks and constant cleaning are required to maintain operation tempo in a desert environment (Miner, 2003).

Functional Responsibilities for Army Aviation Maintenance

Army regulation AR 750-1 is the Army Material Maintenance Policy. It provides the regulations for the maintenance of Army equipment. Chapter 6 of AR 750-1 provides the defined responsibilities for Army Aviation Maintenance. According to AR 750-1 (2007),

> The functional responsibilities of the Army aviation maintenance activities are to 1) Provide safe, reliable, and fully mission capable (FMC) aircraft to the user, 2) Sustain material in an operational status and/or restore

> equipment to a FMC condition, 3) Enhance or upgrade aircraft functional usefulness through MWO, material change, or product improvement (Department of the Army, 2007, AR 750-1, p. 57).

Origin of RESET

Each helicopter platform at AMCOM created a RESET program for their model fleet of aircraft. These are UH-60, CH-47, AH-64, and OH-58. Like all of the models, UH-60 RESET was created as a separate Technical Bulletin (TB 1-1520-237-30-1) special inspection to execute specific tasks that exist in the UH-60 Technical Manual (TM 1-1520-237-PMI) plus other tasks associated with operation conditions (Department of Army, TB 1-1520-237-30-1, 2009). Without the provision of RESET as a separate special inspection, AMCOM would have been required to revise the technical manuals of every helicopter model with the specific details containing RESET tasks and requirements. It was more effective to issue technical bulletins with the RESET requirements. Fred Pieper of the Army Aviation Resource and Assessment office at AMCOM stated that it was correct to issue RESET as special technical inspections for each aircraft model because it could be targeted to specific operations and conditions (F. Pieper, personal communication, February 18, 2010). It was quicker and more efficient to issue RESET as a Technical Bulletin than to revise the existing technical manuals for each aircraft model. Specific instructions had to be written to be capable of being executed by Intermediate maintainers themselves. However, contract maintenance was expected to be necessary to provide some portion of the labor to support RESET.

RESET Task

During RESET maintenance, the airframe interior and exterior are cleaned to remove the sand. Each helicopter is inspected from nose to tail. Combat damage and crash damage are analyzed for repair (Wall, 2004). Corrosion and crack repairs are performed on each airframe and its component parts. Deferred maintenance is completed during RESET.

Summarized tasks of RESET include removal of GE T700 engines to perform maintenance according to separate RESET TB 1-2840-248-30-1 (Department of Army, 2007). The remainder of the RESET maintenance for the UH-60 helicopter is maintained by TB 1-1520-237-30-1. Phased Maintenance Inspection (PMI) is accomplished according to TM 1-1520-237-PMI (Department of the Army, TB 1-1520-237-30-1, 2009). An ACE technical inspection is performed by ACE technical evaluators. In addition to the Phased Maintenance Inspection, RESET inspections are performed of the following components. The Auxiliary Power Unit (APU), the intermediate gearbox, and tail rotor gearbox assembly are each removed for inspection. The cabin floor is removed for accomplishing airframe inspection. The tail pylon assembly is inspected. The antennas and landing lights are removed for inspection. All flight controls are disassembled to remove sand and debris. Rotor blades are removed and inspected. The rotor hub and main rotor head is inspected for sand intrusion and corrosion. The airframe is inspected for cracks, corrosion, loose fasteners, and dents. The valves are inspected for pumps and starters connected to engine. The oil cooler is inspected. All bearings are inspected for sand entrapment. Hydraulics are inspected and cleaned to remove sand and debris. Main rotor blade expandable pins are inspected for cleanliness. Main rotor blade

nickel abrasion strips are inspected for wear. The tail rotor blades are inspected inside the tip cap for sand and debris. The main module gearbox housing is inspected for damage to the paint system. The swashplate grease shield is inspected for debonding. The swashplate uniball is inspected for sand entrapment. All wire bundles and cannon plugs are inspected for sand entrapment and corrosion. The lower console control heads are inspected for sand intrusion.

Following repairs and inspection, the airframe interior receives application of corrosion preventive compounds. All cleaned and repaired components are reinstalled. Those components not passing corrective maintenance inspection are replaced. T700 series engines are installed following maintenance according to separate RESET TB 1-2840-248-30-1 (Department of Army, 2007). Finally, the aircraft is reassembled to include rigging flight controls. Post RESET, the aircraft is next test flown by a qualified maintenance test pilot. After passing test flight, the aircraft may be released to the owning unit.

Maintenance Capacity Limited

Due to budgetary cost and set capacity limits at depot repair facilities, the existing depot maintenance program cannot absorb the numbers of aircraft to be repaired through the RESET maintenance program (Solis, 2006). Therefore, the depot aviation repair facility, Corpus Christi Army Depot, does not perform RESET designated maintenance. The intermediate maintenance sites in the field perform RESET on Army helicopter assets (F. Pieper, personal communication, February 18, 2010).

Stingel and Componation (2006) found that depot maintenance was limited in capacity for the implementation of a refurbishment called the Recapitalization Program

Plan for UH-60 Black Hawk helicopters. The burden of the UH-60 Recapitalization Program could not be fully absorbed by the capacity for maintenance overhaul and supply chain depot repair facilities. The study found that depot capacity could not absorb 28% of the 300 UH-60 helicopters for the Recapitalization Program from 2003 to 2013.

Hahn and Newman (2006) presented that the U.S. Coast Guard's limited helicopter maintenance capacity in personnel hours and facilities restrict the amount of helicopters that can undergo maintenance at the same time. In fact, aircraft queues have formed due to limited capacity at the U.S. Coast Guard's Clearwater repair station until they could be accepted for maintenance. The U.S. Army also monitors its flight hours closely to control as best as possible the maintenance capacity requirements.

Hahn and Newman (2006) presented that maintenance requirements restrict aircraft availability to fly missions. They supported this by stating the example of the U.S. Coast Guard's aviation maintenance program for the HH-60 Jay Hawk helicopter. The HH-60 is manufactured by Sikorsky and is in the same class of helicopters as the U.S. Army UH-60 Black Hawk. In the Coast Guard's maintenance program, the aircraft flight hours determine thresholds for heavy maintenance visits. Each 200 hours flown requires a combined inspection for each HH-60J helicopter.

The U.S. Coast Guard operates its HH-60J helicopter fleet in a corrosive environment. The Coast Guard found that high cycle time and the corrosive condition and associated with operating in a sea environment necessitates frequent maintenance of each HH-60J on a graduated timetable of flight hours (Hahn & Newman, 2006). The U.S. Coast Guard schedules maintenance of each HH-60J on a graduated intensity inspection at 200, 400, 600, and 800 flight hours. At every 200-flight hours each helicopter

undergoes the combined inspection. The inspections are more intrusive, requiring greater disassembly, in each graduated interval.

Similarly, U.S. Army helicopters experience high operation tempo, and a corrosive environment due to operations in desert sand and humid environment (Solis, 2006). The sand coupled with humid environment provides conditions for the corrosion chemical reaction. Second, the erosive reaction of sand degrades the surfaces of components like rotor blades and engine turbine blades.

RESET and Safety

Eiff and Suckow (2008) wrote that the control of processes can reduce accidents and incidents. Given that RESET is an established Army maintenance program with the process identified by the RESET TB 1-1520-237-30-1 that the Army has come to rely on since 2003, it is possible that there is a safety risk associated with not retaining RESET as a maintenance program. Maintaining an existing RESET aviation maintenance program could prevent higher risk of accidents or unsafe condition as defined in the Definition of Terms.

According to AR 750-1 (2007), an unsafe condition includes the conditions that cause loss or serious damage to the end item or major components, loss of control, death, serious injury, or illness. Cited by AR 750-1, the standard MIL-STD-882 (2000) defines safety as the freedom from those conditions that can cause death injury, occupational illness, damage to or loss of equipment or property, or damage to the environment. As defined in the Definition of Terms and according to AR 750-1, an unsafe condition is the Category I and II mishap severity conditions specified by MIL-STD-882. In MIL-STD-882 (2000), Category I is termed Catastrophic, which is an environmental, safety, and

health result condition that “could result in death, permanent total disability, loss exceeding $1 million, or irreversible severe environmental damage that violates law or regulation” (p. 18). Category II is termed Critical which is an environmental, safety, and health result condition that “could result in permanent partial disability, injuries or occupational illness that may result in hospitalization of at least three personnel, loss exceeding $200000 but less than $1 million, or reversible environmental damage causing a violation of law or regulation” (p. 18). Aircraft that have returned from operations in Afghanistan and Iraq are maintained through RESET to perform necessary maintenance to reestablish a baseline of safety. Safety will be evaluated as a portion of the survey as discussed in Chapter 3.

RESET and Reliability

Besterfield (2009) defines reliability as “the probability that a product will perform its intended function satisfactorily for a prescribed life under certain stated environmental conditions” (p. 462). In a report to the Committee on House Armed Services Subcommittee on Readiness, William M. Solis, Director of the Defense Capabilities and Management Government Accountability Office, discussed the significant impact of desert environment on military equipment. According to Solis (2006), “Harsh environmental conditions such as sand and high humidity levels accelerate equipment corrosion, which may not be apparent until extensive depot maintenance is performed” (¶ 37).

It is possible that not performing RESET on aircraft could affect the reliability of an aircraft to perform its function until the next maintenance event; the periodic Phased Maintenance Inspection that occurs at every 360 and 720 flight hours (Department of

Army, TM 1-1520-237-PMI, 2010). Reliability will be evaluated in the survey as discussed in Chapter 3.

RESET and Mission Readiness

The Department of Army unit equipment readiness goal for aircraft is seventy-five percent (75%) fully mission capable (Department of the Army, 2004, AR 700-138). Maintenance of Army helicopters is periodic, based on flight hours. UH-60 aircraft are inspected at Phased Maintenance Inspection #1 and #2 every 360 and 720 hours respectively (Department of the Army, TB 1-1520-237-PMI, 2010). Each individual helicopter is tracked by its flight hours to perform maintenance on schedule.

This mission readiness requirement is by the fleet model. This thesis evaluates RESET for the UH-60 Black Hawk. Therefore, information on the readiness rates for the Black Hawk is presented as follows. The Active Army fully mission capable percentage for the Black Hawk is displayed in Table 1 for each month beginning October 2009 to September 2010. By totaling each month and dividing by 12 months, the Active Army was at an average 74.3% fully mission capable for this period.

Table 1

UH-60 Black Hawk Active Army Fleet Fully Mission Capable (FMC) Ratio Expressed as a Monthly Percentage October 2009-September 2010

2009-2010 (Month)	O	N	D	J	F	M	A	M	J	J	A	S
FMC (%)	76	76	71	70	74	73	75	74	79	75	75	74

Department of Army Webdesk database, 2010.

The UH-60 Black Hawk mission readiness ratio for both the U.S. Army Reserve and U.S. Army National Guard is presented for clarity because of the mission differences

from the Active Army. The National Guard Black Hawks have a lower mission readiness ratio than the Active Army. However, the National Guard has a lower priority for spare parts than that assigned to the Active Army. The monthly readiness ratio for the U.S. Army Reserves is presented in Table 2. The monthly readiness ratio for the U.S. Army National Guard is presented in Table 3.

Table 2

UH-60 Black Hawk U.S. Army Reserves Fully Mission Capable Ratio (FMC) Expressed as a Monthly Percentage October 2009-September 2010

2009-2010 (Month)	O	N	D	J	F	M	A	M	J	J	A	S
FMC (%)	76	78	77	74	68	70	66	65	65	67	74	78

Table 3

UH-60 Black Hawk U.S. Army National Guard Fully Mission Capable (FMC) Expressed as a Monthly Percentage October 2009-September 2010

2009-2010 (Month)	O	N	D	J	F	M	A	M	J	J	A	S
FMC (%)	N/A	48	45	44	42	42	47	44	46	44	46	47

Summary

U.S. Army Black Hawk aircraft are significantly degraded following deployment in Afghanistan and Iraq. AR 750-1 defines the functional responsibilities for Army aviation aircraft. RESET was established to perform necessary maintenance following these deployments in austere conditions. The maintenance tasks of RESET for the Army UH-60 Black Hawk are identified by the RESET TB 1-1520-237-30-1 (2009). Operating

at high cycle mission requirements in a high corrosion environment in Afghanistan and Iraq is similar to the U.S. Coast Guard mission experience. Hahn and Newman describe a maintenance requirement of the Coast Guard that is similar for the Army in that each requires maintenance following operation in high flight cycle, and highly corrosive environment. The Department of Army has a goal of 75% fully mission capable for its UH-60 Black Hawk fleet. The 2009-2010 ratio was 74.3% for Active Army aircraft. Besterfield's (2009) definition of reliability indicates that RESET maintenance program has effect on aircraft reliability. AR 750-1 defines safety and cites for unsafe conditions as the MIL-STD-882 definitions of hazard Category I and II mishap severities. By these definitions, safety is enhanced by the RESET maintenance program. Safety, reliability, and mission readiness will be evaluated using survey research as discussed in Chapter 3.

CHAPTER 3- METHODOLOGY

Procedure

The thesis methodology was a quantitative survey design (Creswell, 2009). The procedure compared the Black Hawk maintenance program of unit level and intermediate level field maintenance against the enhanced Black Hawk maintenance program of RESET. Safety, reliability, and mission readiness were the three means in which this survey tested if RESET has an effect on each of them. The participants in the study were Black Hawk helicopter maintenance test pilots, AVUM/AVIM aviation maintenance supervisory personnel of UH-60 owning units, and ACE technical evaluators. The participants were chosen by a selected sampling of aviation maintenance personnel at Fort Campbell, Kentucky; Fort Hood, Texas; Fort Stewart, Georgia; and Fort Lewis, Washington. Participants were not selected at random, but self-selected through an invitation to take the survey. The survey was implemented via email notification and link to website where the survey was conducted for Groups 1 and 2: UH-60 Maintenance Test Pilots, and AVUM/AVIM supervisory personnel of Black Hawk helicopters. The survey was implemented via paper survey for Group 3 the ACE Technical Evaluators.

Potential survey participants for Groups 1 and 2 were notified by contacting each site's Brigade Aviation Maintenance Office command chain to use as a forwarding official to provide the survey invitation to their associated UH-60 personnel at each site. All Group 3 ACE personnel received the invitation and survey by distribution on paper.

The electronic survey was created in the Western Kentucky University software program entitled Qualtrics, http://www.wku.edu/infotech/index.php?page=1000. Most questions

were answered using a Likert scale. Two open–ended questions allowed participants to make comments. Open-ended input answers encouraged participants to enter valuable feedback rather than restrict the participants to a Likert model.

Threats to Validity

A potential threat to validity was the selection of personnel for the survey. Maintenance test pilots were selected because they are the first pilots to test aircraft following RESET and therefore have an intimate knowledge of the condition of helicopter condition following RESET. AVUM/AVIM maintenance supervisory personnel were selected because they have an intimate knowledge of daily safety, reliability, and mission readiness of the unit aircraft. In addition, AVUM/AVIM maintenance supervisory personnel have an intimate knowledge of the condition of redeployed aircraft before being inducted into RESET, and the condition of aircraft having completed RESET maintenance. ACE technical evaluators were selected because they conduct an annual evaluation of every aircraft in the Army fleet. Therefore, ACE technical evaluators have an intimate knowledge of the condition of aircraft that have undergone RESET and those that have not undergone RESET. The potential threat to validity due to survey selection was expected to be neutralized because the independent roles of three groups are plentiful to distribute surveys among respondents to obtain characteristic data. In addition, four locations were surveyed that provided a wide dispersal of the survey.

Another potential threat to validity was the mortality of the survey. Not all surveys were expected to be returned in complete condition. However, this mortality threat was expected to be neutralized by employing a large sample size of maintenance

operations at Fort Campbell, Kentucky; Fort Hood, Texas; Fort Stewart, Georgia; and Fort Lewis, Washington to account for those who drop out, not completing the survey.

Another potential threat to validity was that changes over time that may alter or change the research survey responses, such as a terrorist attack, a new combat theater, or changes to the budget. However, this potential threat cannot be predicted or controlled.

Survey Content

The survey began with a designation check block to designate each respondent's responsibility as one of three choices: Test Pilot, ACE Inspector, and Maintenance Supervisor. The survey was not customized for each group.

The following questions were posted to the survey:

- Place a check next to your present position: UH-60 Maintenance Test Pilot; ACE Technical Inspector; AVIM/AVUM supervisor of the production control of UH-60 maintenance.
- How many years of service do you have at your present position/duties?

The following questions asked the participants to use a Likert ranking scale (Trochim, 2006). The scale was as follows:

a. strongly disagree
b. disagree
c. neutral
d. agree
e. strongly agree

- Respond to the following statements using the scale below:
    - The RESET Aviation Maintenance Program provides a significant benefit to improve the safety of UH-60 Helicopters returning from Afghanistan and/or Iraq theaters.
    - The RESET Aviation Maintenance Program provides a significant benefit to improve the reliability of UH-60 Helicopters returning from Afghanistan and/or Iraq theaters.
    - The RESET Aviation Maintenance Program provides a significant benefit to improve the mission readiness of UH-60 Helicopters returning from Afghanistan and/or Iraq theaters.
    - The RESET Aviation Maintenance Program provides a significant benefit to improve the overall airworthiness condition for UH-60 Helicopters returning from Afghanistan and/or Iraq theaters.
- Respond to the following open-ended questions by writing in the space below:
    - What is the most significant reason for performing RESET maintenance for the UH-60 helicopter following deployment in Afghanistan and/or Iraq?
    - The RESET TB 1-1520-237-30-1 requires performance of a Phased Maintenance Inspection (PMI) according to TM 1-1520-237-PMI plus the special maintenance inspections that seek to address the deployed condition. Without the special inspections of RESET, would the Phased Maintenance Inspection alone be

sufficient for the maintenance of UH-60 helicopters returning from Afghanistan and/or Iraq? Why or why not?

Analysis Procedure

The independent variable being evaluated was the effectiveness of the RESET Aviation Maintenance Program. The dependent variables were safety, reliability, and mission readiness. A fourth dependent variable, overall airworthiness, was posed as part of the survey to look for significant variance. However, overall airworthiness was insignificant in providing additional data and therefore the question was removed for the analysis.

The survey responses were divided into three groups corresponding to the role of each respondent indicated by the first check block question. Maintenance Test Pilots were Group 1. AVUM/AVIM maintenance supervisors were Group 2. ACE Technical Evaluators were Group 3.

The questions with Likert scale responses were quantitatively analyzed using descriptive statistics for each group. In addition, the responses of the groups were compared to each other. An Analysis of Variance (ANOVA) statistically compared the differences between the groups and within each group. Tests of F ratio determined if these differences are considerable.

A content analysis was performed for the open-ended (non-Likert) responses. These responses were analyzed qualitatively for content relating to the thesis questions. Analysis included determination if a congruency existed between the open-ended responses and the Likert scale responses.

Summary

The thesis methodology was a quantitative survey design. The independent variable being evaluated was the effectiveness of the RESET Aviation Maintenance Program. Safety, reliability, and mission readiness were the three dependent variables that were measured. Both Likert scale and open ended questions composed the survey. The open-ended responses were evaluated for congruency with the Likert scale responses and for additional insight. The survey responses were divided into three groups corresponding to the role of each respondent indicated by the first check block question: Maintenance Test Pilots, AVUM/AVIM personnel, and ACE Technical Evaluators. ANOVA analysis was employed to statistically analyze the differences between the groups and within each group. The findings of the study are reported in Chapter 4.

CHAPTER 4- ANALYSIS

Survey Participation

The survey was distributed to the three identified groups: UH-60 Maintenance Test Pilots, AVUM/AVIM supervisory personnel of UH-60 production control, and ACE Technical Evaluators. The survey invitation was distributed by email to two participant groups: UH-60 Maintenance Test Pilots, and AVUM/AVIM maintenance supervisory personnel of UH-60 production control. The survey was distributed on paper to ACE Technical Evaluators. A total of 57 participants volunteered to complete the survey.

The total participant distribution from each group is given in the Table 4. Twelve UH-60 Maintenance Test Pilots participated. Five AVUM/AVIM maintenance supervisory personnel participated. Forty ACE Technical Evaluators participated.

Table 4

Distribution of 57 Total Survey Participants

UH-60 Maintenance Test Pilots	12
AVUM/AVIM Maintenance Supervisory Personnel	5
ACE Technical Evaluators	40
Total	57

Likert Scale Responses

All 57 participants completed 100 percent of the Likert scale questions. Safety, reliability, and mission readiness were the three dependent variables that were measured. For calculation of the mean, responses to the Likert scale questions are coded as follows: Strongly Disagree =1, Disagreed=2, Neutral=3, Agree=4, and Strongly Agree=5.

Among All Groups, RESET Improves Safety of UH-60 Helicopters

The first Likert scale question asked participants to evaluate the following statement: The RESET Aviation Maintenance Program provides a significant benefit to improve the safety of UH-60 Helicopters returning from Afghanistan and/or Iraq theaters. A test for normalcy was conducted, but it did not yield a normal distribution. Of the total number of respondents, 40 strongly agreed (70.2%), 14 agreed (24.6%), 1 neutral (1.8%), 2 disagreed (3.5%), and 0 strongly disagreed (0.0%). These data are presented with corresponding percentage plotted in the Pareto chart in Figure 1. The mode is 5; that is equal to Strongly Agree. The minimum is 2, and the maximum is 5.

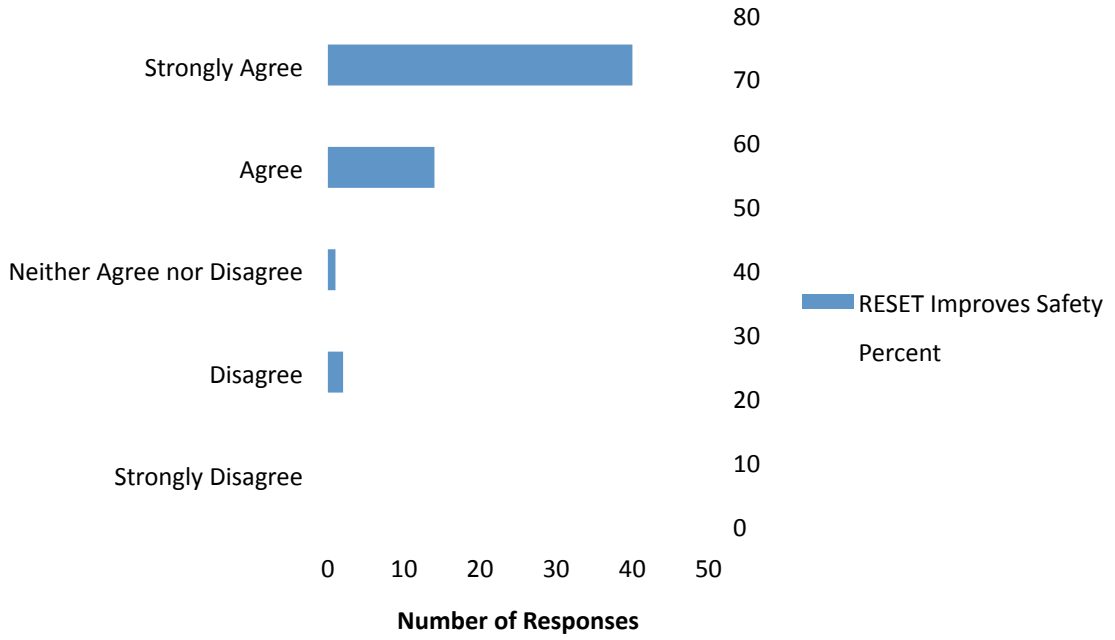

Figure 1. RESET Improves Safety, Total among All Groups.

The histogram and normality plot indicated the total distribution was not normal. There were greater high scores than low scores. Among all groups, for the total composite score that RESET improves safety, the mean is 4.6 with a standard deviation of 0.7.

Among All Groups, RESET Improves Reliability of UH-60 Helicopters

The second Likert scale question asked participants to evaluate the following statement: The RESET Aviation Maintenance Program provides a significant benefit to improve the reliability of UH-60 Helicopters returning from Afghanistan and/or Iraq theaters. A test for normalcy was conducted, but it did not yield a normal distribution. Of the total number of respondents, 40 strongly agreed (70.2%), 14 agreed (24.6%), 1 neutral (1.8%), 2 disagreed (3.5%), and 0 strongly disagreed (0.0%). These data are presented with corresponding percentage plotted in the Pareto chart in Figure 2. The mode is 5; that is equal to Strongly Agree. The minimum is 2, and the maximum is 5.

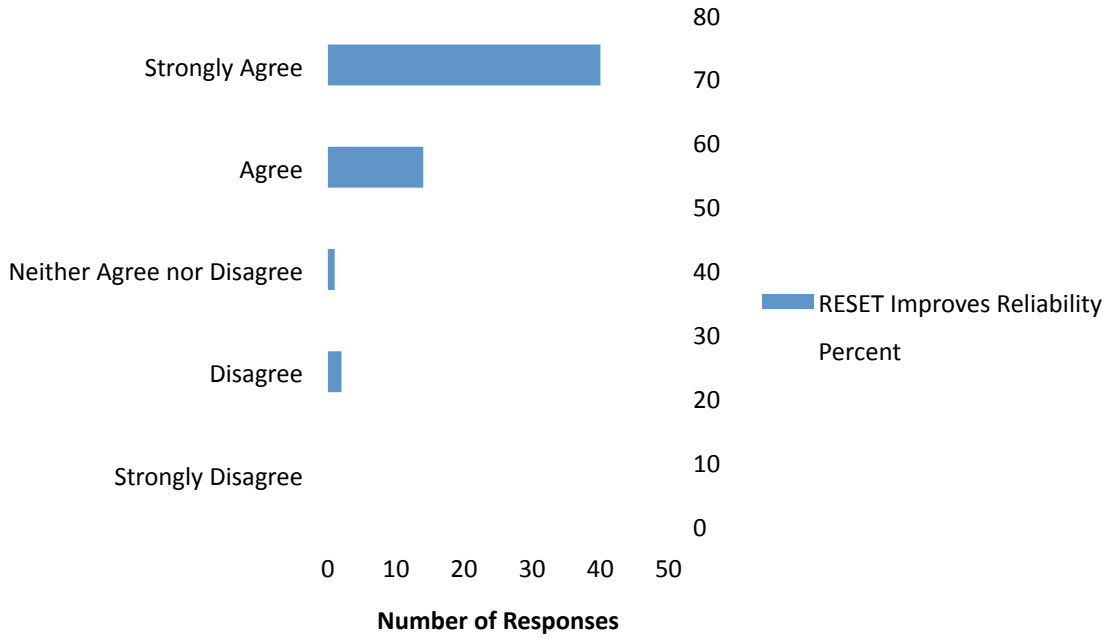

Figure 2. RESET Improves Reliability, Total among All Groups.

The histogram and normality plot indicated the total distribution was not normal. There were greater high scores than low scores. Among all groups, for the total composite score that RESET improves reliability, the mean is 4.6 with a standard deviation of 0.7.

Among All Groups, RESET Improves Mission Readiness of UH-60 Helicopters

The third Likert scale question asked participants to evaluate the following statement: The RESET Aviation Maintenance Program provides a significant benefit to improve the mission readiness of UH-60 Helicopters returning from Afghanistan and/or Iraq theaters. A test for normalcy was conducted, but it did not yield a normal distribution. Of the total number of respondents, 37 strongly agreed (64.9%), 15 agreed (26.3%), 3 neutral (5.3%), 1 disagreed (1.8%), and 1 strongly disagreed (1.8%). These data are presented with corresponding percentage plotted in the Pareto chart in Figure 3. The mode is 5; that is equal to Strongly Agree. The minimum is 1 and the maximum is 5.

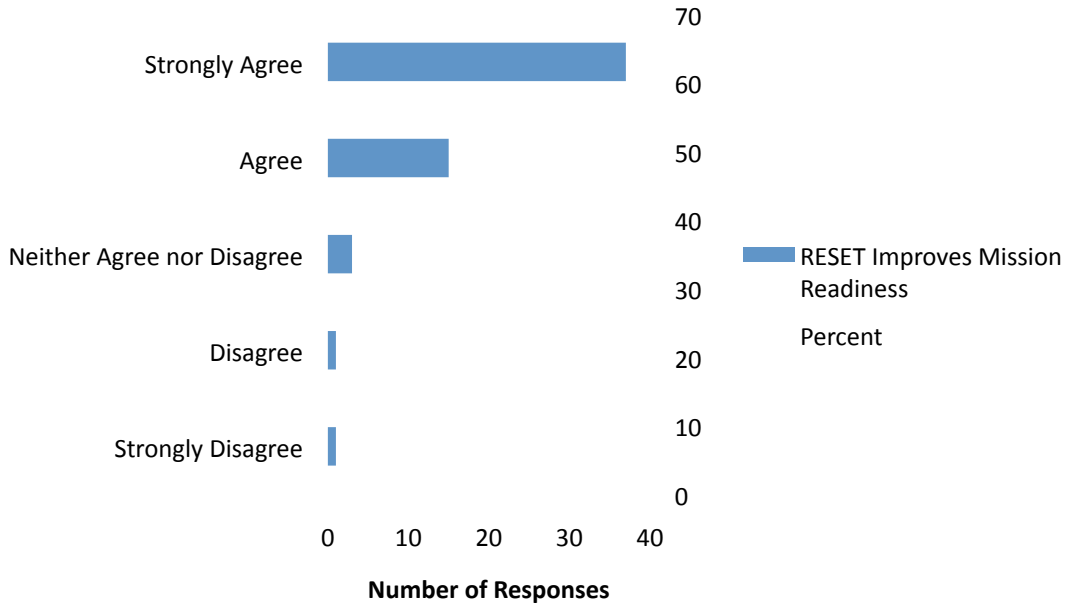

Figure 3. RESET Improves Mission Readiness, Total among All Groups.

The histogram and normality plot indicated the total distribution was not normal. There were greater high scores than low scores. Among all groups, for the total composite score that RESET improves mission readiness, the mean is 4.5 with a standard deviation of 0.8.

Group 1: UH-60 Maintenance Test Pilots

Among UH-60 Maintenance Test Pilots, RESET Improves Safety of UH-60 Helicopters.

The first Likert scale question asked UH-60 maintenance test pilots to evaluate the following statement: The RESET Aviation Maintenance Program provides a significant benefit to improve the safety of UH-60 Helicopters returning from Afghanistan and/or Iraq theaters. A test for normalcy was conducted, but it did not yield a normal distribution. Of the respondents, 6 strongly agreed (50.0%), 5 agreed (42.7%), 0 neutral (0.0%), 1 disagreed (8.3%), and 0 strongly disagreed (0.0%). These data are presented with corresponding percentage plotted in the Pareto chart in Figure 4. The mode is 5; that is equal to Strongly Agree. The minimum is 2, and the maximum is 5.

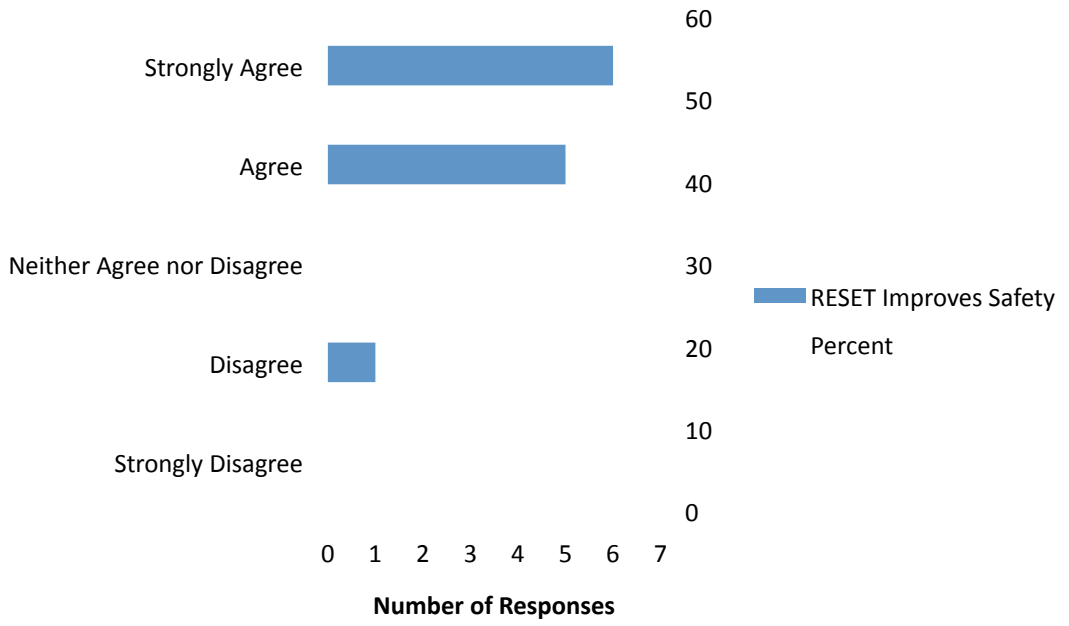

Figure 4. RESET Improves Safety, Among UH-60 Maintenance Test Pilots.

Next, a histogram plot and normality plot were made to measure if there was a normal distribution. The histogram and normality plot indicated the distribution was not normal. There were greater high scores than low scores. Among UH-60 maintenance test pilots, for the score that RESET improves safety, the mean is 4.3 with a standard deviation of 0.9.

Among UH-60 Maintenance Test Pilots, RESET Improves Reliability of UH-60 Helicopters.

The second Likert scale question asked participants to evaluate the following statement: The RESET Aviation Maintenance Program provides a significant benefit to improve the reliability of UH-60 Helicopters returning from Afghanistan and/or Iraq theaters. A test for normalcy was conducted, but it did not yield a normal distribution. Of the respondents, 6 strongly agreed (50.0%), 5 agreed (42.7%), 0 neutral (0.0%), 1 disagreed (8.3%), and 0 strongly disagreed (0.0%). These data are presented with corresponding percentage plotted in the Pareto chart in Figure 5. The mode is 5; that is equal to Strongly Agree. The minimum is 2, and the maximum is 5.

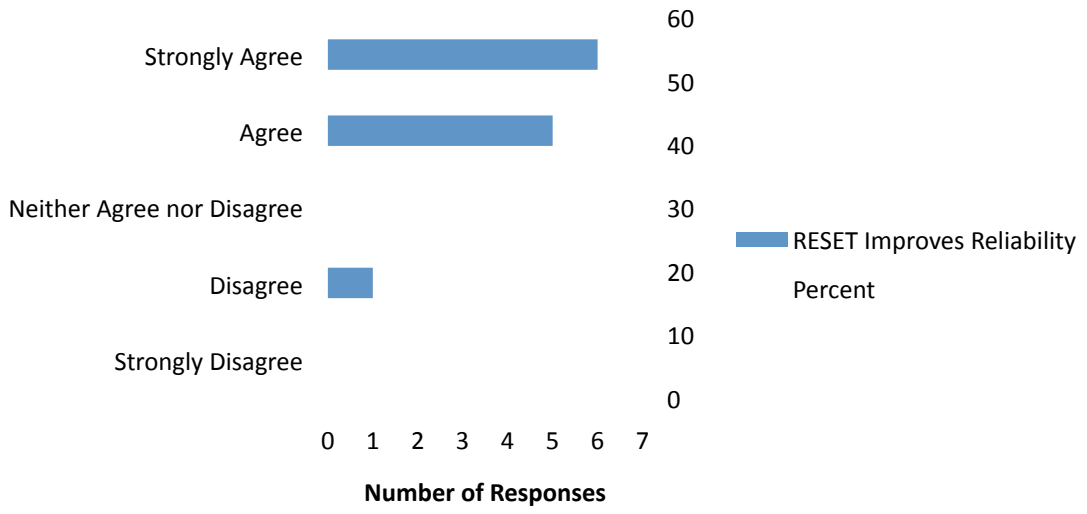

Figure 5. RESET Improves Reliability, Among UH-60 Maintenance Test Pilots.

The histogram and normality plot indicated the distribution was not normal. There were greater high scores than low scores. Among UH-60 maintenance test pilots, for the score that RESET improves reliability, the mean is 4.3 with a standard deviation of 0.9.

Among UH-60 Maintenance Test Pilots, RESET Improves Mission Readiness of UH-60 Helicopters.

The third Likert scale question asked participants to evaluate the following statement: The RESET Aviation Maintenance Program provides a significant benefit to improve the mission readiness of UH-60 Helicopters returning from Afghanistan and/or Iraq theaters. A test for normalcy was conducted, but it did not yield a normal distribution. Of the respondents, 7 strongly agreed (58.3%), 3 agreed (25.0%), 1 neutral (8.3%), 1 disagreed (8.3%) and 0 strongly disagreed (0.0%). These data are presented with corresponding percentage plotted in the Pareto chart in Figure 6. The mode is 5; that is equal to Strongly Agree. The minimum is 1 and the maximum is 5.

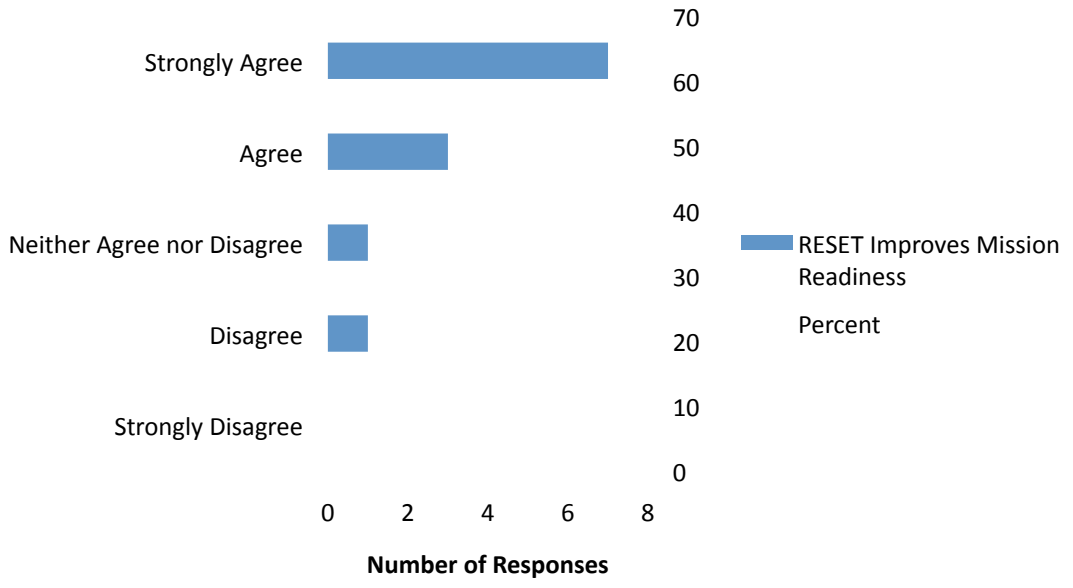

Figure 6. RESET Improves Mission Readiness, Among UH-60 Maintenance Test Pilots.

The histogram and normality plot indicated the distribution was not normal. There were greater high scores than low scores. Among UH-60 maintenance test pilots, for the score that RESET improves mission readiness, the mean is 4.3 with a standard deviation of 1.0.

Group 2: AVUM/AVIM Maintenance Supervisory Personnel

Among UH-60 AVUM/AVIM Maintenance Supervisory Personnel, RESET Improves Safety of UH-60 Helicopters.

The first Likert scale question asked UH-60 AVUM/AVIM maintenance supervisory personnel to evaluate the following statement: The RESET Aviation Maintenance Program provides a significant benefit to improve the safety of UH-60 Helicopters returning from Afghanistan and/or Iraq theaters. A test for normalcy was conducted, but it did not yield a normal distribution. Of the respondents, 2 strongly agreed (40.0%), 2 agreed (40.0%), 0 neutral (0.0%), 1 disagreed (20.0%), and 0 strongly disagreed (0.0%). These data are presented with corresponding percentage plotted in the Pareto chart in Figure 7. The mode is 4 and 5; that is equal to Agree and Strongly Agree. The minimum is 2, and the maximum is 5.

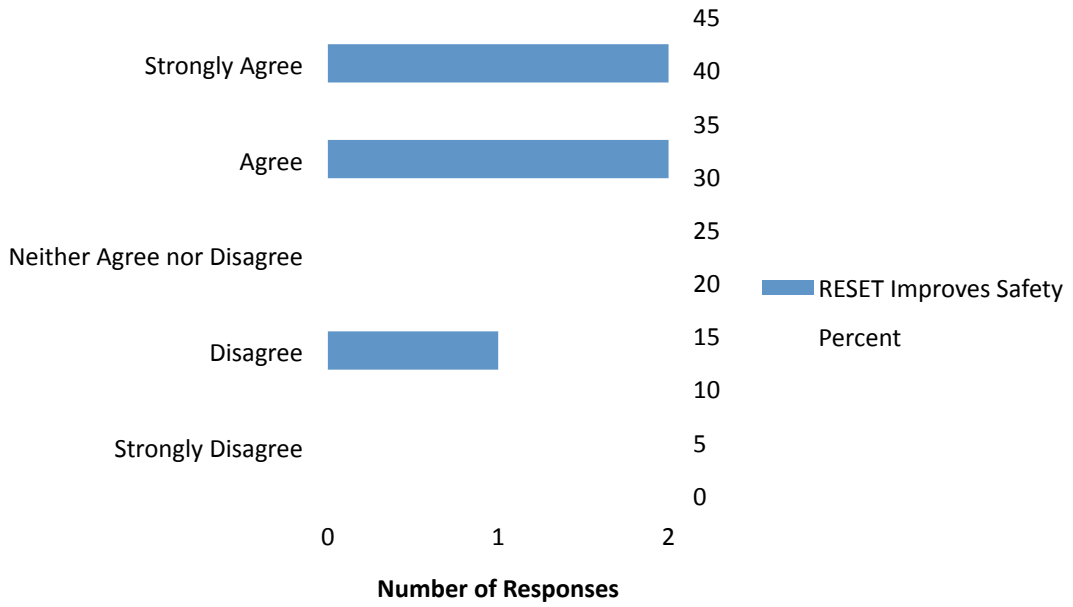

Figure 7. RESET Improves Safety, Among UH-60 AVUM/AVIM Maintenance Supervisory Personnel.

The histogram and normality plot indicated the distribution was not normal. There were greater high scores than low scores. Among UH-60 AVUM/AVIM maintenance supervisory personnel, for the score that RESET improves safety, the mean is 4.0 with a standard deviation of 1.2.

Among UH-60 AVUM/AVIM Maintenance Supervisory Personnel, RESET Improves Reliability of UH-60 Helicopters.

The second Likert scale question asked participants to evaluate the following statement: The RESET Aviation Maintenance Program provides a significant benefit to improve the reliability of UH-60 Helicopters returning from Afghanistan and/or Iraq theaters. A test for normalcy was conducted, but it did not yield a normal distribution. Of the respondents, 2 strongly agreed (40.0%), 2 agreed (40.0%), 0 neutral (0.0%), 1 disagreed (20.0%), and 0 strongly disagreed (0.0%). These data are presented with

corresponding percentage plotted in the Pareto chart in Figure 8. The mode is 4 and 5; that is equal to Agree and Strongly Agree. The minimum is 2, and the maximum is 5.

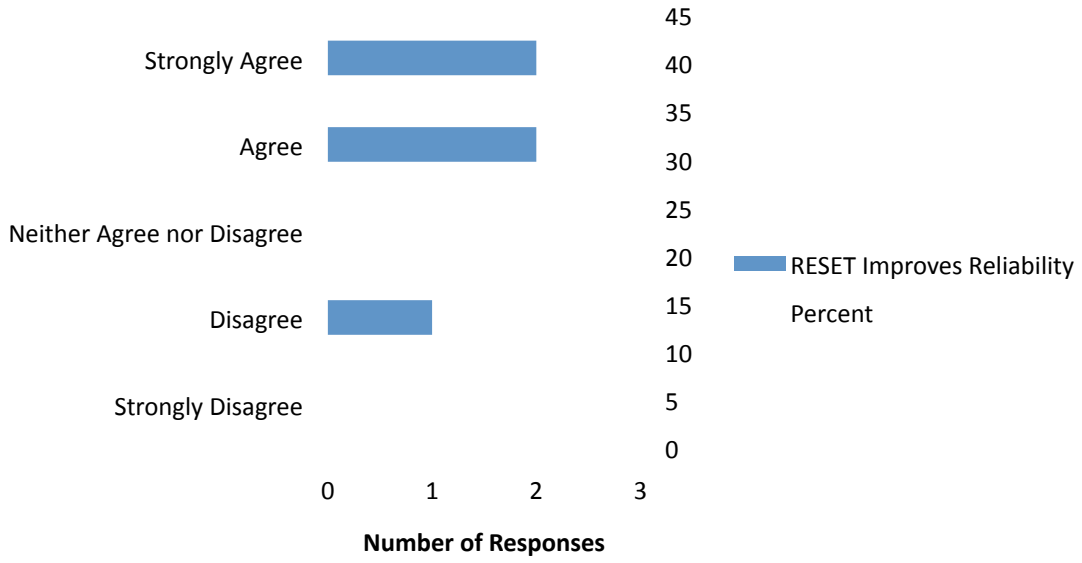

Figure 8. RESET Improves Reliability, Among UH-60 AVUM/AVIM Maintenance Supervisory Personnel.

The histogram and normality plot indicated the distribution was not normal. There were greater high scores than low scores. Among UH-60 AVUM/AVIM maintenance supervisory personnel, for the score that RESET improves reliability, the mean is 4.0 with a standard deviation of 1.2.

Among UH-60 AVUM/AVIM Maintenance Supervisory Personnel, RESET Improves Mission Readiness of UH-60 Helicopters.

The third Likert scale question asked participants to evaluate the following statement: The RESET Aviation Maintenance Program provides a significant benefit to improve the mission readiness of UH-60 Helicopters returning from Afghanistan and/or Iraq theaters. A test for normalcy was conducted, but it did not yield a normal distribution. Of the respondents, 1 strongly agreed (20.0%), 2 agreed (40.0%), 1 neutral (20.0%), 0 disagreed (0.0%) and 1 strongly disagreed (20.0%). These data are presented

with corresponding percentage plotted in the Pareto chart in Figure 9. The mode is 4; that is equal to Agree. The minimum is 1 and the maximum is 5.

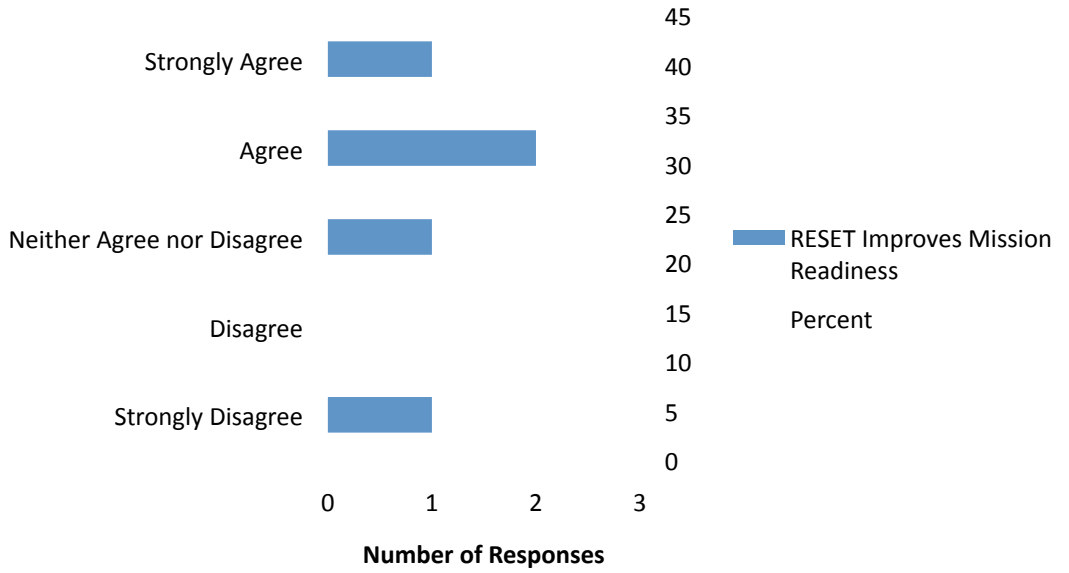

Figure 9. RESET Improves Mission Readiness, Among UH-60 AVUM/AVIM Maintenance Supervisory Personnel.

The histogram and normality plot indicated the distribution was not normal. There were greater high scores than low scores. Among UH-60 AVUM/AVIM maintenance supervisory personnel, for the score that RESET improves mission readiness, the mean is 3.4 with a standard deviation of 1.5.

Group 3: ACE Technical Evaluators

Among ACE Technical Evaluators, RESET Improves Safety of UH-60 Helicopters.

The first Likert scale question asked ACE technical evaluators to evaluate the following statement: The RESET Aviation Maintenance Program provides a significant benefit to improve the safety of UH-60 Helicopters returning from Afghanistan and/or

Iraq theaters. A test for normalcy was conducted, but it did not yield a normal distribution. Of the respondents, 32 strongly agreed (80.0%), 7 agreed (40.0%), 1 neutral (0.0%), 0 disagreed (0.0%), and 0 strongly disagreed (0.0%). These data are presented with corresponding percentage plotted in the Pareto chart in Figure 10. The mode is 5; that is equal to Strongly Agree. The minimum is 3, and the maximum is 5.

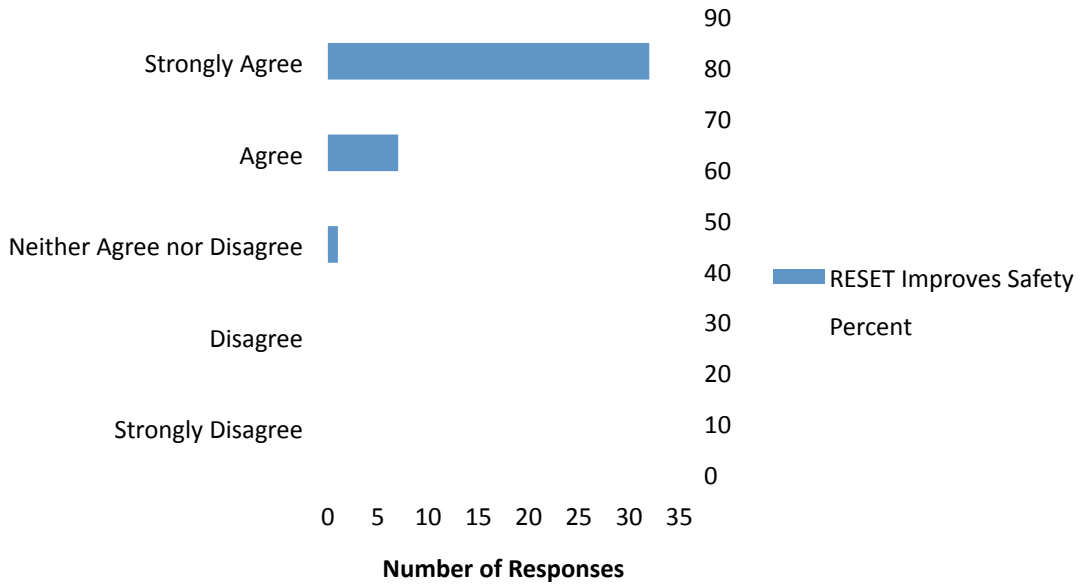

Figure 10. RESET Improves Safety, Among ACE Technical Evaluators.

The histogram and normality plot indicated the distribution was not normal. There were greater high scores than low scores. Among ACE technical evaluators, for the score that RESET improves safety, the mean is 4.8 with a standard deviation of 0.5.

Among ACE Technical Evaluators, RESET Improves Reliability of UH-60 Helicopters.

The second Likert scale question asked ACE Technical Evaluators to evaluate the following statement: The RESET Aviation Maintenance Program provides a significant benefit to improve the reliability of UH-60 Helicopters returning from Afghanistan

and/or Iraq theaters. A test for normalcy was conducted, but it did not yield a normal distribution. Of the respondents, 32 strongly agreed (80.0%), 7 agreed (40.0%), 1 neutral (0.0%), 0 disagreed (0.0%), and 0 strongly disagreed (0.0%). These data are presented with corresponding percentage plotted in the Pareto chart in Figure 10. The mode is 5; that is equal to Strongly Agree. The minimum is 3, and the maximum is 5.

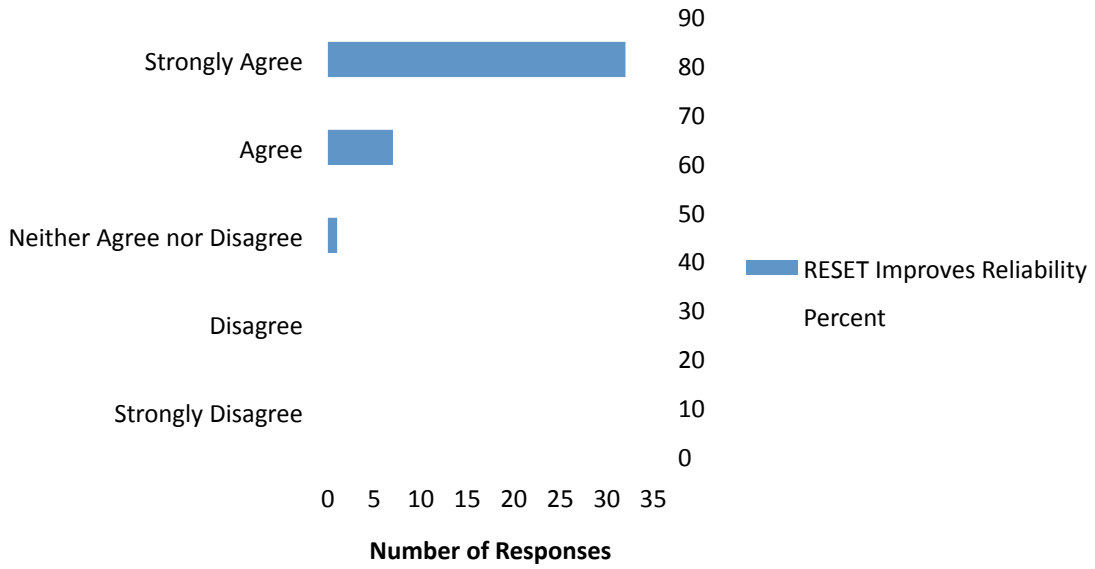

Figure 11. RESET Improves Reliability, Among ACE Technical Evaluators.

The histogram and normality plot indicated the distribution was not normal. There were greater high scores than low scores. Among ACE technical evaluators, for the score that RESET improves reliability, the mean is 4.8 with a standard deviation of 0.5.

Among ACE Technical Evaluators, RESET Improves Mission Readiness of UH-60 Helicopters.

The third Likert scale question asked participants to evaluate the following statement: The RESET Aviation Maintenance Program provides a significant benefit to improve the mission readiness of UH-60 Helicopters returning from Afghanistan and/or Iraq theaters. A test for normalcy was conducted, but it did not yield a normal

distribution. Of the respondents, 29 strongly agreed (72.5%), 10 agreed (25.0%), 1 neutral (2.5%), 0 disagreed (0.0%) and 0 strongly disagreed (0.0%). These data are presented with corresponding percentage plotted in the Pareto chart in Figure 12. The mode is 5; that is equal to Strongly Agree. The minimum is 3 and the maximum is 5.

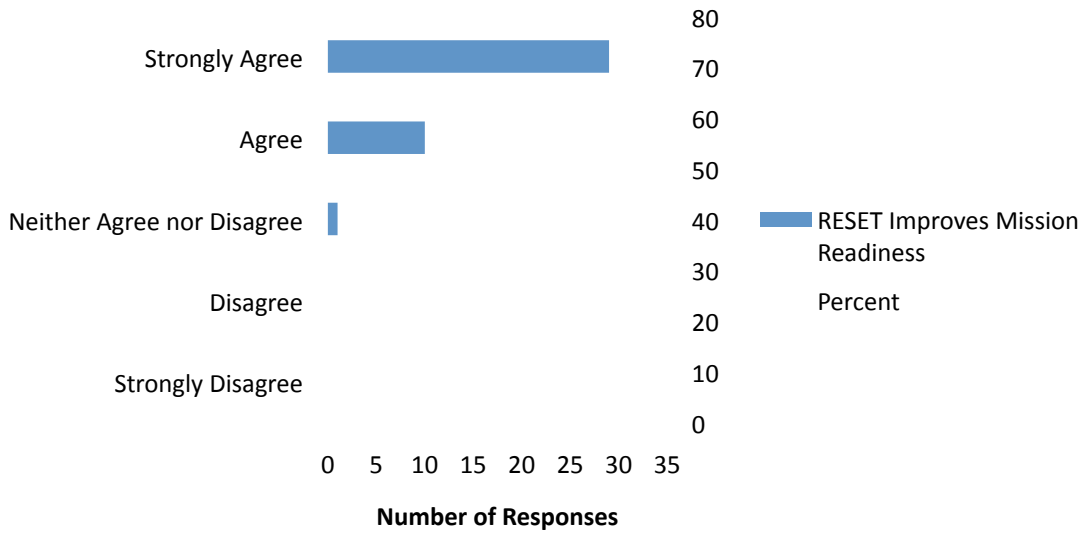

Figure 12. RESET Improves Mission Readiness, Among ACE Technical Evaluators.

The histogram and normality plot indicated the distribution was not normal. There were greater high scores than low scores. Among ACE technical evaluators, for the score that RESET improves mission readiness, the mean is 4.7 with a standard deviation of 0.5.

ANOVA Analysis: RESET Improves Safety

As discussed, a test for normalcy was conducted, but it did not yield a normal distribution. The following ANOVA analysis was conducted of each group on the question of does RESET improve safety. The null hypothesis was that the samples are

identical. This means that Group 1=Group 2= Group 3. The alternative hypothesis was that one or more of the groups were different from the others.

ANOVA analysis of each group on the question of does RESET improve safety is presented in Table 5. The standard deviation for Group 1, Maintenance Test Pilots was 0.9. The standard deviation for Group 2, AVUM/AVIM Supervisory Personnel was 1.2. The standard deviation for Group 3, ACE Technical Evaluators was 0.5. The calculated F value was 4.42 with a probability of less than 0.017. The probability of different mean is very small, $p < 0.02$. There is less than 1 in 100 of obtaining means as different from the means of the samples produced in this analysis, provided the samples come from identical populations. The critical value of F from the sampling distribution is 3.18 with $\alpha = 0.05$. F is greater than F distribution. Therefore, the null hypothesis was not true and thus is rejected. The alternative hypothesis is true: At least one of the groups produced a score that was statistically different from the other two groups.

Table 5

One Way ANOVA, Among All Groups RESET Improves Safety

Source of variation	Sum squares	DF	Mean square	F statistic	p
Group	3.9	2	1.9	4.42	0.0167
Residual	23.6	54	0.4		
Total	27.5	56			

ANOVA Analysis: RESET Improves Reliability

As discussed, a test for normalcy was conducted, but it did not yield a normal distribution. The following ANOVA analysis was conducted of each group on the question of does RESET improve reliability. The null hypothesis was that the samples are

identical. This means that Group 1=Group 2= Group 3. The alternative hypothesis was that one or more of the groups were different from the others.

ANOVA analysis of each group on the question of does RESET improve Reliability is presented in Table 6. The standard deviation for Group 1, Maintenance Test Pilots was 0.9. The standard deviation for Group 2, AVUM/AVIM Supervisory Personnel was 1.2. The standard deviation for Group 3, ACE Technical Evaluators was 0.5. The calculated F value was 4.42 with a probability of less than 0.017. The probability of different mean is very small, $p < 0.02$. There is less than 1 in 100 of obtaining means as different from the means of the samples produced in this analysis, provided the samples come from identical populations. The critical value of F from the sampling distribution is 3.18 with $\alpha = 0.05$. F is greater than F distribution. Therefore, the null hypothesis was not true and thus is rejected. The alternative hypothesis is true: At least one of the groups produced a score that was statistically different from the other two groups.

Table 6

One Way ANOVA, Among All Groups RESET Improves Reliability

Source of variation	Sum squares	DF	Mean square	F statistic	p
Group	3.9	2	1.9	4.42	0.0167
Residual	23.6	54	0.4		
Total	27.5	56			

ANOVA Analysis: RESET Improves Mission Readiness

As discussed, a test for normalcy was conducted, but it did not yield a normal distribution. The following ANOVA analysis was conducted of each group on the question of does RESET improve mission readiness. The null hypothesis was that the

samples are identical. This means that Group 1=Group 2= Group 3. The alternative hypothesis was that one or more of the groups were different from the others.

ANOVA analysis of each group on the question of does RESET improve Mission Readiness is presented in Table 7. The standard deviation for Group 1, Maintenance Test Pilots was 1.0. The standard deviation for Group 2, AVUM/AVIM Supervisory Personnel was 1.5. The standard deviation for Group 3, ACE Technical Evaluators was 0.5. The calculated F value was 7.12 with a probability of less than 0.002. The critical value of F from the sampling distribution is 3.18 with $\alpha = 0.05$. The probability of different mean is very small, $p < 0.002$. There is less than 1 in 100 of obtaining means as different from the means of the samples produced in this analysis, provided the samples come from identical populations. F is greater than F distribution. Therefore, the null hypothesis was not true and thus is rejected. The alternative hypothesis is true: At least one of the groups produced a score that was statistically different from the other two groups.

Table 7

One Way ANOVA, Among All Groups RESET Improves Mission Readiness

Source of variation	Sum squares	DF	Mean square	F statistic	p
Group	8.0	2	4.0	7.12	0.0018
Residual	30.3	54	0.6		
Total	38.2	56			

Summary of ANOVA Analysis

Statistical analysis of each group indicated the following: For the dependent variable, RESET improves safety; ANOVA statistical analysis indicated the groups were not all equal. For the dependent variable, RESET improves reliability; ANOVA statistical

analysis indicated the groups were not all equal. For the dependent variable, RESET improves mission readiness; ANOVA statistical analysis indicated the groups were not all equal.

ANOVA analysis was followed with Pearson correlation test for each dependent variable. However, the correlation testing yielded no more distinguishable results from the descriptive statistics already performed.

Report of Open-ended Questions

Following the Likert scale questions on the survey, two questions were asked that were open-ended. The first open-ended question was as follows: What is the most significant reason for performing RESET maintenance for the UH-60 helicopter following deployment in Afghanistan and/or Iraq?

A content analysis was performed. The responses indicated a congruency among survey participants. UH-60 Maintenance Test Pilots remarks supported a significant improved difference between pre-RESET and post-RESET test flights. ACE Technical Evaluators remarks supported the greater disassembly of RESET for more thorough inspection.

The responses were similar in content and are summarized herein. Significant reasons for performing RESET maintenance for the UH-60 helicopter following deployment in Afghanistan and/or Iraq were:

- During combat operations the aircraft is exposed to extremes of weather, stresses on the airframe and, of course, combat damage. RESET allows the

airframe and components to be cleaned, inspected, repaired or replaced, then returned to a mission-ready, safe aircraft.

- RESET provides an opportunity for depopulation or disassembly for a more thorough inspection than in deployed theater.
- The high op-tempo in theater leaves units little time to maintain these aircraft. Deployed aircraft do not have time to conduct details such as major repairs, replacement of parts, and special inspections.
- To make repairs that were deferred during deployment in theater
- Cleaning sand and other grime from wires, cannon plugs, and components to prevent corrosion build up, and identify problem areas caused by desert operations. Removal of foreign contaminants that affect bearings, cables, pulleys, and components that retain debris not associated with a regular scheduled maintenance event.
- The desert/dusty environment encountered in theater leaves the aircraft with fine grains of sand everywhere conceivable. RESET's main intent is for cleaning and corrosion control. The added benefit of the aircraft being almost totally disassembled is that areas not normally visible are subject to scrutiny.
- To repair combat damage and to assess serviceability of components and structures following deployments
- To bring the aircraft back to a like new condition in a short amount of time.

The second open-ended question was as follows: The RESET TB 1-1520-237-30-1 requires performance of a Phased Maintenance Inspection (PMI) according to TM 1-1520-237-PMI plus the special maintenance inspections that seek to address the deployed condition. Without the special inspections of RESET, would the Phased Maintenance Inspection alone be sufficient for the maintenance of UH-60 aircraft returning from Afghanistan and/or Iraq? Why or why not?

A content analysis was performed. The responses indicated a congruency among survey participants. The responses were similar content and are summarized herein. A majority, 49 of 53, wrote that the Phased Maintenance Inspection (PMI) was insufficient to the RESET aviation maintenance program. Reasons given were the special inspections of RESET not included in PMI, the extra disassembly of RESET for a more thorough inspection than PMI, the cleaning and inspection of avionics/electronics equipment during RESET. Data indicated that the extra disassembly for special inspections of RESET is valuable for discovering and correcting deficiencies such as cracks and corrosion on the airframes and operational damage of components.

A repeated response was that PMIs are perceived to be accomplished in a specific amount of time (20 days for PMI 1, 30 days for PMI 2). This is not near enough time to address the severe wear and tear that the aircraft incur during a deployment.

Another repeated response was that the PMI is restricted to only specific items defined by the inspection checklist for PMI 1 or PMI 2, whereas, RESET includes PMI plus special inspections with more extensive disassembly and cleaning of airframe and components.

Of fifty-three responses, four responses stated that PMI was sufficient to perform on aircraft after deployment. Quality was mentioned in one remark from a UH-60 maintenance test pilot who stated that it depends on who performs PMI, and who performs RESET. Remarks stated some units meet the minimum threshold of the PMI inspection, while other units go beyond the threshold of the PMI inspection. Quality analysis among PMI maintenance production sites was beyond the scope of this study. However, two of these four responses provided the condition that for effectiveness the ACE inspection must be performed in conjunction with the post-deployment PMI. The RESET program requires an ACE inspection is performed.

CHAPTER 5- CONCLUSION

The purpose of this study was to verify or refute that the addition of the RESET maintenance program improves safety, reliability, and mission readiness of Army helicopters. The study surveyed three groups: maintenance test pilots of UH-60 Black Hawk helicopters, AVUM (unit level maintenance) and AVIM (intermediate level maintenance) supervisory personnel of Black Hawk helicopters, and Airframe Condition Evaluation (ACE) technical evaluators.

Maintenance test pilots were selected because they are the first pilots to test aircraft following RESET and therefore have an intimate knowledge of the condition of helicopter condition following RESET. AVUM/AVIM maintenance supervisory personnel were selected because they have an intimate knowledge of daily safety, reliability, and mission readiness of the unit aircraft. In addition, AVUM/AVIM maintenance supervisory personnel have an intimate knowledge of the condition of redeployed aircraft before being inducted into RESET, and the condition of aircraft having completed RESET maintenance. ACE technical evaluators were selected because they conduct an annual evaluation of every aircraft in the Army fleet. Therefore, ACE technical evaluators have an intimate knowledge of the condition of aircraft that have undergone RESET and those that have not undergone RESET.

The data verified that among each group, performing the RESET aviation maintenance program improves safety, reliability, and mission readiness for UH-60 helicopters returning from deployment in Afghanistan and/or Iraq. This supported the

defined responsibilities for Army Aviation Maintenance according to AR 750-1 (2007) to provide safe, reliable, and fully mission capable (FMC) aircraft to the user.

Each group was analyzed separately for each dependent variable. For the UH-60 maintenance test pilots, the data indicated the RESET aviation maintenance program improves safety, reliability, and mission readiness. For the AVUM/AVIM maintenance supervisory personnel of UH-60, the data indicated the RESET aviation maintenance program improves safety, reliability, and mission readiness. For the Airframe Condition Evaluation (ACE) technical evaluators the data indicated the RESET aviation maintenance program improves safety, reliability, and mission readiness. The data indicated respondents attributed value to the RESET aviation maintenance program for improved safety, reliability, and mission readiness.

Data from the open-ended questions indicated that the cleaning requirement of RESET the aircraft to remove the sand, dirt, and debris was highly valued to the preservation of the airframes, flight controls, electronics, and wiring to prevent both obstructive binding and corrosion. This result supported the fact of operating in sand and high humidity levels accelerate equipment corrosion (Solis, 2006). As was experienced in the first Gulf War in 1991, sand can cause sticking or binding of flight control bearings, disruption of wiring contact and corrosion in airframe mating surfaces (Department of the Army, 1992).

Data from open-ended questions supported the accessibility of RESET to repair and return aircraft in a short period of time. This result supported the fact that maintenance capacity is limited at depot maintenance facilities (Solis, 2006).

Data from open-ended questions indicated the extra disassembly and special inspections of RESET are valuable for discovering and correcting deficiencies such as cracks and corrosion on the airframes and operational damage of components. Cracks and corrosion of the airframe and operational damage of components affect the safety, reliability, and mission readiness of the aircraft. Aircraft corrosion represents significant personnel-hours to perform sheet metal repairs to the airframe (Hahn & Newman, 2006). Compared to RESET, the PMI inspection is both limited in disassembly and does not include the special inspections of RESET. Therefore, the extra disassembly and special inspections of RESET are valuable for the condition of the UH-60 helicopters.

RESET was determined a successful program that should be continued. Based on the effectiveness of RESET in discovering these deficiencies and the value attributed to RESET, the RESET maintenance program should be a permanent addition to the existing Army aviation maintenance programs.

Recommendations for Future Study

The study focused on evaluating the RESET aviation maintenance program for the UH-60 Black Hawk fleet. It is expected that a significant similarity exists for the RESET programs for other Army helicopter fleets: CH-47 Chinook, AH-64 Apache, and OH-58 Kiowa. An equivalent study of each of these three aircraft fleets is expected to support the original hypothesis.

A potential area for study is a fatigue analysis for undiscovered cracks and/or corrosion for an operational deficiency of a major component of the helicopter such as drive train, main rotor head, or tail rotor head.

APPENDIX A

Survey of the U.S. Army RESET Aviation Maintenance Program

Confidentiality Disclosure: Participants remain anonymous in the questions of this survey. All answers will be kept confidential. Aviation maintenance personnel at four RESET sites are participating in this survey: Fort Campbell, Kentucky; Fort Hood, Texas; Fort Stewart, Georgia; and Fort Lewis, Washington. Information provided will be used to research the RESET Aviation Maintenance Program.

1. Place a check next to your present position:
   [ ] UH-60 Maintenance Test Pilot
   [ ] ACE Technical Inspector
   [ ] AVIM/AVUM supervisor of the production control of UH-60 maintenance

2. How many years of service do you have at your present position/duties?

   _____ years

Respond to the following statements using the scale below:

3. The RESET Aviation Maintenance Program provides a significant benefit to improve the safety UH-60 Helicopters returning from Afghanistan and/or Iraq theaters.
   a) strongly disagree b) disagree c) neutral d) agree e) strongly agree

4. The RESET Aviation Maintenance Program provides a significant benefit to improve the reliability UH-60 Helicopters returning from Afghanistan and/or Iraq theaters.
   a) strongly disagree b) disagree c) neutral d) agree e) strongly agree

5. The RESET Aviation Maintenance Program provides a significant benefit to improve the mission readiness UH-60 Helicopters returning from Afghanistan and/or Iraq theaters.
   a) strongly disagree b) disagree c) neutral d) agree e) strongly agree

6. The RESET Aviation Maintenance Program provides a significant benefit to improve the overall airworthiness condition for UH-60 Helicopters returning from Afghanistan and/or Iraq theaters.
   a) strongly disagree b) disagree c) neutral d) agree e) strongly agree

The survey is continued on the next page.

Respond to the following open-ended questions by writing in the space below:

7. What is the most significant reason for performing RESET maintenance for the UH-60 helicopter following deployment in Afghanistan and/or Iraq?

8. The RESET TB 1-1520-237-30-1 requires performance of a Phased Maintenance Inspection (PMI) according to TM 1-1520-237-PMI plus the special maintenance inspections that seek to address the deployed condition. Without the special inspections of RESET, would the Phased Maintenance Inspection alone be sufficient for the maintenance of UH-60 aircraft returning from Afghanistan and/or Iraq? Why or why not?

APPENDIX B

DEPARTMENT OF THE ARMY
US ARMY MEDICAL RESEARCH AND MATERIEL COMMAND
504 SCOTT STREET
FORT DETRICK, MD 21702-5012

MCMR-RP 11 February 2011

MEMORANDUM FOR THE RECORD

SUBJECT: Determination for the Protocol, "RESET Aviation Maintenance Program Study of US Army Aviation," Submitted by Kristopher Williams, Fort Campbell, KY, IRB Protocol Log Number M-10095

1. The subject protocol received on 24 January 2011 by the U.S. Army Medical Research and Materiel Command's Office of Research Protections Institutional Review Board Office (ORP IRBO) has been reviewed for applicability of human subjects protection.

2. The research involves an anonymous survey of maintenance supervisors, technical inspectors, and maintenance test pilots at Fort Stewart, GA, Fort Campbell, KY, Fort Hood, TX, and Fort Lewis, WA about their opinion of the RESET Aviation Maintenance Program on the safety, reliability, mission readiness, and overall airworthiness of U-60 helicopters following the aircrafts' return from service in theater.

3. The Western Kentucky Human Subjects Review Board (HSRB) determined on 13 January 2011 that the protocol is exempt research. In accordance with 32 CFR 219.101(b)(2), the ORP IRBO concurs that the protocol is exempt research, as it involves the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

4. No further review by the ORP IRBO is required.

5. The ORP IRBO point of contact for this review is the undersigned at DSN 343-7801.

KLINE.ANDREA.J.1021335750
Digitally signed by KLINE.ANDREA.J.1021335750
DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=KLINE.ANDREA.J.1021335750
Date: 2011.02.11 16:14:15 -05'00'

ANDREA J. KLINE, MS, CIP
Director, Institutional Review Board Office
Office of Research Protections

APPENDIX C

RDMR-TM-SD 15 April 2011

MEMORANDUM FOR PERSONNEL CONCERNED

SUBJECT: Request for Public Release Approval: "RESET Aviation Maintenance Program Study of US Army Aviation" FN5234

1. The Information Product "RESET Aviation Maintenance Program Study of US Army Aviation" was reviewed by AMRDEC personnel to ensure it met Technical, OPSEC, Military Critical Technologies List Determination, Foreign Disclosure, and Public Affairs requirements.

2. IAW AR Regulation 360-1 the Information Product was approved for Public Release and assigned DISTRIBUTION STATEMENT A: Approved for public release; distribution is unlimited.

3. The Information Product was assigned the Control Number: FN5234 and a copy of it and the review paperwork will be maintained in the Public Affairs office.

4. POC for this action is the undersigned.

MERVIN E. BROKKE
AMRDEC PAO

AMRDEC REQUEST REVIEW/APPROVAL FOR PUBLIC RELEASE
DISTRIBUTION STATEMENT A: "APPROVED FOR PUBLIC RELEASE; DISTRIBUTION IS UNLIMITED"

I. ORIGINATOR:

Signature on this document signifies awareness of and compliance with governing AR 360-1: The Army Public Affairs Program. Originator ensures the information product has been reviewed by or coordinated with the contracting officer, Project or Program Manager, or other external agency as required.

AUTHOR'S PRINTED NAME: _____ OFFICE ADDRESS: 308 Creey St. MS 55, Co
AUTHOR'S SIGNATURE: WILLIAMS.KRISTOPHER.B.1259248139
OFC SYMBOL: RDMR-AEM DATE: 4/12/2011
PHONE: 270-798-7957 FAX: 270-798-7983

II. IDENTIFICATION OF MATERIAL:

1. **Title:** RESET AVIATION MAINTENANCE PROGRAM STUDY OF U.S. ARMY AVIATION
2. **Type:**
   - [X] Paper or Briefing Presentation: Date: April 28, 2011 ; Location: Western Kentucky University
   - [ ] Technical/Special/Contractor Report
   - [ ] Abstract
   - [ ] Journal Article for Open Literature (Give Title of Journal): _____
   - [ ] Website (Note: Legal review is mandatory. Complete AMRDEC Public Release (PR) Legal Review Form)

III. MILITARILY CRITICAL TECHNOLOGY REVIEW RELEASE CRITERIA QUESTIONNAIRE

Please check a favored or not favored release analysis for each of the following criteria.

CRITERIA:	RELEASE FAVORED	RELEASE NOT FAVORED
1. TECHNOLOGY MATURITY: Is the nature of the information very theoretical or is it nearing application?	[X] Theoretical	[ ] Nearing application
2. TECHNOLOGY'S MILITARY VALUE: Is the information's military value great or small?	[X] Incremental improvements in reliability, maintainability or logistic support	[ ] Major improvements to weapons system performance, survivability, or countermeasure
3. TECHNOLOGY LEAD OR LAG: Is the U.S. the world leader in this technology area?	[X] U.S. not world leader	[ ] U.S. is world leader
4. TECHNOLOGY'S STATE OF THE ART: Does the information reflect the newest developments in the field?	[X] Old, public knowledge	[ ] Brand-new information
5. LEVEL OF TECHNICAL DETAIL: Does the document contain detailed, technical information?	[X] Vague, nonspecific general information	[ ] Detailed technical information

6. DOCUMENT ABSTRACT and KEY WORDS: Provide as an Attachment if Applicable

AMRDEC REQUEST REVIEW/APPROVAL FOR PUBLIC RELEASE
DISTRIBUTION STATEMENT A: "APPROVED FOR PUBLIC RELEASE; DISTRIBUTION IS UNLIMITED"

IV. TECHNICAL REVIEW:

Subject material has been reviewed and determined to be factual and unclassified and to contain no copyrighted material. The subject material has been reviewed for originality and uniqueness and this information has been found:

☐ Not to contain original and unique material.

☒ To contain original or unique material not of a patentable nature (e.g., scholarly work).

☐ To contain original and unique material and requires Legal review. (Complete AMRDEC PR Legal Review Form)

"I, the undersigned, certify that I have sufficient technical expertise in the subject matter of this material and that, to the best of my knowledge, it is technically accurate. I recommend that the attached material be (☒) approved / (☐) approved with changes as noted below / (☐) disapproved for public release and returned to Originator."

SIGNATURE: _____ NAME: James J. Shamess DATE: 13 April 2011
OFC SYMBOL: RDMR-AEM TITLE: Chief, Aircraft Support Branch PHONE: (361) 961-3990

V. OPSEC REVIEW:

"I, the undersigned, am aware of the hostile intelligence interest in open-source publications and the subject matter of the information I have reviewed for OPSEC purposes. I certify that I have sufficient security expertise in the subject matter of this material and that, to the best of my knowledge, the net benefit of this public release outweighs the potential damage to the essential secrecy of all related HQS, RDECOM/PEO/PM; USAMC, DA or other DOD programs of which I am aware. I conducted an OPSEC review of the enclosed material and found no classified or sensitive unclassified information. I recommend that the attached material be (☒) approved / (☐) approved with changes as noted below / (☐) disapproved for public release and returned to Originator."

SIGNATURE: _____ NAME: David B Cripps DATE: 13 April 2011
OFC SYMBOL: RDMR-AE TITLE: Deputy Director, AED PHONE 256 313 8403

VI. MILITARILY CRITICAL TECHNOLOGIES LIST (MCTL) DETERMINATION REVIEW:

It is recommended that the attached material be (☑) approved since the subject matter does not concern the technology items of the MCTL or (☐) approved since the subject matter relates to _____ and does not relate to technologies of _____ as covered in MCTL paragraph _____.

SIGNATURE: _____ NAME: MARK Lewis DATE: 15 APR 11
OFC SYMBOL: RDMR-SS TITLE: Sctv MGR PHONE 256-842-7403

VII. AMRDEC INTELLIGENCE AND SECURITY DIVISION REVIEW:

It is recommended that the attached material be (☑) approved / (☐) approved with changes as noted below / (☐) disapproved for public release.

SIGNATURE: _____ NAME: CLARK Lewis DATE: 15 APR 11
OFC SYMBOL: RDMR-SS TITLE: FSO, AMRDEC PHONE 256-842-7403

VIII. AMRDEC PUBLIC AFFAIRS OFFICE REVIEW: CONTROL NO. FN5234

The attached information is (☐) approved / (☒) approved as amended / (☐) disapproved for public release.

SIGNATURE: _____ NAME: Ellen Brooks DATE: 15 Apr 2011
OFC SYMBOL: RDMR-TM-SD TITLE: AMRDEC PAO PHONE 256.313.5742

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