ESTIMATE OF THE ANNUAL IMPACT OF CORROSION ON AVAILABILITY OF ARMY AVIATION WEAPON SYSTEMS

REPORT OSD13T2

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LMI

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LMI

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Executive Summary

LMI was tasked by the Corrosion Prevention and Control Integrated Product Team (CPC IPT) in May 2010 to measure corrosion's impact on the availability of all Department of Defense aviation weapon systems. This report estimates corrosion-related aircraft availability effects for Army aviation systems.

Using FY2008 and FY2009 as a measurement baseline, we estimated the annual corrosion availability impact for Army aviation systems to be 1.72 million non-available hours for all Army aviation assets. This number represents approximately 16 percent of the total non-availability of 10.74 million hours reported by the Army for its aviation weapon systems.[1] This percentage equates to an average of 17 days of corrosion-related non-availability per year for each aircraft.

When retraining aircraft and aviation weapon systems that are part of a reset or recap/rebuild program are removed, the total corrosion-related non-available hours are 1.57 million. This number represents 16 percent of the 9.76 million non-available hours the Army reported for these aircraft.

Our review of Army aviation assets is part of a multiple-year plan to measure the impact of corrosion on cost and availability. This is the first of the availability studies for Army aviation assets. Table ES-1 lists past and future cost studies, and Table ES-2 lists availability studies.[2]

[1] LMI based the Army's non-availability figures on FY2009 as that was the most recent year for which study data were available. The total corrosion-related non-available hours is measured in a way consistent with how the Army reports its not-mission-capable (NMC) time.

[2] DoD funded these studies.

Table ES-1. DoD Studies on the Cost of Corrosion

Study year[a]	Study segment	Annual cost of corrosion	Data baseline
2005–2006	Army ground vehicles	$2.0 billion	FY2004
	Navy ships	$2.4 billion	FY2004
2006–2007	DoD facilities and infrastructure	$1.8 billion	FY2005
	Army aviation and missiles	$1.6 billion	FY2005
	Marine Corps ground vehicles	$0.6 billion	FY2005
2007–2008	Navy and Marine Corps aviation	$2.6 billion	FY2005 and FY2006
	Coast Guard aviation and vessels	$0.3 billion	FY2005 and FY2006
2008–2009	Air Force	$5.7 billion	FY2006 and FY2007
	Army ground vehicles	$2.4 billion	FY2006 and FY2007
	Navy ships	$2.5 billion	FY2006 and FY2007
	DoD—other equipment	$5.1 billion	FY2006
2009–2010	Marine Corps ground vehicles	$0.5 billion	FY2007 and FY2008
	DoD facilities and infrastructure	$1.9 billion	FY2007 and FY2008
	Army aviation and missiles	$1.4 billion	FY2007 and FY2008
2010–2011	Air Force	$4.5 billion	FY2008 and FY2009
	Navy and Marine Corps aviation	$2.6 billion	FY2008 and FY2009
2011–2012	Army ground vehicles and Navy ships	Pending	FY2008–FY2010
2012–2013	Repeat 2009–2010 schedule	Pending	FY2009–FY2011

[a] Study period is 1 calendar year.

Table ES-2. DoD Studies on the Effect of Corrosion on Availability

Study year[a]	Study segment	Annual non-available time attributable to corrosion	Avg. non-availability per aircraft attributable to corrosion	Data baseline
2010–2011	Army aviation	1,717,898 hours	17.4 days	FY2008 and FY2009
	Navy and Marine Corps aviation	95,237 days	26.5 days	FY2008 and FY2009
	Air Force	2,102,476 hours	15.9 days	FY2008 and FY2009
2011–2012	Army ground vehicles	Pending	Pending	FY2008–FY2010
	Marine Corps ground vehicles	Pending	Pending	FY2008–FY2010

[a] Study period is 1 calendar year.

Our estimate of corrosion's effect applies to 56 types of Army aviation weapon systems, including 10 different models of engines. The scope of the study included an average inventory of 4,108 aircraft.

We stratified the corrosion-related non-availability for Army aviation weapon systems by type, model, and series (TMS); total non-available hours; and non-available hours per item. We then ranked the top 10 systems for total corrosion non-available hours and average corrosion non-available hours. The order in which Table ES-3 lists aircraft suggests a priority for the Army to further examine those aircraft from a corrosion-related non-availability standpoint.

Table ES-3. Highest Combined Rankings for Total Corrosion-Related Non-Available Hours and Average Corrosion-Related Non-Available Hours per Aircraft, FY2009

Line item number	Description	Total corrosion-related non-availability		Avg. per-aircraft corrosion-related non-availability		Combined rank score	Overall rank
		Hours	Rank	Hours	Rank		
K31795	Helicopter utility UH-1H	144,085	6	1,022	1	7	1
K32293	Helicopter utility UH-60A	431,104	1	501	8	9	2
K31042	Helicopter observation OH-58A	119,978	7	645	3	10	3
A21633	Helicopter observation OH-58D	175,675	4	537	7	11	4
H30517	Helicopter cargo transport CH-47D	168,519	5	556	6	11	4
H31110	Helicopter observation OH-58C	67,113	9	664	2	11	4
H48918	Helicopter attack AH-64D	217,188	2	416	10	12	7
H28647	Helicopter attack AH-64A	76,434	8	602	5	13	8
H30616	Helicopter electronic countermeasure EH-60A	34,080	10	620	4	14	9
H32361	Helicopter utility UH-60L	179,385	3	313	13	16	10

In FY2009, the UH-1H utility helicopter had the highest average corrosion-related non-available hours per aircraft and the sixth highest total corrosion-related non-available hours for Army aviation, making it the greatest contributor of corrosion-related non-available hours from a combined-ranking standpoint.

Three of the top six aircraft from a combined-ranking standpoint in Table ES-3 are from the OH-58 family.

Nearly three-fourths of the corrosion-related NMC hours can be attributed to preventive maintenance. In Table ES-4, we show a breakdown of the non-available hours attributable to preventive maintenance. Inspection is by far the biggest contributor to total corrosion-related non-available hours.

Table ES-4. Total Preventive Corrosion-Related, Non-Available Hours by Activity, FY2009

Activity	Number of total preventive, non-available hours	Percentage of total preventive, non-available hours
Inspections and testing	527,937	32.2
Cleaning	199,648	95.0
Treatment	191,068	89.0
Preservation	55,666	53.7
All preventive activity	1,240,544	100.0

An opportunity may exist to reduce the NMC hours attributable to preventive maintenance actions by examining how inspections, tests, and quality assurance checks are performed.

Contents

Figures

Tables

Chapter 1
Background and Analysis Method

Congress, concerned with the high cost of corrosion, enacted legislation in December 2002 that assigned the Office of the Under Secretary of Defense for Acquisition, Technology and Logistics (USD[AT&L]) with the policy and oversight responsibilities for preventing and mitigating the effects of corrosion on military equipment and infrastructure.[1] To perform its mission of preventing and mitigating corrosion, fulfilling congressional requirements, and responding to Government Accountability Office (GAO) recommendations, the USD(AT&L) established the Corrosion Prevention and Control Integrated Product Team (CPC IPT), a cross-functional team of personnel from all the military services as well as representatives from private industry.

In response to a GAO recommendation to "develop standardized methodologies for collecting and analyzing corrosion cost, readiness, and safety data,"[2] the CPC IPT created standard methods to measure both the cost[3] and availability[4] impact of corrosion for DoD's military equipment and infrastructure.

In April 2006, the CPC IPT announced the results of the first corrosion cost study,[5] which used the standard corrosion cost estimation method. More recently, LMI was tasked by the CPC IPT with measuring both the corrosion-related cost for Air Force and Navy and Marine Corps aviation assets and the effect of corrosion on weapon system availability for all DoD aviation assets. We used data from FY2008 and 2009 to conduct these studies. We present the results of the cost studies in Table 1-1 and present the results of the availability studies in Table 1-2.

The current annual cost of corrosion for DoD is $20.9 billion. We derived this total by aggregating the most recent cost of each study segment (less the 2007–2008 totals from the Coast Guard aviation and vessels study).[6]

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[1] *The Bob Stump National Defense Authorization Act for Fiscal Year 2003*, Public Law 107-314, 2 December 2002, p. 201; Public Law 107-314 was enhanced by Public Law 110-181, *The National Defense Authorization Act for Fiscal Year 2008*, Section 371, 28 January 2008.

[2] GAO, *Opportunities to Reduce Corrosion Costs and Increase Readiness*, GAO-03-753, July 2003, p. 39.

[3] LMI, *Proposed Method and Structure for Determining the Cost of Corrosion for the Department of Defense*, Report SKT40T1, Eric F. Herzberg, August 2004.

[4] DoD CPC IPT, *The Impact of Corrosion on the Availability of DoD Weapon Systems and Infrastructure*, October 2009.

[5] LMI, *The Annual Cost of Corrosion for Army Ground Vehicles and Navy Ships*, Report SKT50T1, Eric F. Herzberg et al., April 2006.

[6] We disregarded the Coast Guard aviation and vessels total of $0.3 billion in this study, because they are part of the Department of Homeland Security.

Table 1-1. DoD Studies on the Cost of Corrosion

Study year[a] baseline	Study segment	Annual cost of corrosion	Data
2005–2006	Army ground vehicles	$2.0 billion	FY2004
	Navy ships	$2.4 billion	FY2004
2006–2007	DoD facilities and infrastructure	$1.8 billion	FY2005
	Army aviation and missiles	$1.6 billion	FY2005
	Marine Corps ground vehicles	$0.6 billion	FY2005
2007–2008	Navy and Marine Corps aviation	$2.6 billion	FY2005 and FY2006
	Coast Guard aviation and vessels	$0.3 billion	FY2005 and FY2006
2008–2009	Air Force	$5.7 billion	FY2006 and FY2007
	Army ground vehicles	$2.4 billion	FY2006 and FY2007
	Navy ships	$2.5 billion	FY2006 and FY2007
	DoD—other equipment	$5.1 billion	FY2006
2009–2010	Marine Corps ground vehicles	$0.5 billion	FY2007 and FY2008
	DoD facilities and infrastructure	$1.9 billion	FY2007 and FY2008
	Army aviation and missiles	$1.4 billion	FY2007 and FY2008
2010–2011	Air Force	$4.5 billion	FY2008 and FY2009
	Navy and Marine Corps aviation	$2.6 billion	FY2008 and FY2009
2011–2012	Army ground vehicles and Navy ships	Pending	FY2008–FY2010

[a] Study period is 1 calendar year.

Table 1-2. DoD Studies on the Effect of Corrosion on Availability

Study year[a]	Study segment	Annual non-availability due to corrosion	Average per-aircraft annual non-availability due to corrosion	Data baseline
2010–2011	Army aviation	1,717,898 hours	17.4 days	FY2008 and FY2009
	Navy and Marine Corps aviation	95,237 days	26.5 days	FY2008 and FY2009
	Air Force	2,102,476 hours	15.9 days	FY2008 and FY2009
2011–2012	Army ground vehicles	Pending	Pending	FY2008–FY2010
	Marine Corps ground vehicles	Pending	Pending	FY2008–FY2010

[a] Study period is 1 calendar year.

The corrosion-related cost studies for DoD aviation assets (2009–10 for Army, and 2010–11 for Air Force and Navy and Marine Corps) were follow-on efforts of previously studied segments. The availability studies are initial efforts to quantify the effect corrosion has on weapon system availability. Future cost and availability studies will produce updates to help the services identify trends over time.

This report presents the results of the Army aviation portion of the availability impact of corrosion study.

STUDY OBJECTIVES

We had two specific objectives for this study:

- Measure the most recent corrosion-related effect on availability for Army aviation assets.
- Identify corrosion-related availability improvement opportunities for Army aviation assets.

ANALYSIS METHOD

We applied the same analysis methods to Army aviation assets as those outlined in the original corrosion reports we produced for the CPC IPT. For the sake of brevity, we provide only a short description of those methods in this report. Chapter 2 of *The Impact of Corrosion on the Availability of DoD Weapon Systems and Infrastructure*[7] contains more information on how we measured the effect of corrosion on availability.

To ensure consistency, we used the definition of corrosion that Congress developed: "The deterioration of a material or its properties due to a reaction of that material with its chemical environment."[8] We have applied this definition of corrosion to each corrosion study.

Our estimation method for availability impact segregates maintenance activities by their source and nature, using the following three schemas:[9]

1
- *Depot*—corrosion non-available hours incurred while performing depot maintenance, or DM
- *Field*—corrosion non-available hours incurred while performing organizational or intermediate maintenance, referred to as field-level maintenance, or FLM

2
- *Corrective*—corrosion non-available hours incurred while addressing an existing corrosion problem
- *Preventive*—corrosion non-available hours incurred while addressing a potential future corrosion issue

3
- *Structure*—direct corrosion non-available hours incurred by the body frame of a system or end item
- *Parts*—direct corrosion non-available hours incurred by a removable part of a system or end item.

[7] LMI, *The Impact of Corrosion on the Availability of DoD Weapon Systems and Infrastructure*, Report DL907T1, Eric F. Herzberg, October 2009.

[8] *Bob Stump*, p. 202.

[9] According to the ISO 9000:2000 definition of corrective and preventive actions, preventive costs involve steps taken to remove the causes of potential nonconformities or defects. Preventive actions address future problems. Corrective actions address actual problems. Corrective costs are incurred when removing an existing nonconformity or defect.

Summary of Availability Methodology

To estimate the corrosion impact on availability, we used a combined top-down and bottom-up approach. For the top-down portion, we used monthly reporting of not-mission-capable hours by the Army for each individual aircraft. This approach established a maximum total for corrosion-related non-available hours in each maintenance area.

For the bottom-up portion, we used detailed work order records to aggregate actual occurrences of corrosion maintenance activities. We identified those records that accounted for the reported top-down, non-available hours within the bottom-up data. We aggregated the corrosion-related non-available hours associated with only these maintenance records. This approach established a minimum level of corrosion-related non-availability in each activity area. Where necessary, we used statistical methods to bridge any significant gaps between the top-down and bottom-up figures and derived a final estimate for the impact of corrosion on non-availability in each area of maintenance.

In terms of corrosion-related costs, it is useful to determine the ratio between corrective costs and preventive costs. Over time, it is usually more expensive to fix a problem than it is to prevent a problem. But it is also possible to overspend on preventive measures. Classifying maintenance records into corrective and preventive maintenance helps decision makers strike the appropriate balance between the two categories and minimize the overall cost of corrosion.

It is also useful to determine the relationship between the corrosion-related spending and availability (see Figure 1-1).

Figure 1-1. The Relationship between Spending on Corrosion-Related Maintenance and Availability

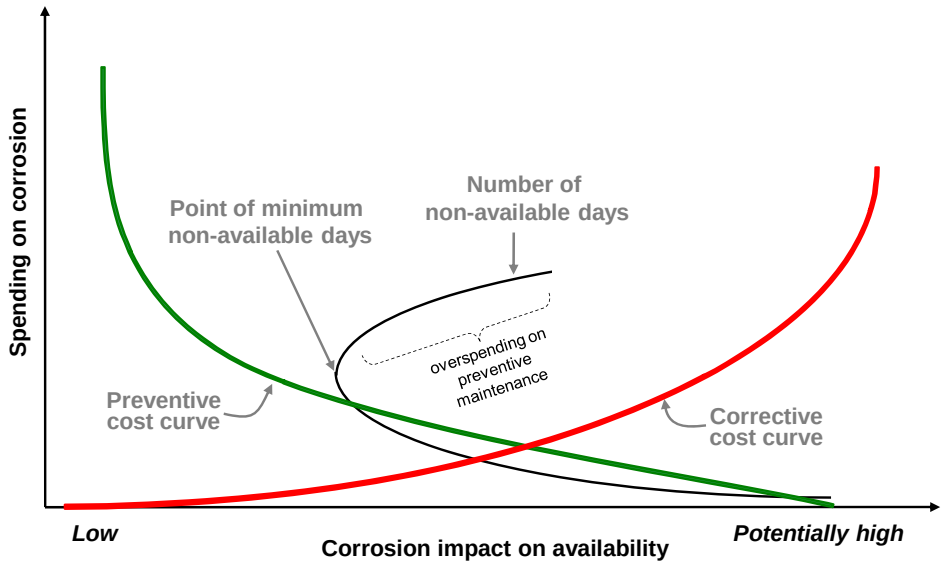


Figure 1-1 displays two relationships. The first is the relationship between preventive maintenance spending and corrective maintenance spending. This is typically an inverse relationship; the higher the amount of spending on preventive measures, the lower the corrective corrosion spending will be. The amount of preventive spending drives the resultant corrective actions.

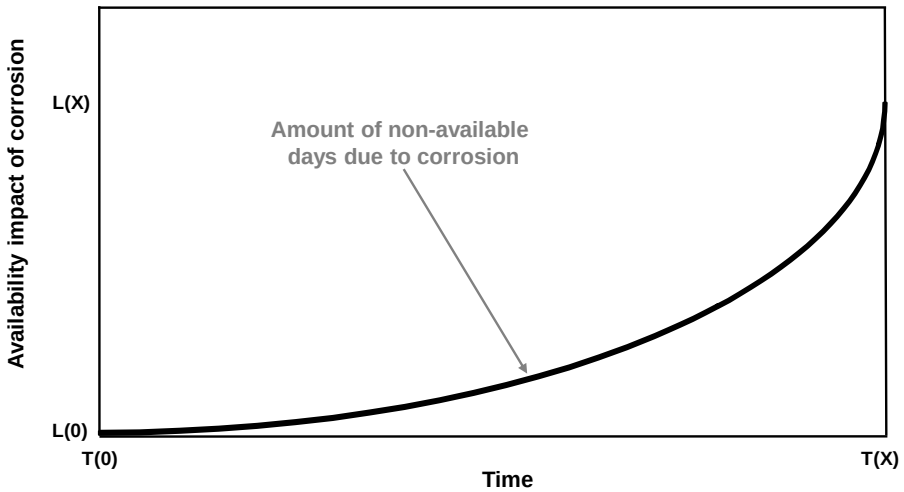
The second relationship is the amount of corrosion-related spending and its effect on availability. An extreme amount of spending on preventive measures that do not result in a reduction of corrective maintenance actions will have an overall negative impact on availability. This is similar to changing the oil in a car every month. The excessive amount of preventive maintenance has only a negligible effect on improving the reliability of the car's engine, but it reduces the car's availability while the maintenance is performed.

Of course, spending too little on preventive measures will eventually result in greater corrective corrosion-related spending. This, too, can have a negative effect on availability. This is only a potential negative impact, because organizational units could increase their efficiency when dealing with unplanned corrective requirements, or they could take exceptional measures—such as working an extensive amount of unplanned maintenance hours—to minimize the availability impact of corrective corrosion actions.

The point of minimum non-available days on the curve in Figure 1-1 represents a theoretically optimum preventive to corrective maintenance ratio.

It is also useful to examine the availability-related effects of not spending on corrosion. Figure 1-2 shows the effect on availability of not spending any maintenance funds for corrosion. This initial impact is minimal; however, over time, as corrosion starts to degrade all aircraft at the same time, the negative effect on availability accelerates.

Figure 1-2. Availability over Time at Zero Corrosion-Related Spending



Notes: L(0) = initial level of corrosion impact on availability; L(x) = level of corrosion impact on availability at time interval *x*; T0 = start time; T(*x*) = time interval *x*.

Study Method Limitations

The combined top-down and bottom-up approach, although a useful and comprehensive estimating technique, has its limitations. The most significant of these being a lack of detailed descriptions and encoding, gaps in available data, and lack of commercial depot records.

Lack of Detailed Text Descriptions and Coding

To find corrosion-related maintenance records, we searched both the manually entered corrective action descriptions and the malfunction and maintenance action codes within the data records. Although Army maintenance records contain a number of the necessary data elements to conduct this analysis, they do not contain malfunction codes. In addition, some maintenance records have an insufficient amount of descriptive text, which makes determining the corrosion relationship for each data record more challenging, although not impossible.

Data Gaps

Although we made every effort to accumulate as many of the bottom-up records as possible, gaps exist between the top-down reporting and bottom-up totals. Scaling the bottom-up totals to account for the top-down to bottom-up gaps assumes the gap is represented by the existing bottom-up data. In other words, the gap is assumed to be randomly distributed across the existing data.

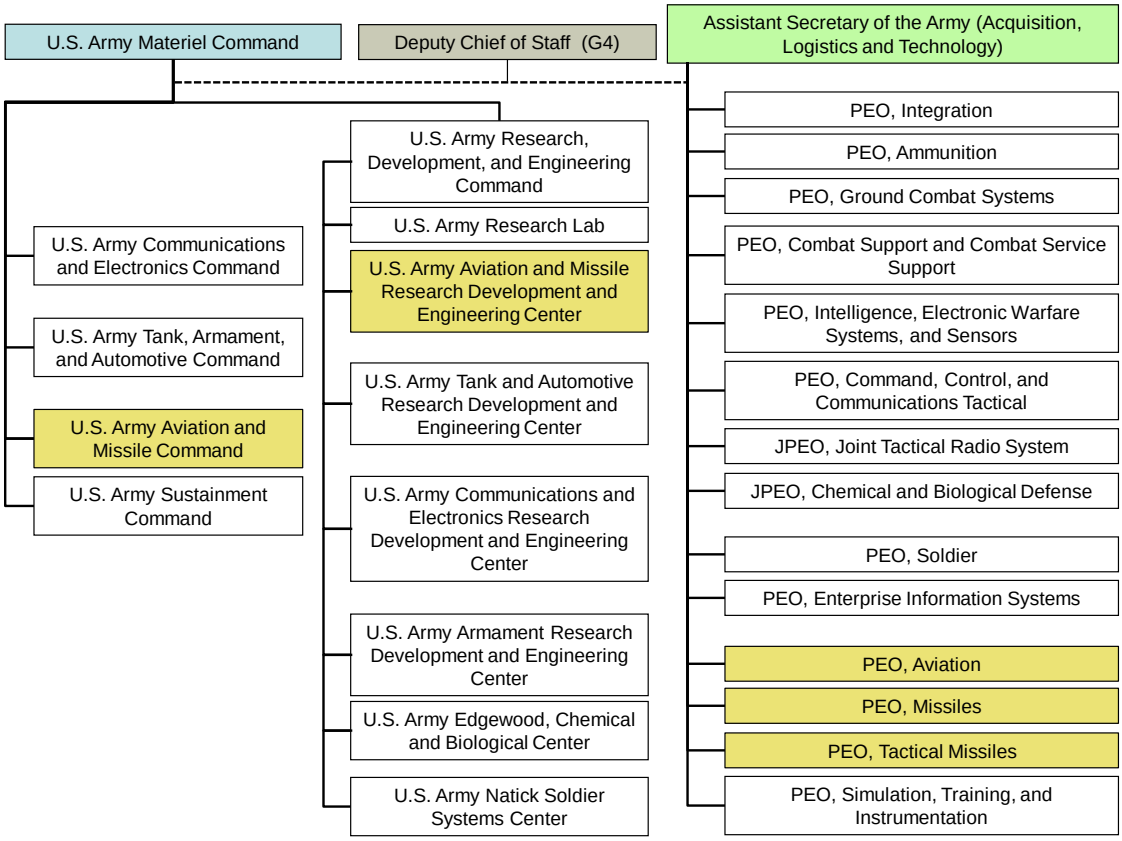
Lack of Commercial Depot Bottom-Up Records

No commercial depot bottom-up records are available for Army aviation. Therefore, we applied the results from the organic depot analysis to the total reported non-availability attributed to DM (both commercial and organic). Because a portion of the reported non-availability is attributable to commercial DM, a possible shortcoming exists if commercial depots perform their maintenance in a wholly different method than the Army depot, or if the type of equipment the depot maintains is systemically different.

Army Aircraft Organization

Figure 1-3 shows the organizations (highlighted in yellow) that play a major role in the acquisition and sustainment of Army aviation and missile systems.

Figure 1-3. Army Organizations with a Major Role in Acquisition and Sustainment of Aviation and Missile Systems



Source: Dr. Roger Hamerlinck, Office of the Assistant Secretary for Acquisition, Logistics and Technology—Business Operations.

Note: JPEO = joint program executive office; PEO = program executive office.

The U.S. Army Materiel Command (AMC) is the Army organization with the overall responsibility for sustaining fielded weapon systems, procuring replacement components for those systems, and maintaining readiness of all Army equipment.

The U.S. Army Aviation and Missile Life Cycle Management Command (AMCOM LCMC), a subordinate organization of the AMC, establishes maintenance policy regarding the sustainment of aviation platforms and associated systems (e.g., aviation life support equipment, ground support equipment, and weapon and target acquisition systems).[10]

[10] The AMC organization chart, dated 4 January 2006, reflects the life-cycle management commands.

The Research, Development, and Engineering Command (RDECOM)—specifically, its subordinate unit, the Aviation-Missile Research, Development, and Engineering Center (AMRDEC)—provides aviation-related research, development, and engineering support. RDECOM is also a subordinate unit of AMC.

The office of the Assistant Secretary of the Army for Acquisition, Logistics, and Technology (ASA[ALT]) is responsible for developing, acquiring, and fielding new weapon and support systems. The ASA(ALT), which is also the Army Acquisition Executive (AAE), provides oversight of these acquisition programs via an organizational structure of program executive offices (PEOs) and associated program managers (PMs). The PEOs and PMs draw engineering and sustainment expertise from the Army Materiel Command as matrix support. The AMC includes research, development, and engineering centers (RDECs) and life-cycle management commands (LCMCs). Together, PEOs and PMs and the RDECs and LCMCs address the entire life cycle of aviation and missile equipment.

Aviation Maintenance Structure

The Army generally categorizes existing aviation maintenance as either sustainment[11] maintenance or FLM.

- Sustainment maintenance consists of maintenance functions formerly known as general support (GS) and depot operations of the Army maintenance system and Army-wide program for commodity-unique maintenance.[12] Figure 1-4 highlights the aviation depot at Corpus Christi (in gray shading). Sustainment is the more comprehensive and most complex repair work performed by civilian artisans at either a government-owned and -operated Army facility (an organic depot) or a commercial contractor facility.

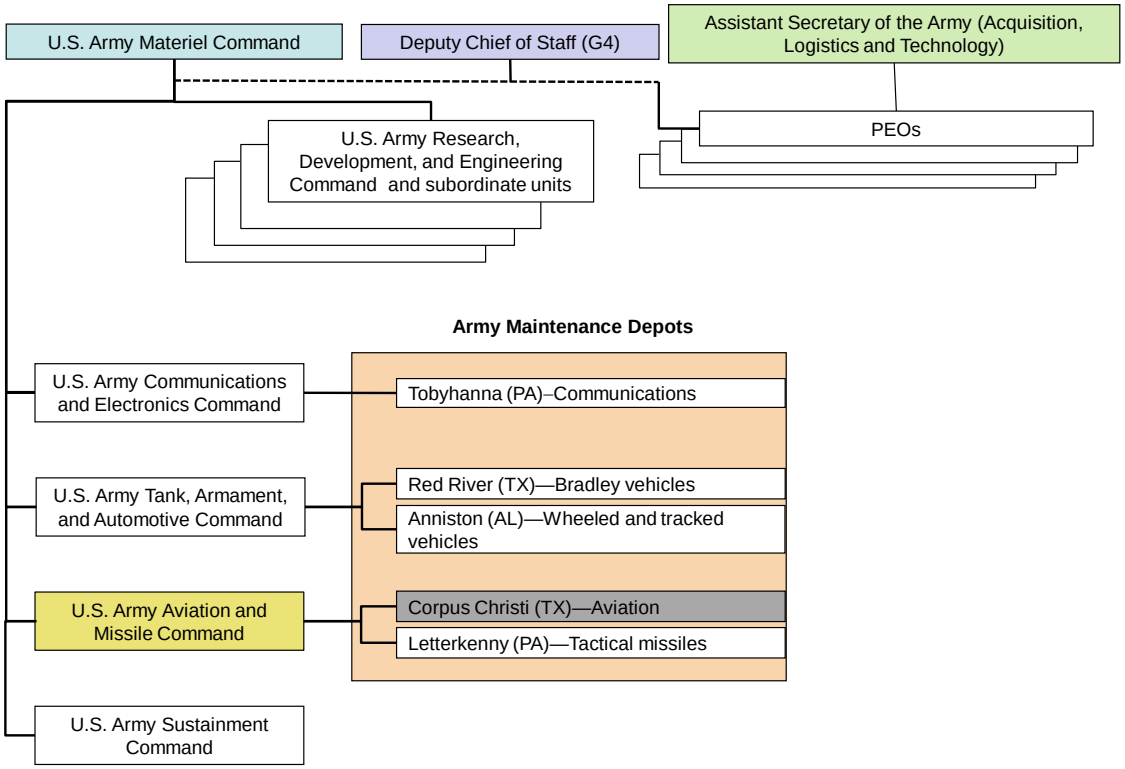
- FLM consists of maintenance functions formerly known as operator or crew (as in equipment operators and vehicle crews), unit, and direct support. FLM involves the daily care and upkeep of aviation weapon systems as the Army uses them in an operational environment. This care includes on-platform, at-platform, and many off-platform component repairs.

Operating units and in-theater intermediate organizations perform FLM. These capabilities can be quite extensive and include remove-and-replace operations for major components and subcomponents. Army FLM is performed at hundreds of different posts, camps, and stations throughout the world.

[11] We use the maintenance terms “sustainment” and “depot” synonymously. We refer to the activities associated with this category of maintenance as DM. The primary aviation maintenance depot, located in Corpus Christi, Texas, is a subordinate organization to the AMCOM LCMC.

[12] Definition provided by Dr. Roger Hamerlinck, Office of the Assistant Secretary for Acquisition, Logistics and Technology—Business Operations.

Figure 1-4. Organizational Structure with DM Responsibility



Source: Dr. Roger Hamerlinck, Office of the Assistant Secretary for Acquisition, Logistics and Technology—Business Operations.

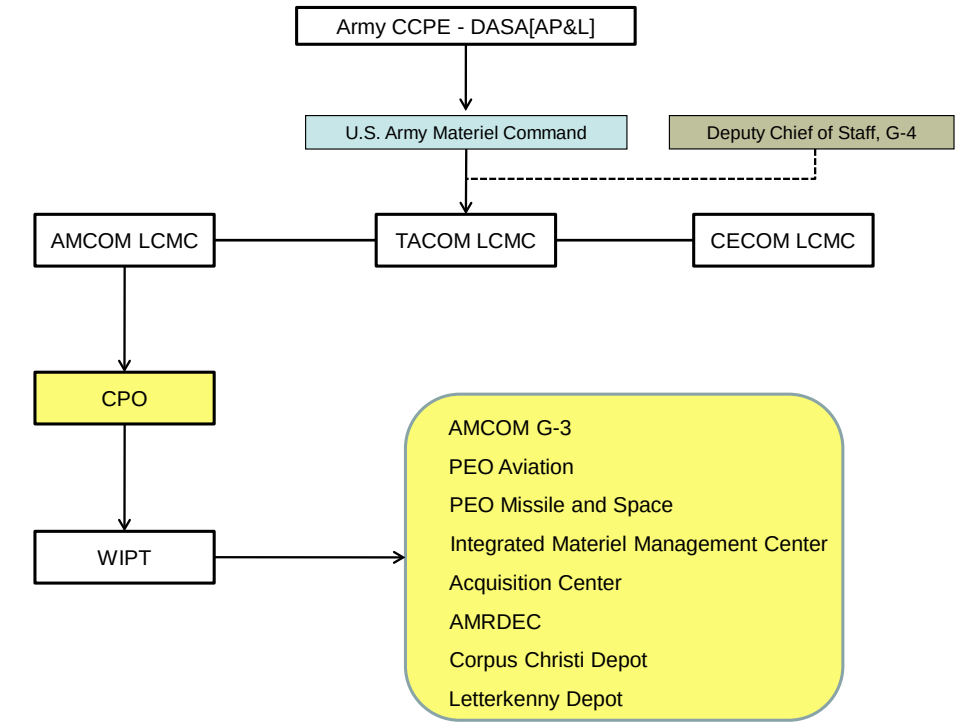
Corrosion Organization

The National Defense Authorization Act for 2009, Section 905, "Corrosion Control and Prevention Executives (CCPE) for the military departments," requires that each military department designate a CCPE. The legislation also lists specific responsibilities for those designees. In January 2009, the Army appointed a corrosion executive. The Deputy Assistant Secretary of the Army for Acquisition Policy and Logistics (DASA[AP&L]) holds that position, working within the Office of the ASA(ALT).

Figure 1-5 depicts the Army aviation and missile corrosion organization.[13] The Aviation and Missile Corrosion Program Office (CPO) is part of the AMCOM LCMC. The CPO hosts a working integrated product team (WIPT) of technical experts and stakeholders, which develops action plans to mitigate and prevent the effects of corrosion on aviation and missile equipment.

[13] Organizational diagram from presentation at Army Corrosion Control Summit, *Aviation and Missile Corrosion Prevention and Control*, 10 February 2010, Robert Herron, p. 12.

Figure 1-5. AMCOM LCMC Corrosion Organization



Note: TACOM = Tactical Army Command; CECOM = Communications Electronics Command.

The CPO has the following three goals:

- Ensure the Army considers corrosion prevention and control as a key element of every aviation and missile acquisition. It directly participates in and supports the mandated corrosion prevention action team for each new acquisition.

- Support overseas contingency operations by getting corrosion prevention and control technology into the hands of the warfighter. The program administrators actively participate in the efforts of the joint community to identify proven corrosion prevention and control technologies and provide these technologies to Army aviation and missile weapon systems through field application demonstrations. These technologies are low risk, in that they do not require development lead times.

- Seek to reduce the cost of ownership and maintenance while increasing safety for soldiers. The program addresses improved maintenance practices and procedures for aviation and missile weapon systems.

Aviation Weapon System List

The scope of this study includes all Army aviation end items and major subcomponents in the inventory during FY2009. Fifty-six types of aircraft existed at the type, model, and series (TMS) level of detail, totaling 4,108 aircraft and more than 50,000 major aircraft subcomponents.

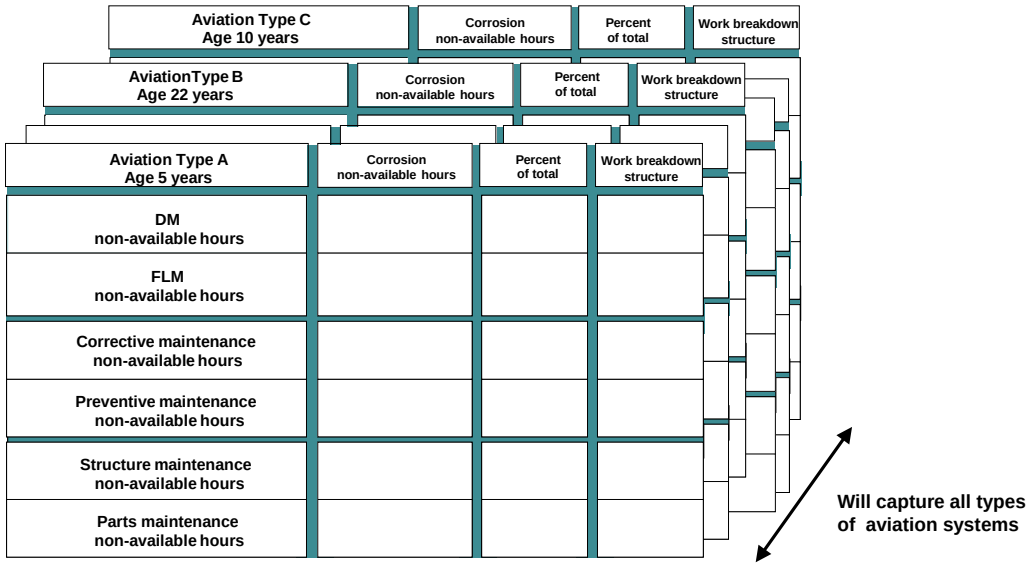
We compiled inventories for Army aviation equipment at the line-item-number (LIN) level of detail, using data extracted from the Army's Readiness Integrated Database (RIDB) contained in the Army Logistics Information Warehouse (LIW). The AMC Logistics Support Activity maintains the LIW and provides online access to Army wholesale and retail asset accountability databases.

In Appendix A, we provide a complete listing of all Army aviation equipment we accounted for in this study.

DATA STRUCTURE AND ANALYSIS CAPABILITIES

To accommodate the anticipated variety of decision makers and data users, we designed a corrosion impact data structure that maximizes analysis flexibility. Figure 1-6 illustrates this data structure and our different methods of analysis.

Figure 1-6. Data Structure and Methods of Analysis



Using this data structure, we were able to analyze all available data against the following:

- Equipment type
- Age of equipment

- Corrective versus preventive cost
- DM or FLM
- Structure versus parts
- Work breakdown structure (WBS).[14]

Any of these data structures can be combined with another to create a new analysis category. For example, we can isolate the corrective corrosion-related NMC hours for FLM on the airframe as compared to all avionics subsystems.

CURRENT ARMY AVAILABILITY REPORTING

The Army reports aircraft availability data in terms of the aircraft either being fully mission capable (FMC), mission capable (MC), partially mission capable (PMC), or not mission capable (NMC). The definitions of each are as follows:[15]

- Any piece of military equipment, aircraft, or training device is FMC if its material condition indicates that it can perform all of its missions.
- An aircraft is MC if its material condition indicates it can perform at least one, and potentially all, of its designated missions.
- An aircraft or training device is PMC if its material condition indicates it can perform at least one, but not all, of its missions.
- A system or piece of equipment is NMC if its material condition indicates it is not capable of performing any of its assigned missions because of maintenance or other requirements.

Maintenance issues that cause an aircraft to enter NMC status are the most important and require the focus of resources, because they prevent the aircraft from accomplishing any of its missions. For the purposes of this study, we focused on the MC rate, the NMC hours, and the causes for the Army to place an aircraft into NMC status.

The Readiness Integrated Database contains Army availability reporting data. The Army reported 10,741,072 hours of NMC time for its aviation weapon systems in FY2009. The average NMC figure of 2,614 hours per aircraft equates to roughly 109 days per aircraft for the year.

Table 1-3 summarizes total and average NMC time in hours for the 20 Army aircraft with the largest average inventory.

[14] Work breakdown structure coding determines the aircraft subsystem on which the Army is performing work. Chapter 2 further details the Army aircraft WBS.

[15] *Dictionary of Military and Associated Terms*, U.S. Department of Defense, 2005.

Table 1-3. Total and Average NMC Hours for the 20 Army Aircraft with the Highest Average Aircraft Inventory in FY2009

LIN	Nomenclature	No. of Army-reported aircraft (avg.)	Total Army-reported NMC hrs.	NMC hrs. per aircraft (avg.)
K32293	Helicopter utility UH-60A	861	2,243,000	2,605
H32361	Helicopter utility UH-60L	573	1,129,907	1,972
H48918	Helicopter attack AH-64D	522	1,165,823	2,233
A21633	Helicopter observation OH-58D	327	718,663	2,198
H30517	Helicopter cargo transport CH-47D	303	911,145	3,007
K31042	Helicopter observation OH-58A	186	547,506	2,944
H32611	Helicopter flight training TH-67A	183	346,030	1,891
K31795	Helicopter utility UH-1H	141	625,908	4,439
H28647	Helicopter attack AH-64A	127	375,045	2,953
H31110	Helicopter observation OH-58C	101	237,454	2,351
H32429	Helicopter utility UH-60M	84	113,907	1,356
H31872	Helicopter utility UH-1V	75	311,324	4,151
H31329	Helicopter light utility UH-72A	62	50,433	813
BA108Q	Airplane, cargo transport C-12U	62	70,055	1,130
H30616	Helicopter electronic countermeasure EH-60A	55	159,830	2,906
C15172	Helicopter cargo transport CH-47F	52	77,105	1,483
NL0162	Helicopter special operations MH-6M	51	82,953	1,627
Z01054	Helicopter cargo MH-47G	48	116,754	2,432
NL0067	Helicopter special operations MH-60L	37	69,390	1,875
NL0221	Airplane cargo C-23C	31	29,927	965
Total—all aircraft		4,108	10,741,072	2,614

As Table 1-3 shows, the Army reported an average of 2,614 NMC hours per aircraft for FY2009. Although the UH-60A has the highest total NMC hours, more than 2.2 million hours, its average of 2,605 NMC hours per aircraft is actually below the overall Army average. This is because the UH-60A also represents the largest aviation inventory for the Army. The UH-1H utility helicopter has the highest average NMC hours per aircraft, with 4,439 hours. The UH-1V utility helicopter has the second highest average per-aircraft NMC hours at 4,151 hours. The UH-72A light utility helicopter has the lowest average NMC hours per aircraft (813 hours).

The aircraft inventory we used in the availability analysis (4,108) is the average number of aircraft reported by the Army for non-availability in FY2009.

NMC Reporting Calculations

If an aircraft is reported as NMC, the Army differentiates the non-availability it reports as being caused either by maintenance (M) or supply (S). The service designates NMC hours caused by maintenance as NMCM, and those caused by supply as NMCS.

The Army further breaks down each of these categories into maintenance or supply non-availability at the organizational level (ORG) and at the intermediate or support (SPT) level. The NMCM category has a further classification of non-availability hours for DM. Table 1-4 lists the schema for these reporting categories.

Table 1-4. Army Aviation NMC Reporting Metrics

Mission capable (MC)	Not mission capable (NMC) NMC–Supply (NMCS) NMC–Supply Organizational (NMCS ORG) NMC–Supply Support (NMCS SPT) NMC–Maintenance (NMCM) NMC–Maintenance Organizational (NMCM ORG) NMC–Maintenance Support (NMCM SPT) NMC–Maintenance Depot (NMCM Depot)

Table 1-5 shows an example of the key reporting parameters and metrics for the UH-60A.

Table 1-5. Illustration of Army Aviation Availability Reporting

LIN	Average no. of aircraft	MC%	NMCM%	NMCM ORG%	NMCM SPT%	NMCM Depot%	NMCS%	NMCS ORG%	NMCS SPT%
K32293	861	65.6	30.2	25.0	3.6	1.6	4.2	3.0	1.2

In the reporting relationship illustrated in Table 1-5, the following formulas hold:

- MC% = 100 − the sum of the two main NMC reporting categories, or 100 − (NMCM% + NMCS%)
- NMCM% = the sum of ORG, SPT, and Depot NMCM percentages, or NMCM ORG% + NMCM SPT% + NMCM Depot%
- NMCS% = the sum of ORG and SPT NMCS percentages, or NMCS ORG% + NMCS SPT%.

To calculate the average number of reported aircraft (i.e., 861 in Table 1-5), we add the number of NMC and MC hours the Army reported for each aircraft and divide that figure by the total number of hours in the reporting period. Because this study is for a fiscal year, the total number of hours in the reporting period is 8,760 (365 × 24).

Availability Reporting Results

In general terms, the availability figure, or MC%, is the percentage of time during the reporting period that, on average, aircraft are available to perform their mission.

Table 1-6 summarizes the MC and three main NMC metrics as reported by the Army in FY2009 for the 20 Army aircraft types with the highest average number of aircraft. Appendix B provides a full listing of the reported MC and NMC rates for each aircraft for FY2008 and FY2009.

Table 1-6. Summary of MC and NMC Metrics for the 20 Army Aircraft with the Highest Average Aircraft Inventory in FY2009

LIN	Nomenclature	Average no. of aircraft	MC%	NMC%	NMCM%	NMCS%
K32293	Helicopter Utility UH-60A	861	65.6	34.4	30.2	4.2
H32361	Helicopter Utility UH-60L	573	75.1	24.9	23.1	1.8
H48918	Helicopter Attack AH-64D	522	70.8	29.2	25.2	4.0
A21633	Helicopter Observation OH-58D	327	71.8	28.2	26.1	2.1
H30517	Helicopter cargo transport CH-47D	303	60.9	39.1	31.3	7.8
K31042	Helicopter Observation OH-58A	186	63.3	36.7	31.0	5.7
H32611	Helicopter flight training TH-67A	183	76.0	24.0	20.6	3.4
K31795	Helicopter Utility UH-1H	141	41.8	58.2	56.9	1.3
H28647	Helicopter Attack AH-64A	127	61.7	38.3	29.4	8.9
H31110	Helicopter Observation OH-58C	101	69.0	31.0	27.7	3.3
H32429	Helicopter Utility UH-60M	84	80.5	19.5	14.8	4.7
H31872	Helicopter Utility UH-1V	75	47.8	52.2	51.3	0.9
H31329	Helicopter Light Utility UH-72A	62	89.8	10.2	7.5	2.7
BA108Q	Airplane, cargo transport C-12U	62	85.6	14.4	10.9	3.5
H30616	Helicopter electronic countermeasure EH-60A	55	61.3	38.7	29.6	9.1
C15172	Helicopter cargo transport CH-47F	52	80.0	20.0	18.5	1.5
NL0162	Helicopter special operations MH-6M	51	79.6	20.4	18.4	2.0
Z01054	Helicopter Cargo MH-47G	48	69.4	30.6	24.5	6.1
NL0067	Helicopter special operations MH-60L	37	76.5	23.5	17.9	5.6
NL0221	Airplane cargo C-23C	31	88.1	11.9	11.3	0.6
Total—all aircraft (as reported by Army)		4,108	68.9	31.1	27.2	3.9

As Table 1-6 depicts, the average MC rate for all reported Army aircraft is 68.9 percent. This makes the NMC rate 31.1 percent.

The majority of the non-availability is the result of maintenance (27.2 percent) rather than supply (3.9 percent). To avoid confusion, for the remainder of this report, the NMC rate reported in each table includes both NMCM and NMCS non-available hours.

REPORT ORGANIZATION

In this chapter, we explained our analysis approach, the Army maintenance and corrosion organizations, the current maintenance structure, and the aviation assets included within the scope of this study. We also explained how we determined the total non-available hours by aircraft for maintenance and the NMC rate.

In Chapter 2, we turn our attention to an assessment of the effect corrosion has on Army aviation weapon system availability (based on FY2009 maintenance data). In Chapter 3, we provide an overall analysis of the effect corrosion has on aviation availability and identify areas of opportunity to reduce the negative impact of corrosion on these assets. The appendixes provide supporting data and analysis.

Chapter 2
Determining Corrosion's Impact on Availability

We estimate that, each year, corrosion results in 1,717,898 hours of non-availability for Army aviation assets (based on FY2009 data). This figure represents 16.0 percent of the total non-available hours reported by the Army for its aircraft. When we exclude training aircraft as well as aircraft in a reset or recap/rebuild maintenance program, the number of corrosion-related non-available hours is 1,566,268, which represents 16.0 percent of the non-available hours for the same group of aircraft.[1]

In this chapter, we explain how we arrived at this estimate. From a standpoint of consistency with the Army's current policy on availability reporting, the total non-available hours for this analysis is the same as what the Army reported for the same period. The total non-available hours for this analysis include non-availability attributable to both field-level and depot maintenance. We used FY2009 data, as they were the most recent. Our challenge was to determine the amount of NMC hours attributable directly or partially to corrosion.

We obtained maintenance records for all Army-readiness reportable aircraft. These maintenance records contained essentially the same level of detail as those we used in the cost of corrosion study, with the additional annotation of whether the maintenance action caused the aircraft being worked on to enter NMC status.

DETERMINING NMC STATUS

For FLM records, the NMC status is reflected in a data field called "status." Maintenance records with a "z" code depict work on the aircraft that resulted in reported non-availability. We used organically performed maintenance portrayed in the FLM records in our analysis because we do not have detailed, bottom-up records for commercially performed maintenance.

All DM records, by default, depict an NMC status for the aircraft. Any aircraft undergoing DM is not available to perform its mission because of the extensive nature of the maintenance. We used only organically performed DM records, because we do not have detailed information for commercially performed DM.

[1] The effect of excluding training aircraft and aircraft undergoing a reset or recap/rebuild is negligible when assessing the corrosion-related non-available hours as a percentage of the total non-available hours.

DETERMINING CORROSION-RELATED WORK

We met with Army aviation maintenance subject matter experts (SMEs) to review the search algorithm we use to find corrosion-related maintenance records and assess a corrosion percentage. Based on these discussions, we revised the algorithm to accommodate failure codes and keywords that relate to availability. Table 2-1 depicts a general summary of the revised algorithm. We list the specific failure codes, corrosion search words, and corresponding corrosion percentages in Appendix C.

Table 2-1. Corrosion Search Algorithm Steps

Step 1	Search for Army aviation failure codes (a total of 26 failure codes are used).	Apply appropriate corrosion percentage (from 5–100).
Step 2	Search for Process Analysis Data Collection System (PADCS) defect codes (a total of 26 defect codes are used).	Apply appropriate corrosion percentage (from 5–100).
Step 3	Search for corrosion keywords from the descriptive text. (We modified keyword corrosion percentages to match corrosion percentages of failure codes based on similar corrosion actions.)	Apply appropriate corrosion percentage (from 5–100).

We searched through all Army aviation data records and flagged a record as corrosion-related work if any of the criteria in Table 2-1 was met.

In a cost of corrosion study, when a record is flagged for corrosion (a specific failure code or keyword is found), we determine the corrosion-related cost for that record by applying the assigned corrosion percentage to the labor and materials cost. (The corrosion percentage varies from 5 percent to 100 percent based on the type of work.) When assessing the effect corrosion has on availability, we apply the corrosion percentages to the NMC hours.

For example, one of the corrosion keywords is “cracked.” Cracking is a fault that is only sometimes caused by corrosion, so it has a corrosion percentage of 50. To assess the impact of corrosion on non-available time, we associate only 50 percent of the non-available hours for each maintenance record that indicates “cracked” as a cause for maintenance.

We provide the following example to illustrate how we assessed the maintenance records for corrosion and determine corrosion-related non-available hours. In Table 2-2, the highlighted blocks show various means of flagging a maintenance record as being corrosion-related work consistent with the method outlined.

Table 2-2. An Example of Calculating the Effect of Corrosion on NMC Hours

TMS	Failure code	Action code	Work center	Discrepancy narrative	NMC?	NMC hrs.	Corrosion-related work?	Corrosion-related %	Corrosion-related NMC hrs.
AH-64D	170	G	DC010	Left door hinges need replaced	No		Yes	100	
CH-47D	158	Z	Z5120	Clean corrosion and treated	Yes	2	Yes	100	2
OH-58C	255	A	QE110	Replaced drive shaft support bearing	Yes	1	No		
UH-60A	255	9	QE110	Phase inspection	Yes	5	Yes	40	2
UH-60L	230	V	QE220	Replaced packings and installed screens	No		No		
UH-1H	020	1	QE220	Replaced pitch trim assembly	No		No		
AH-64D	020	1	QR221	Reinstalled co-pilots door	No		No		
UH-60L	117	Z	1E720	Replaced corroded lock assemblies	Yes	4	Yes	100	4
Total corrosion non-available hours									8

Work records with an entry of "Yes" in the "NMC?" category designate the specific work that resulted in the aircraft entering NMC status. The "NMC hours" depict the length of time the aircraft was in NMC status.

For records with corrosion-related work that also resulted in the aircraft entering NMC status, the corrosion NMC hours lists the product of the NMC hours and the corrosion percentage. For the records presented in Table 2-2, the corrosion NMC total was 8 hours.

SUMMARY OF RESULTS

In depicting the effect corrosion has on Army aircraft non-availability, we show the total impact of corrosion as well as the corrosion impact on two subsets of the Army aircraft inventory. We also show the corrosion impact on training aircraft as well as the impact of corrosion on aircraft undergoing a reset or recap/rebuild program. We display the results for these two populations of aircraft separately, because they involve situations different than the normal operational or maintenance posture of most Army aircraft. In particular, training aircraft have less urgency than other Army combat-ready aircraft. Aircraft within a reset or recap/rebuild program experience significantly heavier-than-normal maintenance workloads.

For the remainder of the chapter, we present the corrosion impacts results in the following four views:

- Total results for all aircraft
- Results for training aircraft
- Results for aircraft undergoing a reset or recap/rebuild program
- Total results excluding training aircraft or those undergoing a reset or recap/rebuild program (referred to as operationally ready aircraft).

Note that some training aircraft were undergoing a reset or recap/rebuild during the study period.

Maintenance Records Flagged for Corrosion

In Table 2-3, we present a top-level summary of the effect of corrosion for Army aircraft on NMC hours for both FLM and DM based on the number of maintenance records flagged by the corrosion search algorithm (see Table 2-1).

Table 2-3. Maintenance and Availability Records for Army Aviation, FY2009

Depot maintenance	All aircraft	Training aircraft	Aircraft in reset or recap/rebuild	Operationally ready aircraft
Total number of maintenance records	261,913	1,116	1,643	260,260
Total number of maintenance records flagged for corrosion	108,045	397	599	107,444
Percentage of maintenance records flagged for corrosion	41.3%	35.6%	36.5%	41.3%
Number of maintenance records resulting in NMC time	261,913	1,116	1,643	260,260
Number of maintenance records resulting in NMC time and flagged for corrosion	108,045	397	599	107,444
Percentage of records resulting in NMC time and flagged for corrosion	41.3%	35.6%	36.5%	41.3%

Field-level maintenance	All aircraft	Training aircraft	Aircraft in reset or recap/rebuild	Operationally available aircraft
Total number of maintenance records	2,632,909	54,355	294,900	2,288,720
Total number of maintenance records flagged for corrosion	962,518	21,003	119,263	824,564
Percentage of maintenance records flagged for corrosion	36.6%	38.6%	40.4%	36.0%
Number of maintenance records resulting in NMC time	532,995	17,095	127,252	390,786
Number of maintenance records resulting in NMC time and flagged for corrosion	169,953	6,257	37,620	126,833
Percentage of records resulting in NMC time and flagged for corrosion	31.9%	36.6%	29.6%	32.5%

In general, records for performance of DM have a higher percentage of records flagged for corrosion than FLM records. A fairly large percentage of the maintenance records that result in NMC time involve corrosion as a contributing cause for both DM and FLM, although these numbers can be misleading, because many of these maintenance records involve inspections. Unless the action is a specific corrosion-related inspection, corrosion is only an ancillary contributor to the NMC time. In addition, the amount of NMC time spent on an inspection tends to be less than the NMC time from a major mechanical malfunction.

Corrosion-Related NMC Hours

The difference between the percentage of maintenance records flagged for corrosion and the percentage of corrosion-related NMC hours is clear when we examine the impact of corrosion on the number of NMC hours attributed to maintenance. We list these results in Table 2-4.

Table 2-4. NMC Hours Reported for Army Aviation, FY2009

Depot maintenance	All aircraft	Training aircraft	Aircraft in reset or recap/rebuild	Operationally ready aircraft
Total NMC hours	3,536,379	16,324	26,287	3,510,040
Total corrosion-related NMC hours	572,873	1,987	3,544	569,321
Corrosion-related NMC hours as a percentage of total NMC hours	16.2%	12.2%	13.5%	16.2%

Field-level maintenance	All aircraft	Training aircraft	Aircraft in reset or recap/rebuild	Operationally available aircraft
Total NMC hours	7,204,693	206,976	756,228	6,249,538
Total corrosion-related NMC hours	1,145,025	35,395	114,276	996,947
Corrosion-related NMC hours as a percentage of total NMC hours	15.9%	17.1%	15.1%	16.0%

For both DM and FLM, the percentage of hours that aircraft were reported as non-available due to corrosion was significantly less than the percentage of records flagged for corrosion (presented in Table 2-3). This pattern is consistent for all four aircraft groups listed in Table 2-4. For example, 41.3 percent of the DM records for all aircraft were flagged for corrosion (see Table 2-3), but the corresponding corrosion-related NMC hours were only 16.2 percent of the total non-available hours (see Table 2-4).

In Table 2-5, we show the impact of corrosion on the total number of reported NMC hours for each group.

Table 2-5. Maintenance and Availability for Army Aviation—All Categories of Reporting, FY2009

Category	All aircraft	Training aircraft	Aircraft in reset or recap/rebuild	Operationally ready aircraft
Total NMC hours—all categories (FLM and DM)	10,741,072	223,300	782,515	9,759,578
Total NMC hours related to corrosion	1,717,898	37,382	117,821	1,566,268
Percentage of total NMC hours attributed to corrosion	16.0%	16.7%	15.1%	16.0%

Based on the total number of aircraft NMC hours for all reporting categories, corrosion is a contributing cause to 16.0 percent of the combined total of non-available hours for Army aviation assets. This percentage is higher for the training aircraft, but lower for the aircraft undergoing a recap or reset/rebuild.

CORROSION-RELATED NON-AVAILABILITY—VARIOUS DATA VIEWS

Because we characterize each maintenance record by the schema in Chapter 1, we are able to create various data views that yield differing perspectives on the availability results. For the purpose of this study, we use two data views:

- Non-available hours by LIN
- Non-available hours by system using the aviation work breakdown structure (AWBS).

In the following sections, we show each of these data views by total Army aircraft inventory and also by removing training aircraft and aircraft undergoing a reset or recap/rebuild.

Corrosion-Related Non-Availability by LIN

The following tables show the effect of corrosion on availability by aircraft type and level of maintenance and list the 10 aircraft with the highest NMC hours. In Appendix D, we provide a complete summary of the corrosion effect on non-available hours for FY2009 for all aircraft.

CORROSION'S IMPACT ON FLM NMC HOURS BY LIN

Table 2-6 shows the corrosion-related impact on total FLM NMC hours by aircraft type for all Army aircraft in FY2009.

Fleet size plays a major role in corrosion-related NMC totals and per-aircraft averages. For example, the UH-60A has both the largest inventory of aircraft and the highest total corrosion-related NMC hours for FLM, but it is in the mid-range for the per-aircraft average for NMC hours related to corrosion. Interestingly, the OH-58C observation helicopter—among the lowest in terms of average inventory—has the highest percentage of corrosion-related NMC hours (26.0 percent) and the highest average corrosion-related non-available hours for FLM per aircraft (660).

Table 2-6. Corrosion's Impact on FLM NMC Hours by LIN for All Army Aircraft, FY2009

LIN	LIN nomenclature	No. of aircraft (avg.)	Total FLM NMC hrs.	Total corrosion-related FLM NMC hrs	Percentage of corrosion-related FLM NMC hrs.	Corrosion-related NMC hrs. per aircraft (avg.)
K32293	Helicopter utility UH-60A	861	1,612,582	274,589	17.0	319
H32361	Helicopter utility UH-60L	573	878,594	133,990	15.3	234
H48918	Helicopter attack AH-64D	522	980,616	165,181	16.8	316
A21633	Helicopter observation OH-58D	327	397,622	61,126	15.4	187
H30517	Helicopter cargo transport CH-47D	303	745,238	123,287	16.5	407
K31042	Helicopter observation OH-58A	186	556,065	107,308	19.3	577
K31795	Helicopter utility UH-1H	141	152,612	33,619	22.0	238
H28647	Helicopter attack AH-64A	127	277,036	46,393	16.7	365
H31110	Helicopter observation OH-58C	101	255,785	66,612	26.0	660
H30616	Helicopter electronic countermeasure EH-60A	55	171,587	34,080	19.9	620

Table 2-7 shows corrosion's impact on total FLM NMC hours by aircraft type for all operationally ready aircraft in FY2009.

The UH-60A again has the highest total of corrosion-related FLM NMC hours among Army aircraft when we exclude training aircraft or aircraft undergoing a reset or recap/rebuild. The OH-58C observation helicopter has the highest corrosion-related NMC percentage (26.1 percent) and the highest average corrosion-related FLM non-available hours per aircraft (919).

Table 2-7. Corrosion's Impact on FLM NMC Hours by LIN for Operationally Ready Aircraft, FY2009

LIN	LIN nomenclature	No. of aircraft (avg.)	Total FLM NMC hrs.	Total corrosion-related FLM NMC hrs.	Percentage of corrosion-related FLM NMC hrs	Corrosion-related NMC hrs. per aircraft (avg.)
K32293	Helicopter utility UH-60A	546	1,343,580	233,609	17.4	428
H48918	Helicopter attack AH-64D	409	935,335	157,285	16.8	385
H32361	Helicopter utility UH-60L	292	577,644	93,590	16.2	321
H30517	Helicopter cargo transport CH-47D	195	593,383	98,031	16.5	503
K31042	Helicopter observation OH-58A	173	551,070	106,202	19.3	614
A21633	Helicopter observation OH-58D	146	276,911	41,240	14.9	282
K31795	Helicopter utility UH-1H	141	152,612	33,619	22.0	238
H28647	Helicopter attack AH-64A	123	257,774	42,220	16.4	343
H31110	Helicopter observation OH-58C	69	243,491	63,523	26.1	921
H32429	Helicopter utility UH-60M	52	113,432	20,801	18.3	400

CORROSION'S IMPACT ON DM NMC HOURS BY LIN

Table 2-8 shows the effect corrosion has on total DM NMC hours by aircraft type for all Army aircraft in FY2009.

As with FLM, the UH-60A and UH-1H have the highest total of corrosion-related DM NMC hours among all Army aircraft. The OH-58A observation helicopter has the highest corrosion-related NMC percentage among all Army aircraft (33.1 percent); however, the UH-1H utility helicopter—among the highest in terms of average inventory—has more than double the next highest helicopter (the OH-58D) in terms of average corrosion-related NMC hours per aircraft (783).

Table 2-8. Corrosion Impact on DM NMC Hours by LIN for All Aircraft, FY2009

LIN	LIN nomenclature	No. of aircraft (avg.)	Total DM NMC hrs.	Total corrosion-related DM NMC hrs.	Percentage of corrosion-related DM NMC hrs.	Corrosion-related NMC hrs. per aircraft (avg.)
K32293	Helicopter utility UH-60A	861	850,244	156,515	18.4	182
H32361	Helicopter utility UH-60L	573	339,640	45,395	13.4	79
H48918	Helicopter attack AH-64D	522	292,368	52,007	17.8	100
A21633	Helicopter observation OH-58D	327	387,501	114,549	29.6	350
H30517	Helicopter cargo transport CH-47D	303	245,275	45,232	18.4	149
K31042	Helicopter observation OH-58A	186	38,279	12,670	33.1	68
K31795	Helicopter utility UH-1H	141	520,377	110,467	21.2	783
H28647	Helicopter attack AH-64A	127	127,135	30,040	23.6	237
H32429	Helicopter utility UH-60M	84	70,608	3,241	4.6	39
H30766	Helicopter utility MH-60K	23	13,899	2,134	15.4	93

Table 2-9 shows corrosion's effect on total DM NMC hours by aircraft type for all operationally ready aircraft in FY2009.

When we compare Table 2-8 with Table 2-9, we see little variation. Only the UH-60A, OH-58D, and CH-47D fleets had training aircraft and aircraft undergoing DM reset or recap/rebuild. The effect corrosion has on the availability of aircraft had minimal effect on the overall percentage of corrosion-related DM NMC.

Table 2-9. Corrosion's Impact on DM NMC Hours by LIN for Operationally Ready Aircraft, FY2009

LIN	LIN nomenclature	No. of aircraft (avg.)	Total DM NMC hrs.	Total corrosion-related DM NMC hrs.	Percentage of corrosion-related DM NMC hrs.	Corrosion-related NMC hrs. per aircraft (avg.)
K32293	Helicopter utility UH-60A	850	847,112	155,990	18.4	184
H32361	Helicopter utility UH-60L	573	339,640	45,395	13.4	79
H48918	Helicopter attack AH-64D	522	292,368	52,007	17.8	100
A21633	Helicopter observation OH-58D	326	387,449	114,541	29.6	351
H30517	Helicopter cargo transport CH-47D	295	222,120	42,212	19.0	143
K31042	Helicopter observation OH-58A	186	38,279	12,670	33.1	68
K31795	Helicopter utility UH-1H	141	520,377	110,467	21.2	783
H28647	Helicopter attack AH-64A	127	127,135	30,040	23.6	237
H32429	Helicopter utility UH-60M	84	70,608	3,241	4.6	39
H30766	Helicopter utility MH-60K	23	13,899	2,134	15.4	93

CORROSION'S IMPACT ON TOTAL NON-AVAILABLE HOURS BY LIN

Table 2-10 shows the corrosion-related total non-available hours for all Army aircraft for FLM and DM combined by aircraft type for FY2009.

The UH-60A has the highest total of corrosion-related NMC hours (431,104), among all Army aircraft. The UH-1H utility helicopter has the highest average corrosion-related NMC hours per aircraft (1,025). Although the OH-58C observation helicopter has the highest corrosion-related percentage among all Army aircraft (26.0 percent), the spread between the highest and lowest corrosion percentages (14.7 vs. 26.0) is not drastic.

Table 2-10. Corrosion's Impact on Total NMC Hours by LIN for All Aircraft, FY2009

LIN	LIN nomenclature	No. of aircraft (avg.)	Total NMC hours	Total NMC hours	Percentage of corrosion-related NMC hours	Corrosion-related NMC hrs. per aircraft (avg.)
K32293	Helicopter utility UH-60A	861	2,462,826	431,104	17.5	501
H32361	Helicopter utility UH-60L	573	1,218,234	179,385	14.7	313
H48918	Helicopter attack AH-64D	522	1,272,984	217,188	17.1	416
A21633	Helicopter observation OH-58D	327	785,123	175,675	22.4	537
H30517	Helicopter cargo transport CH-47D	303	990,513	168,519	17.0	556
K31042	Helicopter observation OH-58A	186	594,344	119,978	20.2	645
K31795	Helicopter utility UH-1H	141	672,989	144,085	21.4	1,022
H28647	Helicopter attack AH-64A	127	404,171	76,434	18.9	602
H31110	Helicopter observation OH-58C	101	257,830	67,113	26.0	664
H30616	Helicopter electronic countermeasure EH-60A	55	175,347	34,080	19.4	620

Table 2-11 shows the corrosion impact on total NMC hours by aircraft type for operationally ready aircraft for FY2009.

The UH-60A had the highest total NMC corrosion-related NMC hours among operationally ready aircraft (no training aircraft or aircraft undergoing a reset or recap/rebuild). Although the OH-58C had the highest corrosion percentage (26.1), the OH-58D observation helicopter had the highest average corrosion-related NMC hours per aircraft (1,064).

Table 2-11. Corrosion's Impact on Total NMC Hours by LIN for Operationally Ready Aircraft, FY2009

LIN	LIN Nomenclature	No. of aircraft (avg.)	Total NMC hrs.	Total corrosion-related NMC hrs.	Percentage of corrosion-related NMC hrs.	Corrosion-related NMC hrs. per aircraft (avg.)
K32293	Helicopter utility UH-60A	546	2,190,692	389,600	17.8	714
H48918	Helicopter attack AH-64D	409	1,227,703	209,292	17.0	512
H32361	Helicopter utility UH-60L	292	917,284	138,985	15.2	476
H30517	Helicopter cargo transport CH-47D	195	815,503	140,242	17.2	719
K31042	Helicopter observation OH-58A	173	589,349	118,872	20.2	687
A21633	Helicopter observation OH-58D	146	664,360	155,781	23.4	1,067
K31795	Helicopter utility UH-1H	141	672,989	144,085	21.4	1,022
H28647	Helicopter attack AH-64A	123	384,909	72,260	18.8	587
H31110	Helicopter observation OH-58C	69	245,536	64,024	26.1	928
H32429	Helicopter utility UH-60M	52	184,040	24,042	13.1	462

Corrosion-Related Non-Availability by System

We developed the AWBS to more accurately and efficiently identify the types of maintenance and the system, subsystem, or item on which an activity is performed. We created the AWBS in support of the AMRDEC Corrosion Office's request to provide a more detailed work breakdown structure (WBS) than the standard WBS.[2]

AVIATION WORK BREAKDOWN STRUCTURE FOR ARMY AVIATION

The AWBS provides adequate detail for aviation-relevant analysis while remaining useful and relatively burden free to the maintenance technicians.

The AWBS is a five-character alphanumeric code that describes the end item type, maintenance activity, main system being maintained, and specific subsystem or part being worked.

[2] The standard work breakdown structure convention referred to is established in *DoD Financial Management Regulation*, Volume 6, Chapter 14, Addendum 4, January 1998.

The first character in the AWBS denotes the end item type. Table 2-12 identifies the maintenance action codes and gives examples of each.

Table 2-12. AWBS End Item Type Codes (First Character)

Code	End item type
F	Fixed wing aircraft
R	Rotary aircraft
E	Engines
X	Common use across aircraft types

The second character of the AWBS denotes the maintenance action. We show the different types of maintenance activity codes in Table 2-13.

Table 2-13. AWBS Maintenance Activity Codes (Second Character)

Code	Maintenance activity	Examples
A	Assemble	Combine parts into subassembly
B	Calibrate	Bring into tolerance, adjust
C	Clean	Wash, decontaminate, blast, bath
D	Disassemble	Separate subassembly into parts
E	Dispose	Cannibalize, destroy
F	Fix	Remove, repair, reinstall
I	Inspect/Test	Troubleshoot, warranty, non-destruction inspection (NDI)
L	Installation	Install equipment, load, reload
M	Modify	Reconfigure, remove but do not repair or replace
O	Administrative	Order parts, prepare reports
P	Preserve	Lubricate, package, wrap
R	Replace	Remove and put back a new or refurbished operational part
T	Treat	Prime, paint, coat
U	Unknown	Unknown activity

The third and fourth characters denote which system is being maintained. Table 2-14 shows these codes.

Table 2-14. AWBS System Codes (Third and Fourth Characters)

Code	Maintenance system
01	Engines
02	Airframe
03	Landing gear
04	Power distribution and electrical
05	Rotor and propeller system
06	Drive system
07	Hydraulics and pneudraulics
09	Miscellaneous aircraft
10	Fuel system
11	Flight control
12	Measuring and testing instruments
13	Environmental control
14	Ground support equipment
19	Avionics
20	Consumables and toolbox hardware
21	Bearings
22	Valves and pumps
31	Fire control system and target acquisition
34	Night vision assembly
35	Armament

The fifth, and last, character in the AWBS denotes the subsystem or part. Each system has up to nine associated subsystems, including an "other" category. Table 2-15 shows an example of the subsystem mapping of one aviation system: fire control system and target acquisitions.

Table 2-15. Example of AWBS in System 31, Fire Control System and Target Acquisition

Subsystem	Subsystem description	FSC code[a]	FSC code description
1	Fire control designating and indicating equipment	1210	Fire control directors
		1217	Fire control equipment
		1260	Fire control designating/indicating equipment
		1265	Fire control transmitting/receiving equipment, except airborne
		1285	Fire control radar equipment, except airborne
2	Aircraft gunnery fire control components	1270	Aircraft gunnery fire control components

Table 2-15. Example of AWBS in System 31, Fire Control System and Target Acquisition

Sub-system	Subsystem description	FSC code[a]	FSC code description
3	Optical sighting and ranging equipment	1240	Optical sighting and ranging equipment
4	Fire control computing sights and devices	1220	Fire control computing sights and devices
5	Miscellaneous fire control equipment	1290	Miscellaneous fire control equipment
6	Photographic and video equipment	5836	Video recording and reproducing equipment
		6710	Cameras, motion picture
		6720	Cameras, still picture
		6740	Photographic developing/finishing equipment
		6750	Photographic supplies
		6760	Photographic equipment and accessories
7	Underwater sound equipment	5845	Underwater sound equipment
8	Aircraft bombing fire control components	1280	Aircraft bombing fire control components
9	Other	1550	Drones

[a] The Federal Supply Classification (FSC) code indicates the federal class to which the item has been assigned. The first four numbers of the 13-character national stock number (NSN) are the FSC code. All parts have an NSN, and thus, all parts have an FSC code.

An example AWBS code is RR312, which breaks down as

- R = rotary wing aircraft,
- R = replace,
- 31 = fire control system and target acquisition, and
- 2 = aircraft gunnery fire control components, which consists of subsystems or parts with FSC code 1270.

The AWBS does not come from the maintenance technician choosing the most appropriate category of work among hundreds of possible choices. The assignment of AWBS codes is based on the parts that are ordered or worked on within each maintenance record. Each part is mapped to the correct AWBS code according to the FSC and part number. This code is then assigned retroactively to each maintenance activity, providing a more definitive historical record of the work. If no part is associated with the labor record, we used the text description of the work to determine the appropriate AWBS. We were able to map a majority of the records and derive additional analytical value from these records.[3]

Appendix E provides a complete list of the AWBS codes.

[3] We could not map a portion of the maintenance records to a particular system because not all parts records could be linked to a specific job control number within the labor record, and the text description of the work did not always provide enough detail to determine the system and subsystem.

CORROSION'S IMPACT ON NMC HOURS BY AWBS SYSTEM

Table 2-16 shows the effect corrosion has on total NMC hours for all aircraft by AWBS system in FY2009.

Table 2-16. Corrosion's Impact on NMC Hours by Aircraft System for All Aircraft, FY2009

AWBS system code	Description	Total NMC hours	Total corrosion-related NMC hours	Percentage of corrosion-related NMC hours
UN	Unknown[a]	3,988,879	529,101	13.3
02	Airframe	1,540,609	253,683	16.5
04	Power distribution and electrical	860,441	202,292	23.5
01	Engines	1,548,219	201,113	13.0
05	Rotor and propeller system	886,065	192,789	21.8
09	Miscellaneous aircraft	324,264	53,505	16.5
22	Valves and pumps	166,984	33,496	20.1
13	Environmental control	197,200	23,478	11.9
19	Avionics	126,842	21,015	16.6

[a] These records could not be linked to a job control number, and their text descriptions were insufficient to assign an AWBS code.

We see the highest contributor to corrosion-related NMC hours is the airframe, followed by power distribution and electrical. The range of the percentage of NMC hours related to corrosion by system is fairly narrow.

Table 2-17 shows the corrosion-related NMC hours by AWBS system for operationally ready aircraft.

Table 2-17. Corrosion's Impact on NMC Hours by Aircraft System for Operationally Ready Aircraft, FY2009

AWBS system code	Description	Total NMC hours	Total corrosion-related NMC hours	Percentage of corrosion-related NMC hours
UN	Unknown	3,960,148	521,277	13.2
02	Airframe	1,252,917	196,484	15.7
04	Power distribution and electrical	763,739	186,260	24.4
01	Engines	1,344,195	180,931	13.5
05	Rotor and propeller system	818,097	180,829	22.1
09	Miscellaneous aircraft	255,039	47,781	18.7
22	Valves and pumps	145,805	30,878	21.2
13	Environmental control	164,737	20,410	12.4
07	Hydraulics and pneudraulics	101,577	19,778	19.5

Chapter 3
Analysis of Corrosion-Related Non-Availability

Corrosion has a definite impact on the availability of Army aviation weapon systems, contributing to roughly 1 out of every 6 reported hours of non-availability for Army aviation platforms.

We wanted to identify areas of opportunity to reduce the negative impact of corrosion, focusing on aircraft type (TMS), maintenance type (DM versus FLM), and maintenance classification (preventive versus corrective).

CORROSION-RELATED NON-AVAILABILITY BY TMS

Aircraft with both a large number of corrosion-related NMC hours and a higher per-aircraft average for corrosion-related NMC hours should receive close scrutiny. In Table 3-1, we identify the 10 aircraft that merit the most attention, ranking them by total and per-aircraft average NMC hours.

Table 3-1. Rankings of Aircraft by Total and Average, per-Aircraft NMC Hours, FY2009

LIN	Description	Total corrosion-related NMC		Average per-aircraft corrosion-related NMC	
		Hours	Rank	Hours	Rank
K32293	Helicopter utility UH-60A	431,104	1	501	8
H48918	Helicopter attack AH-64D	217,188	2	416	10
H32361	Helicopter utility UH-60L	179,385	3	313	13
A21633	Helicopter observation OH-58D	175,675	4	537	7
H30517	Helicopter cargo transport CH-47D	168,519	5	556	6
K31795	Helicopter utility UH-1H	144,085	6	1,022	1
K31042	Helicopter observation OH-58A	119,978	7	645	3
H28647	Helicopter attack AH-64A	76,434	8	602	5
H31110	Helicopter observation OH-58C	67,113	9	664	2
H30616	Helicopter electronic countermeasure EH-60A	34,080	10	620	4

We treated the importance of total corrosion non-available hours and average corrosion non-available hours per aircraft equally in our ranking in Table 3-1.

In Table 3-2, we add the rankings from Table 3-1 to find a combined rank score and overall ranking of these 10 weapon systems. The UH-1H helicopter has the highest combined ranking of total and average corrosion-related non-available hours.

Table 3-2. Combined Corrosion-Related NMC Rankings of Aircraft, FY2009

LIN	Description	Total corrosion-related NMC rank	Average per-aircraft corrosion-related NMC rank	Combined rank score	Overall rank
K31795	Helicopter utility UH-1H	6	1	7	1
K32293	Helicopter utility UH-60A	1	8	9	2
K31042	Helicopter observation OH-58A	7	3	10	3
A21633	Helicopter observation OH-58D	4	7	11	4
H30517	Helicopter cargo transport CH-47D	5	6	11	4
H31110	Helicopter observation OH-58C	9	2	11	4
H48918	Helicopter attack AH-64D	2	10	12	7
H28647	Helicopter attack AH-64A	8	5	13	8
H30616	Helicopter electronic countermeasure EH-60A	10	4	14	9
H32361	Helicopter utility UH-60L	3	13	16	10

Although, the UH-1H has the highest rank in terms of average per-aircraft corrosion-related NMC hours, it ranks sixth in terms of total corrosion-related NMC. When we combine the two ranks, the UH-1H receives the lowest combined rank score, which translates into the highest overall ranking. We therefore know the UH-1H merits priority when considering where to focus resources to mitigate the effects of corrosion on weapon systems.

Three of the top six aircraft in terms of combined ranking in Table 3-2 are versions of the OH-58 observation helicopter. The root causes of corrosion's impact on non-availability are likely similar across all three series. Like the UH-1H, these three OH-58 aircraft present a significant opportunity to focus resources. We consider this possibility in Table 3-3 by listing the corrosion impact on non-available hours for the three OH-58 helicopter versions by AWBS.[1]

[1] As we reviewed the data needed to compile Table 3-3, we encountered a significant number of records for which we could not determine the AWBS, especially for the OH-58A and OH-58C aircraft.

Table 3-3. Corrosion's Impact on NMC Hours for OH-58 by Series, FY2009

AWBS system code	Description	Total NMC hours	Total corrosion-related NMC hours	Percentage of corrosion-related NMC hours
OH-58A				
UN	Unknown	332,051	69,909	21.1%
02	Airframe	70,677	16,554	23.4%
01	Engines	78,270	9,686	12.4%
05	Rotor and propeller system	34,396	9,230	26.8%
04	Power distribution and electrical	23,237	4,301	18.5%
09	Miscellaneous aircraft	14,241	2,575	18.1%
10	Fuel system	11,817	2,390	20.2%
21	Bearings	2,497	1,548	62.0%
19	Avionics	2,206	703	31.9%
OH-58C				
UN	Unknown	237,116	62,880	26.5%
02	Airframe	4,544	1,430	31.5%
01	Engines	5,568	858	15.4%
10	Fuel system	1,520	468	30.8%
05	Rotor and propeller system	1,592	412	25.9%
04	Power distribution and electrical	2,219	363	16.4%
07	Hydraulics and pneudraulics	972	258	26.5%
09	Miscellaneous aircraft	974	117	12.0%
22	Valves and pumps	276	82	29.8%
OH-58D				
UN	Unknown	97,114	17,532	18.1%
05	Rotor and propeller system	104,136	33,549	32.2%
01	Engines	200,512	32,269	16.1%
02	Airframe	59,244	16,266	27.5%
04	Power distribution and electrical	46,559	15,472	33.2%
31	Fire control system and target acquisition	70,130	14,706	21.0%
22	Valves and pumps	44,898	13,841	30.8%
07	Hydraulics and pneudraulics	26,889	5,654	21.0%
09	Miscellaneous aircraft	22,807	4,414	19.4%

From the records with an assigned AWBS, the top four systems contributing to corrosion non-availability for the OH-58 aircraft are as follows:

- System 01: Engines
- System 02: Airframe
- System 05: Rotor and propeller system
- System 04: Power distribution and electrical

These systems are also the top contributors to corrosion-related non-available hours for all aircraft (see Table 2-16). When we compare the corrosion percentage of the AWBS systems of the OH-58 to all other aircraft, we derived the results presented in Table 3-4.

Table 3-4. Corrosion's Impact on NMC Hours by Aircraft System for OH-58 Versions Compared to All Other Aircraft Types, FY2009

AWBS system code	Description	Percentage of corrosion-related NMC for OH-58 A, C, and D	Percentage of corrosion-related NMC for all other aircraft types	Difference
01	Engines	16.1	12.5	3.6
02	Airframe	18.7	16.3	2.4
05	Rotor and propeller system	32.1	20.4	11.7
04	Power distribution and electrical	27.1	23.2	3.9

The OH-58 helicopter, while experiencing the same corrosion-related non-availability issues as other Army aircraft, shows a more severe effect on each system, especially for the rotor and propeller system. This could be attributable to a different maintenance posture, different materials used, or some other systemic disparity between the OH-58 and other aircraft.

Table 3-5 shows a similar breakdown of the corrosion-related non-availability hours for the other aircraft of focus, the UH-1H helicopter.

Table 3-5. Corrosion's Impact on NMC Hours by UH-1H System, FY2009

AWBS system code	Description	Total NMC hours	Total corrosion-related NMC hours	Percentage of corrosion-related NMC hours
UN	Unknown	128,554	29,493	22.9
05	Rotor and propeller system	270,121	71,739	26.6
02	Airframe	171,740	15,916	9.3
04	Power distribution and electrical	58,437	12,097	20.7
09	Miscellaneous aircraft	18,589	8,765	47.2
01	Engines	8,526	793	9.3
21	Bearings	638	243	38.1
07	Hydraulics and pneudraulics	761	172	22.6

As evidenced in Table 3-5, the rotor and propeller system, the main cause of corrosion-related non-available hours for the UH-1H, bears further examination. In Table 3-6, we show a further breakdown of the corrosion-related NMC hours for the rotor system for this aircraft.

Table 3-6. Corrosion's Impact on Rotor and Propeller System NMC Hours for UH-1H, FY2009

NIIN	Description	Total NMC hours	Total corrosion-related NMC hours	Percentage of corrosion-related NMC hours
007572905	Yoke, main rotor assembly	110,420	38,165	34.6
009247749	Spider, lower, main T	104,167	20,581	19.8
002406465	Shaft tail rotor	16,726	4,521	27.0
012567464	Mast assembly	5,895	1,723	29.2
002406463	Case assembly gearbox	7,658	1,652	21.6
007014142	Coupling driveshaft	3,199	703	22.0
002552896	Mast rotor helicopter	2,659	700	26.3
010146006	Transmission	4,410	634	14.4
000564869	Quill assembly	469	247	52.7

Note: NIIN = national item identification number.

Table 3-6 shows a significant localization in the corrosion-related NMC hours for the UH-1H on its rotor system. The top two parts—the main rotor assembly yoke and the lower, main T spider—should be areas of further attention.

CORROSION-RELATED NON-AVAILABILITY BY TYPE OF MAINTENANCE

We can also examine the corrosion-related NMC hours by type of maintenance, as shown in Table 3-7.

Table 3-7. Corrosion NMC Hours by Level of Maintenance, FY2009

Maintenance level	Total NMC hours	Total corrosion-related NMC hours	Percentage of corrosion-related NMC hours
DM	3,536,379	572,873	16.2
FLM	7,204,693	1,145,025	15.9
Total	10,741,072	1,717,898	16.0

Although more NMC and corrosion-related NMC hours occurred during the performance of FLM than DM, the percentage of corrosion-related NMC hours is slightly higher for DM.

We take a closer look at the corrosion-related NMC hours for each level of maintenance with regard to the top 10 contributors by AWBS system and AWBS activity. We only include those records for which we have a valid AWBS system or action code.

DM Analysis

Table 3-8 depicts the corrosion-related DM NMC hours by AWBS.

Table 3-8. Top 10 Corrosion-Related Contributors to NMC Hours by AWBS System, FY2009

AWBS system code	Description	Total NMC hours	Total corrosion-related NMC hours	Percentage of corrosion-related NMC hours
04	Power distribution and electrical	504,225	146,648	29.1
05	Rotor and propeller system	589,718	141,577	24.0
01	Engines	756,743	106,177	14.0
02	Airframe	540,219	57,477	10.6
22	Valves and pumps	80,012	23,566	29.5
09	Miscellaneous aircraft	89,384	21,006	23.5
31	Fire control and target acquisition	45,056	15,322	34.0
07	Hydraulics and pneudraulics	46,665	12,384	26.5
21	Bearings	47,256	6,180	13.1
35	Armament	19,629	5,167	26.3
Total		3,536,379	572,973	16.2

Systems 04 (power distribution and electrical) and 05 (rotor and propeller system) are the greatest contributors to DM corrosion-related NMC hours. The power distribution and electrical category is somewhat misleading, as the majority of the corrosion-related NMC hours within this category is attributable to electrical components that are part of a larger system, such as communications, avionics, or control systems. Future analyses will be able to pinpoint the systems for which common electrical components are used, providing further insight into the root causes of corrosion-related non-availability.

We can also examine the DM corrosion NMC hours by type of activity, as shown in Table 3-9. The major activities contributing to corrosion NMC hours for DM are mostly preventive in nature. This is not surprising given that corrosion treatment programs are generally administered during depot maintenance.

Table 3-9. Top 10 DM Corrosion Related Contributors to NMC Hours by AWBS Action Code, FY2009

AWBS action code	Description	Total NMC hours	Total corrosion-related NMC hours	Percentage of corrosion-related NMC hours
I	Inspect/test (troubleshoot, warranty, NDI, check, service, period, scheduled, phased)	727,606	246,344	33.9
T	Treat (corrosion treatment, prime, paint, coat)	168,309	154,071	91.5
C	Clean (wash, degrease, decontaminate)	134,675	116,967	86.9
P	Preserve (lubricate, package, wrap)	40,189	39,942	99.4
F	Fix (remove, repair, and reinstall)	1,913,796	15,021	0.8
R	Replace (remove and add a refurbished operational part)	165,707	332	0.2
L	Installation (install equipment, load, reinstall, reload)	108,195	84	0.1
B	Calibrate (bring into tolerance, adjust)	19,242	36	0.2
O	Administrative	118,163	34	0.0
A	Assemble (combine parts into subassembly)	5,601	30	0.5

FLM Analysis

Table 3-10 depicts the corrosion-related NMC hours by AWBS.

Table 3-10. Top 10 FLM Corrosion Related Contributors to NMC Hours by AWBS System, FY2009

AWBS system code	Description	Total NMC hours	Total corrosion-related NMC hours	Percentage of corrosion-related NMC hours
02	Airframe	1,000,390	196,206	19.6
01	Engines	791,477	94,936	12.0
04	Power distribution and electrical	356,215	55,643	15.6
05	Rotor and propeller system	296,347	51,212	17.3
09	Miscellaneous aircraft	234,881	32,499	13.8
13	Environmental control	173,662	20,918	12.0
19	Avionics	130,218	20,700	15.9
10	Fuel system	63,060	11,446	18.2
35	Armament	80,252	11,069	13.8
03	Landing gear	69,951	10,240	14.6

Systems 02 (airframes) and 01 (engines) are the highest contributors to FLM corrosion-related NMC hours. This FLM result is different than for DM in Table 3-8. The corrosion percentages seem fairly low and consistent for each AWBS system, which implies a lower-level common cause is contributing to the FLM corrosion-related NMC hours.

Table 3-11 examines the FLM corrosion NMC hours by type of activity.

Table 3-11. Top 10 FLM Corrosion-Related Contributors to NMC Hours by AWBS Action Code, FY2009

AWBS action code	Description	Total NMC hours	Total corrosion-related NMC hours	Percentage of corrosion-related NMC hours
F	Fix (remove, repair, and reinstall)	4,047,207	648,425	16.0
I	Inspect/test (troubleshoot, warranty, NDI, check, service, period, scheduled, phased)	911,763	281,979	30.9
C	Clean (wash, degrease, decontaminate)	142,750	126,852	88.9
T	Treat (corrosion treatment, prime, paint, coat)	50,139	37,310	74.4
R	Replace (remove and add an operational part)	1,063,881	31,968	3.0
P	Preserve (lubricate, package, wrap)	63,633	15,784	24.8
B	Calibrate (bring into tolerance, adjust)	107,304	1,062	1.0
L	Installation (install equipment, load, reinstall, reload)	312,258	759	0.2
A	Assemble (combine parts into subassembly)	42,324	436	1.0
M	Modify (reconfigure, remove but do not repair or replace)	351,754	288	0.1

The major activity contributing to corrosion-related NMC hours for FLM is repair, followed by the actions of inspect, clean, and treat. This is somewhat intuitive. Unit maintainers are often the first to notice corrosion-related concerns and intervene to correct those concerns. Maintenance performed during FLM tends to have a higher corrective maintenance composition than maintenance performed during DM.

CORROSION-RELATED NON-AVAILABILITY BY WORK CLASSIFICATION

Corrosion's impact on availability can be identified by work classification—corrective versus preventive maintenance.[2] We show this for all Army aircraft and all operationally ready aircraft (all aircraft except training aircraft and those undergoing a reset or recap/rebuild).

In Table 3-12, we show the corrosion-related impact on NMC hours for all aircraft by the nature of the work performed.

[2] As a reminder, corrective work deals with a known problem. Preventive work seeks to mitigate an as-yet-unknown potential future problem.

Table 3-12. Corrosion's Impact on NMC Hours by Nature of Work for All Aircraft, FY2009

NMC hours	Corrosion-related NMC hours	Corrective corrosion-related NMC hours	Preventive corrosion-related NMC hours	Percentage of corrective corrosion-related NMC hours	Percentage of preventive corrosion-related NMC hours
10,741,072	1,717,898	477,340	1,240,544	27.8	72.2

Note: The sum of the corrective and preventive corrosion NMC hours does not equal to total NMC hours related to corrosion because some of the work cannot be classified as either preventive or corrective. Examples include ordering parts and other administrative or reporting tasks.

Nearly three-fourths of the corrosion-related NMC hours that can be classified as either corrective or preventive are attributable to preventive work. In Table 3-13, we show a similar result when we exclude training aircraft and those aircraft in a reset or recap/rebuild program.

Table 3-13. Corrosion's Impact on NMC Hours by Nature of Work for Operationally Ready Aircraft, FY2009

NMC hours	Corrosion-related NMC hours	Corrective corrosion-related NMC hours	Preventive corrosion-related NMC hours	Percentage of corrective corrosion-related NMC hours	Percentage of preventive corrosion-related NMC hours
9,759,578	1,566,268	671,773	894,481	42.9	57.1

The percentage of corrective and preventive corrosion-related NMC hours for operationally ready aircraft is still weighted higher for preventive corrosion tasks, although not to the same degree as it is for all aircraft from Table 3-12.

In Table 3-14, we show a final breakdown of the top four activities contributing to the preventive NMC hours.

Table 3-14. Top Preventive NMC Hours by Activity for All Aircraft FY2009

Activity	Total preventive NMC hours	Percentage of total preventive NMC hours
Inspect/test	527,937	42.6
Clean	199,648	16.1
Treat	191,068	15.4
Preserve	55,666	4.5
All preventive activity	1,240,544	100.0

Inspection is, by far, the major contributor to corrosion-related preventive total NMC hours. It contributes more than twice as many corrosion-related NMC hours as the next largest preventive maintenance activity, clean. This area bears additional attention, especially because, from a methodology standpoint, the corrosion-related NMC hours are only a portion of the total NMC hours attributable to inspection. In other words, inspection is a leading cause of non-corrosion–related NMC unavailability, as well. An opportunity may exist to reduce the NMC hours attributable to preventive maintenance actions by examining how inspections, tests, and quality assurance checks are performed.

Appendix A
Army Aviation Equipment

The scope of this analysis included all Army aviation weapon systems. We also incorporated aircraft engines that often show up as depot-level reparables and examined 56 unique types of aircraft.

In FY2009, approximately 4,108 aircraft existed in the Army inventory, as reported in the Readiness Integrated Database (RIDB).

Table A-1 lists the Army's aircraft in the inventory for FY2009.

Table A-1. Army's Aircraft Inventory, FY2009

LIN	Model	Nomenclature	FY2009 inventory
1F0001	C-37A	Fixed wing aircraft	2
1F0002	C-37B	Fixed wing aircraft	1
1F0003	EO-5C	Airplane reconnaissance	5
A21633	OH-58D	Aerial scout helicopter	327
A29744	C-12C	Airplane cargo—transport	7
A29812	C-12D	Airplane cargo—transport	7
A30062	C-12F	Airplane cargo—transport	2
A31039	UV-20A	Airplane utility	1
A46758	C-26B	Airplane cargo—transport	9
A46888	C-20E	Airplane utility	1
BA1000	C-23A	Airplane cargo—transport	21
BA1002	RC-12G	Airplane reconnaissance	1
BA108Q	C-12U	Airplane cargo—transport	62
BA2006	EH-60L	Helicopter utility	6
C15172	CH-47F	Helicopter cargo—transport	52
H28647	AH-64A	Helicopter advanced attack	127
H30517	CH-47D	Helicopter cargo—transport	303
H30616	EH-60A	Helicopter electronic countermeasure	55
H30766	MH-60K	Helicopter utility	23
H31110	OH-58C	Helicopter observation	101
H31329	UH-72A	Helicopter light utility	62
H31872	UH-1V	Helicopter utility	75
H32361	UH-60L	Helicopter utility	573
H32429	UH-60M	Helicopter utility	84
H32611	TH-67A	Helicopter flight training	183

Table A-1. Army's Aircraft Inventory, FY2009

LIN	Model	Nomenclature	FY2009 inventory
H46150	MH-47E	Helicopter cargo	6
H48918	AH-64D	Helicopter attack	522
K29694	AH-1S	Helicopter attack AH-1S	1
K31042	OH-58A	Helicopter observation	186
K31795	UH-1H	Helicopter utility	141
K32293	UH-60A	Helicopter utility	861
M33458	HH-60M	Helicopter search and rescue	10
M85588	MH-60M	Helicopter utility	11
NL0015	C-12J	Airplane utility	3
NL0024	C-31A	Airplane utility	2
NL0051	EO-5B	Airplane electronic countermeasure	1
NL0053	EH-60B	Helicopter electronic countermeasure	1
NL0067	MH-60L	Helicopter special operations	37
NL0069	MH-6C	Helicopter special operations	0
NL0162	MH-6M	Helicopter special operations	51
NL0164	UC-35B	Airplane utility VIP	8
NL0221	C-23C	Airplane cargo	31
O01690	O-2A	Airplane observation	2
O02020	CE-182	Airplane utility	2
O02130	C-20F	Airplane utility	1
U84291	HH-60L	Helicopter utility	29
U84541	HH-60A	Helicopter utility	4
Z00836	C-27J	Airplane cargo—transport	1
Z01054	MH-47G	Helicopter cargo—transport	48
Z04549	RC-12D	Airplane reconnaissance	9
Z04821	RC-12N	Airplane reconnaissance	14
Z06669	RC-12H	Airplane reconnaissance	6
Z06737	RC-12K	Airplane reconnaissance	5
Z07365	RC-12P	Airplane reconnaissance	8
Z07433	RC-12Q	Airplane reconnaissance	3
Z95382	UC-35A	Airplane utility	19
Total			4,108

Note: LIN = line item number.

Appendix B
MC and NMC Rates by Aircraft

This appendix details the reported NMC hour totals for each Army aircraft.

Table B-1 shows the mission-capable (MC) and non-mission-capable (NMC) rates for FY2008 and FY2009 consolidated by line item number (LIN).

Table B-1. MC and NMC Rates by LIN for FY2008 and FY2009

Transaction date	LIN	Average aircraft	MC%	NMC%	NMCM%	NMCS%
FY2008	1F0001	1	83%	17%	17%	0%
FY2008	1F0002	1	99%	1%	1%	0%
FY2008	1F0003	4	53%	47%	44%	3%
FY2008	A21633	343	78%	22%	20%	2%
FY2008	A29744	12	95%	5%	5%	0%
FY2008	A29812	11	93%	7%	6%	1%
FY2008	A30062	5	74%	26%	25%	1%
FY2008	A30989	4	70%	30%	28%	2%
FY2008	A31039	0	48%	52%	32%	20%
FY2008	A46758	10	81%	19%	15%	4%
FY2008	A46888	1	92%	8%	8%	0%
FY2008	BA1000	26	76%	24%	22%	2%
FY2008	BA1002	1	0%	0%	0%	0%
FY2008	BA108Q	61	78%	22%	19%	3%
FY2008	BA2006	6	64%	36%	36%	0%
FY2008	C15172	36	81%	19%	18%	1%
FY2008	H28647	165	62%	38%	28%	9%
FY2008	H30517	330	65%	35%	29%	6%
FY2008	H30616	56	61%	39%	33%	6%
FY2008	H30766	23	77%	23%	16%	8%
FY2008	H31110	113	58%	42%	33%	9%
FY2008	H31329	25	90%	10%	8%	1%
FY2008	H31872	103	45%	55%	53%	2%
FY2008	H32361	593	77%	23%	20%	3%
FY2008	H32429	37	77%	23%	18%	5%
FY2008	H32611	183	75%	25%	21%	3%
FY2008	H44644	1	0%	100%	100%	0%
FY2008	H46150	13	73%	27%	26%	0%

Table B-1. MC and NMC Rates by LIN for FY2008 and FY2009

Transaction date	LIN	Average aircraft	MC%	NMC%	NMCM%	NMCS%
FY2008	H48918	495	73%	27%	24%	3%
FY2008	K29694	1	57%	43%	43%	0%
FY2008	K31042	197	68%	32%	26%	7%
FY2008	K31795	185	37%	63%	61%	2%
FY2008	K32293	892	66%	34%	28%	6%
FY2008	M33458	1	0%	0%	0%	0%
FY2008	M85588	1	66%	34%	34%	0%
FY2008	NL0015	3	84%	16%	12%	4%
FY2008	NL0024	2	61%	39%	37%	1%
FY2008	NL0051	1	55%	45%	45%	0%
FY2008	NL0053	1	40%	60%	60%	0%
FY2008	NL0067	36	74%	26%	20%	5%
FY2008	NL0069	6	71%	29%	16%	13%
FY2008	NL0162	48	83%	17%	14%	3%
FY2008	NL0164	8	74%	26%	20%	5%
FY2008	NL0221	27	89%	11%	10%	1%
FY2008	O01690	2	61%	39%	39%	0%
FY2008	O02020	2	82%	18%	18%	0%
FY2008	O02130	1	74%	26%	26%	0%
FY2008	U84291	29	79%	21%	19%	2%
FY2008	U84541	4	76%	24%	15%	10%
FY2008	Z00836	0	0%	0%	0%	0%
FY2008	Z01054	37	68%	32%	27%	4%
FY2008	Z04549	8	91%	9%	7%	1%
FY2008	Z04821	10	58%	42%	39%	3%
FY2008	Z06669	5	87%	13%	11%	2%
FY2008	Z06737	7	83%	17%	9%	7%
FY2008	Z07365	9	72%	28%	18%	9%
FY2008	Z07433	3	6%	94%	81%	13%
FY2009	1F0001	2	89%	11%	11%	0%
FY2009	1F0002	1	85%	15%	15%	0%
FY2009	1F0003	5	68%	32%	30%	3%
FY2009	A21633	327	72%	28%	26%	2%
FY2009	A29744	7	90%	10%	4%	7%
FY2009	A29812	7	93%	7%	4%	3%
FY2009	A30062	2	83%	17%	14%	3%
FY2009	A30989	4	73%	27%	27%	1%
FY2009	A31039	1	83%	17%	10%	7%
FY2009	A46758	9	77%	23%	22%	1%

Table B-1. MC and NMC Rates by LIN for FY2008 and FY2009

Transaction date	LIN	Average aircraft	MC%	NMC%	NMCM%	NMCS%
FY2009	A46888	1	32%	68%	67%	1%
FY2009	BA1000	21	74%	26%	25%	1%
FY2009	BA1002	1	0%	0%	0%	0%
FY2009	BA108Q	62	86%	14%	11%	3%
FY2009	BA2006	6	62%	38%	35%	4%
FY2009	C15172	52	80%	20%	19%	1%
FY2009	H28647	127	62%	38%	29%	9%
FY2009	H30517	303	61%	39%	31%	8%
FY2009	H30616	55	61%	39%	30%	9%
FY2009	H30766	23	76%	24%	18%	6%
FY2009	H31110	101	69%	31%	28%	3%
FY2009	H31329	62	90%	10%	7%	3%
FY2009	H31872	75	48%	52%	51%	1%
FY2009	H32361	573	75%	25%	23%	2%
FY2009	H32429	84	81%	19%	15%	5%
FY2009	H32611	183	76%	24%	21%	3%
FY2009	H44644	1	0%	100%	72%	27%
FY2009	H46150	6	87%	13%	13%	0%
FY2009	H48918	522	71%	29%	25%	4%
FY2009	K29694	1	93%	7%	7%	0%
FY2009	K31042	186	63%	37%	31%	6%
FY2009	K31795	141	42%	58%	57%	1%
FY2009	K32293	861	66%	34%	30%	4%
FY2009	M33458	10	76%	24%	22%	1%
FY2009	M85588	11	4%	96%	96%	0%
FY2009	NL0015	3	79%	21%	16%	5%
FY2009	NL0024	2	87%	13%	12%	1%
FY2009	NL0051	1	41%	59%	58%	0%
FY2009	NL0053	1	43%	57%	57%	0%
FY2009	NL0067	37	77%	23%	18%	6%
FY2009	NL0069	0	0%	0%	0%	0%
FY2009	NL0162	51	80%	20%	18%	2%
FY2009	NL0164	8	83%	17%	15%	2%
FY2009	NL0221	31	88%	12%	11%	1%
FY2009	O01690	2	54%	46%	46%	0%
FY2009	O02020	2	99%	1%	1%	0%
FY2009	O02130	1	61%	39%	38%	1%
FY2009	U84291	29	87%	13%	11%	2%
FY2009	U84541	4	66%	34%	32%	2%

Table B-1. MC and NMC Rates by LIN for FY2008 and FY2009

Transaction date	LIN	Average aircraft	MC%	NMC%	NMCM%	NMCS%
FY2009	Z00836	1	56%	44%	33%	11%
FY2009	Z01054	48	69%	31%	24%	6%
FY2009	Z04549	9	94%	6%	4%	2%
FY2009	Z04821	14	65%	35%	31%	4%
FY2009	Z06669	6	90%	10%	9%	1%
FY2009	Z06737	5	70%	30%	25%	5%
FY2009	Z07365	8	54%	46%	42%	4%
FY2009	Z07433	3	14%	86%	85%	1%
FY2009	Z95382	19	78%	22%	17%	5%

Appendix C
Corrosion Search Algorithm

We developed the corrosion search algorithm (see Table C-1) through an iterative process using our experience from previous studies, feedback from maintenance managers, discussions and observations from site visits with Army subject matter experts, and a scan of potential corrosion keywords within the maintenance description activity field from each database.

Table C-1. Corrosion Search Algorithm Steps

Step 1	Search for Army aviation failure codes (a total of 26 failure codes are used).	Apply appropriate corrosion percentage (varies from 5–100).
Step 2	Search for Process Analysis Data Collection System (PADCS) defect codes (a total of 26 defect codes are used).	Apply appropriate corrosion percentage (varies from 5–100).
Step3	Search for corrosion keywords from the descriptive text. (We modified keyword corrosion percentages to match corrosion percentages of failure codes based on similar corrosion actions.)	Apply appropriate corrosion percentage (varies from 5–100).

Table C-2 shows the fault cause codes that some Army FLM databases uses.

Table C-2. FLM Fault Cause Codes

Failure code	Description	Nature of maintenance	Final algorithm percentage
002	Air leak	Corrective	33
007	Arcing, arced	Corrective	5
710	Bearing or bushing failure	Corrective	40
705	Beyond specified tolerance	Corrective	50
135	Binding, includes friction excessive, locked	Corrective	75
050	Blistered	Corrective	100
170	Corroded	Corrective	100
190	Cracked	Corrective	50
846	Delamination	Corrective	60
117	Deteriorated	Corrective	100
507	Exposed to salt water environment	Corrective	100
240	Flaking	Corrective	100
280	Fungus effect	Corrective	100
923	Inspection required before use	Preventive	40
381	Leaking (liquid)	Corrective	33
385	Loose or missing rivets	Corrective	40

Table C-2. FLM Fault Cause Codes

Failure code	Description	Nature of maintenance	Final algorithm percentage
040	Mechanical binding	Corrective	75
420	Moisture saturation (condensation)	Corrective	90
307	Oil leak	Corrective	5
520	Pitted	Corrective	90
263	Poor bonding	Corrective	50
473	Seal/gasket blown	Corrective	5
840	Seized	Corrective	40
701	Warped	Corrective	5
722	Weld, cracked or broken	Corrective	50
622	Wet	Corrective	90

Table C-3 shows the fault cause codes the Corpus Christi Army Depot in Texas uses in the PADCS database.

Table C-3. PADCS Defect Cause Codes

Failure code	Description	Nature of maintenance	Final algorithm percentage
F001	Air leak	Corrective	33
A003	Arcing, arced	Corrective	5
E005	Bearing or bushing failure	Corrective	40
I005	Beyond specified tolerance	Corrective	50
E006	Binding	Corrective	75
E007	Blistered	Corrective	100
E008	Bonding separation	Corrective	50
I055	Corroded/rusty	Corrective	100
E026	Cracked	Corrective	50
I056	Delamination	Corrective	60
E029	Deteriorated	Corrective	100
C004	Exposed to salt water environment	Corrective	100
I016	Flaking	Corrective	100
C005	Fungus effect	Corrective	100
B010	Liquid leak	Corrective	33
E048	Loose hardware	Corrective	40
E056	Oil leak	Corrective	5
E066	Pitted	Corrective	90

Table C-3. PADCS Defect Cause Codes

Failure code	Description	Nature of maintenance	Final algorithm percentage
H008	Preservation	Preventive	100
E069	Rivets incorrect	Corrective	40
C007	Saturation moisture	Corrective	90
I048	Seal/gasket incorrect	Corrective	5
E078	Seized	Corrective	40
E091	Tooth broke on gear	Corrective	5
E099	Weld incorrect (cracked or broken)	Corrective	50
E100	Wet	Corrective	90

Table C-4 show the third element of our corrosion search algorithm, the appropriate keywords to be entered.

Table C-4. Corrosion Search Words

Preventive words	Corrective words
A&E	Abatement
acrylic	Abradable
activated silica	Abrasive
aerosol	Acetone
alclad	Acid
alkyd	Age harden
alkyl benzene sulfonate	Anti galling
alloying	Beach mark
alodine	Blast
alodining	Bleach
alternate-immersion	Blush
aluminiz	Body work
aluminum ion plat	Bodywork
anneal	Breakdown potential
anode	Brittle fracture
anodic	Caustic cracking
anodiz	Caustic dip
anolyte	Caustic embrittlement
anti pitt	Cavitation
arc wire spray	Cold crack
autoclav	Contaminants
bainite	Corro
black oxide	Crack
booth	Cracking

Table C-4. Corrosion Search Words

Preventive words	Corrective words
braz	Crateri
Cad A	Crawling
Cad C	Crazi
Cad P	Critical pitting potential
Cad S	Cure
Cadmium ion plat	Deactivation
Cadmium plat	Dealloy
Cadmuim	Dealloying
Calcareous	Deburr
Carbonitrid	Decay
Carburiz	Deioniz
Caseharden	Denickelification
Cass	Detergent
Cathode	Deterio
Cathodic	Deterriora
Caulk	Dewett
Cementation coat	Dezincification
Check	Disbond
Chemical conversion coat	Electrolysis
Chemical vapor deposition	Electrolytic cell
Chr P	Embrittl
Chrom	Environmental crack
Chromad	Erosion
Chromat	Exfoliate
Chromate treatment	Exfoliation
Chrome	Filamentary
Chromium	Filiform
Chromiz	Fish Eye
Cl/prep/pt/final each	Flake
Clad metal	Fogged metal
Cladd	Fouling
Clean	Fracture
Coat	Fretting
Copper accelerated salt spray	FSW
Copper plat	Galling
Corrodkote test	Gallionella ferruginea
Dehumidif	Grain Drop
Deposition	Graphiti
Detonation gun	Green rot

Table C-4. Corrosion Search Words

Preventive words	Corrective words
Dielectric fitt	Grind
Dielectric shield	Grnd
Diffusion coat	GTAW
Diluent	Hydraulic cement
E&E	Hydrogen blister
Earth pigment	Hydrogen damage
Eggshell	Hydroly
Electro plating	Impinge
Electrochemical cell	Inclusion
Electrod	Induced cracking
Electroles	Intercrystalline
Electroless nickel	Interdentric
Electroplat	Intergranular
Electropolish	Iron bacter
Electrostatic spray	Kiscc
Emulsion paint	Knifeline attack
Enamel	Lamellar
Epoxy	Leak
Eval	Leakage
Exempt solvent	Local cell
Extender	Long-line current
Feedwater treat	Lpps
Final test	Mechanical bond
Finish	Metal dusting
Flame harden	Metal polish
Flame spray	Metal wk
Flowcoat	Metal work
Galfan	Microbial
Galv	Mirobiological
Gel zeolite	Moisture
Glazing	Molten salt
Gloss	Oxidat
Gloss meter	Oxide
Groundb	Oxygen attack
Hardener	Oxygen concentration cell
Hardening	Ozone
Hardfac	Passivation
Hardness	Passive metal
Haze	Passive-active cell

Table C-4. Corrosion Search Words

Preventive words	Corrective words
Hiding power	Passivity
High velocity oxy	Patina
Hot crack	Peening
Hot isostatic	Pickle
Huey test	Pickling
Humidity test	Pitting
Hydration	Poultice
Hydrostatic test	Radiation damage
Immunity	Reactive metal
Impregnat	Red water
Impressed current	Reducing agent
Incubation period	Reducing atmosphere
Induction harden	Ringworm
Induction heat	Rot
Inert anode	Rust
Inhibit	Saline water
Inorganic zinc	Salt
Insp	Sand
Insulation	Scale
Intensiostatic	Scaling
Ion	Scrape
Ion implant	Sheet metal
Ion nitrid	Sheet mt
Ioniz	Sheet/M
Isopropyl	Sheetmetal
Lacquer	Shotpeen
Langelier ind	Shotpn
Lanthanide	Sht metal
Lapping	Sht metl
Latex	Shtpeen
Lithopone	Sigma phase
Lubrica	Sodium bicarbonate
Luggin	Sodium chloride
Magnetic particle exam	Sohic
Manganese greensand	Solder
Manganese zeolite	Solvent
Mask	Spalling
Matte	Specialty steel
Metal spray	Spotting

Table C-4. Corrosion Search Words

Preventive words
Metallizing
Metallurgical bond
Methylene blue active
Micrograph
Mineral spirit
MMA
Moneypenny-strauss
Mottle
Mtl spr
Mtl spray
Mtl spy surf
Naphtha
NDI
NDT
Neutraliz
Nirtrocarb
Nitrid
Nitrocarburizing
Noble metal
Noble potential
Open-circuit potential
Orange peel
Overspray
Paint
Passivator
Pearlite
Penetrant exam
Permanganate
Permeability
Phophatizing
Phosphatizing
Photo-thermal
Physisorption
Pigment
Plating

Corrective words
Stray current
Stress
Strip
Substrate
Sulfate-reducing bact
Sulfidation
Sulfide
Surface active agent
Surface preparation
Surfacer
Surfactant
Threshold stress
Tuberculation
Tungesten arc
Undercutting
Underfilm
Weld
Wrinkling

Table C-4. Corrosion Search Words

Preventive words
Polarization
Polish
Polymer
Polyphosphate
Polyurethane
Polyvinyl chloride
Porosity
Post-weld
Pot life
Potentio
Powder coat
Prechlorinat
Precious metal
Prep
Prep/brush
Prep/cad
Prep/process/plate
Prepare
Preserv
Prime
Priming
Protect
Protection potential
Pull-out
QA
QC
Qualif
Quality
Quenching
Rabbit ears
Radiography
Rapid charcoal
Refractory
Regenerant
Regeneration
Repaint
Re-paint
Resin
Retarder
Rosin

Table C-4. Corrosion Search Words

Preventive words
Rotted
Salinity
Salt fog
Seeds
Semipermeable membrane
Shrinkage
Shroud
Silica
Siliceous
Silicone
Silking
Silver
Skinning
Slow strain rate
Soda ash
Softening
Specific conductance
Splat
Splat cooling
Spray
Spraying
Sputtering
Standard electrode potential
Sulfonate
Surfacing
T.I.
Telegraphing
Tempering
Terne
Test
Thermocouple
Thermography
Thinner
Tinplate
Titanium dioxide
Titanium et
Topcoat
Touch up
Treat
Tribo charging

Table C-4. Corrosion Search Words

Preventive words
U-bend specimen
Ultrasonic
Urethane
UV stabilizers
Vapor deposit
Varnish
Wash
Wetting agent
Wrap around
Zinc

Appendix D
Corrosion NMC by Aircraft for FY2009

Table D-1 details the corrosion non-mission-capable (NMC) hours for the 20 Army aircraft with the largest average inventory.

Table D-1. Corrosion NMC Hours for Army Aircraft, FY2009

LIN	TMS	Total NMC hrs.	Corrosion-related NMC hrs.	Corrosion-related NMC hrs. as a percentage of total NMC hrs.
K32293	UH-60A	2,462,826	446,057	18.1
H32361	UH-60L	1,218,251	183,092	15.0
A21633	OH-58D	785,123	178,464	22.7
H30517	CH-47D	990,513	173,222	17.5
K31795	UH-1H	672,989	144,641	21.5
K31042	OH-58A	594,344	126,510	21.3
H28647	AH-64A	404,171	80,333	19.9
H31110	OH-58C	257,830	68,648	26.6
H48918	AH-64D	1,272,967	58,802	4.6
H32429	UH-60M	197,616	27,466	13.9
H31872	UH-1V	341,153	16,909	5.0
Z01054	MH-47G	116,754	13,128	11.2
C15172	CH-47F	87,075	12,616	14.5
NL0067	MH-60L	69,273	10,680	15.4
H30766	MH-60K	44,824	8,640	19.3
U84291	HH-60L	33,909	6,680	19.7
NL0162	MH-6M	82,953	6,088	7.3
M33458	HH-60M	17,068	3,605	21.1
U84541	HH-60A	10,723	1,702	15.9
H46150	MH-47E	6,016	1,306	21.7

Appendix E
Aviation Work Breakdown Structure Coding

We used the aviation work breakdown structure (AWBS) convention to assign codes to the work records for Army aviation equipment.

The AWBS is a five-character alphanumeric code that describes the

- end item type (i.e., “F” stands for fixed wing, “R” for rotary wing, and “M” is missile),
- maintenance activity,
- main system being maintained, and
- specific subsystem or part being worked.

Table E-1 shows the second character of the five-character alphanumeric code. The second character designates the action taken.

Table E-1. List of Maintenance Activity Codes (Second AWBS Character)

Code	Maintenance activity	Description
A	Assemble	Combine parts into subassembly
B	Calibrate	Bring into tolerance, adjust
C	Clean	Wash, decontaminate, blast, bath
D	Disassemble	Separate subassembly into parts
E	Dispose	Cannibalize, destroy
F	Fix	Remove, repair, reinstall
I	Inspect/test	Troubleshoot, warranty, non-defective inspection (NDI)
L	Installation	Install equipment, load, reload
M	Modify	Reconfigure, remove but do not repair or replace
O	Administrative	Administrative activities, such as paperwork and requisitions
P	Preserve	Lubricate, package, wrap
R	Replace	Remove and add an operational part
T	Treat	Prime, paint, coat
U	Unknown	Activity cannot be determined

The next two digits—the third and fourth characters—in the AWBS denote the system on which the action will be performed. Most of these codes align with the Army's aviation functional group codes (FGCs).[1]

The fifth character in the AWBS is a number that denotes the subsystem or part. Each system has up to nine subsystems associated with it, including an "Other" category. Table E-2 presents a complete system-to-subsystem mapping of the AWBS.

Table E-2. AWBS System and Subsystem Codes and Descriptions

Description	Sub-system	Subsystem description	FSC	Description
System 01				
Engines	0	Unknown	—	Unknown
	1	Gas turbine and jet engines	2840	Gas turbines and jet engines, aircraft, prime moving; and components
			2850	Gasoline rotary engines and components
	2	Gasoline reciprocating engines	2810	Gasoline reciprocating engines, aircraft prime mover; and components
	3	Engine system cooling components, aircraft prime moving	2935	Engine system cooling components, aircraft prime moving
	4	Engine electrical system components, aircraft prime moving	2925	Engine electrical system components, aircraft prime moving
	5	engine air and oil filters, cleaners, aircraft prime moving	2945	Engine air and oil filters, cleaners, aircraft prime moving
	6	Miscellaneous engine accessories, aircraft	2995	Miscellaneous engine accessories, aircraft
	7	Centrifugals, separators, and pressure and vacuum filters	4330	Centrifugals, separators, and pressure and vacuum filters
	7	Centrifugals, separators, and pressure and vacuum filters	4335	Centrifugals separators and filters
	8	Compressors and vacuum pumps	4310	Compressors and vacuum pumps
	9	Other	2815	Diesel engines and components

[1] The Army's Functional Group Codes are identified in Department of the Army Pamphlet 738-751, Functional Users Manual for the Army Maintenance Management System Aviation (TAMMS-A), 15 March 1999, p. 30, Table 1-10. The Army uses these codes to record the functional group of the aircraft and subsystems.

Table E-2. AWBS System and Subsystem Codes and Descriptions

Description	Sub-system	Subsystem description	FSC	Description
System 02				
Airframe	0	Unknown	—	Unknown
	1	Structural (aircraft, panel, plates)	1520	Aircraft, rotary wing
			5335	Metal screening
			9510	Bars and rods
			9515	Plate, sheet, strip, foil, and leaf
			9540	Structural shapes, nonferrous base metal
			9530	Bars and rods, nonferrous base metal
			9650	Nonferrous base metal refinery and intermediate forms
			1560	Airframe structural components
	2	Supports	1560	Airframe structural components
	3	Rib, covers, skins		
	4	Insulation		
	5	Door		
	6	Stiffener		
	7	Duct		
	8	Fitting, brackets, fairing		
	9	Other	9520	Structural shapes
System 03				
Landing gear	0	Unknown	—	Unknown
	1	Aircraft landing gear components	1620	Aircraft landing gear components
	2	Aircraft wheel and brake systems	1630	Aircraft wheel and brake systems
	3	Tires and tubes, pneumatic, aircraft	2620	Tires and tubes, pneumatic, aircraft
			2640	Tire rebuilding and tire and tube repair materials
	4	Aircraft landing equipment	1710	Aircraft landing equipment
	9	Other		
System 04				
Power distribution and electrical	0	Unknown	—	Unknown
	1	Batteries	6140	Batteries, rechargeable
			6160	Miscellaneous battery retaining fixtures, liners, and ancillary items
			6135	Batteries, non-rechargeable

Table E-2. AWBS System and Subsystem Codes and Descriptions

Description	Sub-system	Subsystem description	FSC	Description
	2	Lighting	6230	Electric portable and hand lighting equipment
			6240	Electric lamps
			6250	Ballasts, lampholders, and starters
			6260	Nonelectrical lighting fixtures
	3	Generators and generator sets	6115	Generators and generator sets electrical
	4	Circuitry	5945	Relays and solenoids
			5930	Switches
			5905	Resistors
			5940	Lugs, terminals, and terminal strips
			5925	Circuit breakers
			5920	Fuses, arrestors, absorbers, and protectors
			5955	Oscillators and piezoelectric crystals
			5961	Semiconductor devices and associated hardware
			5910	Capacitors
			5960	Electron tubes and associated hardware
			5962	Microcircuits, electronic
			5963	Electronic modules
	5	Transformers and amplifiers	5996	Amplifiers
			6120	Transformers, distribution, and power station
			5950	Coils and transformers
	6	Electrical hardware	6130	Converters, electrical, non-rotating
			6110	Electrical control equipment
			5999	Miscellaneous electrical and electronic components
			5935	Connectors, electrical
			5977	Electrical contact brushes and electrodes
			6125	Converters, electrical, rotating
			6145	Wire and cable, electrical
			5975	Electrical hardware and supplies
			5998	Electrical and electronic assemblies, boards, cards, and associated hardware

Table E-2. AWBS System and Subsystem Codes and Descriptions

Description	Sub-system	Subsystem description	FSC	Description
	7	Optics	5980	Optoelectronic devices and associated hardware
			6070	Fiber optic accessories and supplies
			6080	Fiber optic kits and sets
	8	Miscellaneous power distribution and transformer	3040	Miscellaneous power transmission equipment
			6150	Miscellaneous electric power and distribution equipment
			6105	Motors, electrical
			5990	Synchros and resolvers
			5915	Filters and networks
	9	Other	4440	Driers, dehydrators, and anhydrators
System 05				
Rotor and propeller system	0	Unknown	—	Unknown
	1	Main rotor blade	1615	Helicopter rotor blades, drive mechanisms and components
	2	Transmission (excluding main)		
	3	Rotary spindle head		
	4	Swashplate		
	5	Tail rotor (gearbox, blade, shaft)		
	6	Hub assembly		
	7	Driveshaft assembly		
	8	Mixer assembly		
	9	Aircraft propellers and components	1610	Aircraft propellers and components
System 06				
Drive system	0	Unknown	—	Unknown
	1	Main transmission	3010, 3020	Gears, pulleys, sprockets, and transmission chains; torque converters and speed changers
	2	Drive unit assembly		
	3	Clutch assembly		
	4	Gearbox		
	9	Other	3030	Belting, drive belts, fan belts, and accessories

Table E-2. AWBS System and Subsystem Codes and Descriptions

Description	Sub-system	Subsystem description	FSC	Description
System 07				
Hydraulics and pneudraulics	0	Unknown	—	Unknown
	1	Servo assembly/servocylinder	1650	Aircraft hydraulic, vacuum, and de-icing system components
	2	Cylinder assembly		
	3	Accumulator		
	4	Hydraulic/pneumatic actuator		
	5	Dampener, flutter		
	6	Piston, motor, pump		
	7	Filter		
	8	Valve		
	9	Other	9017	Fuels, lubricants, oils, and waxes
	9	Other	9028	Fuels, lubricants, oils, and waxes
	9	Other	9029	Fuels, lubricants, oils, and waxes
	9	Other	9032	Fuels, lubricants, oils, and waxes
	9	Other	9033	Fuels, lubricants, oils, and waxes
	9	Other	9034	Fuels, lubricants, oils, and waxes
	9	Other	9045	Fuels, lubricants, oils, and waxes
	9	Other	9051	Fuels, lubricants, oils, and waxes
	9	Other	9052	Fuels, lubricants, oils, and waxes
	9	Other	9056	Fuels, lubricants, oils, and waxes
	9	Other	9057	Fuels, lubricants, oils, and waxes
	9	Other	9059	Fuels, lubricants, oils, and waxes
	9	Other	9064	Fuels, lubricants, oils, and waxes
	9	Other	9066	Fuels, lubricants, oils, and waxes
	9	Other	9077	Fuels, lubricants, oils, and waxes
	9	Other	9079	Fuels, lubricants, oils, and waxes
	9	Other	9083	Fuels, lubricants, oils, and waxes
	9	Other	9084	Fuels, lubricants, oils, and waxes
	9	Other	9085	Fuels, lubricants, oils, and waxes
	9	Other	9091	Fuels, lubricants, oils, and waxes
	9	Other	9093	Fuels, lubricants, oils, and waxes
	9	Other	9097	Fuels, lubricants, oils, and waxes
	9	Other	9110	Fuels, solid
	9	Other	9205	Fuels, lubricants, oils, and waxes
	9	Other	9237	Fuels, lubricants, oils, and waxes
	9	Other	9251	Fuels, lubricants, oils, and waxes
	9	Other	9265	Fuels, lubricants, oils, and waxes
	9	Other	9150	Oils and greases: cutting, lubricating, and hydraulic

Table E-2. AWBS System and Subsystem Codes and Descriptions

Description	Sub-system	Subsystem description	FSC	Description
System 09				
Miscellaneous aircraft	0	Unknown	—	Unknown
	1	Aircraft maintenance and repair shop specialized equipment	4920	Aircraft maintenance and repair shop specialized equipment
			3210	Sawmill and planing mill machinery
			3439	Miscellaneous welding, soldering, and brazing supplies and accessories
			3460	Machine tool accessories
			3895	Miscellaneous construction equipment
			3920	Material handling equipment, non-self-propelled
			3950	Winches, hoists, cranes, and derricks
			4931	Fire control maintenance and repair shop specialized equipment
			4933	Weapons maintenance and repair shop specialized equipment
			4935	Guided missile maintenance, repair, and checkout specialized equipment
			4940	Miscellaneous maintenance and repair shop specialized equipment
			3230	Tools and attachments for woodworking machinery
			3433	Gas welding, heat cutting, and metalizing equipment
			3455	Cutting tools for machine tools
			3465	Production jigs, fixtures, and templates
	2	Panels	1680	Miscellaneous aircraft accessories and components
	3	Seats	1680	Miscellaneous aircraft accessories and components
	4	Non-hydraulic and non-pneudralic actuators	1680	Miscellaneous aircraft accessories and components
	5	Control devices	1680	Miscellaneous aircraft accessories and components
	6	Bell crank	1680	Miscellaneous aircraft accessories and components
	7	Safety	1680	Miscellaneous aircraft accessories and components
			4240	Safety and rescue equipment
	8	Windshield	1680	Miscellaneous aircraft accessories and components

Table E-2. AWBS System and Subsystem Codes and Descriptions

Description	Sub-system	Subsystem description	FSC	Description
	9	Other	9390	Miscellaneous fabricated nonmetallic materials
			3940	Blocks, tackle, rigging, and slings
			9749	Nonferrous scrap
			9535	Plate, sheet, strip, and foil; nonferrous base metal
			9320	Rubber fabricated materials
			9330	Plastics fabricated materials
			1680	Not indicators, not above
			7195	Miscellaneous furniture and fixtures
			7930	Cleaning and polishing compounds and preparations
			8010	Paints, dopes, varnishes, and related products
			8020	Paint and artists' brushes
			1670	Parachutes; aerial pick-up, delivery, recovery systems; and cargo tie-down equipment
			8475	Specialized flight clothing and accessories
System 10				
Fuel system	0	Unknown	—	Unknown
	1	Engine fuel system components, aircraft and missile prime movers	2915	Engine fuel system components, aircraft and missile prime movers
	2	Engine fuel system components, non-aircraft	2910	Engine fuel system components, non-aircraft
	3	Liquid propellants and fuels, petroleum base	9130	Liquid propellants and fuels, petroleum base
	4	Lubrication and fuel dispensing equipment	4930	Lubrication and fuel dispensing equipment
	9	Other	3655	Gas generating and dispensing systems, fixed or mobile
			4530	Fuel burning equipment units
			9140	Fuel oils
System 11				
Flight control	0	Unknown	—	Unknown
	1	Flight instruments	6610	Flight instruments
			1680	Indicators
	2	Radar equipment, airborne	5841	Radar equipment, airborne

Table E-2. AWBS System and Subsystem Codes and Descriptions

Description	Sub-system	Subsystem description	FSC	Description
	3	Automatic pilot mechanisms and airborne gyro components	6615	Automatic pilot mechanisms and airborne gyro components
	4	Engine instruments	6620	Engine instruments
	5	Headsets, handsets, microphones, and speakers	5965	Headsets, handsets, microphones, and speakers
	6	ADP equipment software, supplies and support equipment	7025	ADP input/output and storage devices
			7021	ADP central processing unit (CPU), computer, digital
			7045	ADP supplies
			7050	ADP components
			7010	ADPE system configuration
			7020	ADP CPU, computer, analog
			7030	ADP software
	7	Aircraft control cable products	1640	Aircraft control cable products
	9	Other	6316	Alarm and signal systems
			6310	Traffic and transit signal systems
System 12				
Measuring and testing instruments	0	Unknown	—	Unknown
	1	Electrical and electronic properties measuring and testing instruments	6625	Electrical and electronic properties measuring and testing instruments
	2	Liquid and gas flow, liquid level, and mechanical motion measuring instruments	6680	Liquid and gas flow, liquid level, and mechanical motion measuring instruments
	3	Combination and miscellaneous instruments	6695	Combination and miscellaneous instruments
	4	Pressure, temperature, and humidity measuring and controlling instruments	6685	Pressure, temperature, and humidity measuring and controlling instruments
			6655	Geophysical instruments
			6660	Meteorological instruments and apparatus
	5	Optical instruments, test equipment, components, and accessories	6650	Optical instruments, test equipment, components, and accessories
	6	Chemicals	6810	Chemicals
			6830	Gases, compressed and liquefied
			6850	Miscellaneous chemical specialties
			6505	Drugs and biologicals
			6630	Chemical analysis instruments
			6840	Pest control agents and disinfectants

Table E-2. AWBS System and Subsystem Codes and Descriptions

Description	Sub-system	Subsystem description	FSC	Description
	9	Other	6665	Hazard-detecting instruments and apparatus
			6670	Scales and balances
			6675	Drafting, surveying, and mapping instruments
			6640	Laboratory equipment and supplies
			5210	Measuring tools, craftmen's
			6635	Physical properties, testing and inspection
System 13				
Environmental control	0	Unknown	—	Unknown
	1	Wallboard, building paper, and thermal insulation materials	5640	Wallboard, building paper, and thermal insulation materials
	2	Electrical insulators and insulating materials	5970	Electrical insulators and insulating materials
	3	Firefighting equipment	4210	Firefighting equipment
	4	Fans, air circulators, and blower equipment	4140	Fans, air circulators, and blower equipment
	5	Waste disposal equipment	4540	Waste disposal equipment
			4230	Decontaminating and Impregnating Equipment
			4235	Hazardous material spill containment and clean-up equipment and Material
			4250	Recycling and reclamation equipment
	6	Aircraft air conditioning, heating, and pressurizing equipment	1660	Aircraft air conditioning, heating, and pressurizing equipment
			4110	Refrigeration equipment
			4120	Air conditioning equipment
			4460	Air purification equipment
			4130	Refrigeration and air conditioning components
	9	Other	4520	Space and water heating equipment
System 14				
Ground support equipment	1	Demolition and ammunition handling equipment	1190	Specialized test and handling equipment, nuclear ordnance
			1375	Demolition materials
			1390	Fuzes and primers
			1398	Specialized ammunition handling and servicing equipment

Table E-2. AWBS System and Subsystem Codes and Descriptions

Description	Sub-system	Subsystem description	FSC	Description
	2	Medical and dental equipment	6515	Medical and surgical instruments, equipment, and supplies
			6520	Dental instruments, equipment, and supplies
			6525	X-ray equipment and supplies: medical, dental, veterinary
			6530	Hospital furniture, equipment, utensils, and supplies
			6532	Hospital and surgical clothing and related special purpose items
			6545	Replenishable field medical sets, kits, and outfits
	3	Aircraft launching and servicing equipment	1720	Aircraft launching equipment
			1730	Aircraft ground servicing equipment
			1740	Airfield specialized trucks and trailers
	4	Vehicle systems and parts	6220	Electric vehicular lights and fixtures
			2320	Trucks and truck tractors wheeled
			2330	Trailers
			2410	Tractor, full tracked, low speed
			2510	Vehicular cab, body, and frame structural components
			2520	Vehicular power transmission components
			2530	Vehicular brake, steering, axle, wheel, and track components
			2540	Vehicular furniture and accessories
			2590	Miscellaneous vehicular components
			2610	Tires and tubes, pneumatic, except aircraft
	5	Engine and engine accessories, non-aircraft	2805	Gasoline reciprocating engines, except aircraft; and components
			2825	Steam turbines and components
			2835	Gas turbines and jet engines; non-aircraft prime mover, aircraft non-prime mover, and components
			2895	Miscellaneous engines and components
			2920	Engine electrical system components, non-aircraft
			2930	Engine cooling system components, non-aircraft

Table E-2. AWBS System and Subsystem Codes and Descriptions

Description	Sub-system	Subsystem description	FSC	Description
			2940	Engine air and oil filters, strainers, and cleaners, non-aircraft
			2950	Turbo-supercharger and components
			2990	Miscellaneous engine accessories, non-aircraft
	6	Industrial equipment	3220	Woodworking machines
			3405	Saws and filing machines
			3431	Electric arc welding equipment
			2030	Deck machinery
			2132	Railway equipment
			2198	Railway equipment
			2239	Railway equipment
			3410	Electrical and ultrasonic erosion machines
			3417	Milling machines
			3419	Miscellaneous machine tools
			3456	Cutting and forming tools for secondary metalworking machinery
			3620	Rubber and plastics working machinery
			3635	Crystal and glass industries machinery
			3645	Leather tanning and leather working industries machinery
			3695	Miscellaneous special industry machinery
			5510	Lumber and related basic wood materials
			5675	Non-wood construction lumber and related materials
			3530	Industrial sewing machines and mobile textile repair shops
			3610	Printing, duplicating, and bookbinding equipment
			3611	Industrial marking machines
			3694	Clean work stations, controlled environment, and related equipment
			3825	Road clearing, cleaning, and marking equipment
			3835	Petroleum production and distribution equipment

Table E-2. AWBS System and Subsystem Codes and Descriptions

Description	Sub-system	Subsystem description	FSC	Description
			3930	Warehouse trucks and tractors, self-propelled
			4220	Marine lifesaving and diving equipment
			4410	Industrial boilers
			4420	Heat exchangers and steam condensers
			4430	Industrial furnaces, kilns, lehrs, and ovens
			4470	Nuclear reactors
			4510	Plumbing fixtures and accessories
			4910	Motor vehicle maintenance and repair shop specialized equipment
			5430	Storage tanks
			5440	Scaffolding equipment and concrete forms
			5530	Plywood and veneer
			5670	Building components, prefabricated
			5680	Miscellaneous construction materials
	7	Lighting and recording devices	5815	Teletype and facsimile equipment
			5820	Radio and television communication equipment, except airborne
			5825	Radio navigation equipment, except airborne
			5835	Sound recording and reproducing equipment
			5840	Radar equipment, except airborne
			6010	Fiber optic conductors
			6021	Fiber optic switches
			6029	Fiber optic repeaters
			6030	Fiber optic devices
			6034	Fiber optic mod/demodulators
			6035	Fiber optic light/image transfer
			6060	Fiber optic interconnectors
			6072	Fiber optic accessories and supplies
			6210	Indoor and outdoor electric lighting fixtures

Table E-2. AWBS System and Subsystem Codes and Descriptions

Description	Sub-system	Subsystem description	FSC	Description
	8	Packaging and office supplies	7035	ADP support equipment
			7105	Household furniture
			7110	Office furniture
			7125	Cabinets, lockers, bins, and shelving
			7220	Floor coverings
			7230	Draperies, awnings, and shades
			7240	Household and commercial utility containers
			7290	Miscellaneous household and commercial furnishings and appliances
			7210	Household furnishings
			7253	Household and commercial furnishings and appliances
			7320	Kitchen equipment and appliances
			7460	Visible record equipment
			7540	Standard forms
			7610	Books and pamphlets
			7310	Food cooking, baking, and serving equipment
			7330	Kitchen hand tools and utensils
			7340	Cutlery and flatware
			7350	Tableware
			7490	Miscellaneous office machines
			7510	Office supplies
			7520	Office devices and accessories
			7530	Stationery and record forms
			7690	Miscellaneous printed matter
			7910	Floor polishers and vacuum cleaning equipment
			7920	Brooms, brushes, mops, and sponges
			8105	Bags and sacks
			8110	Drums and cans
			8115	Boxes, cartons, and crates
			8120	Commercial and industrial gas cylinders
			8125	Bottles and jars
			8130	Reels and spools
			8135	Packaging and packing bulk materials
			8140	Ammunition and nuclear ordnance boxes, packages and special containers
			8145	Specialized shipping and storage containers

Table E-2. AWBS System and Subsystem Codes and Descriptions

Description	Sub-system	Subsystem description	FSC	Description
	9	Miscellaneous materials, non-aircraft	8305	Textile fabrics
			8310	Yarn and thread
			8315	Notions and apparel findings
			8330	Leather
			8345	Flags and pennants
			8405	Outerwear, men's
			8415	Clothing, special purpose
			8430	Footwear, men's
			8460	Luggage
			8465	Individual equipment
			8510	Perfumes, toilet preparations, and powders
			8520	Toilet soap, shaving preparations, and dentifrices
			8530	Personal toiletry articles
			8540	Toiletry paper products
			8960	Beverages, nonalcoholic
			9310	Paper and paperboard
			9340	Glass fabricated materials
			9545	Plate, sheet, strip, foil, and wire: precious metal
			9905	Signs, advertising displays, and identification plates
			9999	miscellaneous items
			2010	ship and boat propulsion components
			2090	Miscellaneous ship and marine equipment
System 15				
Training devices	0	Unknown	—	Unknown
	1	Operational training devices	6930	Operation training devices
	2	Armament training devices	6920	Armament training devices
	3	Communication training devices	6940	Communication training devices
	4	General training aids, including computers	6910	Training aids
	9	Other		
System 19				
Avionics	0	Unknown	—	Unknown
	1	Communication	5895	Miscellaneous communication equip-ment

Table E-2. AWBS System and Subsystem Codes and Descriptions

Description	Sub-system	Subsystem description	FSC	Description
			5995	Cable, cord, and wire assemblies: communication equipment
			5821	Radio and television communication equipment, airborne
			5811	Other cryptologic equipment and components
			5805	Telephone and telegraph equipment
			5831	Intercommunication and public address systems, airborne
			5810	Communications security equipment and components
			5850	Visible and invisible light communication equipment
	2	Navigation	6605	Navigational instruments
			5826	Radio navigation equipment, airborne
	3	Antennas, waveguides, and related equipment	5985	Antennas, waveguides, and related equipment
	4	Alarms	6340	Aircraft alarm and signal systems
			6350	Miscellaneous alarm, signal, and security detection systems
	5	Electronic countermeasures	5865	Electronic countermeasures, counter-countermeasures and quick reaction capability equipment
	6	Time-measuring instrument	6645	Time measuring instruments
	9	Other	5860	Stimulated coherent radiation devices, components, and accessories
System 20				
Consumables and toolbox hardware	0	Unknown	—	Unknown
	1	Metal	5310	Nuts and washers
			5340	Hardware, commercial
			5306	Bolts
			5320	Rivets
			5315	Nails, machine keys, and pins
			5365	Bushings, rings, shims, and spacers
			5305	Screws
			4030	Fittings for rope, cable, and chain
			5360	Coil, flat, leaf, and wire springs
			5307	Studs
			5136	Taps, dies, and collets; hand and machine
			4061	Rope, cable, chain, and fittings

Table E-2. AWBS System and Subsystem Codes and Descriptions

Description	Sub-system	Subsystem description	FSC	Description
			9505	Wire, nonelectrical
			9525	Wire, nonelectrical, nonferrous base metal
			5133	Drill bits, counterbores, and countersinks: hand and machine
	2	Adhesives and fasteners	5325	Fastening devices
			8040	Adhesives
	3	Rubber	5330	Packing and gasket materials
			4710	Pipe, tube and rigid tubing
			4720	Hose and flexible tubing
			5331	O-ring
	4	Plastic	4730	hose, pipe, tube, lubrication, and railing fittings
			5355	knobs and pointers
	5	Preservative and sealing compound	8030	preservative and sealing compounds
	6	Rope	4020	Fiber rope, cordage, and twine
			4010	Chain and wire rope
	7	Hand tools	5120	Hand tools, non-edged, non-powered
			5100	Hand tools
			5108	Hand tools
			5112	Hand tools
			5115	Hand tools
			5135	Hand tools
			5143	Hand tools
			5224	Measuring tools
			5240	Measuring tools
			5275	Measuring tools
			5130	Hand tools, power driven
			5180	Sets, kits, and outfits of hand tools
			5220	Inspection gages and precision layout tools
			5110	Hand tools, edged, non-powered
	9	Other	5140	Tool and hardware boxes
			5356	Hardware and abrasives
			5399	Hardware and abrasives
			5345	Disks and stones, abrasive
			5350	Abrasive materials

Table E-2. AWBS System and Subsystem Codes and Descriptions

Description	Sub-system	Subsystem description	FSC	Description
System 21				
Bearings	0	Unknown	—	Unknown
	1	Bearings, antifriction, unmounted	3110	Bearings, antifriction, unmounted
	2	Bearings, plain, unmounted	3120	Bearings, plain, unmounted
	3	Bearings, mounted	3130	Bearings, mounted
	9	Other		
System 22				
Valves and pumps	0	Unknown	—	Unknown
	1	Power and hand pumps	4320	Power and hand pumps
	2	Valves, powered	4810	Valves, powered
	3	Valves, non-powered	4820	Valves, non-powered
	9	Other		
System 31				
Fire control system and target acquisition	0	Unknown	—	Unknown
	1	Fire control designating and indicating equipment	1260	Fire control designating and indicating equipment
			1217	Fire control equipment
			1265	Fire control transmitting and receiving equipment, except airborne
			1210	Fire control directors
			1285	Fire control radar equipment, except airborne
	2	Aircraft gunnery fire control components	1270	Aircraft gunnery fire control components
	3	Optical sighting and ranging equipment	1240	Optical sighting and ranging equipment
	4	Fire control computing sights and devices	1220	Fire control computing sights and devices
	5	Miscellaneous fire control equipment	1290	Miscellaneous fire control equipment
	6	Photographic and video equipment	6760	Photographic equipment and accessories
			6720	Cameras, still picture
			6740	Photographic Developing and Finishing Equipment
			6710	Cameras, motion picture
			5836	Video Recording and Reproducing Equipment
			6750	Photographic supplies
	7	Underwater Sound Equipment	5845	Underwater sound equipment

Table E-2. AWBS System and Subsystem Codes and Descriptions

Description	Sub-system	Subsystem description	FSC	Description
	8	Aircraft Bombing Fire Control Components	1280	Aircraft bombing fire control components
	9	Other	1550	Drones
System 34				
Night vision assembly	0	Unknown	—	Unknown
	1	Infrared System	5855	Night Vision Equipment, Emitted and Reflected Radiation
	2	Image Intensifier		
	3	Lens Assembly, Focus		
	4	Eyepiece Assembly		
	5	Shelf, Pivot and Adj		
	9	Other		
System 35				
Armament	0	Unknown	—	Unknown
	1	Guns	1005	Guns, through 30mm
			1010	Guns, over 30mm up to 75mm
			1015	Guns, 75mm through 125mm
			1025	Guns, over 150mm through 200mm
	2	Hardware, weapon system	5342	Hardware, weapon system
	3	Launchers, rocket and pyrotechnic	1340	Rockets, rocket ammunition and rocket components
			1055	Launchers, rocket and pyrotechnic
	4	Non-missile ammunition	1377	Cartridge and propellant actuated devices and components
			1306	Ammunition through 30mm
			1331	Grenades
			1358	Torpedo explosive components
			1361	Depth charges and components, explosive
			1320	Ammunition, over 125mm
			1350	Underwater mine and components, inert
	5	Guided missile systems and warheads	1336	Guided missile warheads and explosive components
			1338	Guided missile and space vehicle inert propulsion units, solid fuel; and components
			1410	Guided missiles
			1420	Guided missile components
			1111	Nuclear ordnance
			1425	Guided missile systems, complete

Table E-2. AWBS System and Subsystem Codes and Descriptions

Description	Sub-system	Subsystem description	FSC	Description
			1427	Guided missile subsystems
			1430	Guided missile remote control systems
			1440	Launchers, guided missile
			1450	Guided missile handling and servicing equipment
	6	Ammunition maintenance	4925	Ammunition maintenance, repair, and checkout specialized equipment
	7	Degaussing and mine sweeping equipment	1075	Degaussing and mine sweeping equipment
	9	Other	1090	Assemblies interchangeable between weapons in two or more classes
			1095	Miscellaneous weapons

Appendix F
Abbreviations

AAE	Army Acquisition Executive
ASA(ALT)	Assistant Secretary of the Army for Acquisition, Logistics, and Technology
AMC	Army Materiel Command
AMCOM	Aviation and Missile Command
AMRDEC	Aviation-Missile Research, Development, and Engineering Center
USD(AT&L)	Under Secretary of Defense for Acquisition, Technology and Logistics
AWBS	aviation work breakdown structure
CCPE	Corrosion Control and Prevention Executives
CPC IPT	Corrosion Prevention and Control Integrated Product Team
CPO	Corrosion Program Office
DASA(AP&L)	Deputy Assistant Secretary of the Army for Acquisition Policy and Logistics
DM	depot maintenance
FLM	field-level maintenance
FMC	fully mission capable
FSC	Federal Supply Classification
GAO	Government Accountability Office
GS	general support
JPEO	joint program executive office
LCMC	life-cycle management command
LIN	line item number
LIW	logistics information warehouse
M	maintenance
MC	mission capable
NDI	non-destructive inspection
NMC	not mission capable
NMCM	not mission capable maintenance
NMCS	not mission capable supply
NSN	national stock number

ORG	organizational level
PADCS	Process Analysis Data Collection System
PBUSE	Property Book Unit Supply Enhanced
PEO	program executive office
PMC	partially mission capable
PM	program manager
RDECOM	Research, Development, and Engineering Command
RDEC	research, development, and engineering center
RIDB	readiness integrated data base
S	supply
SME	subject matter expert
SPT	Support level
TMS	type/model/series
USD(AT&L)	Under Secretary of Defense for Acquisition, Technology and Logistics
WBS	work breakdown structure
WIPT	working integrated product team