CorrDefense DoD News about Preserving Military Assets

Volume 8, Number 1
Spring 2012
Inside DoD

DoD Releases a Report on the Effects of Corrosion on the Cost and Availability of Air Force Aircraft and Missiles

By Eric Herzberg

The Corrosion Prevention and Control Integrated Product Team (CPC IPT) asked LMI Government Consulting in May of 2010 to estimate the impact of corrosion on the availability of all DoD aviation weapon systems and on the cost of Navy, Marine Corps, and Air Force aviation systems. This report presents our estimates of the corrosion-related availability and cost impact for Air Force aircraft and missiles.

Using fiscal year (FY) 2008 and FY2009 as a measurement baseline, we estimated the annual corrosion cost for Air Force aviation and missiles to be $4.5 billion, or 24.0 percent of maintenance costs. We also estimated the effect of corrosion on non-available hours (NAH) for all Air Force aviation assets. Corrosion is a contributing factor in approximately 2.1 million hours of non-availability, or 12.1 percent of the total. These hours equate to an average of 15.9 days of corrosion-related non-availability per year for every aircraft in active status.[1]

This review of Air Force aviation and missiles is part of a multiple-year plan to measure the impact of corrosion on cost and availability. This is the first availability study. Table 1 lists past and future cost studies, while Table 2 lists the availability studies.

Table 1 - Cost of Corrosion Studies

Study year[a]	Study segment	Annual cost of corrosion (in billions)	Data baseline
2005–2006	Army ground vehicles	$2.0	FY2004
	Navy ships	$2.4	FY2004
2006–2007	DoD facilities and infrastructure	$1.8	FY2005
	Army aviation and missiles	$1.6	FY2005
	Marine Corps ground vehicles	$0.6	FY2005
2007–2008	Navy and Marine Corps aviation	$2.6	FY2005 and FY2006
	Coast Guard aviation and vessels	$0.3	FY2005 and FY2006
2008–2009	Air Force	$3.6	FY2006 and FY2007
	Army ground vehicles	$2.4	FY2006 and FY2007
	Navy ships	$2.5	FY2006 and FY2007
	DoD—other equipment	$5.1	FY2006
2009–2010	Marine Corps ground vehicles	$0.5	FY2007 and FY2008
	DoD facilities and infrastructure	$1.9	FY2007 and FY2008
	Army aviation and missiles	$1.4	FY2007 and FY2008
2010–2011	Air Force	$4.5	FY2008 and FY2009
	Navy and Marine Corps aviation	$2.6	FY2008 and FY2009
2011–2012	Army ground vehicles and Navy ships	–	FY2008–FY2010
2012–2013	Repeat 2009-2010	–	FY2009–FY2011

Study period is one calendar year.

Table 2 - Effect of Corrosion on Availability Studies

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

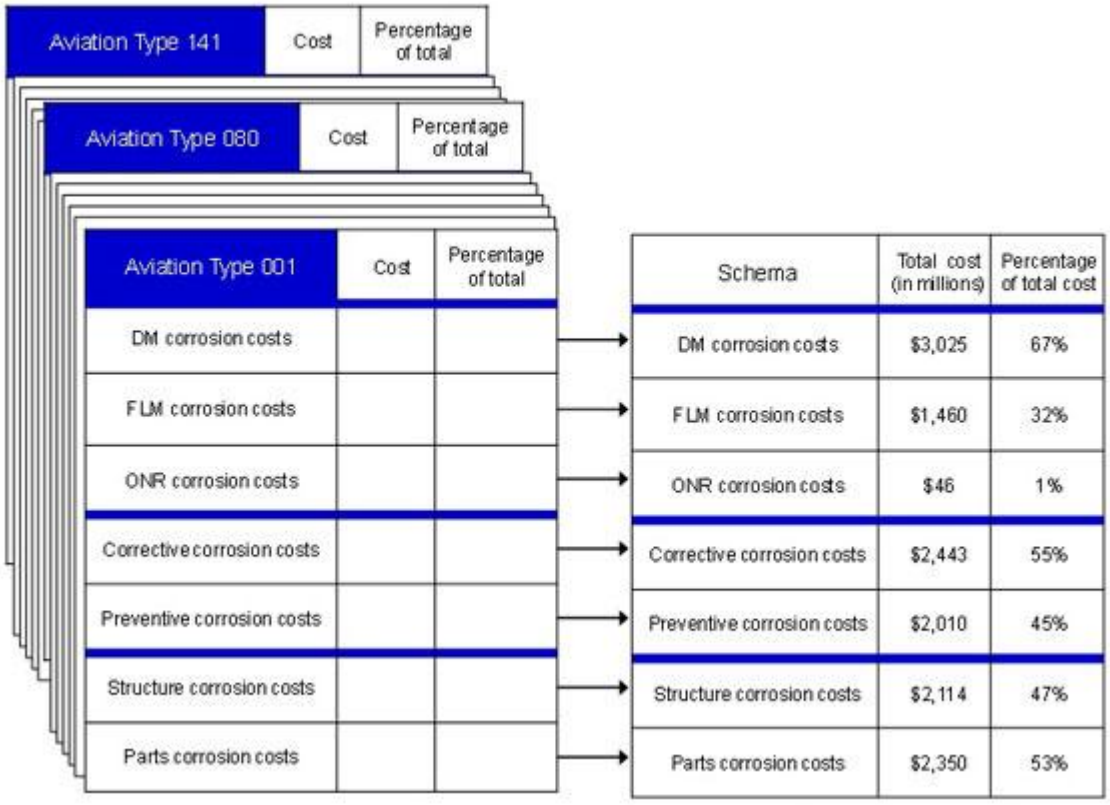
Study period is one calendar year.

To provide a sense of scale for our estimates, the overall aircraft and missile corro-sion-related costs equate to an average of 24 percent of total annual Air Force maintenance costs. This percentage is among the highest in the corrosion cost studies completed thus far. The overall Air Force aviation and missile corrosion cost as a percent of maintenance cost has been steadily increasing over the last four years of the study.

Our estimated corrosion costs apply to 136 types of Air Force aviation equipment and to 25 different engine models. The scope of the study included an inventory of 5,938 aircraft and 9 ballistic missile types for the cost study, and 5,504 aircraft for the availability study. To our knowledge, these data include all Air Force aviation and missile types.

We used three schema groups to categorize corrosion costs associated with aviation and missile equipment. In Figure 1, we show the study results segregated by sche-ma. The percentages indicate the relative ratios of the different schemas.

Figure 1 - Cost of Corrosion for Air Force Aircraft and Missile Equipment by Schema (FY2009 data)



Note: This figure does not depict the $32 million in corrosion costs that we were unable to classify as either preventive or corrective, nor does it depict the $21 million in corrosion costs that we could not assign to structure or parts. DM = depot maintenance; FLM = field-level maintenance; ONR = outside normal reporting.

Schema group 1 shows that corrosion-related depot maintenance (DM) costs exceed corrosion-related field-level maintenance (FLM) costs. This is true both on a total cost and percentage of maintenance basis. Corrosion-related DM costs ($3.025 bil-lion) are more than double the corrosion-related FLM costs ($1.460 billion). Addi-tionally, the DM corrosion cost as a percentage of total DM cost is 27.5 percent, exceeding the FLM corrosion cost as a percentage of total FLM, 19.0 percent, (see Table 3). Together, DM and FLM account for 99 percent of the total combined corrosion cost for Air Force aircraft and missiles ($4.484 billion). Outside normal reporting corrosion costs are minor ($46 million) when compared to those associated with DM and FLM.

Table 3 - Comparison of DM and FLM Corrosion Cost ($ in millions)

Type of maintenance	Maintenance cost (in millions)	Corrosion cost (in millions)	Corrosion cost as percentage of maintenance cost
DM	$10,986	$3,024	27.5
FLM	$7,671	$1,461	19.0

Schema group 2 compares corrective costs ($2,443 million, or 55 percent) and preventive costs ($2,010 million, 45 percent). Schema 3 compares structure-related costs ($2,114 million, or 47 percent) to parts-related costs ($2,350 million, or 53 percent). We distributed the $4.5 billion corrosion costs among each schema separately to the extent that we could classify the respective maintenance records by their schema.

We stratified the corrosion costs of Air Force aviation and missile systems by type/model/series (TMS), total cost, and cost per item. We then ranked the top 10 systems by their total corrosion cost and average corrosion cost. The order in which Air Force aviation assets are listed in Table 4 suggests a priority for further examination from a corrosion cost standpoint. The TMS that we highlight are among the top 10 for combined total and average corrosion cost ranking for each of the four study years. The B-52H was the second largest contributor to average corrosion cost for Air Force aviation and the fourth largest in total corrosion cost, making it the greatest contributor from a combined ranking standpoint.

Table 4 - Highest Combined Ranking for Average and Total Corrosion Cost (FY2009)

TMS	Description	Corrosion cost per item (in millions)	Per-item corrosion cost rank	Total corrosion cost (in millions)	Corrosion cost rank	Combined rank score	Weapon system rank
B-52H	Long range heavy bomber	$3.6	2	$273.9	4	6	1
E-3B	Airborne warning and control aircraft	$7.6	1	$174.3	7	8	2
B-1B	Long range bomber	$3.5	3	$233.5	6	9	3
KC-135R	Aerial refueling tanker	$1.7	10	$613.8	1	11	4
C-5B	Tactical airlift aircraft	$3.4	4	$160.4	9	13	5
C-5A	Tactical airlift aircraft	$2.7	6	$161.3	8	14	6
C-130H	Tactical airlift aircraft	$1.4	11	$373.7	3	14	6
MC-130H	Special operations missions	$2.8	5	$56.6	18	23	8
A-10A	Close air support aircraft	$1.0	14	$143.8	10	24	9
FA-22A	Multi-role fighter aircraft	$0.8	15	$104.6	14	29	10

We measured the total corrosion-related NAH (2,102,476) in a manner consistent with how the Air Force reports its availability results. Corrosion-related NAH account for 12.1 percent of the total reported. We show the highest 10 contributors to corrosion-related NAH in Table 5.

Table 5 - Highest 10 Corrosion Contributors to Total NAH (Non-Available Hours) by TMS (FY2009)

TMS	Description	Total NAH	NAH related to corrosion	Percentage of total NAH related to corrosion
F-16C	Multi-role fighter	2,852,064	340,503	11.9
KC-135R	Refueling tanker	1,097,994	220,344	20.1
C-130H	Transport and utility	909,784	196,400	21.6
F-15C	Multi-role fighter	938,333	119,614	12.7
A-10C	Close air support	713,486	111,885	15.7
A-10A	Close air support	642,492	89,551	13.9
F-15E	Multi-role fighter	672,679	83,585	12.4
T-38C	Supersonic trainer	1,003,854	82,314	8.2
C-17A	Transport and utility	429,222	71,012	16.5
FA-22A	Multi-role fighter	459,311	64,550	14.1

The F-16C fighter has the largest total of corrosion-related NAH; its large fleet size compensates for a relatively low percentage of corrosion-related NAH (11.9 percent). The KC-135R tanker and C-130H transport have the highest corrosion-related NAH percentages at 20.1 and 21.6.

Preventive maintenance accounts for nearly two-thirds of the total corrosion-related NAH, with inspection being by far the major contributor to corrosion-related total NAH. Table 6 shows a breakdown of the preventive maintenance NAH.

Table 6 - Preventive Corrosion NAH by Activity (FY2009)

Activity	Number of total preventive NAH	Percentage of total preventive NAH
Inspect/test (troubleshoot, warranty, non-destructive inspection, check, service, period, scheduled, phased)	931,070	63.6
Treat (corrosion treatment, prime, paint, coat)	260,134	17.8
Clean (wash, degrease, decontaminate, blast, bath, buff)	218,455	14.9
Preserve (lubricate, package, wrap)	53,731	3.7
Calibrate (bring into tolerance, adjust)	643	0.0
Total	1,464,143	100.0

We identified an apparent strong relationship between corrosion cost and corrosion-related NAH by aircraft type for the largest corrosion cost aircraft (see Table 7). Three of the top four aircraft types with the largest cost of corrosion also are among the four highest contributors to corrosion-related NAH (some aircraft do not have NAH reported). These aircraft are the KC-135R, C-130H, and F-16C. This relationship between corrosion cost and corrosion-related NAH also holds from a percentage standpoint. If an aircraft has a corrosion cost as a percentage of maintenance cost that is among the highest, then the corrosion NAH as a percentage of total NAH is also among the highest. This finding further suggests that the opposite should also be true: a reduction in the corrosion cost percentage should improve the corrosion-related availability results.

“Multiple aircraft” is a category assigned to those items of repair that are used in different aircraft types. The cost of the repair cannot be assigned to a specific type. Examples include engines, communication systems, and some ground support systems.

Table 7 - Relationship between Total Corrosion Cost and Total NAH

TMS	Corrosion-related cost			Corrosion-related non-availability		
	Rank	Total corrosion cost (in millions)	Corrosion cost as percentage of maintenance	Rank	Total NAH	Corrosion-related NAH as percentage of total NAH
KC-135R	1	$613.8	28.0	2	220,343	19.4
Multiple aircraft	2	$580.1	28.1	N/A[a]	N/A[a]	N/A[a]
C-130H	3	$373.7	30.9	3	196,401	21.0
B-52H	4	$273.9	29.1	12	61,342	20.2
F-16C	5	$261.2	16.3	1	340,503	11.3
B-1B	6	$233.5	24.0	15	43,619	11.5
E-3B	7	$174.3	35.4	28	12,372	19.5
C-5A	8	$161.3	21.7	13	52,290	14.8
C-5B	9	$160.4	22.7	17	32,038	15.5
A-10A	10	$143.8	24.3	6	89,551	12.6

NAHs are not reported for multiple aircraft, only by serial number and aircraft type.