

***Corrosion Prevention and Control
Integrated Product Team***

Cost of Corrosion

Air Force Aircraft and Missiles



**Eric Herzberg LMI
March 25, 2009**



The background of the slide is a stylized, semi-transparent American flag. The stars are white and arranged in a grid pattern on a blue field, while the stripes are white and red, wavy in appearance. The overall image has a halftone or dithered texture.

Purpose –

The Office of the Secretary of Defense has tasked LMI to measure the annual cost of corrosion across the DoD in a series of annual studies for each Service. This year we are completing the Air Force Aircraft and Missiles cost of corrosion study.

The background of the slide is a stylized, grayscale American flag. It features a field of white stars on a dark background in the upper left, and wavy horizontal stripes in the lower right. The overall image has a halftone or dithered texture.

Corrosion –

The deterioration of a material or its properties due to a reaction of that material with its chemical environment

Outline

- **Background**
 - Why Estimate Cost of Corrosion?
 - Results Summary
- **Methodology**
 - Top down and Bottom up Approach
 - Cost trees (emerging AF)
 - Data conversion process
- **Data structure**
- **Slice and dice – Army Aviation and Missiles example**
- **Maintenance and corrosion database – Army example**

Why Estimate DoD's Cost of Corrosion?

“.....reliable corrosion cost estimates are necessary to identify areas that require aggressive action and to justify the expenditure of resources for prevention and mitigation strategy.”

DoD Corrosion Executive in 2005 Corrosion Report to Congress

- Previous annual DoD corrosion cost estimate of \$10B - \$20B was too vague
- LMI developed the DoD cost of corrosion methodology – approved by CPCIPT
- GAO recommended DoD develop an action plan to use study results (GAO-07-618, April 2007)

Results – Studies to Date

Cost of Corrosion Studies

Study Year	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	\$0.7 billion	FY2005
2007-2008	Navy and Marine Corps Aviation	\$3.0 billion	FY2005 and FY2006
	Coast Guard Aviation and Vessels	\$0.3 billion	FY2005 and FY2006
2008-2009	Air Force and Repeat 2005-2006		FY2006 and FY2007
2009-2010	Repeat 2006-2007		
2010-2011	Repeat 2007-2008		

Results of Studies to Date

A Closer Look

(\$ millions)

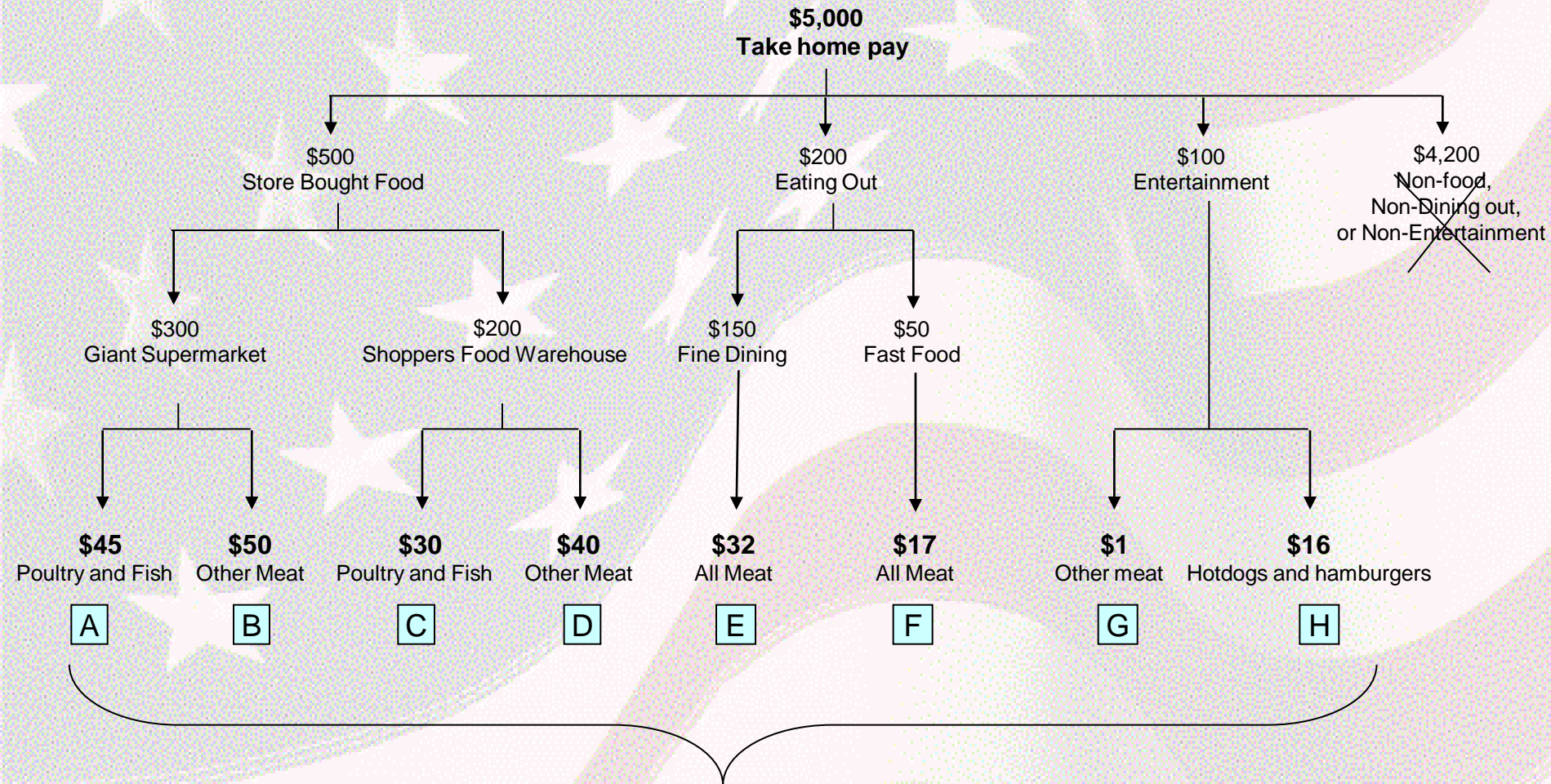
Study Focus	Data Year	Total Maintenance Cost				Total Corrosion Cost ^b				% Corr
		Depot	Field	ONR ^a	Total	Depot	Field	ONR ^a	Total	
Army ground vehicles	FY2004	1,956	6,980	1,784	10,720	274	1,045	693	2,012	14.8%
Navy ships	FY2004	4,812	5,892	423	11,127	1,345	779	304	2,428	19.8%
Marine Corps ground vehicles	FY2005	520	1,862	362	2,744	119	379	171	669	20.8%
Army aviation/missiles	FY2005	1,861	6,505	148	8,514	529	1,028	63	1,620	18.6%
Navy/Marine Corps aviation	FY2006	3,369	5,847	116	9,332	1,458	1,443	63	2,964	31.5%
Total		12,518	27,086	2,833	42,437	3,725	4,674	1,294	9,693	21.2%
Study Focus	Data Year	Total Maintenance Cost				Total Corrosion Cost				Total
		Non-family housing	Family housing	Non-family housing	Family housing	Non-family housing	Family housing	Non-family housing	Family housing	
DoD Facilities/Infrastructure	FY2005	9,153	1,063	7,537	1,512	1,361	185	173	32	1,751

^a ONR is "Outside Normal Reporting" costs

^b Totals do not reflect purchase card corrosion costs

Combined Top-down/Bottom-up Methodology

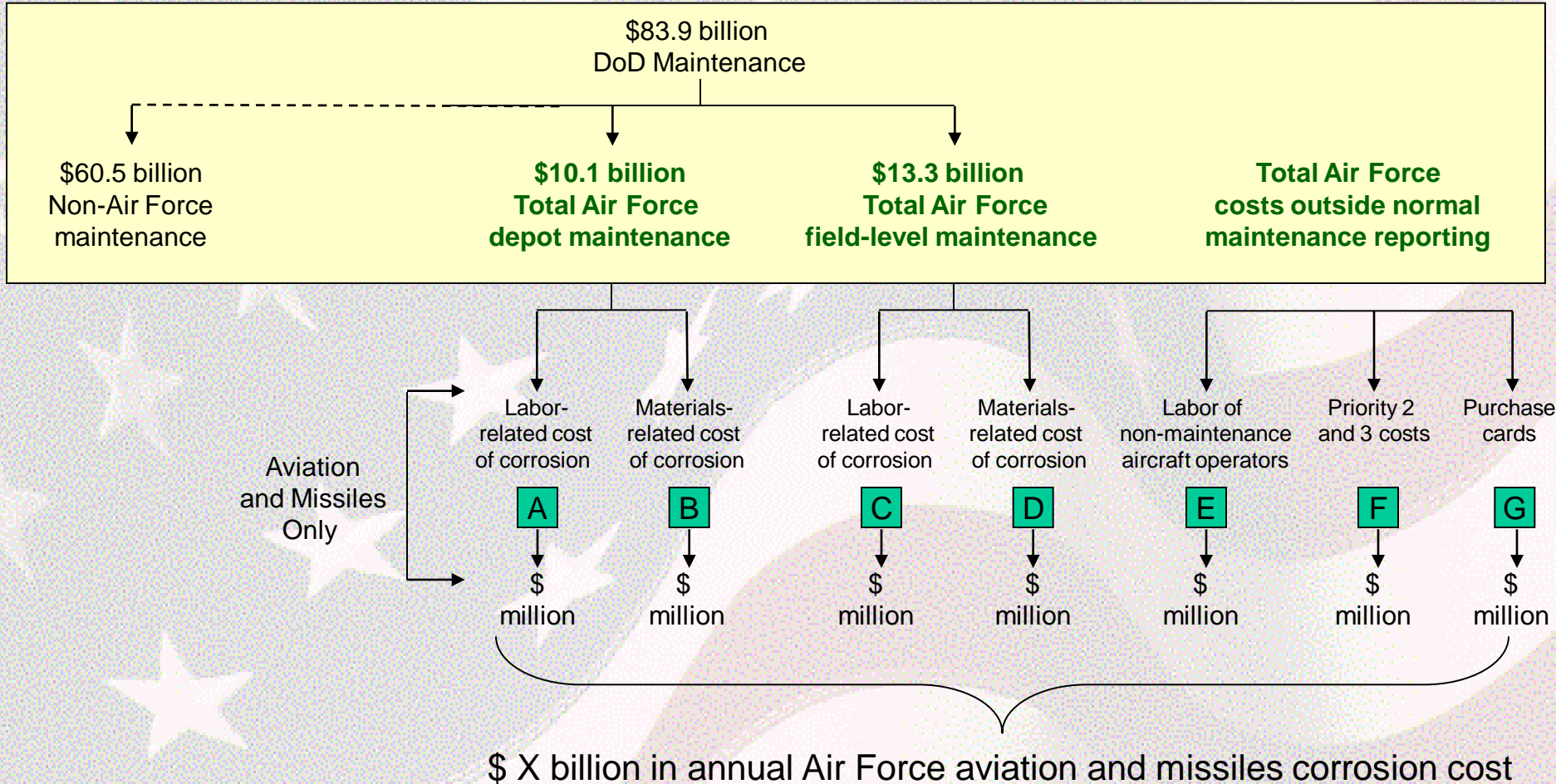
(Example – Determining Monthly Expenses for Meat)



Must use detailed receipts (grocery, restaurant, entertainment) to determine meat expenses

Combined Top-down/Bottom-up Methodology Data Collection and Cost Tree

(Emerging 2007 Air Force Aviation and Missiles)

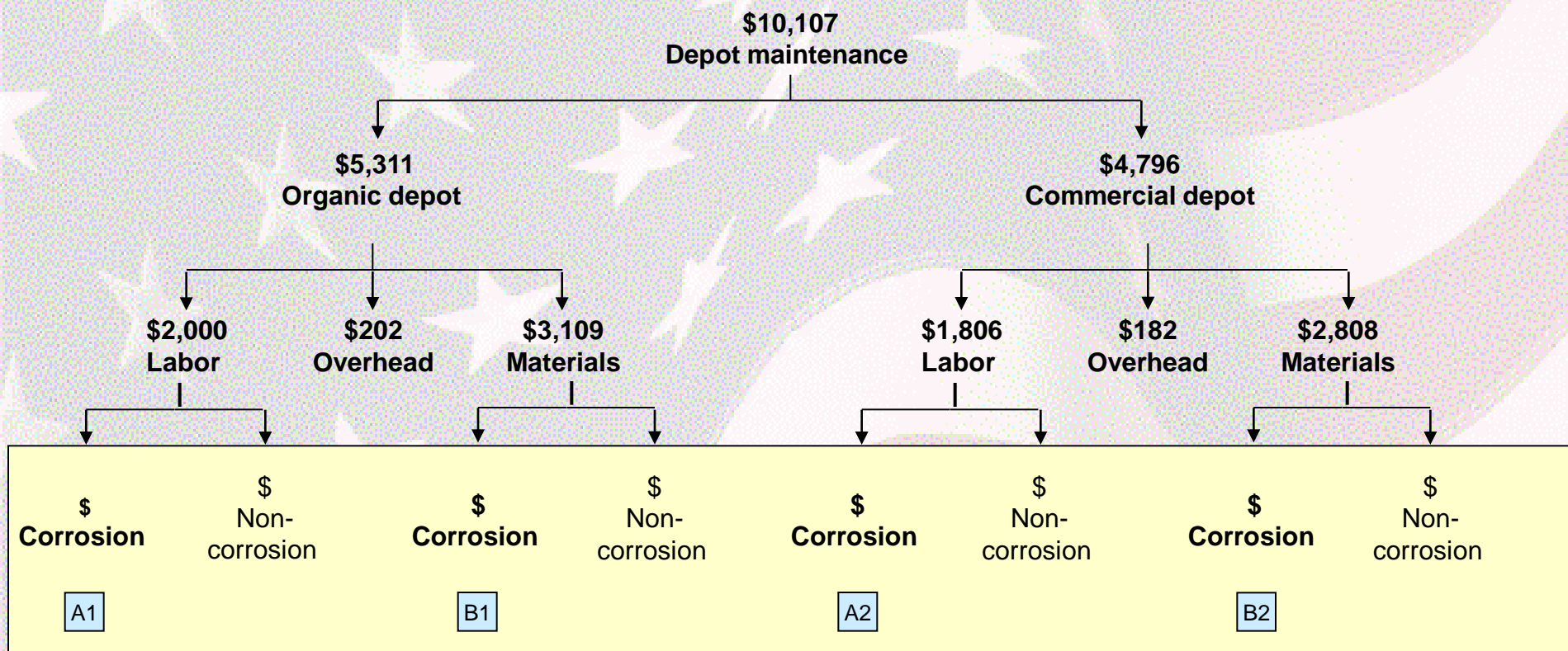


Step 1. The top-down data comes from authoritative sources.
This establishes the Maintenance Ceiling

Cost Tree – Depot

Air Force Aviation and Missiles

(Emerging 2007 Example)



Step 2. Gather the bottom-up data from the authoritative sources. This permits detailed corrosion analysis

Authoritative Data Sources

USAF Aviation and Missiles

Main Depot Data Sources	Data Value	Main Field-Level Data Sources	Data Value	Main "Outside Normal Reporting" Data Sources	Data Value
President's Budget	Top-Down	President's Budget	Top-Down	Operator Survey	Top-Down
"50-50" Report	Top-Down	DMDC	Top-Down	Purchase Card Records	Bottom-up
"1307" Report	Top-Down	OP-31 Exhibit	Top-Down	DoD Reports	Bottom-up
"Sources of Repair" Reports	Top-Down	OP-32 Exhibit	Top-Down	President's Budget (MILCON)	Bottom-up
DIFMS (DMAPS)	Bottom-Up	Material – SBSS	Bottom-Up		
PDMSS	Bottom-up	REMIS	Bottom-up		
G004L	Bottom-up	USAF Mechanic Surveys	Bottom-Up		
G005M	Bottom-up				
Depot Shop Surveys	Bottom-Up				

"50-50" Report – Distribution of DoD Depot Maintenance Workloads (FY06-08)

"1307" Accounting Reports – Defense Business Operations Fund Accounting Reports from OC-ALC, OO-ALC, WR-ALC

"Sources of Repair" Reports – Organic and Commercial Depot workload (e.g., DMCS-Depot Maintenance Cost System)

DMDC – Defense Manpower Data Center information

DIFMS (DMAPS) – Defense Industrial Financial Management System (Defense Maintenance Accounting and Production System)

PDMSS – Programmed Depot Maintenance Scheduling System (FY06-07) – Aircraft and Missiles (G097)

OP-31 Exhibit - Annual Budget Document (consumable spares and repair parts)

OP-32 Exhibit – Annual Budget Document (Inflation Category Code 922-Equipment Maintenance by Contract)

REMIS – Reliability and Maintainability Information System

G004L – DLR, Engine and Tactical Missile Production

G005M – Bill of Materials

SBSS – Standard Base Supply System

Surveys – Depot Shops (All 3 ALCs); Field Mechanics (90 respondents, all major aircraft categories); Non-maintainer Operators (727 respondents)

Data Conversion – Air Force

Example of Field Maintenance records (REMIS) with 100% corrosion costs

HIGHER ASSY EQUIP DESIGNATOR	JOB CONTROL NUMBER	WUC	HOW MAL	ACTION TAKEN	WHEN DSCVRD	WORK CTR	LABOR MAN HRS	LABOR CAT	DISCREPANCY NARRATIVE	CORRECTIVE ACTION NARRATIVE
T038A	50250318	11561	170	G	F	A3130	13.5	6	UPPER BOATTAIL SKIN HAS NUMEROUS CORROSION HOLES	WORK IN PROGRESS.
F015A	52576926	75BM0	170	Z	M	Z5120	1	3	LAU-128 S/N 4964, 18 MO INSP REQD	PAINTING C/W
C017A	60190286	44CA0	255	A	F	QE110	8	3	LT WING LANDING LANDING LIGHT W/N RETRACT	B/C/AND REPAIRED
C017A	60190286	44CA0	255	9	F	QE110	1	3	INOP	NRTS-9
C130E	60238752	13712	230	V	F	QE220	2	1	NLG WHEEL REQUIRES EDDY CURRENT INSPETCION	CLEANED, INSPECTED WHEEL AND TURNED INTO SUPPLY
C130E	60031566	13720	020	1	F	QE220	2	1	NOSE WHEEL SHIMMY	REMOVED WHEEL AND TURNED IN SKIN
C130E	60098808	13722	020	1	F	QE220	2	1	OUT OF ROUND OR OUT OF BALANCE	REMOVED WHEEL AND TURNED IN SKIN
KC135R	62132626	13CA0	865	Z	4	1E720	8	3	#8 BRAKE REMOVE AND REPLACE	PAINTED AS REQ

HIGHER ASSY EQUIP DESIGNATOR	EQUIPMENT DESIGNATOR	ORGANIZATION	JOB CONTROL NUMBER	WUC CD	HOW MAL CD	WORK CTR CD	FSC	Labor Corrosion Cost	Material Corrosion Cost
T038A	2-12100-37	80FTAWG	50250318	11561	170	A3130	1560	\$ 1,879	\$ 43

Step 3. Analyze the bottom-up data for corrosion costs using data field codes and keyword search methods

Data Structure

Aviation Type xxx Age z years		Cost	Percent of total			
Aviation Type 6 Age 5 years		Cost	Percent of total			
Aviation Type 1 Age 12 years		Cost	Percent of total	Labor	Materials	WBS
Corrective corrosion costs						
Preventive corrosion costs						
Depot maintenance corrosion costs						
Field maintenance corrosion costs						
Outside normal reporting costs						
Structure direct corrosion costs						
Parts direct corrosion costs						

Will capture all types of weapon systems

Slice and Dice

Highest 20 Corrosion Cost by End Item (Army Aviation/missiles)

Rank	LIN	Aviation or Missile	General Nomenclature	Corrosion cost (\$ thousands)	Maintenance cost (\$ thousands)	Number of Aviation or Missile Assets	Corrosion Percentage
1	H30517	Aviation	HELICOPTER CARGO TRANSPORT: CH-47D	352,009	1,782,218	413	19.8%
2	K32293	Aviation	HELICOPTER UTILITY: UH-60A	335,336	1,706,795	903	19.6%
3	H32361	Aviation	HELICOPTER UTILITY: UH-60L	243,037	1,630,640	544	14.9%
4	H48918	Aviation	HELICOPTER ATTACK: AH-64D	171,449	859,836	429	19.9%
5	A21633	Aviation	HELICOPTER AERIAL SCOUT: OH-58D	127,199	678,103	357	18.8%
6	ENGT-700	Aviation	T-700 ENGINE	57,385	170,816	1,831	33.6%
7	P11779	Missile	PATRIOT: PAC-3 LAUNCHER STATION	46,372	150,307	31	30.9%
8	H31110	Aviation	HELICOPTER OBSERVATION: OH-58C	38,767	123,450	280	31.4%
9	H28647	Aviation	HELICOPTER ATTACK: AH-64A	37,025	195,257	235	19.0%
10	ENGT-701	Aviation	T-701 ENGINE	24,142	92,870	1,831	26.0%
11	ENGT-701D	Aviation	T-701D ENGINE	21,350	54,995	1,830	38.8%
12	H44644	Aviation	HELICOPTER ATTACK: TOW MISSILE AH-1F	17,400	44,147	71	39.4%
13	H31872	Aviation	HELICOPTER UTILITY: UH-1V	13,778	43,548	150	31.6%
14	L45740	Missile	LAUNCHER TUBULAR GUIDED MISSILE: (TOW)	10,821	55,682	2,825	19.4%
15	ENGT-703	Aviation	T-703 ENGINE	9,704	30,420	786	31.9%
16	K31795	Aviation	HELICOPTER UTILITY: UH-1H	9,318	26,908	273	34.6%
17	H46150	Aviation	HELICOPTER CARGO: MH-47E	7,822	24,056	23	32.5%
18	ENGT-701C	Aviation	T-701C ENGINE	7,516	19,922	1,830	37.7%
19	ENGT-63	Aviation	T-63 ENGINE	6,840	21,443	986	31.9%
20	L44830	Missile	LAUNCHER: GUIDED MISSILE AIRCRAFT	6,425	41,876	2,093	15.3%

Slice and Dice

Highest 20 Average Corrosion Cost

(Army Aviation/missiles)

Rank	LIN	Aviation or Missile	General Nomenclature	Corrosion cost (\$ thousands)	Number of Aviation or Missile Assets	Average corrosion cost per Item (\$ thousands)
1	P11779	Missile	PATRIOT: PAC-3 LAUNCHER STATION	46,372	31	\$1,496
2	H30517	Aviation	HELICOPTER CARGO TRANSPORT: CH-47D	352,009	413	\$852
3	H32361	Aviation	HELICOPTER UTILITY: UH-60L	243,037	544	\$447
4	H48918	Aviation	HELICOPTER ATTACK: AH-64D	171,449	429	\$400
5	K32293	Aviation	HELICOPTER UTILITY: UH-60A	335,336	903	\$371
6	A21633	Aviation	HELICOPTER AERIAL SCOUT: OH-58D	127,199	357	\$356
7	H46150	Aviation	HELICOPTER CARGO: MH-47E	7,822	23	\$340
8	H44644	Aviation	HELICOPTER ATTACK: TOW MISSILE AH-1F	17,400	71	\$245
9	U84291	Aviation	HELICOPTER MEDEVAC: HH-60L	4,214	18	\$234
10	H30766	Aviation	HELICOPTER CARGO: MH-60K	4,673	23	\$203
11	H28647	Aviation	HELICOPTER ATTACK: AH-64A	37,025	235	\$158
12	H31110	Aviation	HELICOPTER OBSERVATION: OH-58C	38,767	280	\$138
13	H31872	Aviation	HELICOPTER UTILITY: UH-1V	13,778	150	\$92
14	Z52435	Aviation	RADAR SET: AN/TPN-18	1,053	15	\$70
15	Q18667	Aviation	RADAR SYSTEM: AN/FSQ-84	914	21	\$44
16	Q14455	Aviation	RADAR SET: AN/FPN-40	662	18	\$37
17	K31795	Aviation	HELICOPTER UTILITY: UH-1H	9,318	273	\$34
18	ENGT-700	Aviation	T-700 ENGINE	57,385	1,831	\$31
19	G93247	Missile	GROUND SUPPORT EQUIPMENT: DS/GS (GLLD)	1,663	54	\$31
20	W00221	Aviation	TEST STAND HYDRAULIC SYSTEM COMPONENTS: GAS ENG DRIVEN	2,059	79	\$26

Slice and Dice

Corrosion Cost by WBS

(Army Aviation/missiles)

WBS	Description	Corrosion cost (in thousands)	Rank
A91	Helicopter (Frames)	954,592	1
A92	Helicopter Engine	170,983	2
A94	Helicopter Electronics and Communications Equipment	80,755	3
A95	Helicopter Armament	36,831	4
F11	Ballistic Basic Missiles (Frame)	22,315	5
F21	Other Missile Basic Missiles (Frames)	16,449	6
A96	Helicopter Support Equipment	15,798	7
F15	Ballistic Missiles Guidance System and Components	12,727	8
F14	Ballistic Missiles Support and Launch Equipment	10,632	9
F25	Other Missiles Guidance System and Components	6,861	10
F16	Ballistic Missiles Surface Communications and Control Systems	5,521	11
F26	Other Missiles Surface Communication and Controls Systems	3,661	12
F24	Other Missiles Support and Launch Equipment	3,178	13
A97	Helicopter Other	1,799	14
F12	Ballistic Missiles Propulsion Systems and Components	1,551	15
A31	Cargo and/or Transport Aircraft Frame	620	16
F28	Other Missiles Other	616	17
F23	Other Missiles Missile Accessories and Components	252	18
F27	Other Missiles Payload System and Components	186	19
A71	Patrol Aircraft Frame	65	20
UNASSIGNED		258,869	

Slice and Dice

Corrosion Cost Percentage by WBS

(Army Aviation/missiles)

WBS	Description	Corrosion cost (in thousands)	Total maintenance cost (in thousands)	Percentage corrosion	Rank
A31	Cargo and/or Transport Aircraft Frame	620	1,797	34.5%	1
F12	Ballistic Missiles Propulsion Systems and Components	1,551	4,800	32.3%	2
F16	Ballistic Missiles Surface Communications and Control Systems	5,521	17,163	32.2%	3
F14	Ballistic Missiles Support and Launch Equipment	10,632	33,280	31.9%	4
A96	Helicopter Support Equipment	15,798	50,030	31.6%	5
F15	Ballistic Missiles Guidance System and Components	12,727	40,723	31.3%	6
A92	Helicopter Engine	170,983	549,867	31.1%	7
A91	Helicopter (Frames)	954,592	3,154,626	30.3%	8
F21	Other Missile Basic Missiles (Frames)	16,449	56,664	29.0%	9
F11	Ballistic Basic Missiles (Frame)	22,315	78,198	28.5%	10
A97	Helicopter Other	1,799	6,983	25.8%	11
A94	Helicopter Electronics and Communications Equipment	80,755	322,696	25.0%	12
A95	Helicopter Armament	36,831	165,679	22.2%	13
F27	Other Missiles Payload System and Components	186	1,091	17.1%	14
F25	Other Missiles Guidance System and Components	6,861	43,365	15.8%	15
F26	Other Missiles Surface Communication and Controls Systems	3,661	26,161	14.0%	16
F24	Other Missiles Support and Launch Equipment	3,178	34,262	9.3%	17
F28	Other Missiles Other	616	249,196	0.2%	18

Slice and Dice

Corrective versus Preventive Corrosion Cost

(Army Aviation/missiles)

	Category	Corrosion cost (in millions)	Percentage of total maintenance cost
Depot-level maintenance	Corrective	\$297	56.1%
	Preventive	\$232	43.8%
	Total	\$529	100.0%
Field-level maintenance	Corrective	\$765	74.4%
	Preventive	\$263	25.6%
	Total	\$1,028	100.0%
Total maintenance	Corrective	\$1,062	68.2%
	Preventive	\$495	31.8%
	Total	\$1,557	100.0%

Slice and Dice

Parts versus Structure Corrosion Cost

(Army Aviation/missiles)

	Cost category	Total maintenance cost (in millions)	Corrosion cost (in millions)	Corrosion as percentage of total maintenance cost
Depot-level maintenance	Structure	\$464	\$131	28.2%
	Parts	\$1,173	\$369	31.5%
Field-level maintenance	Structure	\$1,952	\$647	33.1%
	Parts	\$1,117	\$153	13.7%
Total maintenance	Structure	\$2,417	\$778	32.2%
	Parts	\$2,290	\$522	22.8%
Total		\$4,707	\$1,299	27.6%

Corrosion Cost Database

(Army Aviation and Missiles Example)

ARMY AVATION AND MISSILES MAINTENANCE CORROSION DATA FILE

Filter the query's results by making any selections below. After selections have been made, please click on "Query with Above Filters"

Leaving a Field blank returns all values for that criteria

Clicking an "ALL" Button will set the field to return all values

CLEAR FORM

Maintenance Level	<input type="text"/>	ALL
Missiles or Aviation	<input type="text"/>	ALL
LIN	<input type="text"/>	ALL
WBS	<input type="text"/>	ALL

Query with
Above Filters

CLOSE DATABASE