

Tactical Airlift Division

Combat Ready, Anytime, Anywhere



C-130 Corrosion Prevention and Control Program

***Mr. Dave Peth
C-130 Corrosion Engineer
Tactical Airlift Division***



C-130 Fleet Overview



Warner Robins Air Logistics Center

Dates of Air Force Deployment

1956	1959	1962	1974	1999
C-130A	C-130B	C-130E	C-130H	C-130J



- Over 5 decades of service
- Longest continually running Aircraft production line
- Wide range of operational missions worldwide
- Remains the prime transport for drops into hostile areas



C-130 Fleet Overview



Warner Robins Air Logistics Center

■ C-130 Models

- C-130E
- C-130H/H1
- C-130H2/H2.5
- C-130H3
- C-130J



■ Special Mission Variants

- SOF Variants
 - AC-130H
 - AC-130U
 - EC-130J
 - MC-130E
 - MC-130H
 - MC-130P
 - MC-130W
- CSAR
 - HC-130N
 - HC-130P
 - MC-130P
- Special Mission
 - EC-130H
 - LC-130H
 - WC-130H
 - WC-130J
 - NC-130H
 - TC-130H





Why the Concern with Corrosion?



Warner Robins Air Logistics Center

Corrosion Impacts

■ Safety

- Oct 1993 – Aug 2010
 - 2 Class C mishaps
 - Reportable damage between \$10,000 and \$200,000
 - 8 Class E events
 - An aircraft event that does not meet reportable mishap criteria

■ Readiness/Mission Capability

■ Financial

- The C-130 transport aircraft has the highest combined total corrosion cost of any DoD aircraft/missile system



Corrosion Costs Data Baseline FY 2006 and FY 2007



Warner Robins Air Logistics Center

**Table II-4. Aviation/Missiles with Highest Average per Item and Total Corrosion Costs
(\$ in millions)**

Priority	Nomenclature	Average corrosion cost per item	Rank in top 20: Corrosion cost per item	Total corrosion cost	Rank in top 20: Total corrosion cost	Combined rank
1	C-130	\$1.3	8	\$718	1	9
2	C-5	\$4.0	2	\$431	8	10
3	KC-135	\$1.2	9	\$451	6	15
4	FA-18	\$0.9	13	\$601	2	15
5	B-1	\$3.7	3	\$251	12	15
6	EA-6	\$4.2	1	\$193	15	16
7	B-52	\$2.6	6	\$240	13	19
8	F-15	\$0.8	17	\$444	7	24
9	CH-47	\$0.9	14	\$352	10	24
10	C-17	\$0.8	16	\$137	19	35

DoD Annual Cost of Corrosion, DoD Report July 2009

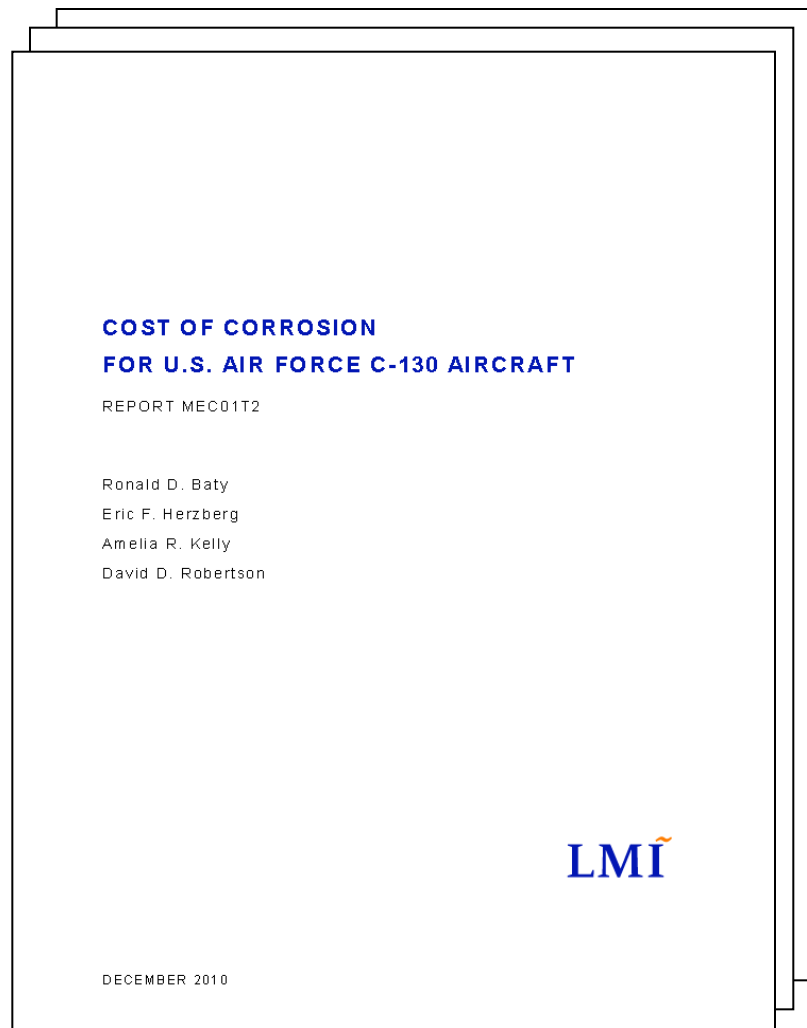


Corrosion Maintenance Cost Data Analysis



Warner Robins Air Logistics Center

- LMI accomplished corrosion cost and maintenance data analysis for FYs 2006 – 2010 on Air Force C-130 fleet
- Results:
 - The average annual corrosion-related field-level maintenance cost decreased by \$76M over the period
 - The annual depot-level corrosion costs increased over that same period by approximately \$111M
 - Estimated average annual cost of corrosion - \$610M
 - Ranged from a low of \$599M in FY2006 to a high of \$634M in FY2010
 - **This is roughly an average of 37% of all C-130 maintenance costs during the period**



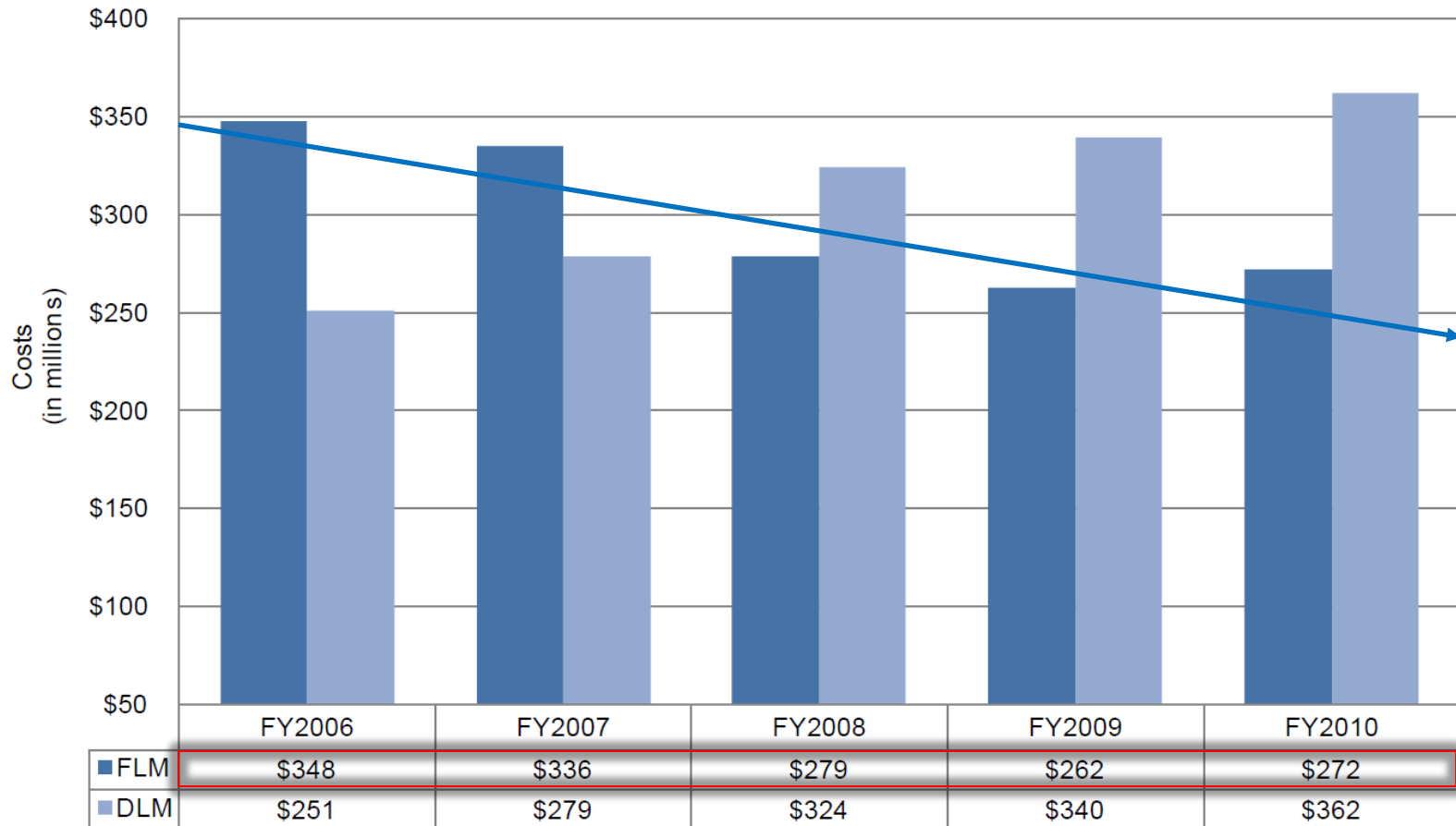


C-130 Field & Depot Corrosion Costs for FY 2006 - FY 2010



Warner Robins Air Logistics Center

Figure 2-2. C-130 Field- and Depot-Level Corrosion Costs for FY2006–FY2010



LMI Cost of Corrosion for US Air Force C-130 Aircraft, Dec 2010

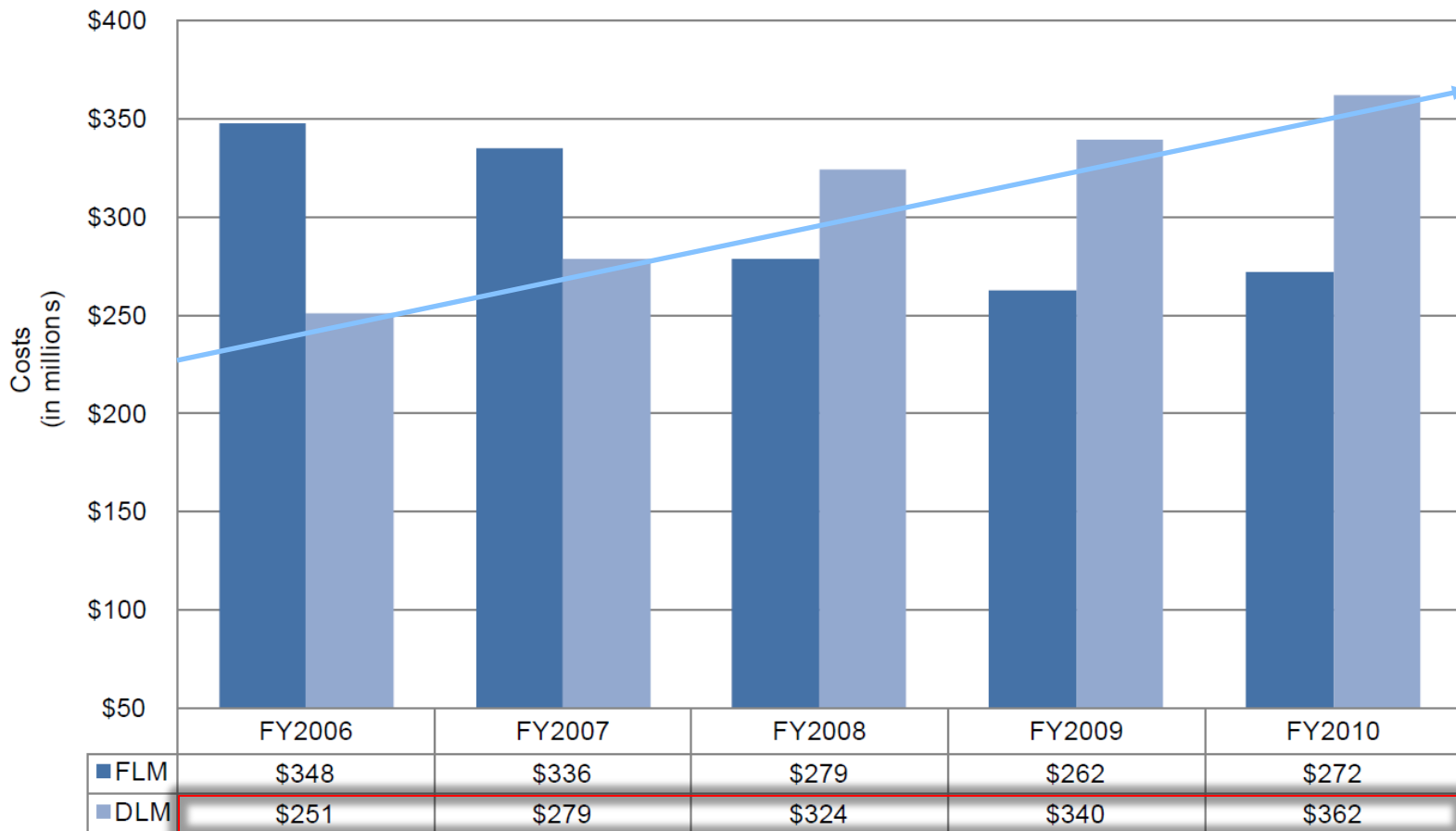


C-130 Field & Depot Corrosion Costs for FY 2006 - FY 2010



Warner Robins Air Logistics Center

Figure 2-2. C-130 Field- and Depot-Level Corrosion Costs for FY2006–FY2010



LMI Cost of Corrosion for US Air Force C-130 Aircraft, Dec 2010

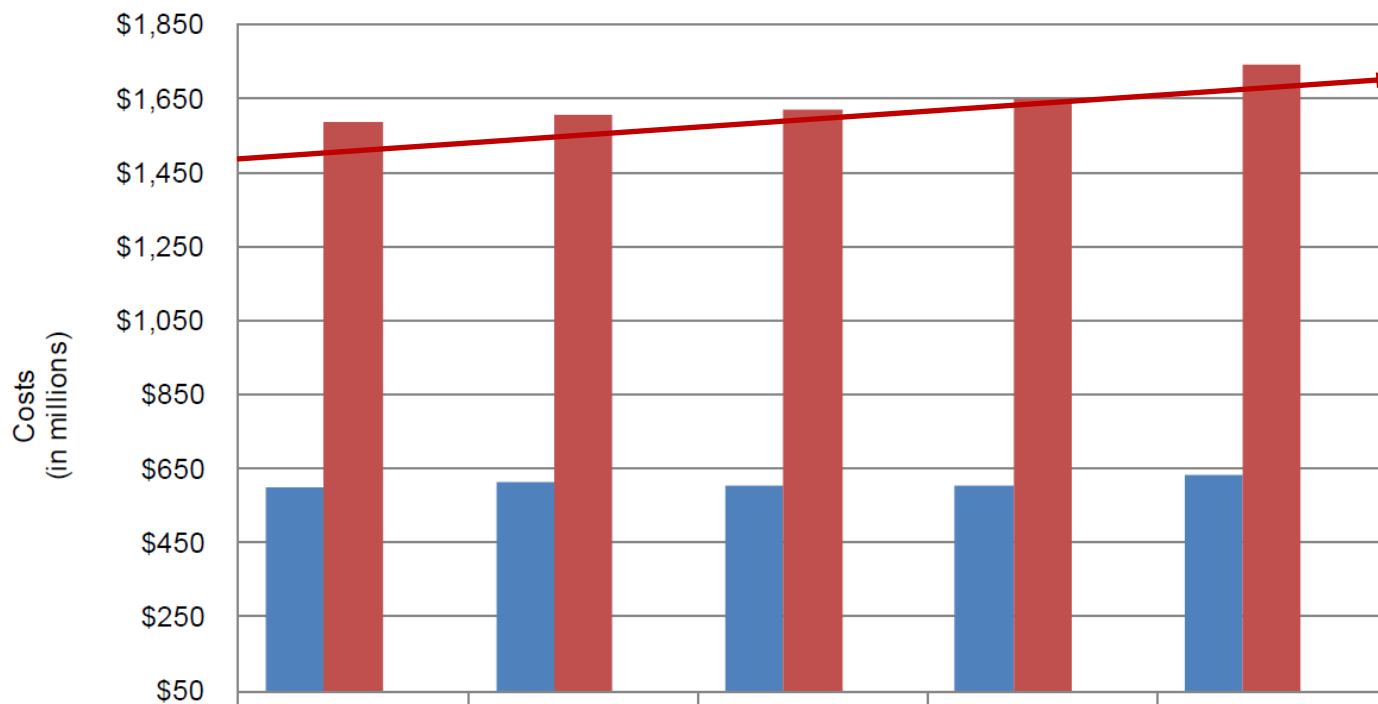


C-130 Corrosion & Maintenance Costs for FY 2006 - FY 2010



Warner Robins Air Logistics Center

Figure 2-1. C-130 Corrosion and Maintenance Costs for FY2006–FY2010



	FY2006	FY2007	FY2008	FY2009	FY2010
Total C-130 corrosion cost	\$599	\$614	\$603	\$602	\$634
Total C-130 maintenance cost	\$1,588	\$1,604	\$1,622	\$1,648	\$1,743
Corrosion as a percentage of maintenance for C-130 fleet	37.7%	38.3%	37.2%	36.5%	36.4%

LMI Cost of Corrosion for US Air Force C-130 Aircraft, Dec 2010

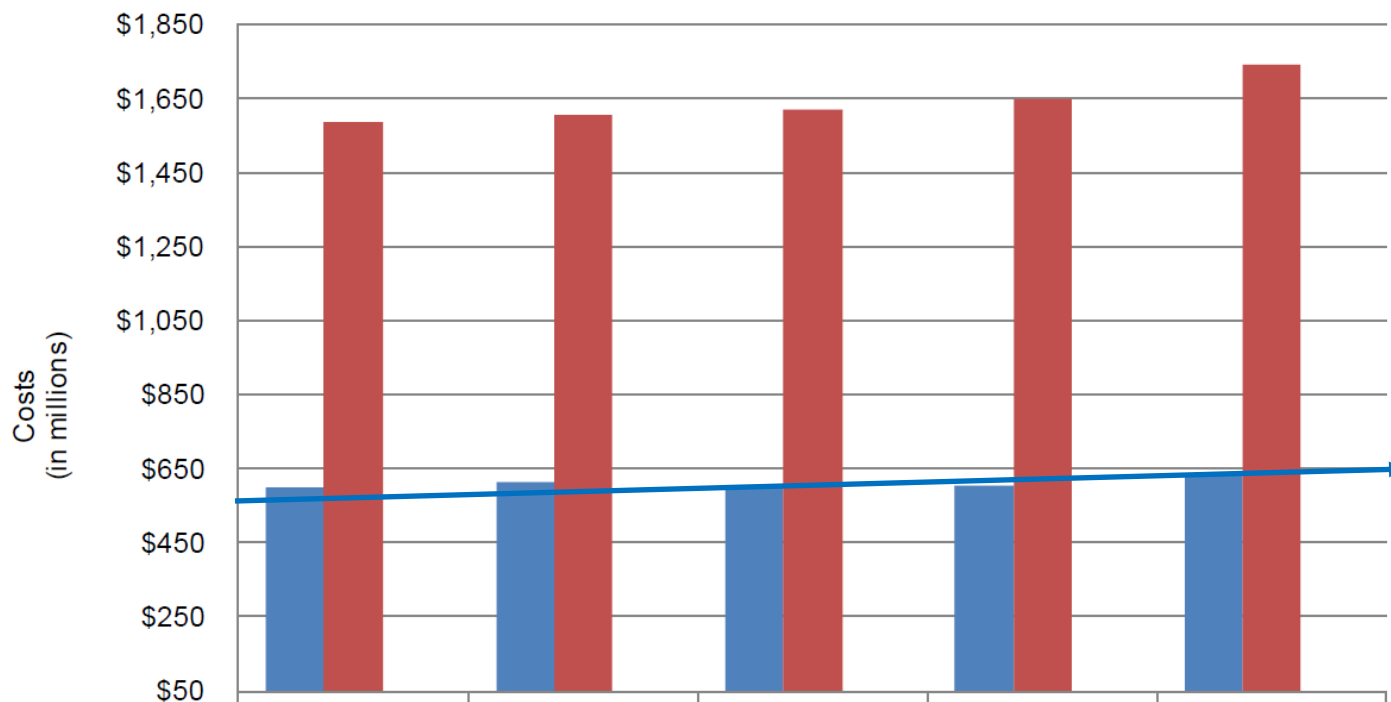


C-130 Corrosion & Maintenance Costs for FY 2006 - FY 2010



Warner Robins Air Logistics Center

Figure 2-1. C-130 Corrosion and Maintenance Costs for FY2006–FY2010



■ Total C-130 corrosion cost	\$599	\$614	\$603	\$602	\$634
■ Total C-130 maintenance cost	\$1,588	\$1,604	\$1,622	\$1,648	\$1,743
Corrosion as a percentage of maintenance for C-130 fleet	37.7%	38.3%	37.2%	36.5%	36.4%

LMI Cost of Corrosion for US Air Force C-130 Aircraft, Dec 2010



C-130 Corrosion & Maintenance Costs for FY 2010



Warner Robins Air Logistics Center

Table 2-4. C-130 Corrosion and Maintenance Costs by Aircraft Type (FY2010)

MDS	Inventory	Corrosion cost	Maintenance cost	Corrosion as a percentage of maintenance
C-130H	268	\$ 243,483,946	\$ 704,000,677	34.6%
MC-130H	20	\$ 75,016,580	\$ 178,002,161	42.1%
AC-130H	8	\$ 69,394,668	\$ 151,599,778	45.8%
MC-130W	8	\$ 64,506,241	\$ 125,513,740	51.4%
AC-130U	17	\$ 59,058,329	\$ 140,907,180	41.9%
MC-130P	27	\$ 40,395,952	\$ 119,089,728	33.9%
C-130E	91	\$ 20,270,142	\$ 82,864,763	24.5%
HC-130P	23	\$ 16,654,713	\$ 63,474,903	26.2%
C-130J	52	\$ 13,936,548	\$ 59,178,451	23.6%
MC-130E	14	\$ 9,208,908	\$ 29,444,027	31.3%
EC-130J	7	\$ 4,939,299	\$ 15,748,917	31.4%
HC-130N	10	\$ 4,167,452	\$ 17,852,929	23.3%
LC-130H	10	\$ 3,938,573	\$ 17,440,141	22.6%
EC-130H	14	\$ 3,148,587	\$ 17,364,700	18.1%
WC-130J	10	\$ 2,092,867	\$ 9,109,167	23.0%
GC-130E	13	\$ 580,930	\$ 1,408,501	41.2%
TC-130H	1	\$ 263,013	\$ 1,115,160	23.6%
C-130T	1	\$ 44,045	\$ 176,374	25.0%
GC-130D	1	\$ 21,556	\$ 58,934	36.6%
GC-130A	1	\$ 19,278	\$ 48,195	40.0%
NC-130H	1	\$ 1,992	\$ 6,721	29.6%
Total		\$ 633,666,491	\$ 1,742,575,586	36.4%

LMI Cost of Corrosion for US Air Force C-130 Aircraft, Dec 2010



10 Most Costly C-130 WUCs in Terms of Corrosion and Maintenance (FY2006–FY2010)



Warner Robins Air Logistics Center

Table 2-5. 10 Most Costly C-130 WUCs in Terms of Corrosion and Maintenance (FY2006–FY2010)

WUC	WUC description	Corrosion cost (in millions)	Maintenance cost (in millions)	Corrosion as a percentage of maintenance
115	Airframe—wings and nacelles	\$334	\$809	41.4%
114	Airframe—fuselage	\$264	\$538	49.1%
461	Fuel systems—tanks	\$195	\$403	48.5%
041	Special inspections	\$128	\$352	36.5%
010	Ground handling, servicing, and related tasks	\$113	\$338	33.5%
037	Scheduled inspection or maintenance—storage	\$111	\$492	22.7%
110	Airframe	\$94	\$181	51.8%
112	Airframe—doors (hydraulic)	\$92	\$211	43.4%
032	Scheduled inspection or maintenance—thruflight inspection	\$90	\$243	37.0%
090	Shop support general code (includes fabrication or local manufacture)	\$66	\$113	58.7%

LMI Cost of Corrosion for US Air Force C-130 Aircraft, Dec 2010



10 Highest C-130 Corrosion and Maintenance Cost by WUC (FY2010)



Warner Robins Air Logistics Center

Table 2-6. 10 Highest C-130 Corrosion and Maintenance Costs by WUC (FY2010)

WUC	WUC Description	Corrosion cost (in millions)	Maintenance cost	Corrosion as a percentage of maintenance
115	Airframe—wings and nacelles	\$75	\$198	38.0%
114	Airframe—fuselage	\$60	\$130	46.4%
461	Fuel systems—tanks	\$47	\$103	45.2%
010	Ground handling, servicing, and related tasks	\$37	\$108	34.0%
041	Special inspections	\$26	\$77	33.7%
112	Airframe—doors-hydraulic	\$23	\$51	45.2%
020	Equipment and facility cleaning—aircraft cleaning	\$22	\$30	72.3%
090	Shop support general code (includes fabrication or local manufacture of miscellaneous items)	\$21	\$35	60.2%
110	Airframe	\$20	\$35	58.4%
032	Scheduled inspection or maintenance—thruflight inspection	\$18	\$49	35.9%

LMI Cost of Corrosion for US Air Force C-130 Aircraft, Dec 2010



Why is this important?



Warner Robins Air Logistics Center

Facilitates decision-making in these fundamental areas:

1. Quantify the overall problem
2. Classify corrosion costs as either preventive or corrective
 - Corrective actions address actual problems
 - Preventive actions address future problems
3. Prioritize efforts by the source of the problem
4. Make project approval decisions and follow up on their effectiveness
5. Identify potential design deficiencies and feed that information back to the acquisition community

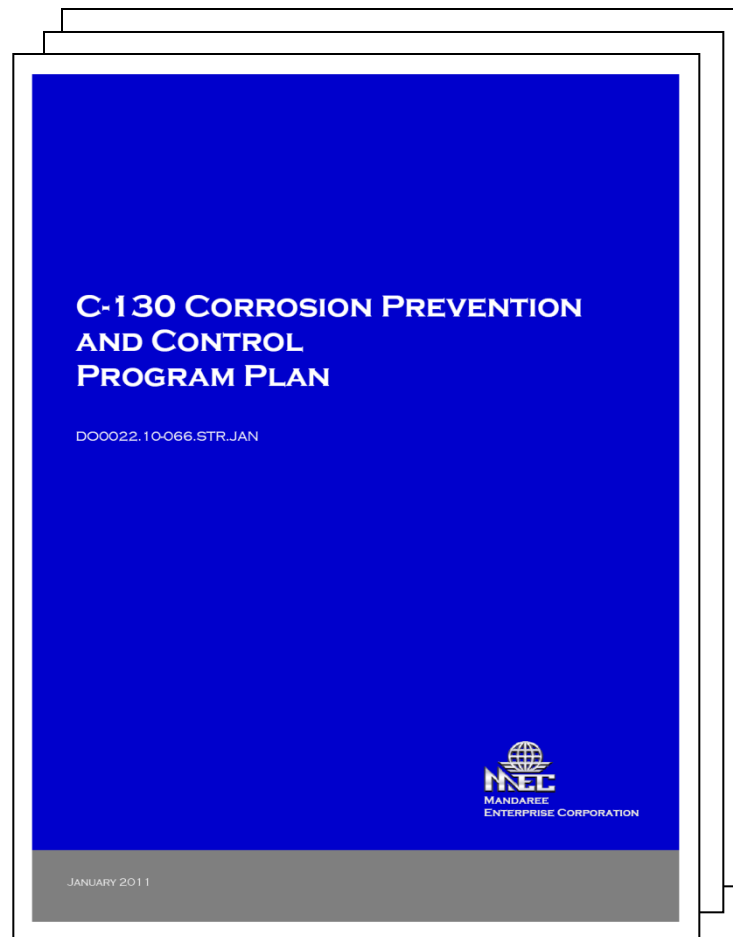


C-130 Corrosion Prevention and Control Program



Warner Robins Air Logistics Center

- The C-130 Corrosion Prevention and Control Program (CPCP) exists to:
 - Address the degradation impacts of corrosion
 - Combat the effects of corrosion to minimize its impact on maintenance
 - Adequately sustain these fleets through their service life
 - Extend the service life of the C-130 weapon system
- Guidance is provided by the CPCP Plan
 - A supplement to the C-130 Aircraft Structural Integrity Program (ASIP) plan
 - Provides guidance in accordance with MIL-STD-1530C
 - Serves as a reference for the C-130 Corrosion Program Manager and support staff responsible for strategic and tactical corrosion management planning





Assessments and Surveys



Warner Robins Air Logistics Center

Purpose

- Conduct on-site equipment and corrosion program surveys and technical assessments at select locations (C-130 fleet, organizational, depot, and contracted depot facilities (CONUS and OCONUS))
- Surveys include
 - C-130 aircraft condition assessments
 - Review of corrosion prevention and control operations and programs
 - Interviews of maintenance personnel
 - Analysis of maintenance data information
 - Compliance with technical and/or corrosion program guidance
 - Recommendations to transition best corrosion prevention and control practices

Approach

- 100% non-retribution endeavor
- Emphasis on survey and not inspection

05/08/2011

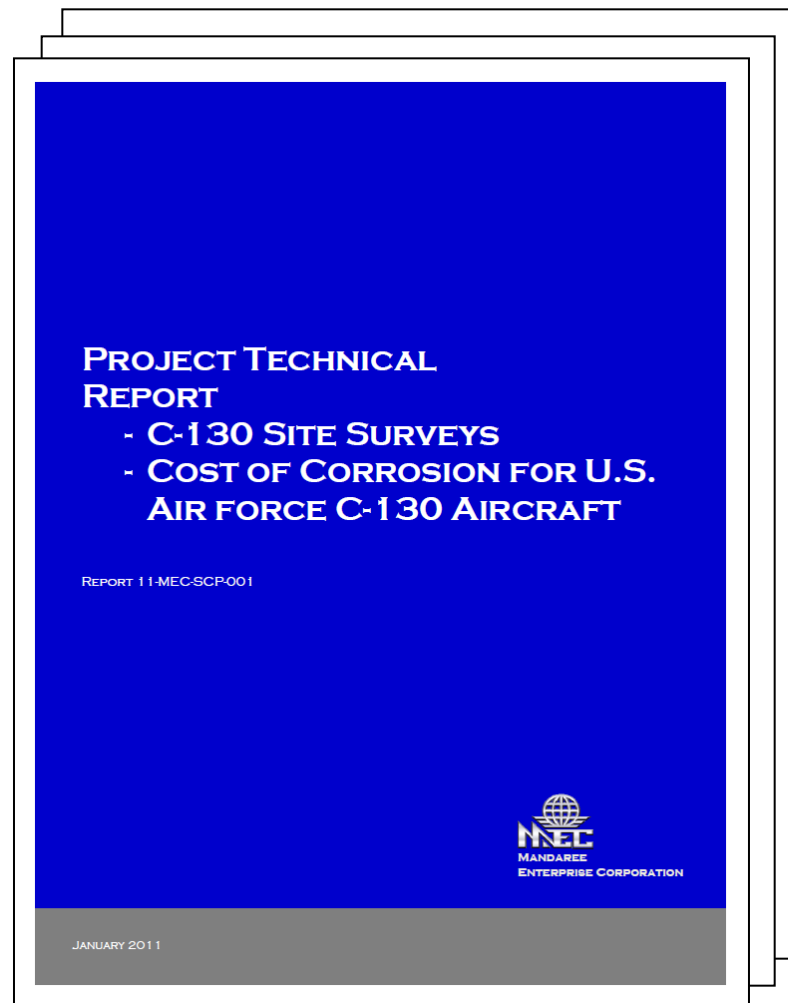


Assessments and Surveys



Warner Robins Air Logistics Center

- Field units encouraged to communicate and submit new and emerging corrosion issues to their MAJCOM Functional managers, the C-130 Corrosion Manger and MEC
- Details concerning the Corrosion Program Surveys are compiled in an annual Project Technical Report





CPCP Short-Term/Long-Term Mission Goals and Thresholds



Warner Robins Air Logistics Center

The C-130 CPCP is transitioning from a reactionary mode of operation to one of strategic and tactical corrosion management planning (2011 C-130 Corrosion Prevention and Control Program Plan) .

■ Strategic Objectives (long-term +5 years)

- Develop standardized methodologies for collecting and analyzing corrosion related cost, readiness and safety data
- Optimize corrosion prevention and mitigation efforts through training tailored to requirements at the management and technical level
- Maintain corrosion technical data currency
- Build and maintain a knowledge base of corrosion prevention, detection, prediction, and treatment processes, leading-edge technologies, R&D results, and technology transition successes
- Development/ implementation of prognostics, diagnostics, and integrated health monitoring systems to facilitate a transition to Condition Based-Maintenance



CPCP Short-Term/Long-Term Mission Goals and Thresholds



Warner Robins Air Logistics Center

■ Tactical Objectives (short-term 1-3 years)

- Conduct a Cost of Corrosion Baseline Study – C-130 weapon systems peculiar
 - Document where corrosion problems exist, identify their causes, and prioritize them according to their relative severity
- Conduct ‘Field Corrosion Assessments and Surveys’
 - Identify corrosion related deficiencies and provide recommendations for corrective actions
- Quarterly management reviews of corrosion issues for the previous 3-month period
- Periodic review of 1-1-8 (Application and Removal of Aerospace Coatings), 1-1-691 (Aircraft Weapon Systems Cleaning and Corrosion Control)
- Periodic review/ update of T.O. 1C-130A-23 (C-130 Corrosion Control Manual), depot specification/ work cards to ensure the use/ application of corrosion prevention technologies and treatments
- Field new materials and other corrosion prevention products
- And more...

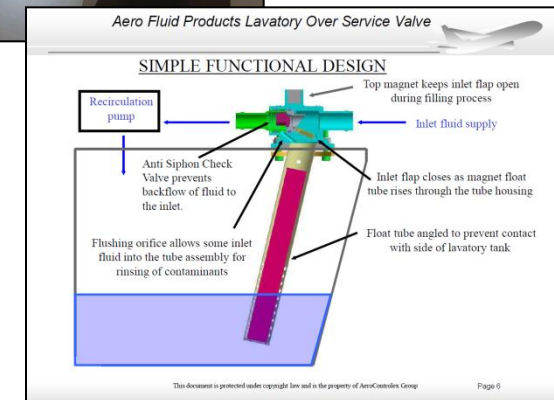
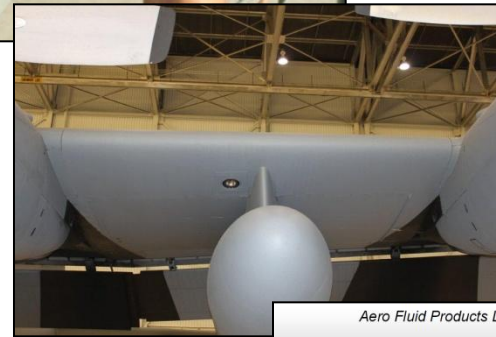


Structural Corrosion Program Projects Listing



Warner Robins Air Logistics Center

- 3M Polyurethane Protective Tape to Leading Edge
- Polysulfide Topcoat Addition to Leading Edge
- Latrine Over Servicing Valve





Structural Corrosion Program Projects Listing



Warner Robins Air Logistics Center

■ AvDec

- Conductive Antenna Gaskets



- Av-Dec Polyurethane Sealant Tapes

- Replacement for Skyflex on window installations
- Replacement for Skyflex on aircraft floor panels



- Polyurethane Injectable Sealants

- FS 737 latrine areas





Structural Corrosion Program Projects Listing



Warner Robins Air Logistics Center

■ Cor-Ban 35

- Cargo Floor Chine Plates (FS 245-737)
- BL 20 and 61 Longerons
- Sloping Longerons
- Lower Empennage Interior Surface
- Dry Bay Access Panels
- Wing Leading Edge Spar Caps
- Center and Outer Wing Trailing Edges
- Wing Joint Attachment Fitting (Rainbows)
- Ailerons/Aileron Swing-down Panels
- Engine truss mounts and braces



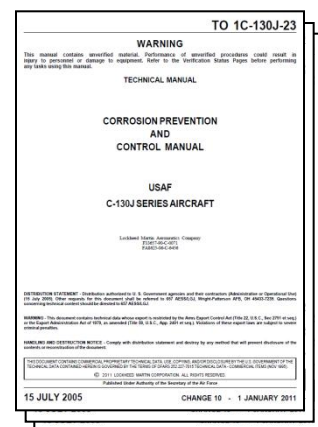


Structural Corrosion Program Projects Listing



Warner Robins Air Logistics Center

- Rewrite/Revision of the C-130 Corrosion Control Manuals, 1C-130A-23 & 1C-130J-23



- Mold and Mildew Remediation

- 3M Weather Excluding Patches



NAVIAIR Corrosion-Inhibited Mildew Remover

- Joint NAVAIR & AMCOM assessment of reformulated Mildew Remover
 - Meets critical characteristics specified in MIL-PRF-85570 and ADC-SIA-PRP cleaning topics
 - Effectively removes mildew without corrosion risk of bleach
- U.S. Patent applications filed for compositions & kit
- Composition and kit licensed to commercial supplier
- NAVAIR & AMCOM authorized in 2005
- Implementation pending current FIFRA registration and NNI assignment
- Interim Kits delivered to Fleet and to Army Units

Mildew Growth inside T-39 Aircraft Before Cleaning

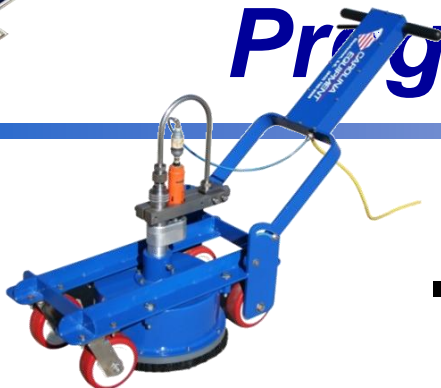
Cleaning Mildew Growth by Spraying Mildew Remover



Structural Corrosion Program Projects Listing



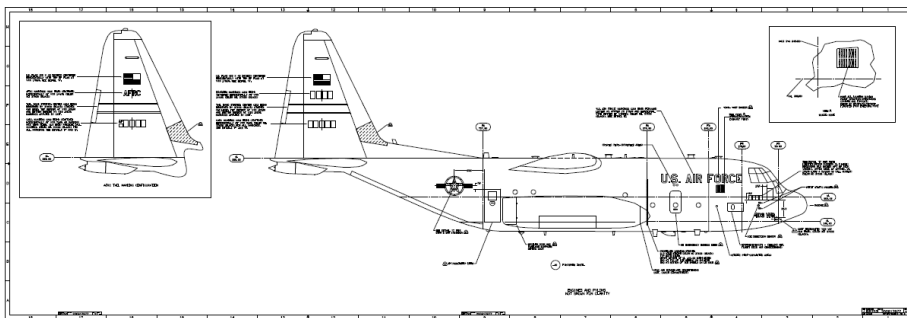
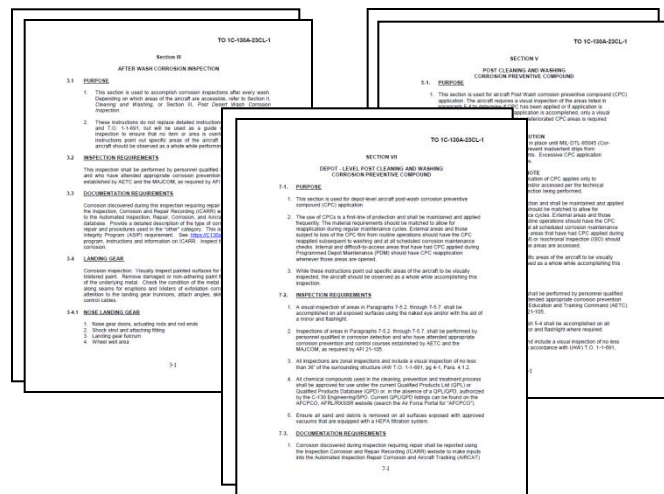
Warner Robins Air Logistics Center



■ C-130 Anti-Skid Tape Removal Process

■ Revisions to the 1C-130A-23CL-1

- Section III, *Post-Desert Wash Corrosion Inspection*
- Section V, *Post Cleaning and Washing Corrosion Preventive Compound / Lubrication*
- Section VII, *Depot - Level Post Cleaning and Washing Corrosion Preventive Compound.*



■ Development of New Paint Drawing: C-130J (long/short) & WC-130J



Structural Corrosion Program Projects Listing



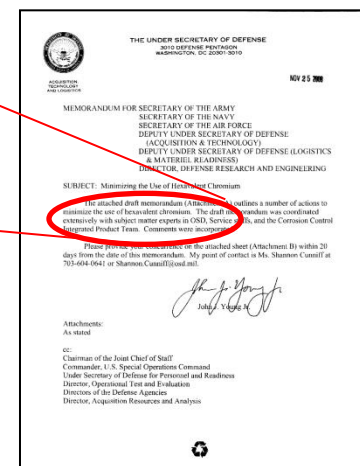
Warner Robins Air Logistics Center

Future Projects

■ Chrome-Free Coating Systems Flight Tests

- AkzoNobel (Sep-Oct 2011)
 - PreKote
 - Aerodur 2100 magnesium rich primer (MgRP)
 - Aerodur 5000 topcoat color #36173
- Deft (June 2012)
 - Rare earth conversion coating (RECC) 1015/3021
 - 02-GN-093 chrome-free primer
 - 99GY-001 Advance Performance Coating

...minimize the use of hexavalent chrome...



■ Robotic Depaint

- Employment of robotics to depaint aircraft via laser



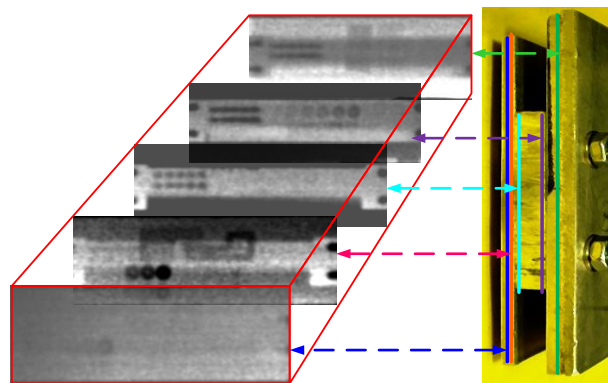
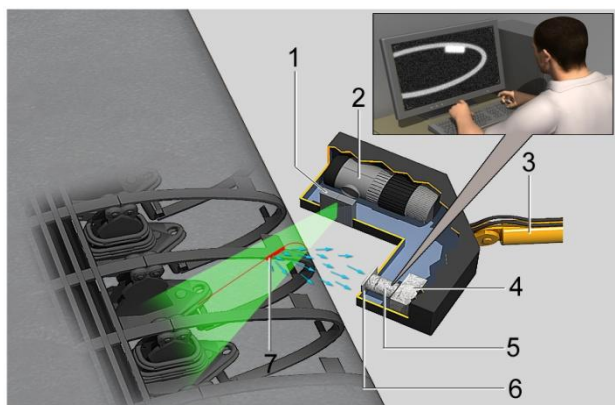
Structural Corrosion Program Projects Listing



Warner Robins Air Logistics Center

SIBR Projects

- Back Scatter X-Ray NDI
 - Detect concealed corrosion
 - Evaluated on C-130 HVM Pre Induction Inspections



- Wireless Sensors with Advanced Detection and Prognostic Capabilities for Corrosion Health Management



POCs



Warner Robins Air Logistics Center



Government

- **David Peth**
C-130 Corrosion Engineer, WR-ALC/GRBEB
Tactical Airlift Division
478-222-5278
David.Peth@robins.af.mil
- **Lt Doug Banning**
C-130 Corrosion Manager, WR-ALC/GRBE
Tactical Airlift Division
478-926-7396
Douglas.Banning@robins.af.mil

Contract Support

- **Larry Cornwell, Program Manager**
478-329-8233
Lawrence.Cornwell@mandaree.com
Lawrence.Cornwell@robins.af.mil
- **Kevin Wilson, Logistician**
Kevin.Wilson@mandaree.com
- **Scott Ward, Logistician**
Scott.Ward@mandaree.com
- **John Lindsey, Logistician**
John.Lindsey@mandaree.com
- **Jim Dean, Logistician**
Jfdean2@cox.net
- **Andrew Carlisle, Logistician**
Andrew.Carlisle@mandaree.com
- **Ed Reid, Materials Engineer**
Edwin.Reid@mandaree.com
- **Josh Kingsley, Materials Engineer**
Joshua.Kingsley@mandaree.com
- **Brandon Hall, Aerospace Engineer**
Brandon.Hall@mandaree.com

