

# ***Tactical Airlift Division***

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***Combat Ready, Anytime, Anywhere***



## **C-130 Corrosion Prevention and Control Program**

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

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***People First...Mission Always***

| Report Documentation Page                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                    |                                     |                                                           | Form Approved<br>OMB No. 0704-0188                  |                                 |
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# C-130 Fleet Overview



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## 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



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## ■ 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



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**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

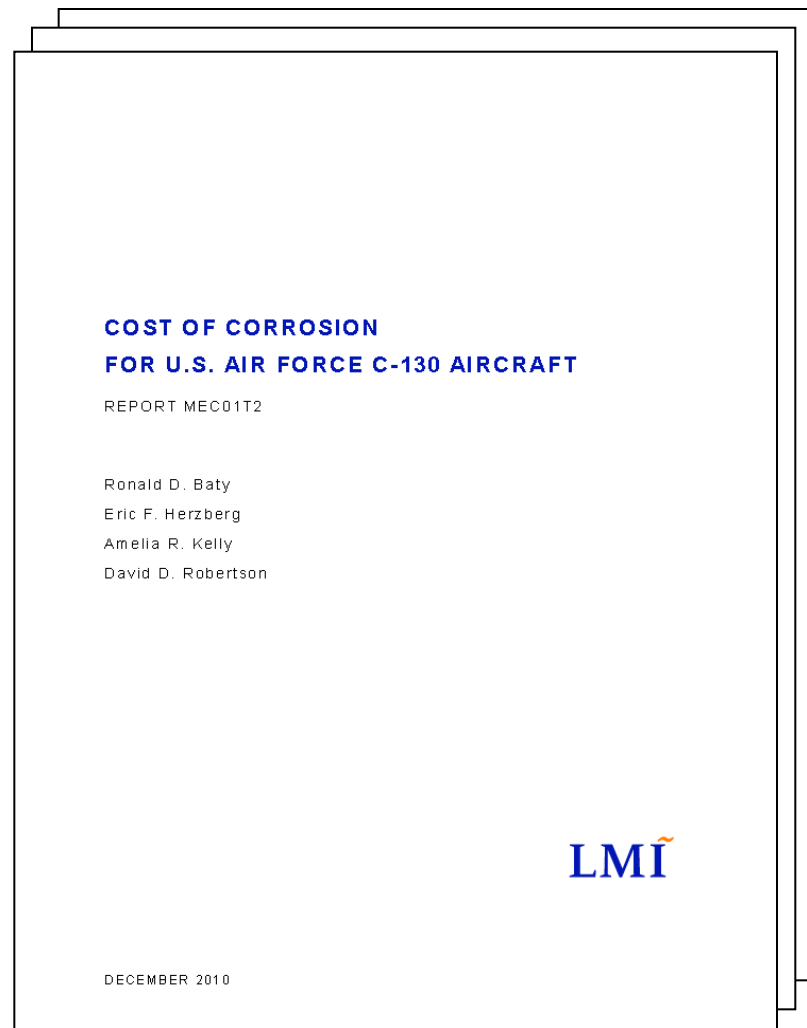


# Corrosion Maintenance Cost Data Analysis



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- 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**



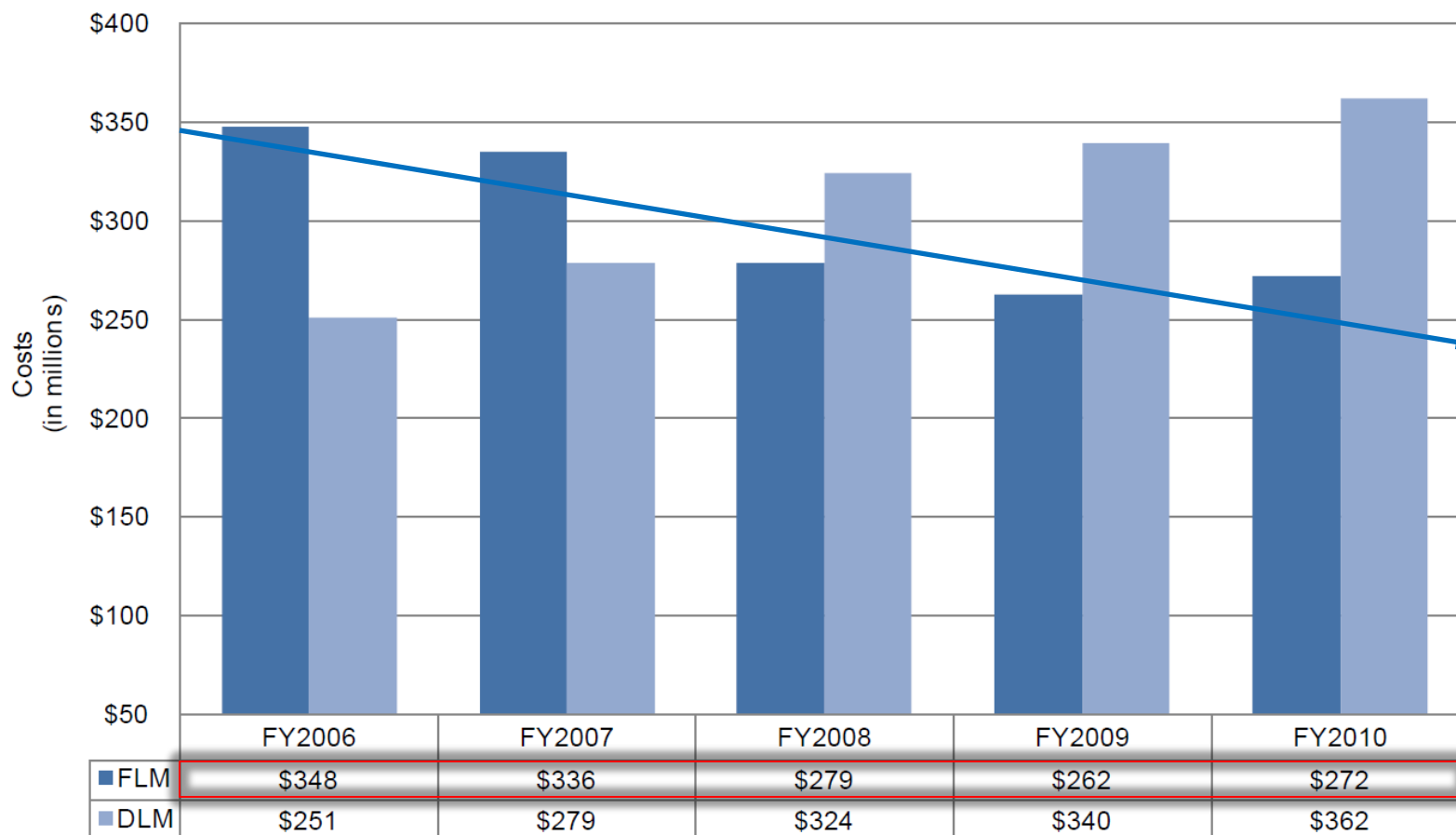


# C-130 Field & Depot Corrosion Costs for FY 2006 - FY 2010



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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

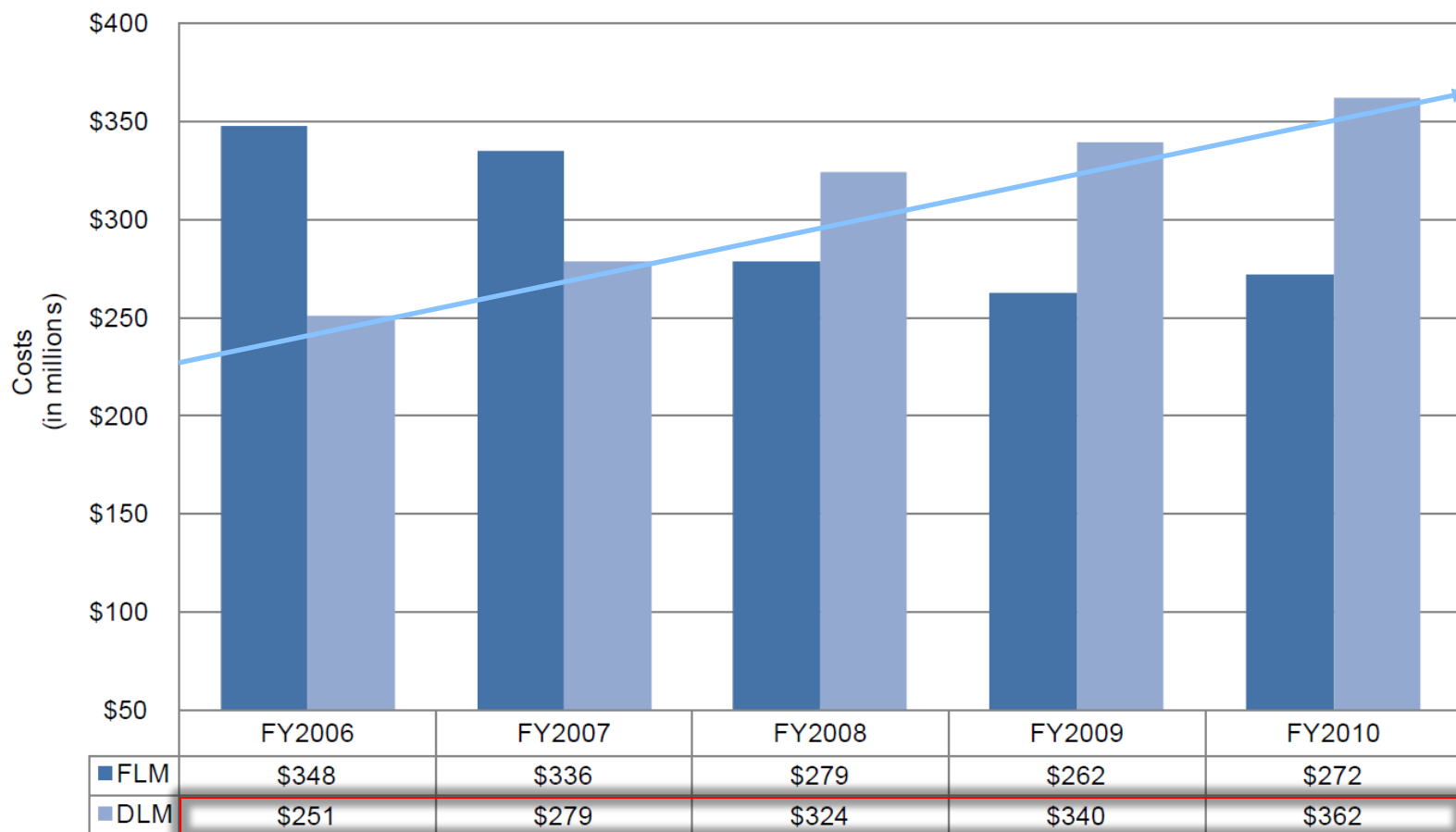


# C-130 Field & Depot Corrosion Costs for FY 2006 - FY 2010



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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

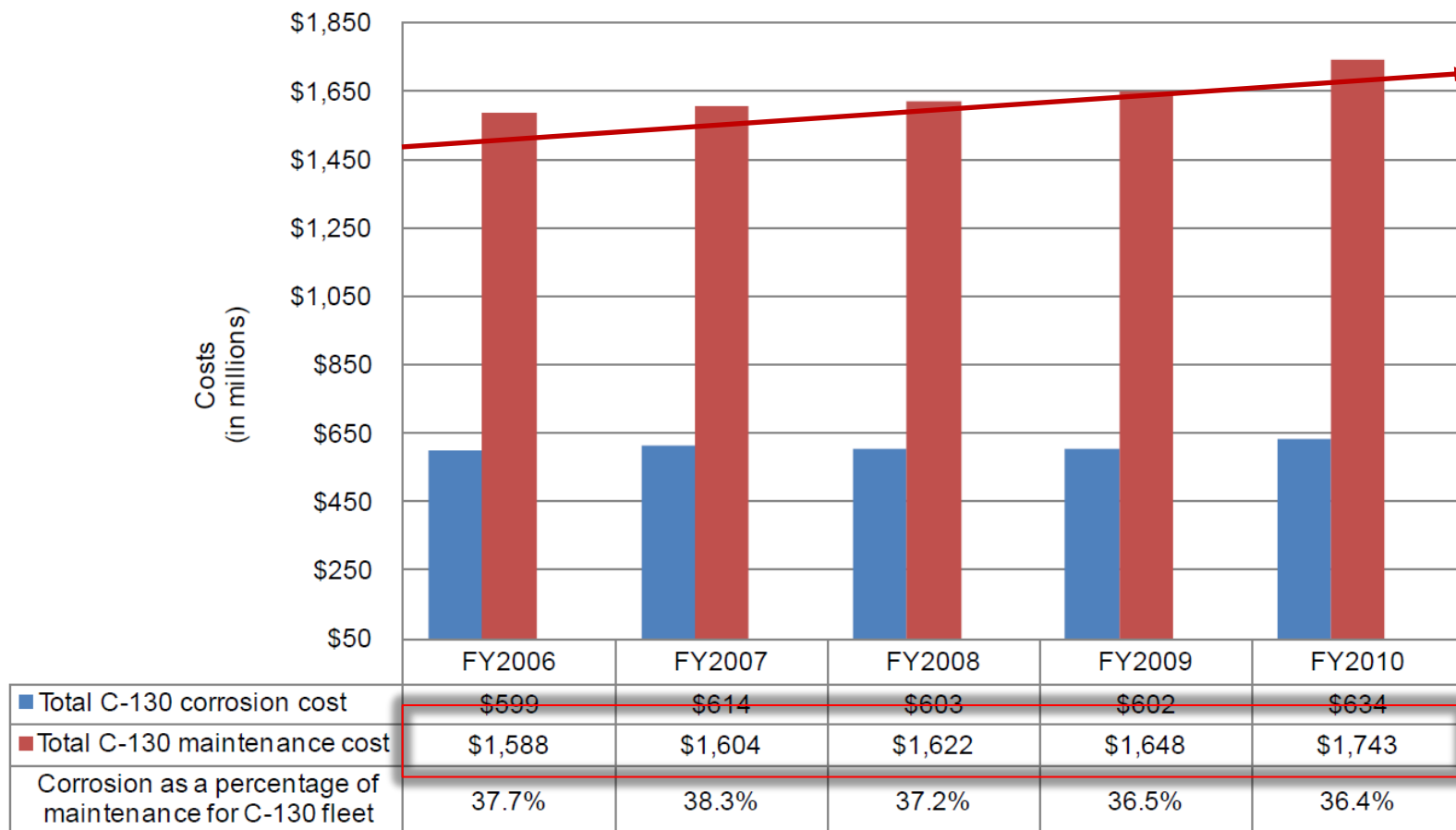


# C-130 Corrosion & Maintenance Costs for FY 2006 - FY 2010



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



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

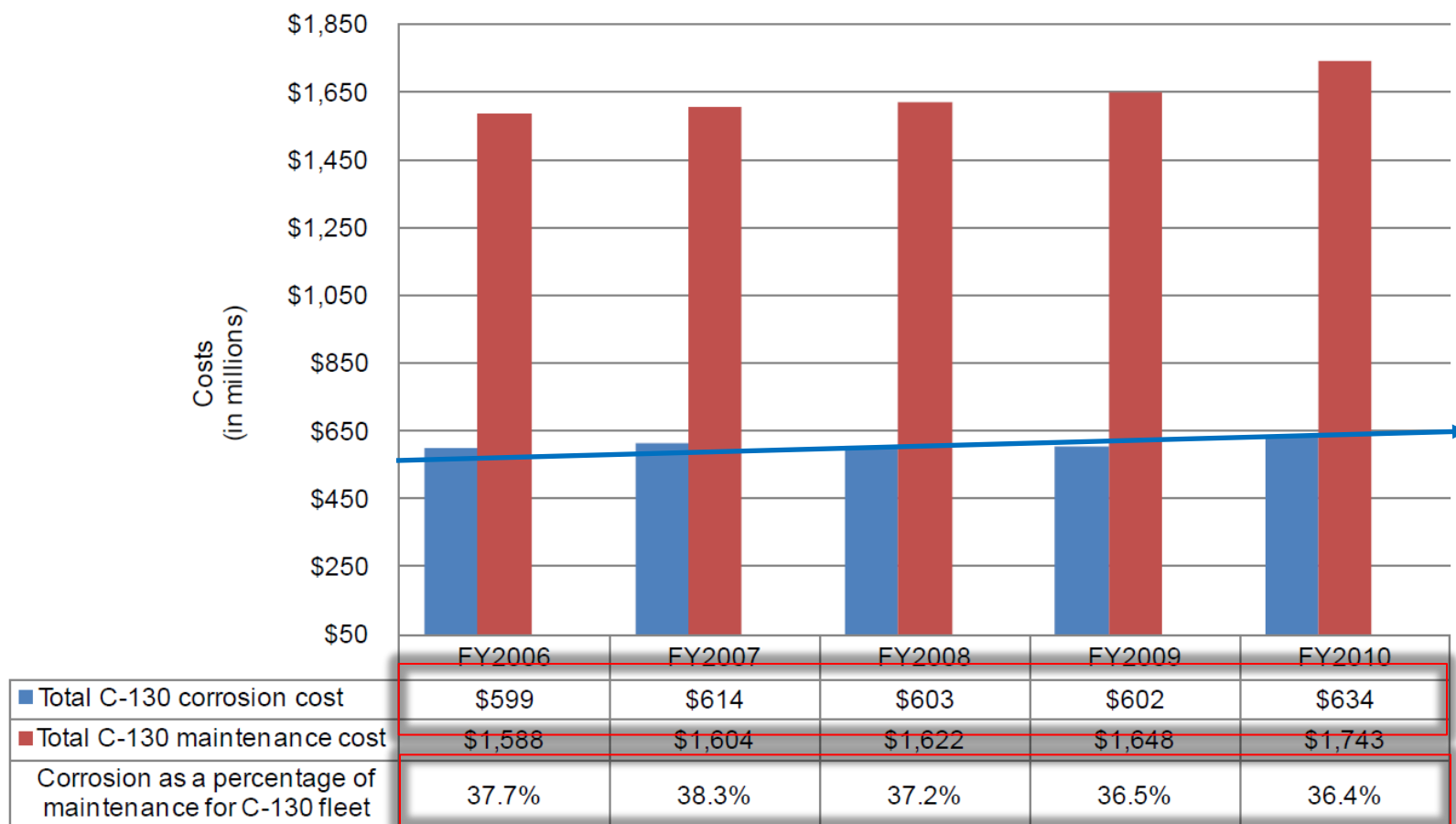


# C-130 Corrosion & Maintenance Costs for FY 2006 - FY 2010



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



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



# C-130 Corrosion & Maintenance Costs for FY 2010



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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)



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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 |
|------------|-----------------------------------------------------------------------|------------------------------|--------------------------------|------------------------------------------|
| <b>115</b> | <b>Airframe—wings and nacelles</b>                                    | <b>\$334</b>                 | <b>\$809</b>                   | <b>41.4%</b>                             |
| <b>114</b> | <b>Airframe—fuselage</b>                                              | <b>\$264</b>                 | <b>\$538</b>                   | <b>49.1%</b>                             |
| <b>461</b> | <b>Fuel systems—tanks</b>                                             | <b>\$195</b>                 | <b>\$403</b>                   | <b>48.5%</b>                             |
| <b>041</b> | <b>Special inspections</b>                                            | <b>\$128</b>                 | <b>\$352</b>                   | <b>36.5%</b>                             |
| 010        | Ground handling, servicing, and related tasks                         | \$113                        | \$338                          | 33.5%                                    |
| 037        | Scheduled inspection or maintenance—storage                           | \$111                        | \$492                          | 22.7%                                    |
| <b>110</b> | <b>Airframe</b>                                                       | <b>\$94</b>                  | <b>\$181</b>                   | <b>51.8%</b>                             |
| <b>112</b> | <b>Airframe—doors (hydraulic)</b>                                     | <b>\$92</b>                  | <b>\$211</b>                   | <b>43.4%</b>                             |
| 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)



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*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?***



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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

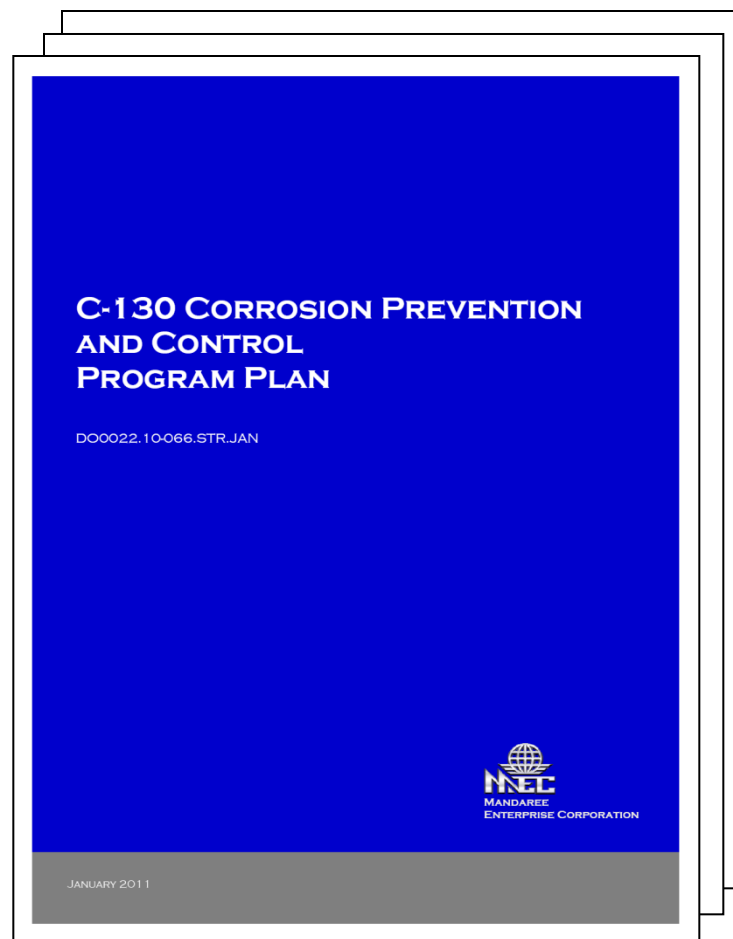


# C-130 Corrosion Prevention and Control Program



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- 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



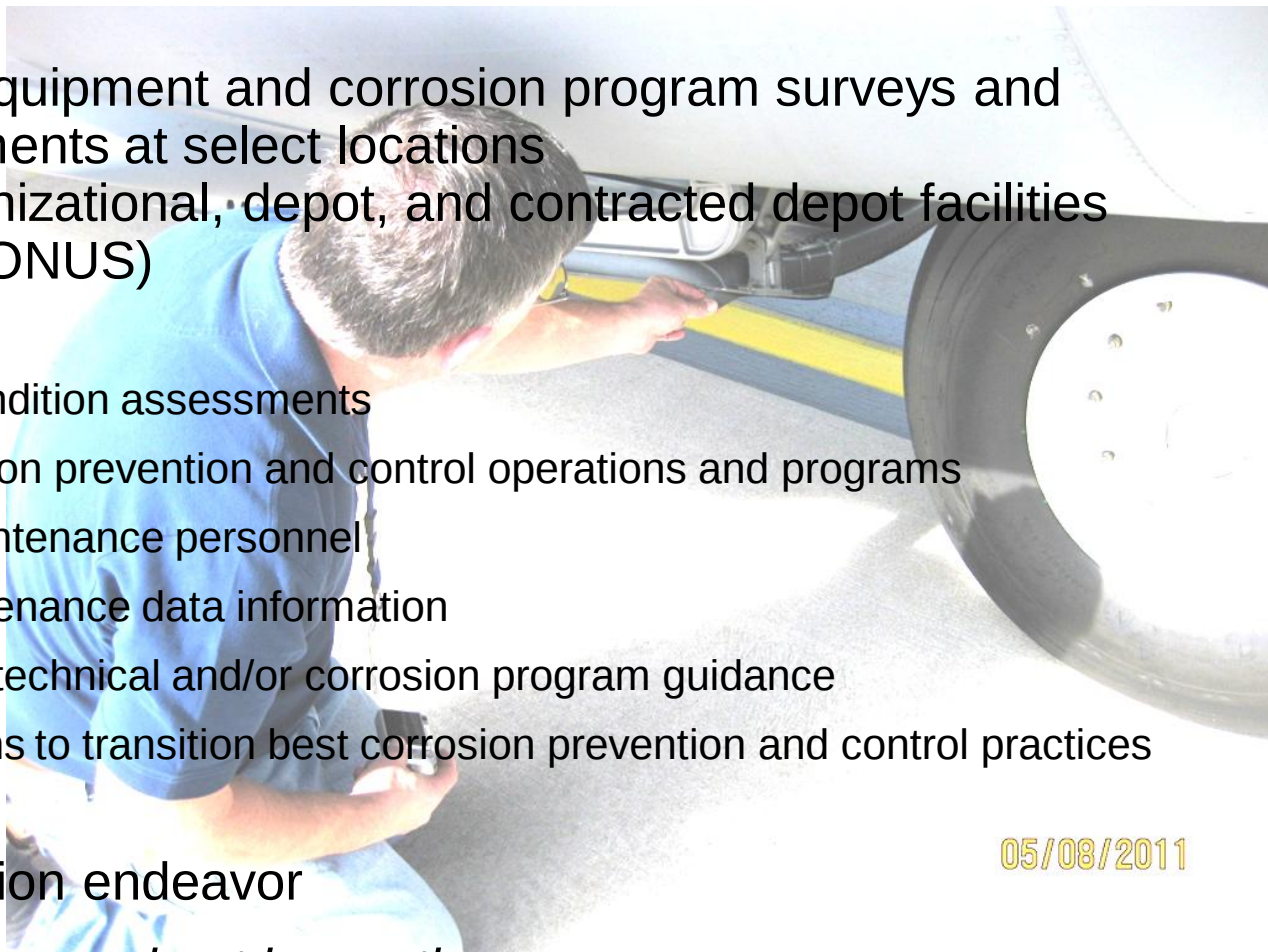
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## Purpose

- 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



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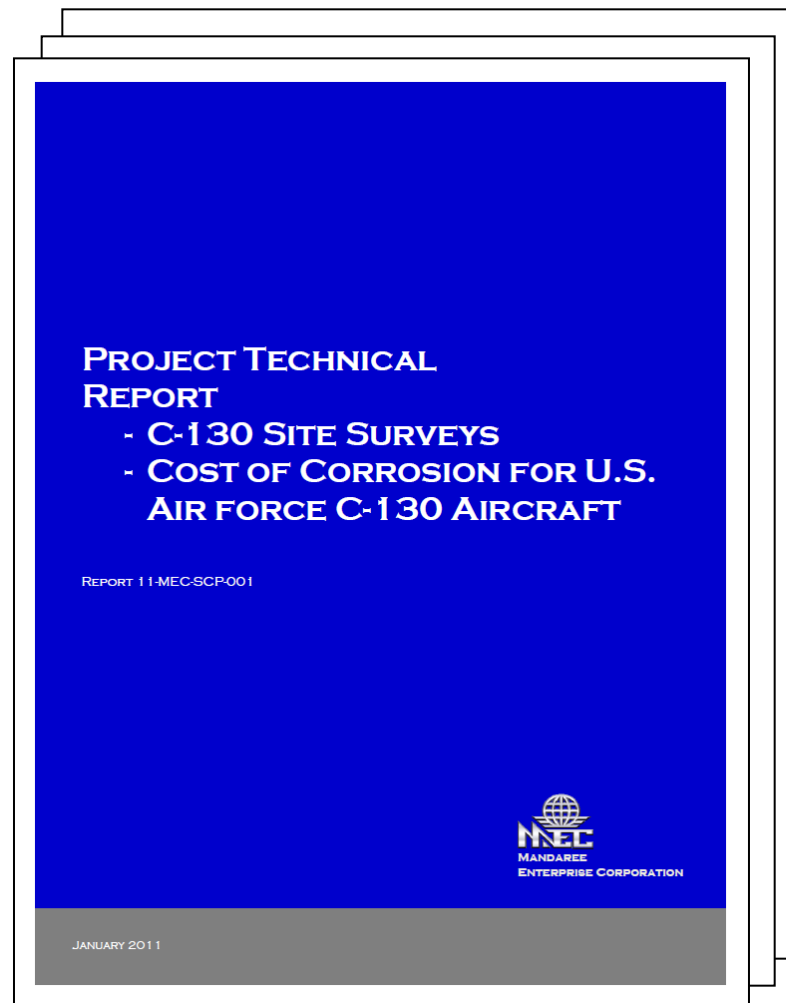


# Assessments and Surveys



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- Field units encouraged to communicate and submit new and emerging corrosion issues to their MAJCOM Functional managers, the C-130 Corrosion Manager 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***



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*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***



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## ■ 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...

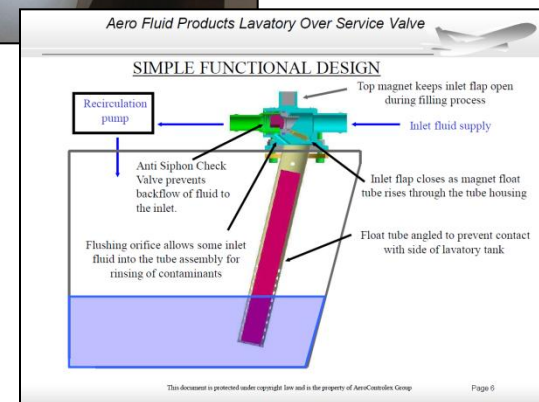
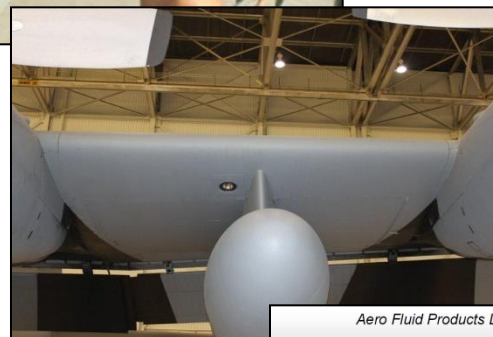


# Structural Corrosion Program Projects Listing



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





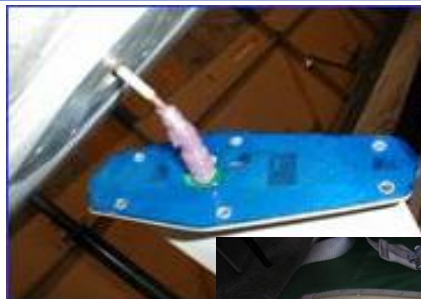
# Structural Corrosion Program Projects Listing



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## ■ 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



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## ■ 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



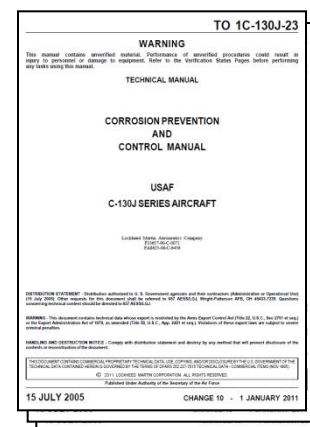


# Structural Corrosion Program Projects Listing



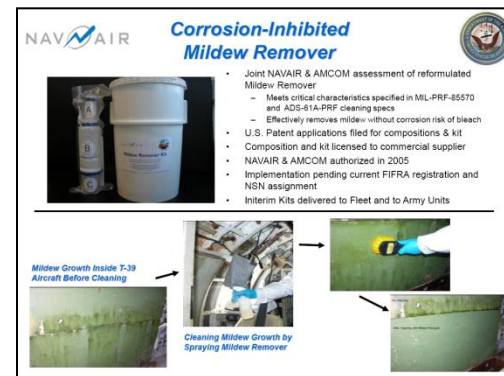
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- Rewrite/Revision of the C-130 Corrosion Control Manuals, 1C-130A-23 & 1C-130J-23



- 3M Weather Excluding Patches

- Mold and Mildew Remediation

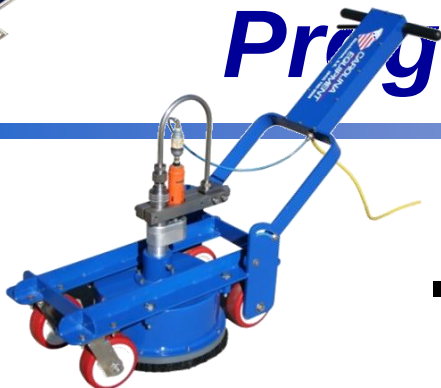




# Structural Corrosion Program Projects Listing



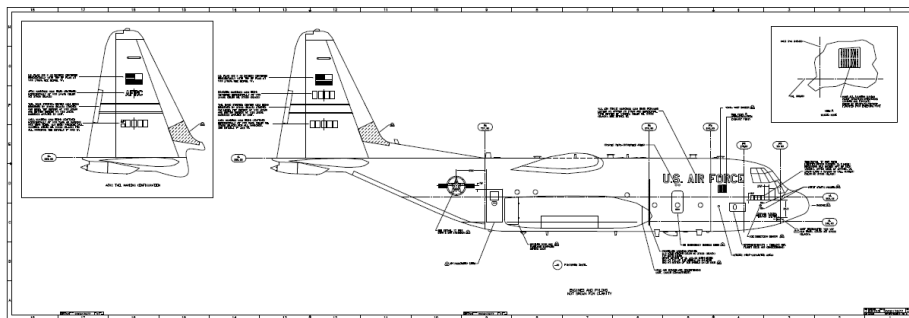
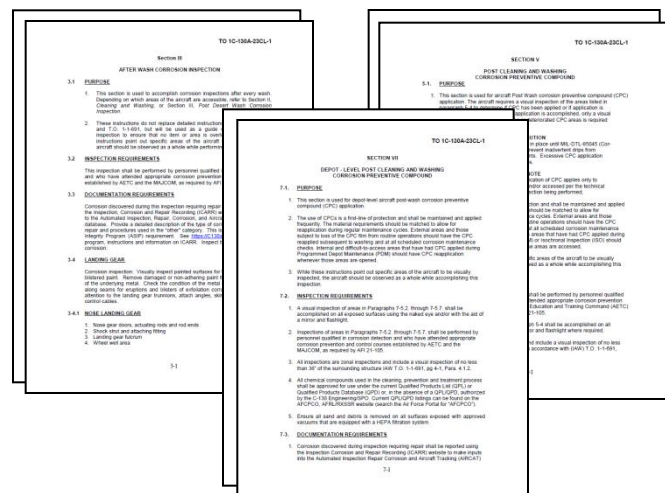
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## ■ C-130 Anti-Skid Tape Removal Process

### ■ 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



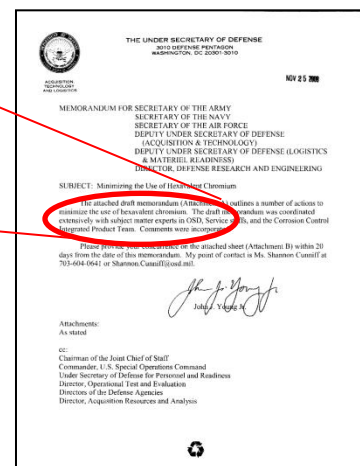
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## Future Projects

### ■ 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



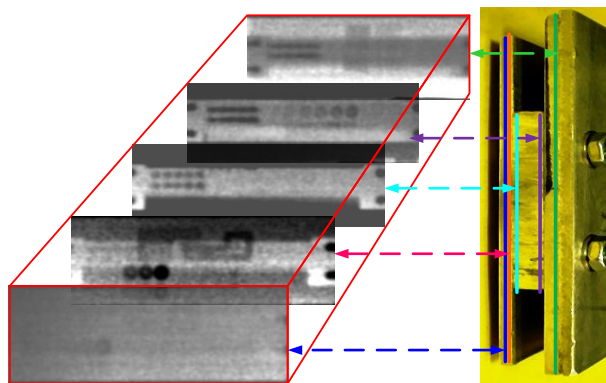
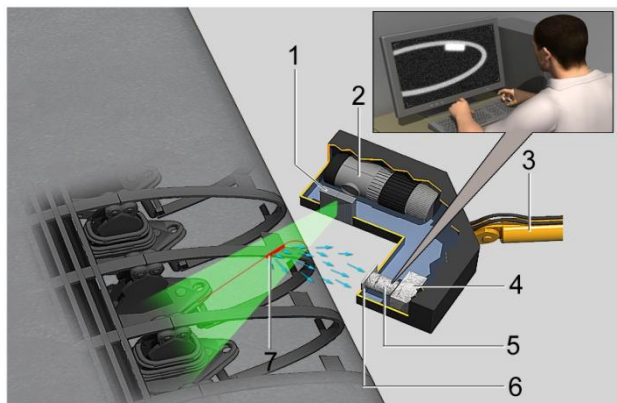
# Structural Corrosion Program Projects Listing



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



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