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Developing, Fielding, and Sustaining America's Aerospace Force

Effects of Corrosion Inhibiting Lubricants On Electronics Reliability

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U.S. AIR FORCE

Integrity - Service - Excellence

Overview

Overview

History

Why Study

Previous Studies

Lab

Flight

Potential Savings

Conclusions

- History
- Why Study
- Previous Air Force Studies
  - Conclusions -- Ground And Lab
  - Conclusions – Flight
- Potential Savings
- Summary

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- **It is well known in theory and experience that thin, often invisible, insulating films can form on the surfaces of electrical connectors. These films/corrosion can be produced by the reactions of natural environments with the material systems used in commercial and military connectors. Such films may represent a significant source of faults such as Cannot Duplicate (CND) and Retest Ok (RETOK).**

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- **Avionics/Connector Corrosion "Does Not Occur" Per Air Force Databases**
  - **Can't be Seen (i.e. It Is Below Levels of Visual Detection)**
  - **Seldom if Ever Reported (i.e. No Data In REMIS by Related Codes)**

- **Connector Corrosion Does Occur In Base Level Environments!!**

Why Study ??

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- **Corrosion Preventive Compounds (CPC) May Inhibit Corrosion To A Degree Which Makes Their Use Worthwhile**

- **Previous Studies Demonstrated that Connector Corrosion can be Prevented with CPC Lubricants**
  - **Inexpensive**
  - **No Risk**
  - **No Impact On Normal Ops**

- **Potential Cost Savings Throughout DOD**

  May Be Large Due To <u>Exchange Cost Avoidance</u>

Previous Air Force Studies

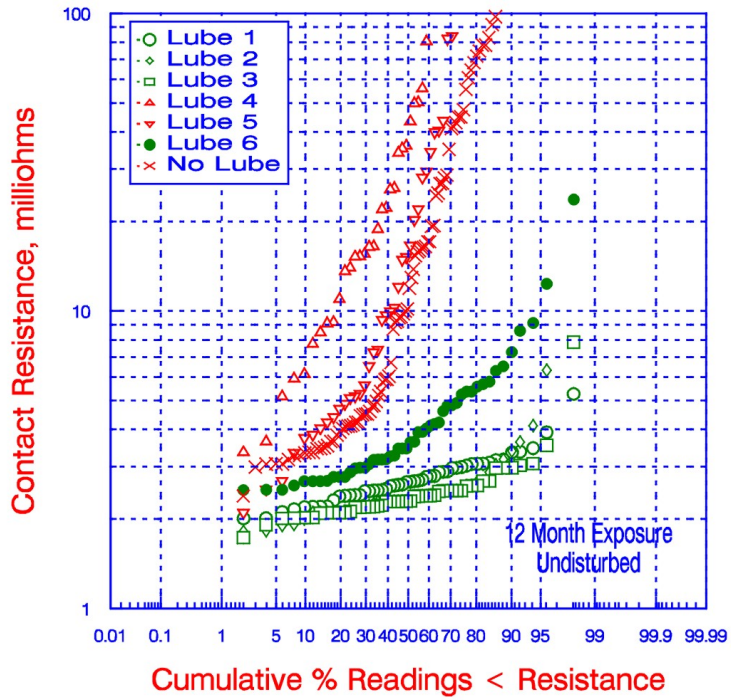
- **Our Work Accomplished by <u>Battelle Labs</u> Contract Support**

- **Phase I -- Ground Based, Field And Lab Study (2 Years)**
  - **Lubricants been qualified under MIL-C-81309E (Navy) or MIL-L-87177A (Air Force)**
  - **Technical Performance (12 Lubricants)**
  - **Risk Evaluation**

- **Phase II -- Flight Tests (2+ Years)**
  - **Select 2 Lubricants; Specific LRUs; Lube I/O Connectors**
  - **F-16; about 150 Aircraft; at 10 Locations**
  - **Evaluate By LRU Performance Data**
  - **Evaluate Any Implementation Problems**

Typical Field Exposure Results On Test Connectors

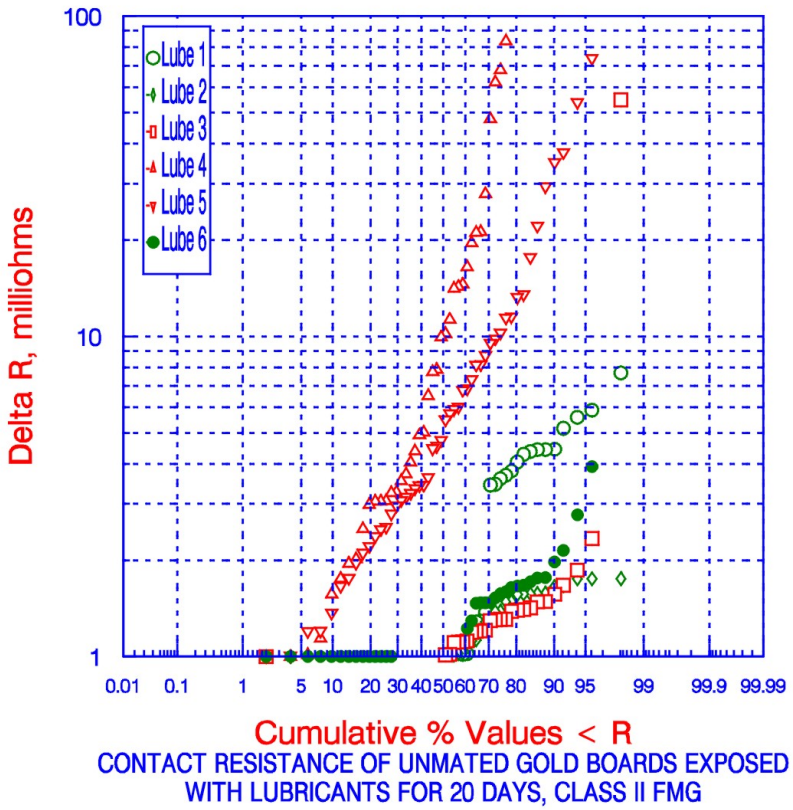
- Contact Resistance Change Distributions
  - 12 COTS CPCs Studied
  - Objective Is Smallest Change Possible (<10 milliohms)
- With No CPC, Failure Is Rapid
- Large Differences Among MIL Spec Lubes
- Few May Promote Corrosion
- Some Give Marginal Benefits
- The Best (2-3) Offer Excellent
- Corrosion Inhibition
- Objectives For Flight Tests Were
  - Corrosion Inhibition
  - Known Risk



CONTACT RESISTANCE OF AGED MATED, GOLD PLATED CONNECTORS AT SHELTERED SEACOAST EXPOSURE; EFFECTS OF LUBRICANTS (MIL 87177A AND 81309E)

Laboratory Validation/Risk Evaluation

- Thermal Ageing To Study Long Term Stability (80 C, 1000 Hrs)
- Corrosive Gas Exposure Of Unmated Connectors As Extreme Condition
- Combined Effects Shown
- Lab Results Parallel Field
- 2-3 COTS CPCs Will Survive Comprehensive Evaluation
- Best 2 Materials Selected For Flight Tests



CONTACT RESISTANCE OF UNMATED GOLD BOARDS EXPOSED WITH LUBRICANTS FOR 20 DAYS, CLASS II FMG

Conclusions -- Ground And Lab Study

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- **Large Difference Among Lubricants In Performance**

- **Only Very Few Lubricants Will Survive Comprehensive Evaluation**

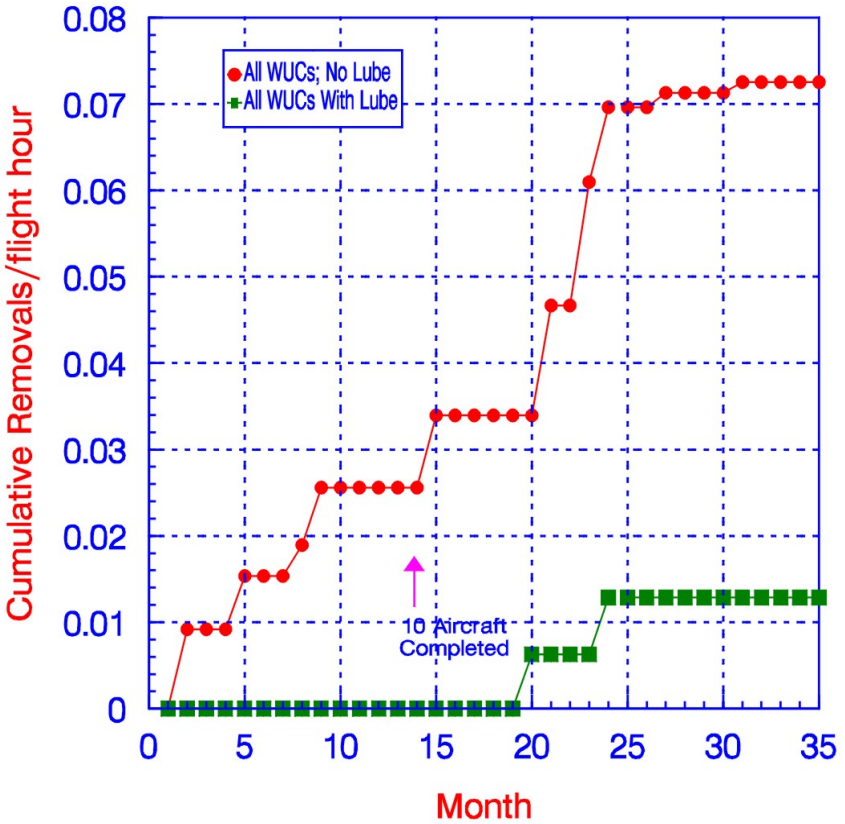
- **Present Qualification Specs Are Inadequate**

- **Best (2) Lubricants: MIL-C-81309E (Zip Chem D5026NS) and MIL-L-87177A (Lektro-Tech Super Corr B)**

  - **Totally Suitable For Flight/Avionics (Tri-Service Manual) "Avionics Cleaning and Corrosion Prevention/Control"**
    - **NAVAIR 16-1-540 (Navy)**
    - **TO 1-1-689 (AF)**
    - **TM-1-1500-343-23 (Army)**
  - **Total Corrosion Inhibition**
  - **No Known Engineering Risk**

F-16 Flight Tests; Treated LRUs

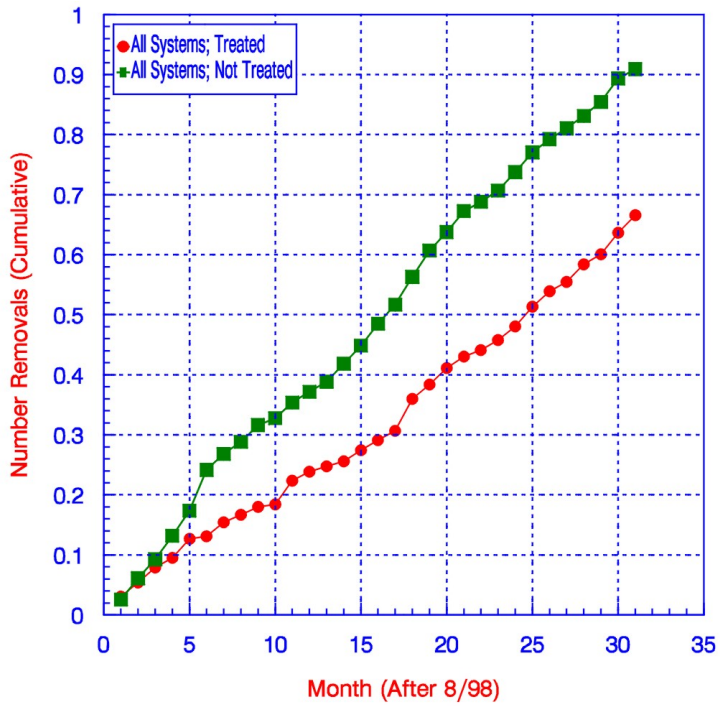
- Weapons System LRUs
  - Treated vs. Untreated
  - Flight Line Applications
  - Removals/Flight Hr.
- Positive Results
- Positive Base Feedback
- No Implementation Problems
- Minimal Labor



PPS (On Equipment) Data For Removals/Flight Hour; All Weapons System (WUC 75); Base A; With And Without Lube

F-16 Flight Tests; Treated LRUs

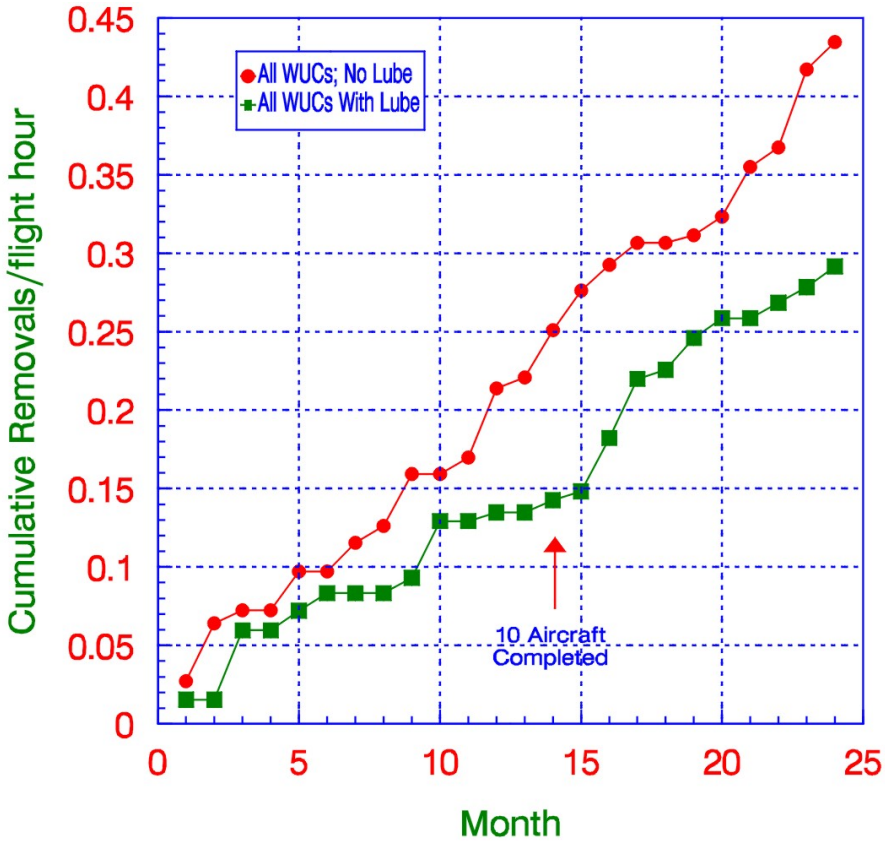
- All System LRUs (Avionics), (Weapons), (Flight Controls)
  - Treated vs. Untreated
  - Flight Line Applications
  - Removals/Flight Hr.
- Positive Results
- Positive Base Feedback
- No Implementation Problems
- Minimal Labor
- Large Potential Cost Savings From Reduced Removals And Exchange Cost Avoidance



F-16 Aircraft PPS (On Equipment) Removals/Flight Hour
Base B With And Without Lube

Example Of Potential Savings – Single Base

- 10 Aircraft Completed
- Single Lubricant
- Weapons and Avionics
- Positive Feedback
- Positive Results
- 482 FW Report Savings of $ 3.1M; 6 months with 10 of 18 A/C Done
- Calculated = $ 2.2M @ $25K Average DLR XCh Cost



PPS (ON) DATA FOR REMOVALS/FLIGHT HOUR; ALL WUCS FOR KYJL WITH AND WITHOUT LUBE; MONTH 1= JANUARY 1997

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- Selected CPCs Offer Inexpensive Means Of Reducing LRU Removals Due To Connector Related Reliability Effects (CNDs, Retoks, etc.)
- Present Test Requirements Are Inadequate To Safely Screen CPCs For These Critical Applications
- Only A Few COTS CPCs Will Survive Comprehensive Evaluation
- No Impediment To Routine Implementation
- No Identified Risk To Aircraft Systems
- No identified Human Factors Problems
- Performance Results – Positive
- High Cost Savings Potential
    - Reduction In MMH/Flight Hour
    - Reduction In Removals and Exchange Costs