

748th Supply Chain Management Group

Low Hydrogen Embrittlement (LHE) Zn-Ni Plating Update

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OPSEC Approved MJM Dec 2016

Case No. 75ABW-2016-0079

Distribution A. Approved for public release: Distribution unlimited

6 December 2016

Parts on the Shelf and Contracts in Place



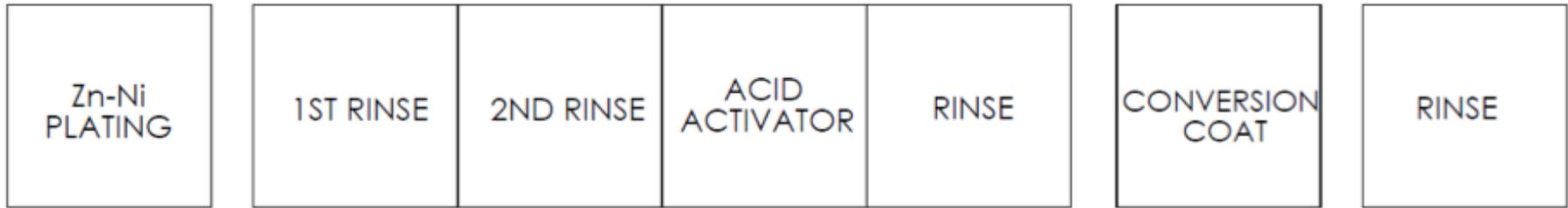
Agenda



- **Plating Procedures**
- **Performance Tracking Program**
- **Field Corrosion (Beach Corrosion)**
- **AFRL Re-Embrittlement Testing Results**



LHE Zn-Ni Plating Process



**Prototype LHE Zn-Ni
Plating Tank**

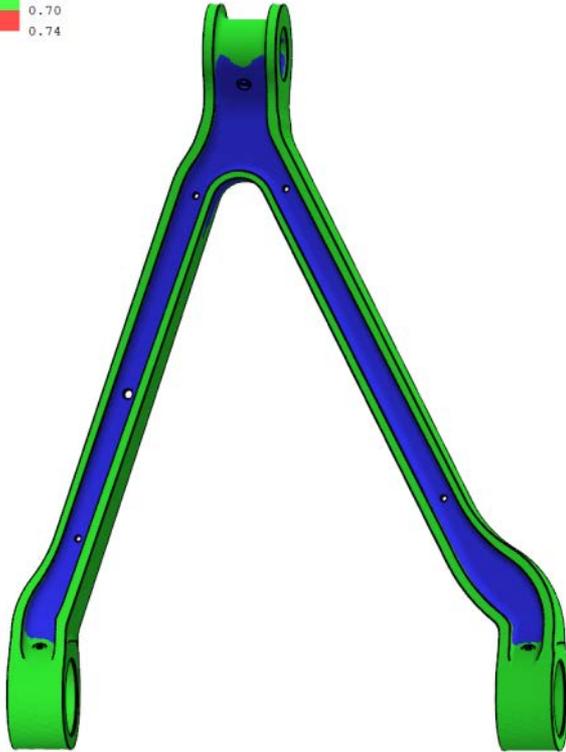


**Prototype Tri-Chromium
Conversion Coating Tank**

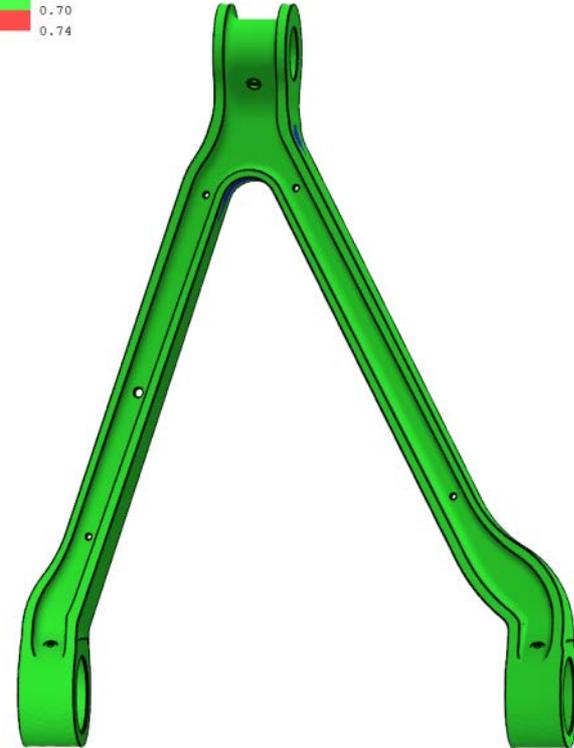
Parts on the Shelf and Contracts in Place



LHE Zn-Ni Plating Simulation



**Plating Simulation
Without Anodes**

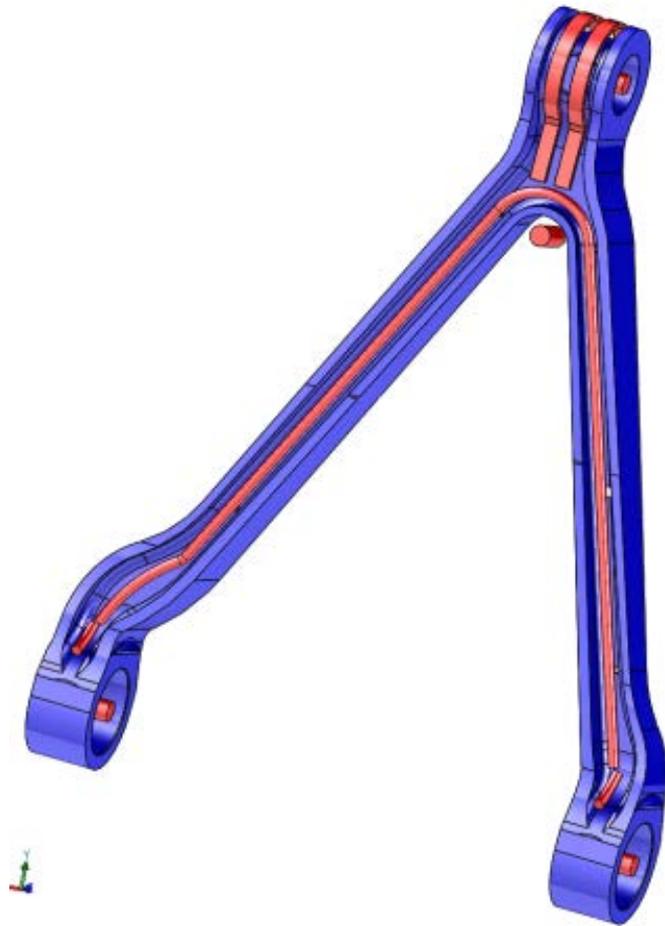


**Plating Simulation
With Anodes**

Parts on the Shelf and Contracts in Place



LHE Zn-Ni Anode Design



Parts on the Shelf and Contracts in Place



LHE Zn-Ni Performance Tracking Program (PTP)



- **Criteria for part selection**
 - **LHE Zn-Ni Conformal Anode Required**
 - **2 to 3 Parts from each Weapon System (NLG & MLG)**
 - **Ease of access to component on aircraft**
 - **Air Force Base**
 - **Location**
 - **Corrosive Environment**
 - **Overhauled at DoD Depot**



PTP Aircraft "A"



Parts on the Shelf and Contracts in Place



PTP Aircraft "A"



**Installed
October
2013**



Parts on the Shelf and Contracts in Place



PTP Aircraft "A" Landing Gear Components

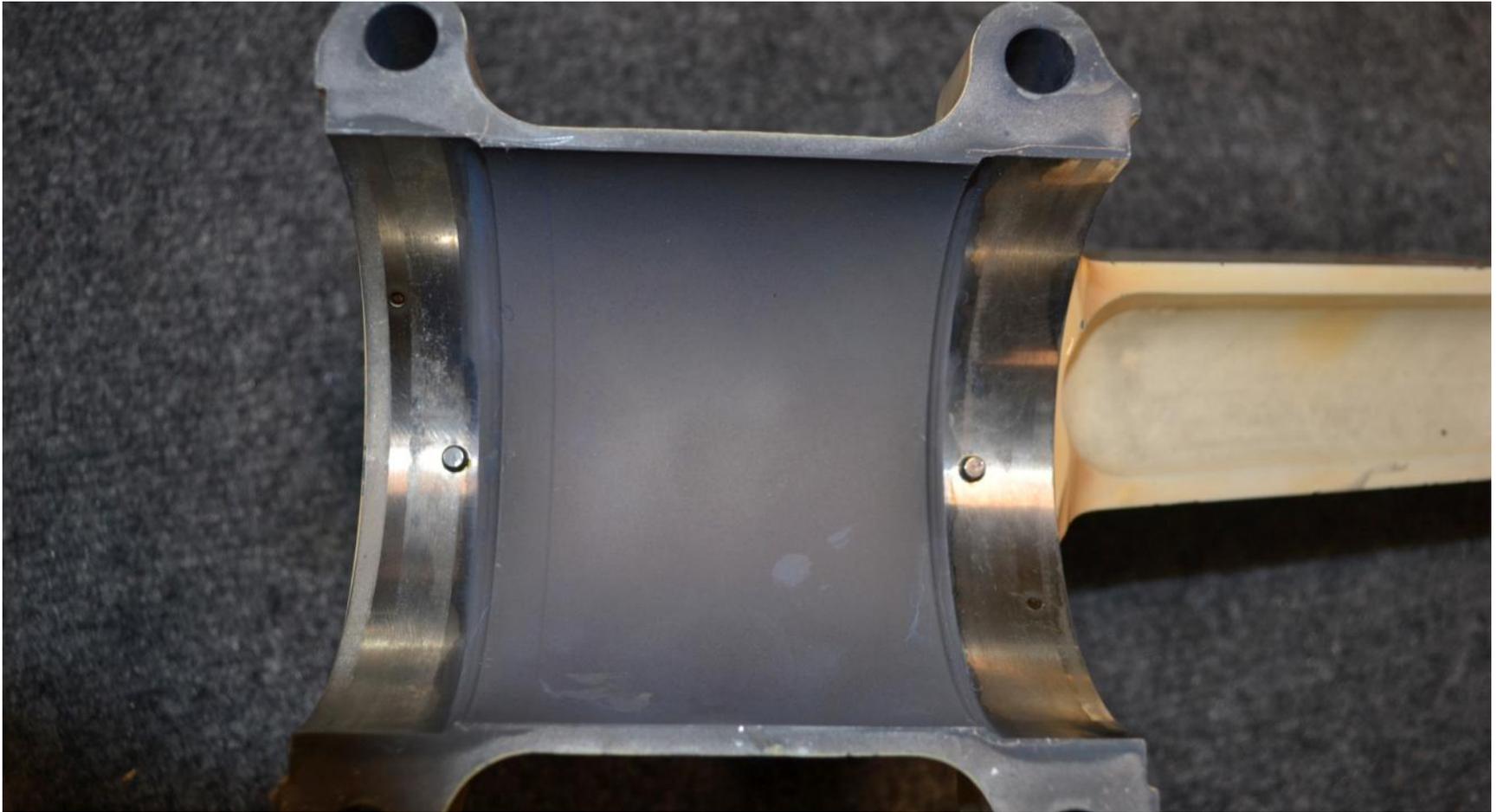


Removed after 18 months due to overheated brakes

Parts on the Shelf and Contracts in Place



PTP Aircraft "A"

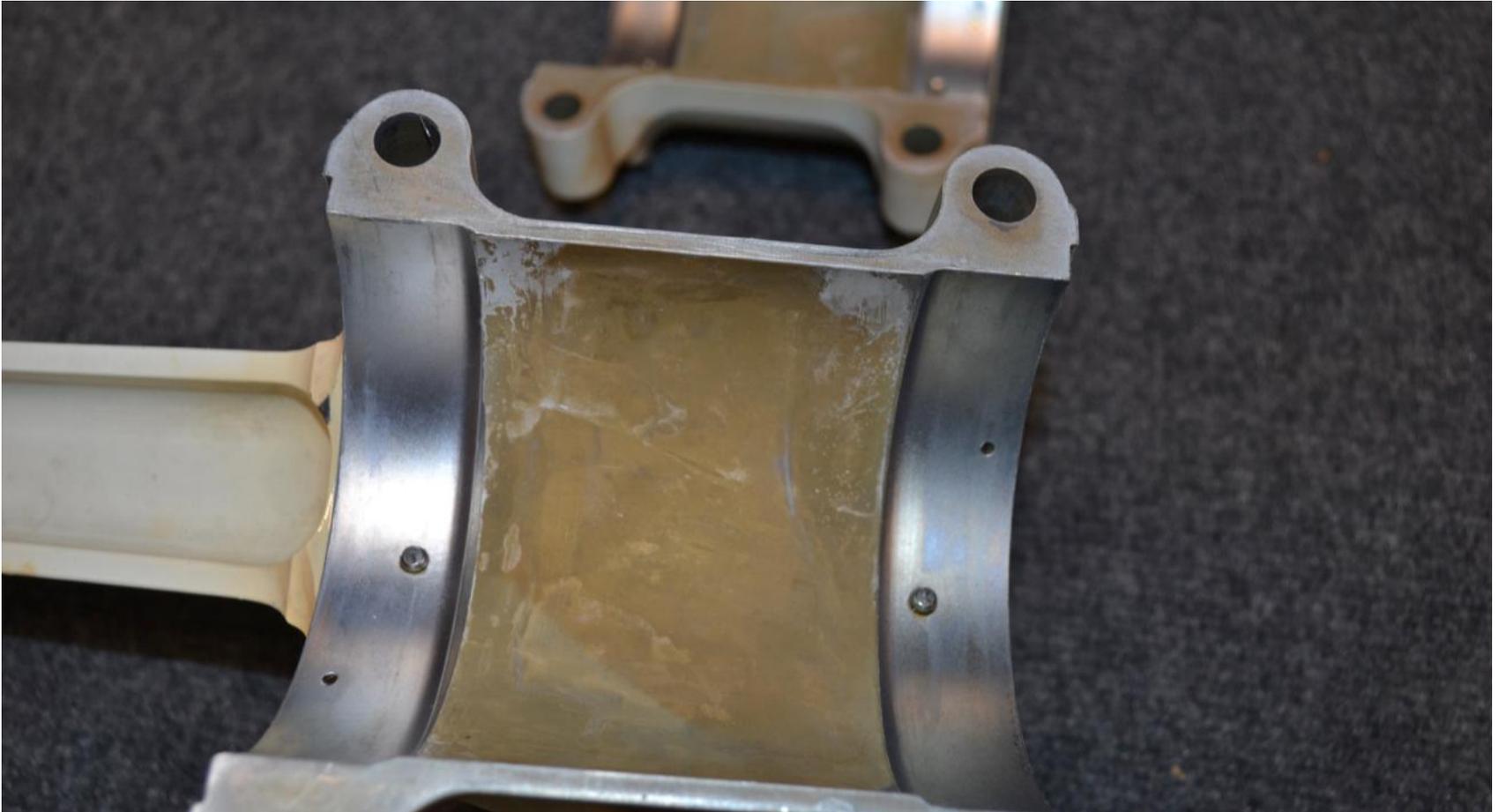


LHE Zn-Ni Collar

Parts on the Shelf and Contracts in Place



PTP Aircraft "A"



Cd Plated Rotation Collar

Parts on the Shelf and Contracts in Place



PTP Aircraft "B"

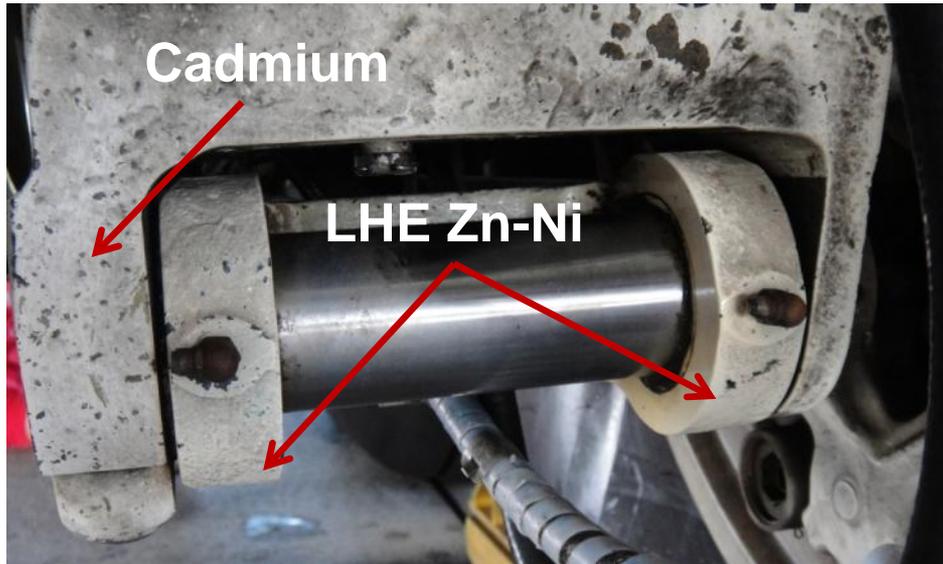
Components



Parts on the Shelf and Contracts in Place



PTP Aircraft "B"



Fwd LHE Zn-Ni Plated



Aft LHE Zn-Ni Plated

Parts on the Shelf and Contracts in Place



PTP Aircraft "B"



Fwd Cadmium Plated

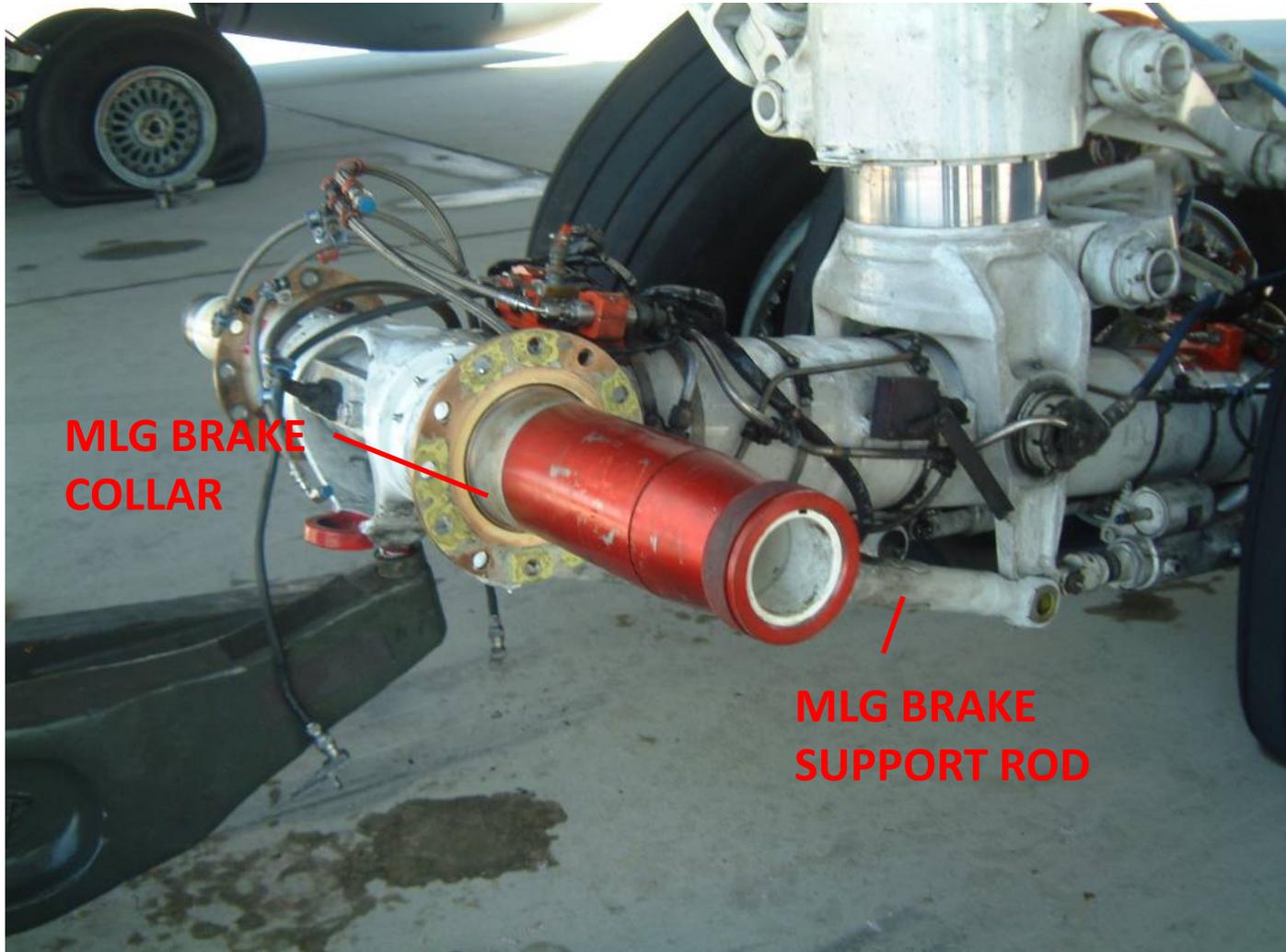


Aft Cadmium Plated

Parts on the Shelf and Contracts in Place



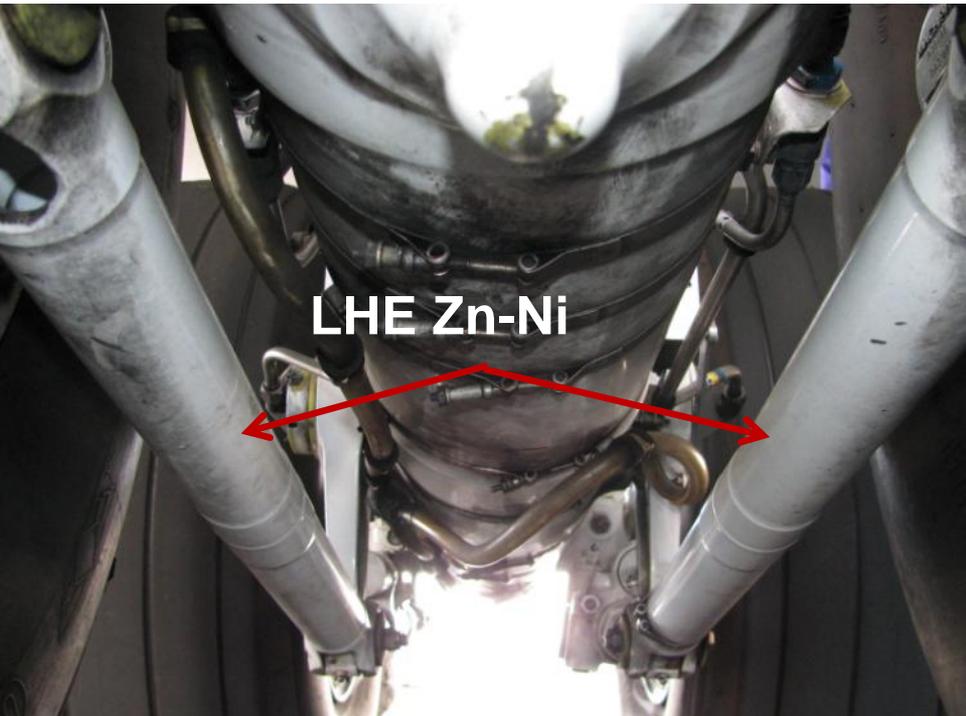
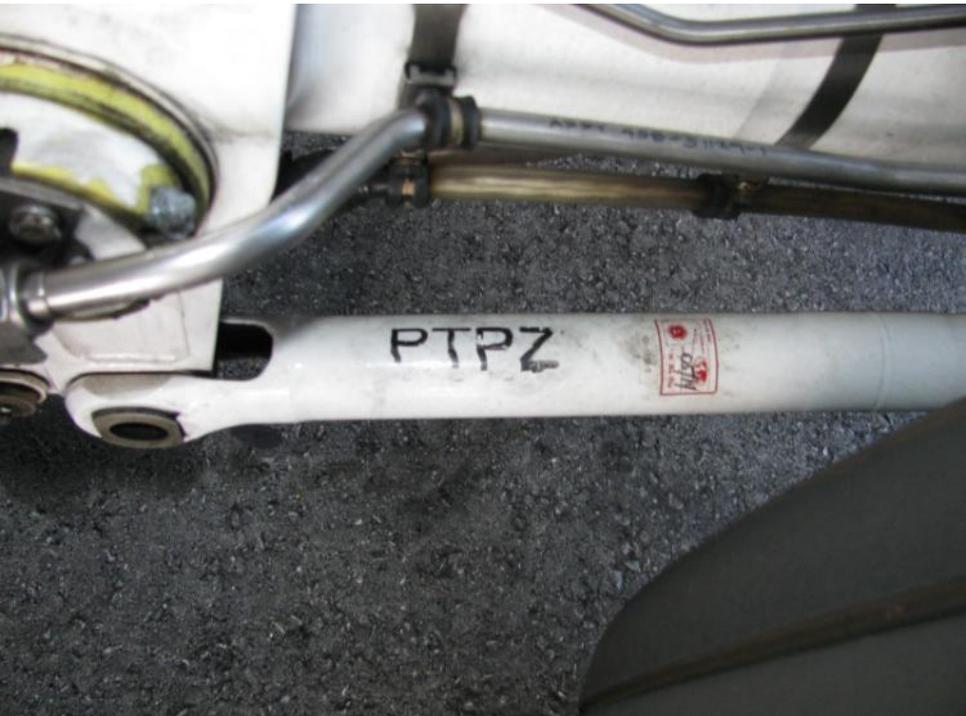
Main Landing Gear PTP Aircraft "C"



Parts on the Shelf and Contracts in Place



PTP Aircraft "C"



LHE Zn-Ni Plated

Parts on the Shelf and Contracts in Place



PTP Aircraft "C"



Cadmium Plated

Parts on the Shelf and Contracts in Place



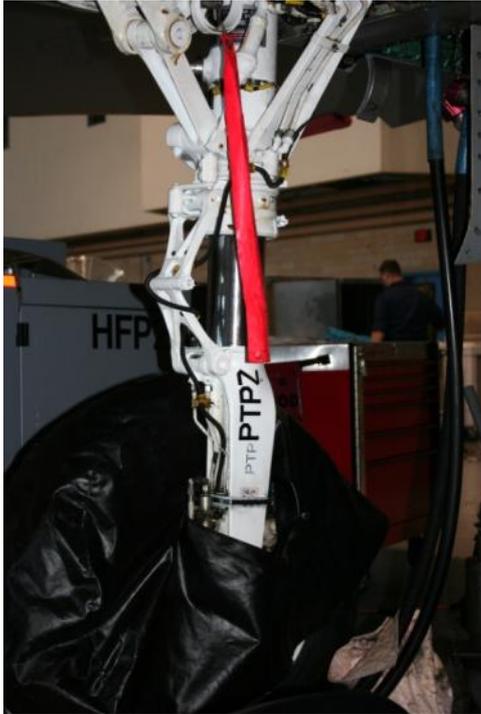
Aircraft "D" Landing Gear PTP Components



Parts on the Shelf and Contracts in Place



PTP Aircraft "D"



**LHE Zn-Ni PTPZ
Landing Gear RH
Installed Oct 14**



**Cadmium PTPC
Landing Gear LH
Installed Oct 14**

Parts on the Shelf and Contracts in Place



PTP Aircraft "D"



Left hand, Cd plated MLG & right hand LHE Zn-Ni MLG

Parts on the Shelf and Contracts in Place



PTP Aircraft "D"



Left hand, Cd plated MLG collar

Parts on the Shelf and Contracts in Place



PTP Aircraft "D"



Right hand, LHE Zn-Ni plated MLG collar

Parts on the Shelf and Contracts in Place



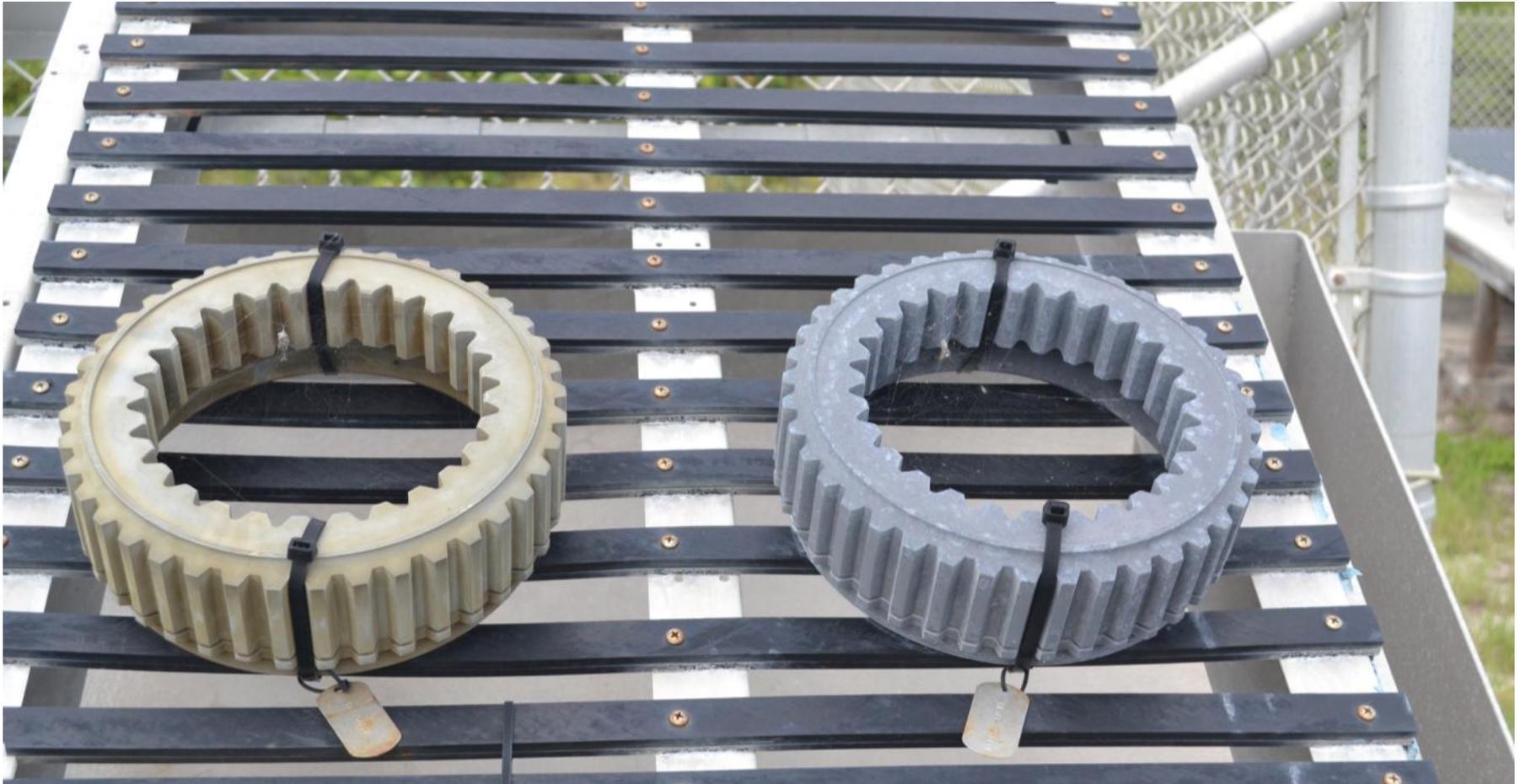
Kennedy Space Center (KSC) Field Corrosion



Parts on the Shelf and Contracts in Place



KSC Field Corrosion



Cd (left) and LHE Zn-Ni (right) Plated Rotation Gear 12 Months

Parts on the Shelf and Contracts in Place



KSC Field Corrosion



**LHE Zn-Ni Plated Drag Brace
12 Months**



**Cd Plated Drag Brace
12 Months**

Parts on the Shelf and Contracts in Place



Field Corrosion Testing El Segundo, CA, Corrosion Site



El Segundo Test Site

Parts on the Shelf and Contracts in Place



Field Corrosion Testing El Segundo, CA, Corrosion Site



**LHE Zn-Ni (left) and Cd (right) Plated Rotation Gear
12 Months**

Parts on the Shelf and Contracts in Place



Field Corrosion Testing *El Segundo, CA, Corrosion Site*



**Cd (left) and LHE Zn-Ni (right) Plated
Rotation Gear
12 Months**



Parts on the Shelf and Contracts in Place



Field Corrosion Whidbey Island, WA



Whidbey Island Naval Air Station

Parts on the Shelf and Contracts in Place



Field Corrosion Whidbey Island



Rotational Collar LHE Zn-Ni 658 Days (22 Months)

Parts on the Shelf and Contracts in Place



Field Corrosion Whidbey Island



Rotational Collar Cd 658 Days (22 Months)

Parts on the Shelf and Contracts in Place



Field Corrosion Whidbey Island



Drag Braces LHE Zn-Ni & Cd 658 Days (22 Months)

Parts on the Shelf and Contracts in Place



AFRL Re-Embrittlement Test Setup

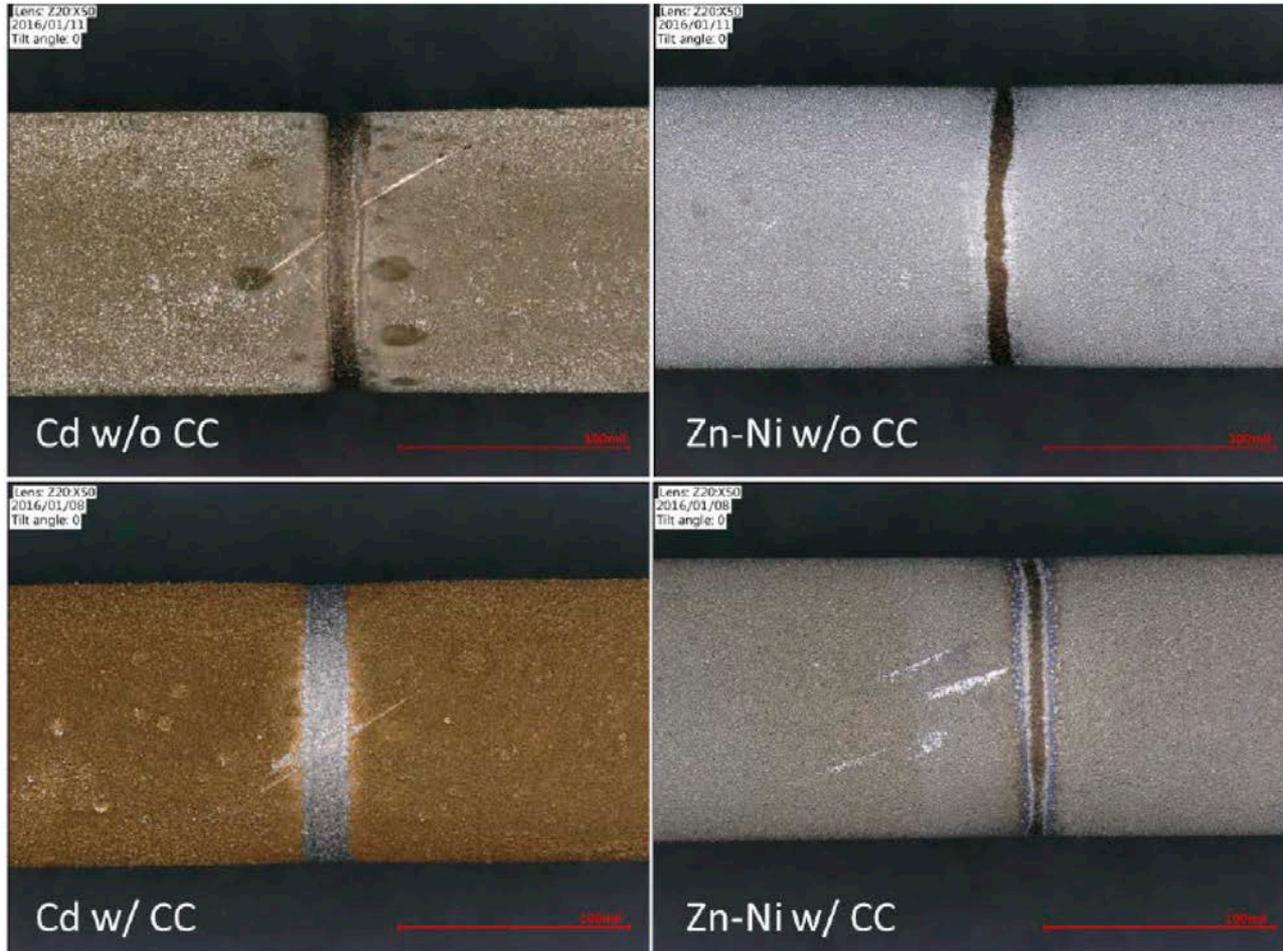


A unique test program was developed by AFRL to determine if the LHE Zn-Ni plating would cause hydrogen re-embrittlement of HSS specimens. Cd-plated specimens were used for comparison. Specimens were held at a constant load and subjected to alternate immersion cycles in a 3.5% NaCl solution.

Parts on the Shelf and Contracts in Place



AFRL Re-Embrittlement Results



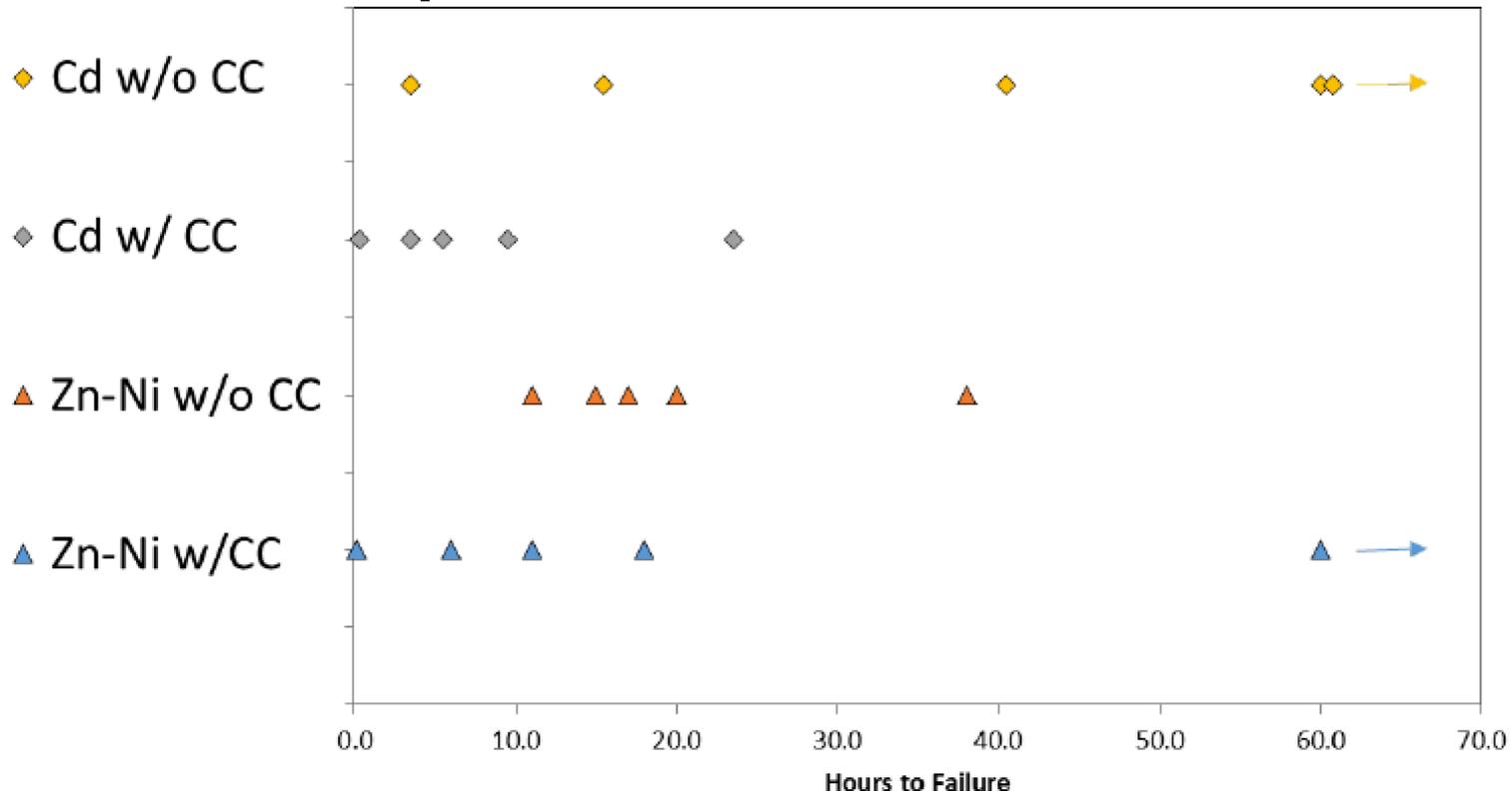
Examples of each type of plated specimen

Parts on the Shelf and Contracts in Place



AFRL Re-Embrittlement Results

Round One: Every specimen passed the 200 hour requirement mark at 75% YS



Hours to failure after reaching 95% YS during step loading (no failures below 95% YS)

Parts on the Shelf and Contracts in Place



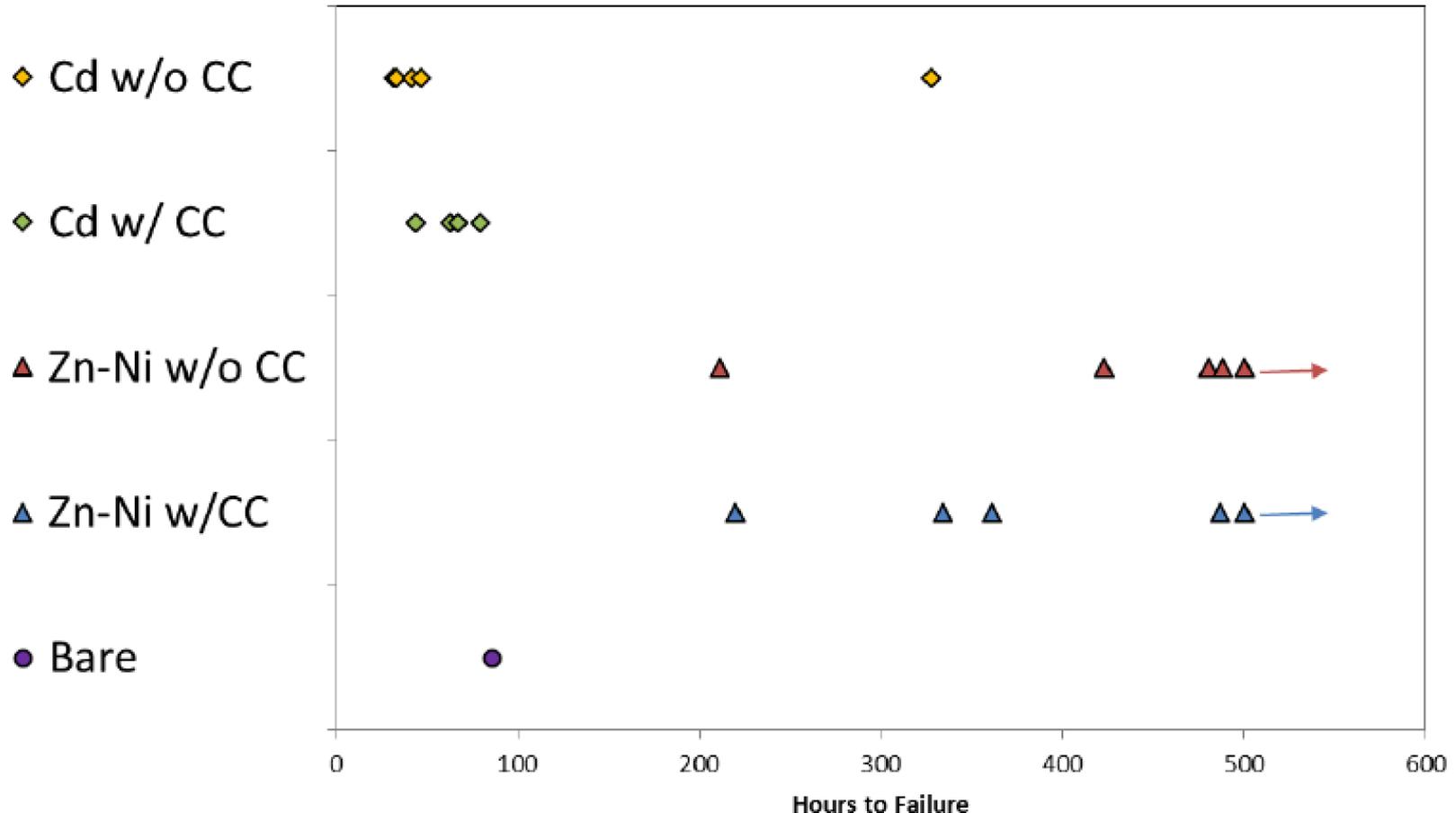
AFRL Re-Embrittlement Results



**General corrosion after 200 hour of testing at 75% YS
(specimen diameter 0.125 inch)**



AFRL Re-Embrittlement Results



Round two: hours to failure at 95% YS, with specimens loaded continuously at 95% YS

Parts on the Shelf and Contracts in Place



AFRL Re-Embrittlement Results



a)



b)

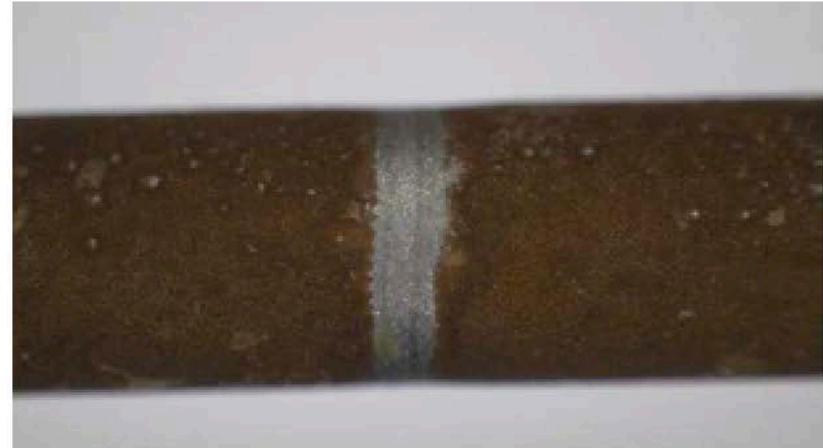
Corrosion comparison after 200 hours of LHE Zn-Ni plated specimens tested at (a) 75% YS AND (b) 95% YS (specimen diameter 0.125 inch)



AFRL Re-Embrittlement Results



a)



b)

Corrosion comparison after 200 hours of Cd plated specimens tested at (a) 75% YS AND (b) 95% YS (specimen diameter 0.125 inch)



AFRL Re-Embrittlement Test Results



■ CONCLUSIONS

- The Zn-Ni plating used by OO-ALC does not present a hydrogen re-embrittlement risk when used in the compositions tested in this study.**
- The Zn-Ni plating performed as well or better than the Cd plating in alternate immersion tests on laboratory specimens.**

■ RECOMMENDATIONS

- The Ogden Air Logistics Complex (OO-ALC) should publish a specification for the Zn-Ni plating process to ensure consistency in the plating composition. (Already in place USAF drawing 201027456)**



Questions



Parts on the Shelf and Contracts in Place

748th Supply Chain Management Group



*The Supply Chain Delivers ...
Parts on the Shelf and Contracts in Place*

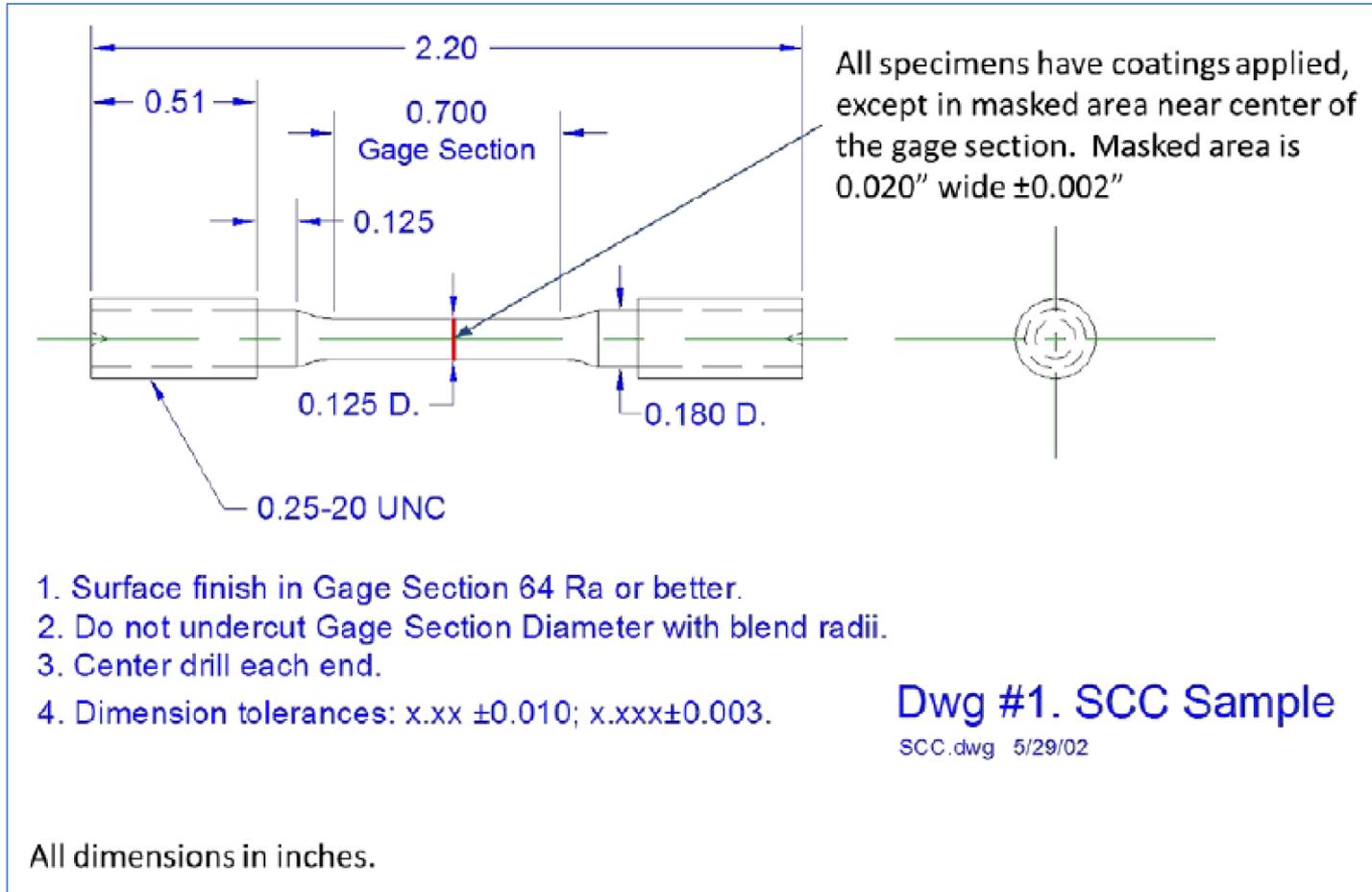


Back Up Slides

Parts on the Shelf and Contracts in Place



AFRL Re-Embrittlement Results



AFRL Test Specimen

Parts on the Shelf and Contracts in Place