C-5 Corrosion Program 2011

Air Force Corrosion Conference

LOCKHEED MARTIN

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Report Documentation Page

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Presentation Overview

- Corrosion Program Team
  - Corrosion Control Website
  - Corrosion Program Concerns
- Non-Chrome Paint System Evaluations
- Coatings for Abrasion Protection
- Plastic Media Blasting for Paint Removal
- Material Changes to Resolve Corrosion and SCC Issues
- Aircraft Wash Procedure Development
- Av-Dec® Tape/Gasket Usage
- Lavatory Modification to Resolve Leaks
- Structural Grind-Out Limitations for Surface Corrosion
- Structural Bonding Process and Certification
- CPC Usage
- C-5M Refurbishment and Anti-Skid Removal Evaluation

C-5 Corrosion Program Team

- **WR-ALC Program Manager - Clay Elliott**
  - Operating Base Maintenance Personnel
  - WR-ALC Equipment Specialist (Joel Mixon, Ron Walderman)
  - WR-ALC ASIP Manager (Dave Wilkinson)
  - Systems Branch Chief (Scott Wrigley)
  - WR-ALC Electrical/Avionics (Jan Ewing, Nick Pitman)
  - WR-ALC Depot Maintenance Personnel
  - Air Force Corrosion Prevention and Control Office (Mac McKenna, SMSgt Scott Pagenkopf, Owen Jett)
  - MSG-3 Team (Chris Carlton, Ed Reardon, Jackie Mason)
  - Lockheed Martin (Dan McTish)
  - Mandaree Enterprise Corporation (Mike Surratt, Larry Cornwell, Eric Lee, John Lindsey, Ed Reid, Talmadge Hutchins, Tom Helms, Josh Kingsley)

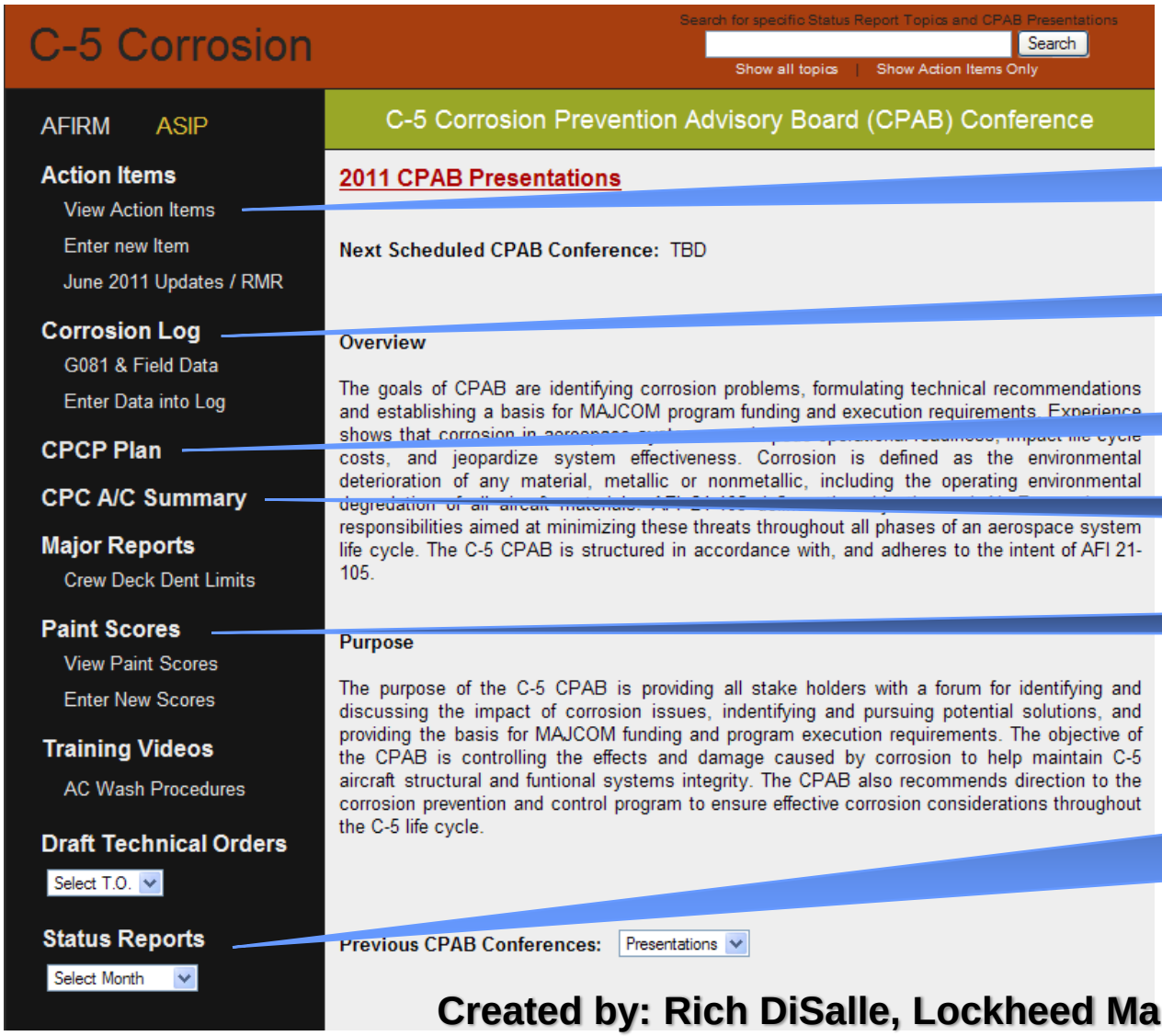
C-5 Program Implementation Team

- **Wing Corrosion Control Contacts**
  - **Westover ARB (SMSgt Rob Ivey, SMSgt Mike Dirienzo, MSgt Joe Whalen)**
  - **Stewart ANGB (SMSgt Vince Lepore, Jeff Peak)**
  - **Lackland AFB (SMSgt Rodney Rael, MSgt Tom Bailey)**
  - **Martinsburg ANGB (MSgt Ed Schwartz, Chuck LaFaver)**
  - **Wright Patterson AFB (MSgt Joe Taylor)**
  - **Memphis ANGB (CMSgt Mark Wagner, Craig Tow)**
  - **Dover AFB (Dennis Walston, Greg Long, MSgt Reece Coleman)**
  - **Travis AFB (MSgt Logan Commins, MSgt Sheldon Jentzsch)**

- **WR-ALC Maintenance Contacts**
  - **Corrosion Control Supervisor (Hector Herrera)**
  - **Planning (Andy Ivey)**
  - **MRRB (Jim Rivers)**

Corrosion Control Website - AFIRM

https://c5.robins.af.mil/afirm/asip/corrosion/corrosion.htm



Action Items

Corrosion Log

Corrosion Plan

CPC Usage

Paint Scores

Monthly Status Reports

Created by: Rich DiSalle, Lockheed Martin

C-5 Corrosion Program Concerns

- **Current Base Level Concerns**
  - New technicians expected to have working knowledge
    - Corrosion removal and repair methods
      - Use of AMS-1640 De-Oxidation prior to Alodine application
    - Grit-Blast/Sol-gel Bonding Certification per TO 1C-5A-3
  - Qualified Products Lists (QPL's) need updated
  - Materials not available with improved stress corrosion ratings (7249/7050/7085) to replace 7075-T6.

- **Engineering Concerns**
  - Problem identification and resolution are quick to develop (3 months), but long to implement (+1 year)
    - Obtaining parts takes a long time (+1 year)
    - TCTO kits must be created to ensure sufficient stock is on hand

Base Level Feedback

- **Continue (or increase) engineering base level visits**
  - **Keeps communication lines open**
  - **Updates engineers on base capabilities and limitations (always changing)**
  - **Emphasizes being proactive instead of reactive**
  - **Encourages base level participation in evaluating resolutions to CPAB action items**
  - **Always Prototype/Kit-Proof CPAB corrective actions**

- **Too much time and money spent on studies and tests**
  - **Need real time solutions with implementable corrective actions**

Non-Chrome Finish Systems
Beachfront/Laboratory Testing

- **Tests proceeding with qualified products.**
  - **Testing to be done with complete coating stack-up.**
  - **Outdoor exposure testing with Battelle and AFRL/CTIO at Daytona and Tyndall AFB.**
    - **PreKote/Aerodur 2100 (Mg-Rich)/Aerodur 5000 (AkzoNobel System)**
    - **PreKote/Aerodur 2100 (Mg-Rich)/99GY001**
    - **RECC1015/RECC3021/02GN093/99GY001 (Deft System)**
    - **Alodine 5200/53055GEP-17036CEH35515APX-35502CMU (Hentzen System)**
    - **EAP-9/PRC CA7236 or CA7502/PRC CA9311 (PPG)**
    - **PreKote/Deft 02-Y-040/Deft 99-GY-001 (Control 1)**
    - **Alodine 1200/Deft 02-Y-040/Deft 99-GY-001 (Control 2)**

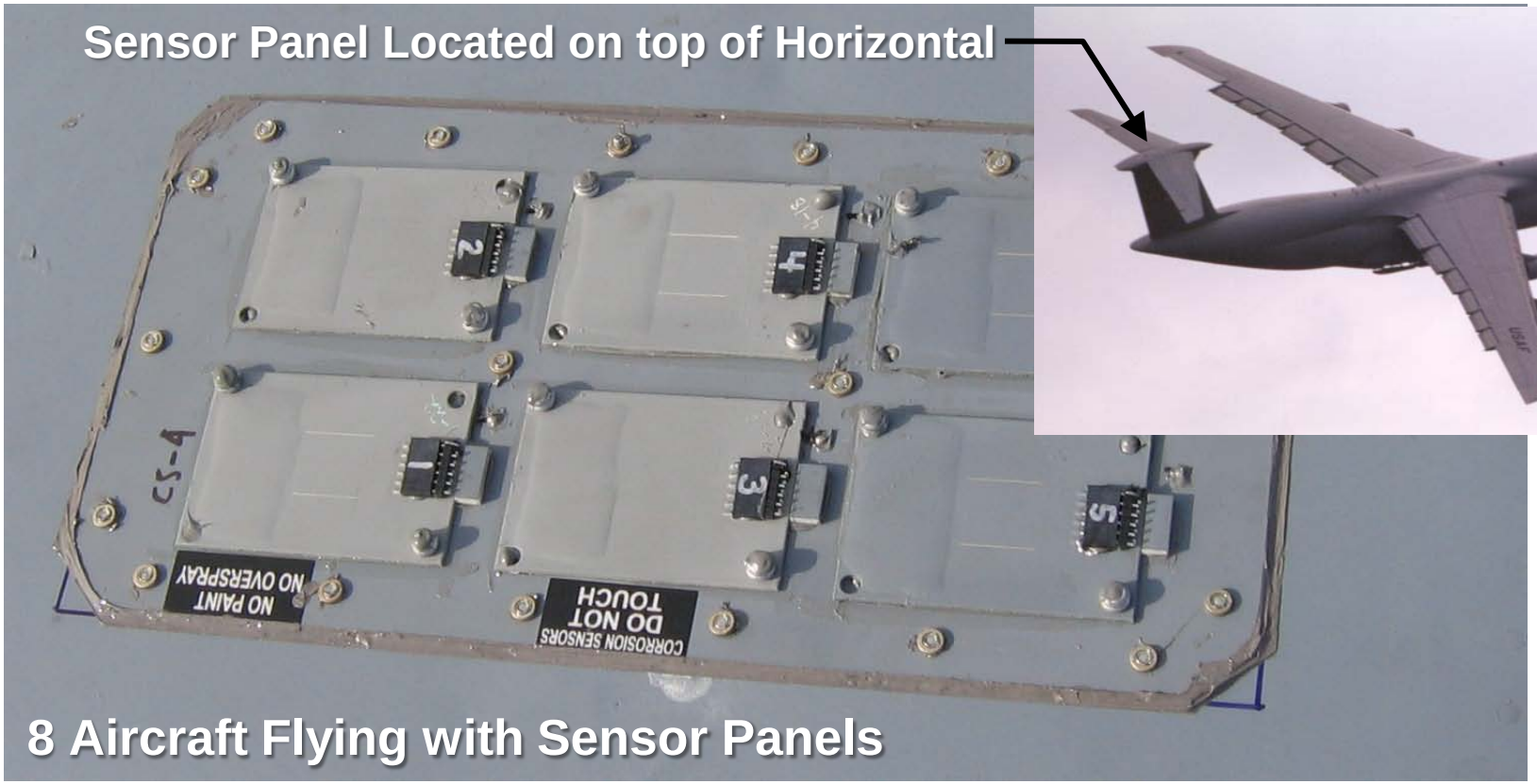
F-15

C-5

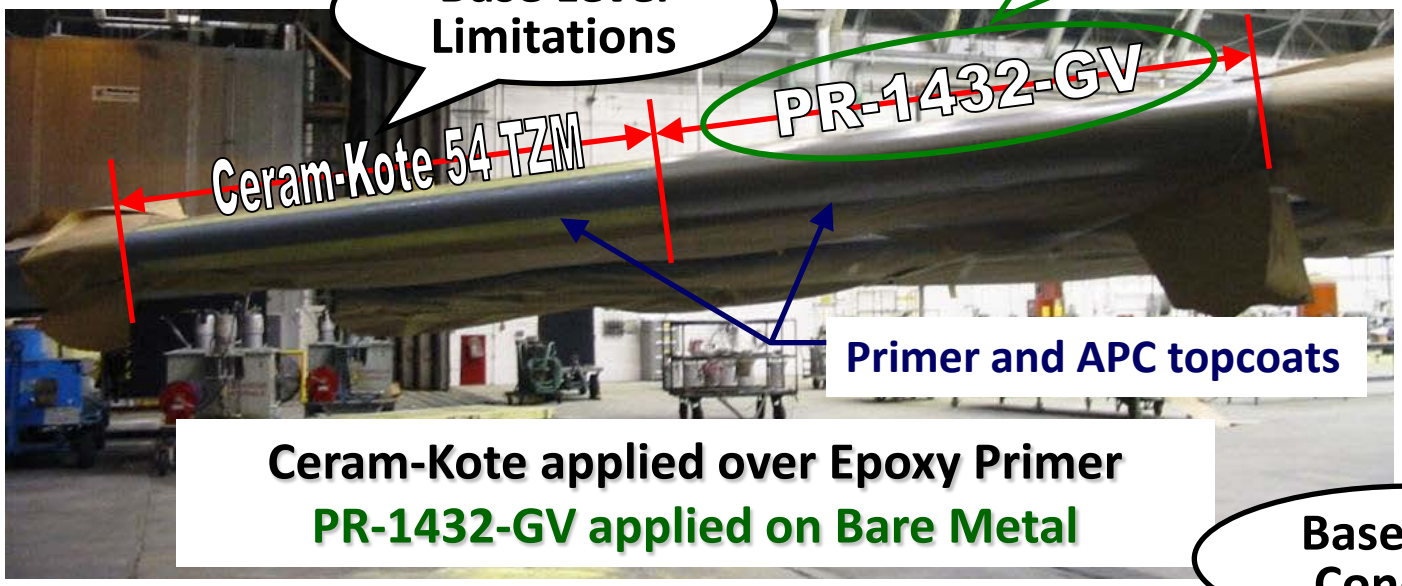
Non-Chrome Finish Systems

Flight Testing with Battelle Sensors

- **Test coatings include all beachfront /lab test coatings.**
- **Following coating systems also in flight tests.**
  - **Turcoat Alumigold/Deft 44GN098(F-35)/Deft 99GY001**
  - **Alodine 5700/Deft 02GN084(F-22)/Deft 99GY001**



Leading Edge Coatings
Evaluations Completed



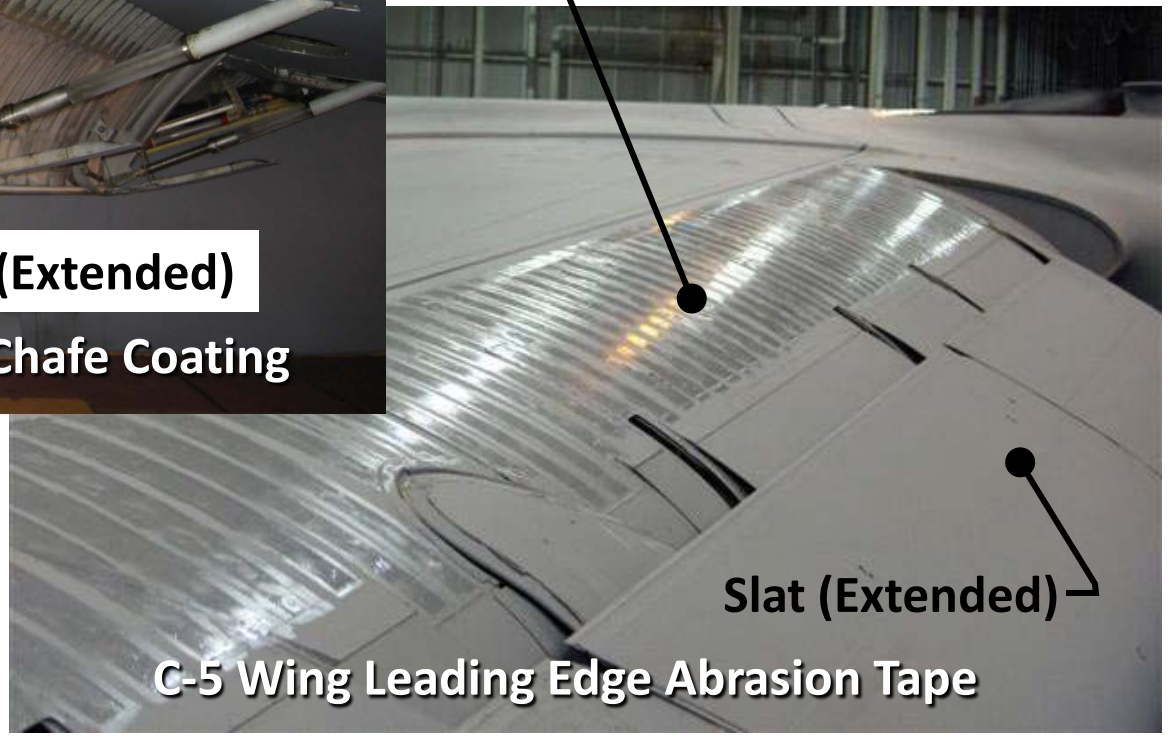
Ceram-Kote applied over Epoxy Primer
PR-1432-GV applied on Bare Metal

150 Day Interval Evaluations Completed over 420 Day Period

- Wing
- Horizontal
- Vertical
- Nose Plug

3M Tape #8681HS Applied over Primer and APC

Slat Lower Surface Coating *and Wing Leading Edge Tape to Reduce Wear*



8681HS (Color 36173) Tape
NSN 9330-01-580-6367
DP190 Edge Seal
NSN 1680-01-431-3607

Plastic Media Blasting (PMB)

Summit held at Robins on 8-9 June 2011

- **Hydrogen peroxide activated benzyl alcohol (HP/BA) chemicals are still being used at Robins/Hill/Tinker AFB**
  - **Chemicals being used to de-paint non-composites**
  - **Scuff sanding on composites**
  - **More time would be required for PMB**
- **PMB (MIL-P-85891, Type VIII media) used on B-1 at Tinker AFB**
  - **Type VIII is used to acquire faster strip rate over Type VII**
  - **Media flow rates, nozzle pressure, stand-off distances, and impingement angles continue to be refined**
- **PMB (MIL-P-85891, Type VIII) used on CH-47 rotor blades.**
  - **US Technologies provided media recovery and separation system**
  - **Stripping performed by US Technologies certified artisans**
- **Type VIII media or any other media, if used incorrectly, can be devastating and detrimental to aircraft components**

Plastic Media Blasting (PMB) on C-5

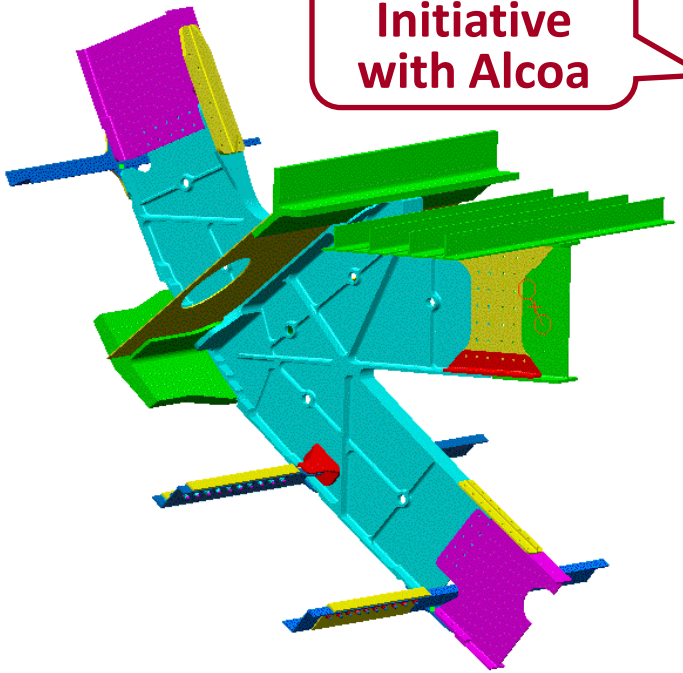
- PMB (Type V media) on C-5 at Kelly AFB in 1990's
  - Approval based upon testing by SwRI
    - PMB not possible on resin-starved composites
    - Facility has been converted back to chemical stripping
- PMB (Type VIII media) being proposed for C-5 at Robins AFB
  - Need additional de-paint capability
  - Building 59D built for PMB stripping of C-5/C-17 aircraft
  - PMB (Type VIII) not currently allowed on anodized/clad, composites, aluminum substrates less than 0.032 inches, and face sheets of bonded panels less than 0.016 inches
    - Test plan submitted for evaluation of Type VIII media on surfaces outside existing limitations.
      - Residual stress, fatigue life, anodize and cadmium removal, clad erosion, crack closure, surface roughness.
    - Standard Process needs developed with aircraft mapping.
    - Training/Certification plan needs to be established.

Horizontal Stabilizer Pivot Shaft Pin
4340 replaced with Ferrium® S53

Ferrium® S53 per AMS5922 would provide higher resistance to SCC and improved corrosion resistance, while eliminating need for cadmium plating

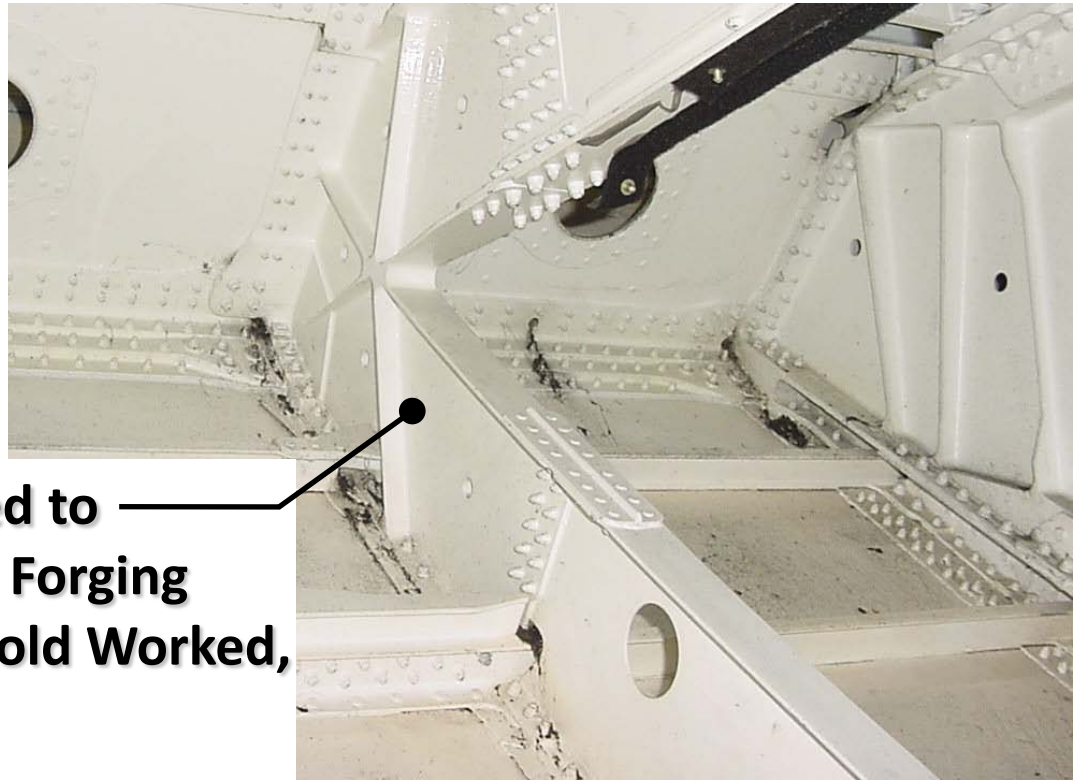
Cargo Floor End Fitting Replacement

Alloys selected with higher resistance to Stress Corrosion Cracking (SCC)



Current Initiative with Alcoa

7085-T7452 Die Forging per AMS4403 and 7085-T7452 hand forging per AMS4414 being Tested for Residual Stress, Crack Growth, and DTA based upon F-35 data.



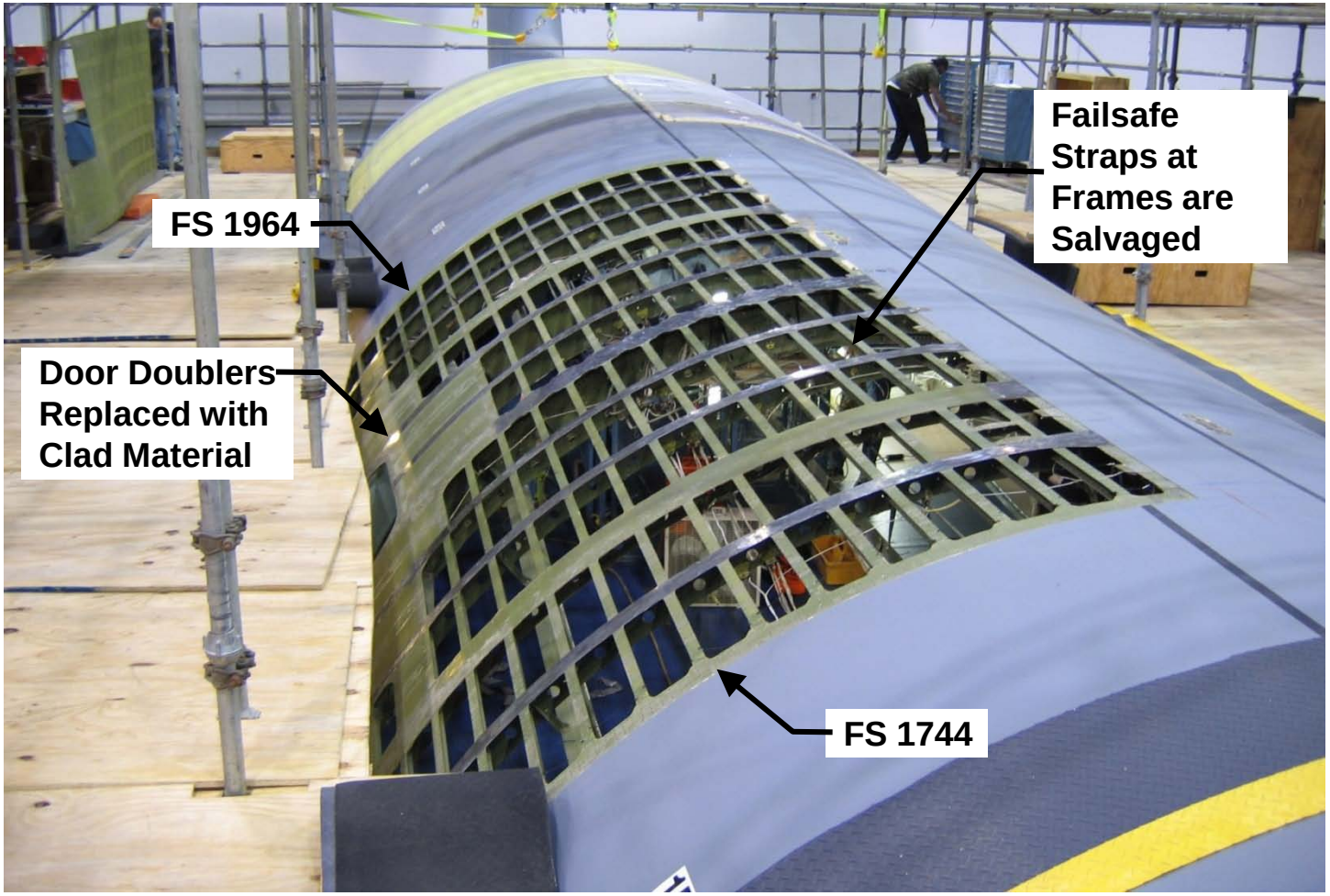
7249-T73 Die Forging Selected to Replace Existing 7075-T6 Die Forging 7249-T7452 or 7050-T7452 Cold Worked, Hand Forgings as Alternate

C-5A Aft Crown Skin Replacement

FS1603 to FS2273

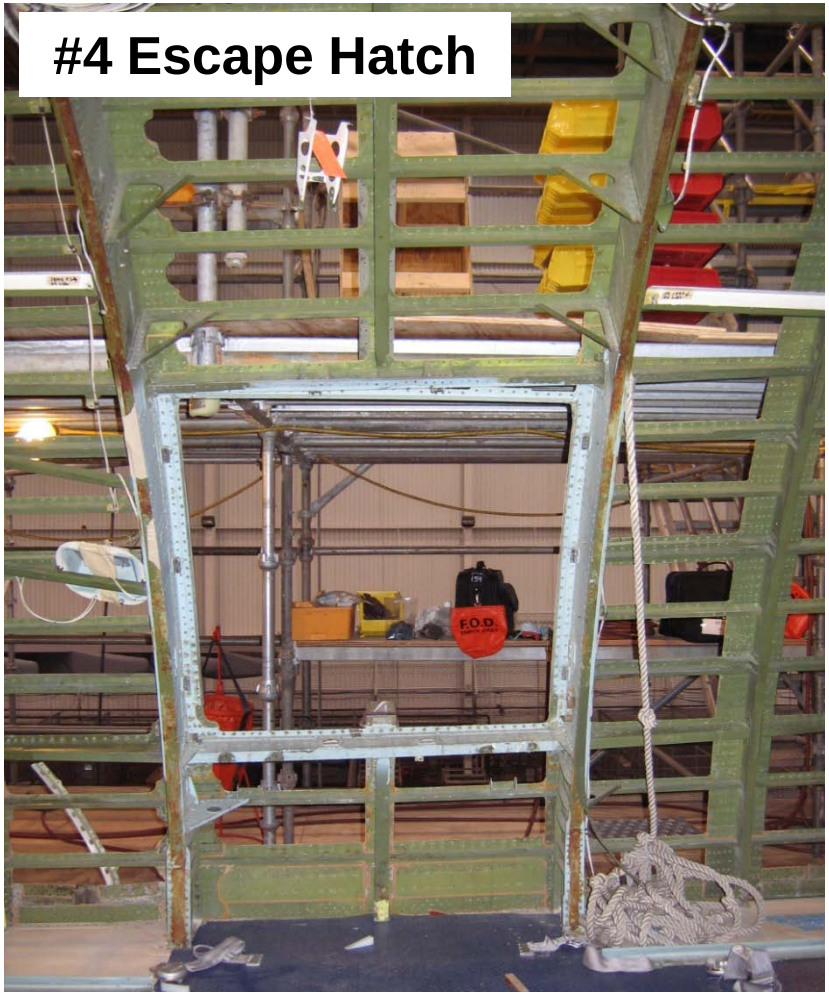
C-5A Aft Crown Skin Replacement

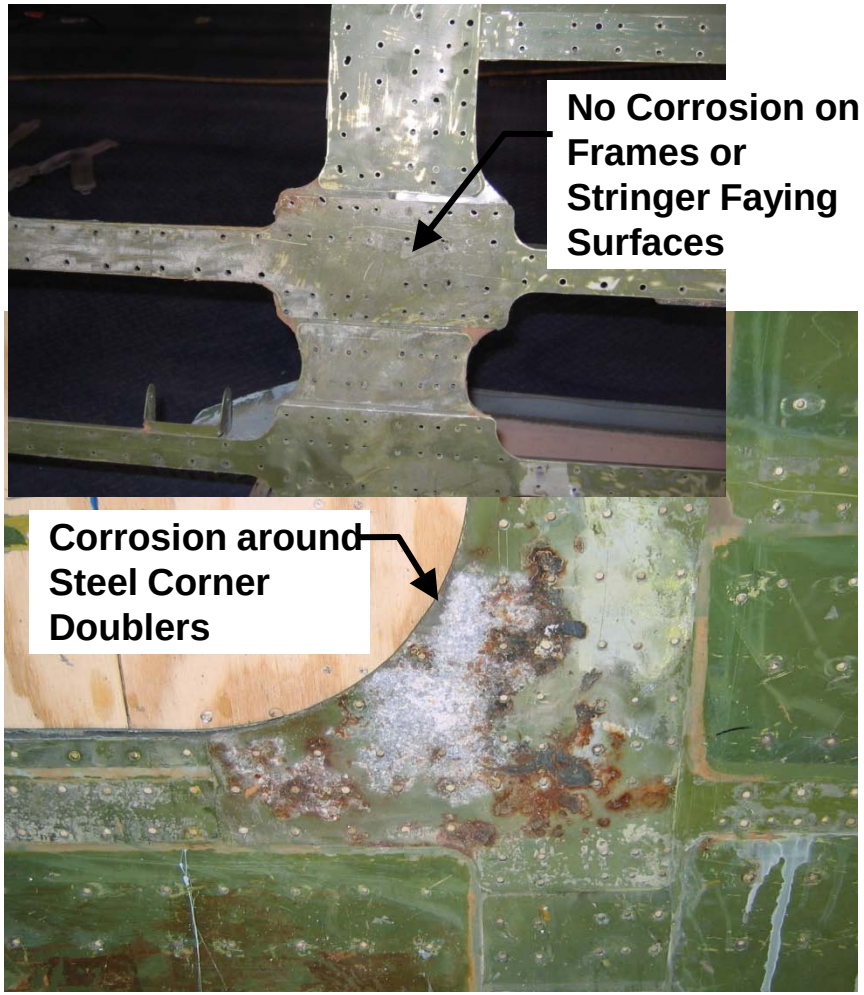
7475-T761 replaced 7079-T6



C-5A Aft Crown Skin Replacement

Access Doors had Steel Corner Doublers





C-5A Aft Crown Skin Replacement

- **Corrosion Issues:**
  - SCC cracks occurring in 7079-T6 skins
  - Corrosion around Doors and Hatches (Galvanic)
  - Corrosion found under Antenna (Av-Dec Gaskets not used)

- **Inspections:**
  - No corrosion found on faying surfaces after removal of chromated sealant (MIL-PRF-81733).
  - Faying surfaces of frames and stringers looked like new.
  - Fastener holes were fine with adequate edge distance and clean up possible using next oversize fastener.
  - No unexpected issues.

C-5A Aft Crown Skin Replacement

Corrosion Prevention Steps

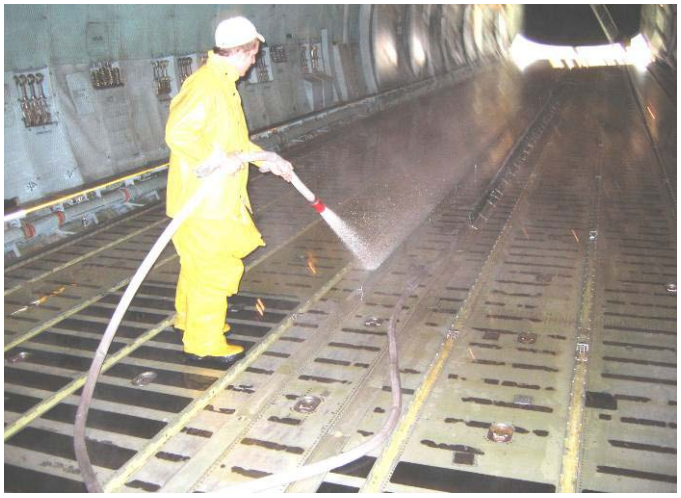
- Skins
  - 7079-T6 (1 side Clad) replaced with thicker 7475-T761 (2 side Clad)
  - Clad was sulfuric acid anodized
  - Chromated primer applied to both internal and external surfaces (MIL-PRF-23377, Type I, Class C2)
  - Internal primed surfaces overcoated with white polyurethane (MIL-PRF-85285, Type I, Class H)
  - External primed surfaces overcoated with 99GY001 Deft APC (MIL-PRF-85285, Type IV)
- Doublers
  - Steel (4130) corner doublers replaced with same thickness 7475-T761 clad aluminum to eliminate galvanic corrosion
  - Clad external Doublers installed around all Doors/Hatches
- Antenna
  - Av-Dec gaskets installed under antenna

C-5A Aft Crown Skin Replacement

MIL-PRF-81733 Chromated Primer on all Faying Surfaces and Fasteners

Interior Skin Surfaces have 1 Coat of White Polyurethane over Chromated Primer

Aircraft Wash Procedures
T.O. 1C-5A-23-1



- Aircraft Configuration
- Covers, Tooling, Equipment List
- Masking List with Pictures
- Masking Tape (3M 8979N)
- Masking Foil (MIL-PRF-131)
- Soap Type and Dilution
- Nozzles (40 °)
- Wash Pads
- Sequencing
- Inspection
- Aircraft Restoration

Aircraft Wash Pads

6” x 12” Used on C-5 Aircraft

Melamine Pads
NSN 7920-01-526-9003

Scotch-Brite ™ Pads with Rubber Coating
NSN 6850-01-496-4901

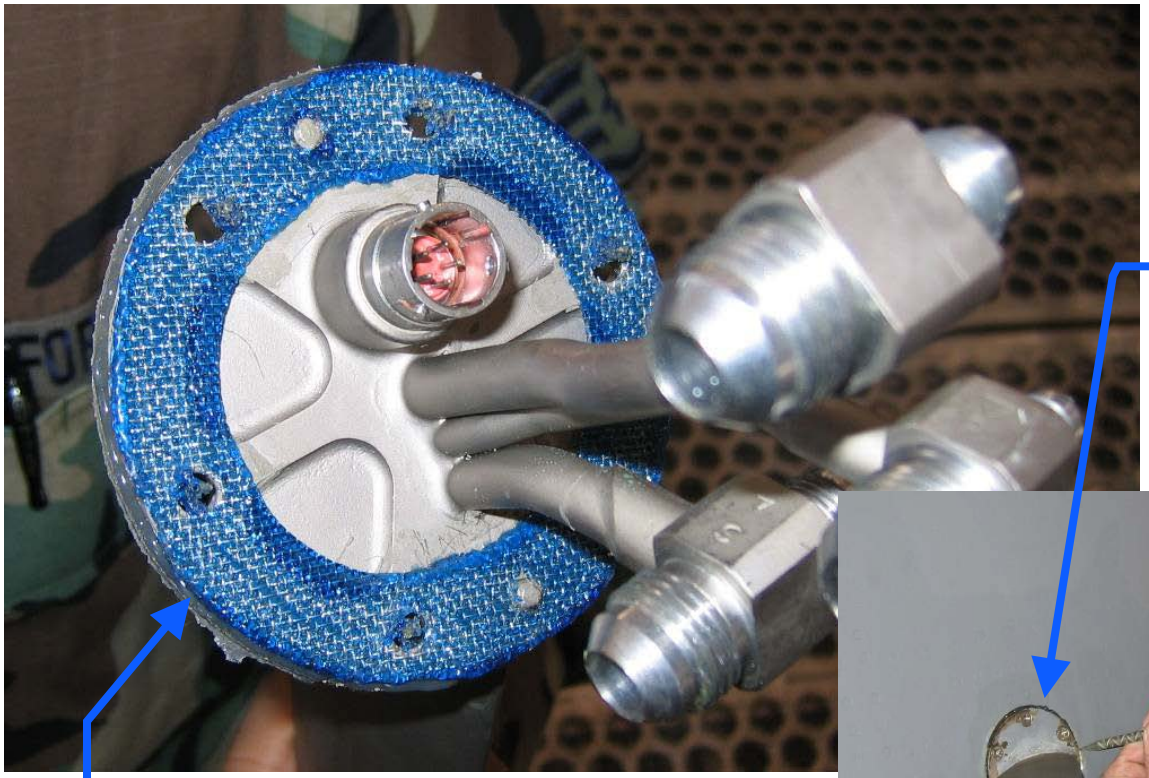
Cleaning efficiency for Melamine is superior to white Scotch-Brite™ on soot.

Melamine Pads tend to Wear Out Fast if Force Used Similar to Scotchbrite Pads

Removable Panel Installation
Av-Dec® HT3000RT Tape

Modified T.O. 1C-5A-23, Para 4-4.11, and T.O. 1C-5A-3, Table 12-7

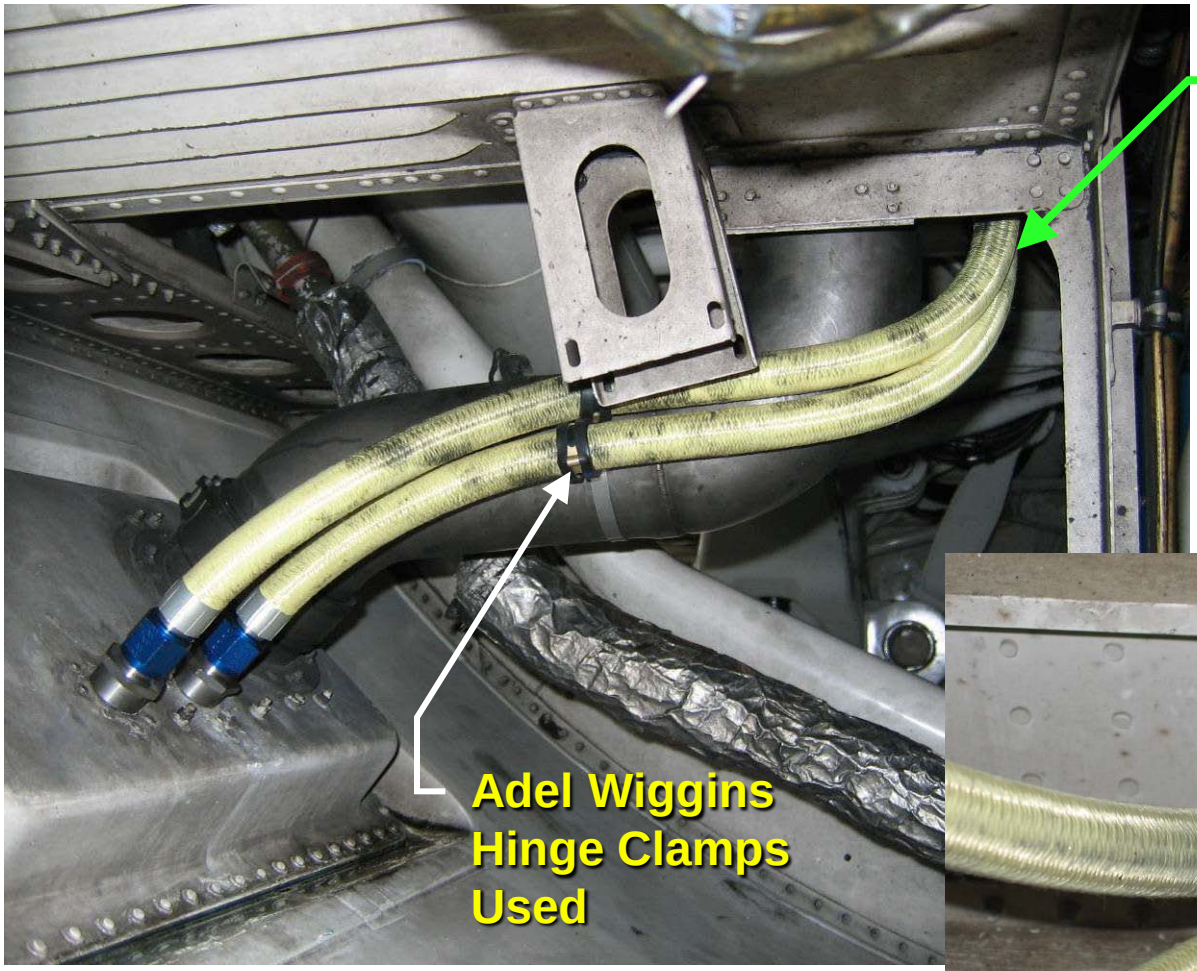
Pitot Tube/Antenna Installation
Av-Dec® Gasket and Thixoflex™ Gray



AG778000-11
Polyurethane
Conductive Gasket

TG8498-50
Thixoflex™
Gray to fill Gap

New Lavatory Fluid Supply Hoses
TCTO 1C-5-813

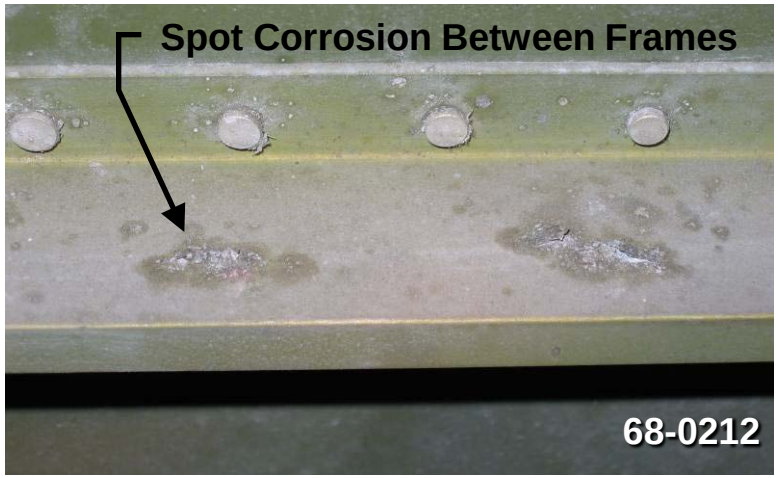


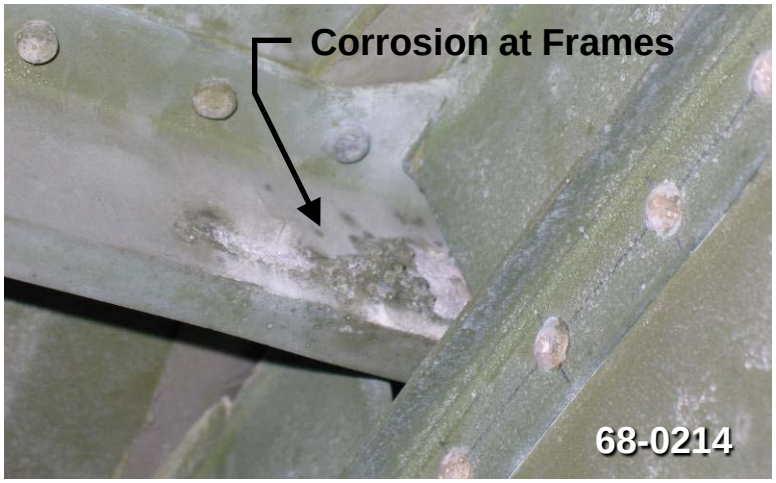
Adel Wiggins
HHB101
Commercial Hoses
(FAA approved)

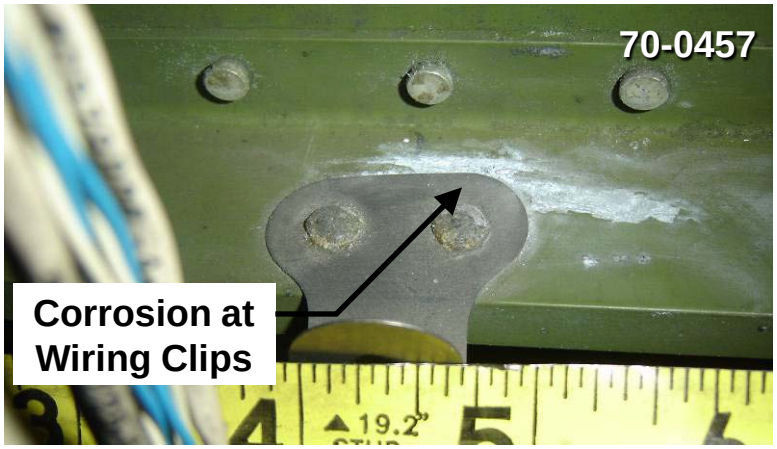
Flared Plumbing
Fittings Swaged
onto Hoses

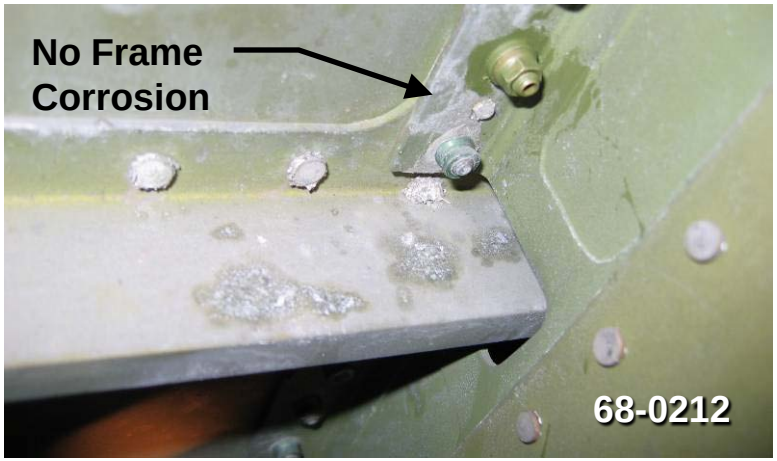
Stringer Corrosion
Grind Outs and Repairs Developed

Corrosion Grind Outs Preferred over Section Removals





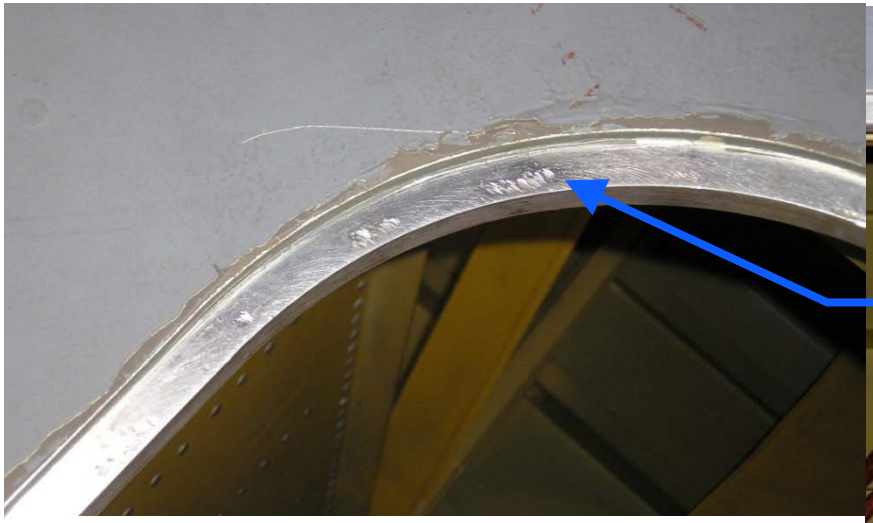


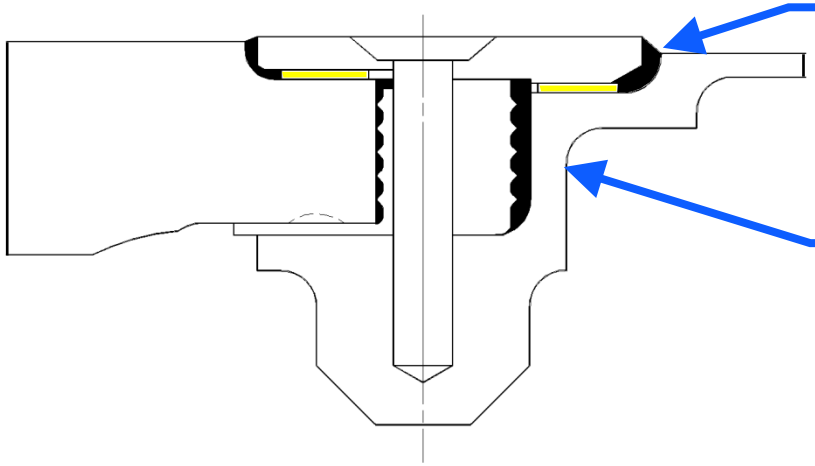


Cor-Ban® 35 now being applied at Depot for Corrosion Prevention

Fuel Tank Access Flange Corrosion
Grind Out Limits Established

Complete Squeeze-Out of Sealant Required around Door Retaining Ring to Prevent Moisture Entry





Corrosion due to Moisture Entry and Bare Surfaces for Electrical Conductivity

P/S 872, Class B, Conductive Sealant Must Fill Gap to Prevent Moisture Entry

Aluminum Structure

Structural Bonding Process Improvements

Grit-Blast Sol-Gel with Fused Primer

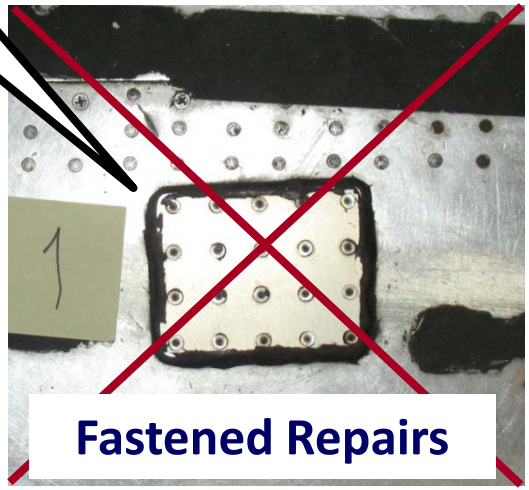
Grit-Blast/Sol-Gel Surface Preparation prior to Bonding required on Primary and Critical Secondary Structure at Base and Depot Level per TO 1C-5A-3

Scotch-Brite/Sol-Gel Surface Preparation only permitted at Field Level on Secondary Structure

Grit-Blast Process

Bonded Repairs

Internal Corrosion Issues



Fastened Repairs

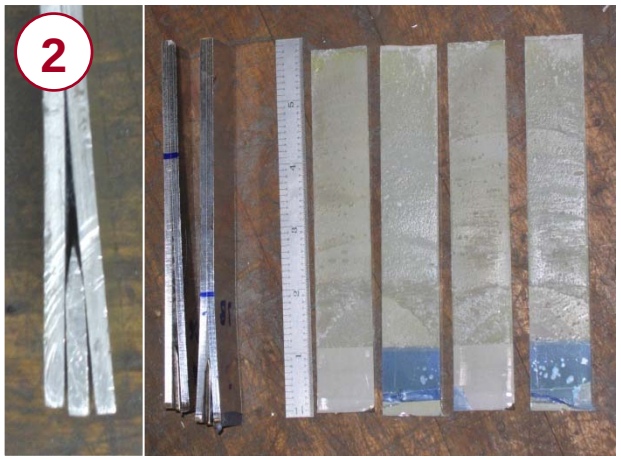
Bonding Certification Procedure for Primary and Critical Secondary Structure

Specimen Fabrication

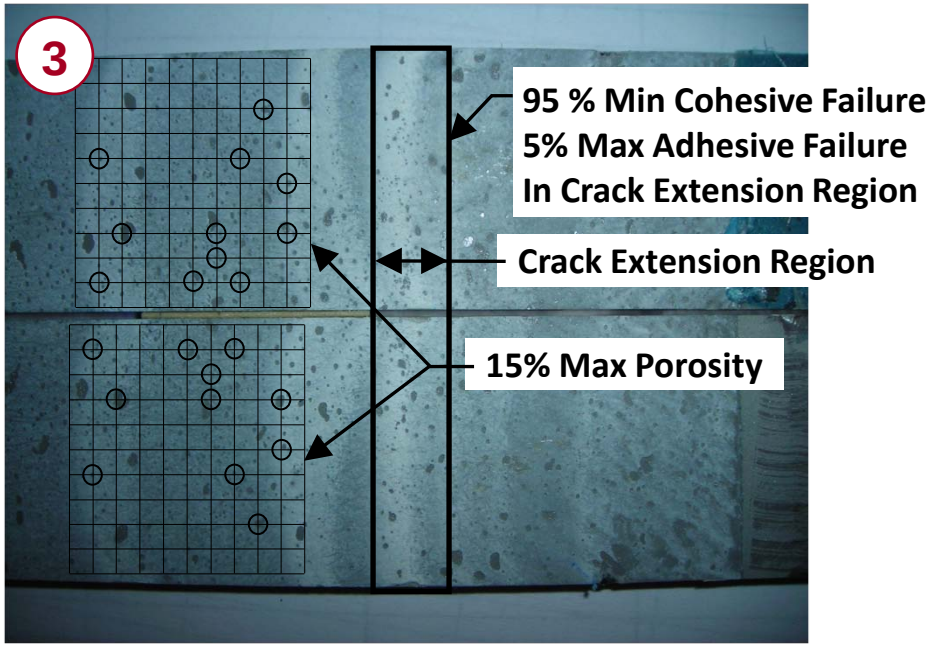
Procedure developed from ASTM D3762 to allow certification of personnel at base and depot level

Humidity Chamber Required

Wedge Insertion
Environmental Exposure
Crack Extension Measurement
Specimen Separation



Failure Mode Evaluation



CPC Applications added to Maintenance Work Cards

MSG-3 Guidelines

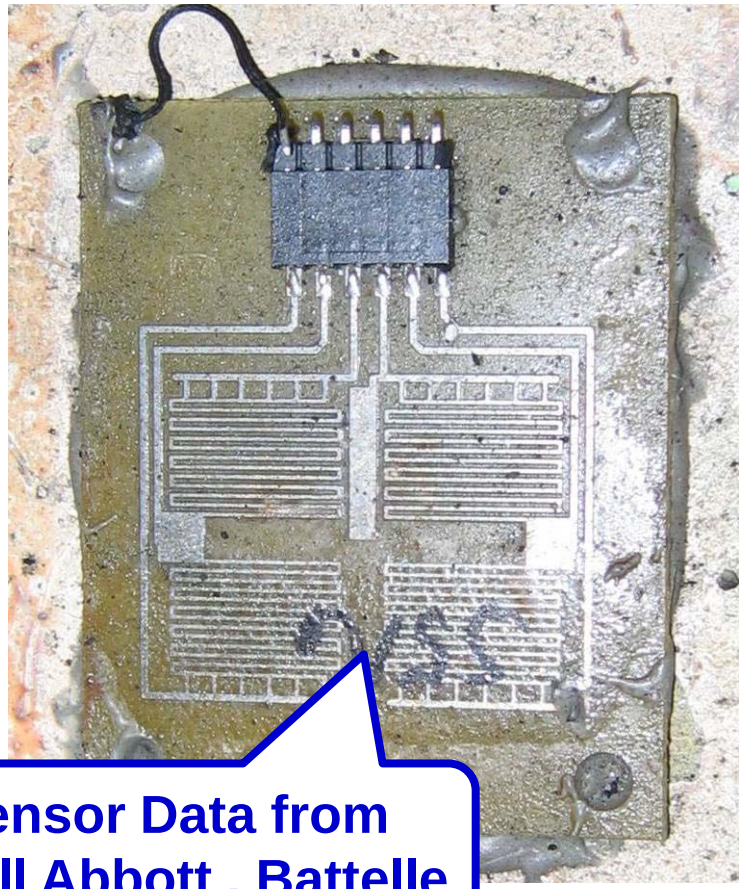
After initial applications, only touch-ups will be required at subsequent checks.

CPC applications will be a fluid program and will be adjusted as needed.

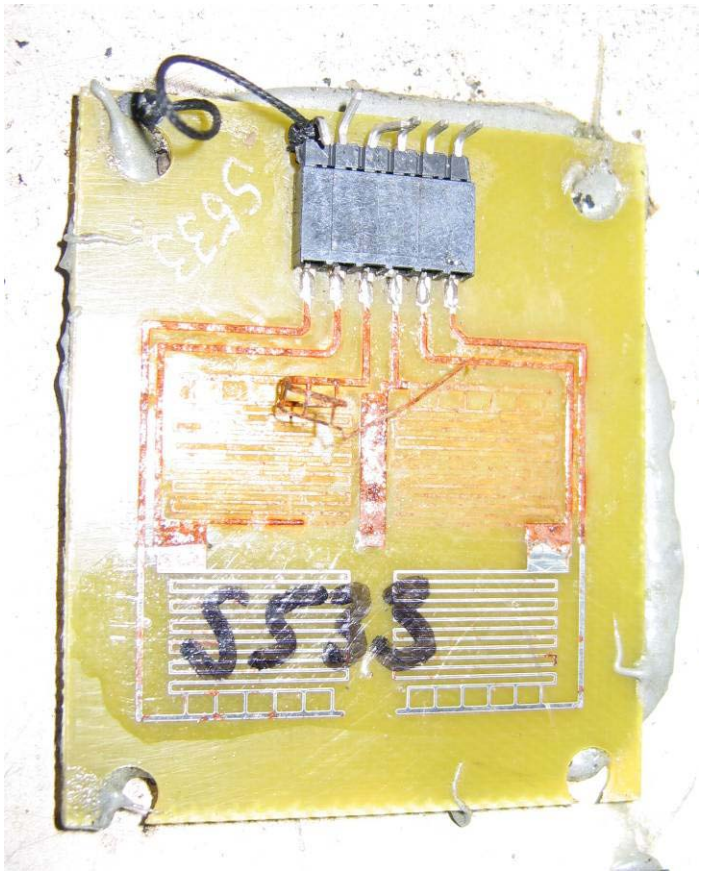
CPC Usage Based upon Battelle Sensor Data and Visual Inspections

Bare and CPC Coated Copper and Steel Sensors Used

Coated Steel Sensor
(No Corrosion)



Bare Steel Sensor
(Expired)

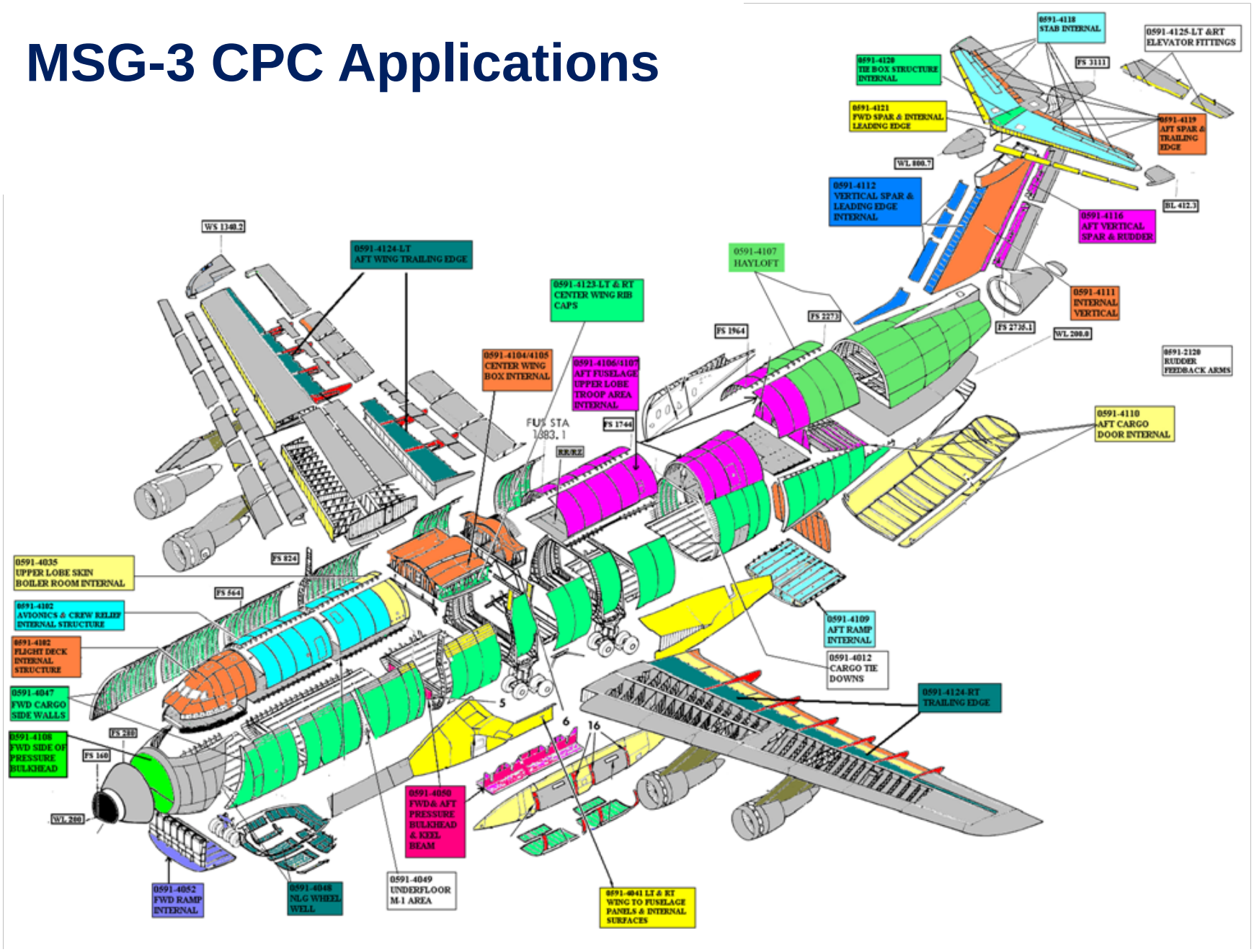


Sensor Data from Bill Abbott , Battelle

CPC Products Selected

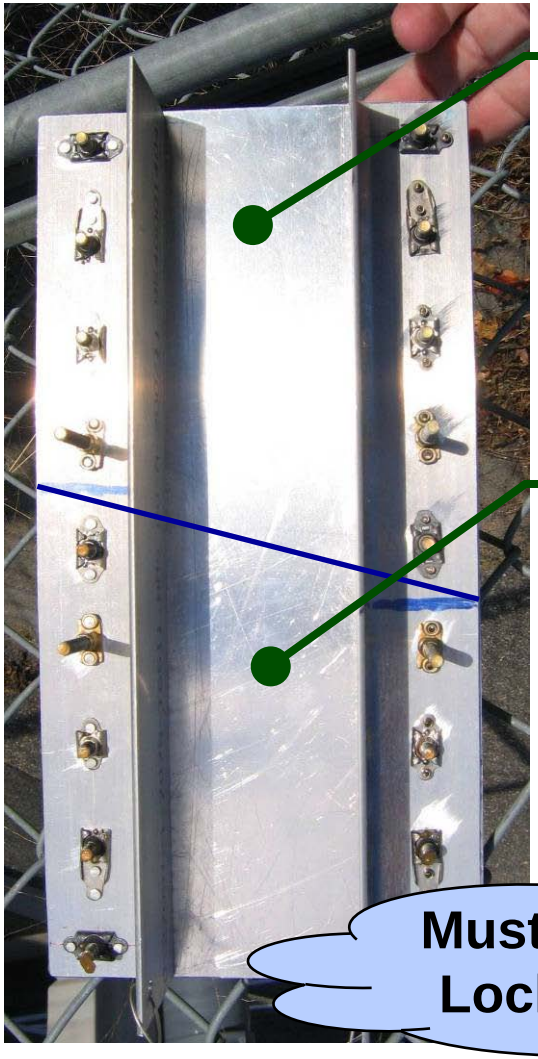
- ***Hard Film (Cor-Ban 35 Undyed)***
  - Used on surfaces with no corrosion after visual inspection.
  - Penetrating, water-displacement capabilities along with barrier type performance with one product.
  - Cure to a very firm, non-tacky, barrier type film.
- ***Wax Film (Cor-Ban 22)***
  - Used on surfaces which have, or may have, corrosion and are not likely to be in contact with corrosive fluids or particles.
  - Excellent exposed surface protection on high strength steel.
  - Does not penetrate faying surfaces very well.
  - Dirt accumulation a problem with tacky coating.
- ***Oil Film (LPS2 for Non-Avionics, Super Corr-A for Avionics)***
  - Used on surfaces which may have corrosion and are susceptible to corrosive fluids or materials. **(Bilge)**
  - Penetrate voids, cracks, and faying surfaces to displace fluids.
  - Less effective in areas of high water runoff when compared to waxy or hard film compounds.
- ***Paste Film (Cor-Ban 27L)***
  - Anti-seize compound for removable fasteners.

MSG-3 CPC Applications



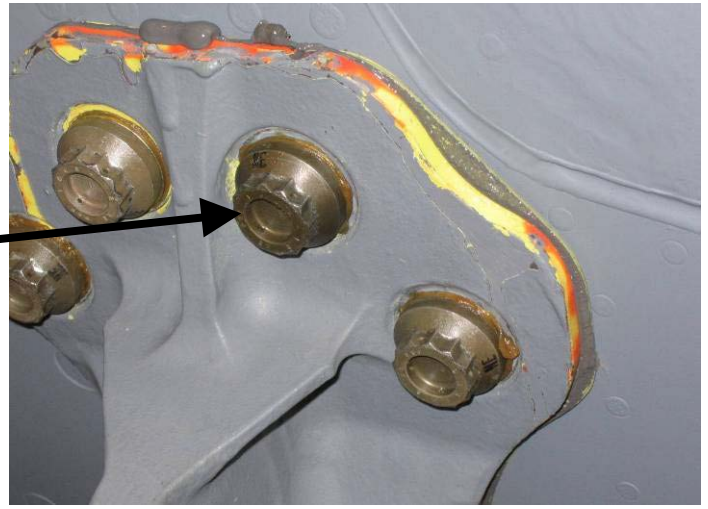
Anti-Seize Paste Film CPC
Cor-Ban 27L on Removable Fasteners

Evaluation → **Incorporation**



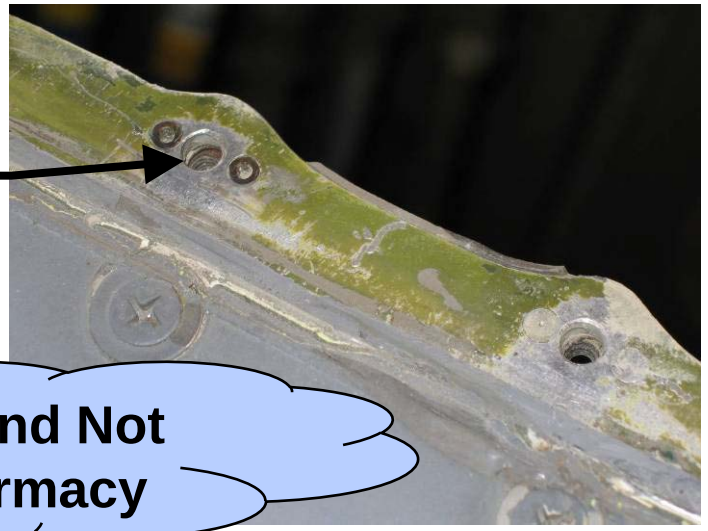
Fasteners Installed Bare (No CPC)

Jackpad Bolts at FS524 and FS1964



Fasteners Installed with Cor-Ban 27L

Removable Panel Fasteners



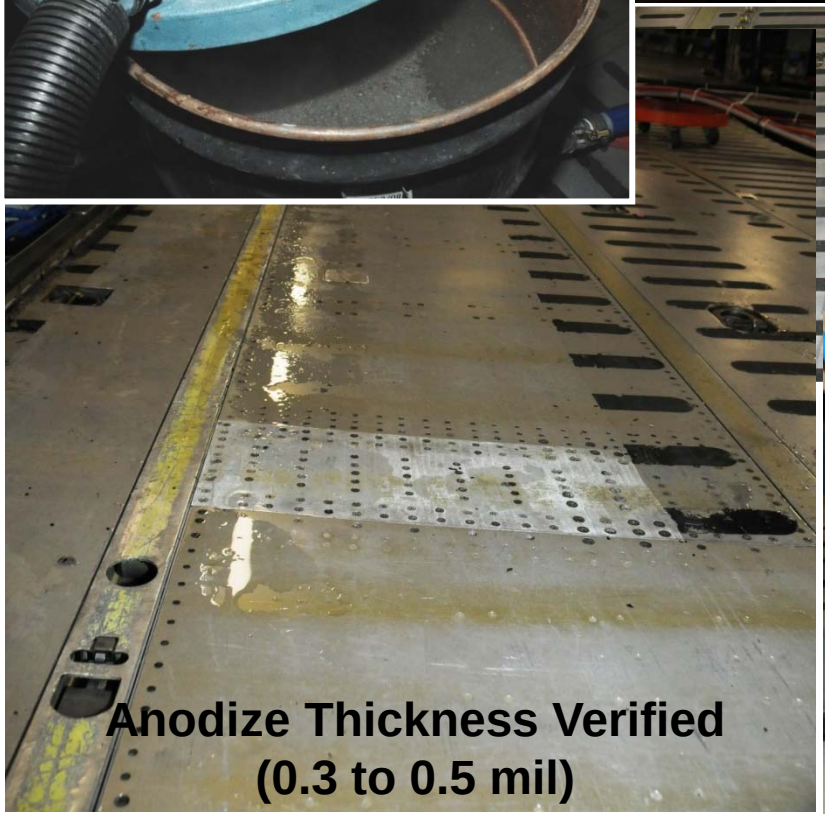
Must be Accessible and Not Locked Away in Pharmacy

C-5M Interior Refurbishment at Stewart ANGB

Lighting, Trim Panels (Gray), Anti-Skid

CESCO Aqua Miser™ Ultra Boss D-115 Anti-Skid Removal Evaluation

Anodize Surface cannot be Damaged



Anodize Thickness Verified
(0.3 to 0.5 mil)

Edges
Manually
Removed


The End