



C-5 Corrosion Program 2011

Air Force Corrosion Conference



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Report Documentation Page

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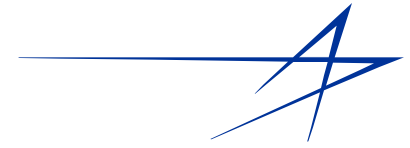
Presentation Overview



- **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>



C-5 Corrosion Search for specific Status Report Topics and CPAB Presentations

Show all topics | Show Action Items Only

AFIRM ASIP **C-5 Corrosion Prevention Advisory Board (CPAB) Conference**

Action Items
View Action Items
Enter new Item
June 2011 Updates / RMR

Corrosion Log
G081 & Field Data
Enter Data into Log

CPCP Plan

CPC A/C Summary

Major Reports
Crew Deck Dent Limits

Paint Scores
View Paint Scores
Enter New Scores

Training Videos
AC Wash Procedures

Draft Technical Orders
Select T.O.

Status Reports
Select Month

2011 CPAB Presentations

Next Scheduled CPAB Conference: TBD

Overview

The goals of CPAB are identifying corrosion problems, formulating technical recommendations and establishing a basis for MAJCOM program funding and execution requirements. Experience shows that corrosion in aerospace systems can reduce operational readiness, impact life cycle costs, and jeopardize system effectiveness. Corrosion is defined as the environmental deterioration of any material, metallic or nonmetallic, including the operating environmental degradation of all aircraft materials. AFI 21-105 outlines the responsibilities aimed at minimizing these threats throughout all phases of an aerospace system life cycle. The C-5 CPAB is structured in accordance with, and adheres to the intent of AFI 21-105.

Purpose

The purpose of the C-5 CPAB is providing all stake holders with a forum for identifying and discussing the impact of corrosion issues, indentifying and pursuing potential solutions, and providing the basis for MAJCOM funding and program execution requirements. The objective of the CPAB is controlling the effects and damage caused by corrosion to help maintain C-5 aircraft structural and funtional systems integrity. The CPAB also recommends direction to the corrosion prevention and control program to ensure effective corrosion considerations throughout the C-5 life cycle.

Previous CPAB Conferences:

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



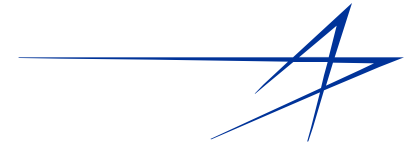
Base Level Feedback



- **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)**
- F-15**
- **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)**
- C-5**



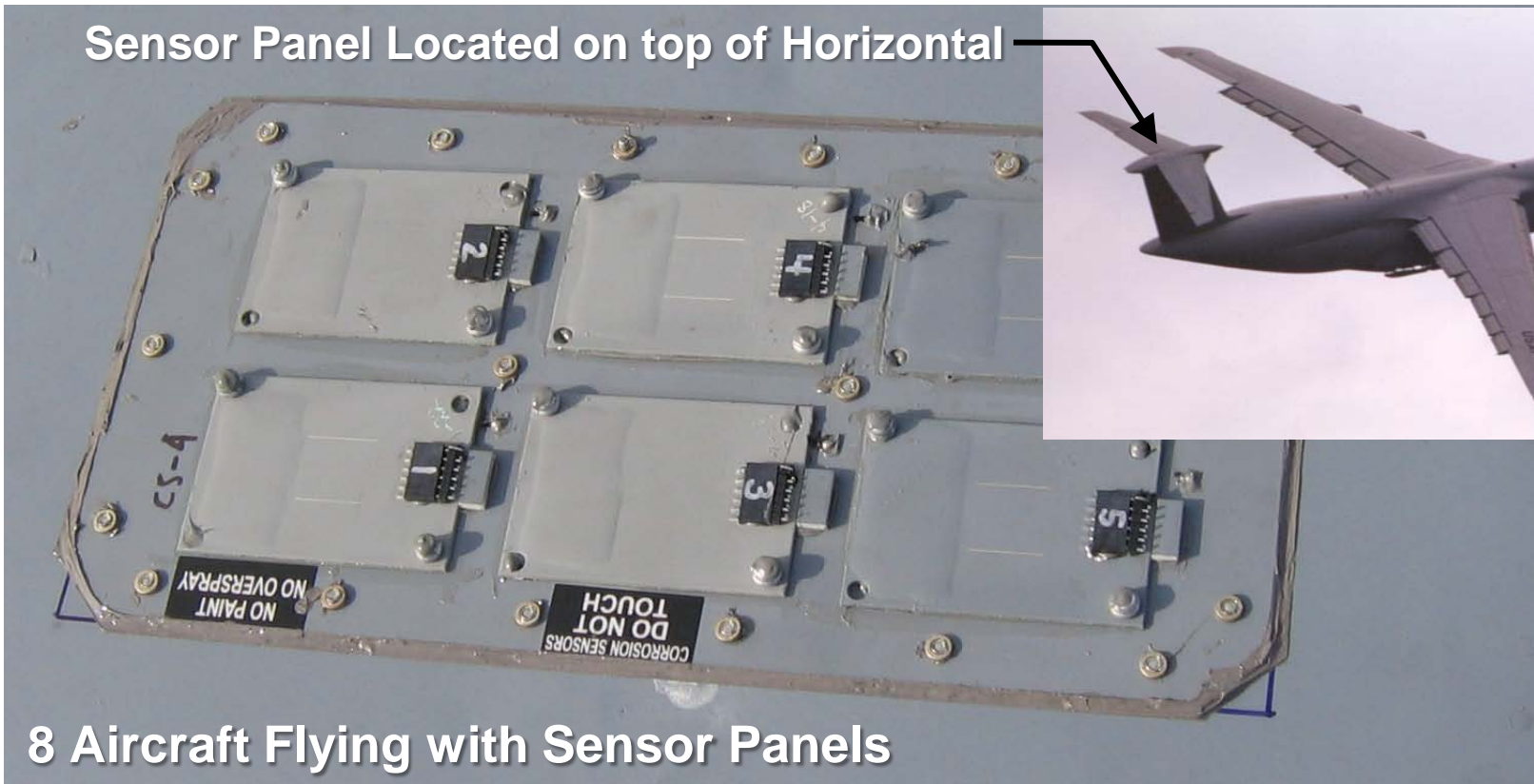
Non-Chrome Finish Systems

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

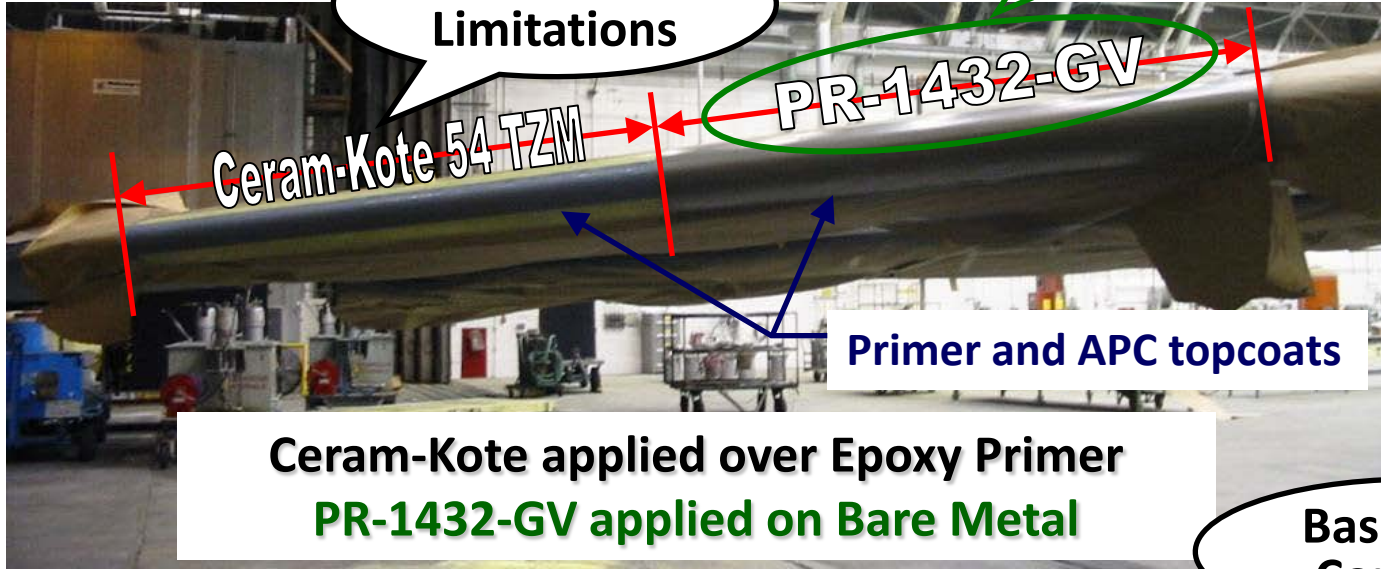
Sensor Panel Located on top of Horizontal



8 Aircraft Flying with Sensor Panels



Leading Edge Coatings Evaluations Completed



150 Day
Interval
Evaluations
Completed
over 420 Day
Period

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



3M Tape #8681HS Applied over Primer and APC

- Wing
- Horizontal
- Vertical
- Nose Plug



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

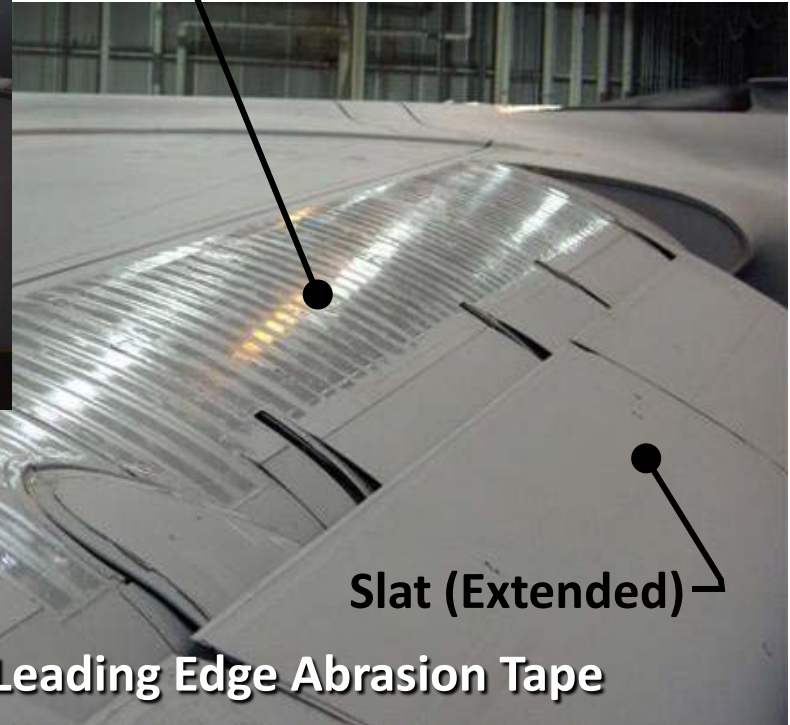


Slat (Extended)

Slat Lower Surface Anti-Chafe Coating

Desothane® HS CA8100
Anti-Chafe Topcoat
under Slat

8681 HS Tape with
DP190 Edge Seal on
top of wing



Slat (Extended)

C-5 Wing Leading Edge Abrasion Tape

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***



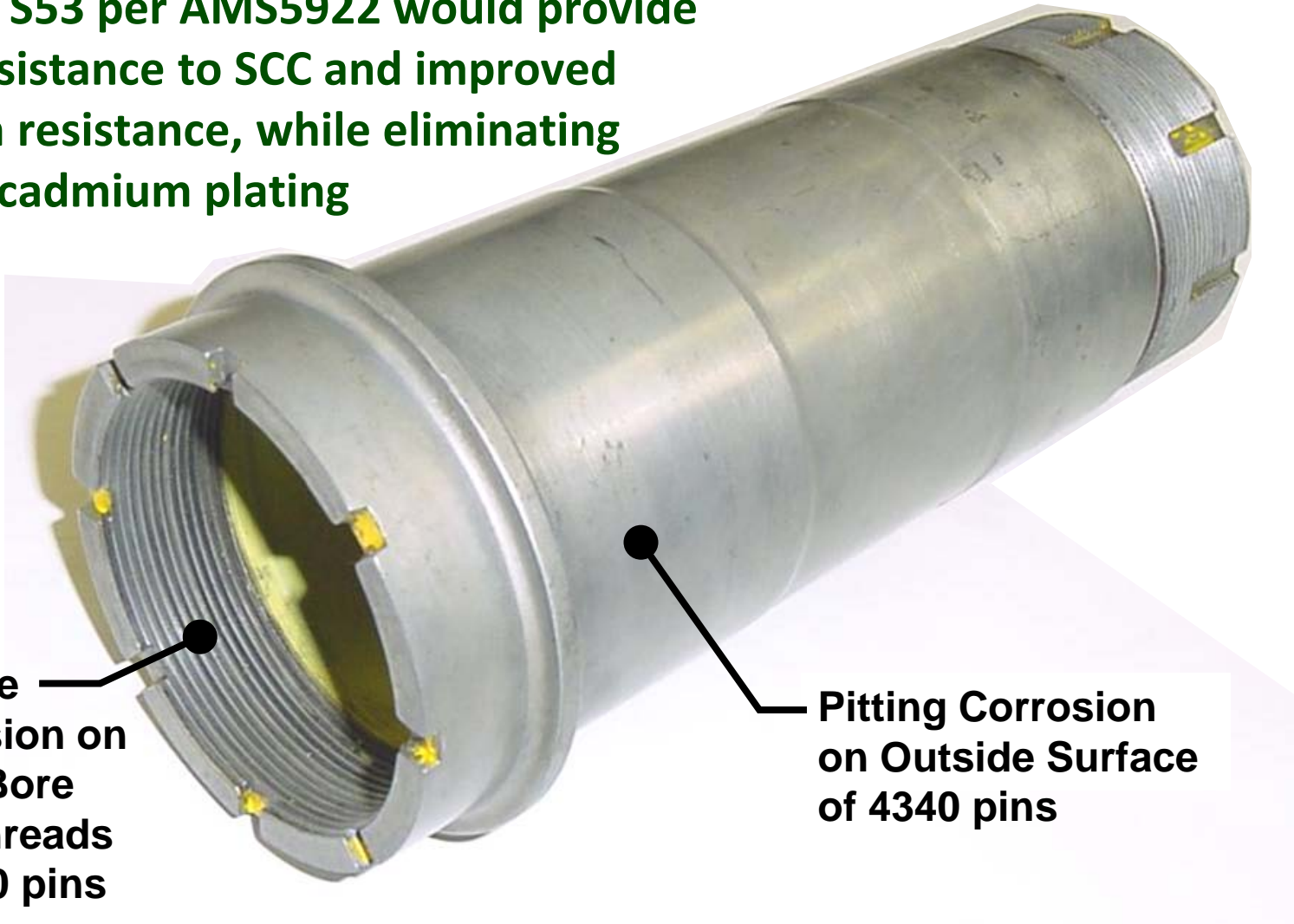
- **PMB (Type V media) on C-5 at Kelly AFB in 1990's**
 - **Approval based upon testing by SwRI**
 - **PMB not possible on resin-starved composites**
 - **Facility has been converted back to chemical stripping**
- **PMB (Type VIII media) being proposed for C-5 at Robins AFB**
 - **Need additional de-paint 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



Surface Corrosion on Inner Bore and Threads of 4340 pins

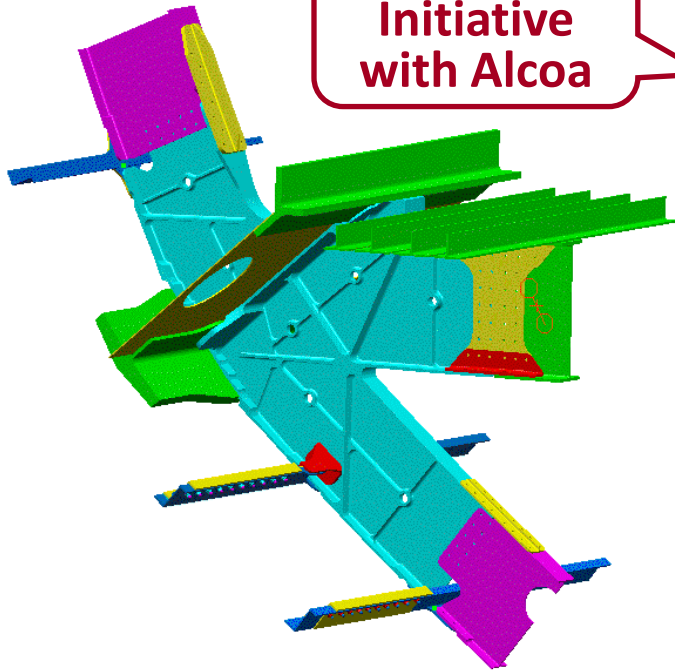
Pitting Corrosion on Outside Surface of 4340 pins



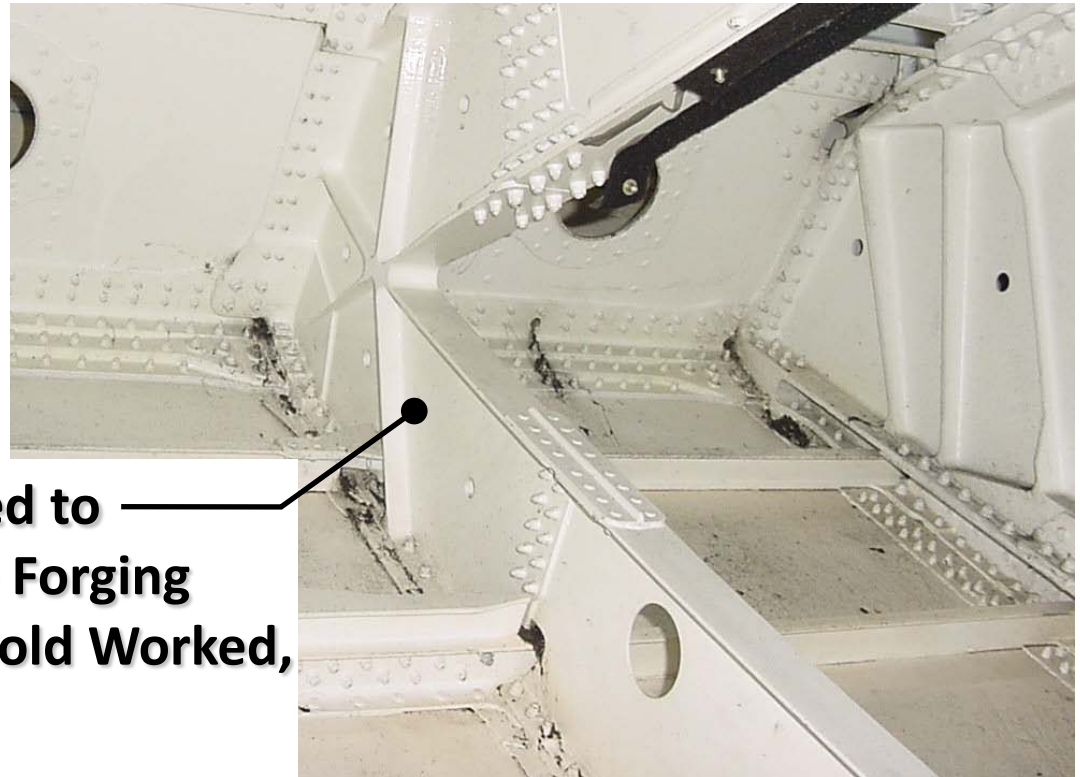
Cargo Floor End Fitting Replacement ***Alloys selected with higher resistance to Stress Corrosion Cracking (SCC)***



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



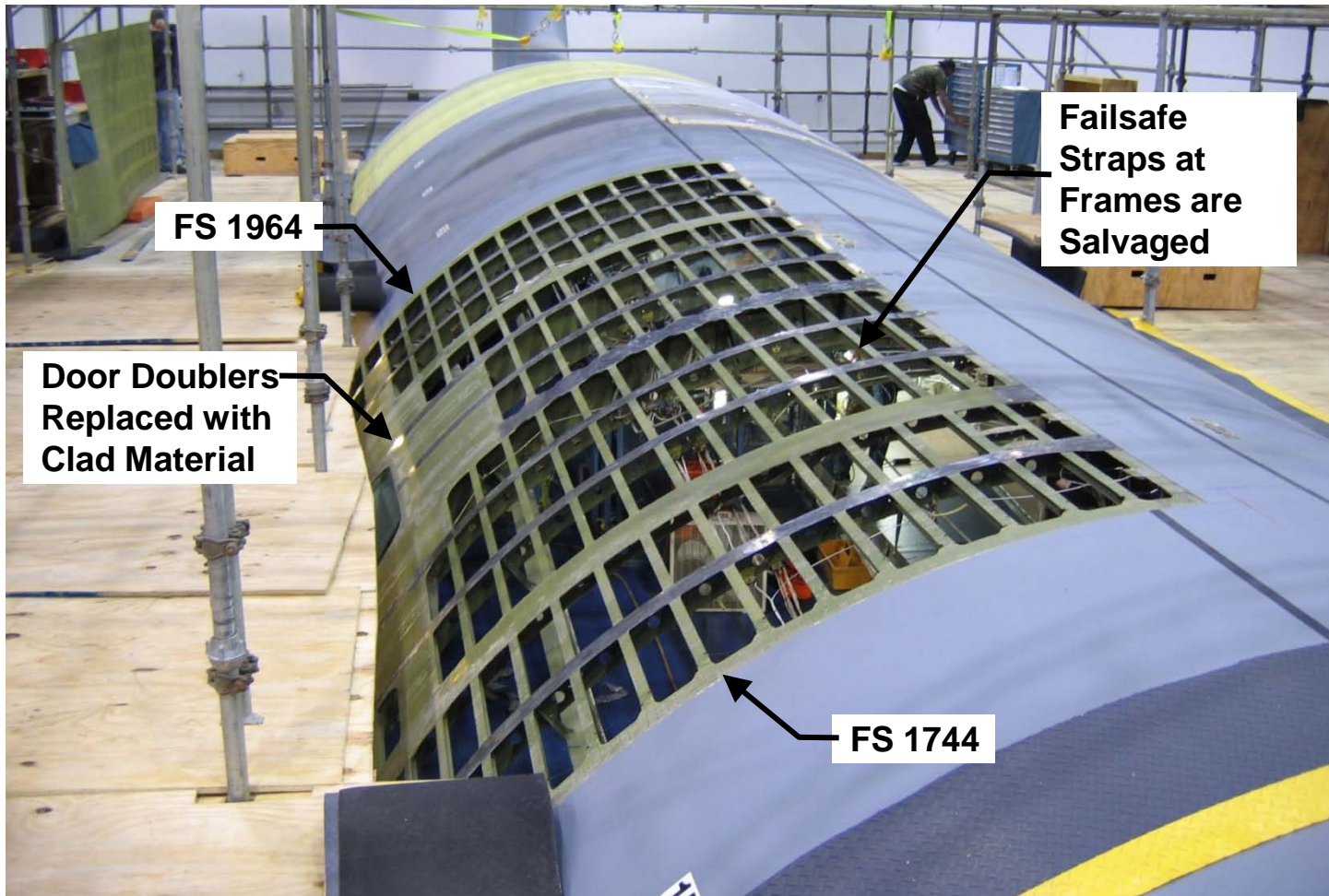
Aft Crown Skins on C-5A were 7079-T6 (one side Clad)





C-5A Aft Crown Skin Replacement

7475-T761 replaced 7079-T6



FS 1964

Door Doublers
Replaced with
Clad Material

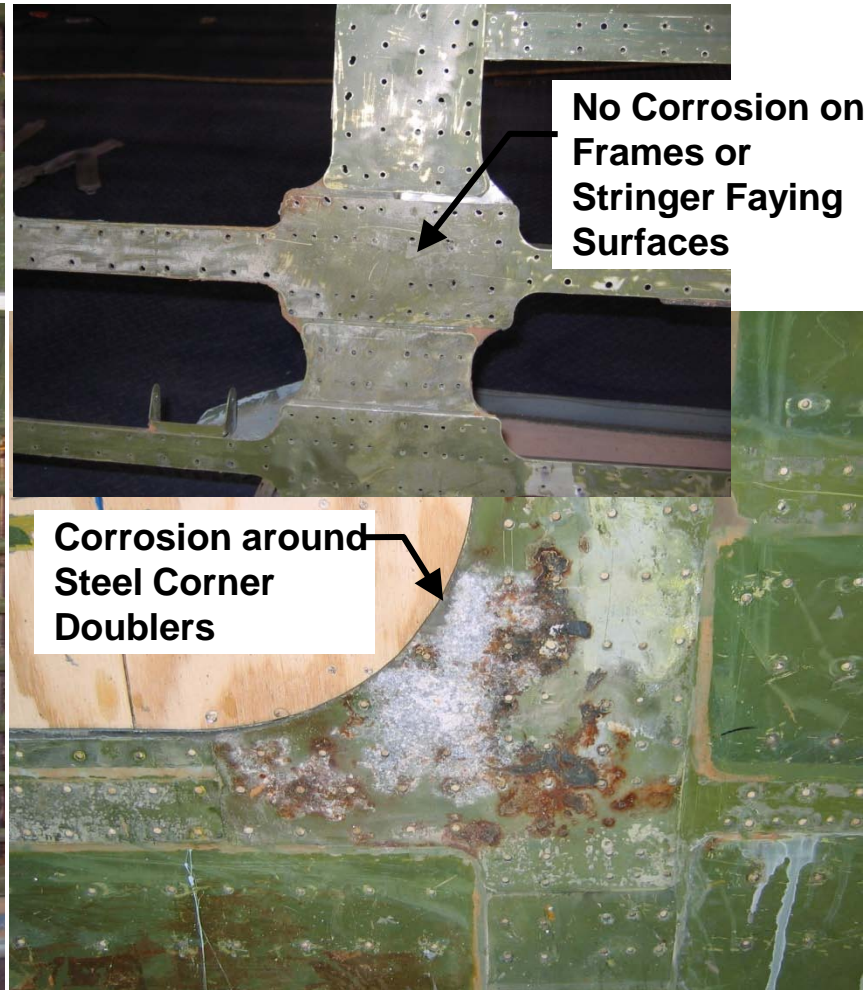
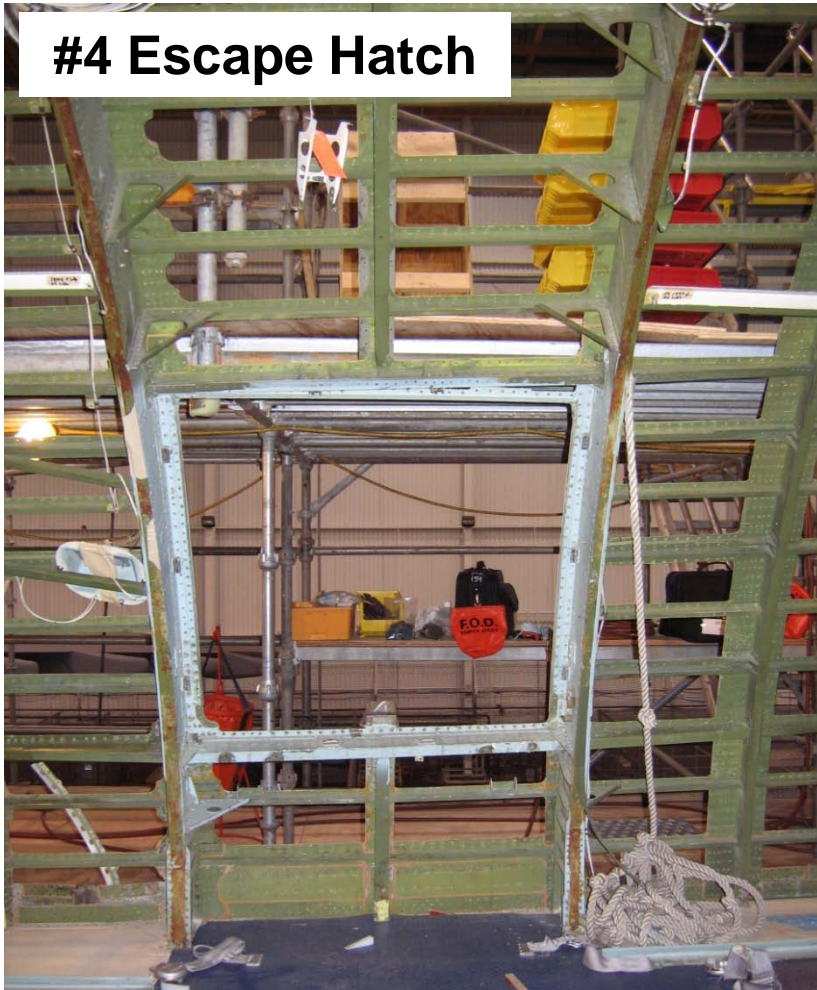
Failsafe
Straps at
Frames are
Salvaged

FS 1744



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



3M #261 Conformable Application Heads
NSN 6850-01-499-5307



Melamine Pads
NSN 7920-01-526-9003

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

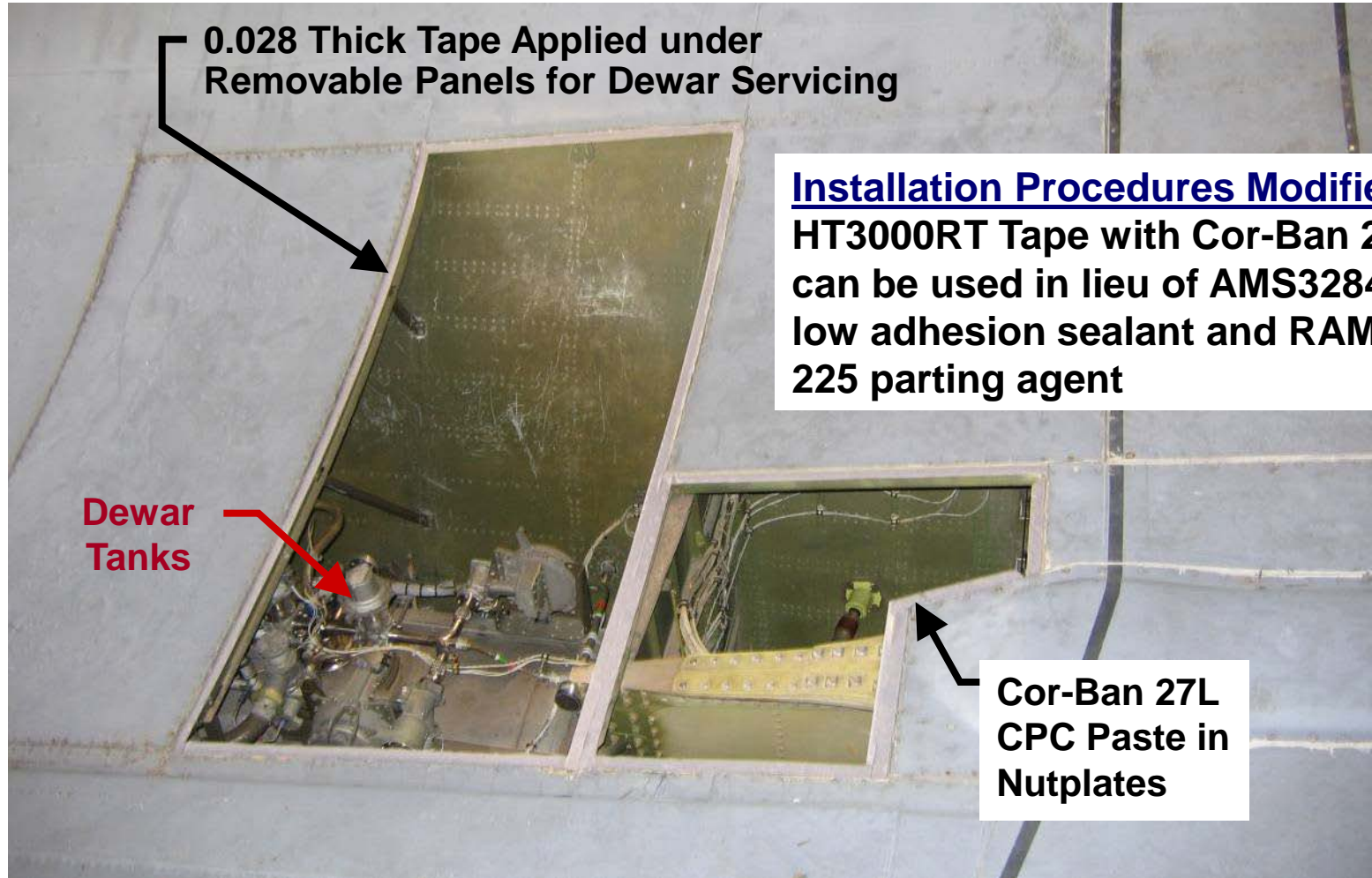
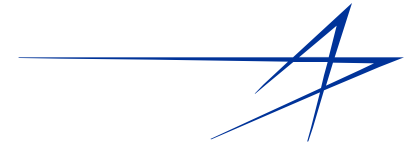


Scotch-Brite™ Pads with Rubber Coating
NSN 6850-01-496-4901



Removable Panel Installation

Av-Dec® HT3000RT Tape



0.028 Thick Tape Applied under Removable Panels for Dewar Servicing

Installation Procedures Modified
HT3000RT Tape with Cor-Ban 27L can be used in lieu of AMS3284 low adhesion sealant and RAM 225 parting agent

Dewar Tanks

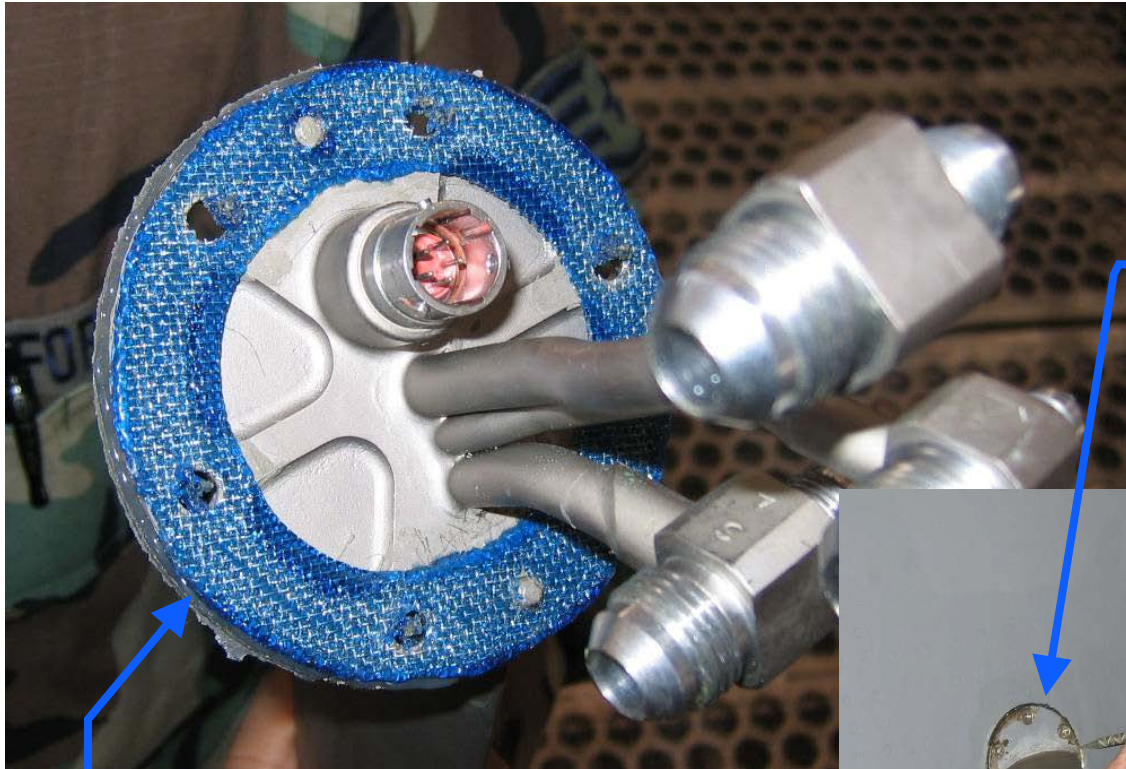
Cor-Ban 27L
CPC Paste in
Nutplates

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**

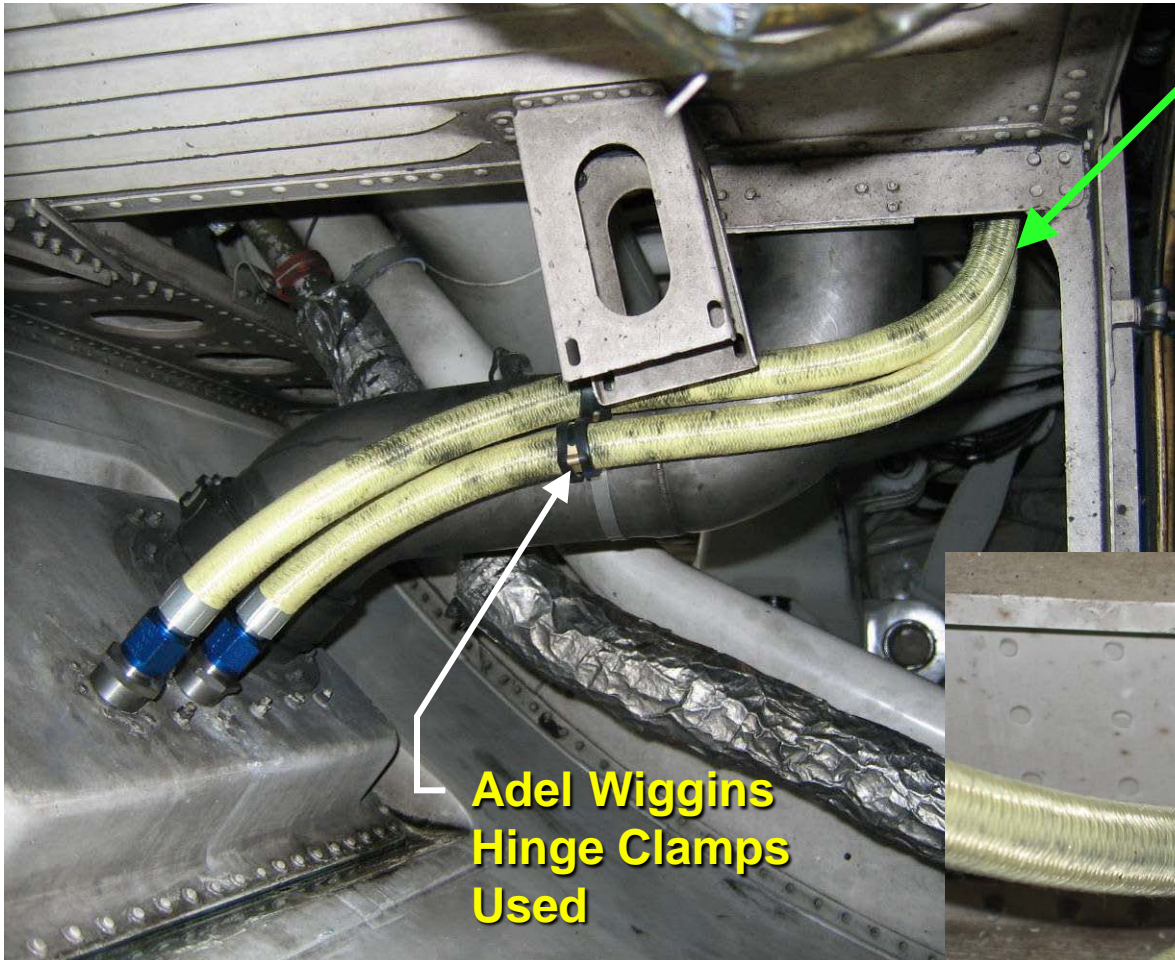
**TG8498-50
Thixoflex™
Gray to fill Gap**





New Lavatory Fluid Supply Hoses

TCTO 1C-5-813



**Adel Wiggins
Hinge Clamps
Used**

**Adel Wiggins
HHB101
Commercial Hoses
(FAA approved)**

**Flared Plumbing
Fittings Swaged
onto Hoses**

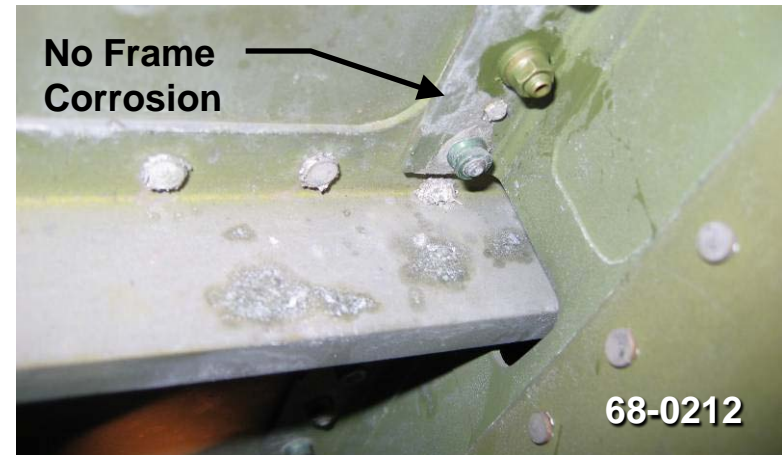
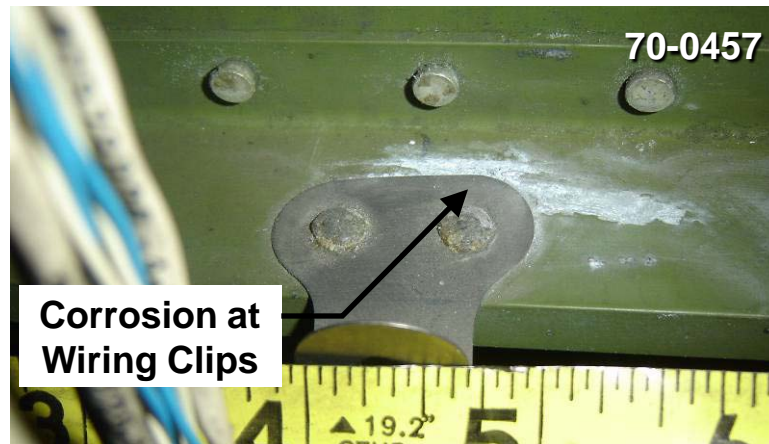
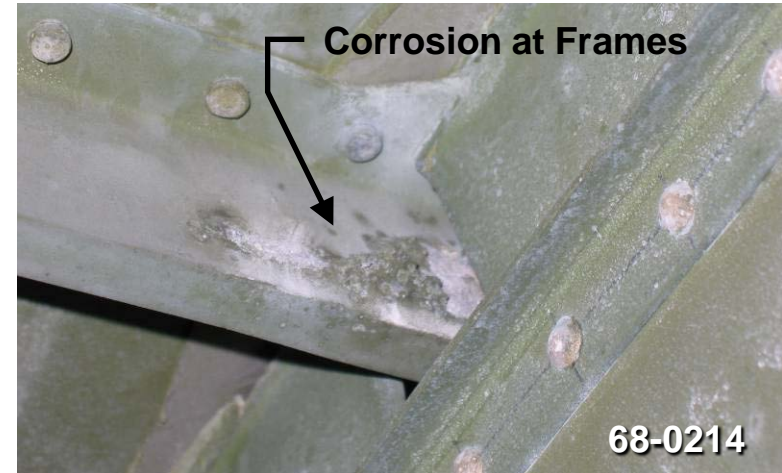
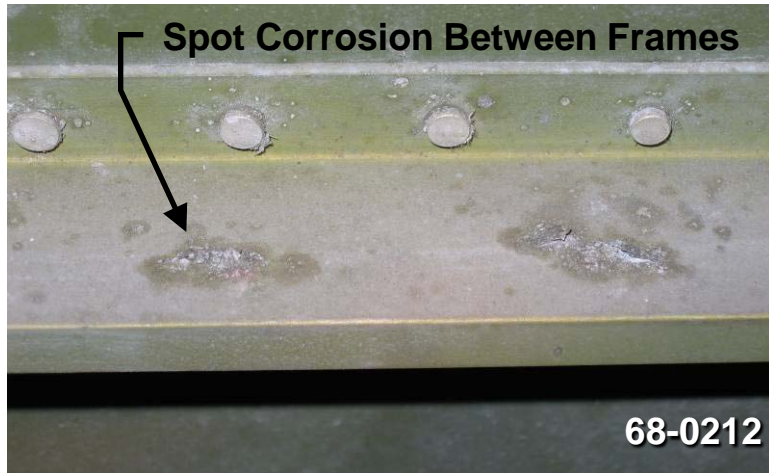




Stringer Corrosion Grind Outs and Repairs Developed



Corrosion Grind Outs Preferred over Section Removals



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



Fuel Tank Access Flange Corrosion

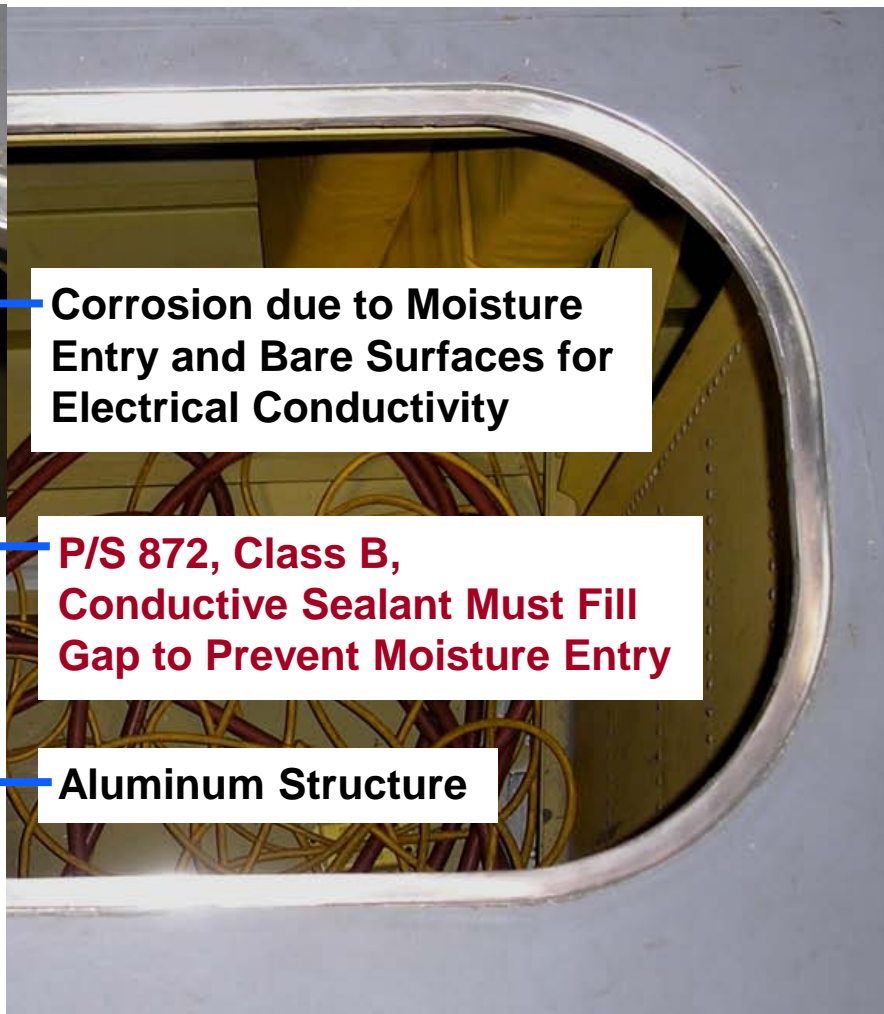
Grind Out Limits Established



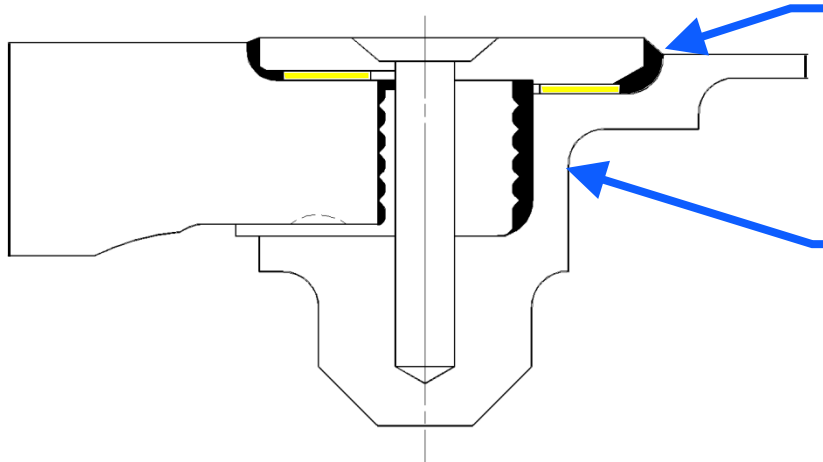
Complete Squeeze-Out of Sealant Required around Door Retaining Ring to Prevent Moisture Entry



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

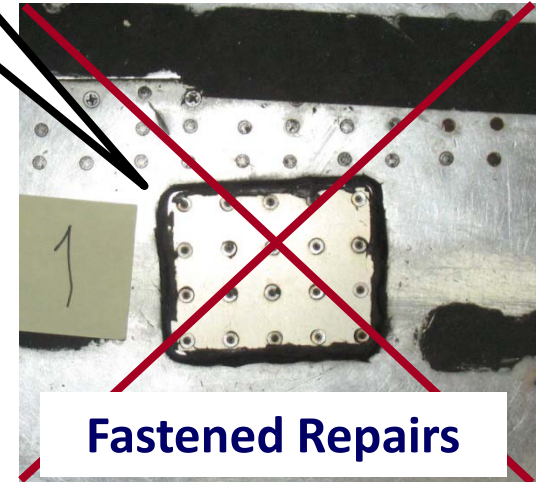


Grit-Blast Process

Internal Corrosion Issues



Bonded Repairs



Fastened Repairs



Bonding Certification Procedure for Primary and Critical Secondary Structure



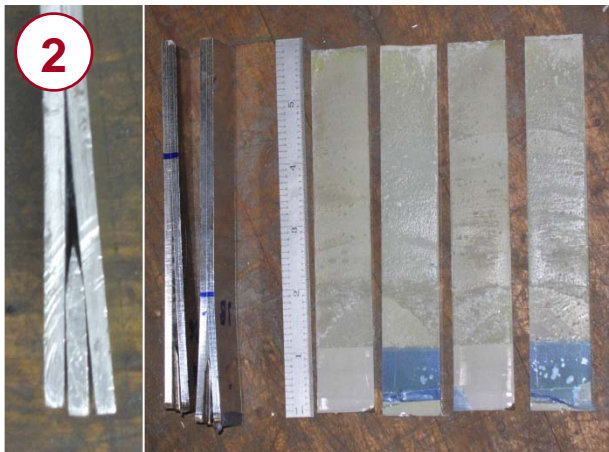
Specimen Fabrication



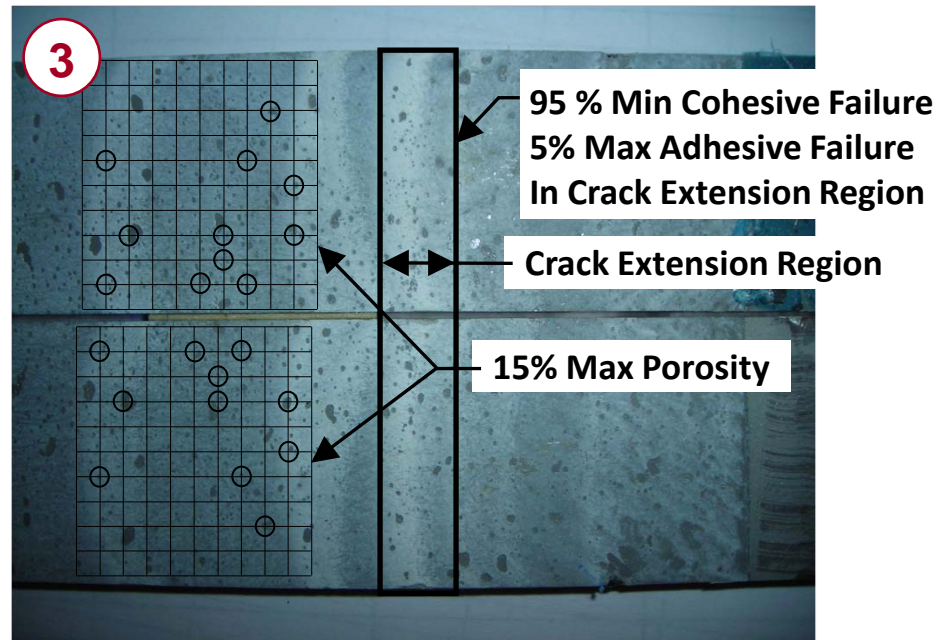
Procedure developed from ASTM D3762 to allow certification of personnel at base and depot level

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.**

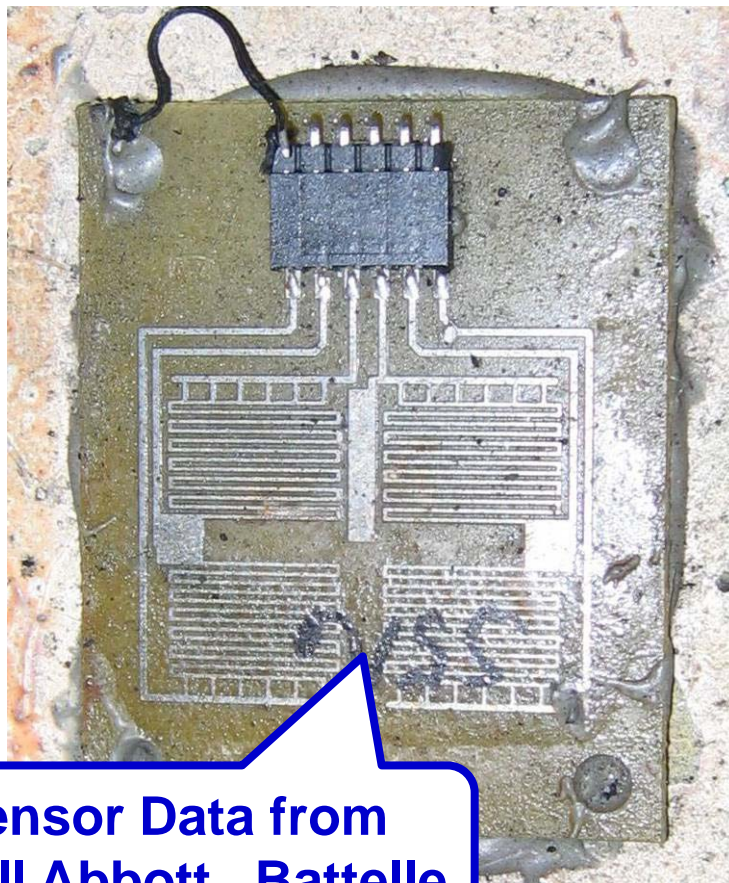


CPC Usage Based upon Battelle Sensor Data and Visual Inspections

Bare and CPC Coated Copper and Steel Sensors Used



**Coated Steel Sensor
(No Corrosion)**



**Sensor Data from
Bill Abbott , Battelle**

**Bare Steel Sensor
(Expired)**





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.



Anti-Seize Paste Film CPC

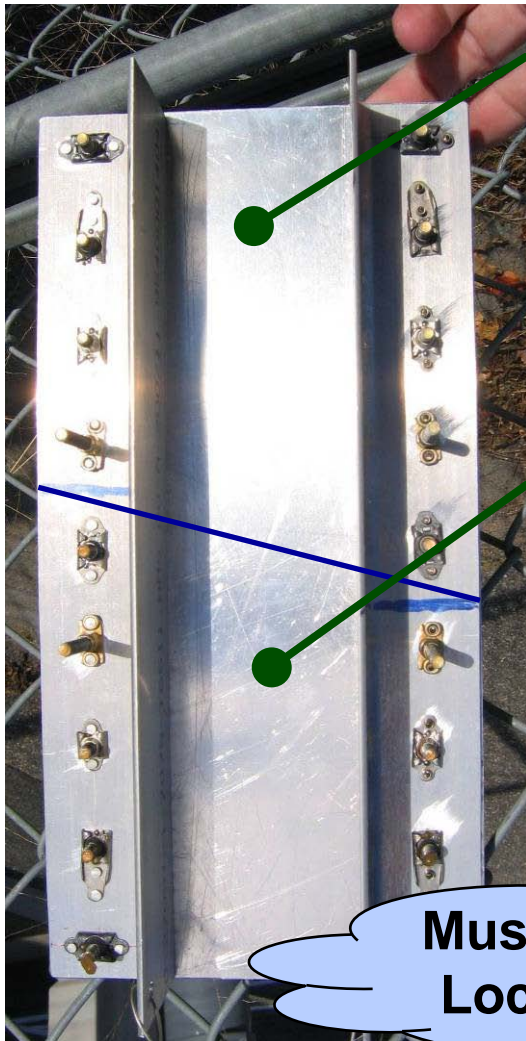
Cor-Ban 27L on Removable Fasteners



Evaluation



Incorporation

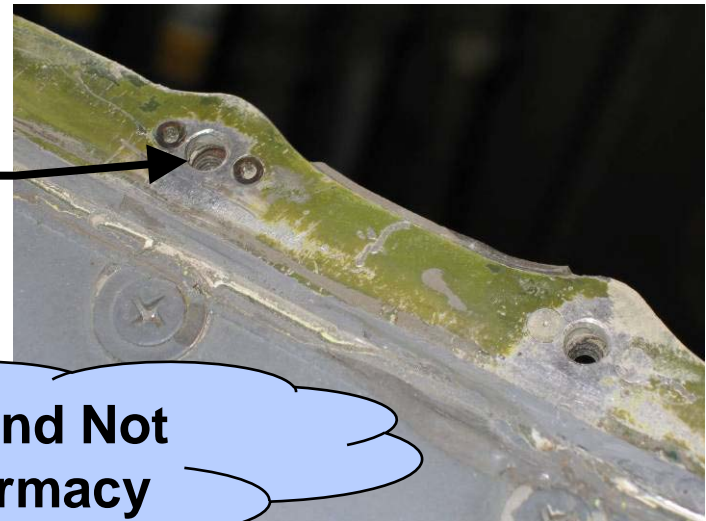
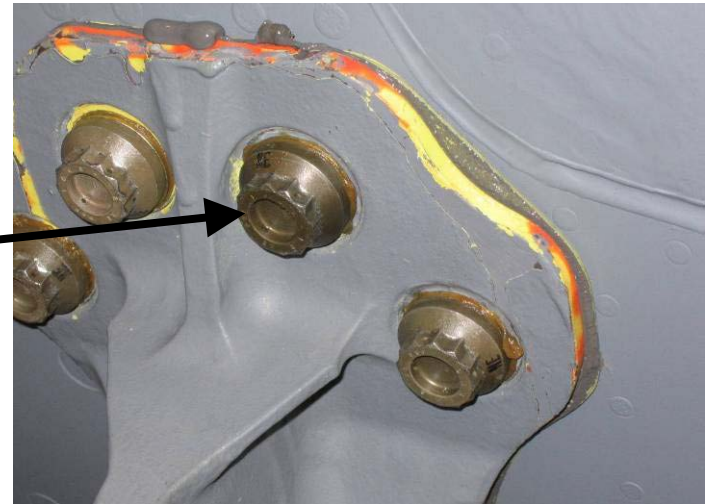


Fasteners
Installed Bare
(No CPC)

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

