

# AFCTIO Project Updates

**AF Corrosion Managers Conference  
16 - 18 August 2011**



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# Overview



## Three Top Issues with Coatings

- **Need DiEGME Resistant Fuel Tank Coatings (AMS-C-27725)**
- **Need Erosion Resistance Coatings (AMS-C-83231 & AMS-C-83445)**
- **Need Non-Chrome Coating Systems (MIL-PRF-32239)**
- **POCs for Projects**



# FTTP – Fuel Tank Topcoat Peeling



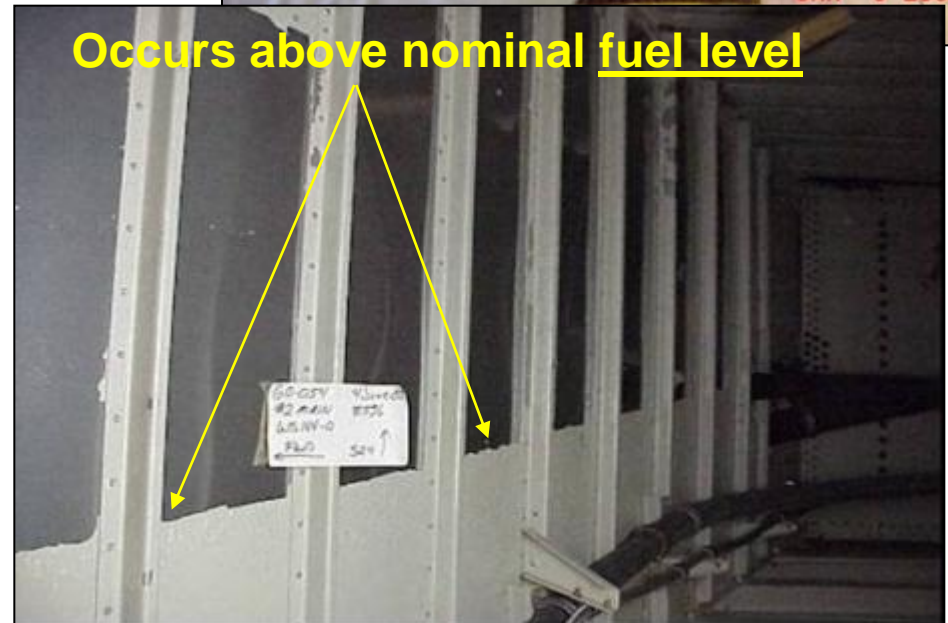
- Problem Identification
  - Fuel System Icing Inhibitor (FSII)
    - Diethylene glycol monomethyl ether (DiEGME)
    - Phase separate at elevated temperatures
  - Result of switch from JP-4 to JP-8
    - JP-8 flash point higher than DiEGME



Resulting clogged fuel filter



Typical lower skin FTTP with water staining



Occurs above nominal fuel level

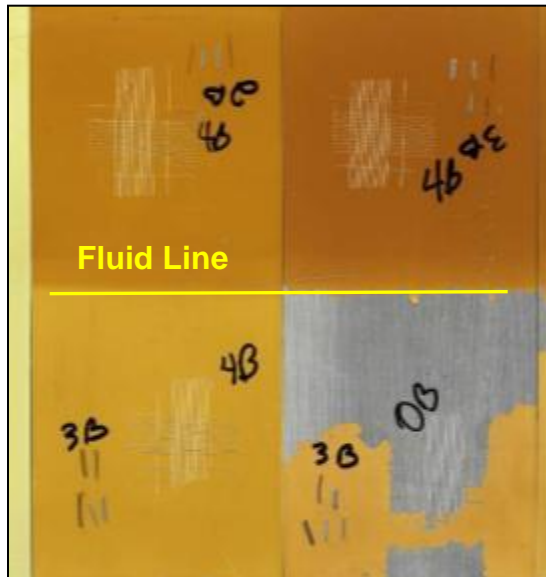


# FTTP – Fuel Tank Topcoat Peeling



## •Plan of attack:

- Develop DIEGME Resistant Coating
  - Compatible with BMS 10-39 and AMS-C-27725
  - Any Chemistry Accepted
  - No Chemical Stripping Requirement
- Develop Laboratory Test and Parameters
  - Implement in AMS-C-27725 as Type IV
  - Field Test Candidate Coatings



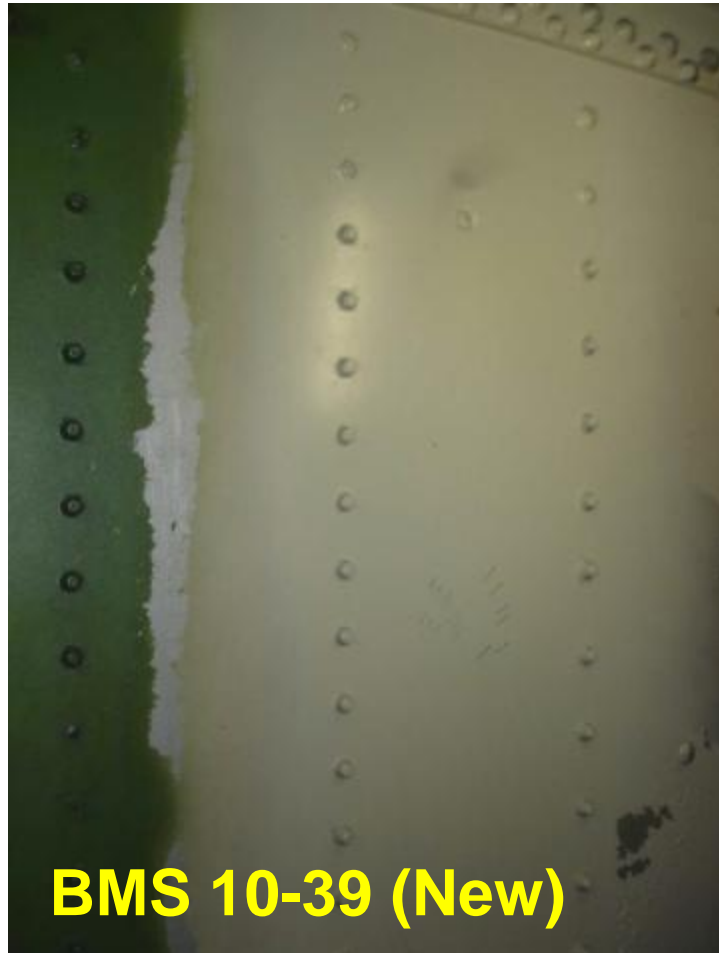


# FTTP – Fuel Tank Topcoat Peeling



- B-52 Field Test
  - Applied Sept 2007
  - Tinker AFB 16-20 Nov 2009

- Coatings that looked good in lab failing in field
- Why?
  - Surface prep issue?
  - Half immersed test, right test?
    - Lab failure mode not consistent with a/c failure mode



**BMS 10-39 (New)**



**Axon**



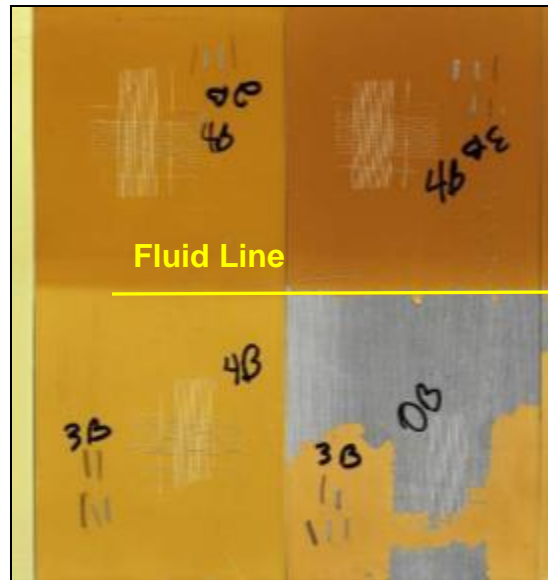
# FTTP – Fuel Tank Topcoat Peeling



- Original Test Method



Panel half submerged  
Beaker covered with foil  
Whole beaker placed in oven



Lab failure modes are:  
Loss of adhesion  
Some blistering



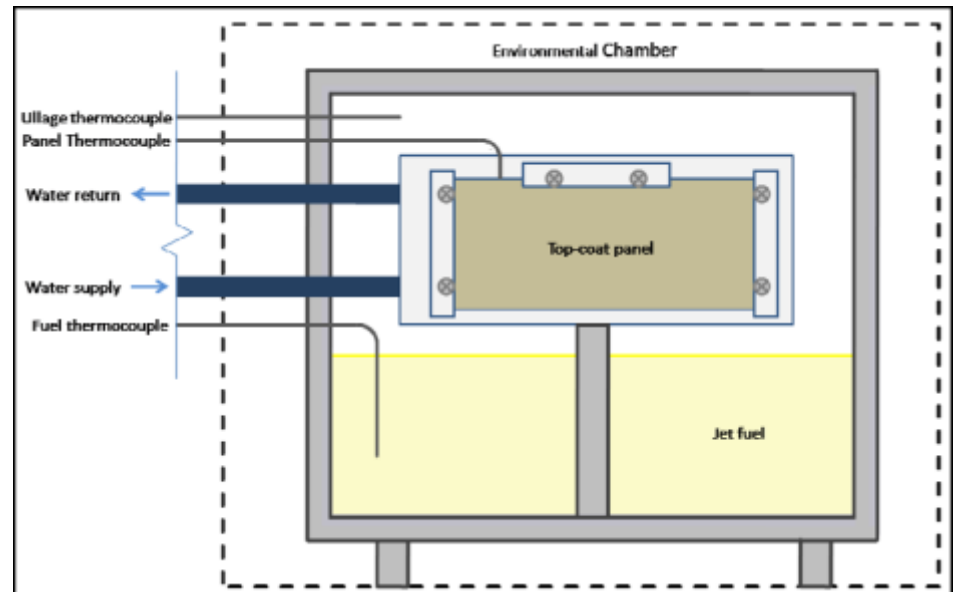
A/C failure modes are:  
Wrinkling and blisters  
Then loss of adhesion



# FTTP – Fuel Tank Topcoat Peeling



- AFRL/RZPF Fuels, created lab test
  - Failure mode same as seen in field
  - Panel hangs in space and is cooled
  - Solution is JP-8/DiEGME
  - But very complicated test
- CTIO to experiment with different test methods
  - Goal: duplicate failure mode seen in field

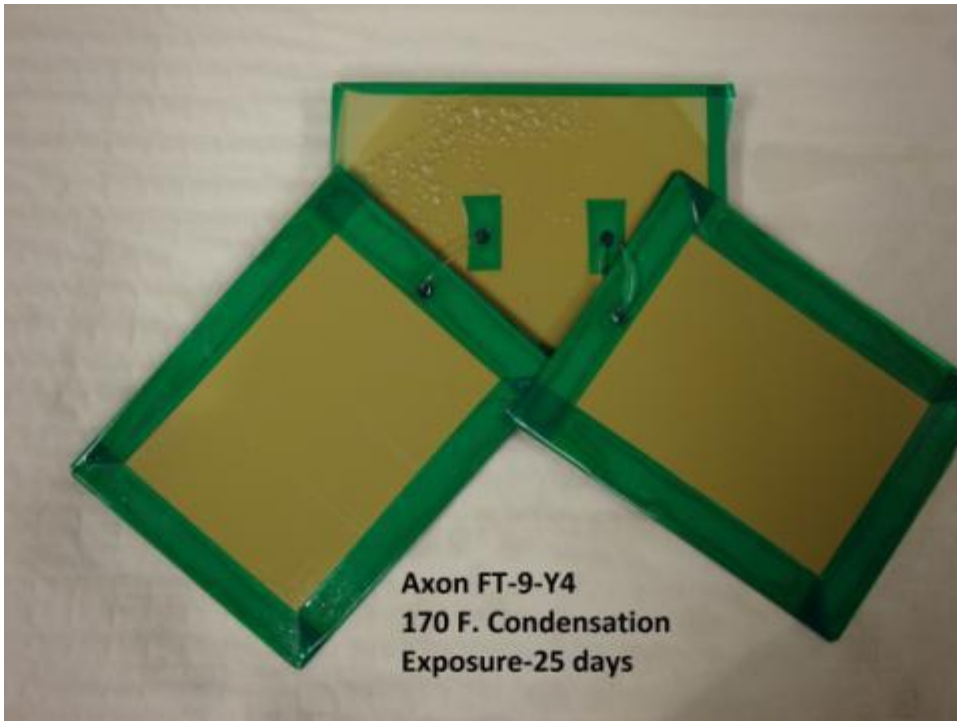
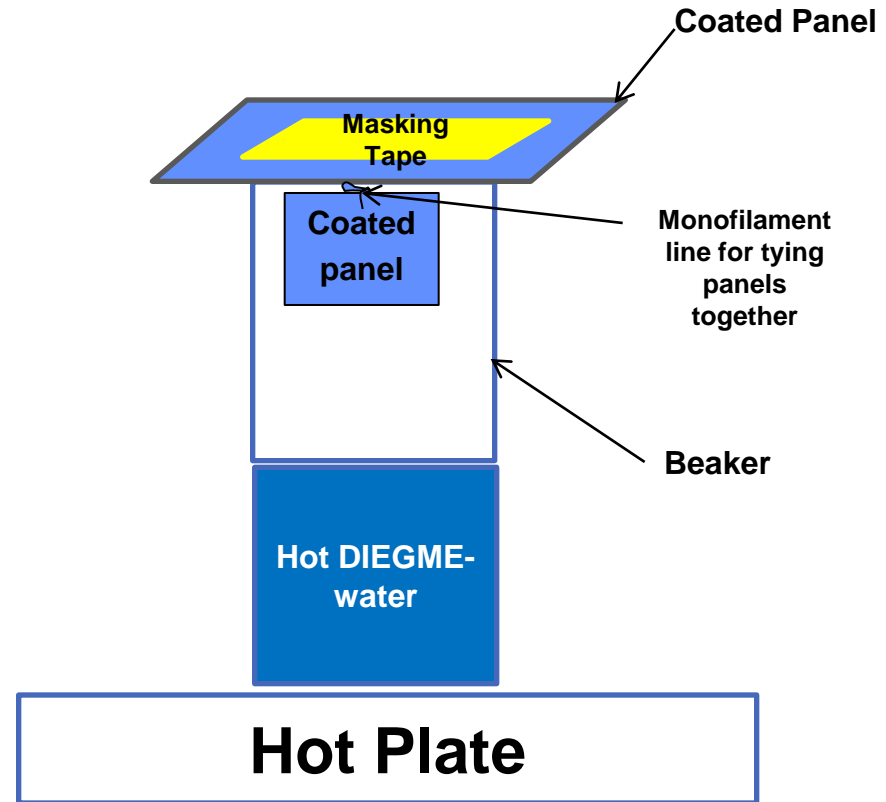




# FTTP – Fuel Tank Topcoat Peeling



- New Test Method Developed
  - Large Jar on Hot Plate
  - Cover Panel and Hanging Panels
    - Both have test coating
  - Cover Entire Opening
    - Tape Holes

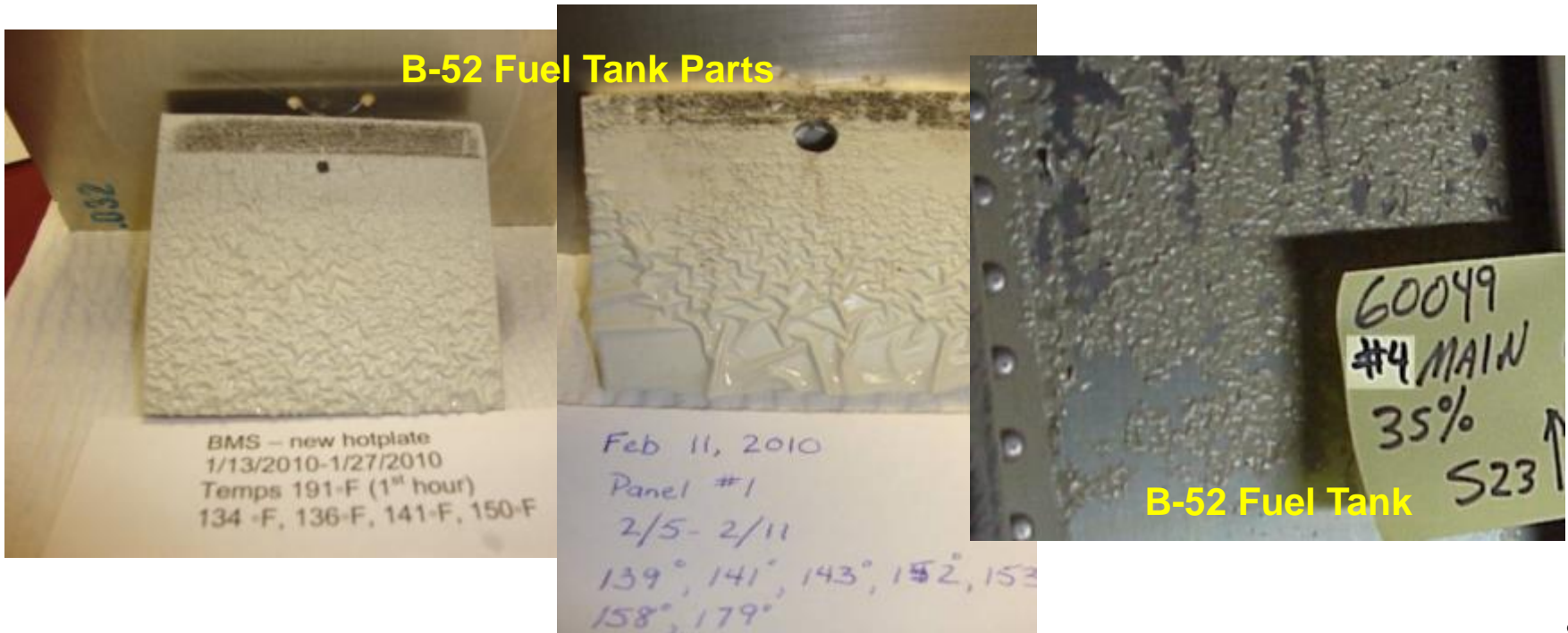




# FTTP – Fuel Tank Topcoat Peeling



- Tested variety of DiEGME/water ratios:
  - 98/2 DiEGME/Water best replicated field failures on BMS panels (B-52 parts)
- Failure Mode: Wrinkles as seen in field

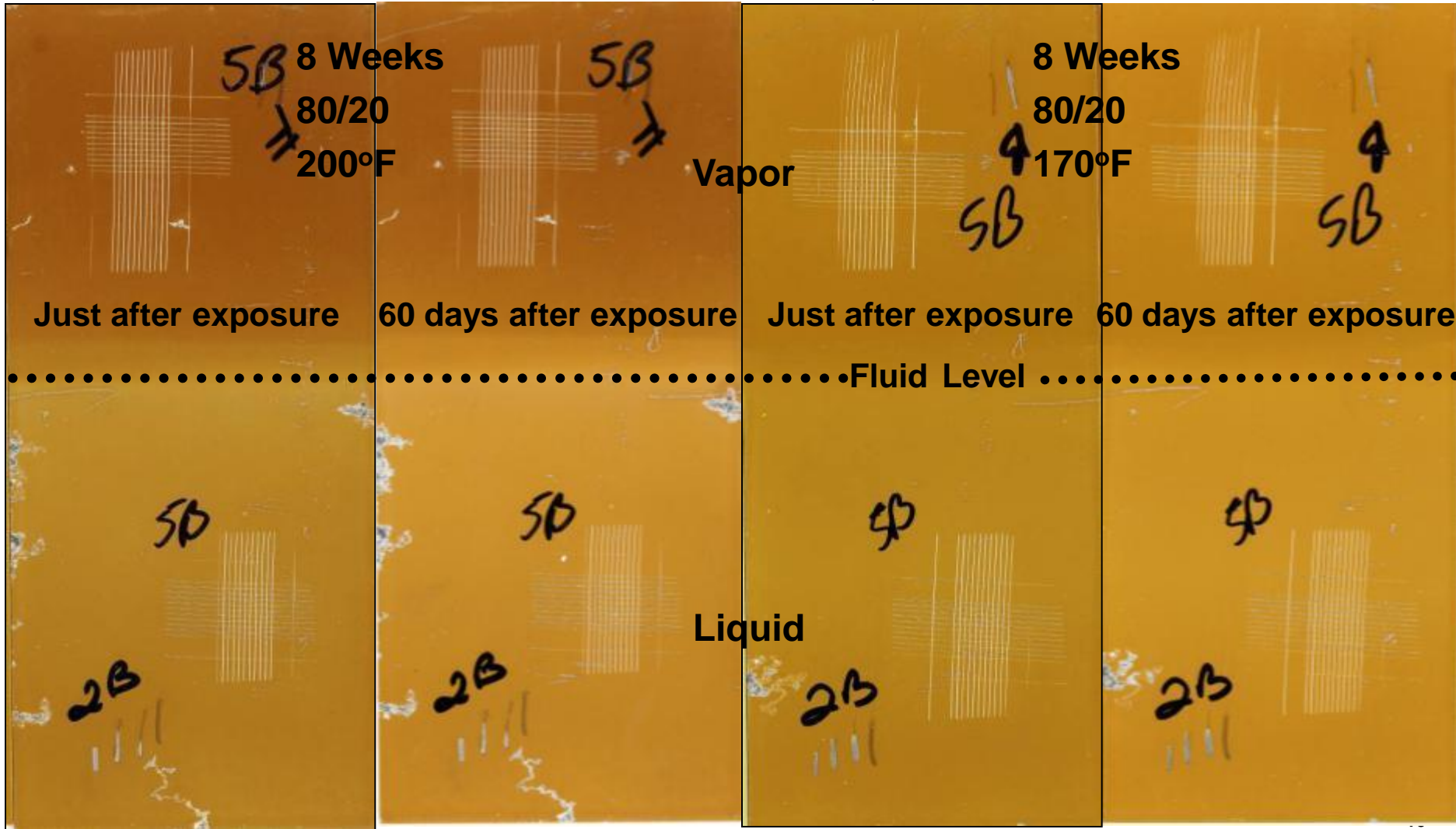




# FTTP – Fuel Tank Topcoat Peeling



## Corrosion – Axon, FT-9-Y4

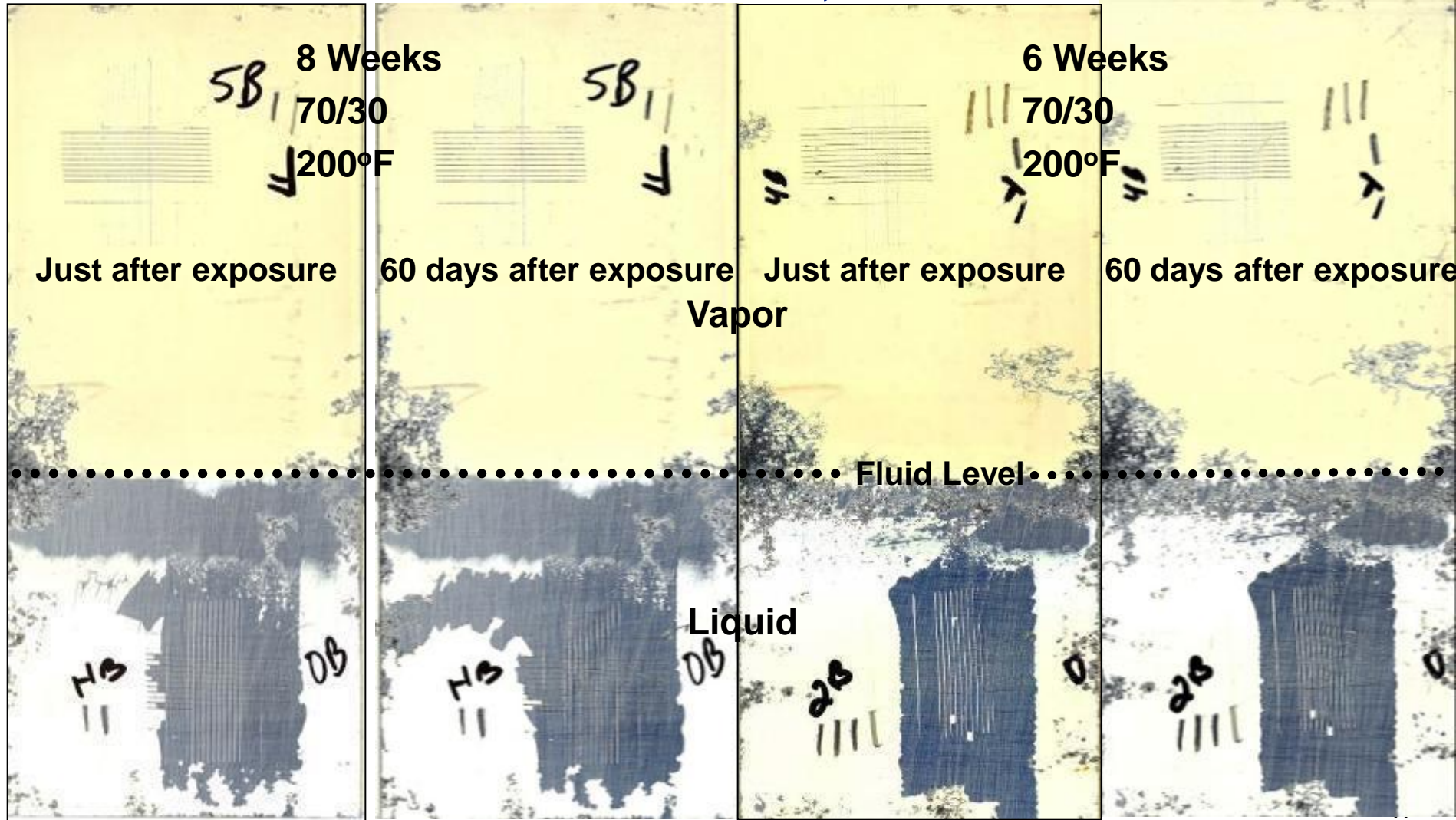




# FTTP – Fuel Tank Topcoat Peeling

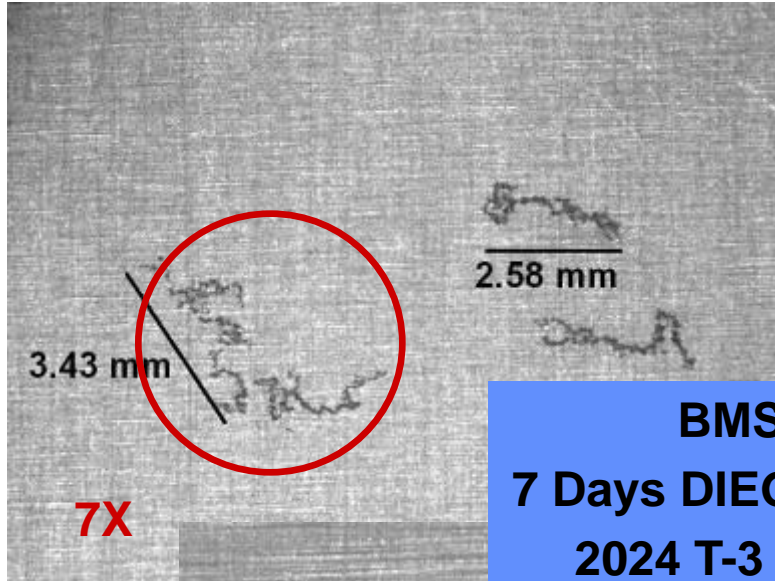


## Corrosion – ACT, Exo-Kote



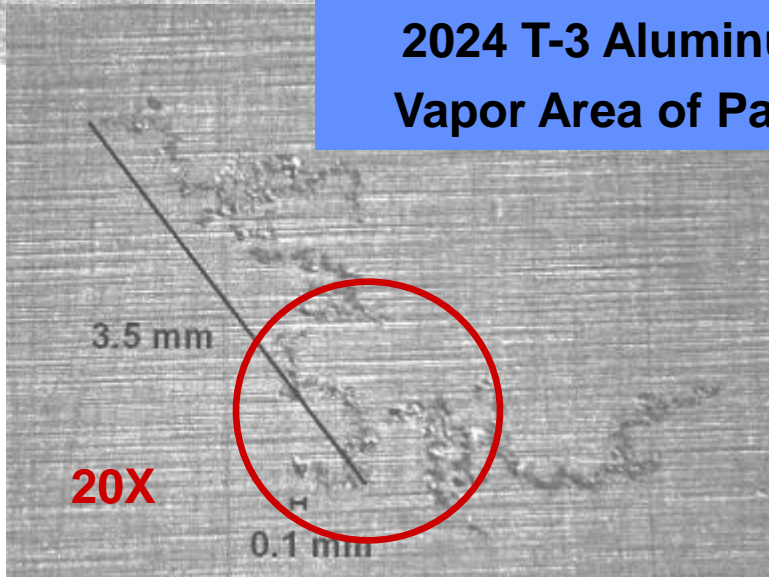


# FTTP – Fuel Tank Topcoat Peeling

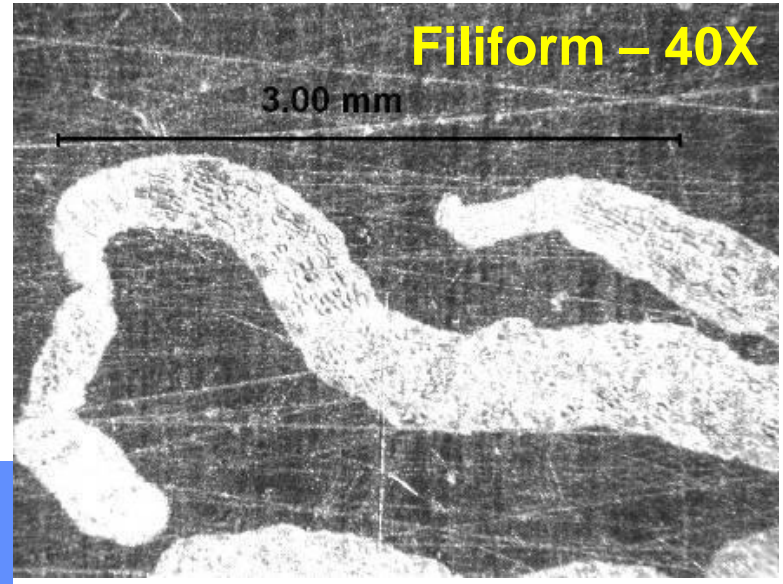


7X

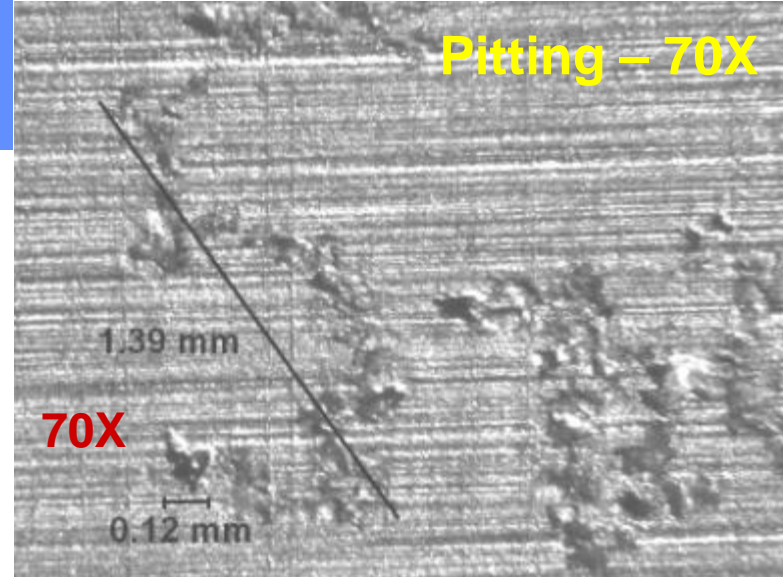
**BMS10-39**  
**7 Days DIEGME @ 170°F**  
**2024 T-3 Aluminum**  
**Vapor Area of Panel**



20X



Filiform – 40X



Pitting – 70X

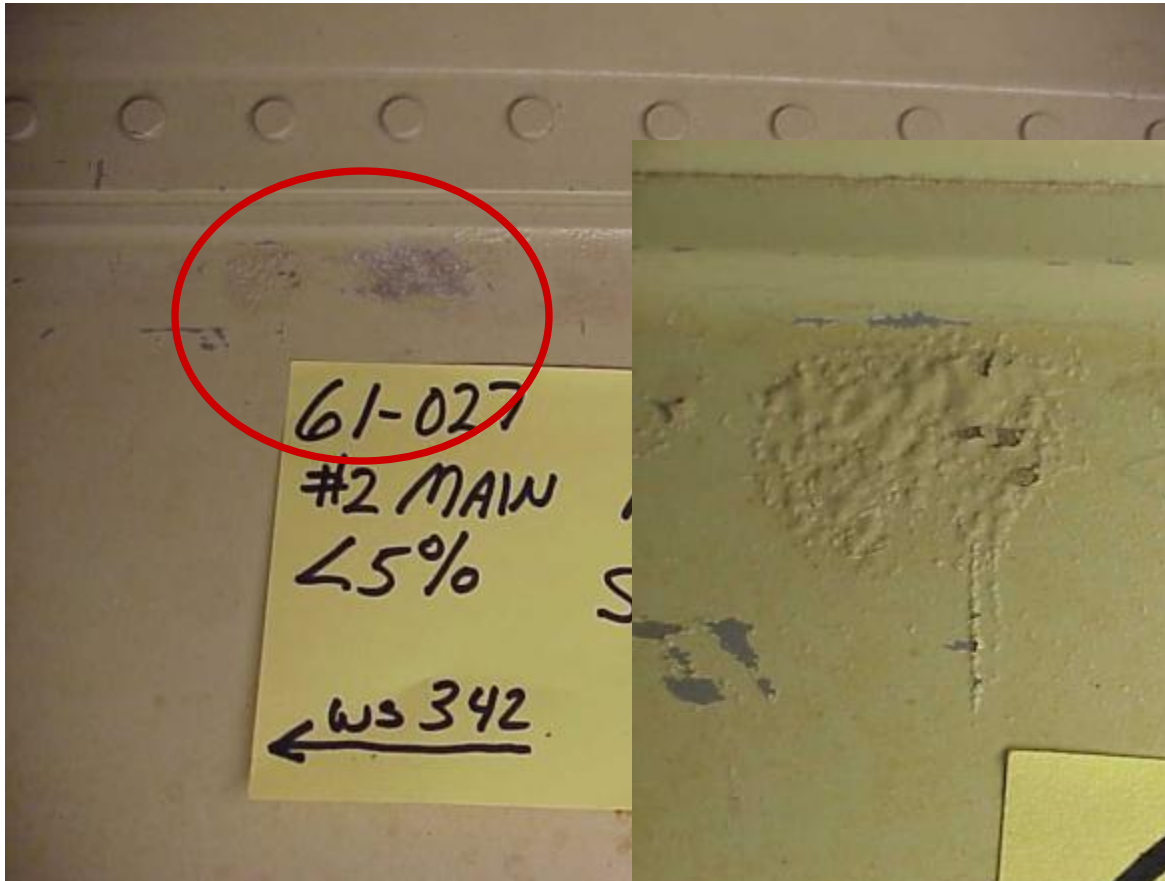
70X



# FTTP – Fuel Tank Topcoat Peeling

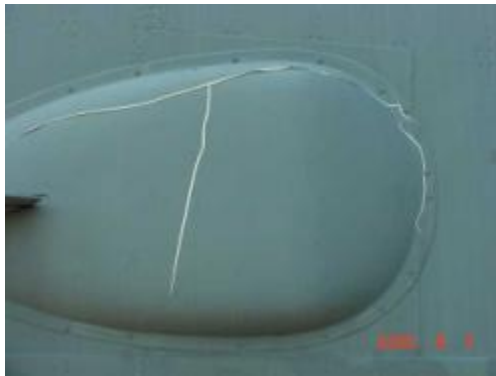


## Corrosion – B-52 Fuel Tank

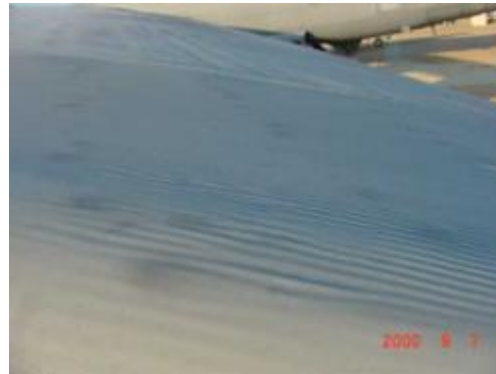




# Erosion Resistant Coatings



- **AMS-C-83445 and AMS-C-83231(SAE G-8)**
  - Caap Co Products were only vendor on QPL
  - No qualified Vendors as of Fall 03
  - Performance is unacceptable
- **Boeing and AFRL/RXSSO(CTIO) confirms**
  - White Thermal Flash Coating – De-polymerizing
  - High Humid High Temperature Environment
- **A-10 Wing Replacement Program – Boeing**
  - Need AMS-C-83231 Product





# Erosion Resistant Coatings



## Test Program

- CTIO funded screening initiative for future qualification program
  - 10 systems (majority of systems from tech orders), + 2 control systems
  - Rain erosion: 1” rain fall @ 500 mph on aluminum & fiberglass airfoils

Spec	Normal Cure 500hrs Xenon Arc Weathering	Normal Cure Aged 24 hrs at 225° F
AMS-C-83231, Ty I	180 min	180 min
AMS-C-83231, Ty II	150 min	150 min
AMS-C-83445	100 min	100 min

- Wear through coating to substrate
- Coating thickness 0.012” to 0.014”
- Successful candidate(s) will be used for a qualification program
  - Obsolete requirements replaced by tests proposed by CTIO in 2006
  - Just received funding for a qualification program



# System 10

## Deft Coating (99-GY-001)



**Aluminum:**

Heat 6.0 min.,

Weathered 8.3 min.

**Fiberglass:**

Heat 3.5 min.,

Weathered 3.5 min.



# System 6 CeramKote



## **Aluminum:**

Heat 22.6 min.,

Weathered 14.5 min.



## **Fiberglass:**

Heat 14.5 min.,

Weathered 14.5 min.



# System 2

## Caap Coating (AS-P108)



**Aluminum:**

Heat 180.0 min.,

Weathered 33.7 min.



**Fiberglass:**

Heat 180.0 min.,

Weathered 34.5 min.



# System 4

## PPG Coating (Celoflex 95)



### Aluminum:

Heat 180.0 min.,

Weathered 92.2 min.

### Fiberglass:

Heat 180.0 min.,

Weathered 95.5 min.



# System 1

## 3M Tape (8542)



### **Aluminum:**

Heat 180.0 min.,

Weathered 92.2 min.



### **Fiberglass:**

Heat 180.0 min.,

Weathered 95.5 min.



# Erosion Resistant Coatings



- **Next phase – Coatings applied to airfoils at CTIO**
- **Evaluate 8 systems**
  - 4 are being retested (Nanosonic, Lord, Sterling, & PPG)
  - 2 are controls (3M tape & Caap Co.)
  - 2 new submission (Hontek, Hentzen)
- **Separate testing for application on radomes/antennas (AMS-C-83231, Type II & AMS-C-83445)**
  - **Current effort to screen 3 products due to reported reversion issues w/ “qualified” thermal flash resistant RE coating**
    - **Kimatsan, Celoflex, & Caap Co.**
- **Candidates TBD for a qualification program (-83231 Ty I, Ty II, -83445)**
- **Priority for anti-static -83231 Ty II qualification over -83445**
  - **CTIO contacted by Robins AFB for a colorized rain erosion resistant coating for radomes**



# Non-chrome Coating System



- **Authorized Non-chrome Pretreatments**

- PreKote approved – T.O. 1-1-8

- **Qualified Non-Chrome Primers**

- MIL-PRF-85582 Class N Primers

- Type I, EWDY048
  - Type II, EEAE118
  - 44-GN-098, Deft
- } PRC DeSoto

- MIL-PRF-23377 Class N Primers

- 16798-TEP, Hentzen
  - 02-GN-083
  - 02-GN-084
- } Deft

**Authorized for use  
under a Chrome  
Primer**

**Qualified over a  
Chrome Conversion  
Coating**

**Result: NO QUALIFIED COMPLETE NON-CHROME COATING SYSTEM  
(Pretreatment/Primer/Topcoat)**



# Issues with Non-Chrome



- **Chrome Inhibitors are a Technology**
  - **Much Characterization before Specifications**
    - **Pretreatment MIL-PRF-81706**
    - **Primer MIL-PRF-23377 or MIL-PRF-85582**
    - **Topcoat MIL-PRF-85285**
  - **Robust could mix and match with little variance in performance**



# Issues with Non-Chrome



- **Non-Chrome is NOT a Technology**
  - **Each Non-Chrome Coating System is a Technology**
    - New technologies require characterization, sub-system field test, full up field test, etc
    - Then specifications built around that technology
  - **But, that is not what happened**
    - Chrome Coating Specifications modified to include a type for Non-chrome
    - If pass salt spray, 2000hrs, then good to go
  - **Problems developed** (Details next three slides)
    - Some success with JGAPP primers on F-15 but failure on KC-135
      - Pre-existing corrosion on OML of KC-135
    - Success in lab tests did not translate to outdoor exposure
    - Changing components of the system yielded big differences



# Issues with Non-Chrome

## (Chrome can Arrest Existing Corrosion)



- **JGAPP – KC-135 Field Test**
  - Hickam AFB
  - Half & Half
    - **Chrome/Non-Chrome**



- **Corrosion in Center of Skins**
  - Existing Corrosion Pits
  - NCr Could NOT Prevent
- **Sent Back to Depot**
  - Out of Cycle = Big Dollars



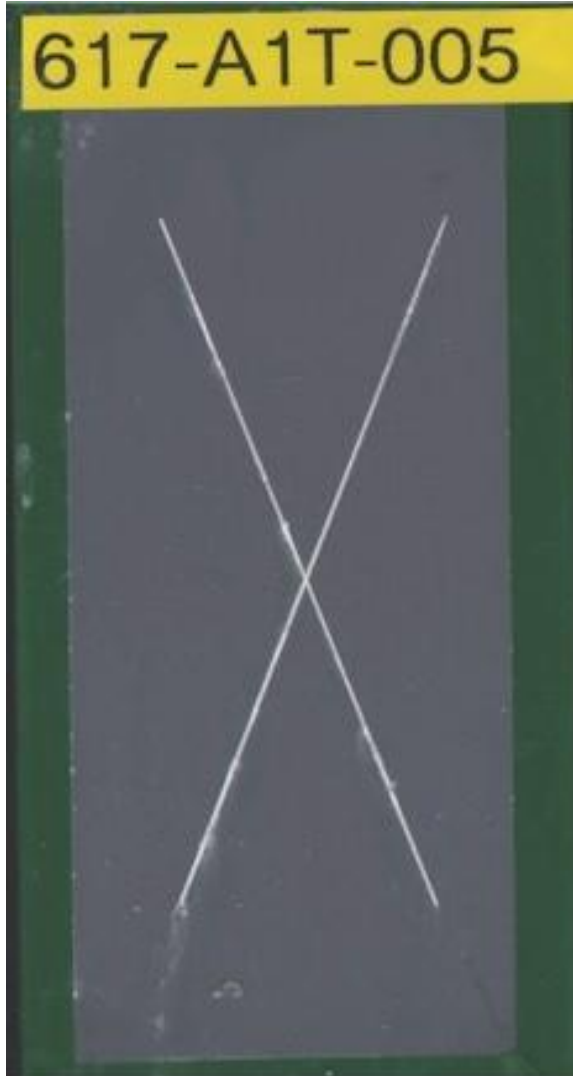
# Issues with Non-Chrome

(Lab Tests Poor Indicators for Non-Chrome)



Laboratory Salt Fog 2000 hrs

Outdoor Exposure After 3+ Years At Daytona  
(Failure <1 year)



Alodine 5200  
Sicopoxy 577-630  
Deft 03GY310  
(MIL-PRF-85285 Ty 1)



# Complete Nonchrome System



633-A1C-001



2024 T-3 Aluminum

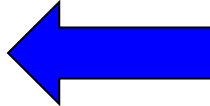
**3000 hours Salt Spray**

MIL-DTL-81706

MIL-PRF-23377, CL N  
(Deft 02-GN-084)

MIL-PRF-85285, Ty IV  
(Deft ELT)

**Non-Chrome Primer**



PreKote

MIL-PRF-23377, CL N  
(Deft 02-GN-084)

MIL-PRF-85285, Ty IV  
(Deft ELT)

**Complete Non-Chrome System**



633-A1N-003



2024 T-3 Aluminum



# AFRL Path Forward

## Advanced Performance Coating System Specification



- **Objectives**

1. Create a Specification to Capture the Advanced Performance Coating Systems being Developed
2. Performance Highly Depends on Interactions between Components

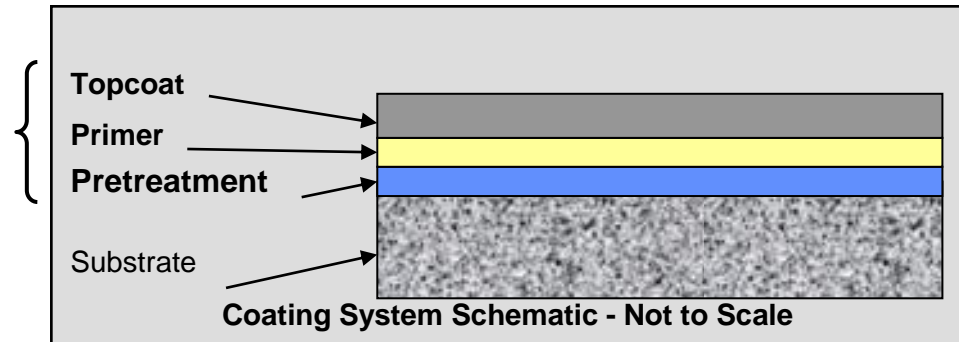
3. Coating System Defined as

- **Status**

1. Approved

MIL-PRF-32239

2. Requirements set high, Qualification event needed to lock in realistic requirements
3. All but on coating manufacture have paid for their coating system(s) to be qualified





# AFRL Path Forward

## Complete Characterization



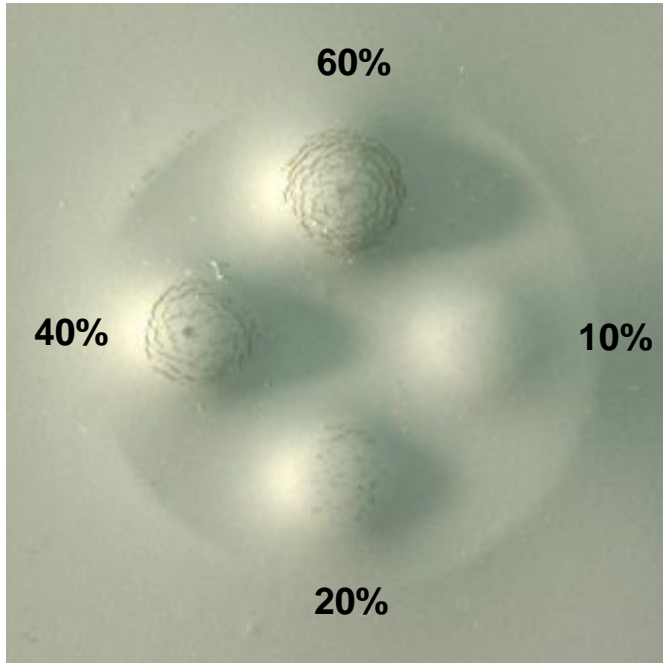
- **Coating System Specification - MIL-PRF-32239**
  - Eliminates issues with mixing components of a coating system
- **Complete Characterization - helps define risk**
- **Joint Test Protocol**
  - **8 Coating Systems + 2 Control Coating Systems**
  - **Qualify to MIL-PRF-32239**
  - **Aircraft Test Panels**
    - **Anodized, CCC Residue, Primer Residue, Pre-Corrosion**
  - **Outdoor Exposure Test**
    - **Scribed Coupons, Riveted Test Panels**
  - **Update MIL-PRF-32239, include outdoor test**



# Advanced Performance Coating System



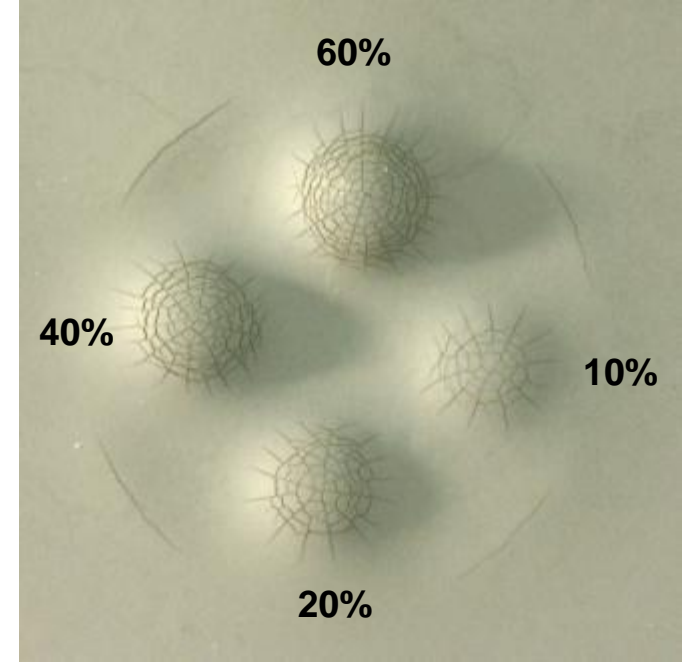
## Why High Flexibility in a primer?



Initial  
5% - 10X Mag  
40% - Pin Hole Det



Weathered (3000 hrs)  
0.5% - 10X Mag  
33.3% - Pin Hole Det

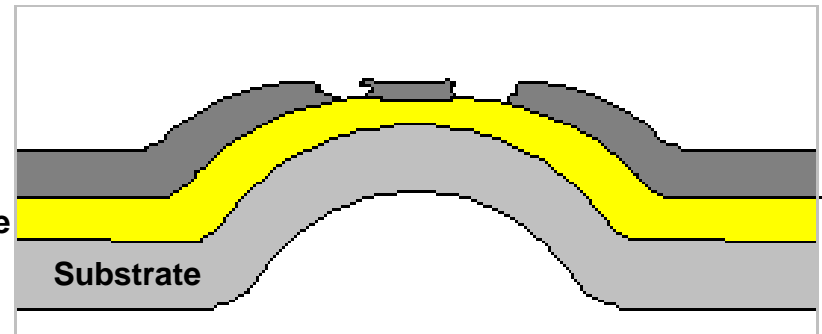


### Corrosion Protection Mechanisms

Barrier – Keep Electrolyte from Metallic Substrate

Inhibitors – Retard Ion Flow in Electrolyte

85285 Ty IV  
87112 Polysulfide  
CCC or PreKote





# POCs



- **DiEGME Resistant Fuel Tank Coatings (AMS-C-27725)** } **Gina Tollefson 937-656-4701**
- **Need Erosion Resistance Coatings (AMS-C-83231 & AMS-C-83445)** } **Lynne Pfledderer, 937-255-4113**
- **Need Non-Chrome Coating Systems (MIL-PRF-32239)** } **Mike Spicer 937-255-0942**