Corrosion Testing and NC Coatings Systems Engineering Circular

ASETS Defense 2011
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NAVAIR Materials Engineering

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15. SUBJECT TERMS

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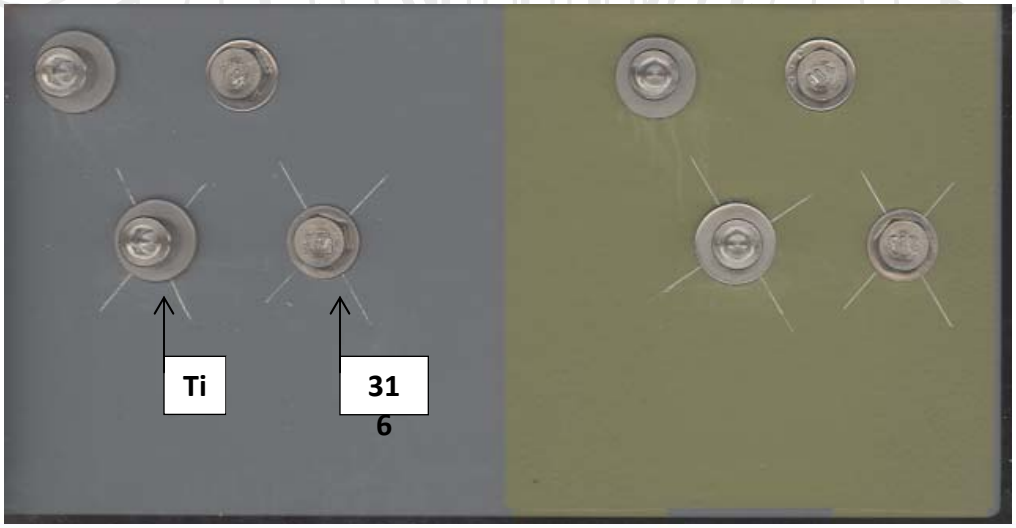
Discussion Points

- Need for relatively rapid and accurate validation of performance of new coatings on aluminum
  - Uses current test methods (love ‘em or hate ‘em, that’s what we’ve got for now)
  - Supports R&D, acquisition, and qualification needs
  - Is easy and inexpensive (relatively)
- Need for a document which establishes NAVAIR engineering authority position on how to implement non-chromate coatings systems

Galvanic Test Assemblies

- Why?
  - Incorporates typical galvanic couples of materials on weapon systems
  - These materials typically are the “business end” of where corrosion is occurring, not large “open” areas
  - Simple way to build upon flat panel testing and data
  - This design creates large cathode interface and presents difficult challenge for coatings
  - Beach exposure validation results in 6 to 8 months

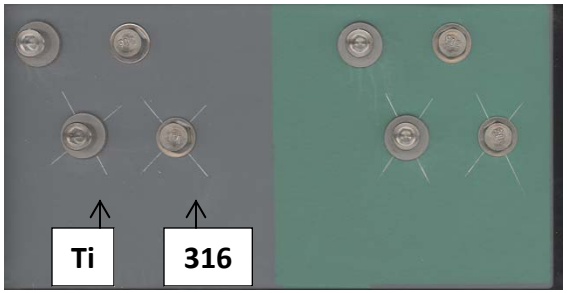
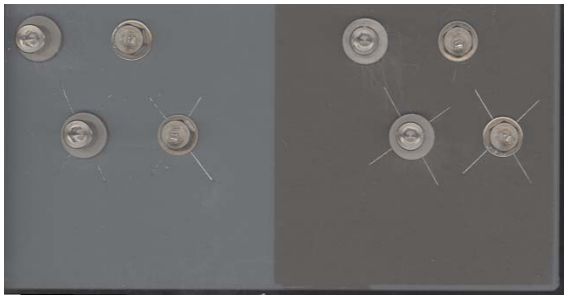
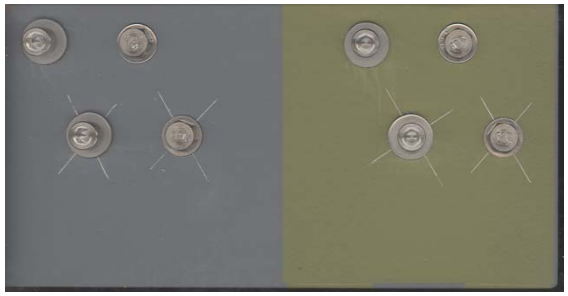
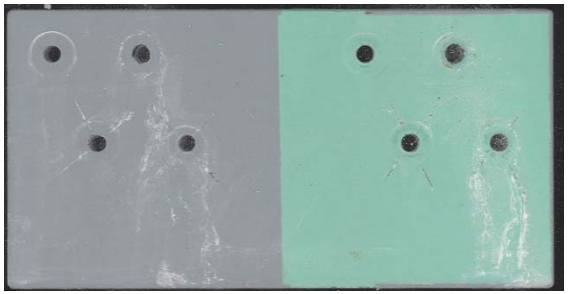
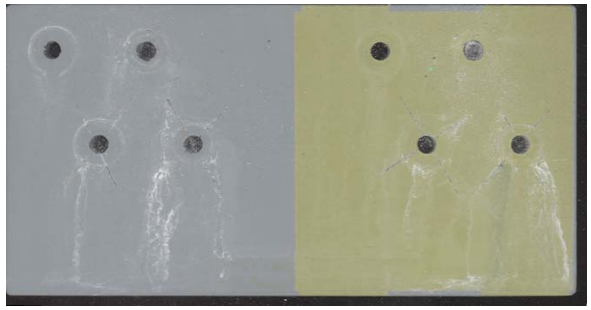
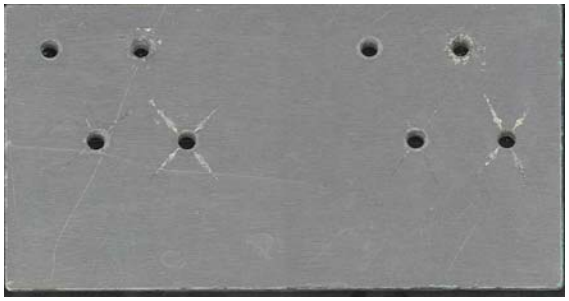
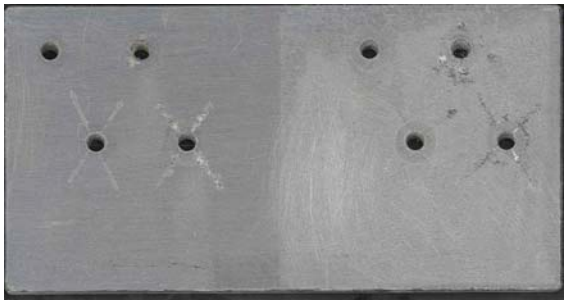


NC Coating Test Parameters on Galvanic Assemblies

- Substrate: 7075-T6 aluminum
- Surface treatments: MIL-DTL-81706 Type I (chromate) and Type II (trivalent chromium), MIL-A-8625 Type IC (boric sulfuric), adhesion promoter, sol-gel adhesion promoter
- Primers: MIL-PRF-23377 Class N, Type I; Metal rich primer; MIL-PRF-23377 Class C, Type I; MIL-PRF-85582 Class N, Type I; MIL-PRF-85582 Class C, Type I; MIL-PRF-85582 Class N, Type II
- Topcoat: MIL-PRF-85285 Type IV- applied over half of each panel
- Fasteners/washers: CRES 316, TiAl6V4
- Fasteners/washers installed “dry” and torqued to 100 inch-lbs after all coatings applied and cured for 14 days at ambient lab conditions
- Panels set at approximately 30 degrees in test chambers
- Corrosion tests: ASTM B117 (3 weeks), ASTM G85 Annex 4 (SO_2) (2 weeks), beachfront at Kennedy Space Center corrosion test site (6-8 months)

Primer/Topcoat over Type I Conversion Coating (chromated)

-after 3 Weeks in ASTM B117

	MIL-PRF-23377 Class N	Metal-rich primer	MIL-PRF-23377 Class C
As Painted and assembled			
After 3 weeks B117- fasteners removed			
After 3 weeks B117- Coatings removed			

Primer/Topcoat over Type I Conversion Coating (chromated)

-after 3 Weeks in ASTM B117

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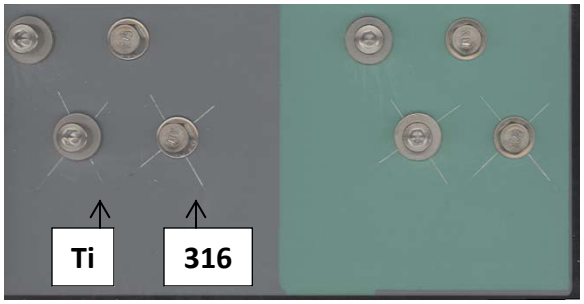
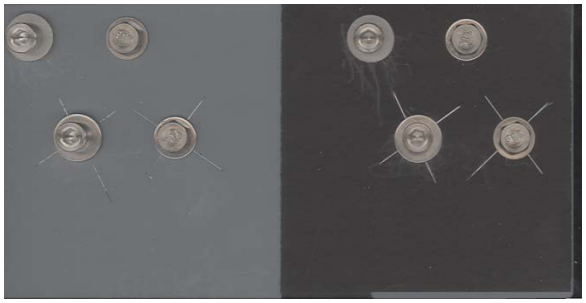
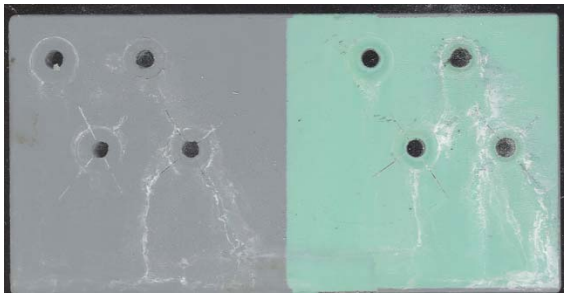
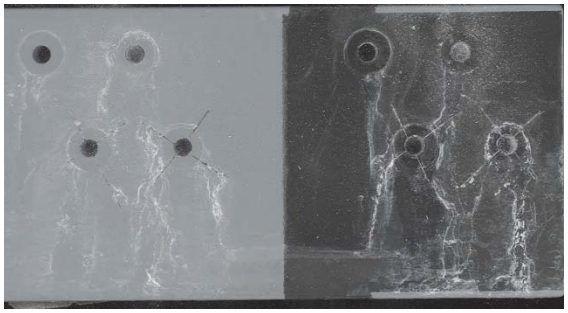
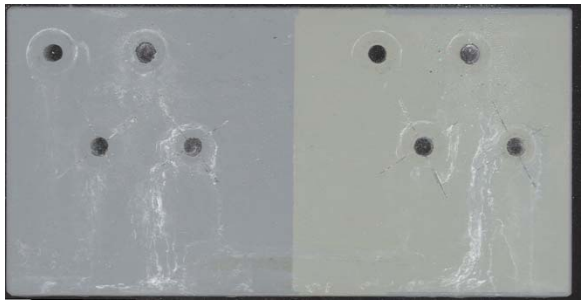
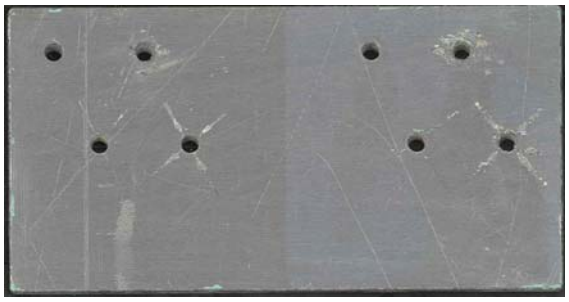
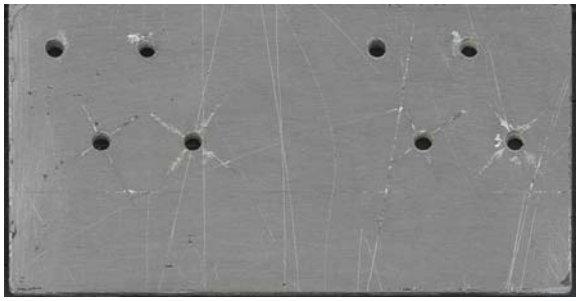
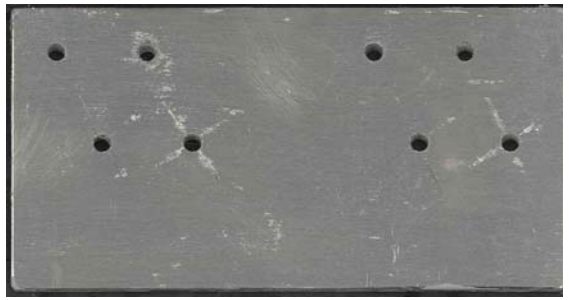
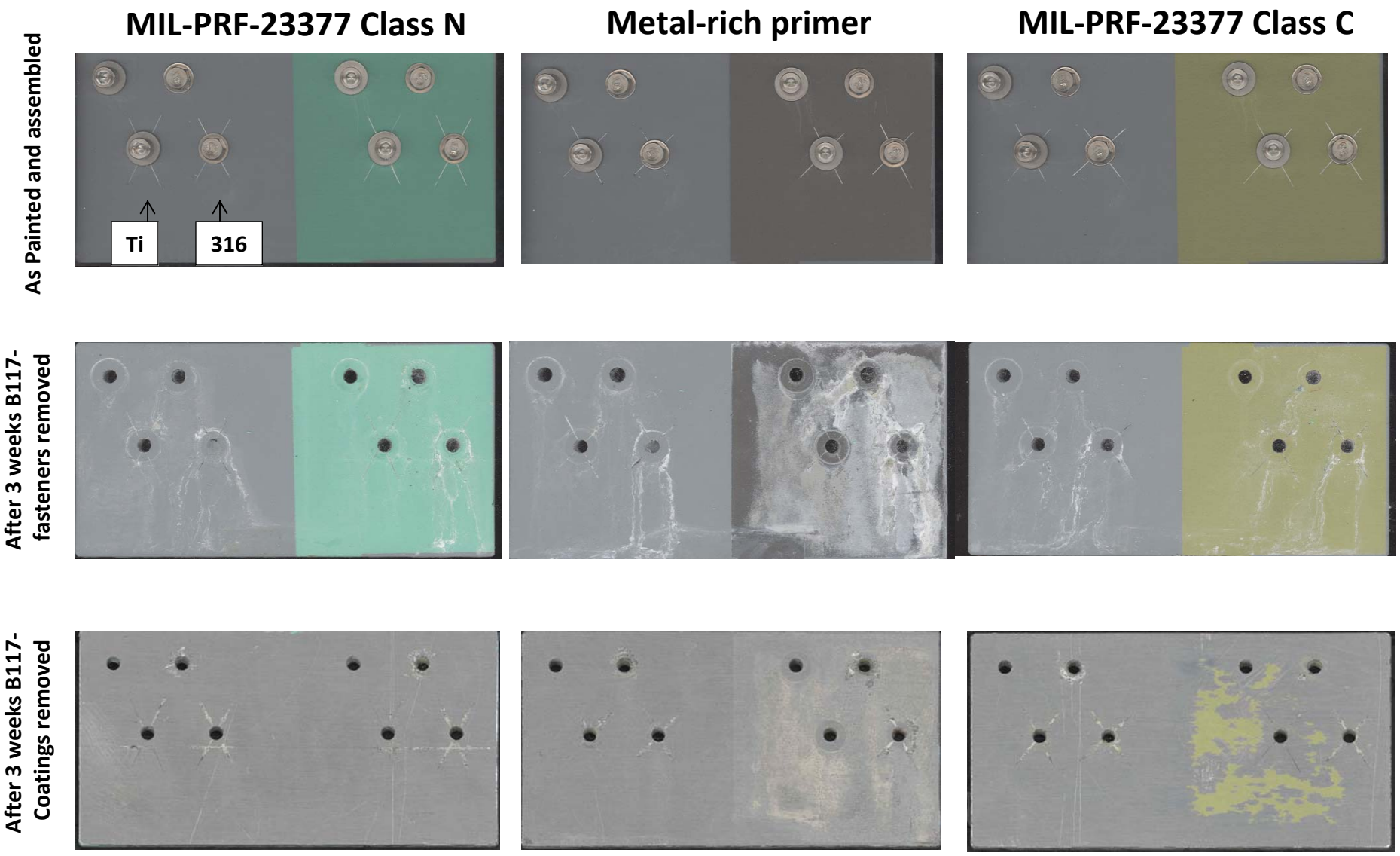
As Painted and assembled			
After 3 weeks B117- fasteners removed			
After 3 weeks B117- Coatings removed			

Primer/Topcoat over Type II Conversion Coating (tri-chrome)

-after 3 Weeks in ASTM B117



Primer/Topcoat over Type IC Anodize

-after 3 Weeks in ASTM B117

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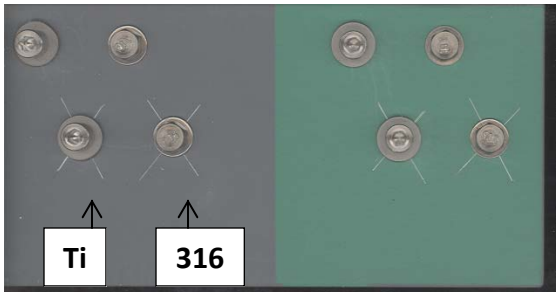
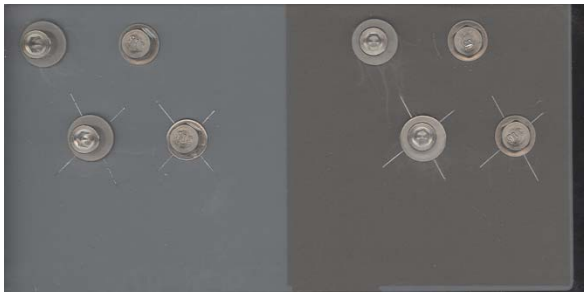
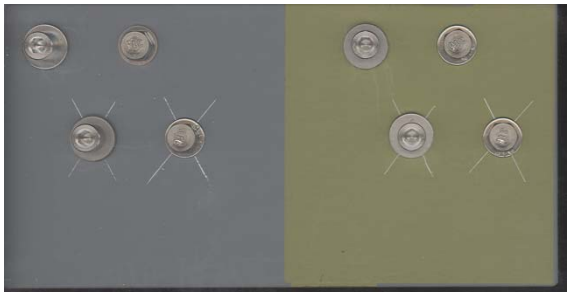
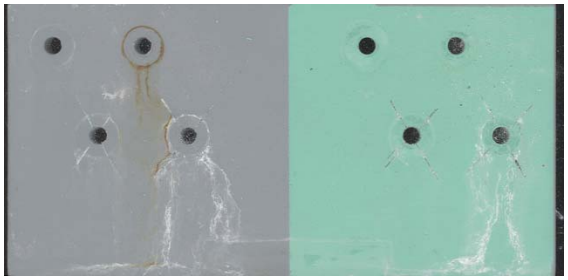
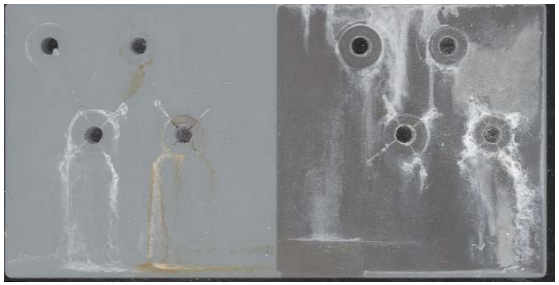
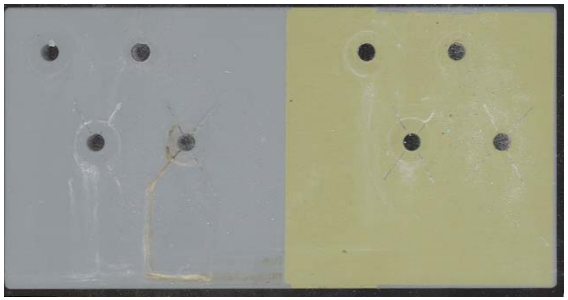
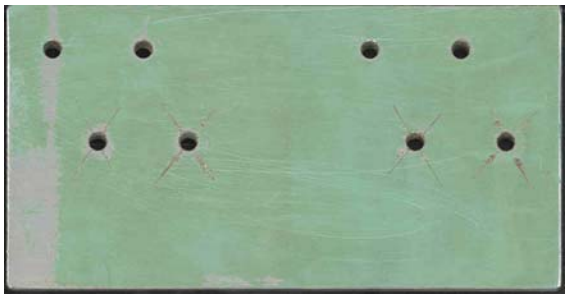
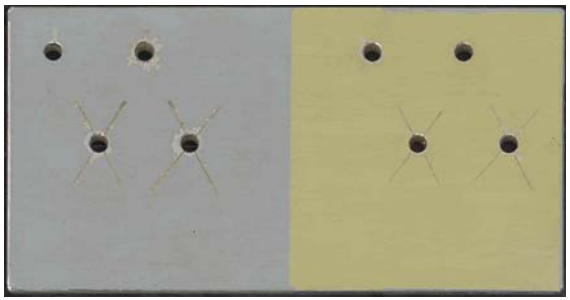
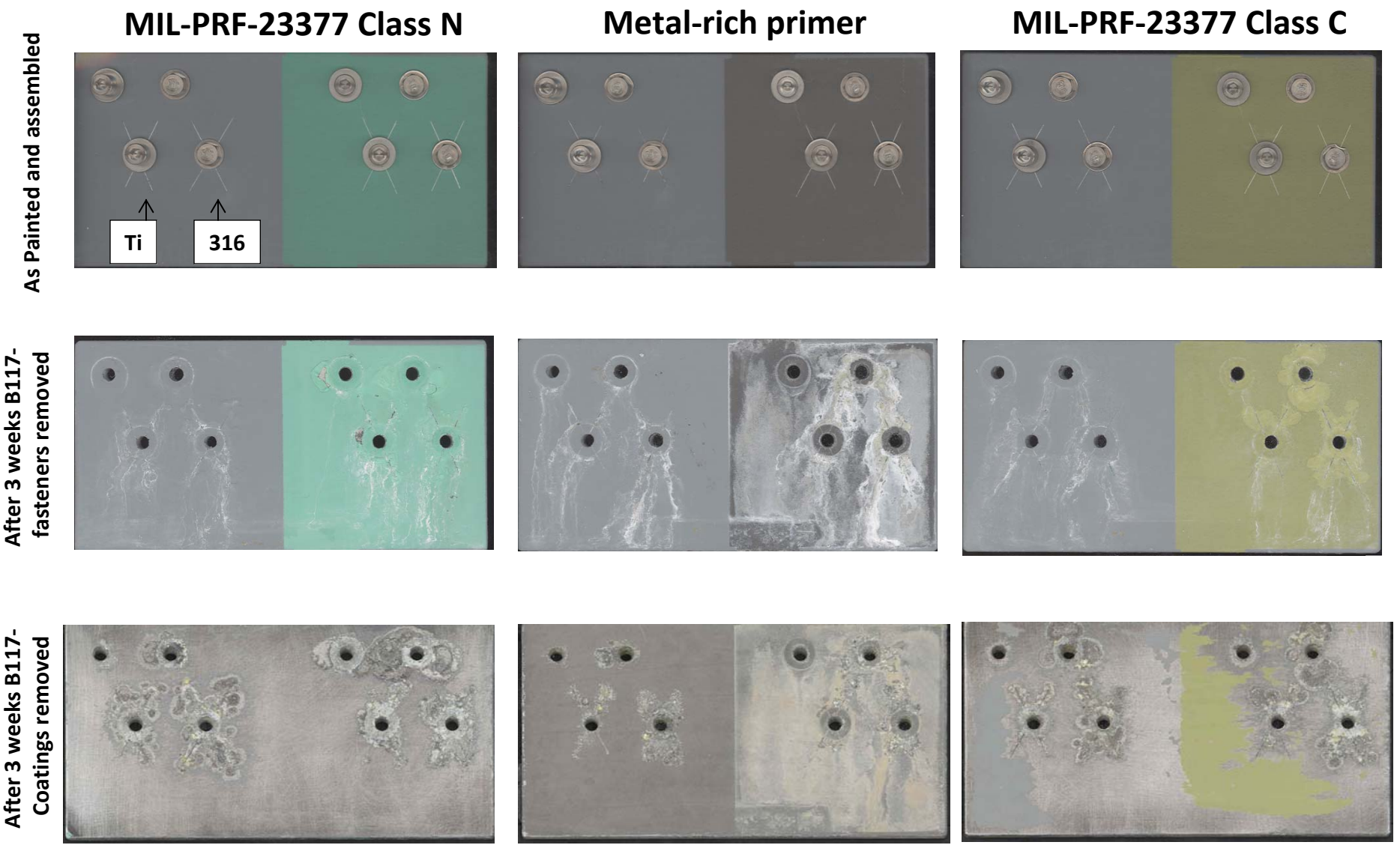
As Painted and assembled			
After 3 weeks B117- fasteners removed			
After 3 weeks B117- Coatings removed			

Primer/Topcoat over Adhesion Promoter

-after 3 Weeks in ASTM B117



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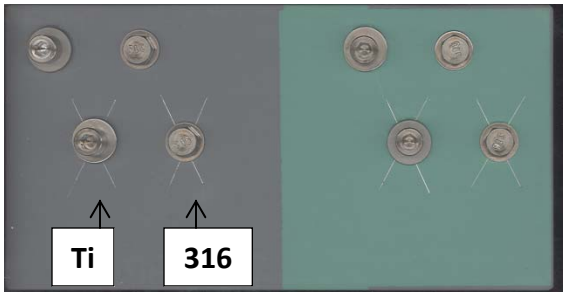
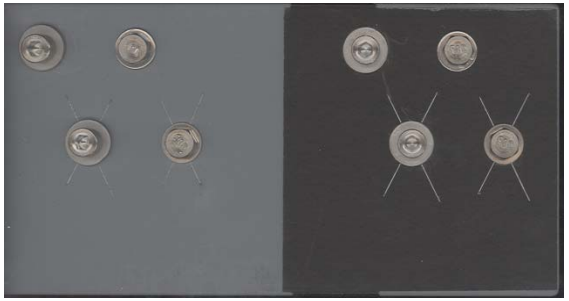
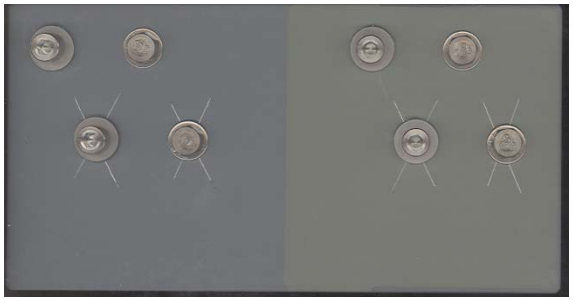
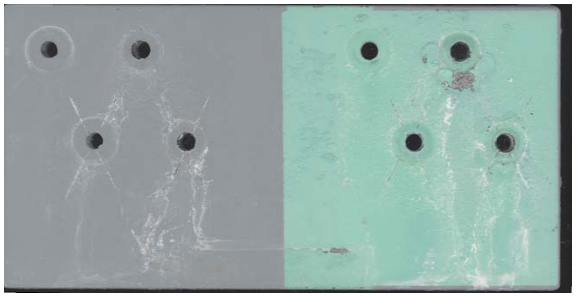
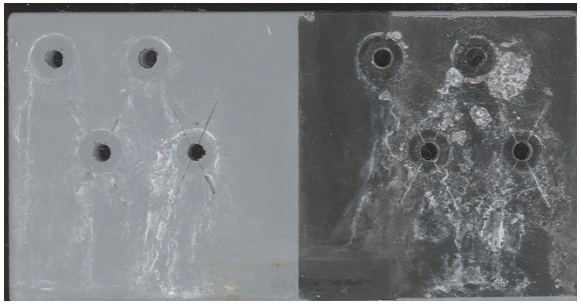
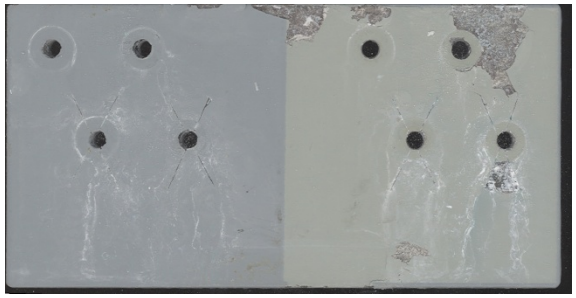
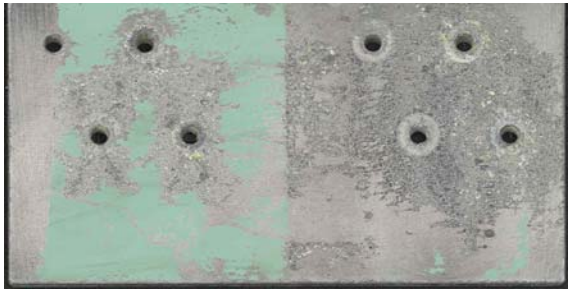
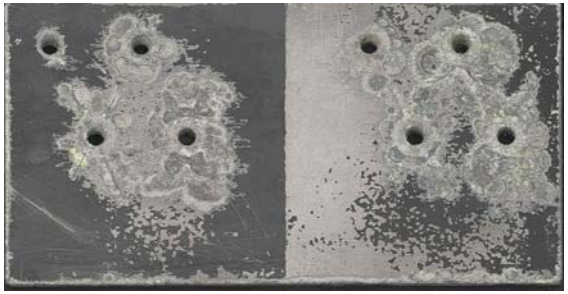
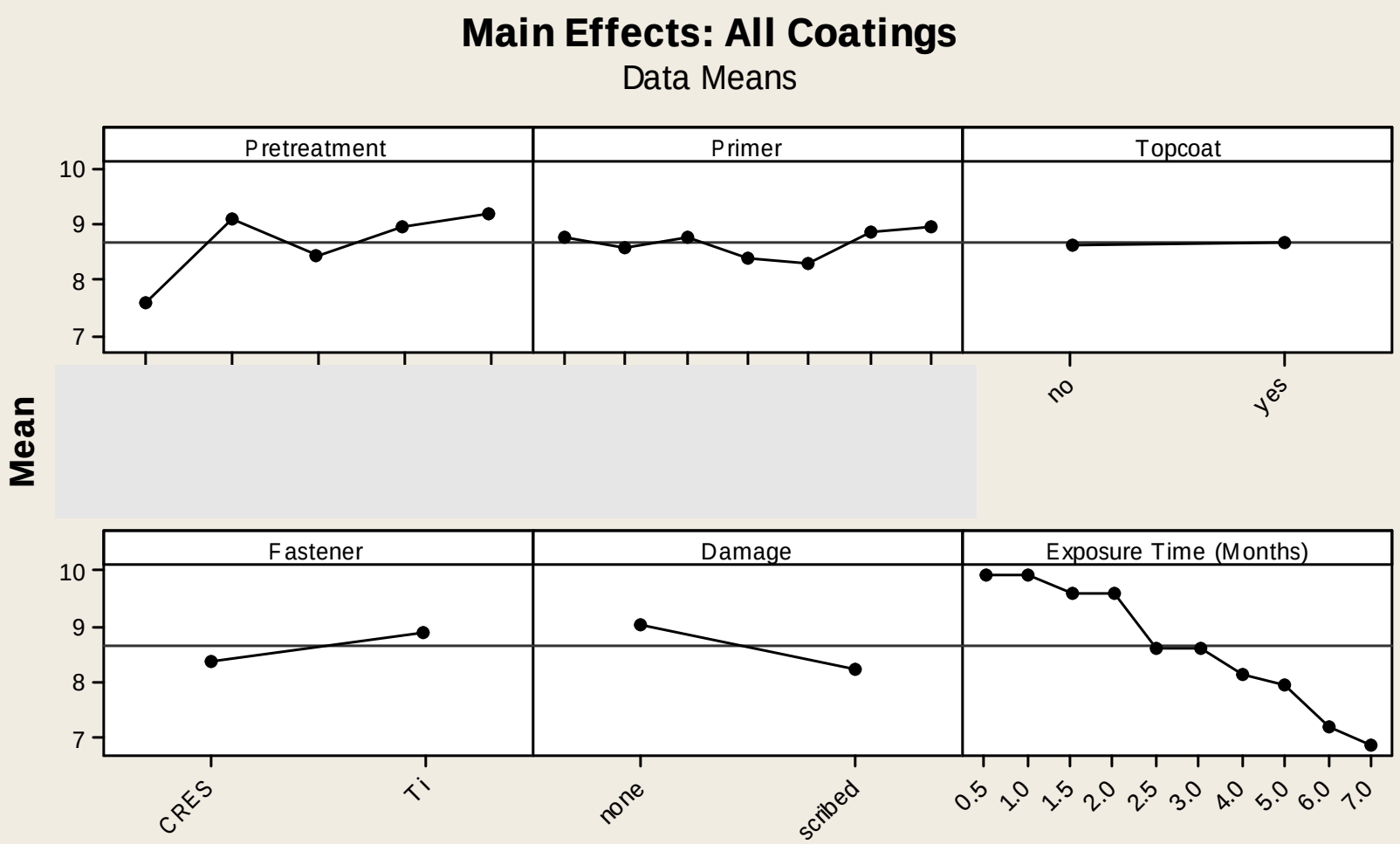
As Painted and assembled			
After 3 weeks B117- fasteners removed			
After 3 weeks B117- Coatings removed			

Recent Test Results- 7 month Beach Exposure of Galvanic Assemblies



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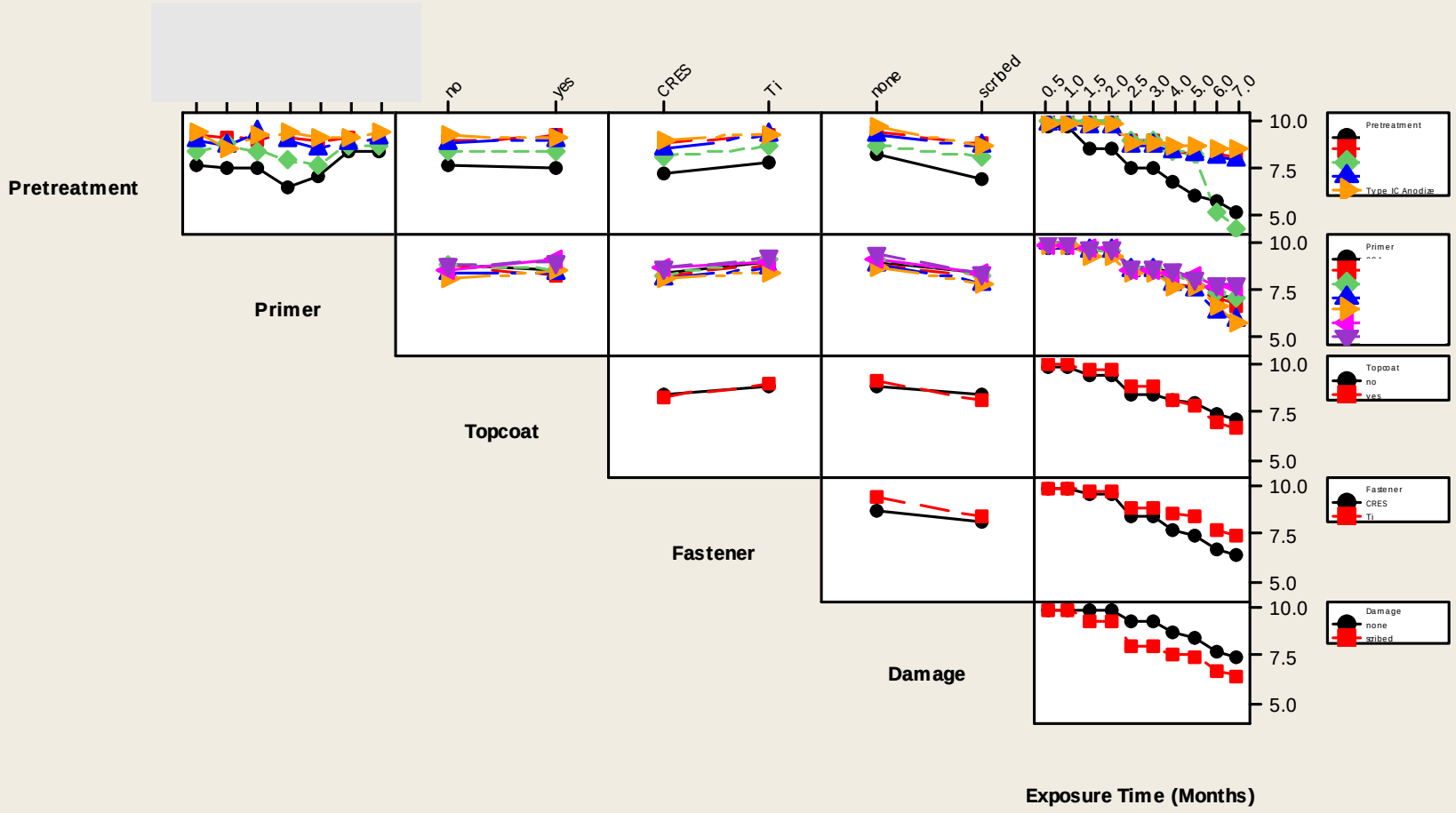
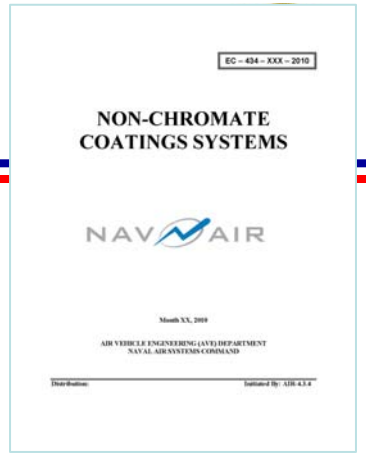


Next Step for Galvanic Assembly Use

- Complete current NC coatings assessment and document results
- Plan and execute similar assessment for Type II primers (as part of ESTCP NC primer porject)
- Review data to see if there is a clear, useable requirement which could be established for corrosion resistance
- Use data to support
  - Potential incorporation in coating specifications
  - Education on value of passivating surfaces properly
  - Improved galvanic materials selection in design
  - New ways to make current materials less aggressive, i.e. low temp carburization as way to stabilize 316 CRES

Non-chromate Coatings Engineering Circular


EC – 434 – XXX – 2010

NON-CHROMATE COATINGS SYSTEMS

NAVAIR

Month XX, 2010

AIR VEHICLE ENGINEERING (AVE) DEPARTMENT
NAVAL AIR SYSTEMS COMMAND

Distribution: Initiated By: AIR 4.3.4

XX Date 2010 EC-434-xxx-2010

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Risk Analysis for Implementation of Non-Chromate Technology

Probability of Failure for Non-Chromate Technology vs. Chromate*	Impact of Non-Chromate Technology Failure			
	Mishap, Replacement	Reduced Service Life, High Repair Costs	Increased Maintenance Activities	Negligible
High				
Medium				
Low				
Same as Chromate				

* Probability of failure of non-chromate technology based on sufficient laboratory testing, comparison to current chromate technology for a particular application, and AIR-4.3.4 endorsement.

High Risk	Critical Application Areas should be avoided until test data supports lowering risk level. Ex. Critical Safety Items (CSI), susceptible to stress corrosion cracking (SCC), high cost for repair, inaccessible areas, etc. **
Medium Risk	Application Areas that need careful consideration and review based on test data. Ex. outer-mold-line, inner-mold line, faying surfaces, direct to metal, metal-to-composite contact, etc. **
Low Risk	Non-Critical Application Areas suitable for Dem-Val/Implementation based on test data. Ex. composites without metallic contact, fiberglass, low impact - low cost components

** Note: Factors such as platform/component operational environment and inspection intervals must be considered and may justify adjustment to the risk analysis level. Ex. Trainer aircraft operate in a less severe environment than ship based aircraft.

NAVAIR Transition Strategy

- Engage all relevant levels and user communities –
  - Military & Commercial OEM's
  - Depot/Manufacturing Sites
  - Industry Partners, Chemical Manufacturers
  - O-level activities
  - Research & Development, Demonstration/Validation, Specifications, Technology Transition
- Implementation Path –
  - Lab validation – process and product performance
  - Field validation – process and product performance
- Risk Analysis & Mitigation – Application Axis vs. Platform/Basing Axis

Non-chromate Coatings Test Protocol

ESTABLISH STANDARD PRACTICE – Minimize or eliminate false positives and negatives in accelerated testing

- Use AA2024-T3 and AA7075-T6 aluminum panels. Use 1 sacrificial coating plated over high strength steel, such as IVD-Al/4340. Use standard 1018/1020 LC steel panels.
- Accelerated Test: ASTM B 117 Neutral Salt Spray, ASTM G 85 Annex 4 Acidified SO2 Salt Spray, and GM9540P Cyclic Corrosion, and ASTM D 2803 Filiform Corrosion Resistance.
  - Run beyond the normal "minimum" specification requirements – 3000 hours in ASTM B 117, 1000 hours in ASTM G85 Annex 4, 120 cycles in GM9540P, and 2000 hours in ASTM D 2803.
- 1+ year minimum beach exposure test – at a facility with a documented salt-laden, corrosive local environment, such as the Kennedy Space Center corrosion test facility.
- Evaluate coatings in faying surface and fastener dissimilar metal couples, as well as with any specialty coatings, always with a known chromate control.
- Test all non-chromate primers in conjunction with currently authorized and promising non-chromate metal finishing technologies, i.e. MIL-DTL-81706, MIL-A-8625, TT-C-490, MIL-DTL-84388, etc.
- Evaluate alternatives with and without topcoat and with simulated damage (scribes) through the coating systems.
- As improved corrosion test methods become available, combine the test protocol with improved accelerated exposures.
- Test in faying surface and fastener dissimilar metal couples
- Evaluate compatibility with composites substrates, ceramics, and other electroplated/mechanically deposited coatings