

Magnesium-Rich Coatings

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ASETS Denver, CO
1-3 September, 2009



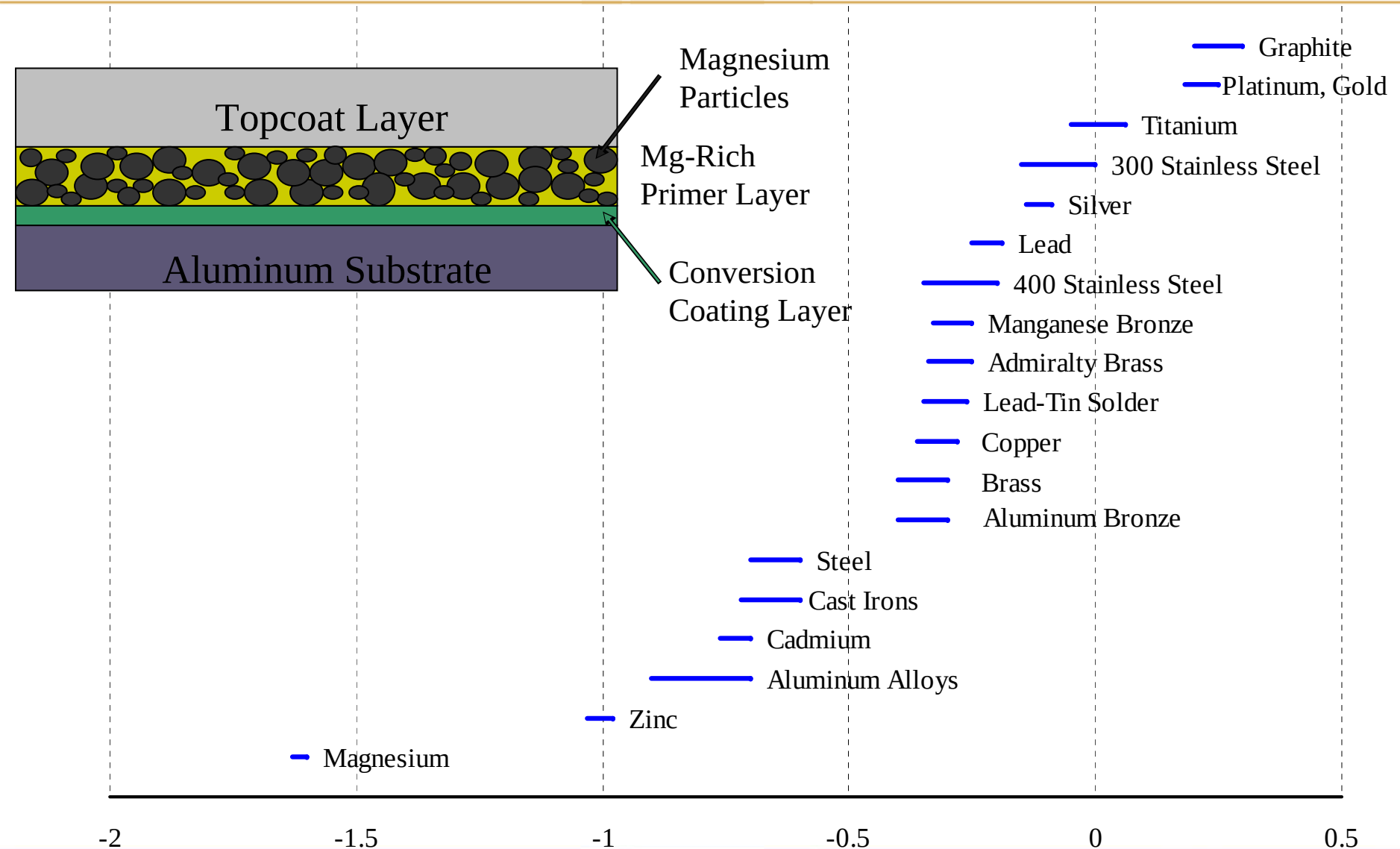
Report Documentation Page				Form Approved OMB No. 0704-0188	
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1. REPORT DATE SEP 2009		2. REPORT TYPE		3. DATES COVERED 00-00-2009 to 00-00-2009	
4. TITLE AND SUBTITLE Magnesium-Rich Coatings				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Air Warfare Center, Materials Engineering Division, 22347 Cedar Point Road, Patuxent River, MD, 20670				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES ASETSDefense 2009: Sustainable Surface Engineering for Aerospace and Defense Workshop, August 31 - September 3, 2009, Westminster, CO. Sponsored by SERDP/ESTCP.					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Same as Report (SAR)	18. NUMBER OF PAGES 30	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

Introduction

- Hexavalent chromium compounds (chromates)
 - “Gold” standard in corrosion prevention
 - Regulatory, environmental and health issues
- Hexavalent chromium elimination efforts
 - Can simplify paint/depaint, decrease the cost
 - Have led to increased corrosion failures
- Much work has been done on chromate-free protection systems
 - No non-chromated primer equivalent performance



Introduction



Test Plan

- Substrates
 - AA2024-T3
 - AA7075-T6
 - AA2219-T87
 - AA2024 Al clad
- Primers
 - Mg-Rich (Multiple Formulations)
 - MIL-PRF-23377 Class C2
 - MIL-PRF-23377 Class N
 - MIL-PRF-85582 Class N
- Conversion Coatings
 - MIL-DTL-81706 Type I
 - MIL-DTL-81706 Type II
 - None (Scotchbrite™ abraded)
- Tests
 - Beach-Front Exposure
 - Salt Fog Exposure
 - Filiform Corrosion



Beach-Front Testing



Kennedy Space Center
Beach Corrosion Test Site
100 feet from mean high-tide
Panels racked 30° from horizontal



Accelerated Testing

ASTM Standard Test Methods

B 117: Neutral Salt Fog

G 85, Annex 4: SO₂ Salt Fog



Accelerated Testing

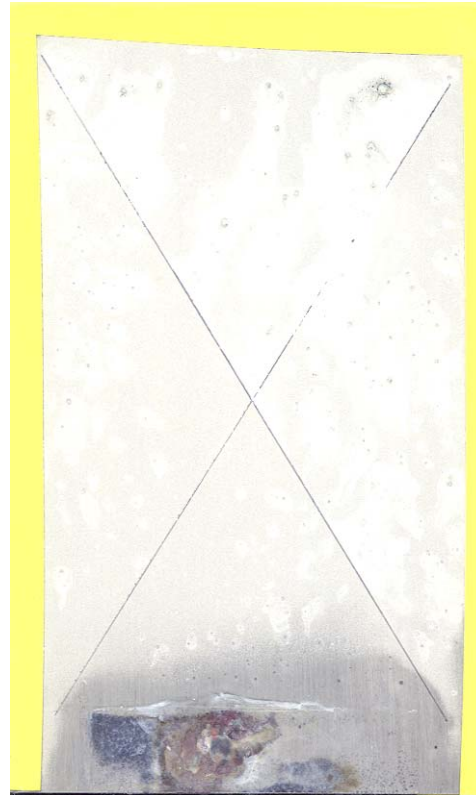


First Generation Test Results

AA2024-T3 (4000 hours B117) – MgRich Primer-only



MIL-DTL-81706 Type I –
Alodine 1200S



No Chemical Pretreatment
Scotchbrite Abrade

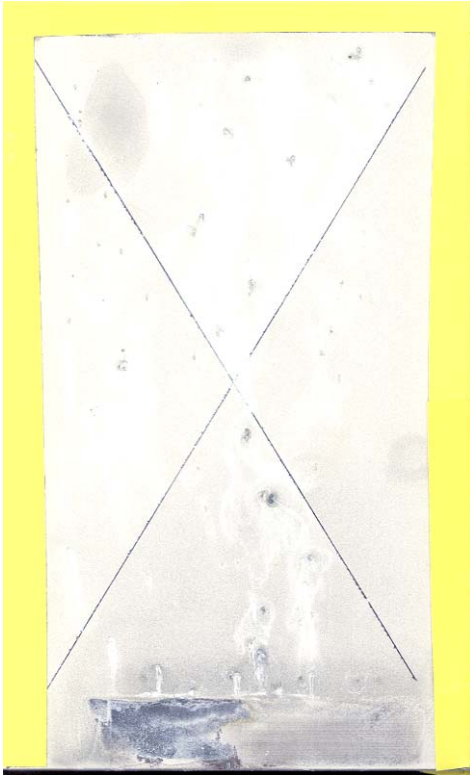


MIL-DTL-81706 Type II –
Alodine T5900

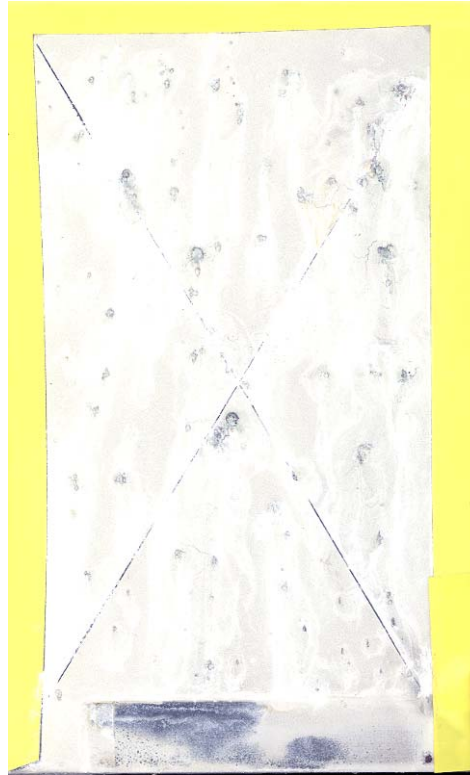


First Generation Test Results

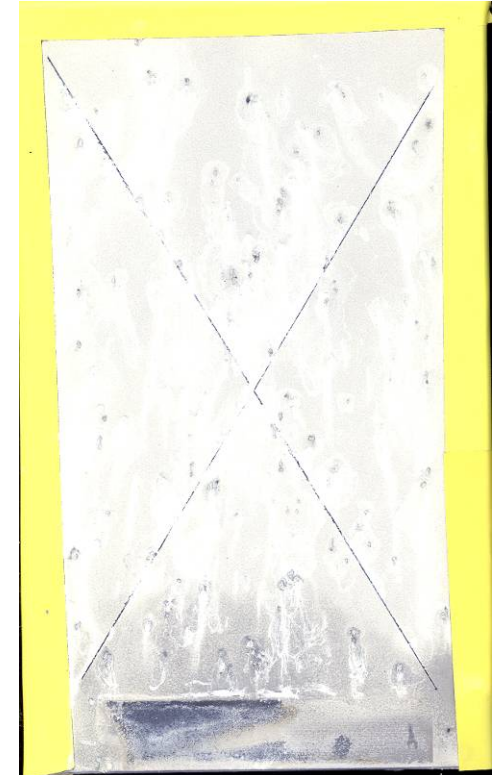
AA2219-T87 (4000 hours B117) – MgRich Primer-only



MIL-DTL-81706 Type I –
Alodine 1200S



No Chemical Pretreatment
Scotchbrite Abrade



MIL-DTL-81706 Type II –
Alodine T5900



First Generation Test Results

AA2024-T3 (1200 hours G85 A4) – MgRich Primer-only



MIL-DTL-81706 Type I –
Alodine 1200S



No Chemical Pretreatment
Scotchbrite Abrade



MIL-DTL-81706 Type II –
Alodine T5900



Second Generation Test Results

AA2024-T3 (1200 hours G85 A4) – MgRich Primer-only

Gen 1



MIL-DTL-81706 Type I –
Alodine 1200S

Gen 2



MIL-DTL-81706 Type I –
Alodine 1200S

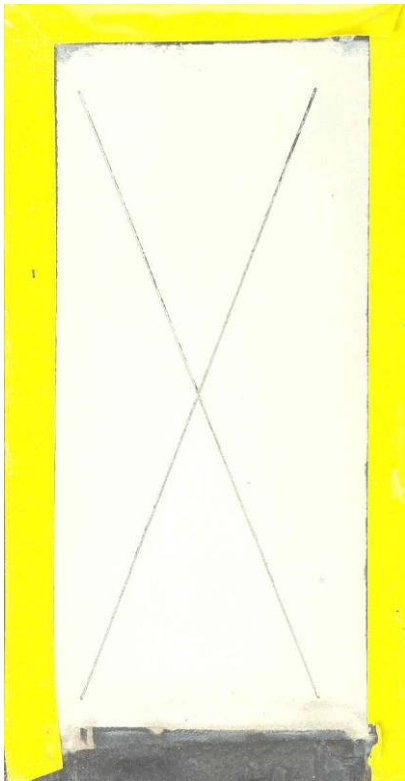


Second Generation Test Results

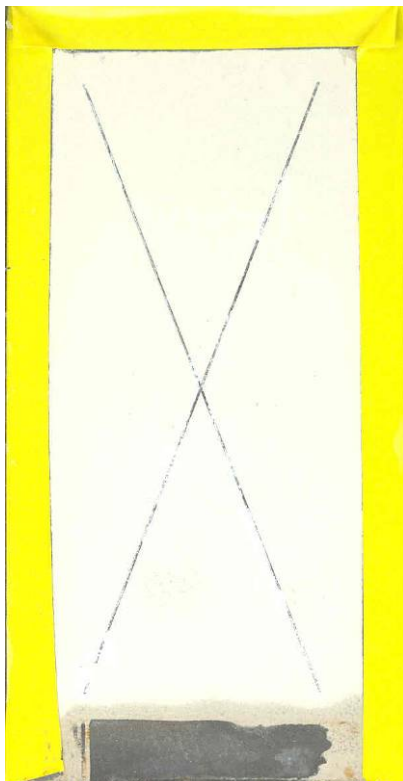
Primer-only panels (5000 hours B117)

Mg-Rich Primer

AA2024-T3

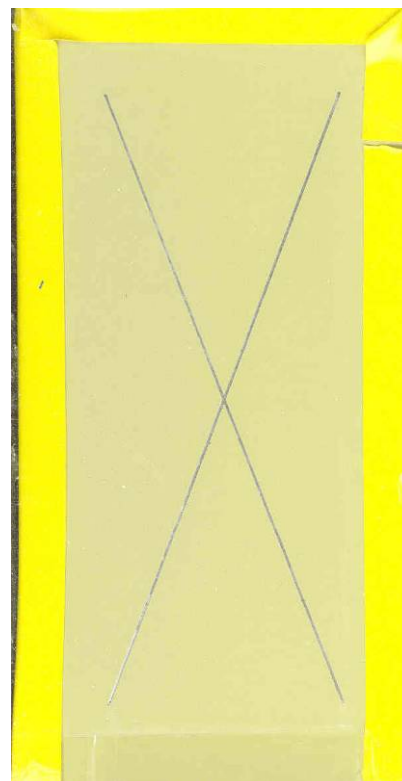


AA7075-T6

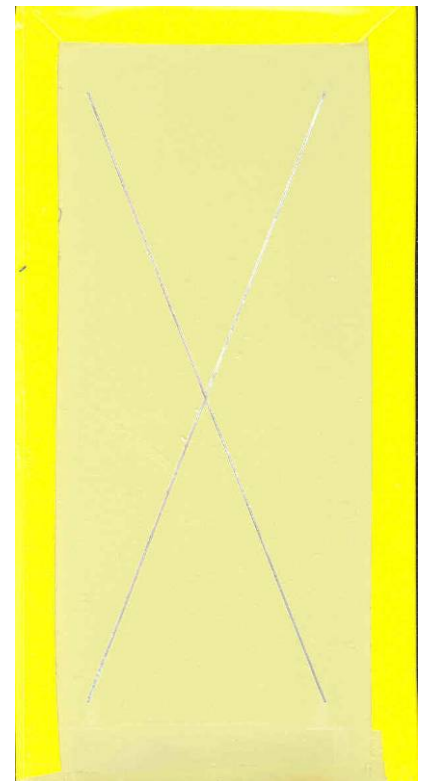


MIL-PRF-23377, Class C2

AA2024-T3



AA7075-T6



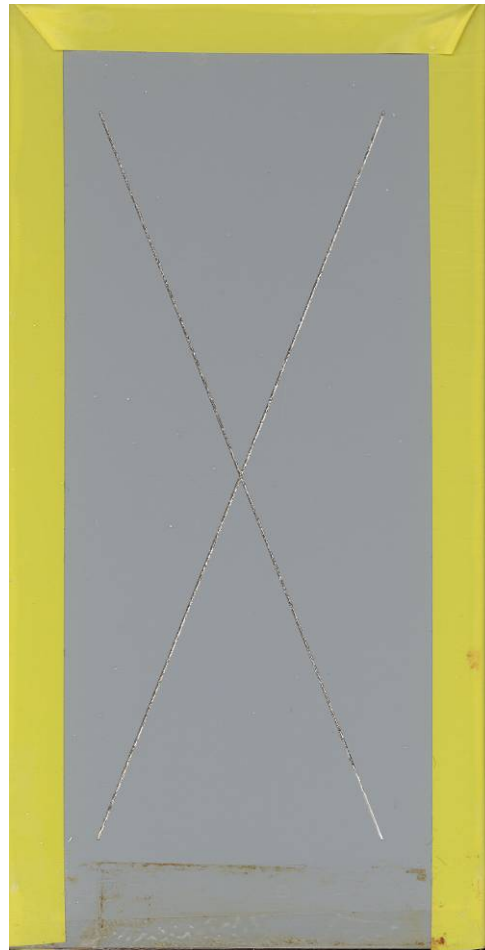
Second Generation Test Results

MIL-PRF-85285 topcoated Mg-Rich panels (ASTM B117)

AA2024-T3



AA7075-T6



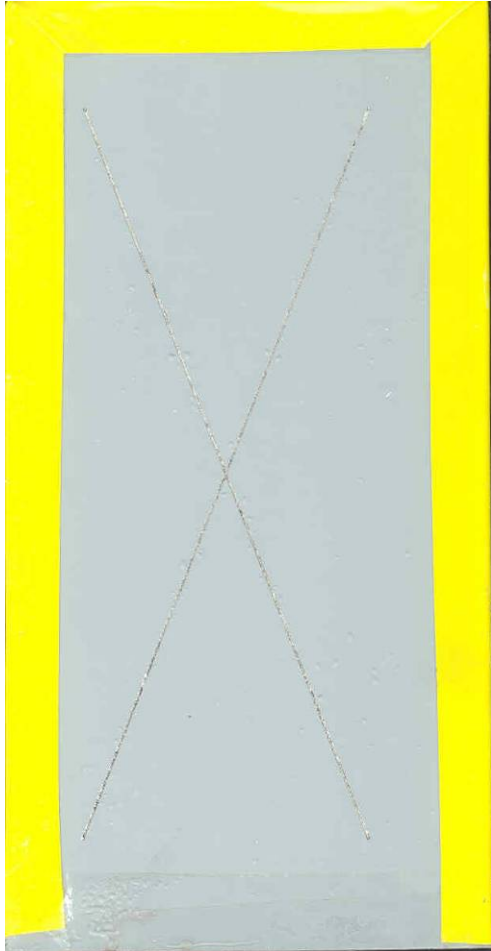
1 Week
(170 hours)



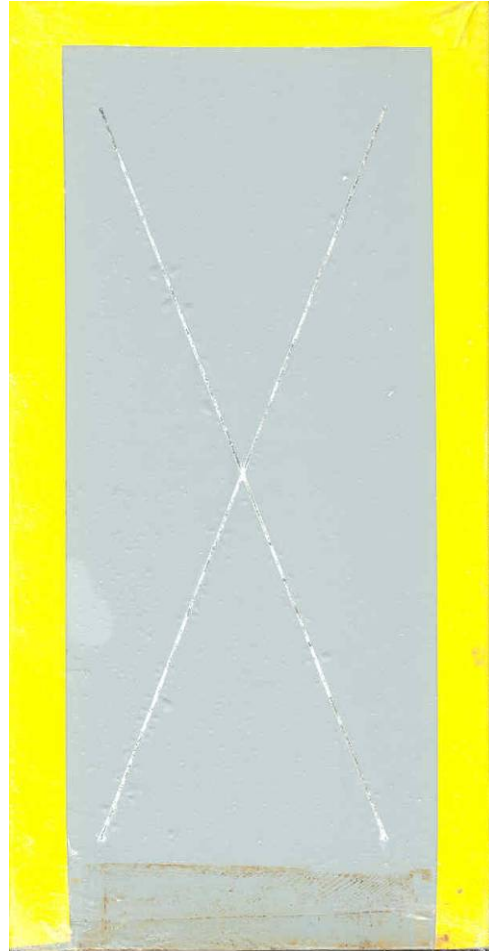
Second Generation Test Results

MIL-PRF-85285 topcoated Mg-Rich panels (ASTM B117)

AA2024-T3



AA7075-T6



12 Weeks
(2000 hours)



Second Generation Test Results

MIL-PRF-85285 topcoated Mg-Rich panels (ASTM B117)

AA2024-T3



AA7075-T6



30 Weeks
(5000 hours)



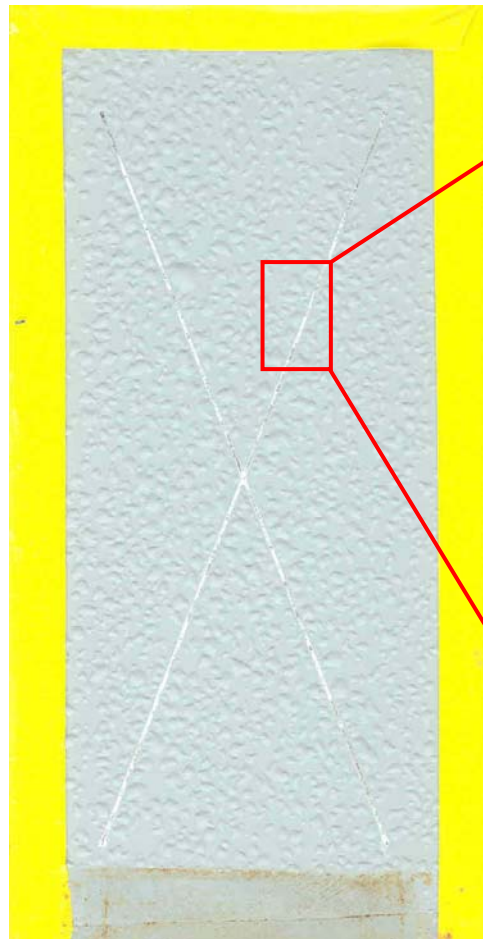
Second Generation Test Results

MIL-PRF-85285 topcoated Mg-Rich panels (ASTM B117)

AA2024-T3



AA7075-T6



Second Generation Test Results

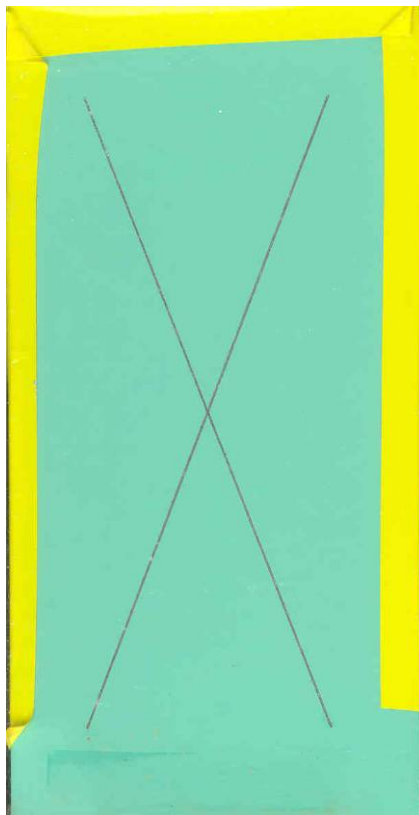
AA7075-T6 (336 hours G85 A4) – MgRich Primer-only

MIL-DTL-81706 Type II

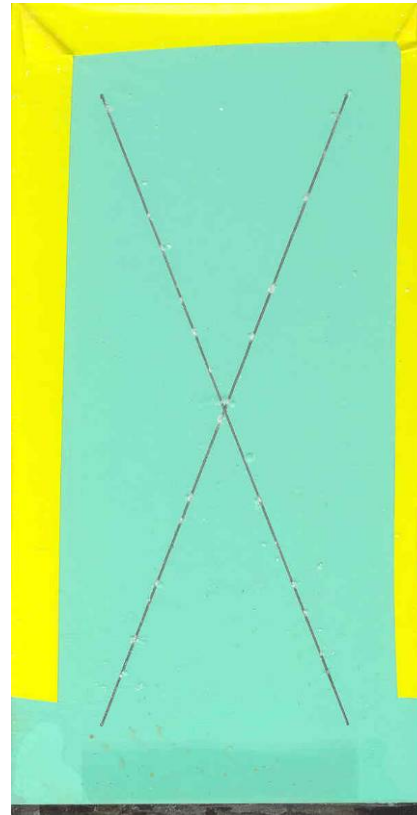
Mg-Rich Primer



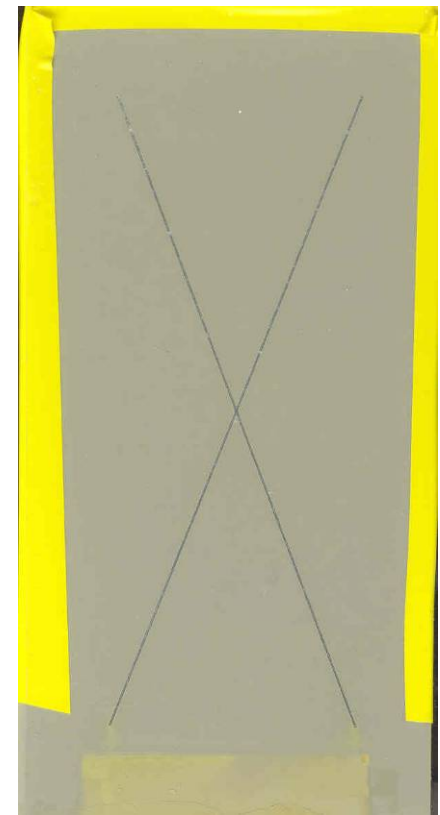
MIL-PRF-23377 Class N



MIL-PRF-85582 Class N



MIL-PRF-23377 Class C2



Second Generation Test Results

AA7075-T6 (1500 hours G85 A4) – MgRich Primer-only

MIL-DTL-81706 Type II

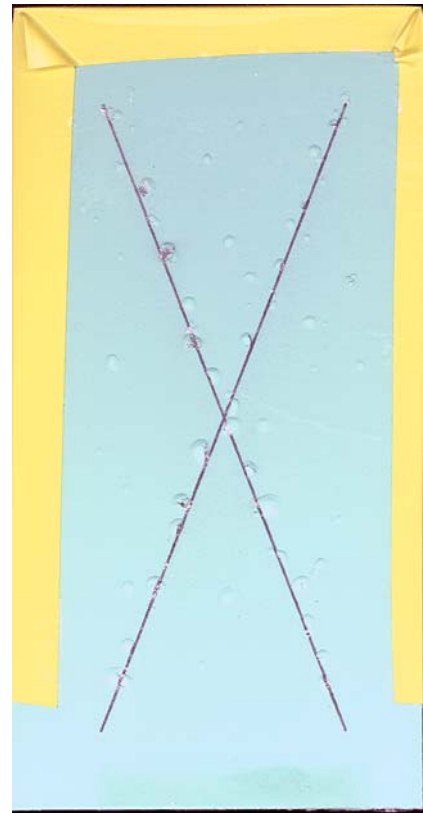
Mg-Rich Primer



MIL-PRF-23377 Class N



MIL-PRF-85582 Class N

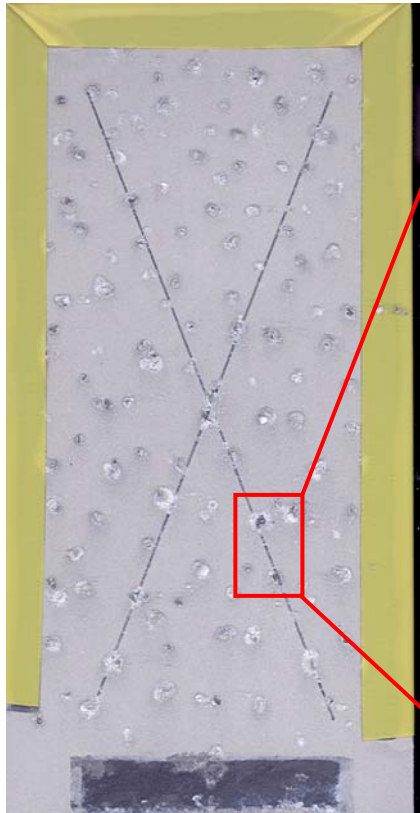


MIL-PRF-23377 Class C2



Second Generation Test Results

Mg-Rich Primer



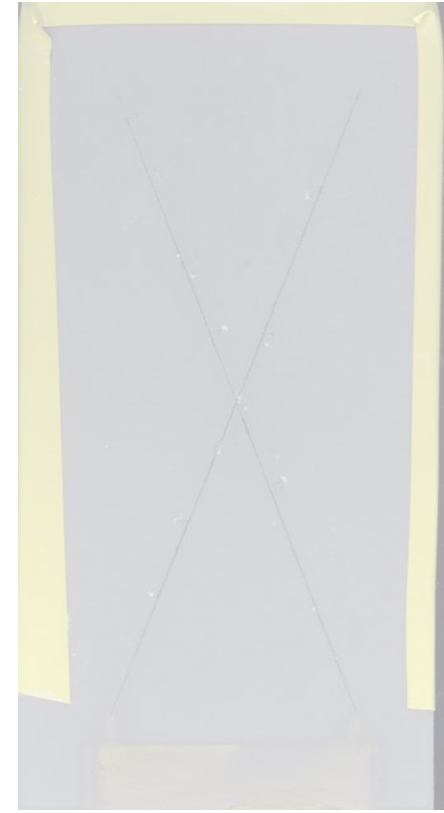
Normal



82 Class N
m Primer



MIL-PRF-23377 Class C2
Hexavalent Chromium Primer



Second Generation Test Results

MIL-PRF-85285, (1500 hours G85 A4)

MIL-DTL-81706 Type II

Mg-Rich Primer



MIL-PRF-23377 Class N



MIL-PRF-85582 Class N



MIL-PRF-23377 Class C2



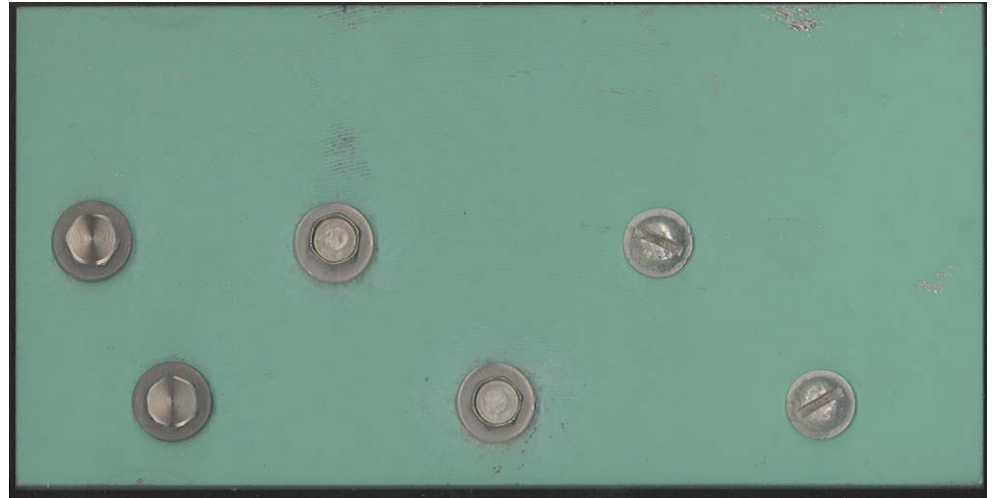
Second Generation Test Results

AA2024-T3 Galvanic panels – Primer-only – 4 month KSC Beach



Mg-Rich Primer

Aluminum test panels with titanium, stainless steel and aluminum bolts.



Class N Control



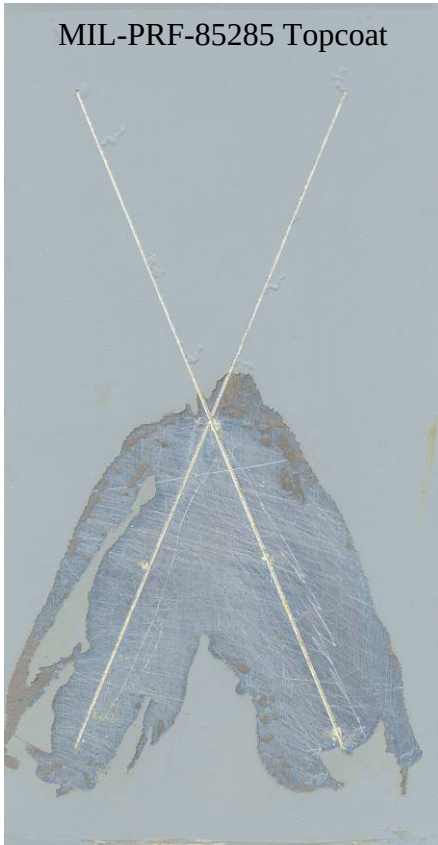


Second Generation Test Results

Filiform corrosion test (1000 hours) – MIL-DTL-81706 Type II

Mg-Rich Primer

MIL-PRF-85285 Topcoat



MIL-DTL-53039 Topcoat

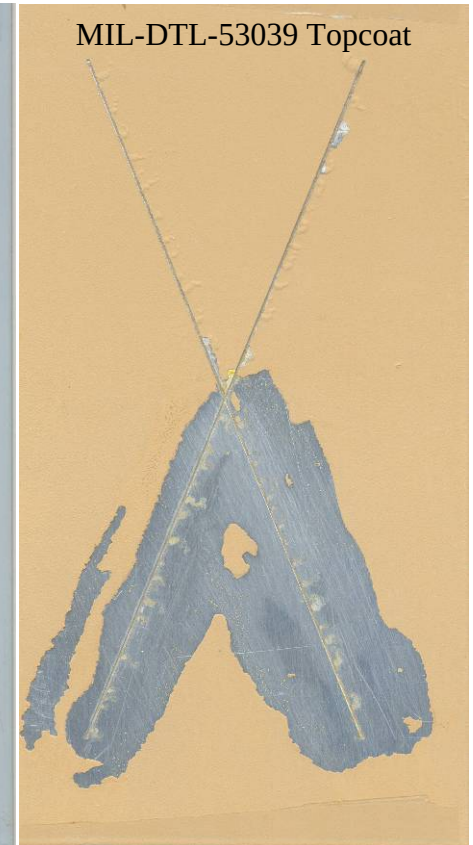


MIL-PRF-23377 Class C2

MIL-PRF-85285 Topcoat



MIL-DTL-53039 Topcoat



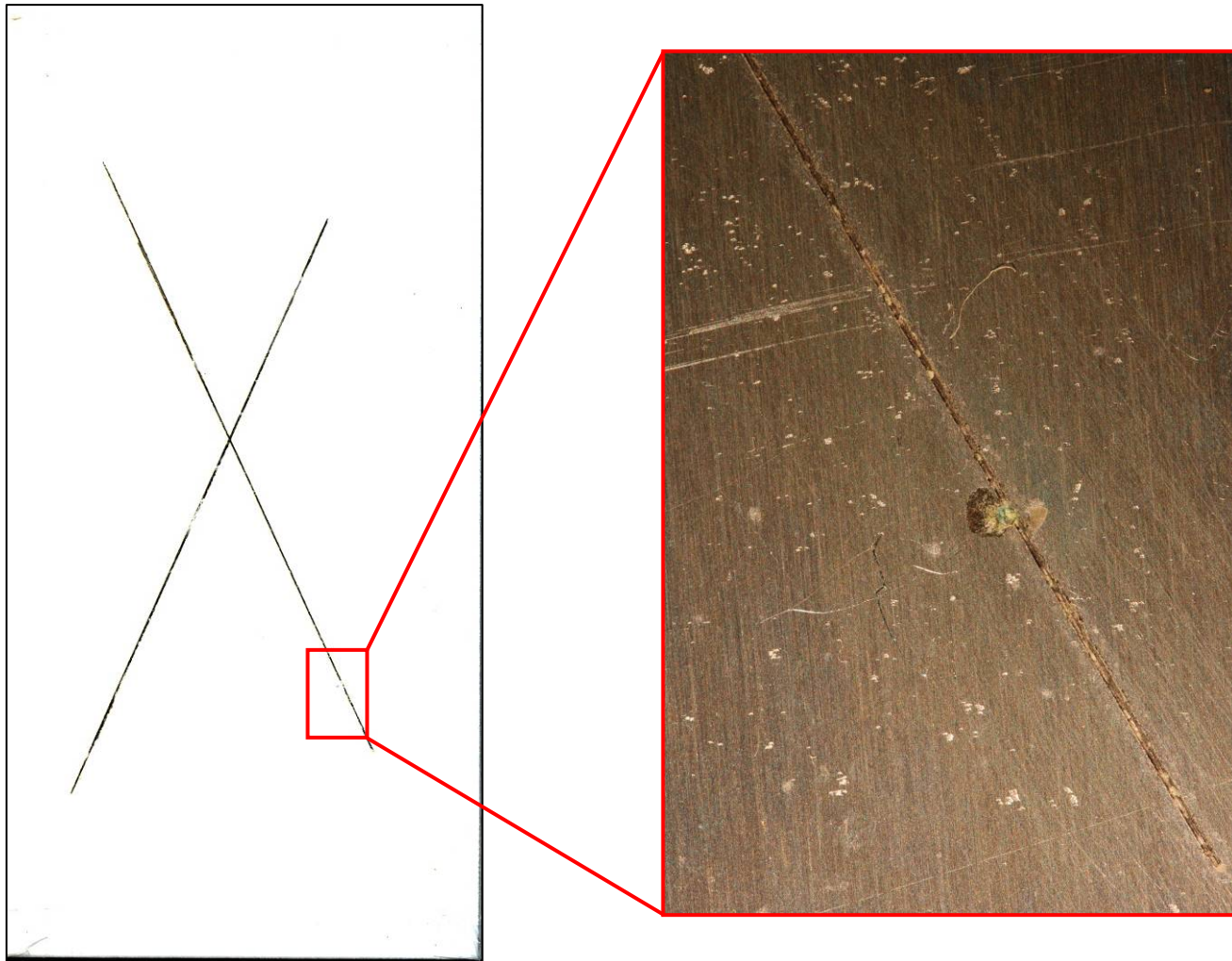
Third Generation Test Results

AA2024-T3 (2000 hours B117) – MgRich Primer-only



Third Generation Test Results

AA2024-T3 (2000 hours B117) – MgRich/MIL-PRF-85285

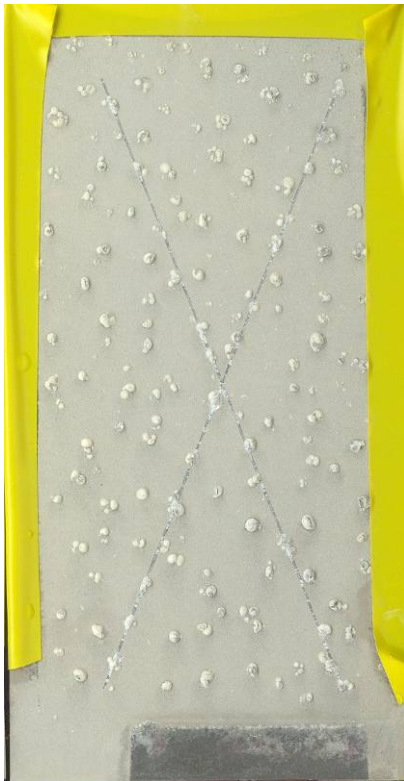


Modifications to Second Generation Mg-Rich

AA7075-T6 (1000 hours G85 A4) – MgRich Primer-only

NAVAIR Non-chromium pretreatment

Second Generation
Mg-Rich



Modification 1



Modification 3

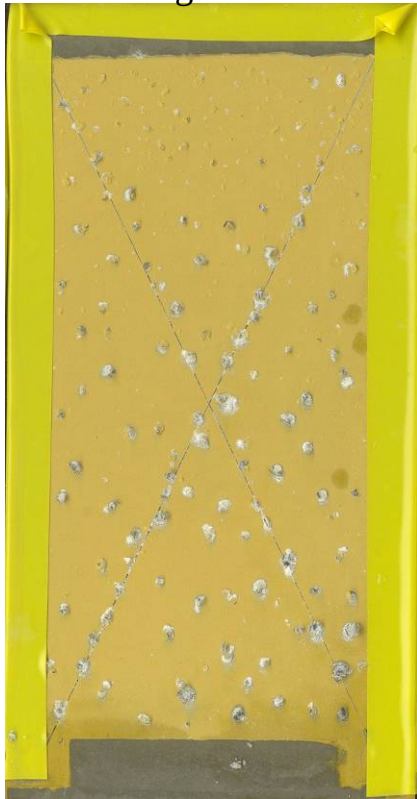


Modifications to Third Generation

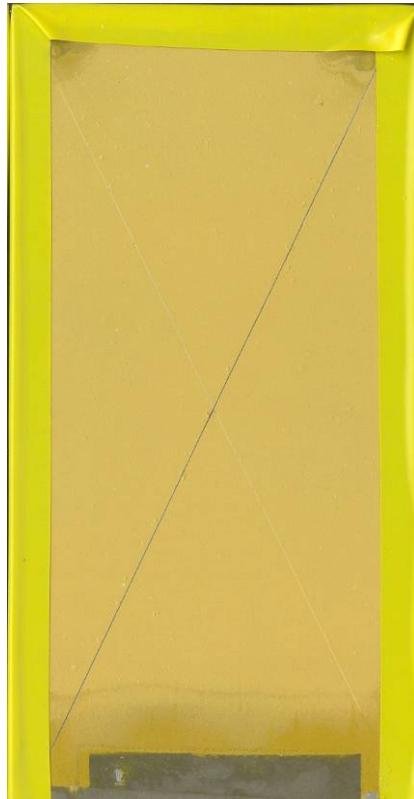
AA7075-T6 (1000 hours G85 A4) – MgRich Primer-only

MIL-DTL-81706 Type II

Third Generation
Mg-Rich



Modification 1



Modification 2



MIL-PRF-23377 Class N



Summary & Conclusions

- No single, universal test for corrosion prevention
 - Multiple alloys, test methods and configurations
- Promising performance – MgRich does well
 - Primer only in neutral salt fog (5000 hours)
 - Topcoated in SO₂ salt fog (1500 hours)
 - Filiform corrosion tests (1000 hours)
- Challenges – MgRich issues not seen with Class N controls
 - Topcoated in neutral salt fog
 - Primer only in SO₂ salt fog
 - Downglossing of High-gloss topcoats
 - Performance degradation on non-2000 series alloys
 - Poor corrosion performance on steel
 - Validation over anodize, Cd, ZnNi, IVD-Al, phosphate, etc.



Summary & Conclusions

- Under certain conditions
 - Mg-Rich primer performs comparably to chromate primers
 - Overall it is not equivalent to chromated OR non-chromated control primers
- Modifications have increased performance over various substrates
 - Fewer ruptures through the coating and blisters
 - Compared to the baseline early generation MgRich primers
 - Fewer blisters and corrosion products in the scribe



Path Forward

- Testing the fourth generation is underway
 - Commercial MgRich product
 - NAVAIR modified MgRich
 - Test Plan
 - Variety of substrates
 - Variety of exposure conditions
 - Beach, ASTM B117, ASTM G85 Annex 4, filliform, galvanic test panels)
 - Go/No-Go Criteria
 - Must be better than the best non-chromate coating system
 - Currently available and transitioned
 - Before implementation will be authorized for Navy and Marine Corps assets



Acknowledgements

Co-Authors:

- Craig Matzdorf
- Bill Nickerson
- Ed Lipnickas

Panel Prep:

- Randy Miller
- Andy Schwartz
- Rachel Naumann
- Alex Everett

Mg-Rich:

- AkzoNobel Aerospace Coatings

Funding:



Environmental Security Technology
Certification Program

