

Implementation Issues for Cr6⁺ Free M&P



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NAVAIR



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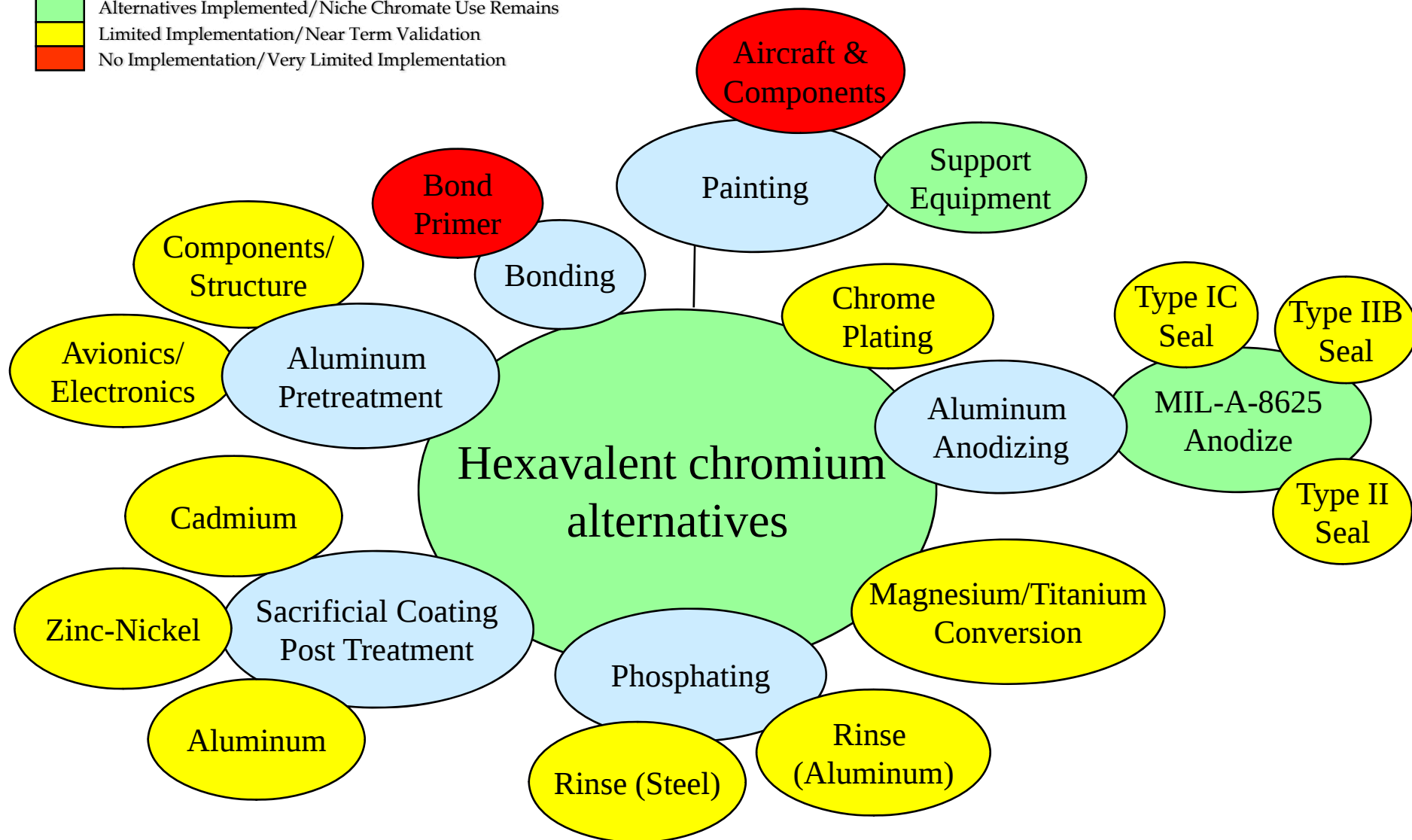
Outline

- **NAVAIR Implementation Status**
- **Non-Chromate Verification and Validation Issues**
- **Proposed Standardized Coating Assessment Method using Current Accelerated Tests**



NAVAIR Application Areas for Hexavalent Chromium Alternatives: Status

-  Alternatives Implemented/Niche Chromate Use Remains
-  Limited Implementation/Near Term Validation
-  No Implementation/Very Limited Implementation



Status of Alternatives at NAVAIR



Alternative Implementation Status					
M&P Area	Sub Area	Location	Process Status	wt vol% of Cr6+ in NAE	% of Cr6+ eliminated
Painting	Support Equipment	Depot and Field	Non-chromate primer in use (MIL-C-53022) for all applications	0	100
	Aircraft and Components	Depot and Field	Non-chromate primer authorized only for scuff sand and overcoat	TBD	TBD
Bonding		Depot and Field	Alternative not authorized	TBD	0
Aluminum Pretreatment	Avionics/Electrical	Depot and Field	Alternative not authorized	TBD	TBD
	Components/Structure	Cherry Point- Aircraft re-paint (spray)	Authorized for use under chromated primer (TCP)	TBD	100
		North Island- Aircraft re-paint (spray)		TBD	0
		Jacksonville- Aircraft re-paint (spray)		TBD	0
		Cherry Point- Component Immersion tanks		TBD	0
		North Island- Component Immersion tanks		TBD	0
		Jacksonville- Component Immersion tanks		TBD	0
		Field		TBD	0
Aluminum Anodizing	Sealing Type II	Cherry Point	Authorization of alternative (TCP) pending final test report	TBD	0
		North Island		TBD	0
		Jacksonville		TBD	0
	Sealing Type IC	Cherry Point	Authorization of alternative (TCP) pending final test report	TBD	0
		North Island		TBD	0
		Jacksonville		TBD	0
	Sealing Type IIB	Cherry Point	Type IIB not authorized currently. Dem/val underway to produce data for potential authorization as Type IC alternate. Being considered by Jacksonville as part of single tank Type II, IIB and III anodize system. Authorization of alternative (TCP) pending final test report	TBD	0
		North Island		TBD	0
		Jacksonville		TBD	0
Sacrificial Coatings	Cadmium Post Treatment	Cherry Point	Authorization of alternative (TCP) pending review of available data	TBD	0
		North Island		TBD	0
		Jacksonville		TBD	0
	IVD Aluminum Conversion	Cherry Point	Authorization of alternative (TCP) pending review of available data	TBD	0
		North Island		TBD	0
		Jacksonville		TBD	0
	Zn-Ni Post Treatment	Cherry Point	Authorization of alternative (TCP) pending review of available data	TBD	0
		Jacksonville		TBD	0
Magnesium Conversion Coating		Cherry Point	Authorization pending for alternative use in component recoating and touch up (Alodine 5700 and TCP)	TBD	TBD
		Field	Authorization pending for alternative use in component coating touch up (Alodine 5700 and TCP)	TBD	TBD
Titanium Conversion Coating		Depot and Field	Alternatives not authorized	TBD	TBD
Phosphating	Steel, "rinse"	North Island	Mn-phosphate process with chromate rinse. New alternative being assessed (ChromiPhos).	TBD	0
		Cherry Point	Zn-phosphate process with chromate rinse. New alternative being assessed (ChromiPhos).	TBD	0

Status of Alternatives

NC Primer Field Demos

- **Primer options:**

- MIL-PRF-85582:
 - **EW DY048A (PPG)**- Good beach testing (5 yrs); probable T-45 transition to non-Cr primer after 2 yr field demo; NI implemented in E2/C2 component paint shop.
 - **44-GN-098 (Deft)**- baseline primer for F-35
- MIL-PRF-23377:
 - **16708TEP (Hentzen)**- Army (AMCOM) implementing at CT AVCRAD. Plan to implement at CCAD in FY08. (all with TCP conversion coating)
 - **02-GN-084 (Deft)**- Air Force F-15 implementation. Army (AMCOM) implementing at CT AVCRAD. Plan to implement at CCAD in FY08. (all with TCP conversion coating)
 - Mg-rich Primer (Akzo)- ESTCP dem/val; more lab and beach testing needed before a/c demo

- **Field Testing Status:**

- FRC SW (North Island)
 - 2-3 Primers to be Selected
 - EW DY048A – Non-chromate control & 02-GN-084
 - Painters to conduct sprayouts on practice a/c sections for (a) sprayability, (b) thickness control, (c) pot life... Evaluation datasheets
 - Using standard hexavalent chromium pretreatment (spray applied)
- FRC SE (JAX)
 - Limited P-3 demo, several primers (wheel)

Paint hanger at North Island



Accelerated Test Use

ASTM B 117 Used Historically as indicator of quality control

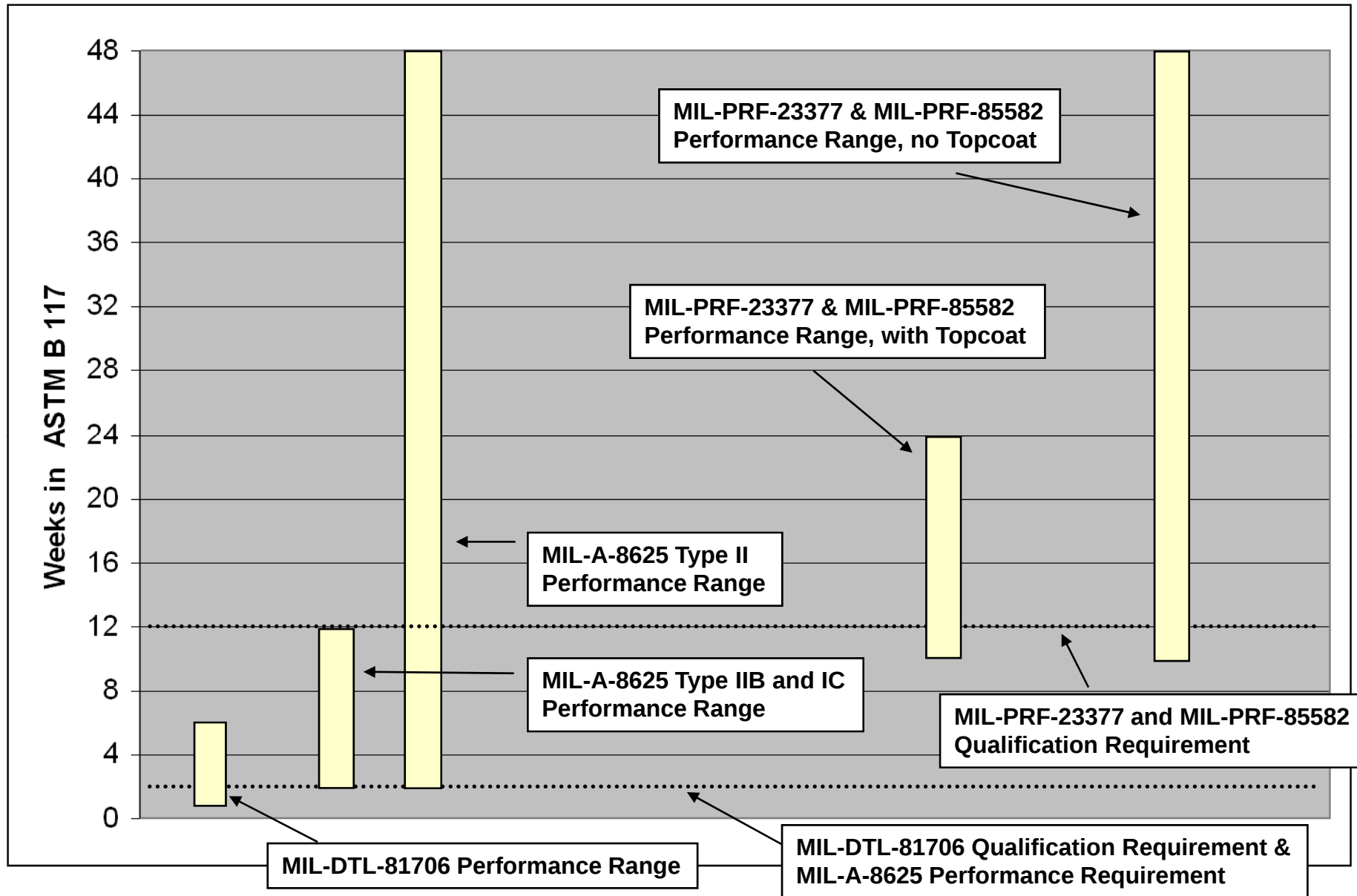
- High-Solids Chromate Primers- initial spec test was 1000 hours in ASTM B 117 (MIL-P-23377 rev F/1989)
 - Based on strontium chromate pigment QC
 - Based on *already established* coating performance on aircraft, i.e. ASTM B 117 was used to validate proper formula, not predict field performance
- Water-Reducible Chromate Primers- adopted test criteria (1000 hours) from high-solids spec (MIL-P-85582 rev B/1988)
 - Presumed performance to spec tests would yield good field performance based on known chromate chemistry
- Class N products in each spec (MIL-P-23377 rev G/1994 & MIL-P-85582 rev B/1994)
 - Salt fog requirement raised to 2000 hours for both specs, all primers
 - Spec change made without field data to establish correlation to accelerated tests
 - Currently no testing of primers in galvanic couples or on beach

Accelerated Test Use

PROBLEMS

- Minimum performance based on quality control does not equal similar performance when trying to validate and authorize new coatings
 - This can only be elucidated by testing to failure
- Unknown correlation of performance of new non-chromate inhibitor chemistries in field compared to accelerated corrosion tests
- Large differences in performance for solvent-borne vs water-reducible primers in galvanic tests regardless of inhibitors
 - Not reflected in spec testing
 - Solvent-borne typically better in lab test data
- Non-chromate primers tend to rely more on pretreatment performance compared to chromate primers
 - Not reflected in spec testing
- No general guidance exists on how to use tests, suggested combinations of alloys and tests, comparative data of accelerated tests versus beach exposure

Test to Failure vs Qualification Criteria



NCAP Data Assessment



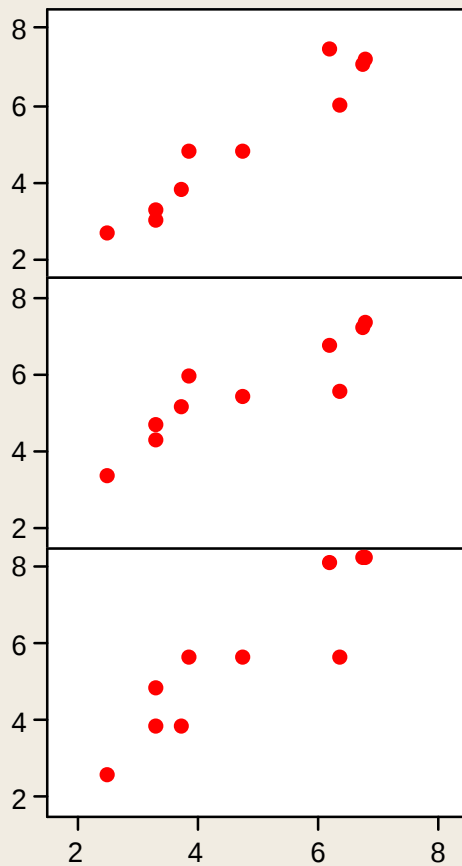
- **Project originally designed to assess performance of aluminum conversion coating alternatives**
- **Data set includes:**
 - 4 aluminum alloys: 2024, 7075, 2219, 5083
 - 9 conversion coatings/pretreatments (including one chromate control)
 - 5 paint systems
 - MIL-PRF-23377 Class C primer w/MIL-PRF-85285 topcoat (chromate, high-solids)
 - MIL-PRF-85582 Class C primer w/MIL-PRF-85285 topcoat (chromate, water)
 - MIL-PRF-85582 Class N primer w/MIL-PRF-85285 topcoat (non-chromate, water)
 - MIL-C-53022 primer w/MIL-C-53039 topcoat (non-chromate, high-solids)
 - MIL-C-53030 primer w/MIL-C-53039 topcoat (non-chromate, water)
 - 4 corrosion tests (with 5 panels per coating system)
 - ASTM B 117 for 3000 hours (completed by ARL)
 - GM9540P for 120 cycles (completed by ARL)
 - ASTM G85 Annex 4 (SO₂) for 500 hours (completed by NAVAIR-PR)
 - Beach front at Kennedy Space Center for 6 years (completed by NASA)

Analysis of Data

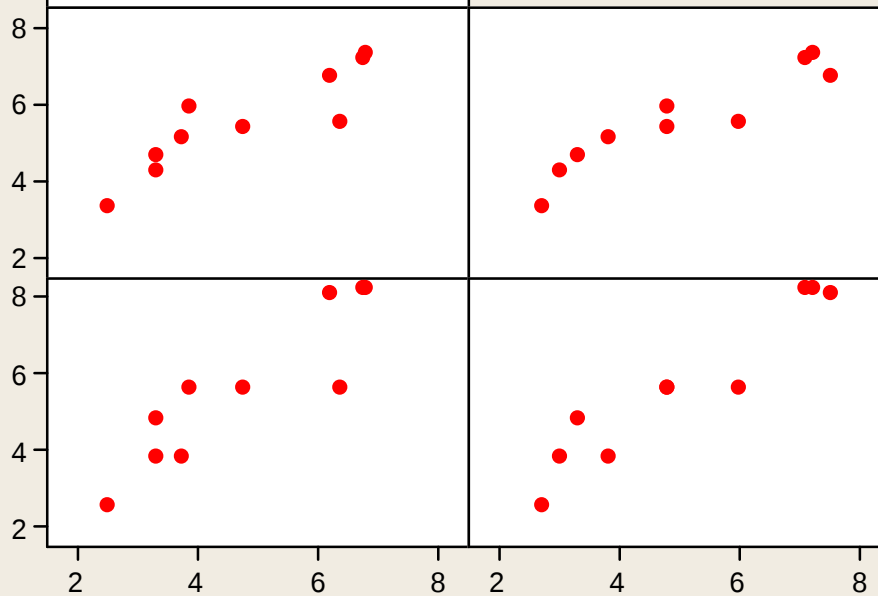
- **Minitab software used to assess data**
- **Initial focus on comparing end points of tests**
- **Plots generated for a variety of combinations of variables**
 - All alloys and coatings
 - 7075 and 2024 for all coatings
 - All alloys for each primer
 - 7075 and 2024 for each primer
- **Regression analysis performed on various data sets comparing 5-year beach results with individual or combinations of accelerated tests**
 - Best “p” values obtained when more than one accelerated test is used and more than one alloy is used
 - Equations generated for combination of B117 & GM9540P, B117 & G85A4, GM9540P & G85A4 and all three
 - These equations will be used to forecast 5-year beach performance of new coating systems being tested
 - Actual beach data will be used to verify and validate forecasts

All Alloys & All Coatings: B117, GM, SO2 vs. Beach

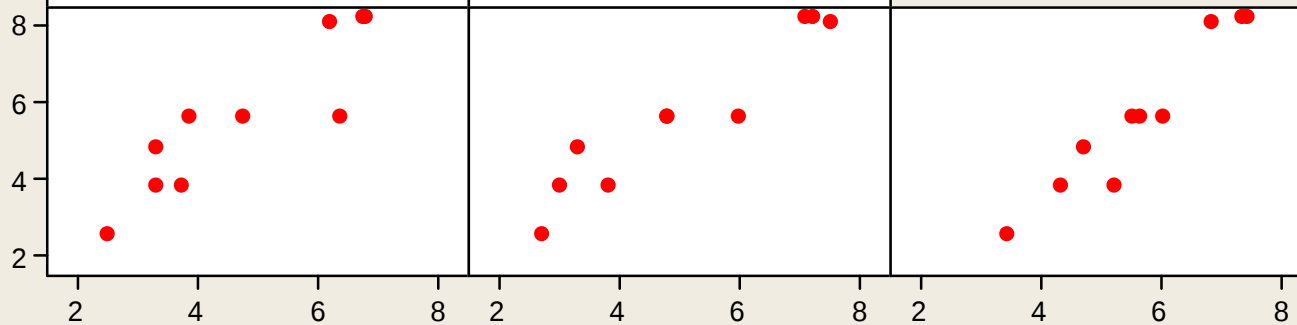
All CoatSo2_500



All CoatB117_3000



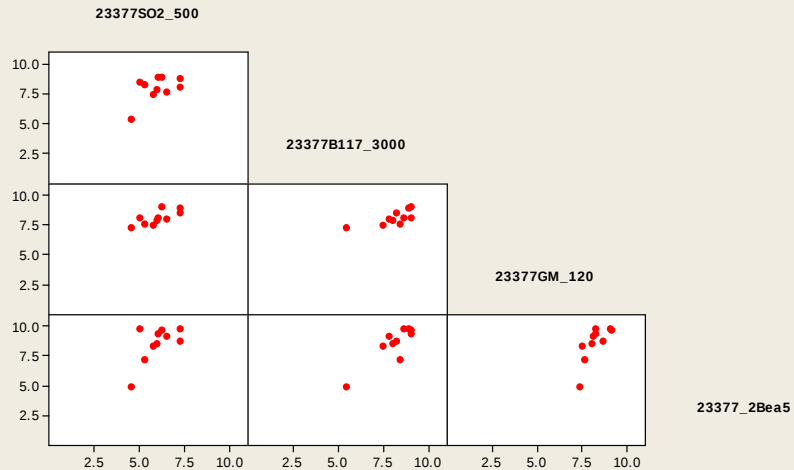
AllCoatGM_120



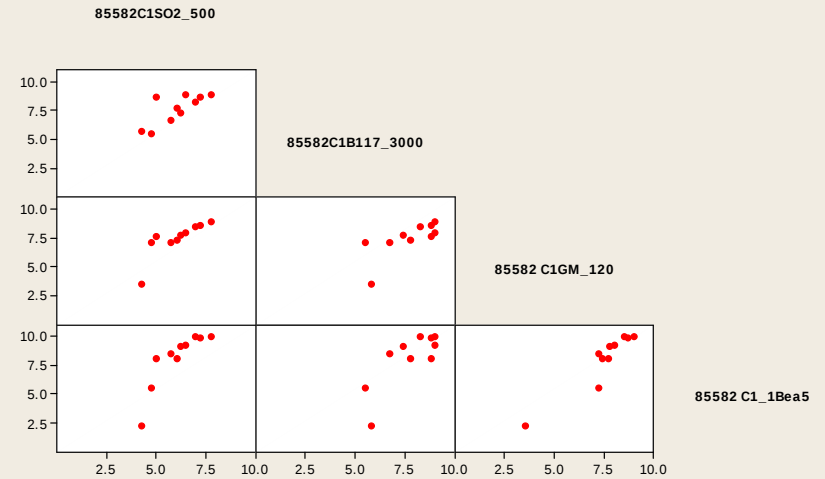
All Coat1Bea5



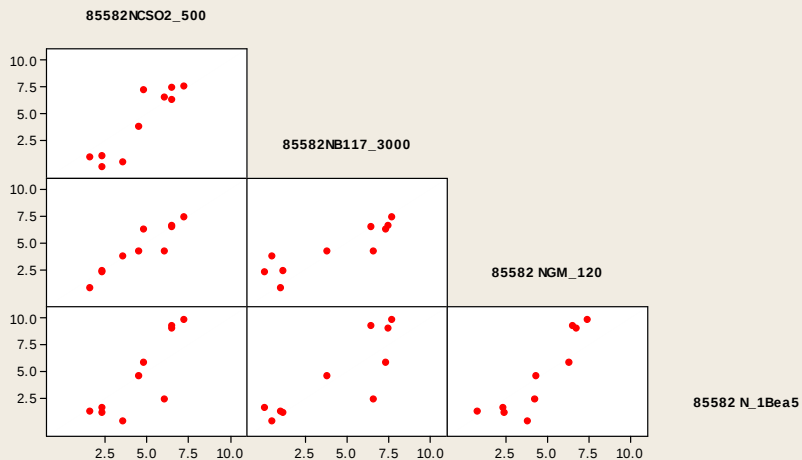
All Alloys & Mil-PRF-23377 C: B117, GM, SO2 vs. Beach



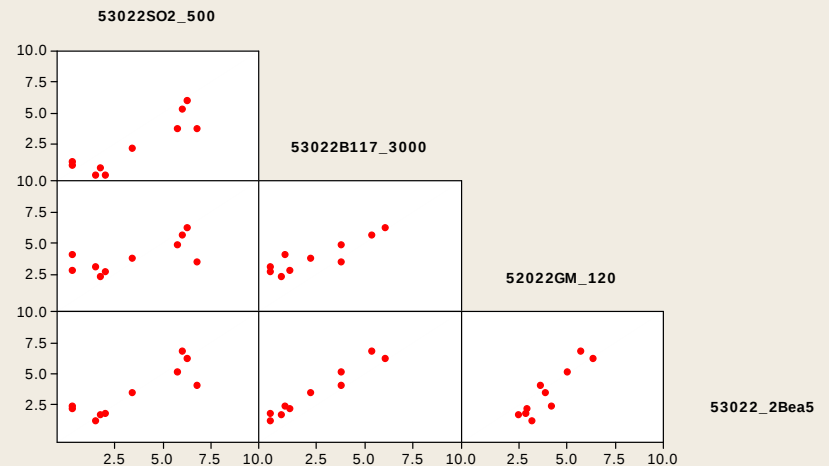
All Alloys & Mil-PRF-85582 C1: B117, GM, SO2 vs. Beach



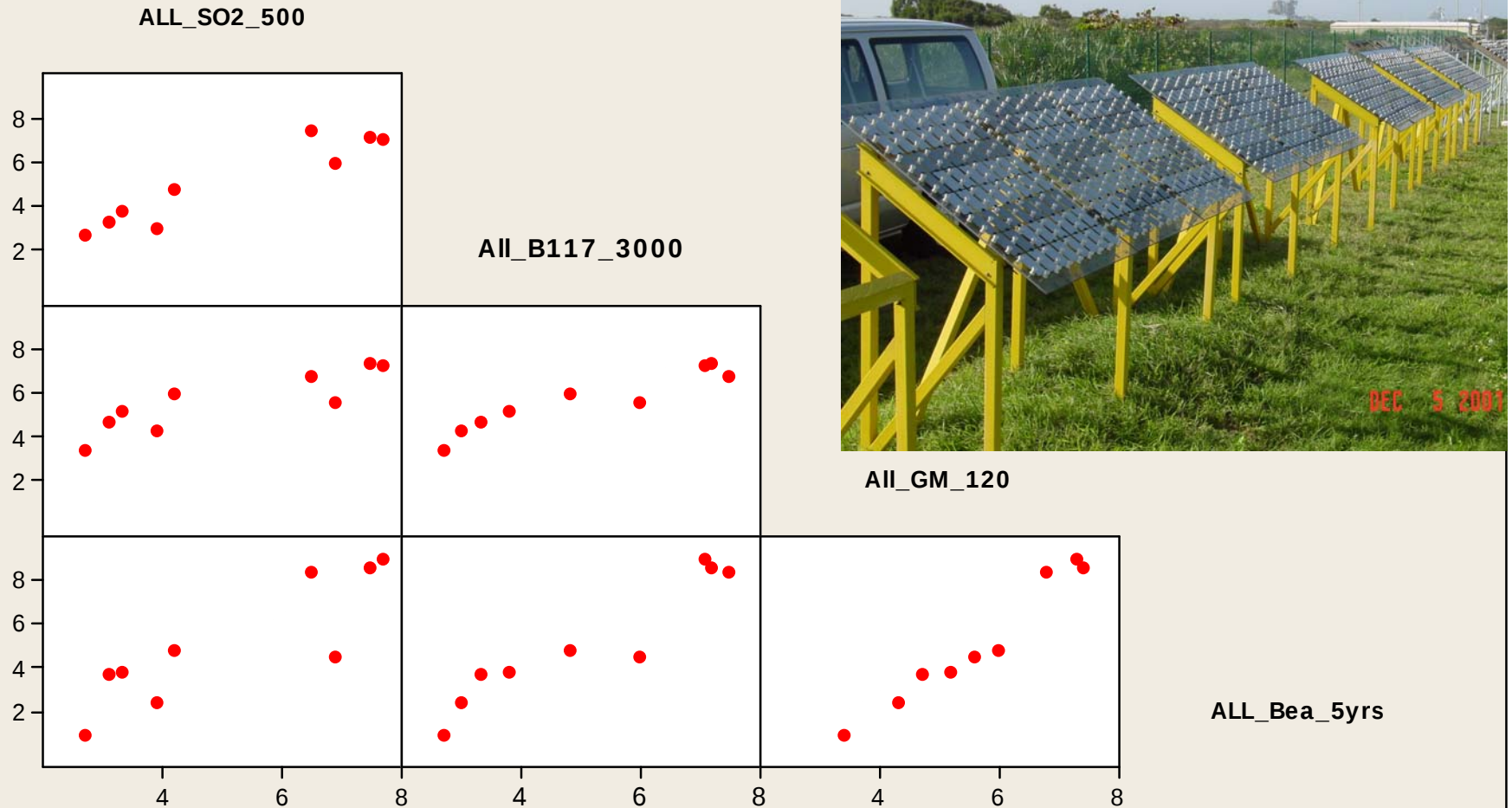
All Alloys & Mil-PRF-85582 N: B117, GM, SO2 vs. Beach



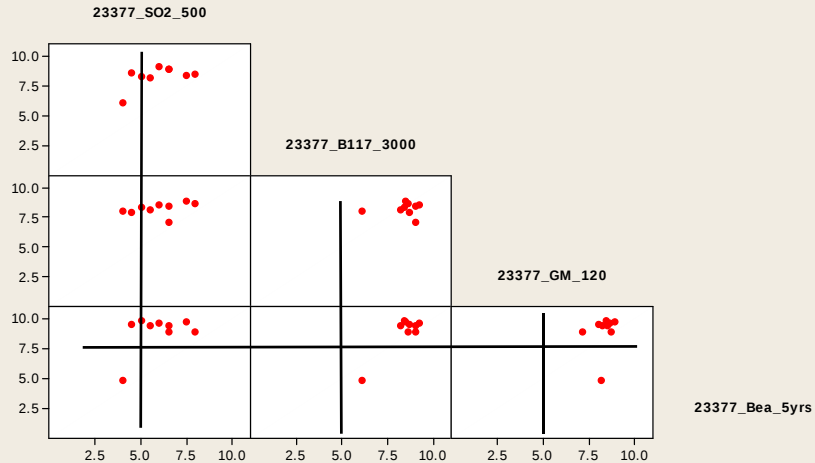
All Alloys & Mil-C-53022: B117, GM, SO2 vs. Beach



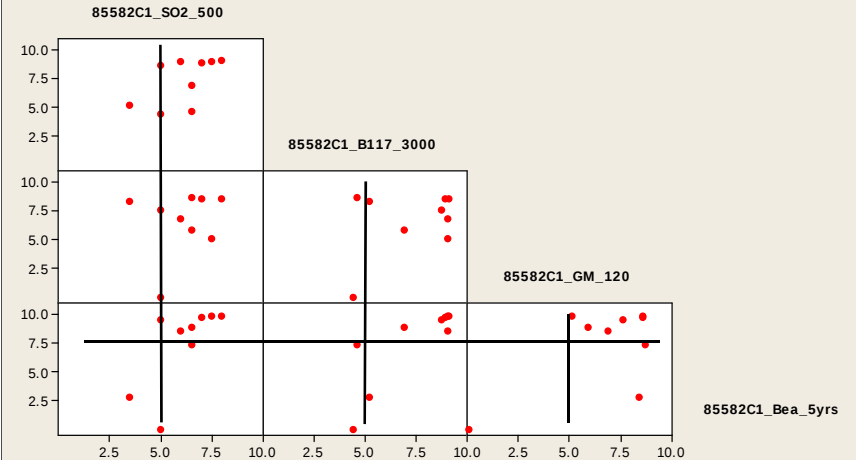
Al2024 and Al7075 & All Coatings: B117, GM, SO2 vs. Beach



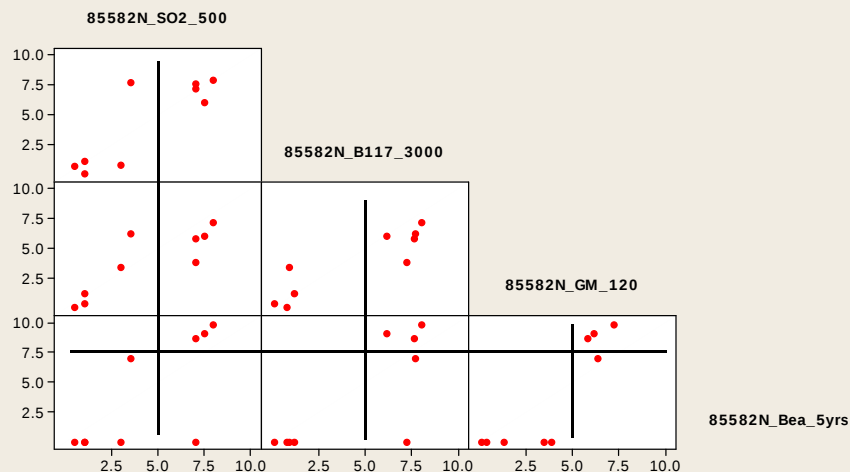
AI2024 and AI7075 & Mil-PRF-23377 C: B117, GM, SO2 vs. Beach



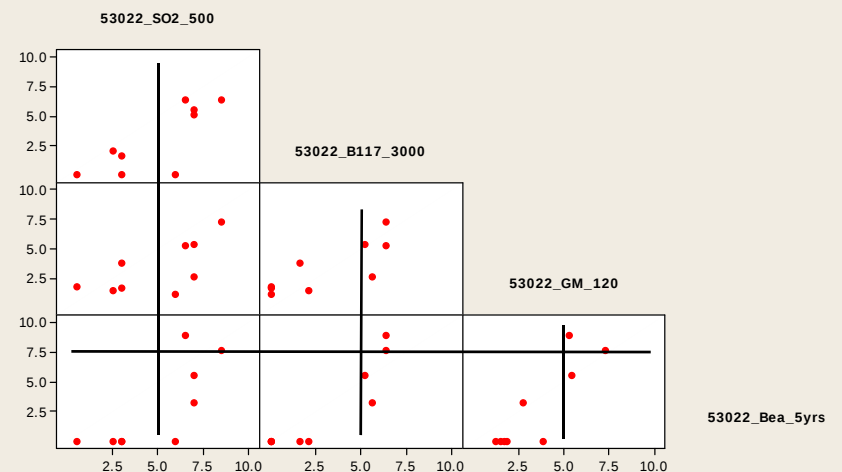
AI2024 and AI7075 & Mil-PRF-85582 C1: B117, GM, SO2 vs. Beach



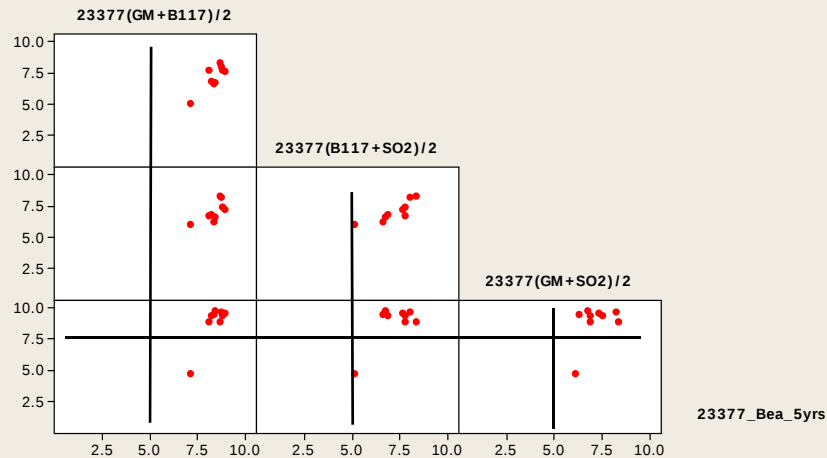
AI2024 and AI7075 & Mil-PRF-85582 N: B117, GM, SO2 vs. Beach



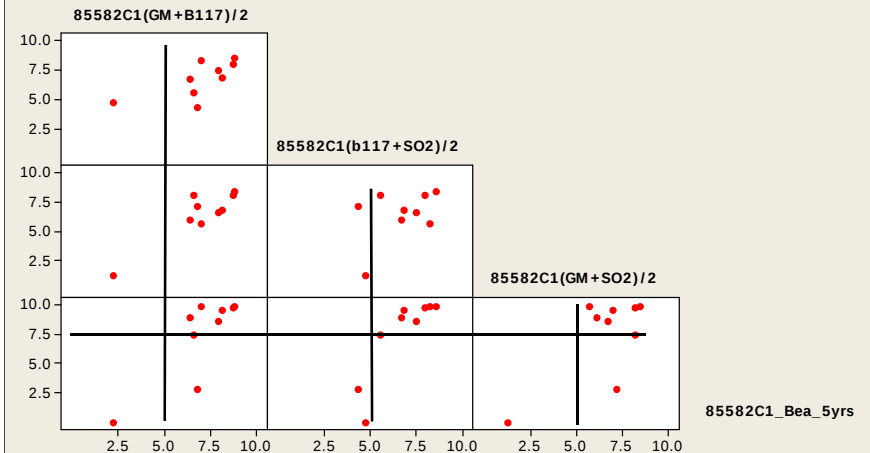
AI2024 and AI7075 & Mil-C-53022: B117, GM, SO2 vs. Beach



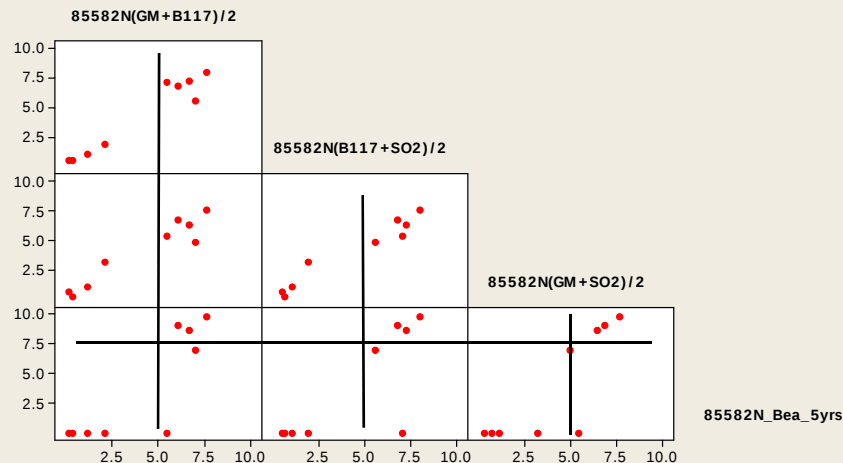
AI2024 and AI7075 & MIL-PRF-23377 C: Test Averages vs. Beach



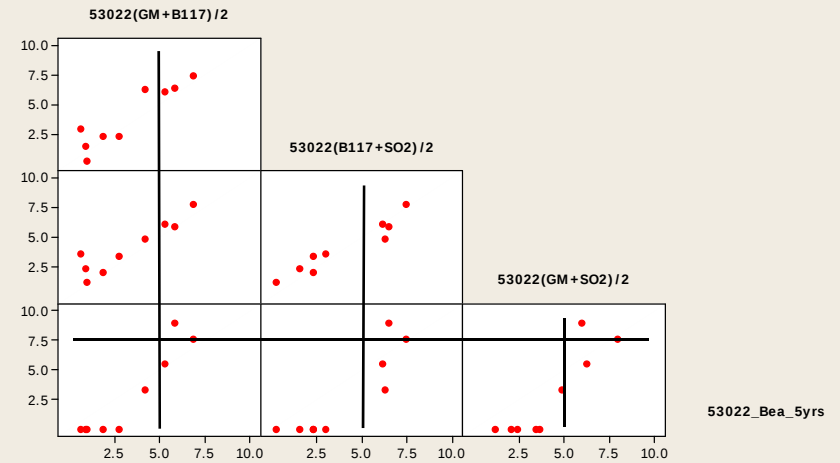
AI2024 and AI7075 & MIL-PRF-85582 C1: Test Averages vs. Beach



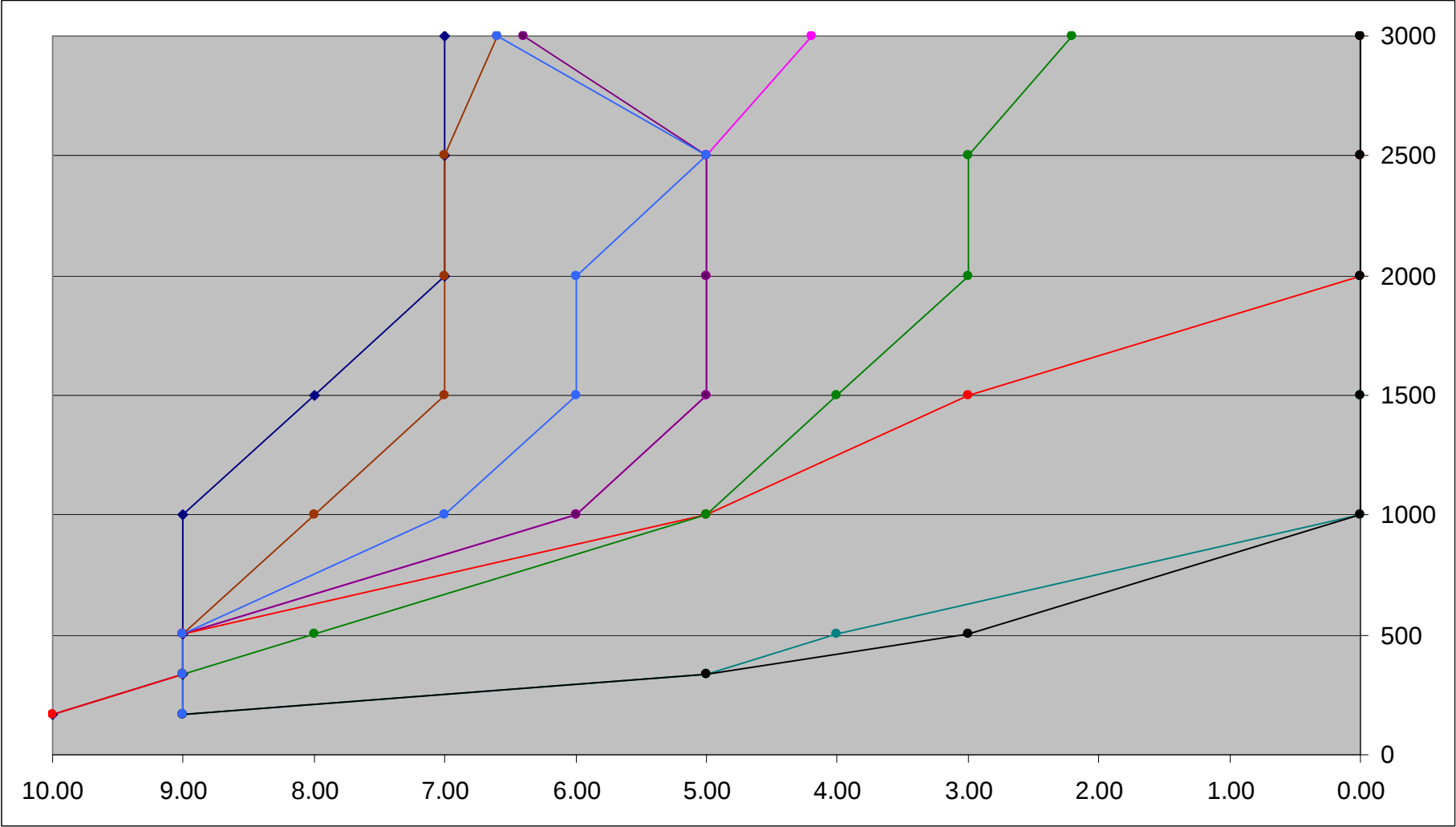
AI2024 and AI7075 & MIL-PRF-85582 N: Test Averages vs. Beach



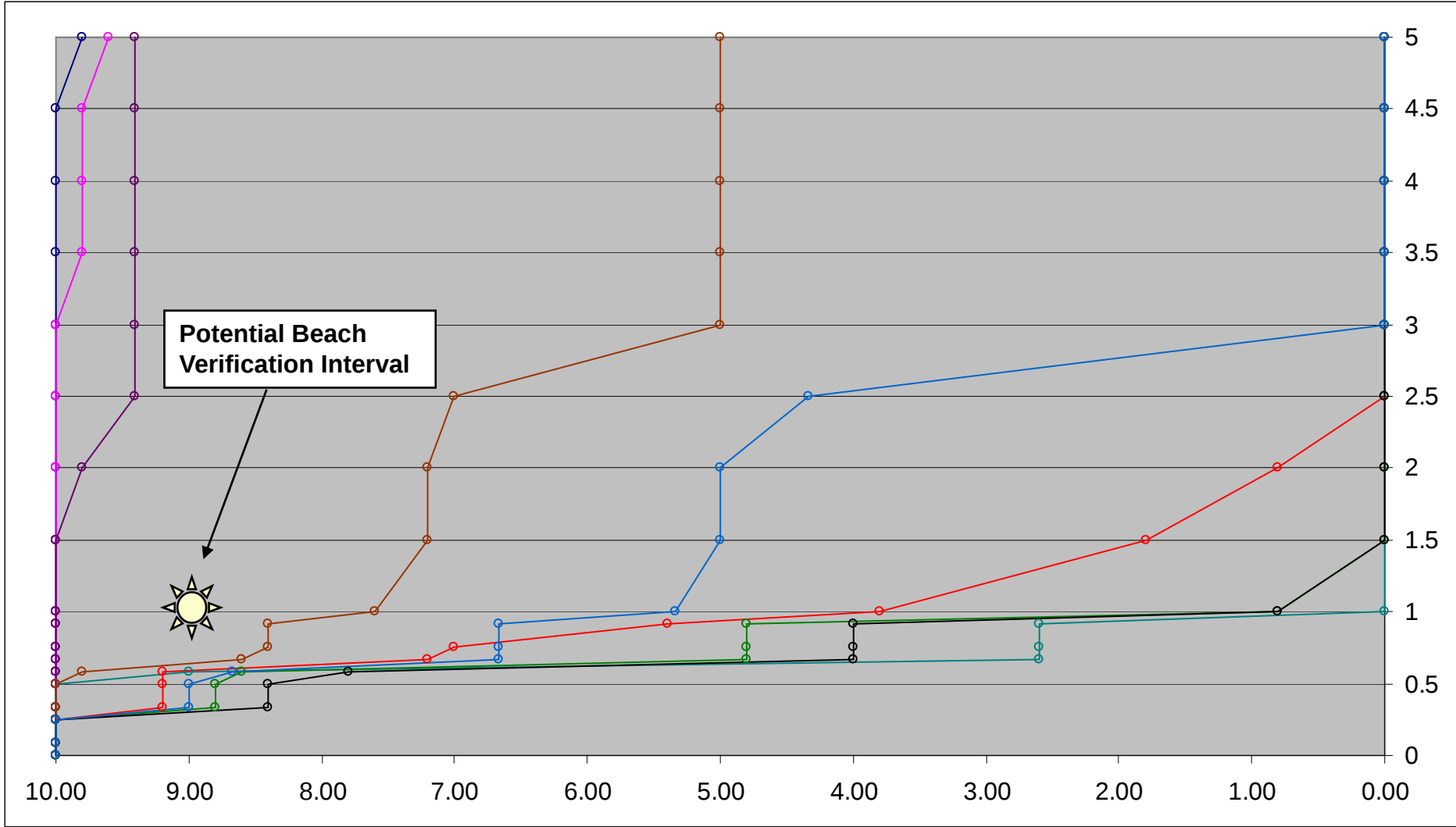
AI2024 and AI7075 & 53022: Test Averages vs. Beach



3000-hour ASTM B 117 Ratings for MIL-PRF-85582 Class N Coatings on 2024-T3



5-year Beach front Ratings for MIL-PRF-85582 Class N Primer on 2024-T3



Initial Regression Analysis

Coating Systems (on 2024 and 7075)	3000 hr B117 (6 panel avg)	552 hr SO2 (6 panel avg)	Regression Equations- Predicted 5 yr Beach Performance						Actual Beach- 2 months (6 panel avg)	Top Predicted Systems
			All Coatings/ All Alloys	23377/All Alloys	85582C/All Alloys	85582N/All Alloys	53022/All Alloys	53030/All Alloys		
1600/23377 C2	10.0	9.2	10.9	11.8	13.6	11.4	10.4	8.6	10	
1600/23377 C2/85285	9.3	8.7	10.2	10.9	12.5	10.7	9.8	8.1	10	
1600/eSPT	6.3	9.8	6.2	8.1	12.2	10.3	7.0	5.4	10	
IC/eSPT	5.5	7.0	5.8	6.2	8.0	7.4	6.4	5.3	10	
IC/23377 C2	9.5	7.3	10.7	10.6	10.9	9.6	10.0	8.5	9.5	
IC/23377 C2/85285	8.5	4.8	10.0	8.7	7.0	7.0	9.2	8.1	10	
IC/85582 C1	10.0	0.5	12.9	8.7	2.3	3.9	10.7	10.2	10	
IC/85582 C1/85285	8.5	8.5	9.2	10.0	11.8	10.1	9.1	7.5	10	
IC/084	9.0	9.2	9.7	10.8	13.0	10.9	9.5	7.8	10	
IC/084/85285	8.3	9.7	8.7	10.2	13.2	11.1	8.9	7.1	10	
IC/16708TEP	9.2	9.5	9.8	11.1	13.5	11.3	9.6	7.8	10	
IC/16708TEP/85285	8.5	9.2	9.0	10.2	12.7	10.7	9.0	7.4	10	
IC/098	6.7	6.7	7.3	7.3	8.3	7.7	7.4	6.3	7	
IC/098/85285	8.3	9.0	8.9	10.0	12.4	10.5	8.9	7.2	10	
IC/XP417	10.0	6.0	11.6	10.7	9.5	8.7	10.5	9.2	10	
IC/XP417/85285	8.3	6.7	9.4	9.1	9.3	8.5	9.0	7.7	10	

Conclusions & Path Forward

- **Statistical analysis will be documented and distributed as part of ESTCP NCAP project report**
- **Initial assessment suggests that a standard practice to assess coating systems can be established to minimize or eliminate false positives and negatives in accelerated testing:**
 - Use at least two alloys (aerospace- 2024 & 7075)
 - Use at least two standard accelerated tests (B 117 & G85A4, B 117 & GM9540P, GM9540P & G85A4)
 - Tests run beyond specification requirements (3000 hours for B 117, 500 hours for G85A4, 120 cycles for GM9540P)
 - Assess performance of promising coating systems on the beach (KSC for NAVAIR) for 1 year (serially or in parallel with accelerated tests)
- **New coating system data will be evaluated against proposed standard practice**
 - “TCP-IC” testing underway- 1 yr beach data due in November 2008
 - Additional NC systems planned start in mid-2008