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Comparative Assessment of Dry Blast Media for FRCSW NI

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Presentation Overview

- Project Team
- Background
- Scope & Objectives
- Technical Approach
- Results of Optimization Testing
- Results of Dem/Val Testing
- Conclusions
- Technical Points of Contact
- Questions

Project Team

Primary Stakeholders

- Navy
  - FRCSW NI
    - R. Paulson, C. Eveland, D. Crowley, T. Woods, A. Richards, W. Loftus
  - NAVAIR Pax River
    - K. Russell, B. Dusch, C. Matzdorf
  - FRCSE JAX
    - J. Benfer. B. Youngers, Z. Ross
  - FRCE CP
    - A. Cahoon, J. Fennell, R. Mehring

Private Industry

- Archer Daniels Midland (ADM)
- Abrasive Warehouse & Equipment (AWE)
- Battelle

Background

- Current coating removal processes for FRCSW NI aircraft and off-aircraft component parts include chemical stripper, Type V media blasting and hand sanding operations that result in:
  - Potential substrate damage
    - Unnecessary rework
    - Reduced life for structures
  - Solvent vapor release
  - Hazardous waste generation, treatment and disposal
  - Unsafe working conditions
- Type VII GPX blasting media and process offers:
  - "Drop-in" replacement with acceptable coating removal rates
  - Reduced damage to delicate substrates (composites, thin skin alloys)
  - Biodegradable and recyclable
  - Conformance to DoD environmental, P2, and toxic chemical use reduction requirements

Scope and Objectives

Scope: To conduct an unbiased Dem/Val assessment of the GPX media and related dry media blasting process on various aircraft composite and thin skin metallic alloys.

Objectives: To compare the performance of Type V acrylic (PMB) and Type VII bio-based (GPX) media on delicate substrates in order to validate the following:

- coating removal efficiency
- reduced potential for substrate damage
- reduction in overall depaint processing time (i.e., masking/demasking, solvent wipe, and hand sanding operations)
- feasibility of implementation at the FRCSW NI

Technical Approach

- Compilation of Type VII GPX-related testing and process implementation information available from industry, academia, and maintenance/repair/overhaul (MRO) facilities responsible for maintaining commercial and military (US and Foreign) aerospace equipment
- Drafting and NAVAIR approval of a Demonstration Test Plan
- Conduct comparative testing of Type V and Type VII media and related processes (bench-scale)
- Conduct demonstration and validation testing of Type V and Type VII media/processes on condemned aircraft component parts and coated test panels at FRCSW NI
- Reporting of comparative testing results w/ production implementation recommendations

Testing Matrix

Test/Contributor	NAVAIR	FRCSW (proposed)	FRCSE	FRCE	NAVSEA	CG	Hill AFB	Robins AFB	AFRL/ CTIO	Others*
Ctg. Removal Efficiency *(MIL-P-85891A)*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Imparted Residual Stress - Almen arc height test *(SAE J442)*	Y	Y	U	U	Y	Y	Y	Y	Y	Y
Post-blast Residues *(MIL-P-85891A)*	U	Y	U	U	U	Y	Y	Y	Y	Y
Peak Saturation Stresses *(SAE J442, AF EQP)*	N	Y	N	N	N	N	Y	Y	Y	Y
Clad Erosion & Removal *(SAE J442, AF EQP)*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Surface Profile/Roughness *(ASTM D 7127, SAE MA4872)*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Crack Closure *(SAE MA4872)*	N	Y	N	N	N	N	N	N	N	Y
Composite Damage *(Microscopic Inspection)*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Media Aggressiveness *(MIL-P-85891A)*	Y	Y	U	U	U	Y	Y	Y	U	Y

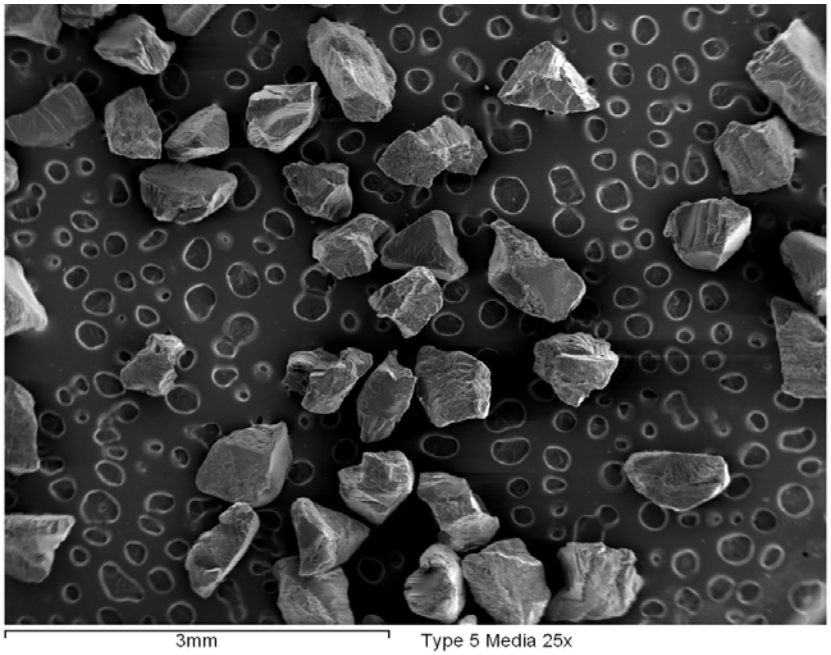
Others include; Boeing Military, Southwest Research Institute, Lockheed, AETC, Concurrent Technologies Corporation

Results of informational summary based on published literature and/or direct conversation with representatives within respective agencies

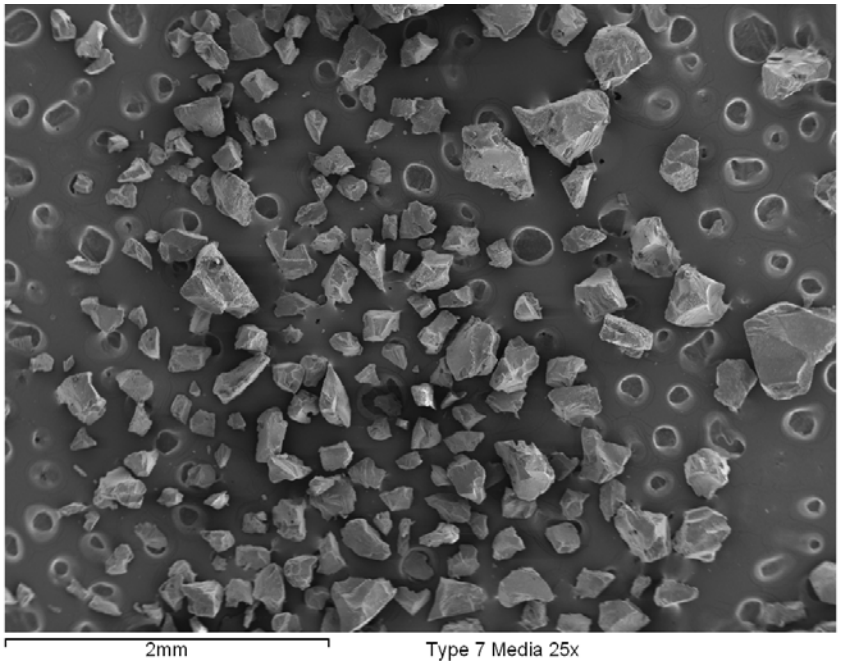
Results

- Media Comparison (SEM @ 25X magnification)
- Conditioned (2X) and collected after testing

Type V



Type VII



Type V Blast Conditions: 30 psi, 60º, 60 %, 10 in. SOD
Type VII Blast Conditions: 35 psi, 60º, 60 %, 6 in. SOD

Results (cont…)

- Mesh Analysis

Mesh Size	20	30	40	50	60	80	100	pan
Type V (new)	0	18.5	77.9	3.9	0	0	0	0
Type V (2X)	0	6.3	56.4	21.7	4.8	9.2	2	3.9
Type VII (new)	14.9	39.2	26.6	12.7	3.8	1.9	0.1	0.1
Type VII (2X)	1.8	11.9	18.9	23	13.1	20.1	6.5	3.1

Results (cont…)

- Test Panels & Blast Conditions (Type V)

Test Identification	Substrate	No. of Tests	Coated (Y/N) DFT	Media Flow Rate (lbs/min)	Nozzle Pressure (psi)	Stand-Off Distance (in)	Blast Angle (degrees)
Coating Removal Rate+ (0.25 ft^2 area) (panels/parts)	0.025 clad 2024-T3 F-18 Wing Plank F-18 Aileron E-2 Nose Dome E-2 Rotodome	3 3 4 3 3 3	Y Y Y Y Y Y	9.0	35	18	40-60
Imparted Residual Stress (4-cycles/test) (almen strips)	0.032 bare 2024-T3 0.032 clad 2024-T3 0.032 bare 7075-T6 0.032 clad 7075-T6	6 6 6 6	N N N N	4-5	35	12	40-60
Surface Residues (almen strips) (large panel)	0.032 bare 2024-T3 0.032 bare 2024-T3	3 1	N N	4-5	35	12	40-60
Clad Erosion (almen strips)	0.032 clad 2024-T3 0.032 clad 7075-T6	3 3	N N	4-5	35	12	40-60
Clad Penetration (almen strips)	0.032 clad 2024-T3	8	N	4-5	35	12	40-60
Surface Roughness (almen strips)	0.032 bare 2024-T3 0.032 clad 7075-T6	3 3	N N	4-5	35	12	40-60
Residual Stress Saturation (almen strips)	0.032 bare 2024-T3	4	N	4-5	35	12	40-60
Composite Damage (panels/parts)	Fiberglass Graphite Epoxy	3 3	N N	4-5	35	12	40-60
Media Aggressiveness (almen strips)	Magnesium	3	N	4-5	35	12	40-60

Note: + - ½ inch double venturi nozzle, all other testing completed with 3/8 inch double venturi nozzle.

Results (cont…)

- Test Panels & Blast Conditions (Type VII)

Test Identification	Substrate	No. of Tests	Coated (Y/N) DFT	Media Flow Rate (lbs/min)	Nozzle Pressure (psi)	Stand-Off Distance (in)	Blast Angle (degrees)
Coating Removal Rate+ (0.25 ft^2 area) (panels/parts)	0.025 clad 2024-T3 0.032 clad 7075-T6 F-18 Wing Plank F-18 Aileron E-2 Nose Dome E-2 Rotodome	3 3 4 3 3 3	Y Y Y Y Y Y	9-10	35	8-12	45-60
Imparted Residual Stress (4-cycles/test) (almen strips)	0.032 bare 2024-T3 0.032 clad 2024-T3 0.032 bare 7075-T6 0.032 clad 7075-T6	6 6 6 6	N N N N	4-5	35	8	40-60
Surface Residues (almen strips) (large panel)	0.032 bare 2024-T3 0.032 bare 2024-T3	3 1	N N	4-5	35	8	40-60
Clad Erosion (almen strips)	0.032 clad 2024-T3	3	N	4-5	35	8	40-60
Clad Penetration (almen strips)	0.032 clad 2024-T3	8	N	4-5	35	8	40-60
Surface Roughness (almen strips)	0.032 bare 2024-T3 0.032 clad 7075-T6	3 3	N N	4-5	35	8	40-60
Residual Stress Saturation (almen strips)	0.032 bare 2024-T3	3	N	4-5	35	8	40-60
Composite Damage (panels/parts)	Fiberglass Graphite Epoxy	3 3	N N	4-5	35	8	40-60
Media Aggressiveness (almen strips)	Magnesium	3	N	4-5	35	8	40-60

Note: + - ½ inch double venturi nozzle, all other testing completed with 3/8 inch double venturi nozzle.

Results (cont…)

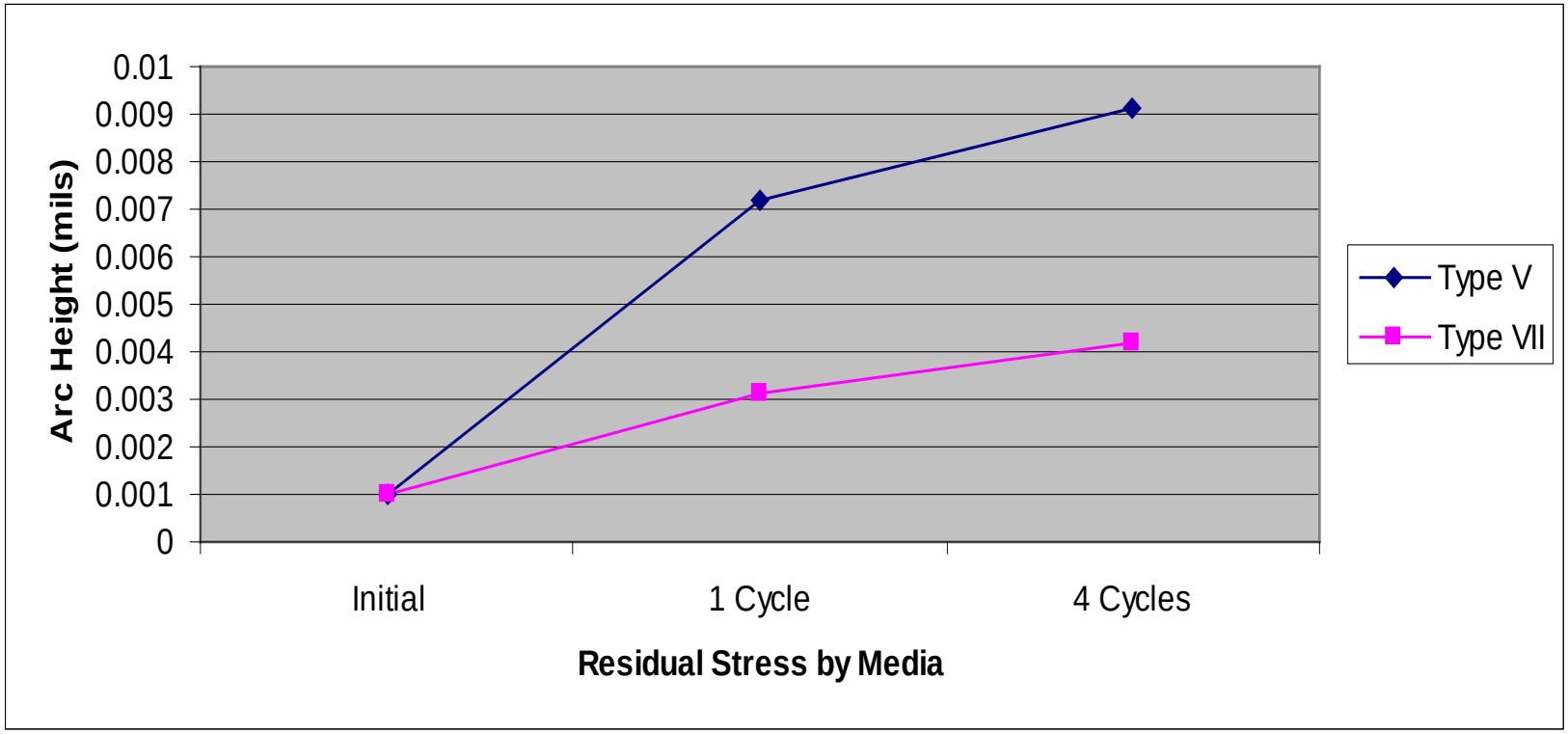
- Coating Removal Rate
  - All coated test panels and component parts were processed with the Type V and Type VII media IAW MIL-P-85891A

Panel ID	Coating Thickness, mils	Type V (ft^2/min)	Type VII (ft^2/min)
U.S Navy Test Panel #2 (Al2024-T3)	3.0 – 3.3	1.06	0.73
Coast Guard Test Panel #2 (Al2024-T3)	2.9 – 3.5	0.81	0.97
Bombardier Fuselage Part (Al2024-T3)	2.0 – 2.3	1.21	0.41
F-18 Aileron Part (Al2024-T3)	4.4 – 4.6	1.16	0.73
Average (Metallic)		1.06	0.71
F-18 Horizontal Stabilizer Part (G. Epoxy)	-	0.58	0.32
F-18 Access Door Part (G. Epoxy)	-	0.22	0.38
Laser Processed Part (Fiberglass)	-	0.29	0.30
F-18 Wing Plank (G. Epoxy)	-	0.31	0.80
Average (Composite)		0.35	0.45

Note: Type V – 9 lbs/min., 35 psi, 18” SOD, 40-60º, ½” DV
Type VII – 9-10 lbs/min., 35 psi, 8-12” SOD, 45-60º, ½” DV

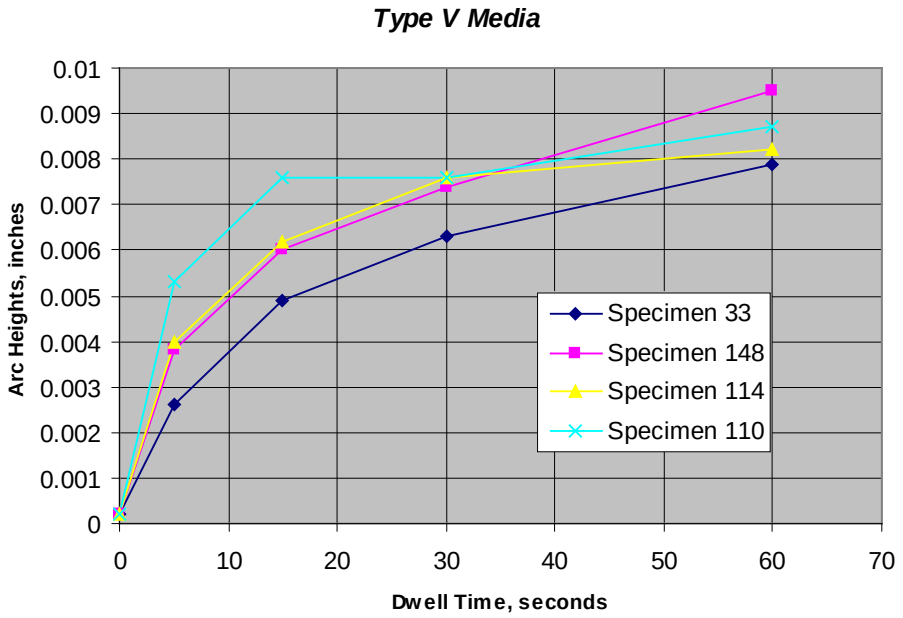
Results (cont…)

- Imparted Residual Stress (Almen Arc Height Data)
  - Al2024-T3 coupons prepared and processed IAW SAE J442
  - Stress assessments include 1 and 4 blast cycles/media type

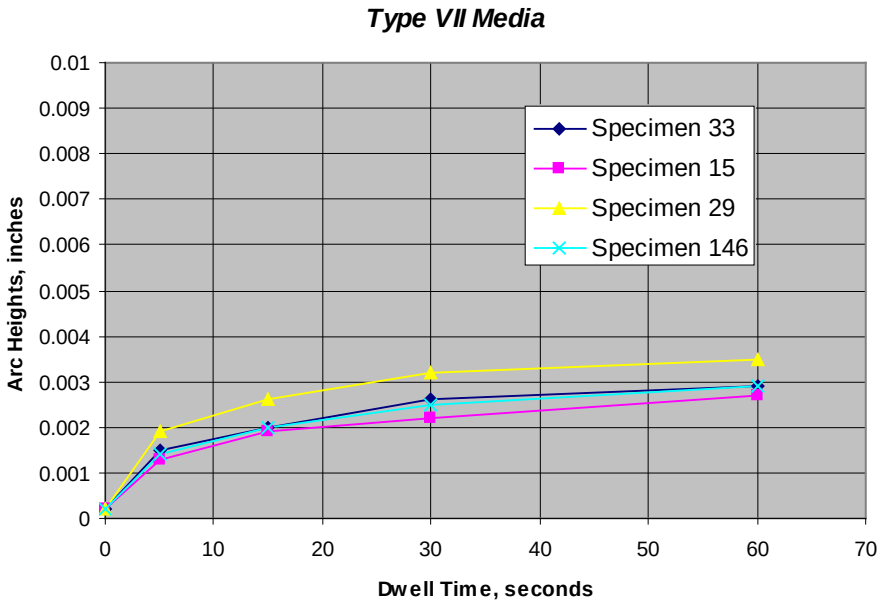


Results (cont…)

- Residual Stress Saturation
  - Al2024-T3 test coupons prepared and processed IAW SAE J442 and USAF EOP



Media Flow Rate - 4-5 lbs/minute
Nozzle Pressure - 35 psi
Stand-Off-Distance - 12 inches
Impingement Angle - 40-60 degrees
3/8-inch double venturi nozzle

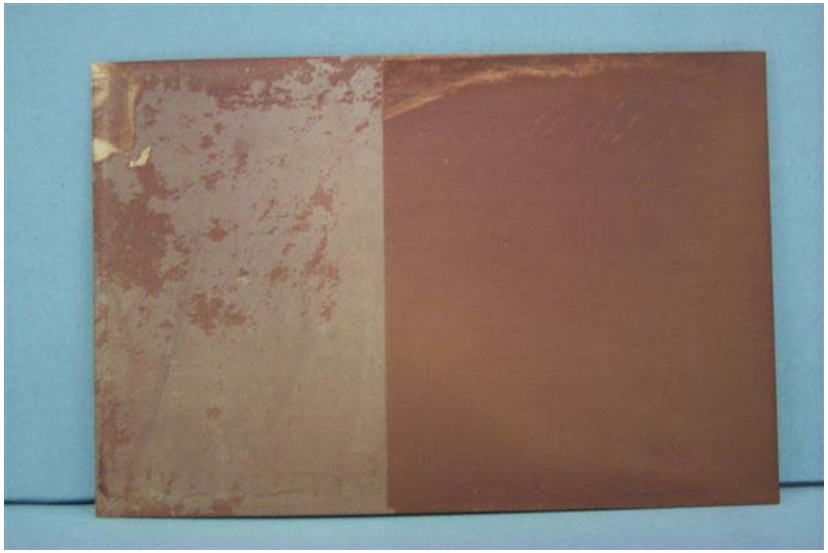


Media Flow Rate - 4-5 lbs/minute
Nozzle Pressure - 35 psi
Stand-Off-Distance - 8 inches
Impingement Angle - 40-60 degrees
3/8-inch double venturi nozzle

Results (cont…)

- Surface Residues
  - 0.032 in. x 4.0 in x 12.0 in. AL2024-T3 panels prepared IAW MIL-P-85891
  - ½ panel masked, ½ panel blasted for 60 s., cleaned w/ alkaline soap, rinsed w/ DI water, immersed in Alodine 1200 for 3 minutes, rinsed w/ DI water, air dry, and photograph

Type V



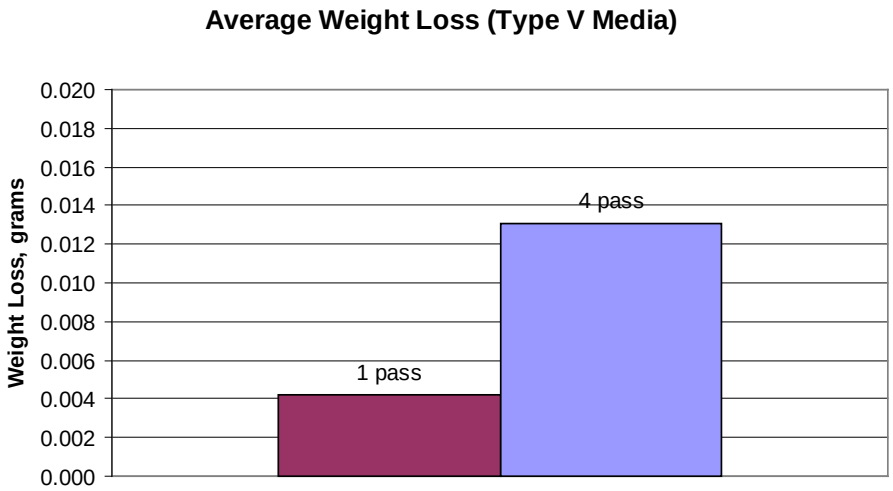
Blasted Surface Unblasted Surface

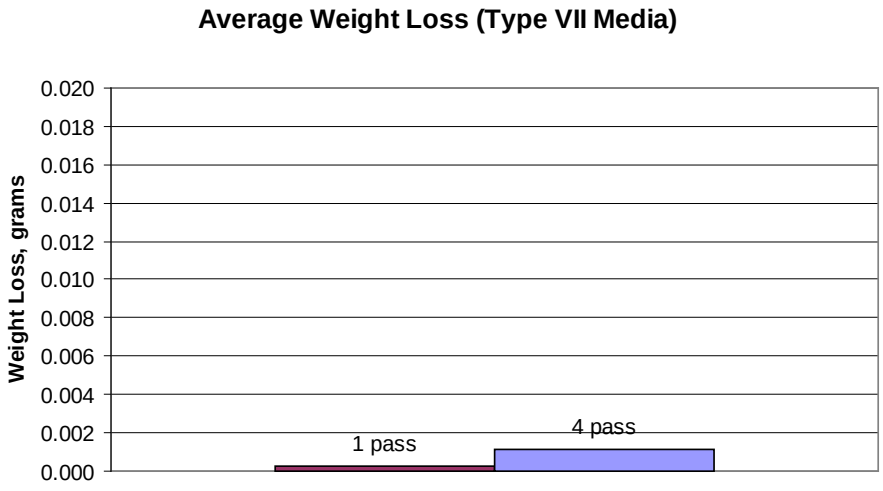
Type VII

Blasted Surface Unblasted Surface

Results (cont…)

- Clad Erosion
  - Al2024-T3 Almen strips prepared, processed and analyzed IAW requirements specified in SAE J442 and AF EQP





	Type V	Type VII
Coated	No	No
Media Flow rate, lbs/min	4-5	4-5
Nozzle pressure, psi	35 +/-1	35 +/-1
Stand-off , inches	12	8
Blast Angle	40-60	40-60
Nozzle (DV)	3/8 inch	3/8 inch

Results (cont…)

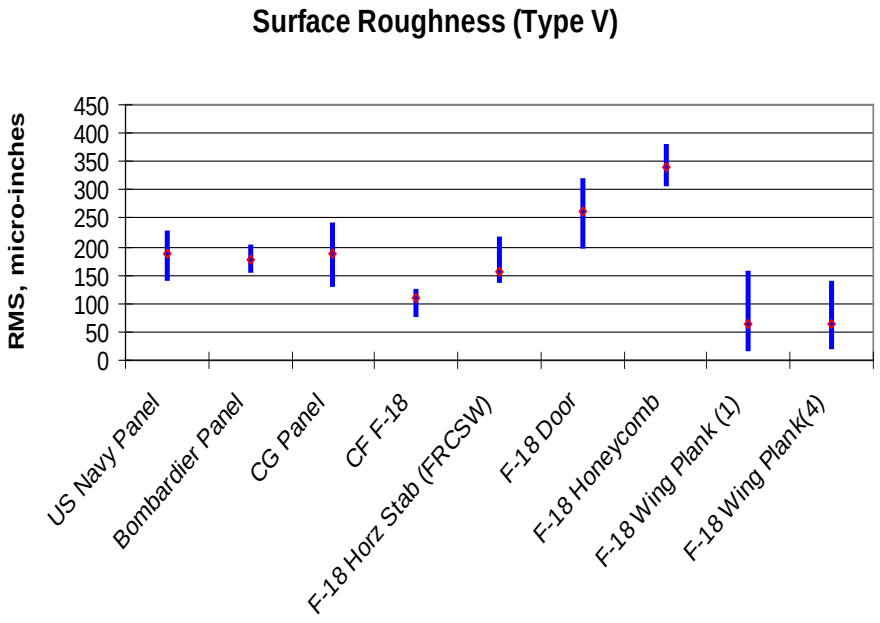
- Clad Penetration
  - 0.032 in. x .75 in x 3.0 in. AL2024-T3 panels prepared IAW MIL-P-85891
  - 3 minute exposure to cladding penetration solution (i.e., KNo_3 and NaOH)

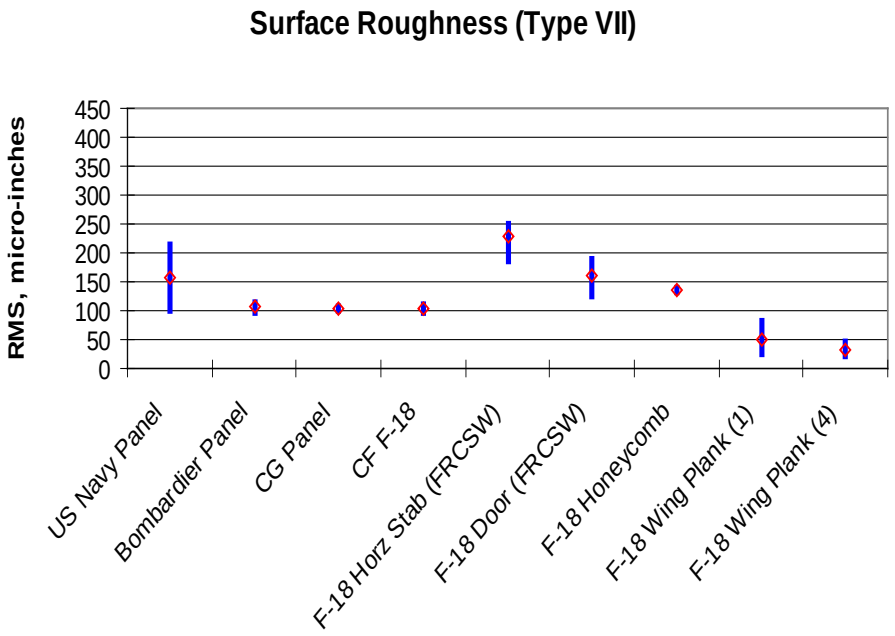
	Type V	Type VII
Coated	No	No
Media Flow rate, lbs/min	4-5	4-5
Nozzle pressure, psi	35 +/-1	35 +/-1
Stand-off , inches	12	8
Blast Angle	40-60	40-60
Nozzle	3/8 inch DV	3/8 inch DV

Type	Sample ID	Pass/Fail	Notes
V	40	F	Solution beaded on application to surfaces of all Type V coupons.
V	44	F	Black discoloration visually apparent immediately upon application.
V	49	F	
V	51	F	
V	53	F	
V	54	F	
V	59	F	
V	66	F	
VII	48	P	No beading of test solution on surfaces of coupons.
VII	52	P	No discoloration noted within 3-minute test period.
VII	56	P	Marker marks were still visible after the coupons were cleaned (before penetrant test).
VII	57	P	
VII	60	P	
VII	68	P	
VII	73	P	
VII	Blank	P	

Results (cont…)

- Surface Roughness (Aircraft Component Parts)
  - Metallic (Al 2024-T3) and Composite Substrates



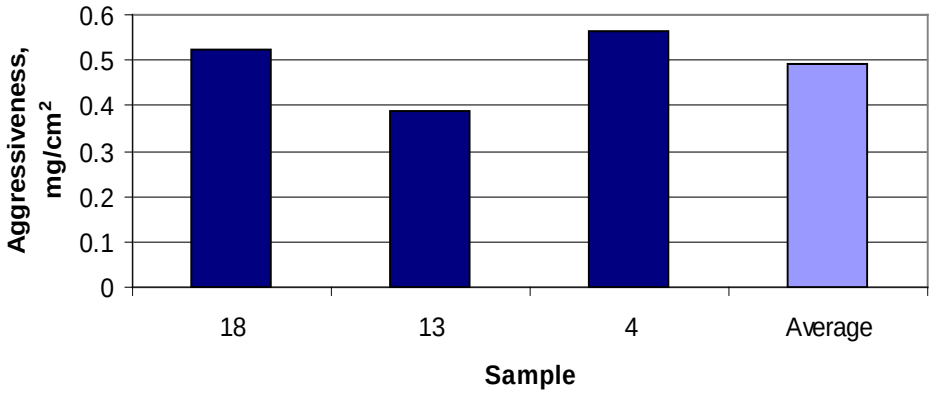


	Type V	Type VII
Media Flow rate, lbs/min	4-5	4-5
Nozzle pressure, psi	30 +/-1	35 +/-1
Stand-off , inches	12	8
Blast Angle	40-60	40-60
DV blast nozzle	3/8 inch	3/8 inch

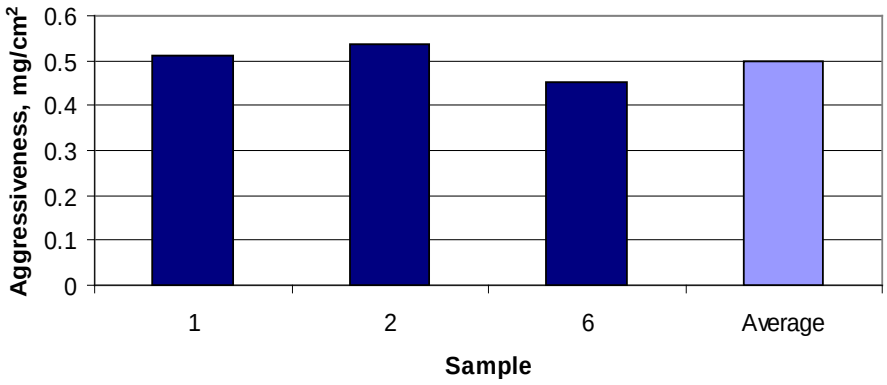
Results (cont…)

- Media Aggressiveness
  - Mg test coupons prepared and processed IAW the requirements specified in MIL-P-85891A
  - Averaged media aggressiveness determined to be equivalent under specified blast conditions

Type V
DV = 3/8 inch, 4-5 lbs/min, 35 psi, 40-60 angle, 12 inch stand-off

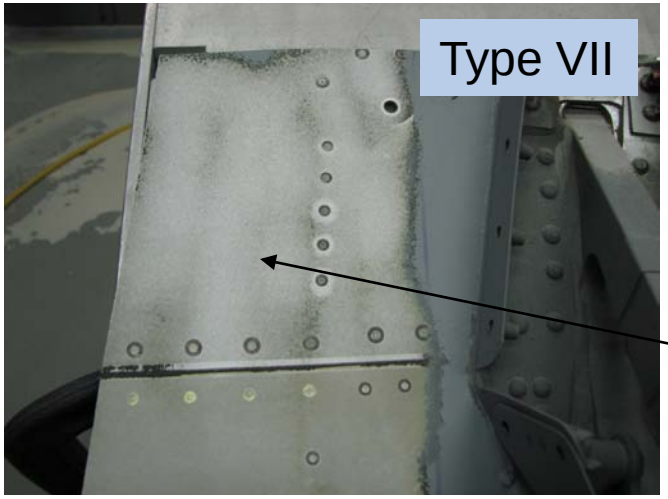


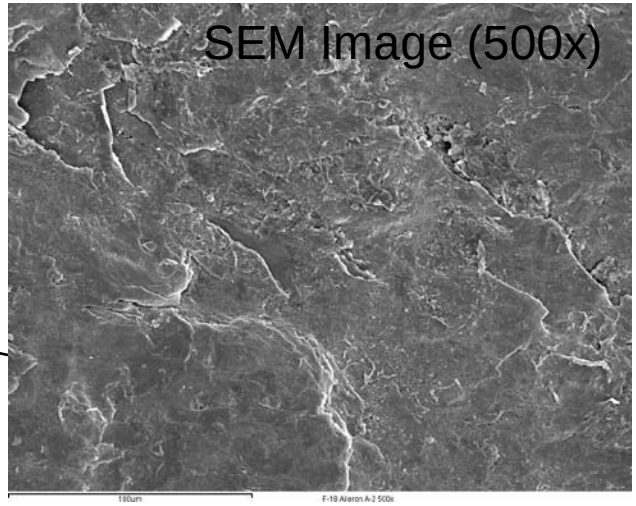
Type VII
4-5 lbs/min, 35 psi, 40-60 angle, 8 inch stand-off



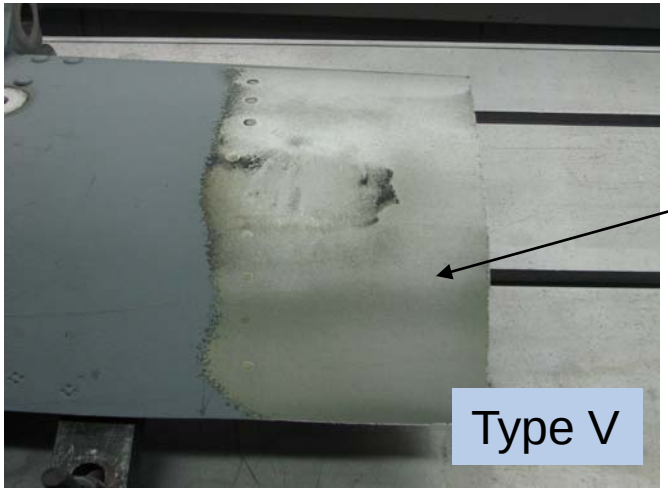
Results (cont…)

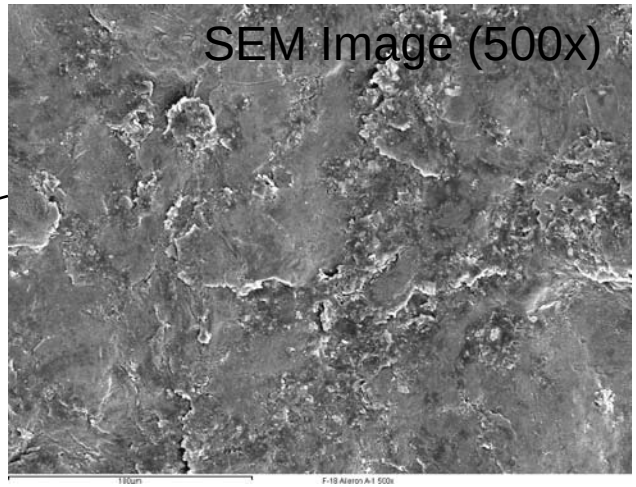
- Post-blast Surface Characterization (Al2024-T3)





Smoother Surface Profile





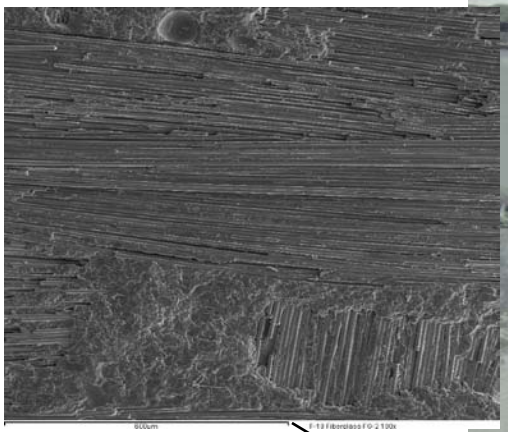
Faster Coating Removal Rate

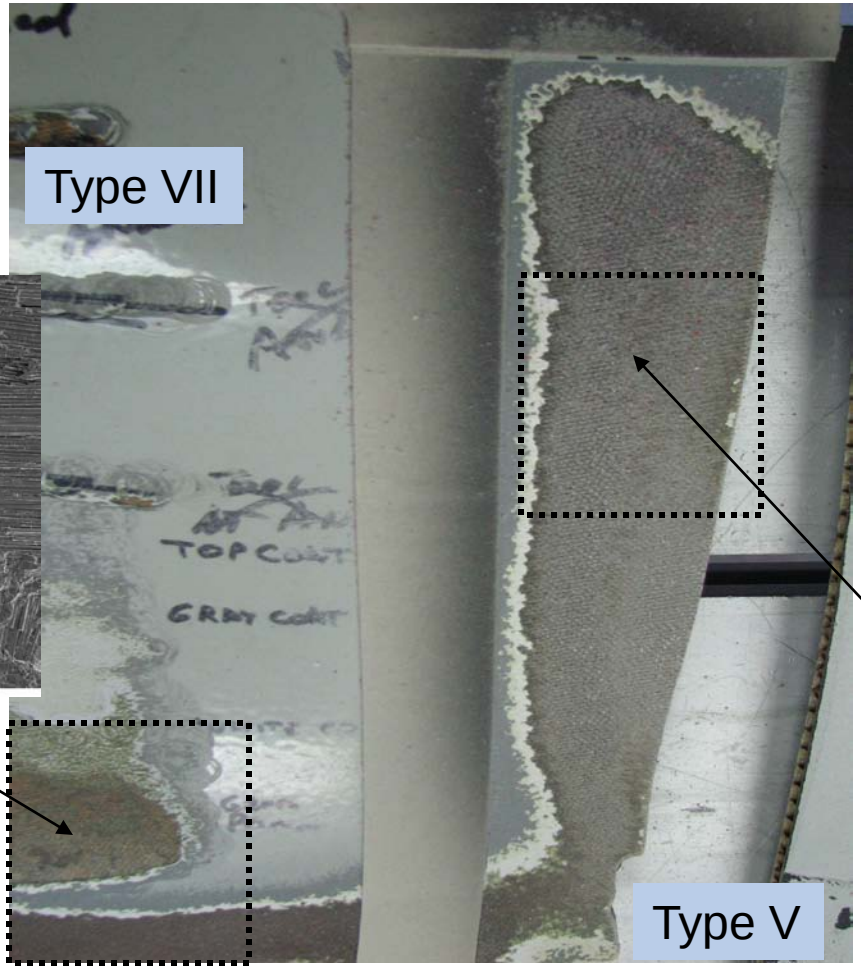
Surface Residues

Results (cont…)

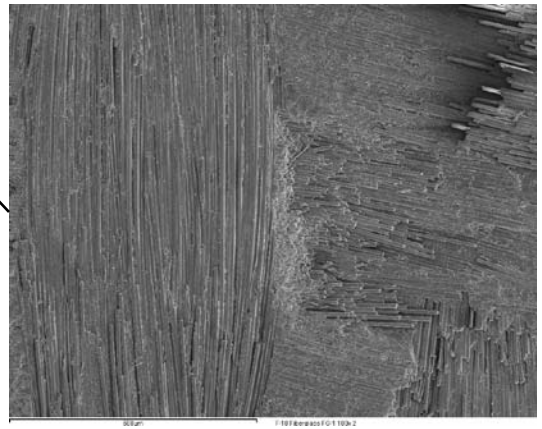
- Post-blast Surface Characterization (Fiberglass Epoxy)

- Resin depletion w/ minimal fiber damage





- Significant fiber damage and resin depletion



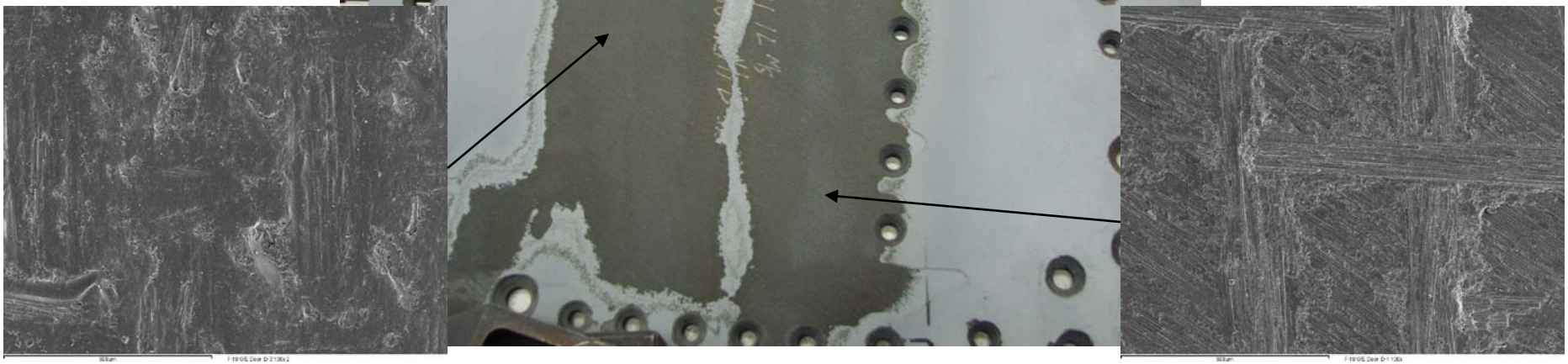
Results (cont…)

- Post-blast Surface Characterization (Graphite Epoxy)

F-18 Graphite-Epoxy Access Door

- Less resin depletion

- Less potential for fiber damage

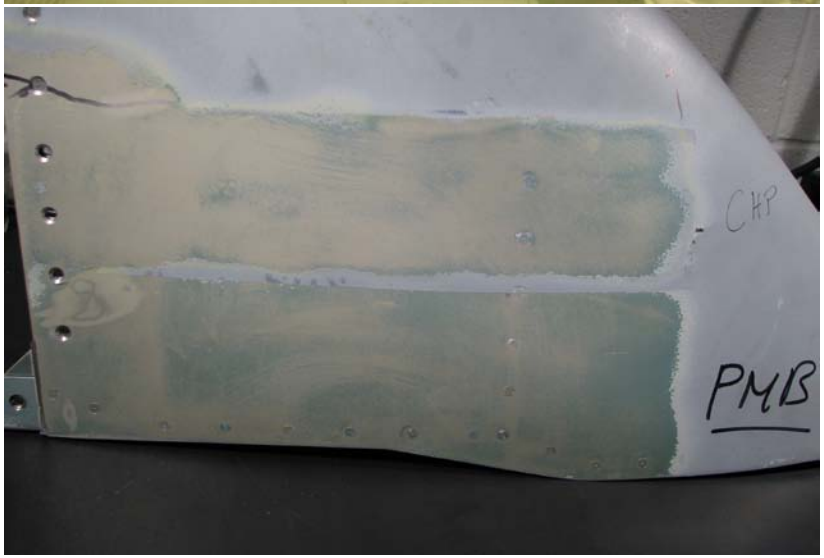


- Slower coating removal rate

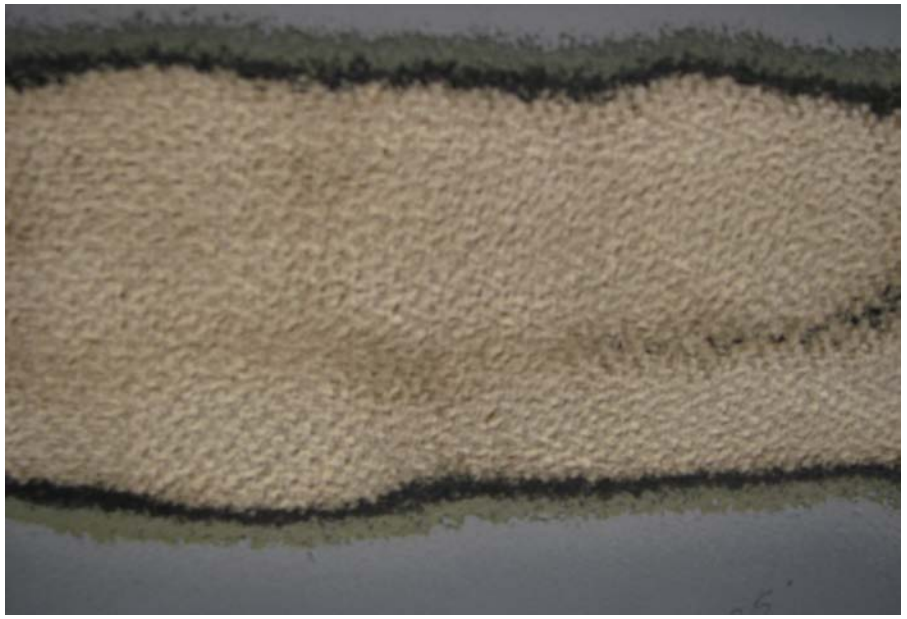
- Resin depletion

Dem/Val Testing

- Use of portable blast equipment to avoid booth contamination
- Conditioned media, optimized blast parameters with ½-inch nozzle
- Multiple composite and metallic parts (F/A-18, E-2, C-2, F-111)
- Depainting completed by FRCSW NI artisans
- Coating removal efficiency, damage assessments and artisan feedback



Dem / Val Testing



Conclusions

The results from optimization and Dem/Val testing confirmed the following advantages over the Type V media being used at the FRCSW NI:

- Coating removal rates for the Type VII GPX media are slightly less for metallic substrates and higher for composite substrates when compared to Type V PMB media. Masking/demasking and post-blast cleaning time considered in comparison
- Type VII media imparts lower residual stress to HS aluminum panels, thus maintaining substrate integrity
- Type VII media does not leave a post-blast surface residue, thus reducing need for solvent wipe-down
- Type VII media effectively capable of removing MIL-PRF-85582 primer and low- high-gloss MIL-P-85285 coatings from aluminum and composite substrates
- Type VII media is less damaging to surfaces of delicate (i.e., thin skin and composite) substrates
- Artisan feedback, demonstration results and cost benefit analysis validates recommendation to proceed with implementation

Points of Contact

- FRCSW NI
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Questions ?????