Air Force Materiel Command

One Materiel Command

Low Temperature Cure Powder Coatings for Aerospace Applications

ESTCP PROJECT
WP-0614

Presented at: NASA/C3P 2008
INTERNATIONAL WORKSHOP ON
POLLUTION PREVENTION AND
SUSTAINABLE DEVELOPMENT

Presenter: Mr. Wayne Patterson
Hill AFB, Utah
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Overview

- Why Powder Coat
- Why Not Powder Coat
- The Technology Today
- Low Temperature Cure Powder Coating (LTCPC)
- ESTCP LTCPC Project (WP-0614)
- LTCPC Application Areas
- LTCPC Current Schedule
- LTCPC Validation Testing
- Substrate Test Summary
- Test Results
- Summary

Why Powder Coat?

- **Eliminates VOCs and HAPs**
- **Eliminates Hazardous Waste**
  - Solvent free, which includes cleanup
  - Eliminates use of hex chrome primers (reduces ESOH concerns)
- **Improved Process Efficiency**
  - No pot life limitations
  - Quicker cure time (minutes/hours vs. days)
  - Quicker equipment prep and clean-up
  - Improved transfer efficiencies
    - High as 95% versus 50 – 60% for wet spray paint

Why Not Powder Coat?

- **Disadvantages of powder coating (past thinking about the technology):**
  - High processing temperature
    - High preheat temperatures – as high as 675°F
    - High cure temperatures – typically as high as 428°F
  - No corrosion protection once barrier protection compromised
  - Part sizes limited by oven dimensions and capacities
  - Faraday Cage effects
  - Film thicknesses less than 1 mil difficult

The Technology Today

- **Today's powders eliminate these limitations**
  - Low temperature cures
    - Thermoset powders can be oven cured at temperatures as low as 230°F to 250°F
  - Corrosion inhibitor packages
    - Barium metaborate and other packages available
  - Newer powder gun technologies
    - Dramatically reduce Faraday Cage effects
    - Improves film thickness uniformity
  - Ultraviolet (UV) and Electron Beam (EB) curing
    - Eliminates need for oven and hence part size limitations

Low Temperature Cure Powder Coating (LTCPC)

- **Developed by GE Global Research, Crosslink Powder and DoD Labs with SERDP funding**
- **Program Results - developed a viable low temperature cure coating:**
  - Cures at 250°F within 30 minutes
  - Corrosion protection built in
  - Performance comparable to conventional solvent borne organic coatings
  - Eliminates need for chromated primer

LTCPC (cont.)

- **Material Advantages**
  - SERDP material met all military ground support equipment requirements for durability, toughness, chemical resistance, gloss, and surface quality
- **Coating met all target performance requirements**
  - Chemical strippability confirmed
  - Cleanability verified using QPL cleaners
  - Complete field repair evaluation verified
  - Weathering and filiform corrosion tests substantiated
- **The Final Product**
  - Acid functional polyester resin and catalyst with triglycidylisocyanurate (TGIC) crosslinker and a barium metaborate type corrosion inhibitor package

ESTCP LTCPC Project (WP-0614)

Taking the LTCPC to the Next Level - Transitioning to the field

This is occurring through an ESTCP funded effort.

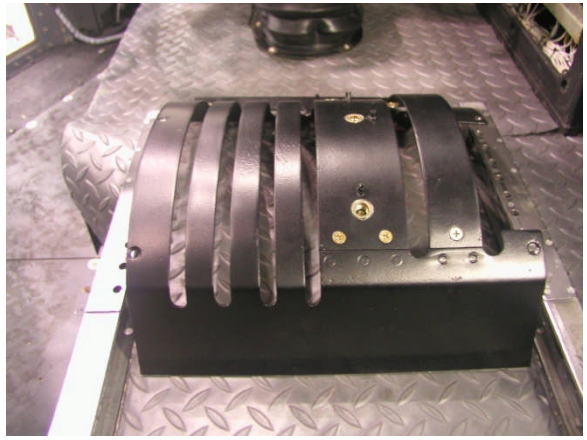
Primary Performers/Stakeholders:

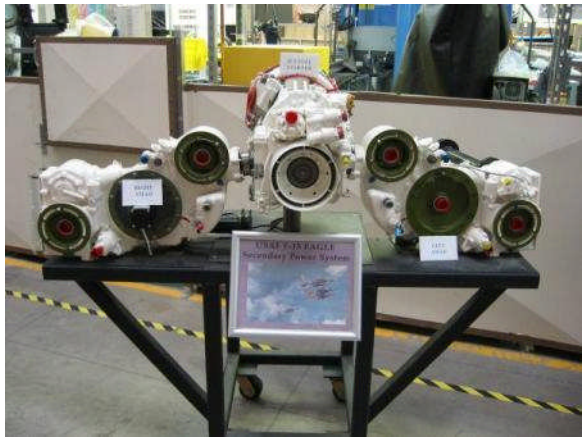
- Air Force Corrosion Office (AFCO)
- Air Force Material Command (AFMC)
- Air Logistics Centers - OC-ALC, OO-ALC, WR-ALC
- Concurrent Technologies Corporation (CTC)
- Crosslink Powder Coatings
- Joint Group on Pollution Prevention (JG-PP)
- National Aeronautics and Space Administration (NASA)
- Propulsion Environmental Working Group (PEWG)
- Science Applications International Corporation (SAIC)
- U.S. NAVY

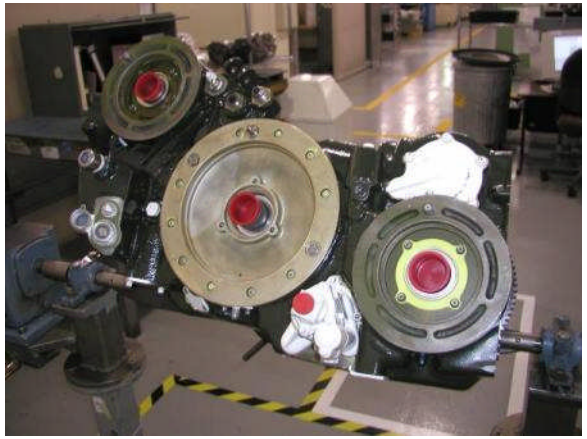
LTCPC Application Areas

Propulsion systems

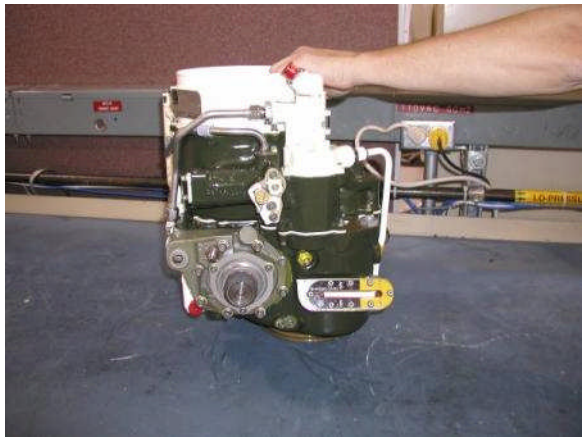
LTCPC Application Areas







Non outer mold line components



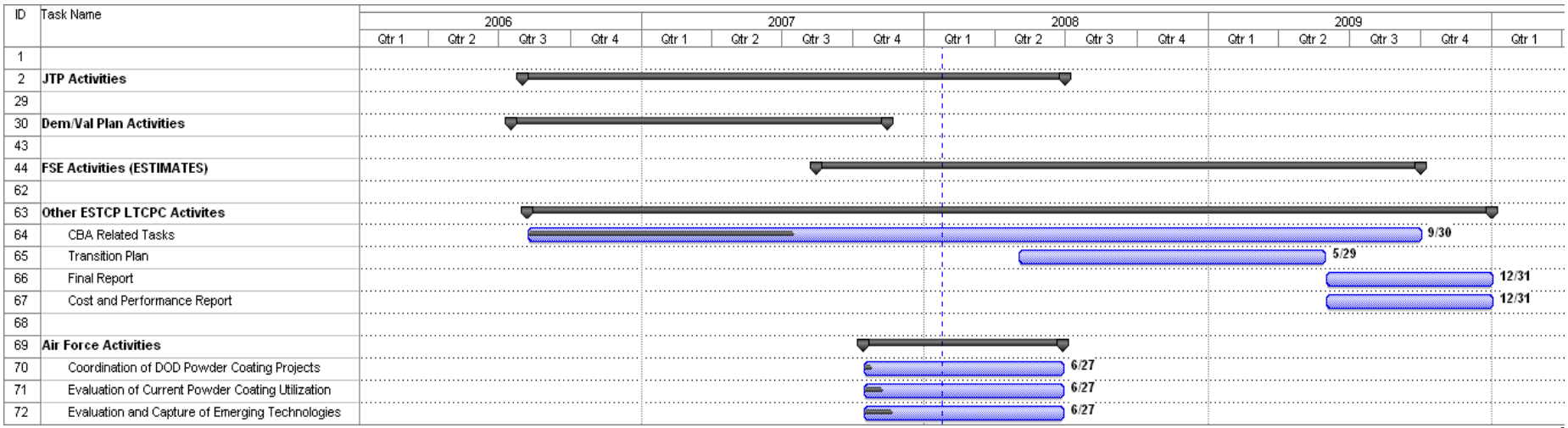
LTCPC Application Areas

Aerospace Ground Equipment (AGE)

LTCPC Current Schedule

- **Major Milestones**
  - Joint Test Protocol – Aug 2006 *Completed!*
  - Demonstration Plan – July 2007 *Completed!*
  - Validation Testing – Nov 2007 *Complete except filiform and LT Flex*
  - Joint Test Report – Jun 2008 *In Process!*
  - Completion of FSE – Aug 2009
  - Cost & Performance Report – Dec 2009
  - Final Report – Dec 2009

Project Schedule



LTCPC Validation Testing

- **Lessons Learned**
  - LTCPC test results demonstrate a conversion coating is required
  - LTCPC less forgiving to substrate cleaning and pretreatment procedural irregularities
  - LTCPC performs best on substrates commonly used in aerospace ground support equipment

Substrate Test Summary

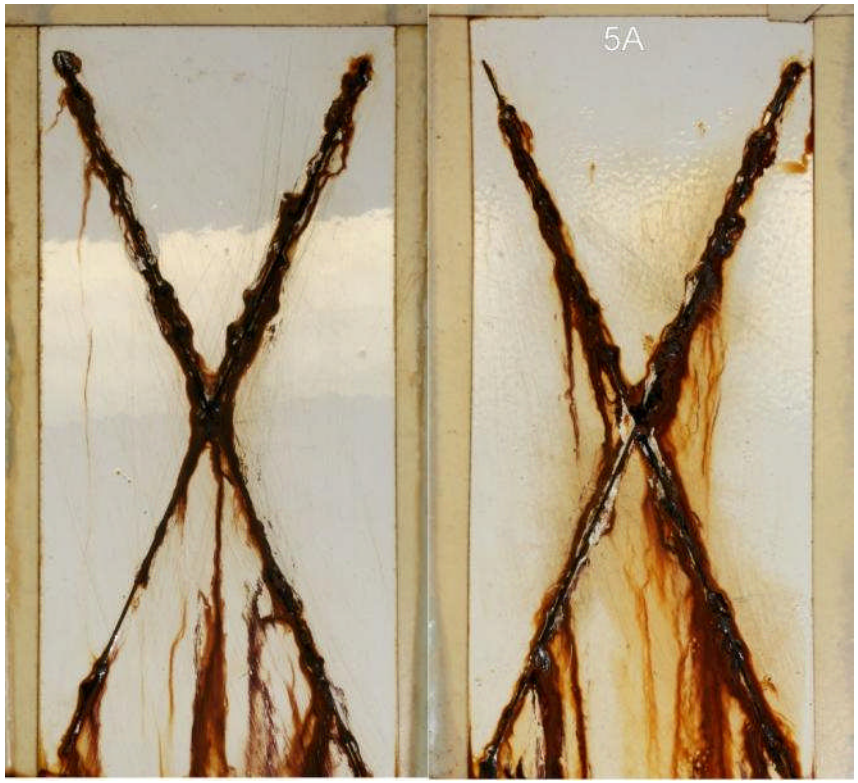
WP-0614 LTCPC JTP Test Results

Substrate	Appearance	Salt Spray	SO2	Cyclic	Filiform	Adhesion	Impact	Strip	Immersion	Humidity	Gravel	Low T Flex
4130 steel	SAME	SAME	SAME	SAME	--	SAME	--	Note 3	--	--	--	--
2024-T0 Al	SAME	--	--	--	--	--	Note 2	--	--	--	--	Note 2
2024-T3 Al (CCC)	SAME	SAME	SAME	--	--	--	--	--	Note 2	Note 2	--	--
2024-T3 Al (No)	SAME	LESS	LESS	--	--	--	--	--	Note 2	Note 2	Note 2	--
6060-T6 Al (CCC)	SAME	SAME	SAME	--	--	--	--	--	--	--	--	--
6060-T6 Al (No)	SAME	LESS	LESS	--	--	--	--	--	--	--	--	--
2024-T3 Clad (CCC)	SAME	SAME	--	BETTR	Note 1	--	--	--	--	--	--	--
2024-T3 Clad (No)	SAME	LESS	--	SAME	Note 1	--	--	--	--	--	--	--
6061-T6 Al (CCC)	SAME	BETTR(note 4)	SAME	--	--	SAME	--	Note 3	--	--	--	--
6061-T6 Al (PK)	SAME	BETTR (note 4)	LESS	--	--	SAME	--	Note 3	--	--	--	--
AZ31B Mg (Dow)	SAME	SAME	--	--	--	SAME	--	Note 3	--	--	--	--

Legend: LESS=Less than control SAME=Same as control BETTR=Better than control

Note 1: Marginal - Some filiments were up to 0.28 inch. (Being redone with controls)
Note 2: Met requirements in the MIL Standard.
Note 3: Non methylene chloride stripper effective.
Note 4: Exceeded 3300 hrs in salt spray

Test Results



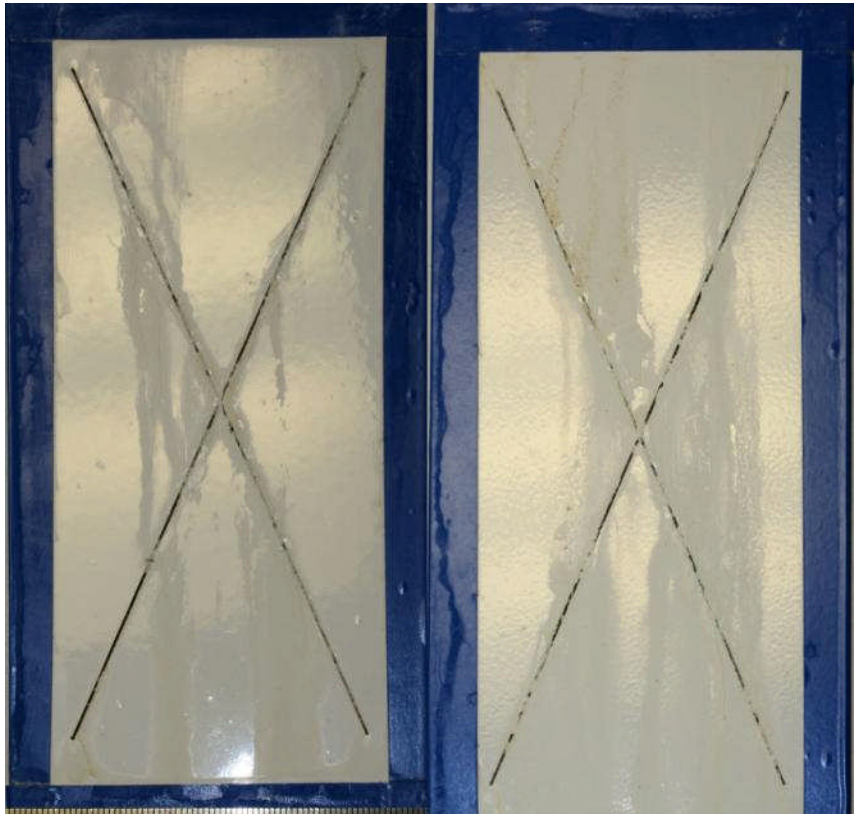
MIL-PRF-53022/85285 Powder Coat
Salt Spray on 4130 steel w/$MnPO_4$ pretreat
1600 hours

MIL-PRF-53022/85285 Powder Coat
GM9540P Cyclic on 4130 steel
w/$MnPO_4$ pretreat, 80 cycles

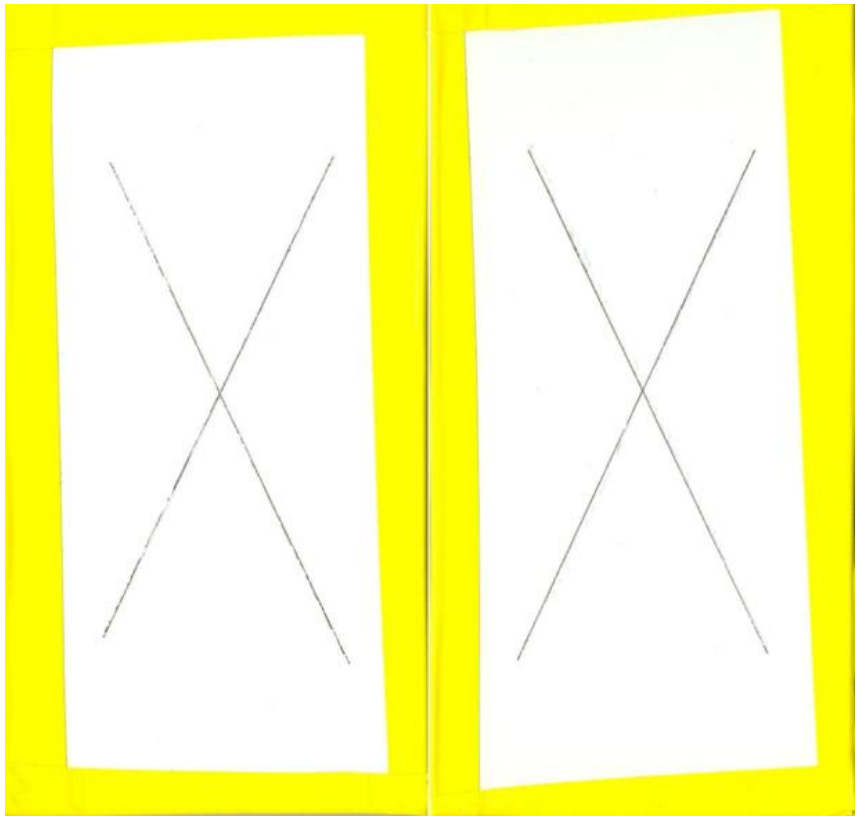
Test Results

MIL-PRF-53022B/85285 Powder Coat
SO_2 on 4130 steel w/$MnPO_4$ pretreat
500 hours

Test Results



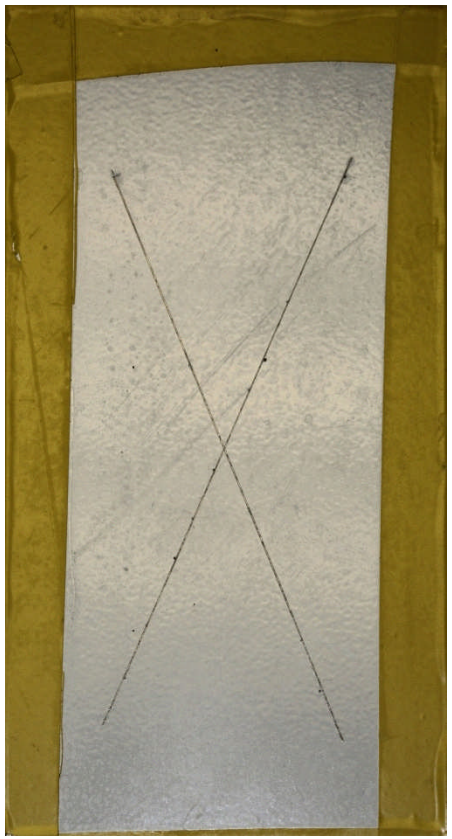
MIL-PRF-23377/85285 Powder Coat
Salt Spray on 2024-T3 Al w/Alodine 1200s
2000 hours



MIL-PRF-23377/85285 Powder Coat
SO_2 on 2024-T3 Al w/Alodine 1200s
500 hours

Test Results

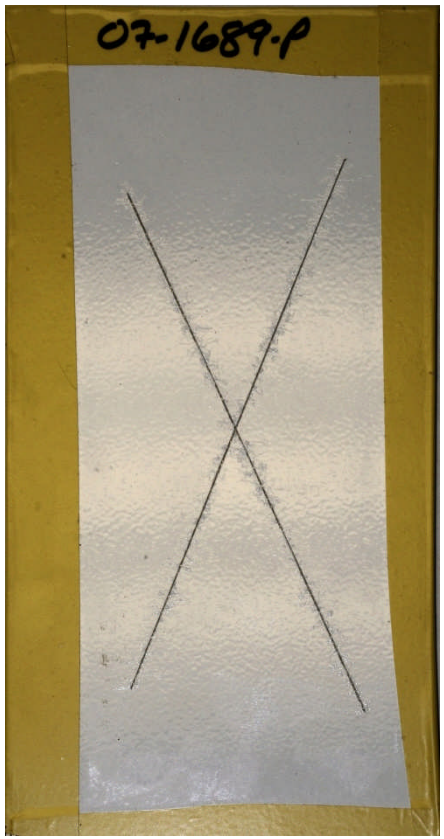
MIL-PRF-23377/85285 on 2024-T3 Clad
GM9540P Cyclic 80-cycles



Powder Coat on 2024-T3 Clad
GM9540P Cyclic 80-cycles

Test Results

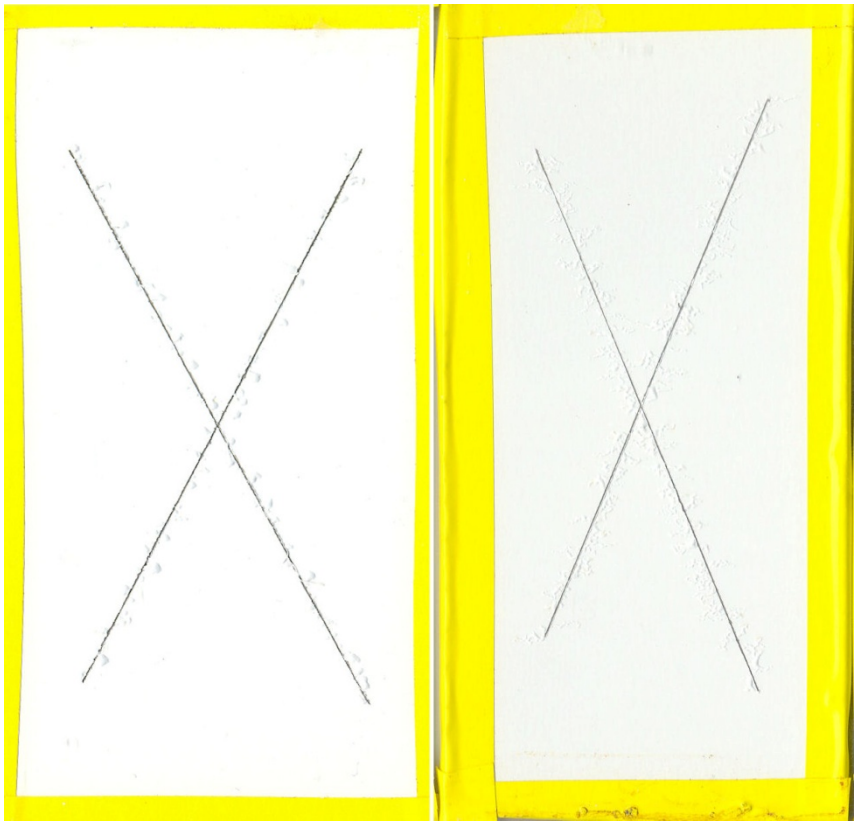
MIL-PRF-85285 on 2024-T3 Clad
Filiform Corrosion Resistance



Powder Coat on 2024-T3 Clad
w/Alodine 1200s
Filiform Corrosion Resistance

Test Results

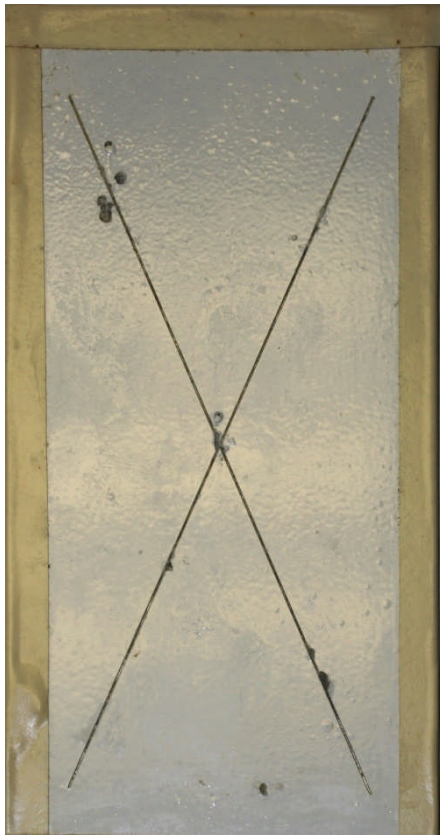
MIL-PRF-23377/85285 Powder Coat
Salt Spray on 6061-T6 Al w/Alodine 1200s
3400 hours



MIL-PRF-23377/85285 Powder Coat
SO_2 on 6061-T6 Al w/Alodine 1200s
500 hours

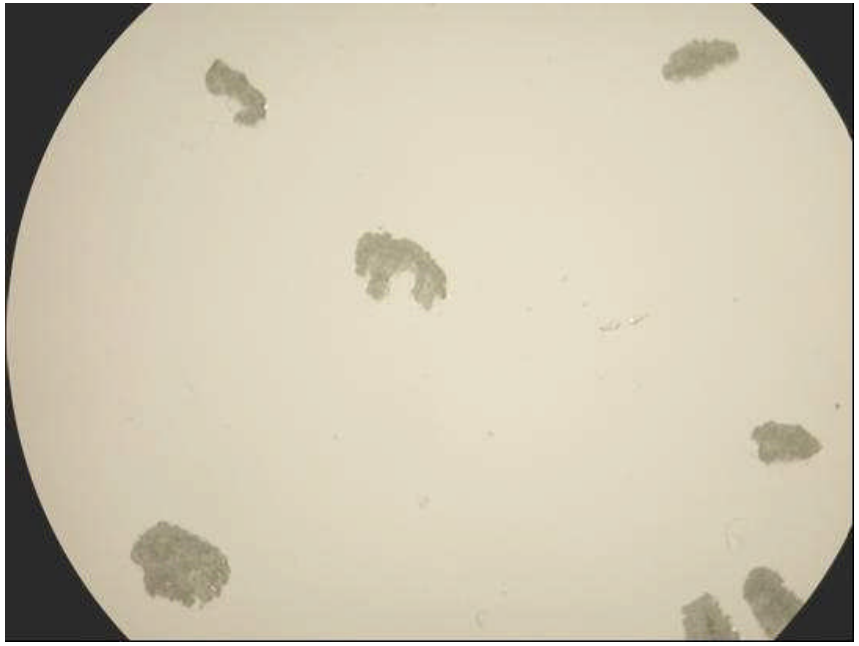
Test Results

MIL-PRF-23377/85285
B117 Salt Spray 2000 hrs.
AZ31B Magnesium w/Dow7 pretreatment

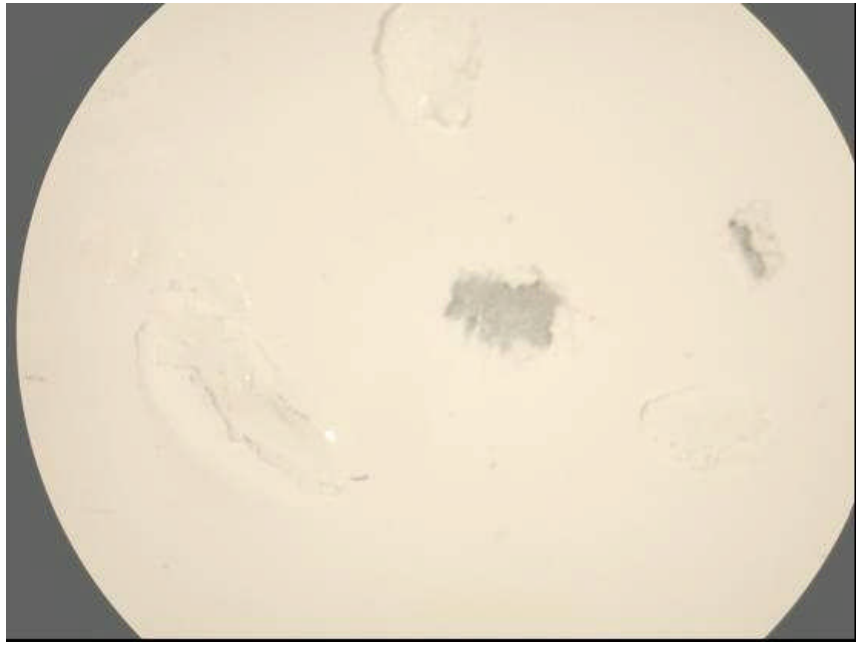


Powder Coat
B117 Salt Spray 2000 hrs.
AZ31B Magnesium w/Dow7 pretreatment

Test Results

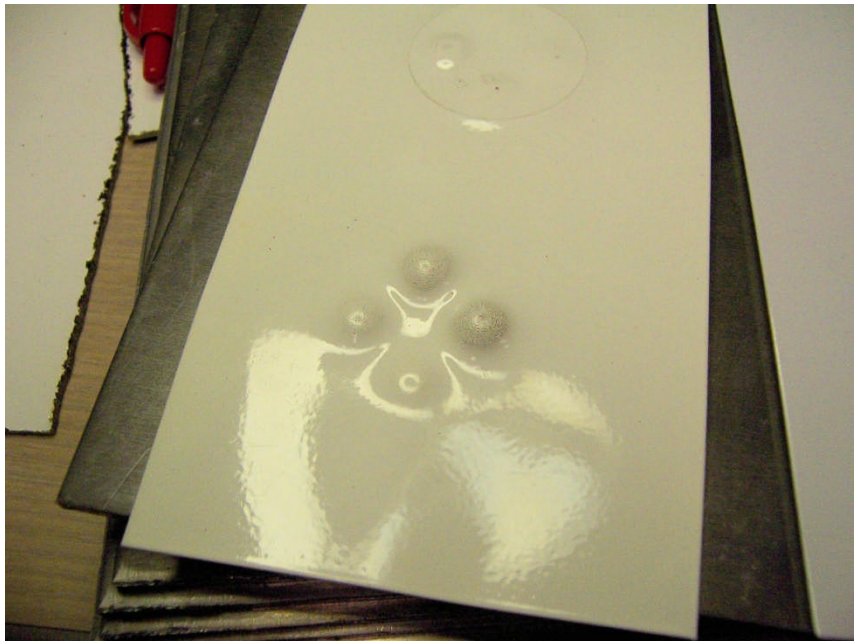


MIL-PRF-23377/85285
Gravelometer results

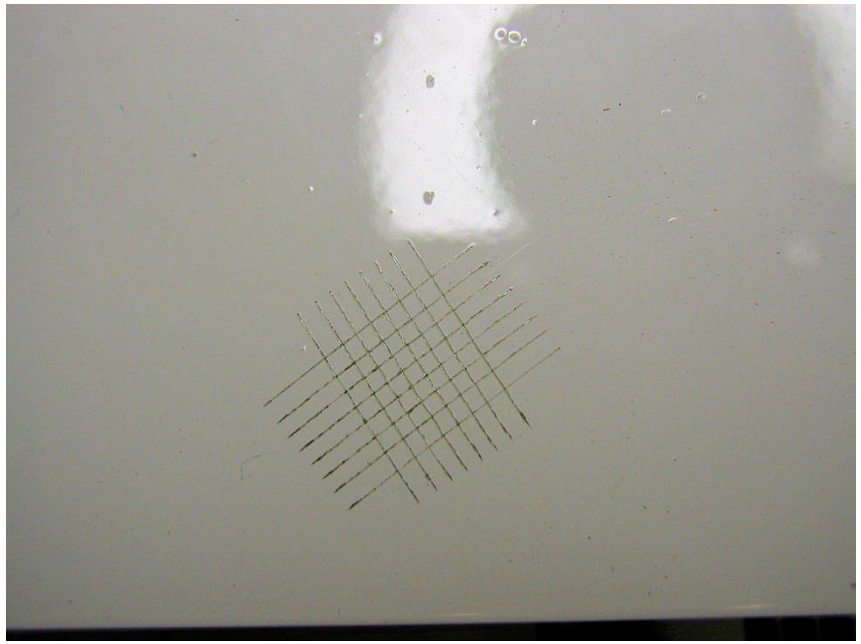


Powder Coat
Gravelometer results

Test Results



Powder Coat
Impact Flexibility



Powder Coat
Cross hatch adhesion

Summary

- **Filiform testing is being redone with controls**
- **Air Force Corrosion Office testing**
- **Field Service Evaluation continues**
  - Navy GSE components in field operations today
  - Air Force component list to change
    - F-15 AMAD and F-16 ADG changes
    - Minuteman missile Ground Support Equipment components
    - Required a change/approval to the ESTCP Demonstration Plan
    - Other components (C-130 doors, TF-33 stators) in process

Questions?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