Electrocoat Process for Non-chromate Primers in DoD Manufacturing

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Electrocoat vs. Spray Application

Conventional Spray Coating Process

Electrocoat process
What is Electrocoat?

- **Proven Technology**
  - Commercially used by industry for over 50 years

- **Environmentally Friendly**
  - Aqueous Process
  - No Chromium or other toxic metals
  - Environmentally Friendly

- **Automated Process**

- **Enables Coating of Complex Parts**

- **Excellent Corrosion Resistance**
Electrodeposition Process

- Application method using electrical current to deposit a coating (aqueous dispersed resins and pigments) onto a conductive substrate
- Several screening studies proved Anodic Electrocoat best choice for Aluminum and their alloys in terms of paint adhesion & corrosion protection

Part is the anode
⇒ Deposition of paint film

Crosslinking of paint film requires thermal cure cycle
⇒ Cure Temperature 200°F (93°C)
The electrocoat system—Four stages:

- Cleaning & pretreatment
- Electrocoat tank - primer application
- Two or more rinse tanks
- Oven (thermal cure)

Electrocoat Process Stages

From Pretreatment

Electrocoat

1st Rinse

DI or RO Rinse

30 min @ 200°F

Metal temp

To Oven
# Why E-Coat – Advantages

## Application & Process
- Precise film build control
- Uniform film thickness
- No runs, drips, or sags
- Throwpower
- Ability to coat complex-shaped parts
- Closed loop process

## Productivity & Efficiency
- High transfer efficiency
- Coats recessed areas
- Automated system: minimal labor
- Non-uniform line loading
- Immediate part handling after thermal cure

## Performance
- Excellent barrier / corrosion resistance properties
- AMS 3144 qualified product
- Weight savings vs. spray primer

## Environmental, Health & Safety
- Aqueous based – low solvent emission
- Chrome-free
- Minimal waste discharge
- Minimal exposure of workers to hazardous materials
- Reduced fire hazard
• Task 8 of AFRL contract #FA8650-05-C-5010

• Electrocoat Process for Non-Chromate Primers in DoD Manufacturing (Navy – Coast Guard – AF)
  – ESTCP Project WP-201010
  – Tested Against Joint Test Protocol under ESTCP program
  – Equal to or better than the commercial non-chrome control

• Aerocron 2100 qualified to AMS 3144: Primer, Anodic Electrodeposition for Aircraft Application

• Aerospace Electrocoat Primer Technology Process Introduction
  – ESTCP Project WP-201568T2
# Technical Results – ESTCP WP201010 Joint Test Protocol Report

<table>
<thead>
<tr>
<th>Test</th>
<th>Comments</th>
<th>Meets specifications</th>
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<tbody>
<tr>
<td>Salt spray</td>
<td>Equal to or better than MIL-PRF-23377*</td>
<td>✓</td>
</tr>
<tr>
<td>Filiform</td>
<td>Equal to MIL-PRF-23377*</td>
<td>✓</td>
</tr>
<tr>
<td>GM9540P</td>
<td>Equal to MIL-PRF-23377*</td>
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<tr>
<td>SO₂</td>
<td>Mixed results</td>
<td>NR</td>
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<tr>
<td>Exposure Galvanic</td>
<td>Equal to or better than MIL-PRF-23377*</td>
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<tr>
<td>Salt spray Galvanic</td>
<td>Mixed results</td>
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<tr>
<td>SO₂ Galvanic</td>
<td>Mixed results</td>
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<tr>
<td>Flexibility</td>
<td>Equal to MIL-PRF-23377*</td>
<td>✓</td>
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<tr>
<td>Impact</td>
<td>Equal to MIL-PRF-23377*</td>
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<tr>
<td>Wet/ Dry Adhesion</td>
<td>Equal to MIL-PRF-23377*</td>
<td>✓</td>
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<tr>
<td>Fluid Resistance</td>
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<tr>
<td>Water Resistance</td>
<td>Equal to MIL-PRF-23377*</td>
<td>✓</td>
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</tbody>
</table>

*Type 1 Class N

NR – Not Required
## AMS3144 Test Results Summary

### Qualification Testing for Aerocron®

<table>
<thead>
<tr>
<th>Quality</th>
<th>Color</th>
<th>Thickness</th>
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<tbody>
<tr>
<td>Hardness</td>
<td>Flexibility Impact Resistance</td>
<td>Flexibility Low Temperature</td>
</tr>
<tr>
<td>Flexibility Elongation</td>
<td>Adhesion Wet Tape</td>
<td>Adhesion Dry Tape</td>
</tr>
<tr>
<td>Compatibility Topcoat</td>
<td>Compatibility Repair Primer</td>
<td>Compatibility Sealant Adhesion</td>
</tr>
<tr>
<td>Fluid Resistance</td>
<td>Humidity Resistance</td>
<td>Solvent Resistance</td>
</tr>
<tr>
<td>Corrosion Resistance Neutral Salt Spray</td>
<td>Corrosion Resistance Filiform</td>
<td>Corrosion Resistance SO2 salt spray</td>
</tr>
<tr>
<td>Rain Erosion</td>
<td></td>
<td>Strippability</td>
</tr>
</tbody>
</table>

Indicates passing result

PRI-QPL-AMS3144 – Listing Nov 2014
Additional Testing – Mini JTP – in process

• **Air Force Specific Testing Request from Tinker AFB**
  - Adhesion with CPC coatings & repair primers
  - Heat resistance at elevated operating temperature (tubing)
  - Corrosion performance with alternative NC pretreatments
  - Bonded Honeycomb structures
E-Coat Field Testing – Part ID

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**E-3**
1 Aircraft

- Saddleback Fairing

**KC-135**
3 Aircraft

<table>
<thead>
<tr>
<th>Engine #</th>
<th>Nacelle Part #</th>
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<tr>
<td>1</td>
<td>65C20608-503</td>
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<td>2</td>
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<td>65C20607-504</td>
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<tr>
<td>4</td>
<td>65C20608-504</td>
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</table>

- Latrine Access Panel
E-Coat Field Testing - Application

- **US Coast Guard**
  - Ecoat System
    - ALC Elizabeth City, NC
  - Supported ESTCP dem/val program with ecoat application for flight test parts
E-Coat Field Testing - Results

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E-Coated parts performing as well as or better than the controls

E-3: 6 mo.@Tinker AFB

KC-135: 12 mo.@Pease AFB
Technology Transition Project

**WP-201568T2 Objective:**

- Reduce time to implement E-coat primer for aircraft
- Produce print and video training materials
- Conduct cross-functional training workshops for stakeholders at 4 Air Force locations
- Evaluate hands-on training vs. video effectiveness

- **E-coat classes @ ALCs (Hill, Tinker, Robins) & WPAFB**
  - 60+ engineers & coatings personnel attended

- **ASETS Defense & AF Corrosion Conference**
Preliminary Evaluation Process (5 Key Factors)

1. Stability
2. Producibility
3. Characterized Mechanical & Physical Properties
4. Predictability of Performance
5. Supportability
Tinker Process Analysis

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AF – DLA (outside of CMXG’s authority)

(A) DLA piece-parts
~ 250,000 parts/yr
assuming 50% replacement factor for FY-12 end-item production

(B) Manufacture shop
~ 50,000 parts/yr
Avg last 3 yrs

(C) Off aircraft parts
~ 1627 end-items/yr
Tabs = 955
B-52 wrap cowls = 381
Foreflaps = 175
Slats = 116

(D) Tubing shop
Approx 60%
Of KC-135 tubing workload require primer
CMXG Commodities Shop

- Parts stripped
- Respective weapon systems evaluate parts
- No additional repair required
- Surface prep
- Paint shop (primer / topcoat)
- Respective weapon systems evaluate parts
- Part released for use

Potential E-coat Insertion Point

- Sheet metal repair shop
- Parts continue in this loop until deemed acceptable for surface preparation

- Repair required
- Weight and balance check
- Parts continue in this loop until deemed acceptable for weight and balance

Duration:
- 1 – 2.5 hrs
- 3 – 3.5 hrs
Next Steps

• Continue monitoring parts on E-3 & KC-135
• Complete Cost Benefit Analysis at Tinker AFB
• Complete Airworthiness Process
  – Presentation to Change Evaluation Team (CET)
• Work with AFLCMC to transition E-coat
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Presented to

PPG Industries

for the development of

Aerocron® 2100 Electrocoat Primer

Selected as

One of the 100 Most Technologically Significant
New Products of the Year in Mechanical/Materials

2016

Bea Riemschneider
R&D 100 Awards Editorial Director
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AIR FORCE RESEARCH LABORATORY