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Chemical Reactivation as a Method for Replacing Scuff Sanding and for Applying Stencils on Aerospace Topcoats

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Why is Reactivation of Aerospace Topcoat Required?

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Examples of In-Service Polyurethane to Polyurethane Adhesion Failures

Between Livery Topcoats



On Painted Stencils



Key Properties of Aerospace Topcoats

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Key Properties

- **Gloss and Color Retention**
- **Hydraulic Fluid Resistance**
- **Flexibility**
- **UV Resistant**
- **Abrasion Resistant**
- **Corrosion Control**

A consequence of achieving a balance of properties is a highly cross-linked, durable, and inert outer surface that is difficult for subsequent coatings to adhere to.



Baseline Reactivation Method for Aerospace Topcoats: Mechanical Abrasion

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Surface Prep

Prime



Apply first topcoat over entire body, then cure



Mask for first accent color

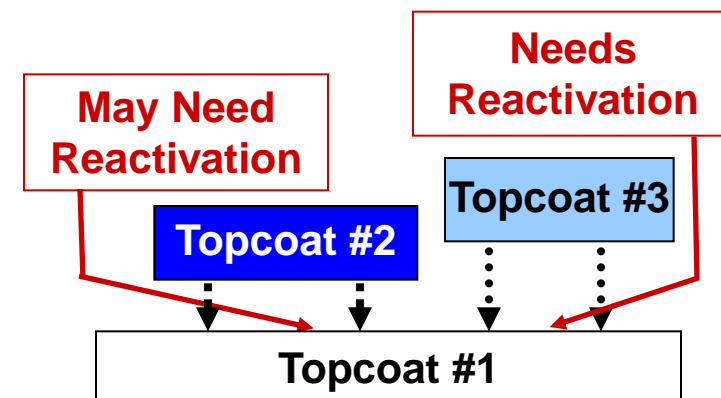


Mechanical abrasion reactivation then remove sanding residue with a tack rag



Apply topcoat, cure, then repeat process steps for additional colors

- Complex liveries require successive topcoat applications.
- Boeing requires a reactivation method for topcoated surfaces ambient cured for more than 48 hours or force cured for more than 4 hours above 105 F.
- Hand applied mechanical abrasion increases ergonomic related injuries, is non-uniform, and is a contamination producer.



Advantages of a Chemical Reactivation Method

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Environment/Safety

- Eliminate injuries due to excessive mechanical abrasion

Production Efficiency

- Reduce flow time

Performance

- Improve durability with more uniform application

Stencils

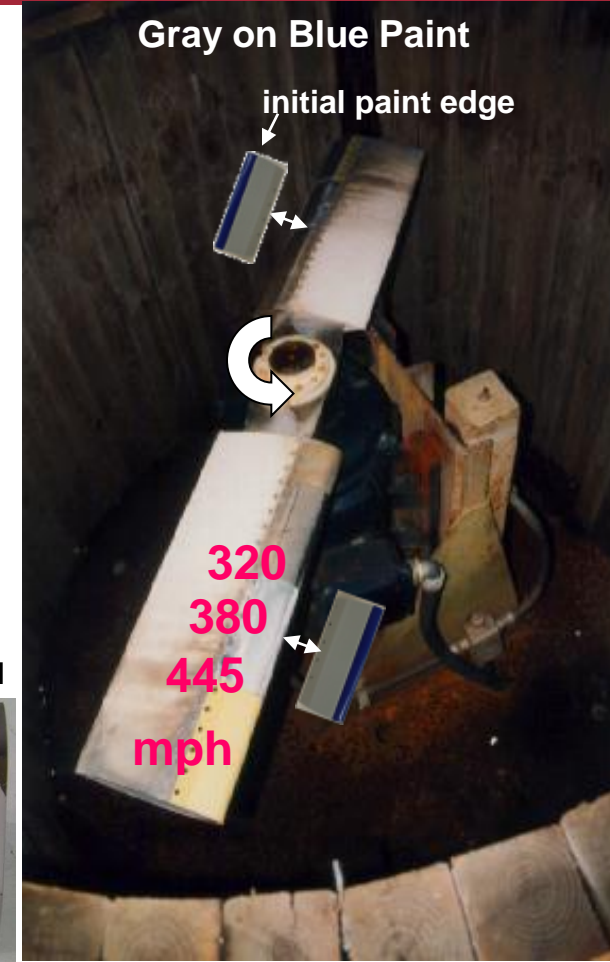
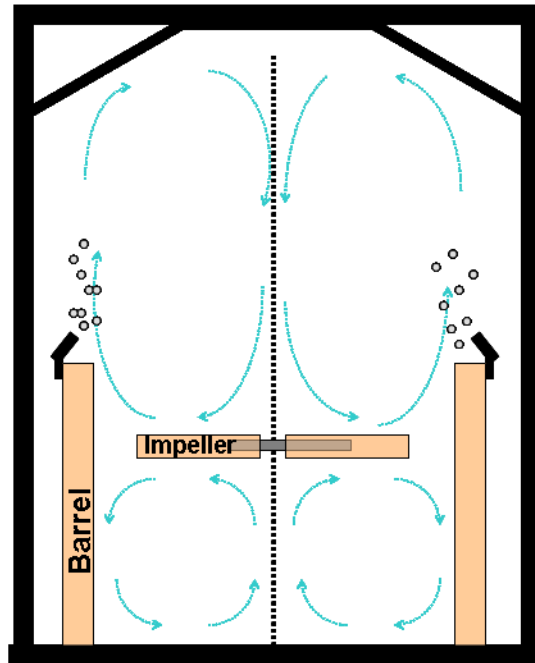
- Small size and intricacy of lettering eliminates mechanical abrasion as a viable reactivation method



Rain Erosion – A Key Screening Test

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- A passing result has $\frac{1}{4}$ inch tear length or less from tape edge.
- Rain erosion is good at finding the weakest interface when multiple coatings are applied.

Rain Erosion Results – Chemical Reactivation Equivalent to Mechanical Abrasion

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Large Paint Area (Thick overcoat film) (Topcoat Brand X)

High Humidity Cure: 12 hour, 120°F

Not
Abraded



Abraded



Low Humidity Cure: 12 hour, 120°F

Not
Abraded



Abraded

Controls:
Not Abraded
or Abraded

Paintbond SM-1
(Sur-Prep AP-1)
Reactivator
BMS10-127

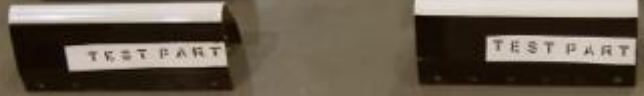
Stencil Lettering (Thin overcoat film) (Topcoat Brand Y)

High Humidity Cure: 12 hour, 120°F

Not
Abraded



Abraded



Low Humidity Cure: 12 hour, 120°F

Not
Abraded



Abraded



Controls:
Not Abraded
or Abraded

Paintbond SM-1
(Sur-Prep AP-1)
Reactivator
BMS10-127

Boeing/CSIRO Joint Formulation Paintbond SM-1

US Patent Application 20080050598

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- **Paintbond SM-1**

- Proprietary reactivator co-developed by Boeing and CSIRO
- Zirconium (Metal) alkoxide in solvent formulation
- Toll produced for Boeing by Zip-Chem® Products as Sur-Prep AP-1

- **Low fly away weight** (< 0.3 lb /1000 sq ft of coverage)

- **Optimized for exterior decorative topcoats** (BMS10-72 and BMS10-125)

- **Solvent based**

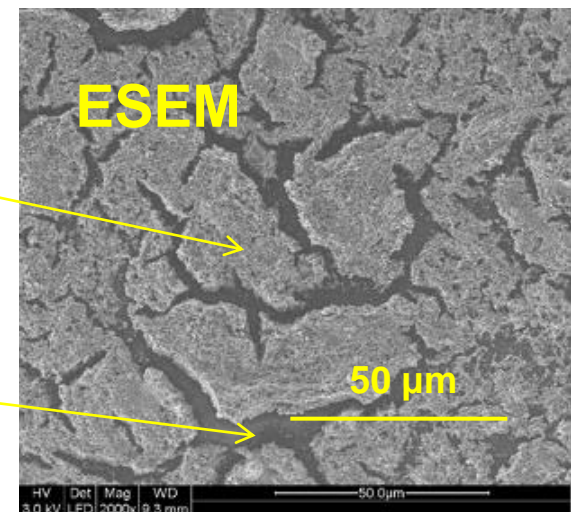
- **Glycol ether:** non-HAP, biodegradable, low VP (0.55 mm Hg at 68°F)
- **Alcohol:** non-HAP, biodegradable
- **ANESHAP compliant** (860 gm/liter)
- **600-1500 sq ft / gal coverage**

Top View of Applied Reactivator



Paintbond SM-1

Substrate



Application Process for Large Areas Gallon and Pint Size – 2 Part Kits

1. **Mask areas not to receive reactivator and subsequent overcoat**
2. **Remove contamination**
3. **Mix – 2 part kit**
 - **Pour Part A into Part B**
 - **Reseal Part B and shake 5 minutes**
 - **Pour into use container**
 - **Keep use container covered until ready for application**
4. **Spray**
 - **Spray apply with preferred equipment.**
 - **Apply one coat that completely wets the surface. Avoid misting.**
 - **Over-application creates a long solvent flash-off which may induce edge attack of maskant materials**
5. **Ambient dry for 30 minutes minimum**
 - **Visual gloss will go flat as it dries due to the formation of a fine white powder**
6. **Overcoat with subsequent topcoat as soon as possible to avoid contamination, however passing data has been obtained up to 24 hours before overcoat.**
7. **Cure per process document**



Aerosol for Stencil Applications and Small Areas

Sur-Prep AP-1 pre-blended then injected into cans along with liquid propellant

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Promoter

After Application



Promoter Application

Final Product

Implementation

➤ June 2008: First Production Trial on 737 (SWA)

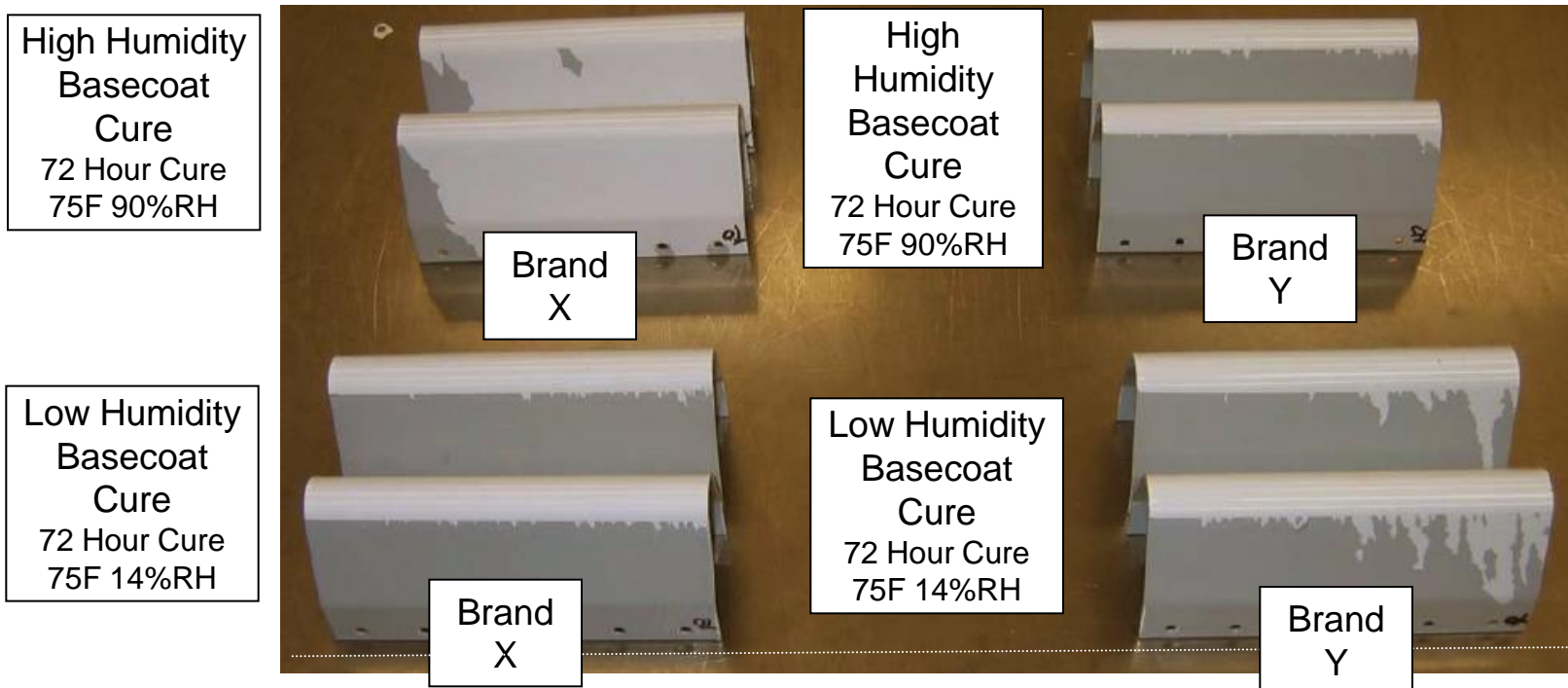
First 737 14 months later



- Sept 2008: First Qualified on D6-1816
- May 2009: First 777
- July 2009: First C-17 (BMS10-72 paint)
- May 2010: First 767 Use
- May 2010: First 787 Use
- Feb 2011: First 747 Use



Key Lesson Learned – Humidity Effects



- **Humidity during cure of polyurethane substrate is a key variable when evaluating a coating's ability to be chemically reactivated.**
- **For most but not all topcoat brands, low humidity cure was the most favorable for chemical reactivation.**
- **Recommend that future coating evaluations involve controlled curing at both ends of the humidity range.**

Summary

- **A chemical reactivator for intercoat bonding of livery colors to replace mechanical abrasion of paint hangar cured paint has been developed.**

Implementation has reduced

- Ergonomic injuries
- Dust exposure and rework due to dust contamination
- Paint hangar flow time

Implementation should

- Improve the uniformity of intercoat livery bonding and the durability of stencils
- Reduce the need for field repair touch-up and paint usage



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Backup Slides

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Paintbond SM-1 Qualification Testing

Engineering Tests:

- **Rain Erosion**
- Dry & Wet Scribe
- Condensing Humidity
- Impact Adhesion
- Conical Mandrel Bend
- Fluid Resistance Low
- Temperature Shock
- Thermal Moisture Cycling
- Acrylic Crazeing
- Sandwich Corrosion
- Metal/Composite Compatibility
- Sealant Compatibility
- Paint Stripability

Manufacturing Tests:

- **Define Limits of Use on Paint Hangar Topcoat**
- **Define Promoter Application Window (T, RH)**
- Ability to mix and use (Pot and Storage Life)
- Sprayability
 - ✓ HVLP, Electrostatic, air assisted airless paint guns
 - ✓ Electrical resistivity
- Cover with less than two paint coats
- Process Equipment Compatibility
- Pre-mask/Stencil/Paper Compatibility
- Promoter (Overspray) Removability
- Waste/Environmental Assessment
- Shop Trials (Large Panel & Tube)