Interagency Depainting Study Status

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Regulatory Background

- The National Emission Standards for Hazardous Air Pollutants for Aerospace Manufacturing and Rework Facilities (Aerospace NESHAP) regulates Depainting Operations

  limits methylene chloride usage for coating removal

  commercial: 26 gallons/craft/year

  military: 50 gallons/craft/year
Regulatory… (Continued)

- Initial Aerospace NESHAP promulgated in **September 1995** - subsequent versions exist.
- First substantive compliance date for existing sources is **September 1998**.
- The Occupational Safety & Health Administration (OSHA) established stringent Permissible Exposure Limits (PEL) effective April 1997.
Partners are:

- EPA
  Emission Standards Division (ESD)

- NASA
  Headquarters, Code JE
  Marshall Space Flight Center (MSFC)

- USAF
  Robins Air Force Base (RAFB)
  Wright Patterson Air Force Base (WPAFB)
Committees are:

- Executive Steering Task Force (ESTF)
  comprised of EPA/HQ, EPA/ESD, NASA/HQ, and NASA/MSFC

- Technical Implementation Committee (TIC)
  comprised of NASA/MSFC

- Technical Advisory Committee (TAC)
  comprised of EPA/ESD, NASA/HQ, NASA/MSFC, USAF/WPAFB, USAF/WRAFB, USCG, General Aviation and Airline Industry
Processes Being Evaluated

- Chemical Stripping
- COLDJET™ (CO$_2$ Blasting)
- TOMCO$_2$ (CO$_2$ Blasting)
- FLASHJET™ Coating Removal
- Laser Stripping
- Plastic Media Blasting
- Sodium Bicarbonate Wet Stripping
- Water Stripping
- Wheat Starch Blasting

* COLDJET™ and TOMCO$_2$ processes deleted from evaluation after 1st stripping.
Initial Parameters of the Study

- **Substrates**
  - 2024-T3 clad Al, in 64, 32, and 16 mil thicknesses
  - 2024-T3 non-clad Al, in 64, 51, and 16 mil thicknesses

- **Paint System**
  - primer: MIL-P-23377F, Type 1, Class 2
  - topcoat: MIL-C-83286B, urethane

- Five sequences of panel preparation and stripping.
Current Parameters of the Study

- Substrates - no change
- Paint System (implemented in 2\textsuperscript{nd} sequence)
  - primer: no change
  - topcoat: MIL-C-85285B (high solids, low voc)
    - previous topcoat no longer available from vendor
- Three to five sequences of panel preparation and stripping.
Stages in Each Sequence

- Coating Application
- Measurements - coating thickness
- Aging
- Stripping
- Measurements - substrate thickness, surface roughness
- Specimen Cleaning - WBF surface
- Chromate Conversion
- Measurements - substrate thickness and weight, surface roughness
- Repeat for next sequence
• Cleaning Steps:
  MEK hand clean.
  Vapor degrease with perchlorethylene, 10 min.
  Immerse in Turco 4215, 25 min.
  Hot DI water rinse, 5 min.
  Immerse in Turco Smut-Go #1, 11 min.
  Cold DI water rinse, 5 min.
  WBF test, DI water.
Test Specimens ..... (Continued)

- Aging Steps per *ISO/SAE MA4872*:
  - Precondition: 12 hours @ 120F, 95%RH
  - Hold at -65 for 1 hour
  - Thermally cycle for -65F to 160F 400x.
  - Return to chamber to ambient temperature.
  - Repeat steps 1-3.
Material Evaluation Testing

- Fatigue and Tensile - baseline & final stripping
- Sandwich & Immersion Corrosion - completed
- Hydrogen Embrittlement - completed except for Gage
- Crack Detectability - PMB, Wheatstarch, Sodablend
- Clad Penetration - baseline & final stripping
- Surface Roughness - on-going
- Material Loss, Change in Thickness - on-going
Status to Date

- Current process status:
  - Chemical Stripping: completed 4 of 5 stripplings
  - COLDJET™: dropped from study
  - TOMCO₂: dropped from study
  - FLashjet™: completed 3 of 3 stripplings
  - Laser Stripping: completed 2 of 3 stripplings
  - Plastic Media Blasting: completed 3 of 4 stripplings
  - Sodium Bicarb. Wet Stripping: completed 3 of 3 stripplings
  - Water Stripping: completed 3 of 3 stripplings
  - Wheat Starch Stripping: completed 3 of 3 stripplings
Next Steps

- Conclude stripping sequences.
- Initiate final material testing to compare to baselines.
- Evaluate process performance.
- Provide conclusions to EPA.
- Targeted conclusion of study is December 1998.
Process Comparisons

- Unable to recommend one process over another due to following:
  - manual vs. automatic
  - ease of use, operability
  - capital investment costs
  - no final fatigue data at present
Chemical Stripping

- Data taken from three sequences.
- Approximately 40 candidates - downselected to 10 chemical strippers (5 alkalines & 5 acids)

<table>
<thead>
<tr>
<th>Chemical Type</th>
<th>Dwell Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baselines</td>
<td>12 minutes</td>
</tr>
<tr>
<td>Alkalines/Neutrals</td>
<td>5.3 hours</td>
</tr>
<tr>
<td>Acids</td>
<td>5 hours</td>
</tr>
</tbody>
</table>
CO$_2$ Blasting

- Two systems: COLDJET™ Model 65-250 and TOMCO$_2$ DI-250.
- COLDJET™ system caused significant deformation on 16 mil specimens and even 64 mil specimens showed surface damage.
- TOMCO$_2$ system was capable of some coating removal but allowable pressure was too low for efficient stripping.
Generous time and effort donated by McDonnell Douglas in St. Louis, MO.

Data taken from two sequences.

<table>
<thead>
<tr>
<th>Strip Rate</th>
<th>Substrate Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>109 in²/min</td>
<td>16 mils</td>
</tr>
<tr>
<td>136 in²/min</td>
<td>51 mils</td>
</tr>
<tr>
<td>128 in²/min</td>
<td>64 mils</td>
</tr>
</tbody>
</table>
Plastic Media Blasting

- Data taken from two sequences.
- Media: type V Plastic Media, 20/30 & 16/20 mesh
- Nozzle diameters: 0.25” @ throat ,0.50” @ exit

<table>
<thead>
<tr>
<th>Substrate Thickness</th>
<th>Blast Pressure</th>
<th>Strip Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 mils</td>
<td>30 psi</td>
<td>17 in²/min</td>
</tr>
<tr>
<td>51 mils</td>
<td>35 psi</td>
<td>20 in²/min</td>
</tr>
<tr>
<td>64 mils</td>
<td>40 psi</td>
<td>18 in²/min</td>
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</table>
Sodium Bicarbonate Wet Stripping

- Data taken from two sequences.
- First sequence was manual with great variance in strip rate.

<table>
<thead>
<tr>
<th>Substrate Thickness</th>
<th>Strip Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 mils</td>
<td>-----</td>
</tr>
<tr>
<td>51 mils</td>
<td>145 in²/min</td>
</tr>
<tr>
<td>64 mils</td>
<td>167 in²/min</td>
</tr>
</tbody>
</table>
Water Stripping

- Data taken from two sequences.
- Stripped using a customized system of robotics and spray equipment.

<table>
<thead>
<tr>
<th>Substrate Thickness</th>
<th>Strip Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 mils</td>
<td>139 in²/min</td>
</tr>
<tr>
<td>51 mils</td>
<td>408 in²/min</td>
</tr>
<tr>
<td>64 mils</td>
<td>390 in²/min</td>
</tr>
</tbody>
</table>
Chemical Stripping

- Maintain environment at an rH of 34% and a temperature between 80 & 86 F.
- Apply fine mist of stripper over panel.
- Apply heavier mist 30 minutes later.
- Check at 2 hour intervals.

if any paint is released, brush panel and reapply stripper as before.
Wheat Starch Stripping

- Generous time and effort donated by CAE Electronics, Montreal Canada.
- Data taken from two sequences.

<table>
<thead>
<tr>
<th>Process</th>
<th>Substrate Thickness</th>
<th>Strip Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>semi-automated</td>
<td>16 mils</td>
<td>249 in²/min</td>
</tr>
<tr>
<td>semi-automated</td>
<td>51 mils</td>
<td>459 in²/min</td>
</tr>
<tr>
<td>semi-automated</td>
<td>64 mils</td>
<td>459 in²/min</td>
</tr>
<tr>
<td>manual</td>
<td>16 mils</td>
<td>76 in²/min</td>
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<tr>
<td>manual</td>
<td>51 mils</td>
<td>96 in²/min</td>
</tr>
<tr>
<td>manual</td>
<td>64 mils</td>
<td>76 in²/min</td>
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