



# Organic Finishing Technologies

## B-52 Paint Life Cycle Extension



***Integrity ★ Service ★ Excellence***

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# Overview



- **Objective/Approach**
- **Results from Laboratory Testing and Field Evaluations**
- **Summary**



# B-52 Paint Life Cycle Extension



## Objective

- Determine if current coating system performance is sufficient to eliminate the four year scuff sand and overcoat while maintaining effective corrosion protection

## Approach

- Gather baseline data for B-52 refinishing process
- Identify coating performance requirements and non-destructive inspection techniques
- Document performance of current coatings in the laboratory and the field
- Provide recommendation based on results



B-52H

## Goal

### AFRL Goal

- Increase Depot Paint Facility Availability and efficiency
- Reduce Hazardous Material Usage

### How Project Responds to Goal

- Supports C+6 reduction mandated by OSD
- Increase Paint Facility availability
- Facilitates USAF environmental burden by reducing Hazardous Air Pollutant and Volatile Organic Compounds
- Keeps aircraft available for Global Operations





# Laboratory Testing



## Laboratory Testing of Belly Skin from B-52 60-008

- Previous Strip and Paint May 2001
- Paint Date for scuff sand and overcoat could not be determined
- Current Strip and Paint date 24 May 2010
  - Akzo-Nobel 10P20-13 primer ECM-F-6118 (APC) topcoat

|  |  |
|--|--|
| Dry Film Thickness                                 | High 9.3 - Low 6.32 - Average 7.93 mil           |
| Initial Cross Hatch                                | 3B – Indicates 5- 15% of the area was removed    |
| Initial Pencil Hardness                            | B – Testing done at room temp.                   |
| Cross Hatch 30 days room temp in DI Water          | 0B – Indicates >65% of area was removed          |
| Cross Hatch / 23699 Oil 24 hr @ 120°C              | 4B – Indicates <5% of area removed               |
| Pencil Hardness / 23699 Oil 24 hr @ 120°C          | B – After immersion                              |
| Flexibility testing, buy mandrel bend (2" mandrel) | No cracking or peel away noted                   |
| Salt Spray B-117                                   | 2500 hours exposure mild corrosion in the scribe |
| UV Weatherability Resistance                       | $\Delta E \geq 1.5$ after 1000 hours of exposure |



# Laboratory Testing



## Laboratory Testing of Belly Skin from B-52 60-008 (cont.)

- Adhesion Testing using Pneumatic Adhesion Tensile Testing Instrument (PATTI) results
  - Six panels with two pulls per panel
  - Predominant failure mode was cohesive failure at the primer
  - Three panels showed adequate pull strength
  - Three panels were lower than desired

| Panel ID  | 1 <sup>st</sup> Pull PSI | 2 <sup>nd</sup> Pull PSI | AVERAGE PSI |
|-----------|--------------------------|--------------------------|-------------|
| 61A1A007A | 1048                     | 1105                     | 1076.5      |
| 61A1A007B | 1011                     | 1452                     | 1231.5      |
| 61A1A008A | 1293                     | 1105                     | 1199        |
| 61A1A008B | 484                      | 713                      | 598.5       |
| 61A1A009A | 631                      | 541                      | 586         |
| 61A1A009B | 395                      | 599                      | 497         |





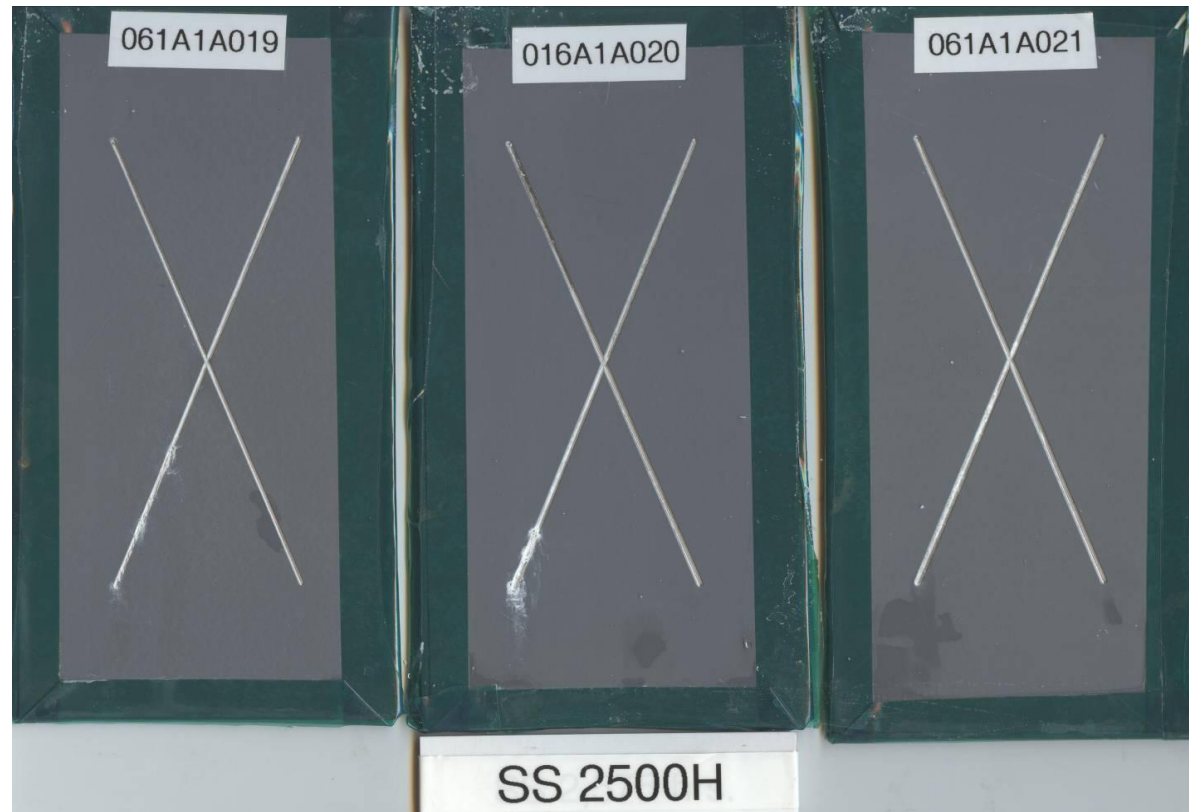
# Laboratory Testing



## Laboratory Testing of Belly Skin from B-52 60-008 (cont.)

- Neutral Salt Fog Corrosion Resistance Testing

- Tested in accordance with ASTM B-117 *Standard Practice for Operating Salt Fog Apparatus*
- Slight corrosion in the scribe at 500 hours; no change for the remainder of testing





# Laboratory Testing



## Laboratory Testing of Belly Skin from B-52 60-008 (cont.)

- **X-Ray Photoelectron Spectroscopy**
  - Cr+6 levels in samples were equal to samples taken from freshly applied primer
  - Indicates still enough Cr+6 to provide corrosion protection
- **Conclusions from Laboratory Testing**
  - Coating system next to substrate was nine years old; still had substantial Cr+6 levels
  - Variance in cross hatch and PATTI indicate it was time to paint the aircraft
  - Flexibility of the coating is still adequate

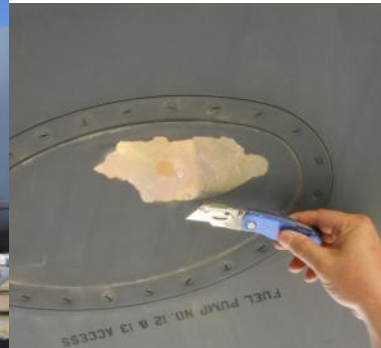




# Field Evaluations



- **Aircraft Maintenance and Regeneration Group (AMARG)**
  - Field Visit conducted 7-10 June 2010
- **Barksdale Air Force Base (AFB), LA**
  - Field Visit conducted 23-26 August 2010
- **Minot AFB, ND**
  - Field Visit conducted 12-15 October 2010





# Field Evaluations



| Serial Number | Base Assigned | Last Paint date | Coating System             | AMARG Arrival Date |
|---------------|---------------|-----------------|----------------------------|--------------------|
| 61-0007       | AMARG (MT)    | 25 Mar 2004     | MIL-PRF-23377/85285 Type I | 25 Jan 2009        |
| 60-0034       | AMARG (MT)    | 17 May 2005     |                            | 8 Dec 2008         |
| 60-0014       | AMARG (LA)    | 1 Oct 2002      |                            | 8 Feb 2009         |
| 61-0024       | AMARG (LA)    | 15 Sep 2005     |                            | 29 Jan 2009        |
| 60-0019       | AMARG (LA)    | 12 Dec 2002     |                            | 11 Dec 2008        |

- **AMARG Inspection Results**

- One adhesion failure noted on the inboard fuel access panel on the bottom of the right wing aircraft 60-0014
- Aircraft from Barksdale showed higher degree of coating degradation
- Minot aircraft showed little signs of degradation
- No corrosion noted on any of the aircraft observed



# Field Evaluations



| Serial Number | Last Paint date | Primer                                 | Topcoat                                       |
|---------------|-----------------|--|---|
| 60-016        | 27 Mar 2003     | MIL-PRF-23377                          | MIL-PRF-85285                                 |
| 61-020        | 16 Sep 2006     | MIL-PRF-23377                          | MIL-PRF-85285                                 |
| 61-012        | 24 Jan 2007     | MIL-PRF-23377                          | MIL-PRF-85285                                 |
| 60-001        | 27 Mar 2006     | MIL-PRF-23377                          | Deft Extended Life Topcoat (ELT)<br>99-GY-001 |
| 60-008        | 24 May 2010     | Akzo Nobel 10P20-13<br>(MIL-PRF-23377) | Akzo Nobel Aerodur 5000<br>ECM-F-6118         |

- **Barksdale Inspection Results**
  - **Several adhesion failures noted on multiple aircraft**
  - **No corrosion was detected during the visual inspection**
  - **No facility to accomplish maintenance touch up**
  - **Color, gloss, and film thickness readings taken on the two aircraft with advanced performance coating (APC)**





# Field Evaluations



| Serial Number | Last Paint date | Primer        | Topcoat                 |
|---------------|-----------------|---------------|-------------------------|
| 61-032        | 13 Sep 2007     | Akzo 10P20-13 | Akzo ECM-6118 (APC)     |
| 61-029        | 16 Jul 2008     | Akzo 10P20-13 | Akzo ECM-6118 (APC)     |
| 61-034        | UNK             | UNK           | UNK                     |
| 60-055        | 15 Apr 2010     | Deft 02Y-40A  | Deft ELT 99-GY-13 (APC) |
| 60-018        | 16 Oct 2008     | Akzo 10P20-13 | Akzo ECM-6118 (APC)     |
| 60-004        | 28 Oct 2009     | Akzo 10P20-13 | Akzo ECM-6118 (APC)     |
| 61-035        | UNK             | UNK           | UNK                     |

## • Minot Inspection Results

- Several adhesion failures noted on multiple aircraft; some as large as 20 ft<sup>2</sup>
- No corrosion was detected during the visual inspection
- No facility to accomplish maintenance touch up
- Color, gloss, and film thickness readings taken on three APC aircraft





# Field Evaluations



- **PATTI Testing**

- Twelve studs glued to each aircraft
- Six under the right wing
- Six on the aft fuselage right side





# Field Evaluations



- **PATTI Results**

| Serial Number | Base Assigned | Under Wing Pull PSI | Predominant Failure Mode | Fuselage Pull PSI | Predominant Failure Mode |
|---------------|---------------|---------------------|--------------------------|-------------------|--------------------------|
| 61-0007       | AMARG (MT)    | 1020.4              | Adhesive glue            | No Reading        |                          |
| 60-0034       | AMARG (MT)    | 1776.2              | Adhesive glue            | 901.4             | Adhesive glue            |
| 60-0014       | AMARG (LA)    | 728.5               | Adhesive glue            | No Reading        |                          |
| 61-0024       | AMARG (LA)    | 1183.1              | Adhesive glue            | No Reading        |                          |
| 60-0019       | AMARG (LA)    | 1117.0              | Adhesive glue            | 459.9             | Adhesive glue            |
| 60-0016       | Barksdale     | 2,030.6             | Cohesive primer          | 1,394.5           | Cohesive primer          |
| 61-0020       | Barksdale     | 2,059.8             | Cohesive primer          | 1,358.4           | Cohesive primer          |
| 61-0012       | Barksdale     | 1,828.0             | Cohesive primer          | 1,456.5           | Cohesive primer          |
| 60-0001       | Barksdale     | 2,374.2             | Cohesive primer          | 1,605.4           | Cohesive primer          |
| 61-0032       | Minot         | 1476.2              | Adhesive glue            | 521.8             | Adhesive glue            |
| 61-0029       | Minot         | 1880.3              | Adhesive glue            | 776.9             | Adhesive glue            |
| 61-0034       | Minot         | 1440.3              | Adhesive glue            | 729.9             | Adhesive glue            |



# Field Evaluations



- **Color Readings**

- Readings were compared to FED-STD-595B Color Chip
- MIL-PRF-85285  $\Delta E < 1$  requirement is for fresh coatings

| Serial Number    | Coating MFG      | Paint Date | Paint Age When Tested | L*    | a*    | b*    | $\Delta E$ |
|------------------|------------------|------------|-----------------------|-------|-------|-------|------------|
| Color Chip 36118 | FED-STD-595B     | N/A        | N/A                   | 40.56 | -1.12 | -4.84 | N/A        |
| 60-008 LA        | Akzo Nobel (APC) | 24 May 10  | 0.25 Years            | 39.57 | -0.95 | -4.84 | 1.00       |
| 60-001 LA        | Deft (APC)       | 27 Mar 06  | 4.41 Years            | 42.88 | -1.37 | -4.84 | 2.52       |
| 60-055 MT        | Deft (APC)       | 15 Apr 10  | 0.50 Years            | 41.88 | -0.83 | -4.52 | 1.39       |
| 61-029 MT        | Akzo Nobel (APC) | 16 Jul 08  | 2.24 Years            | 40.78 | -1.02 | -4.26 | 0.63       |
| 61-032 MT        | Akzo Nobel (APC) | 13 Sep 07  | 3.09 Years            | 40.55 | -1.08 | -4.52 | 0.32       |
| 60-034 MT AMARG  | Deft Type I      | 17 May 05  | 5.06 Years            | 40.50 | -1.08 | -4.65 | 1.00       |
| 61-024 LA AMARG  | Deft Type I      | 15 Sep 05  | 5.09 Years            | 43.30 | -1.19 | -4.31 | 2.79       |



# Field Evaluations



- **Gloss Readings**
  - Used to assess coating degradation from UV exposure
  - MIL-PRF-85285 requirement  $60^{\circ} \leq 5$  units  $85^{\circ} \leq 9$  units

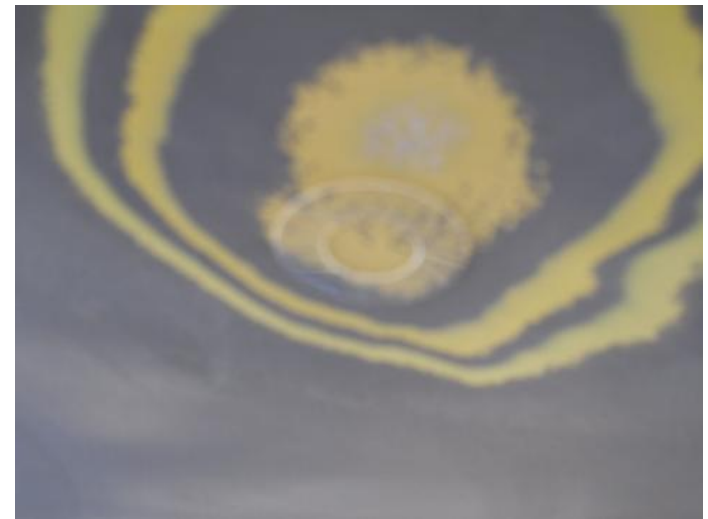
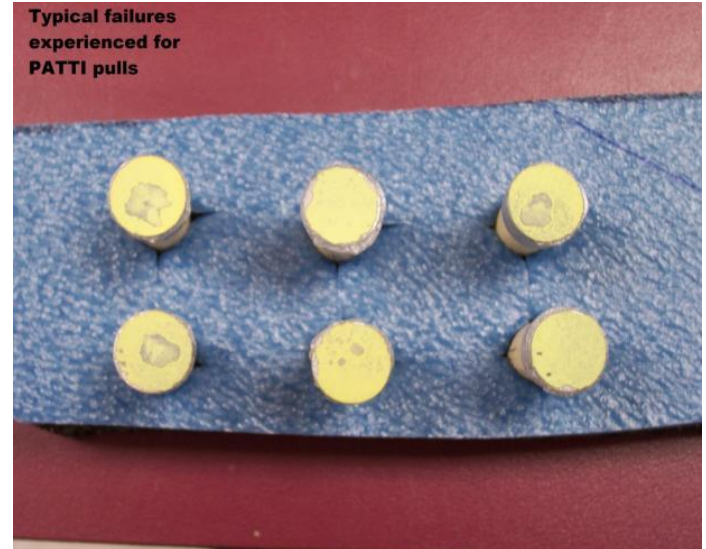
| Serial Number      | Coating MFG      | Paint Date | Paint Age When Tested | 60°  | 85°  |
|--------------------|------------------|------------|-----------------------|------|------|
| 60-008 LA          | Akzo Nobel (APC) | 24 May 10  | 0.25 Years            | 3.31 | 4.29 |
| 60-001 LA          | Deft (APC)       | 27 Mar 06  | 4.41 Years            | 1.13 | 4.80 |
| 60-055 MT          | Deft (APC)       | 15 Apr 10  | 0.50 Years            | 3.23 | 5.12 |
| 61-029 MT          | Akzo Nobel (APC) | 16 Jul 08  | 2.24 Years            | 1.87 | 3.75 |
| 61-032 MT          | Akzo Nobel (APC) | 13 Sep 07  | 3.09 Years            | 2.79 | 6.03 |
| 60-034 MT<br>AMARG | Deft Type I      | 17 May 05  | 5.06 Years            | 0.90 | 2.90 |
| 61-024 LA<br>AMARG | Deft Type I      | 15 Sep 05  | 5.09 Years            | 1.14 | 5.55 |



# XPS Analysis



- **X-Ray Photoelectron Spectroscopy (XPS)**
  - Primer samples collected for XPS analysis
  - Coating was sanded to the base primer layer
  - Dust was collected on tape
  - PATTI studs were used for analysis
  - Fourteen samples were analyzed
- **Cr +6 level equal to or greater than fresh applied primer in 13 of 14 samples**





# Summary



- **Data reported is for the current coatings system (Cr)**
- **Indications from the field evaluations favor eliminating the mid-cycle scuff sand and overcoat**
- **13 out of 14 samples analyzed using XPS showed Cr+6 levels equal to or higher than freshly applied MIL-PRF-23377 primer**
- **No corrosion was identified during visual inspections**
- **Gloss readings indicate aged APC topcoat still meets MIL-PRF-85285 requirement**
- **Lack of a touch-up maintenance facility is cause for concern**
- **The adhesion failures observed can not go untreated for an extended period of time**