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Replacing Scuff Sanding by the Chemical Reactivation of Aged Military Paints

Scuff sanding coatings for subsequent paint adhesion has been common practice until recently. Claims of ergonomic injury along with the push to reduce hexavalent chromium exposures are driving the switch to an alternative reactivation method that is more ergonomic and does not produce respirable dust, which may contain chrome.

Extensive laboratory testing was performed on test panels that were coated with primer and aged at ambient conditions for two months. Several contaminants were then applied to test panels and aged for approximately 5 weeks. The panels were then chemically reactivated, painted with primer, cured, and adhesion tested. Adhesion tests consisted of wet tape adhesion and Hydraulic Adhesion Test Equipment (HATE) adhesion tests. HATE adhesion consists of a dolly or stud that is glued to the coating on the test panel. The apparatus (Figure 1) is then attached to the dolly and delivers a force through the center of the dolly to remove the dolly in flatwise tension. The force necessary to remove the dolly is measured and recorded. The mode of failure of the coatings is also recorded, whether a coating failed cohesively, within itself, or adhesively, between coating layers.

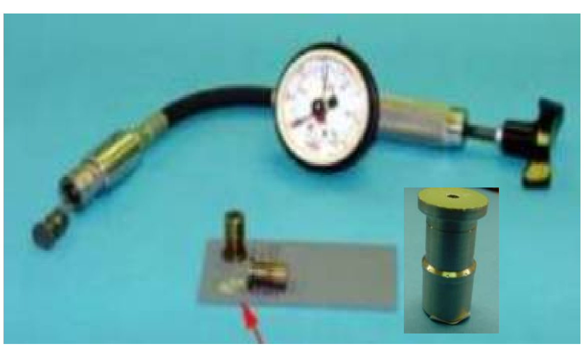

Figure 1 – HATE Adhesion Test Apparatus with Dolly photo inset

Figure 2 – Wet tape adhesion test patches on production subassembly.

Production trials were then performed on actual subassemblies. Both wet tape adhesion and HATE adhesion testing were employed in these trials, allowing for touch up after testing as necessary. Figure 2 shows the production method of wet tape adhesion testing in which cheesecloth is wet with water and sealed to the assembly surface in masking tape.

Boeing St. Louis has now successfully implemented chemical reactivation on the F/A-18, F-15 and T-45 interior subassemblies. Detail parts are received from suppliers with primer already applied.

Instead of scuff sanding by hand (Figure 3), St. Louis workers now apply Desoclean 45 (a blend of MEK, IPA, MIBK, and toluene) to the surface using cheesecloth. This successful implementation has been the result of extensive laboratory testing and closely monitored production trials. The following specifications for the preparation and painting of these assemblies have now been updated with the chemical reactivation process:

- PS 13630.1
- PS 13646
- PS 13375
- PS 13517

However, there are restrictions. This process is only allowed on interior subassemblies. (see Figures 4 and 5) This process is not recommended for moldline painting on fighter aircraft at this time because moldline paint sees a very harsh environment in service. This process is also only recommended for use with aged 85582 or 23377 primers, and only if the overcoating primer is Deft 44GN72, which is the MIL-PRF-85582 chromated waterborne epoxy primer most commonly used in St. Louis. Suppliers are free to use the chemical reactivation process if they choose to do so.

Figure 3 – Scuff Sanding F/A-18 nose barrel subassembly.

St. Louis is also working with Long Beach to test and implement chemical reactivation on the C-17. There are several coating combinations on the C-17 that were not previously tested for chemical reactivation, so testing was performed on combinations of impact resistant and fluid resistant primers and topcoats, and also some of the moldline coatings. There have been recent discussions about replacing the C-17 fluid and impact resistant primers with Deft 44GN72, as it meets the specification requirements for those coatings. Not only would this consolidate materials usage and reduce processing time masking and switching between different paints, but 44GN72 is cheaper than the impact resistant primer, and also less dense, which would result in a fairly significant weight savings. With this in mind, we not only tested the current coating combinations, but also possible future coating combinations with Deft 44GN72.

There were only two poor performing combinations tested, 44GN72 over impact resistant topcoat, and moldline primer over impact resistant primer. All other coating combinations demonstrated

Figure 4 – F/A-18 lower mid subassembly.

good adhesion between coatings. This verifies that current coating combinations work well together, and also shows that 44GN72 performs just as well as the current coating combinations. The impact resistant topcoat is a Urethane which is more difficult to achieve good adhesion when painting an epoxy primer over it. The fluid resistant topcoat is an epoxy, which would explain why the epoxy based 44GN72 adhered well to it.

It is recommended that C-17 switch to 44GN72 primer in place of the different primers based on consolidation, reduction in weight and cost. It is recommended that 44GN72 be added to the QPL's for the different specifications, as it has passed all tests required for qualification. Whether the primer is switched or not, chemical reactivation is recommended except for moldline primer over impact resistant primer, where scuff sand reactivation should still be done. Chemical reactivation would also be allowed on fluid resistant topcoat, but scuff sanding should continue on impact resistant topcoat.

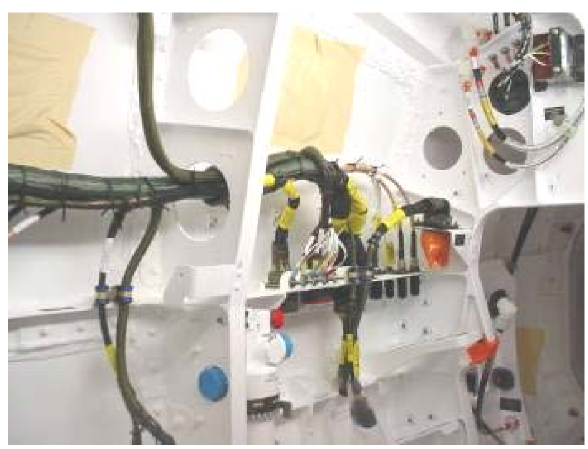

Figure 5 – Example of subassembly interior.

In conclusion, we have implemented Desoclean 45 reactivation on F/A-18, F-15, and T-45 assemblies after 2 years of shop trials and successful production. We recommend chemical reactivation for most coating combinations on C-17 with further testing on a couple combinations not yet recommended, and we also recommend a switch to 44GN72.

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Composite Recycling Revisited

Also see:

http://www.boeing.com/companyoffices/doingbiz/environmental/TechNotes/TechNotes2003-11.pdf

Weapon systems that have reached the end of their design life cycle need to be disposed of in a cost effective, safe, and environmentally responsible way. The option to recycle end of life weapon systems, such as aircraft, is the preferred method since it reuses the materials, including composites. Recycling can generate a financial return and is considerably more beneficial than land filling, which increases cost, places a burden on the environment, and has a potential for future liability.

Until the mid 1990's, recycling scrap carbon fiber composites was not considered viable. The two main reasons: no identifiable market and lack of cost effective technology to separate the carbon fiber. Millions of pounds of composites have been land filled or incinerated. However, towards the late 1990's, markets were identified and technology companies recognized a business opportunity and developed processes to extract the valuable carbon fibers. Markets for recycled carbon fibers include cellular phones and lap top computers. Lighter weight housings are possible due to thinner reinforced walls. Other market uses include injection molding resin compounds and non-woven sheet reinforcement.

Several issues confront attempts to recycle composites from scrap aircraft structures. An initial challenge is separation and segregation of the composites, metals, plastics and other materials used in aircraft. Even more important, however, is the ability to extract the reusable carbon fibers from the resin matrix. The effectiveness of this extraction process will determine the overall success of the composite recycling effort.

For the past three years, Boeing Phantom Works has been working on a composite recycling project. This project involves securing end of life scrap aircraft structure containing a mix of composites and metal structure, identifying a salvage company who can segregate the composites from other materials, and a technology company with a process for carbon fiber extraction.

Boeing secured two scrap AV-8B fuselage assemblies from NADEP Cherry Point, North Carolina. The assemblies were shipped to Fritz Enterprises, a subsidiary of Huron Valley Steel (HVS), an operational metals recovery facility in Detroit, Michigan. This company is a world leader in salvaging scrap automobiles and specializes in the design and development of material sorting devices. Fritz agreed to process the fuselages and attempt to segregate the composites.

In late 2004 the AV-8B assemblies arrived at the R&D facility at Fritz for destruction. A shear tool mounted on a track-hoe was used to cut apart the fuselage into smaller pieces no larger than three feet in diameter (Figure 1).

Figure 1 – Shear tool splitting fuselage*

This initial size reduction (Figure 2) was required to feed the parts into the processing system that grinds and sorts the materials.

Figure 2 – Fuselage reduced to manageable size pieces for Fritz process*

The pieces of aircraft structure were fed into a revolving hammer mill to further reduce the size and allow separation. A magnetic separator pulls ferrous components into a side chute while non-ferrous material fall through the magnetic field and are carried by conveyor belt to an eddy chamber. In the eddy chamber, the lighter components (insulation materials, sealant, composites, etc.) are blown upward into a chute and are segregated from the metals (Figure 3).

Figure 3 – Segregated composites and debris stream*

The hammer mill process was more destructive to the composite structures than desired. The largest identifiable composite fragments were no larger than one inch in diameter as most were reduced almost to a "granular size". Composite residue also contained other undesirable non metallic debris such as sealer and wire harnesses. The combinations of small particle size of composite along with unwanted debris are significant issues to be resolved. Carbon fiber lengths need to be at least two to three centimeters in length to have the value needed to support reclamation and excess debris mixed with the composites will add to the cost of processing.

Adherent Technologies Inc. (ATI), Albuquerque, New Mexico, has been successful in separating carbon fibers from carbon fiber-reinforced epoxy composites. ATI has been investigating catalytic conversion of composites since 1992. In 2003 Boeing provided ATI with samples of uncured prepreg, carbon epoxy composite that ATI has processed through its batch reactor. This project will evaluate the capability of this process on reclaimed materials from an aircraft.

Composite materials shown in Figure 3 have been sent to ATI for evaluation and possible recovery of the carbon fibers using their reactor process. A small portion of the composites have also been sent to Power Technology Services (PTS), Raleigh, North Carolina, a small research and development firm. PTS is developing a novel carbon fiber reinforced plastic (CFRP) disposal and recycling technology based on the pyrolysis of shredded end-of-life CFRP waste.

Both companies will provide Boeing with a summary of their carbon fiber extraction efforts within the next several months. Currently, Boeing is trying to obtain additional scrap composite aircraft structure in an effort to process this scrap through another HVS metal recovery facility that is located next to AMARC in Tucson, Arizona. The objective of processing the scrap composite at HVS is to obtain larger sized composite fragments by adjusting their process. Larger sized composite chunks when processed through ATI's reactor will result in longer extracted carbon fibers, thus making the fibers more valuable.

*** Source: Images courtesy of Fritz Enterprises, Detroit, Michigan**

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