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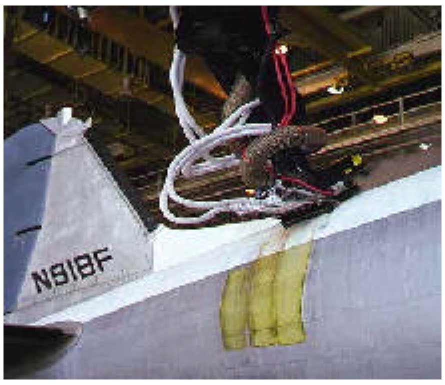
Revolutionary New Paint Removal Process for Aircraft is Both Environmentally-Friendly and Cost Effective

As the fleets of the Air Force, Navy, Army, Marines, and the Coast Guard continue to operate for longer periods, preventative maintenance becomes a much larger portion of life cycle costs. Aircraft painting represents one of the best defenses against the ravages of hostile service environments. It is also one of the most expensive aspects of maintenance. As such, it seemed appropriate to bring this significant advance in the state of the art to your attention.

Aircraft paint removal is an expensive process, representing a significant portion of its total maintenance costs. Not only are conventional processes very labor intensive, but also produce substantial quantities of chemical wastes which require costly disposal. Traditionally, chemical strippers such as methylene chloride have been used to soften the paint, followed by brushing or some other mechanical removal method. Chemical stripping requires extensive surface preparation to mask areas of the aircraft that could be damaged from chemical exposure. In addition, maintenance personnel must be protected from exposure to hazardous chemicals. To comply with environmental regulations, the waste, which consists of paint chips, expended solvent and blasting media, must be disposed of properly. Often times, the cost of this disposal exceeds the original cost of the labor and materials needed to remove the paint.



Alternative removal systems have been evaluated, including sandblasting; laser ablation; cryogenic removal, either with liquid nitrogen or dry ice; and wheat starch. Sandblasting is a good, all purpose removal technique, but can potentially cause mechanical damage to the structure's surface. This is particularly true in the case of aerospace structures, which are increasingly fabricated from organic matrix composites. Significant waste disposal costs are also a limitation of this technique.

The use of laser ablation alone can effectively remove paint, but it is difficult to control the intensity of the beam such that the coating is removed, but the underlying surface remains undamaged by heat buildup. The energy density, duration and frequency of the laser pulse all contribute to heat buildup in the substrate. The thermal conductivity of the substrate material, and its inherent ability to dissipate heat also regulate heat accumulation.

The U.S. Navy has experimented with paint removal systems employing a stream of liquid nitrogen. In this process, the sudden cooling brought about by the liquid nitrogen induces a thermal expansion mismatch (thermal shock) between the coating and the substrate, leading to cracking and spalling of the coating. The coating can then be brushed off or easily scraped away. The National Park Service successfully used this method to remove interior coatings from the Statue of Liberty during its most recent refurbishment. Preliminary tests indicated the thin copper sheets making up the statue would not be harmed by this removal method. In the Navy experiment, analysis indicated the change in temperature was insufficient to lift a thin coat of paint from the surface. Thicker coatings were more easily removed because of the greater difference in temperature between the coating and substrate.

In terms of waste disposal, both laser ablation and cryogenic removal produce more benign waste in less quantities than chemical stripping or sandblasting. When coatings are removed by laser, the waste products are Co2, water, and the ash remaining after the paint is pyrolyzed. In cryogenic removal, the waste products consist only of the removed paint chips.

In the 1990's engineers at the Boeing Company developed a coating removal system that combines the energy pulse of light with the thermal shock and abrasive properties of cryogenic cleaning. When these two methods are combined, the waste products are minimized. Marketed under the trade name Flashjet® Coating Removal System, this de-painting method is currently in use at the Corpus Christi Army Depot, Warner Robins Air Logistics Center and the Naval Air Station in Kingsville, Texas.

Flashjet was developed by a team of engineers from the McDonnell Douglas Corporation (now part of Boeing), Maxwell Laboratories Inc. and Cold Jet Inc. It uses a xenon lamp to first vaporize the painted surface. A low pressure stream of dry ice particles cools the surface almost instantaneously and knocks the remaining ash away from the substrate. A vacuum system is used to collect the particulate waste. The Flashjet system has been proven effective for metal as well as composite surfaces, including fiberglass, Kevlar and boron/graphite, epoxy-based components. Flashjet is capable of removing up to four square feet of paint per minute at a cost of less than $4.00 per square foot.

An analysis of life cycle costs comparing Plastic Media Blasting (PMB) and chemical processes to Flashjet for depainting the U.S. Navy's T-45 fleet demonstrates that Flashjet will result in significant life cycle savings over the projected 20 year service for the fleet. [1] Table 1 shows the cost comparison between the three processes. In terms of environmental impact, the PMB process has the potential to emit cadmium from aircraft fasteners and chromium compounds from the paint. The effluent capture system of Flashjet prevents the introduction of cadmium and chromium compounds into the work environment.

The FLASHJET gantry system at Warner Robins will be used to depaint composite radomes, flight control surfaces, fairings and other surfaces from the U.S. Air Force F-15 Eagle, C-130 Hercules, C-141 Starlifter and C-5 Galaxy aircraft.

A seven-axis robot gantry system for the Corpus Christi Army Depot will accommodate the largest U.S. Army helicopter, the CH-47 Chinook. The FLASHJET system will be used to remove paint from AH-64 Apache, UH-60 Blackhawk, AH-1 Cobra, UH-1 Huey, SH-60 Seahawk and OH-58 Kiowa helicopters.

The Flashjet system offers significant savings in terms of waste disposal turnaround time and the amount of solid waste produced. As program budgets continue their shift from procurement to maintenance, these significant savings will put more funds in the hands of the program offices to address the more urgent aspects of the aging aircraft fleet.

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Table 1: Life Cycle Depainting Cost Comparison for T-45 Aircraft

Depainting Process	Waste Disposal Costs	Turn Around Time	Disposed Media	Process Cost Total	Total Life Cycle Savings
Chemical	$3,404,010.78	375 MH*	3,855,123 lbs	$16,877,646.87	$15,030,501.09
PMB	$863,490.63	220 MH	575,664 lbs	$9,547,129.68	$7,699,983.90
FLASHJET	$16,040.19	28 MH	1342.5 lbs	$1,847,145.78	

*MH - Manhours