Lasering on the Pasquotank

Coast Guard Using Laser Beams to Reduce Hazardous Waste Stream

THE UNITED STATES Coast Guard Aviation Logistics Center (ALC), located on the Pasquotank River in northeastern North Carolina, provides support for 27 Coast Guard Air Stations throughout the United States and Greater Antilles. The Elizabeth City depot employs over 1,450 civil service, active duty and contractor

U.S. Coast Guard ALC in Elizabeth City, NC.
Dave Silva

Representative inventory of Coast Guard operational aircraft in 2009.
Dean Schaan

personnel; one of the elements of this support is the annual depot overhaul of approximately 40 of the 200 aircraft in the Coast Guard's inventory. Possibly the greatest challenge of the aircraft overhaul procedure is the effective removal of the polyurethane topcoat in preparation for new paint prior to re-entering service.

Conventional aerospace coatings removal methods, utilized throughout the Department of Defense (DoD) and Department of Homeland Security (DHS), result in a major waste stream consisting of toxic chemicals and spent media blast materials. The chemicals that are typically used in this process are also high in volatile organic compounds and hazardous air pollutants, both of which are targeted for reduction/elimination by environmental regulations.

Because of these environmental concerns, ALC is continually searching for alternative ways to reduce these process hazardous waste streams.

From Toxic to Biodegradable

In 2005, ALC began using biodegradable cornstarch blast media as an alternative to the abrasive media normally used. This process has proven to be extremely effective and has reduced the hazardous waste stream associated with topcoat removal. In addition, ALC partnered with the U.S. distributor, Midvale Technologies, of GPX, to recycle the spent media into a new product called StarZorb®. StarZorb leaves ALC with a new Material Safety Data Sheet and goes on to a licensed Treatment, Storage and Disposal Facility where it is used as an absorbent. The material is then mixed with other waste liquids and solids at a cement plant, creating fuel for a kiln. The resultant kiln ash has been tested and determined to be sterile. This sterile ash may be mixed with other biodegradable waste products and utilized as backfill in mining operations. Trees and bushes have been successfully planted in the newly filled and landscaped areas, representing a true "cradle to grave" process.

New Technology Sought

Although the cornstarch blast media is ALC's primary topcoat removal

process, there were still areas on the airframe, and individual parts, which could only be stripped utilizing chemicals. Because of the environmental concerns with aircraft overhaul procedures and in support of ALC's Environmental Management System (International Organization for Standardization (ISO) 14001:2004 certified) another methodology was sought to supplement the topcoat removal process and minimize the remaining waste stream.

ALC capitalized on its membership on the Environmental Security Technology Certification Program (ESTCP) board. ESTCP's goal is to demonstrate and validate promising, innovative technologies that target the most urgent environmental needs of DoD. These technologies provide a return on investment through cost savings and improved efficiency. Through this program, the ALC signed a letter of agreement with Wright-Patterson Air Force Base (AFB) to proof a new topcoat removal technology involving handheld lasers.

Laser coating removal is a non-intrusive energy process that can be applied to a variety of substrates, including composites, glass, metal and plastics. Lasers can be created at short, medium or long wavelengths, in either a pulse application or a continuous wave. The pulsed laser application is preferable for topcoat removal because it requires a much lower applied temperature (a higher temperature could harm the substrate). A thin layer of the coating is vaporized by the laser application, creating a plasma, or ionized gas. The plasma cracks the coating, at which point 99 percent of the debris is available for collection in a high efficiency particulate air (HEPA) filtrated vacuum system.

Training sessions for aspiring laser operators. *Dean Schaan*

ALC's Laser Systems

ALC procured two lasers via a simplified acquisitions procedure from a commercial off-the-shelf vendor. Fume extraction units (vacuum systems) for each of the two lasers were also procured. ALC required the units to be handheld (functional for aircraft parts and small areas on an airframe), and the wave guides (fiber optic cables) needed to have sufficient protections to allow for them to be pulled across concrete shop floors and aircraft surfaces. The handheld unit needed to provide scanning widths up to or greater than three inches to maximize the coating removal process. Two lasers were purchased, a 300 watt (maximum pulse peak power of 230 kilowatts (kW)) and a 500 watt (maximum pulse peak power of 450 kW). The historical solicitation for the laser ablation equipment can be found on Federal Business Opportunities dated 24 July 2007 by the Coast Guard at Elizabeth City, NC.

Safe laser operation was foremost on the agenda for the Safety, Environmental and Health Office (SEHO) at the ALC as they wrote a comprehensive Class I-IV laser operating procedure. The office director's primary mission was to ensure that no laser radiation, in excess of the maximum permissible exposure limit, reached the human eye or skin of an ALC employee. The SEHO paralleled its laser safety procedure with the American National Standards Institute Z136.1-2000 standard and appointed a Laser Safety Officer (LSO) to watch over the maturing program.

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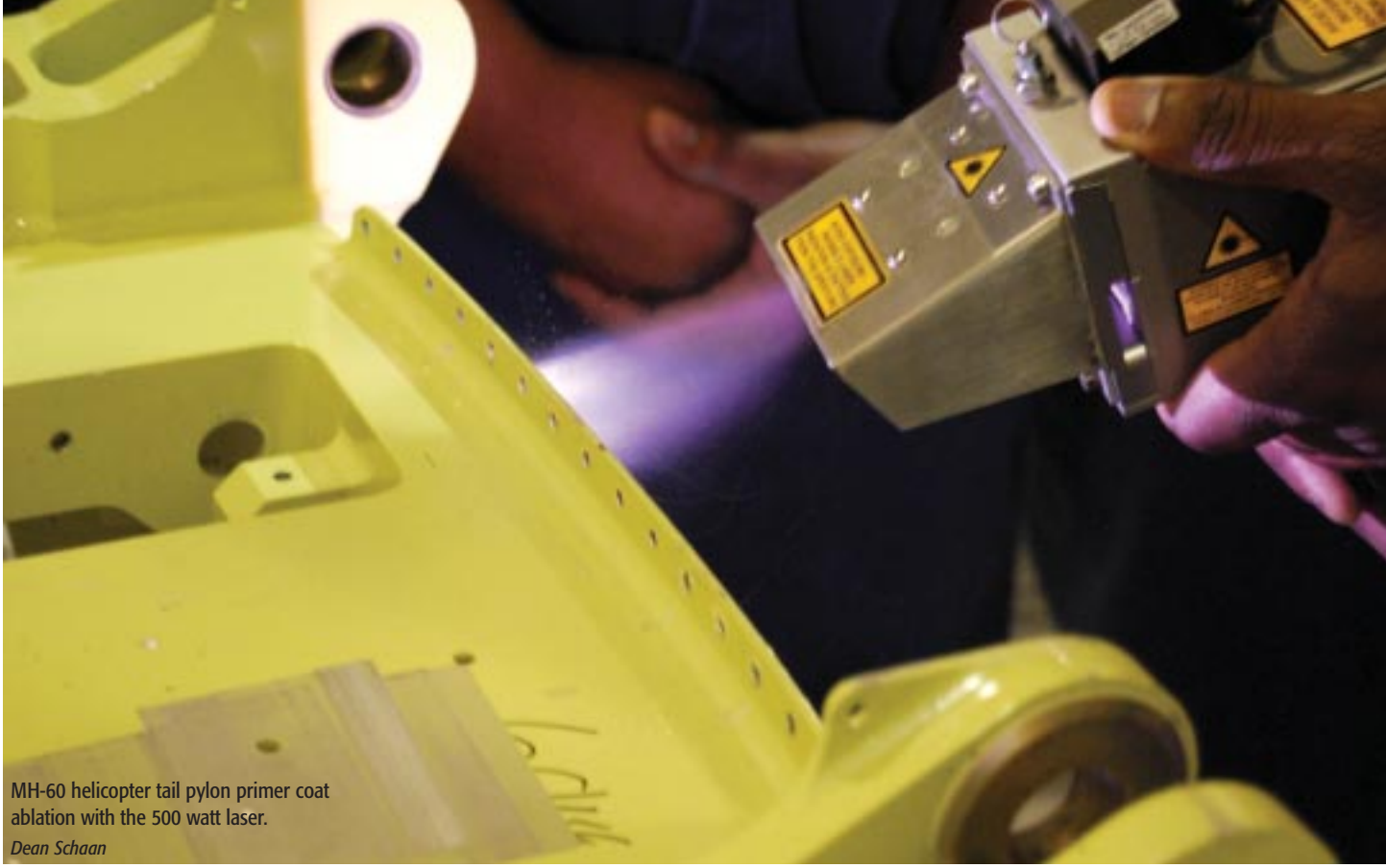
Testing the Laser Process

The MH-60 Jayhawk (Sikorsky) helicopter fleet (one of four product lines at ALC) approved the first engineering request to conduct testing on aircraft wheels. Each of these wheels had previously been chemically stripped at a rate of anywhere from six to eight man hours to seven days work



MH-60 helicopter tail pylon primer coat ablation with the 500 watt laser.
Dean Schaan

per wheel—depending on humidity levels—with a substantial hazardous waste stream being generated. The aluminum/magnesium wheels proved to be a perfect test bed for the two lasers. The 500 watt laser worked well as the wheel was turned on a rotating table. It was determined that constant table rotation was imperative (regardless of revolutions per minute). The 300 watt laser was used to ablate the coatings in the concave forms of the inner wheel taking advantage of the much smaller stylus and one laser eye.

The HU-25 Falcon (Dassault Falcon Jet), a medium-range surveillance fixed-wing aircraft, was utilized for the first airframe testing. After removing 95 percent of the paint using the cornstarch method, sensitive areas around the windows and under belly remained. The laser proved very effective in these areas and provided the functionality that was desired as well as a significant time savings and hazardous waste stream reduction.

The HU-25 product line also experiences unscheduled or "drop-in" maintenance from time to time. One one occasion, a drop-in aircraft from Texas had moderate corrosion on the center wing plank (under belly). This corrosion was effectively removed and the aircraft was returned to service without having to induct the craft prematurely into overhaul. The corrosion removal technique has also been tested successfully on the engine bell mouth on the HU-25, greatly lengthening the service life of that component.

The MH-65 Dauphin (Eurocopter) product line requested an engineering

To Learn More

FOR MORE INFORMATION about the Coast Guard's experience with cornstarch blast media, see our article entitled "Cornstarch & The Coast Guard: Using An Environmentally Benign Substance to Remove Paint" in the winter 2005 issue of *Currents*. You can browse the *Currents* archive and subscribe to the magazine via the Naval Air Systems Command's environmental web site at www.enviro-navair.navy.mil/currents.

Fuselage stripping on a HU-25 Falcon around the search window.
Dean Schaan

study on the practicality of ablating the myriad of topcoat layers from the airframe's vertical stabilizer. This component is constructed of composite material and the heat index on the substrate was understandably a preliminary concern. The 500 watt laser effected the removal of the multi layers with great results. The laser has also been tested to remove the topcoat and corrosion from the helicopter collective handle grip—a handle that controls the blade angle of the helicopter. This part had previously been cleaned in a blasting cabinet (glove box) and the Mean Time Between Failure (MTBF) was historically high. Minimal, if any, damage was transferred to the substrate once the technique was perfected, and the MTBF is expected to migrate even higher.

Another unlikely application was realized during the ongoing testing of the lasers: the removal of soot from engine exhaust guards. The MH-60 has a stainless engine exhaust fairing that is subject to periodic visual inspection and possibly Nondestructive Inspection testing. Soot forms with the incomplete combustion of burning fuel (indicative of a gas turbine engine) and hinders the inspection for cracks or abnormal wear. The laser removed the soot satisfactorily without any damage to the substrate. In addition to facilitating a much more accurate visual inspection, the laser process has also returned badly scored fairings to service.

ALC's material engineer was an integral part of the qualifying of this laser methodology. An analysis was performed on each substrate to determine if peak temperatures during the process were high enough to change the mechanical properties or damage the base substrates. Desired peak temperature limits of 300 degrees Fahrenheit (F) for the aluminum panels and 200 degrees F on the graphite epoxy panels were established.

Adapt Laser fume extraction unit that captures approximately 99 percent of debris.
Dean Schaan

Training is Essential

The training curve for a laser operator is not to be underestimated. Each of the ALC technicians received no less than three hours of classroom training (laser concepts and safety/environmental health) and a minimum of 16 hours of hands-on training to receive laser qualification. The original equipment manufacturer (Adapt Laser Systems in Kansas City, MO) provided the training as part of the procurement.

A vital part of the training involved ergonomics. Awkward body, thumb and hand positioning are required to effectively operate the handheld laser. To reduce the potential for musculoskeletal damage, configuration and control adjustments were made and the majority of the discomfort to the operator was overcome. The ALC training manual and syllabus for this new technology is still being developed, with a focus on safety and health.

In cooperation with ESTCP, the original equipment manufacturer, and Wright-Patterson AFB, the ACL has just begun to realize the opportunities afforded with the new laser systems. The hazardous waste streams associated with topcoat removal processes at ALC decreased by eight percent in calendar year 2007, and is certain to decrease even further once the laser removal process is fully operational. ⚓

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