



U.S. Army Environmental Command

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FOR MORE INFORMATION CONTACT:

Robert E. DiMichele, USAEC Public Affairs Officer
(410) 436-2556, Robert.DiMichele@us.army.mil

Army research and testing reveals “green” paint

Aberdeen Proving Ground, Md. — A new coating system being made available for the Army’s use to paint aircraft and other equipment performs better than the standard system – and it is safer to human health and the environment. This breakthrough comes after two years of research and testing conducted by the Connecticut Army National Guard at its 1109th Aviation Classification Repair Activity Depot (AVCRAD) on trivalent chromium-based primers and sealers.

Chromium has long been used in paint to create dense, protective coatings. This is especially important to the Army which needs to cover its equipment with paint that can resist corrosive chemical agent. However, chromium, in its hexavalent form, is a known carcinogen. Although the Army has used chromium-6-based paint safely to protect and extend the life of its expensive equipment, it was open to trying something else that wasn’t so potentially harmful both to human health and the environment. The question was, what else is there?

Now they know. It’s a different kind of chromium-based paint that uses chromium-3 instead of chromium-6.

Willingness to find a new paint system turned to resolve in 2006 when the Occupational Safety and Health Administration (OSHA) released more stringent regulations for permissible exposure limits of chromium-6. That’s when the Connecticut Army National Guard’s 1109th Aviation Classification Repair Activity Depot, which plays a major role in aircraft maintenance for the Army, decided that finding a green alternative to the standard chromium-6 paint system was better than upgrading its air filters to meet the new requirements.

The maintenance team at the 1109th AVCRAD initiated a rigorous hunt for a suitable replacement. What they found was a water-based chemical agent resistant coating system that exceeds the performance of the old system. The replacement coating system leaves a smoother finish coating and is more resistant to fading and chalking, which minimizes the need for cosmetic painting procedures.

The new chromium-3-based coating system is also safer to human health and the environment because it reduces the use of hazardous materials and the release of potentially harmful air emissions. It also significantly reduces the harmful chemicals that are present when disposing of paint stripping waste.

The new chromium-3-based painting system is a breakthrough for the Army.

“AVCRAD’s willingness to test and demonstrate the viability of alternative aircraft primers will help eliminate they Army’s use of chromium-6, resulting in significant protection of human health and the environment,” says Dana Arnold, Chief of Staff for the Office of the Federal Environmental Executive. “The Office of the Federal Environmental Executive applauds AVCRAD for helping the Army to meet (an Executive Order) while achieving its mission.”

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Partnering with the U.S. Army Aviation and Missile Command, the 1109th Aviation Classification Repair Activity Depot initiated and now manages the effort to promote use of the new paint system in both military and private organizations.

For implementing the aviation industry's first chromium-3 painting system suitable for use to the Army, the Connecticut Army National Guard's Aviation Classification Repair Activity Depot will receive the Army's highest honor in environmental stewardship – the Secretary of the Army Environmental Award. The award will be conferred on the installation at a ceremony on April 4th, 2008.

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This information is provided by USAEC. USAEC is the Army's point organization for supporting the implementation of environmental programs that facilitate sustainable Army training and operations while protecting the environment. We provide environmental program management and technical support products and services in support of Army training operations, acquisition and sound stewardship.

“Sustaining the Environment for a Secure Future”

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FY 2007 Secretary of Defense Environmental Awards

AVCRAD Connecticut ARNG

Pollution Prevention, Installation



Sustaining the Environment for a Secure Future

AVCRAD Connecticut ARNG

Pollution Prevention, Installation



SUMMARY

Aircraft painting innovations of the Connecticut Army National Guard (CTARNG) Aviation Classification Repair Activity Depot (AVCRAD) chromium replacement program set the standard within the aviation community for environmentally-sound painting practices. As a result of the success of AVCRAD's new non-chromium-6 painting system based on a water-dispersible chemical agent resistant coating, the Army Aviation and Missile Command is now revising its technical manuals for the military in favor of the new system. Soon chromium-6 will be eliminated at every Army aviation and maintenance facility, representing a tremendous breakthrough in human health and environmental protection. Accomplishments of the CTARNG Aviation Classification Repair Activity Depot in FY06-FY07 include:

- The switch to non-chromium products and the elimination of methylene chloride for depainting aircraft in favor of plastic media blast has cut the AVCRAD's paint shop hazardous waste stream by over 440,000 pounds annually. Potential disposal cost savings could be as high as \$75,000.00 annually for the CTARNG over the next few years.
- The AVCRAD streamlined and improved hazardous material management with the implementation of its own EMS and is on track for ISO 14001 certification by FY09.
- The AVCRAD holds an aviation summit every two years that is attended by major private aviation corporations and military facilities to promote transferability of information regarding improved processes and alternative products.
- Due to these commitments, the CTARNG AVCRAD remains on track to convert from a large-quantity to a small-quantity waste generator and is striving to achieve a completely green aircraft maintenance program.

“Under Executive Order 13423, “Strengthening Federal Environmental, Energy, and Transportation Management,” agencies are required to reduce the quantity of toxic and hazardous chemicals acquired, used, and disposed. AVCRAD’s willingness to test and demonstrate the viability of alternative, non-chromium-based aircraft primers will help eliminate they Army’s use of chromium-6, resulting in significant protection of human health and the environment. OFEE applauds AVCRAD for helping to meet the E.O. while achieving its mission.”

*- Dana Arnold, Chief of Staff,
Office of the Federal Environmental Executive*

On the cover: U.S. Army Spc. Victor Piacente, of 1st Battalion, 102nd Infantry Regiment, Connecticut National Guard, scans his sector while his convoy stops for a break during an extended patrol in the Gardez province of Afghanistan. (U.S. Army photo by Staff Sgt. Michael Bracken)

INTRODUCTION

The Connecticut Army National Guard (CTARNG) and its Aviation Classification Repair Activity Depot (AVCRAD) 1109th implemented the aviation industry's first non-chromium-6-based coating and painting system; a breakthrough for human health and environmental protection. AVCRAD provides deployable aviation logistics support to Army aviation as well as aircraft repairs, service, test flights and maintenance for the 14 states in its region. The AVCRAD team initiated and now manages the effort of chromium-6 elimination in both military and private organizations. Its main partner is the United States Army Aviation and Missile Command (AMCOM). Responsibilities include:

- *Support Deploying Forces Reception, Staging, onward movement and Integration (RSOI)* – The team performs various maintenance tasks to prepare aircraft for shipment and onward movement, including scheduled and unscheduled maintenance and repairs, disassembly and reassembly of aircraft and coordination of air and sea ports of embarkation and debarkation worldwide.
- *Establish and Operate Theater Aviation Maintenance Program (TAMP)* – TAMP is a centrally-coordinated and controlled aviation logistics sustainment program that assists units for deployment and redeployment, provides technical assistance and supports increased operational tempo to sustain Army aviation operations.
- *Assigned Depot Level* – The AVCRAD provides National Maintenance Program repairs, limited depot airframe repair, aircraft painting and major airframe repair.
- *Classify, Inspect, Manage Aviation Class IX* – The AVCRAD is the regional aviation parts warehouse operation for 25% of the Army National Guard aviation units in the Northeastern United States.

The AVCRAD is located in Southern Connecticut and is a tenant of the Groton New London Airport in New London County where it occupies approximately 20 acres. The airport is bounded by the Poquonock River and Bluff Point State Park Peninsula to the northeast. East is Baker Cove, an estuary of Fishers Island Sound. The pristine Long Island Sound is to the south and southwest. Conrail railroad tracks and



The AVCRAD Paint Force accomplished all material substitution testing. Team members are pictured from left to right: Randy Peckham, John Kerouack, Terry Zurn, Steven Petit, Mark Cinotti, Rorry Williams, Patrick Cianciolo, Lindsay Saunders, William Lewerk, Thomas Newman, Scott Burdick, Astuti Giuseppe, & Louis Pemberton. Not pictured: Mark Perrault, and George Lewis.

Tower Avenue are to the west and northwest. The town of Groton (where AVCRAD resides) is located on the Thames River. During the 2000 census, the city's population was 39,907. Groton is the home of the Electric Boat Corporation, which is the major submarine contractor for United States Navy. The Pfizer pharmaceutical company is also a major area employer. The Avery Point section of Groton is home to a regional campus of the University of Connecticut. Groton is located in an area of large military presence with local economies heavily dependent upon the military; therefore, the political climate is generally highly supportive of the military and government operations.

The AVCRAD performs major aircraft repairs that cannot be performed at an Army Aviation Support Facility. The repair work consists of four operations: aircraft and engine repair, engine testing, aircraft stripping and aircraft coating. The AVCRAD employs over 300 military personnel and civil contractors and contributes approximately \$60 million annually to the local economy.

BACKGROUND

One of the Army's greatest needs is to minimize the environmental footprint of its forces and systems to comply with federal, state, local and international

environmental, safety and occupational health (ESOH) regulations. Vehicle coating system application and removal represent a significant waste stream for the AVCRAD, constituting approximately 85% of the overall hazardous material use and waste disposal, and 50% of the air emissions at the facility. However, the requirement to provide tactical and life-cycle protection to these combat and support systems has driven the Army to use coating systems that are contrary to most existing and potential ESOH regulations. In October 2004, the Occupational Safety and Health Administration (OSHA) issued a proposed new rule that significantly lowered permissible exposure limits (PEL) for hexavalent chromium (Cr^{+6}), a key compound in current coating systems. The PEL was reduced from 0.57 mg/m^3 to 0.001 mg/m^3 , and the proposed rule also mandated significant control requirements on facilities to prevent inadvertent inhalation exposure to hexavalent chromium compounds and waste materials.

The Program Executive Office (PEO) for Aviation initiated a testing program that evaluated potential replacement coating system components in order to address the ESOH issues. The program tested individual coating components – pretreatment, primer and chemical agent resistant coating (CARC) top coat – as a “coating system” to evaluate how it protects the test substrates. It also helped identify coatings that were non-chromate, low volatile organic compounds (VOC) and low hazardous air pollutants (HAP). The coatings’ main use was for Army rotary wing aircraft exterior substrates, primarily aluminum alloys. The program also evaluated the compatibility of the selected coating system on other aircraft substrates including high strength steels, magnesium alloys and composite materials.

The Trivalent Chrome Process (TCP) is used for the pretreatment of aluminum substrates and requires process and material changes. TCP is a conversion coating material developed by Naval Air System Command (NAVAIR) that has nearly equivalent performance to the hexavalent chromium-based Alodine 1200S that was previously used. The TCP is now a commercially-available product manufactured by several vendors. The new TCP application process has three-primary steps that must be completed to provide the finished TCP conversion coating. The

processes use new cleaners, require a deoxidation step following cleaning (new requirement) and end with the application of the TCP to the aircraft.

The new CARC top coats exceed the performance of the preceding versions and reduce the VOC and HAP emissions, thus aiding in compliance with the Clean Air Act regulations and State Implementation Plans (SIPs). The new CARCs leave a smoother, more mar-resistant finish coating. They are also more resistant to fading and chalking, which will minimize cosmetic painting requirements.

Coating Application

Prior to starting the new coating system application process, the AVCRAD team took the following steps:

- Stripped the test CH-47’s old coating and repaired the fuselage.
- Repainted the interior spaces and preserved them with current procedures.
- Sprayed the TCP onto the aircraft exterior while it was still wet from the deoxidation rinse step.
- Performed all of the cleaning, deoxidation and TCP application steps with minimal suggestions from the technical representatives.
- Indicated the process was simple to understand and easy to perform.

The test program used two different epoxy-based primers. One was a solvent-based product conforming to MIL-PRF-23377 Type I Class N, and the other was a water-reducible product conforming to specification



The non-chromium-6 primer painted on this UH 60 Blackhawk helicopter is effective and safer for the environment.

MIL-PRF-85582 Type I Class C. The AVCRAD team applied the Class N primer to one-half of the aircraft located above the fuel cell sponsons and over the top of the fuselage. The Class C primer was applied to the other half of the aircraft on the fuel cell sponsons and below. The purpose of using two different primers on the same aircraft was to evaluate their adhesion and corrosion protection performance to minimize any potential differences in exposure during the test effort. The AVCRAD team applied the CARC coating conforming to specification MIL-DTL-64159 Type II after allowing the two different primers sufficient "flash off" time (nominally four hours) for initial cure.

After a successful field demonstration, the next steps were for AMCOM Life Cycle Management Command (LCMC) G-4 Environmental Division to coordinate the issuing of a Maintenance Information Message (MIM) to advise field activities of the new coating system process and materials. G-4 personnel will also revise pertinent technical manuals (TMs) and depot maintenance work requirements (DMWRs) to begin the transition to the new, non-hexavalent chromium coating system for all activities responsible for aviation maintenance and repair. The AMCOM G-4 Environmental Division will coordinate interim MIMs by advise activities of the new CARC coating specification changes and new primer coatings available for use on Army rotary wing weapon systems.

PROGRAM SUMMARY

The most important part of the environmental and health program was eliminating the chromium-6 coating process. This accomplishment took seven years of preparation before the Occupational Safety and Health Administration (OSHA) regulations on chromium-6 exposure were finalized. Chromium-6 is an extremely toxic compound that is widely used in aircraft paints and primers. The Primary Health Impairments & Effects that result from workplace exposure to hexavalent chromium (Cr(VI)) in humans are lung cancer, asthma and damage to the nasal epithelia and skin. Prior to 2006, OSHA limited exposure levels in aviation to 50 micrograms per cubic meter 50[μ]g/mL³ of air over eight-hour time weighted averages. These limits were due to the adverse health effects and dangers (including

potential for cancers) at higher exposure levels. This limit was reduced in 2006 to 25 micrograms per cubic meter of air 25 [μ] g/mL³ over eight-hour time weighted averages for the aeronautic industry. Rather than simply change air filtration equipment, the AVCRAD found green alternatives to chromium-6 coatings that do not pose health risks. These substitutes also reduce the environmental harm caused by release or disposal of chromium-6.

AVCRAD obtained approval from the Life Cycle Management Command, G-4 Environmental Division and AMCOM to begin use of an alternative primer non-chromium-based coating. This accomplishment was due to working relationships with National Guard Bureau (NGB), AMCOM and private industry aircraft manufacturers. After two years of rigorous product testing with these partners on an aging fleet, the new primer was deemed a suitable substitute in terms of its capacity to protect aircraft surfaces from corrosion with the added benefit of reduced health risks. Coordination, testing and information sharing was achieved without harm to classified or proprietary aviation information. This effort was possible via the collaboration of the organizations mentioned above.

Given that new OSHA regulations were put in place on May 30, 2006, AVCRAD's implementation of this material substitute paved the way for military, private and nautical aviation facilities to make the same change. This switch represents a significant reduction in the release of chromium-6 in wastewater as well as air emissions. With this change and earlier process improvements, the AVCRAD is nearly chromium-6-free for all aircraft painting elements, and will be entirely chromium-6-free upon exhaustion of current material inventories that still contain chromium-6. The CTARNG is transferring its knowledge of this product substitution to all other CTARNG facilities that use chromium-6. In the coming year, the AVCRAD anticipates that process changes will significantly reduce the volatile organic compound (VOC) and hazardous air pollutant (HAPS) emissions from the paint coatings applied at the paint booths, and achieve a "greener" aircraft.

Material Substitution

The AVCRAD Quality Control Office is the initial receiver of all Mil-Spec standards, technical manuals, maintenance requirements, etc. This office reviews all incoming material and disseminates the relevant information to top management. The management then distributes it to the end use level. This information includes requirements for the use of regulated substances or environmentally friendly alternative products. The AVCRAD utilizes internal Environmental Management System management review procedures to identify where environmentally friendly alternative products are approved for use and eliminate language requiring the use of regulated substances where approved. They then initiate the removal of language that previously called for the use of regulated products from all internal documents.



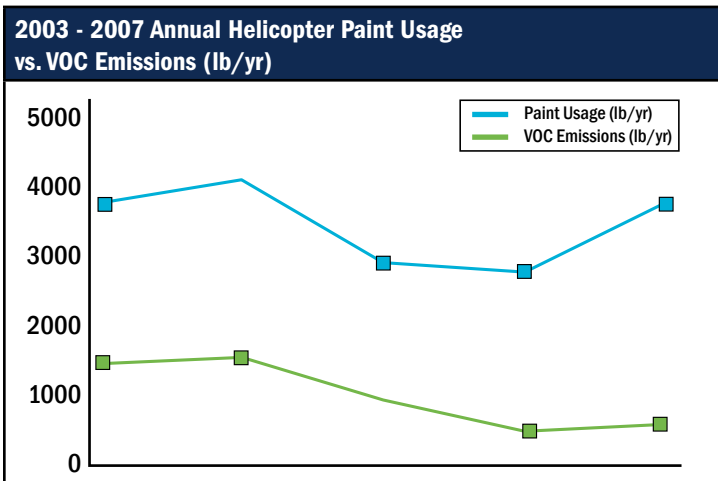
The UH 60 Blackhawk has non-chrome primer applied, which has improved adhesion over other existing primers.

The AVCRAD eliminated both methylene chloride and methyl ethyl ketone from the paint stripping waste stream via the switch to water-based CARC paint. In addition to the benefits of removing such harmful chemicals, there is the potential to reduce future liability related to disposal. The waste stream is now only characteristically hazardous as opposed to being hazardous because of the presence of listed wastes. This allows the characteristic waste to be rendered non-hazardous through treatment prior to disposal, whereas a listed waste cannot be rendered non-listed through treatment.

Process Modification or Improvement

When the AVCRAD began operations in 1979, aircraft were etched with an alodine rinse that contained hexavalent chromium to prepare aircraft for the next stage of the painting process. Disposal of this waste stream cost the CTARNG approximately \$45,000 annually. The alodine rinse is an effective method for etching aircraft prior to painting. However, the hexavalent chromium present in the alodine rinse is a known carcinogen that can be harmful both to applicators and as a disposed waste.

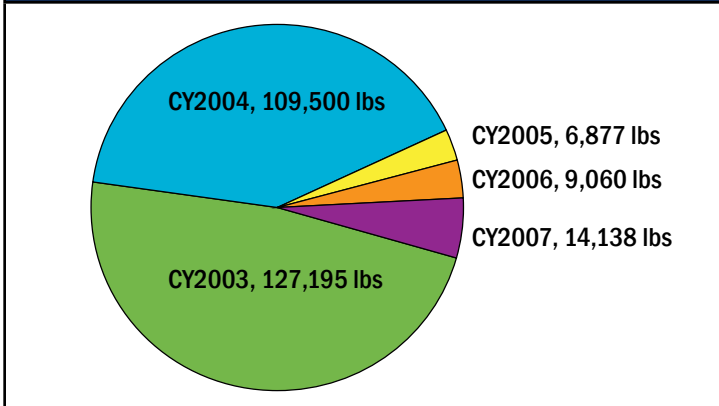
The AVCRAD now utilizes an alodine rinse containing trivalent chromium as opposed to hexavalent chromium for aircraft etching. Although disposal costs remain relatively the same, there is a health benefit gained by the use of the non-carcinogenic trivalent chromium. This reduces worker exposure to carcinogens as well as removes a known carcinogenic from the waste stream for disposal. Additionally, the



The AVCRAD maintains continuous communication with the Aviation Engineering Division to identify alternatives to harmful substances. Through this interaction, the AVCRAD is able to stay abreast of approved environmentally friendly alternative substances. Additionally, it has been a test bed for certain alternative products suitability for possible future use DOD wide.

The AVCRAD team utilizes exhaustive testing methods to determine alternative product suitability as an aviation facility. In the case of the non-chromium-6 primers, over 2,000 hours of exposure to the elements was completed prior to application of the primer to functional aircraft.

Annual Listed Hazardous Waste Generation Reduction from Painting Program at CTAVCRAD



AVCRAD reduced the quantity of alodine rinse applied utilizing a process change in 2003. This process change reduced material applied from approximately 40 gallons per aircraft down to approximately 5 gallons per aircraft. This reduced both exposure to the chemical and concentrations in the waste stream.

Immediately upon approval of the alternative products, the AVCRAD duplicated the process in its blade booth to paint aircraft rotor blades. The use of this technology in the blade booth had the additional benefit of reducing rotor blade weight by two pounds per blade, which extends blade life by allowing blade balance to be maintained for a longer period of time before the blade must be removed from service. This saves approximately \$100,000 for each blade that stays in service. The following are recent pollution prevention (P2) initiatives at AVCRAD:

- Conversion from chromium-6 paint stripper. The AVCRAD targeted waste water containing alodine rinse and chromium by switching the paint operations to water-based CARC paints.
- Streamlining and improving hazardous material management with the implementation of an EMS that is on track for ISO 14001 certification by FY09. Detailed and accessible standard operating procedures (SOPs), records and monitoring data have helped raise awareness of and responsibility for P2 and material management throughout the entire facility.
- The AVCRAD’s inventory and pharmacy system, HAZMART, improved overall material management through tracking and controlling material usage. Any hazardous material requests are reviewed by AVCRAD personnel to determine if more

environmentally friendly products are available. The system also ensures that inventory data on hazardous material is up-to-date. This includes usage, shelf life, disposal and purchase procedures, location and safe handling.

“Environmental awareness is part of the culture of success at the 1109th AVCRAD. An effective and compliant program could not be accomplished without the dedication and discipline of all of our employees. We take our responsibilities to the environment and our employees seriously.”

*- Thomas E. Boland
COL, AV, CTARNG Commander
1109th AVCRAD*

Program Management

In the past two years, the AVCRAD established a number of process and equipment improvements to reduce waste and virgin material purchase at the AVCRAD. The number one project milestone accomplished was the elimination of toxic chromium-6 from the aircraft coating processes. In addition, during the judging period, the AVCRAD eliminated chromium-based paint materials and processes and implemented non-hazardous materials and green equipment. The objectives of the P2 program at AVCRAD address various environmental issues, which include non-chrome and chrome-6-free aircraft coating. This use of alternative products reduces hazardous material use, disposal and air emissions.

These accomplishments were made possible by close coordination between AVCRAD personnel, CTARNG command, NGB and the CTARNG environmental office. The AVCRAD paint shop averages between 25 and 50 helicopters stripped and painted per year. P2 savings include the avoidance of significant hazardous waste disposal, fewer air emissions and increased recycling of spent plastic media. The switch to non-chromium products and the elimination of methylene chloride for depainting aircraft in favor of plastic media blast (as well as recycling the spent plastic media) has cut the AVCRAD’s paint shop hazardous waste stream by over 440,000 pounds annually.

Potential disposal cost savings could be as high as \$75,000.00 annually for the CTARNG over the next few years.

The AVCRAD staff always looks for ways to improve material processes, reduce waste and enhance safety and environmental stewardship. Due to its commitment, the CTARNG AVCRAD remains on track to convert from a large-quantity to a small-quantity waste generator and achieve a completely green aircraft maintenance program.

The AVCRAD has not only implemented an EMS to guide management, it has also worked with the U.S. Navy's Consolidated Hazardous Materials Reutilization Inventory Management Program (CHRIMP) to control hazardous material inventories.

This integrated management approach and the innovations above have allowed the AVCRAD to cut both waste streams and the costs associated with them. The staff learned from peers within the National Guard Bureau and to share their experiences and lessons-learned with other units. They attend workshops and conferences, such as the annual Integrated Compliance Workshop.

The elements of the AVCRAD's P2 and waste reduction program are transferable since their innovations are not necessarily unique to aviation facilities alone. Any paint shop worldwide could benefit from their material substitution and waste treatment improvements. Additionally, the team's approach to interagency cooperation could benefit all military branches to find better cost and process efficiencies. The AVCRAD's commitment to environmental protection endures via excellent standard operating procedures, management plans and EMS.

CONCLUSION

The AVCRAD's chromium replacement innovations set the standard within the aviation community. Private industry has already begun to adopt these material changes. AMCOM is now revising its technical manuals for the military due to the AVCRAD's substitution success. Therefore, chromium-6 will soon be eliminated at every Army aviation and maintenance facility and this is a tremendous breakthrough nationwide to human health and the environment.

The nature of the AVCRAD's work has limited opportunities for community and staff interaction. Because of this, outreach is largely directed at the military community. The AVCRAD staff looks at the CTARNG Soldiers and staff as ambassadors to their families, friends, employers and communities. The lessons the CTARNG soldiers learn are carried far beyond the AVCRAD or other CTARNG installations. With this attitude, the AVCRAD implemented a rigorous training program. All personnel, approximately 300 people, are trained annually in P2 and waste management, compliance and safety. The staff is also trained whenever a new process or equipment change is implemented. This training, along with the continuously demonstrated overall commitment to compliance and waste reduction, has made the AVCRAD one of the nation's leaders in both aviation maintenance and environmental stewardship.