WEAPON SYSTEM POLLUTION PREVENTION

MONITOR

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FEATURE STORY

THE PROPULSION PRODUCT GROUP LEVERAGES RESOURCES ACROSS WEAPON SYSTEMS AND SERVICES

Within the Air Force Single Manager's community, the Air Force Propulsion Product Group (PPG) serves as a model on how to leverage Environment, Safety, and Occupational Health (ESOH) resources across multiple weapon systems. Mr. Robert May Jr., is the Propulsion Product Group Manager (PPGM) and is supported by Single Managers (SMs) in both product (ASC/LP) and logistics centers (SA-ALC/LP and OC-ALC/LP). Notable environmental successes of the Air Force Propulsion Product Group includes the following:

- eliminated all uses of Class I Ozone Depleting Substances (ODSs);
- reduced the use of EPA-17 materials by 353,771 lbs.; and
- facilitated the annual reduction of over 1.33 million lbs. of EPA-17 and 820,000 lbs. of Class I ODSs used by Original Equipment Manufacturers (OEMs).

Central to the Air Force Propulsion Product Group's environmental successes has been its participation and leadership to the Propulsion Environmental Working Group (PEWG). The PEWG addresses common environmental problems through the use of joint and partnering efforts that benefit both government and industry. Details related to the activities of the PEWG and some of its members are provided in this issue of the MONITOR.■

Engine	Engine Model Series	Weapon System	Engine Type	# of Engines
Pratt & Whitney				
F100	F100-PW-100	F-15A/B/C/D	Turbofan	2
F100	F100-PW-200/220BF	F-16A/B/C/D	Turbofan	1
F100	F100-PW-220A/C/E	F-15C/D/E	Turbofan	2
F100	F100-PW-229	F-15E; F-16C/D	Turbofan	2
F117	F117-PW-100	C-17A	Turbofan	4
F119	F119-PW-100	F-22	Turbofan	2
J57	J57-P-21B	QF-100 (Drone)	Turbojet	1
J57	J57-P-43WB	B-52G; KC/NKC-135A	Turbojet	8
J57	J57-P-59W/WB	EC/KC/NC/C-135A/D/G/H/ K/L/Q/Y	Turbojet	4
J60	J60-P-3/3A	T-39B	Turbojet	2
J60	J60-P-5A/5B	C-140A/B	Turbojet	4
J75	J75-P-17	QF-106 (Drone)	Turbojet	1
JT3D	JT3D-3B	VC-137B/C	Turbofan	4
JT3D	JT8D-7B	C-22B	Turbofan	3
JT3D	JT8D-9A	C-9A/C; T-43A	Turbofan	2
PT6A	PT6A-27	UV-18B	Turboshaft	2
TF30	TF30-P-103	EF-111A/F-111A/E	Turbofan	2
TF30	TF30-P-107	FB-111A	Turbofan	2
TF30	TF30-P-109	F-111D; EF-111A	Turbofan	2
TF30	TF30-P-111	F-111F	Turbofan	2
TF33	TF33-P-3/103	B-52H	Turbofan	8
TF33	TF33-P-5	EC/RC/TC/WC/C-135B/ C/M/N/P/S/U/V/W/X	Turbofan	4
TF33	TF33-P-7/7A	NC/C-141A/B	Turbofan	4
TF33	TF33-PW-100A	E-3B/C	Turbofan	4
TF33	TF33-PW-102	EC/KC/NKC/RC/C-135E/ D/H/K/N/P/Y	Turbofan	4
TF33	TF33-PW-102A	EC/C-18A/B	Turbofan	4
Allison/Rolls-Royce				
T-56	T56-A-15/7B/9D	C-130 A/E/H	Turboprop	4
F-113	F113-RR-100	C-20A	Turbofan	2

Engine	Engine Model Series	Weapon System	Engine Type	# of Engines
General Electric (Evendale/Lynn)				
F101	F101-GE-102	B-1B	Turbofan	4
F103	F103-GE-100	F-4B	Turbofan	4
F103	F103-GE-101	KC-10A	Turbofan	3
F103	F103-GE-102	VC-25A	Turbofan	4
F110	F110-GE-100/129	F-16C/D	Turbofan	1
F118	F118-GE-100	B-2	Turbofan	4
F118	F118-GE-101	U-2S	Turbofan	1
J79	J79-15/15A/E	F/RF-4C/D	Turbojet	2
J79	J79-17a/C/F/G	F-4E/G	Turbojet	2
TF39	TF39-GE-1C	C-5A/B	Turbofan	4
F404	F404-GE-F1D2	F117A	Turbofan	2
J85	J85-GE-13C/D	F-5B	Turbojet	2
J85	J85-GE-17A	A/OA-37B	Turbojet	2
J85	J85-GE-21/21A/21B	F-5E/F	Turbojet	2
J85	J85-GE-5H/J/L	AT/T-38/A/B	Turbojet	2
T58	T58-GE-100	CH/HH-3E	Turboshaft	2
T58	T58-GE-5	CH/HH-3E	Turboshaft	2
T64	T64-GE-100	TH/NCH-53A; MH-53J	Turboshaft	2
T700	T700-701C	MH/HH-60G	Turboshaft	2
TF34	TF34-GE-100A	OA/A-10A	Turbofan	2
AlliedSignal/Lycoming/Garrette				
GTC	GTC85-70A	MA-1A/MA-2/MB-2/MB-3	Turboshaft	1
GTC	GTC85-71/71A	C-130A/B/D/E/H	Turboshaft	1
GTC	GTCP165-1/1A	E-3A	Turboshaft	1
GTC	GTCP165-1B	C-5A/B	Turboshaft	2
GTC	GTCP165-9	B-1B	Turboshaft	2
GTC	GTCP85-397	A/M32A-60	Turboshaft	1
Williams International				
F107	F107-WI-101	AGM-86B	Turbofan	1
F112	F112-W1-100	AGM-129A	Turbofan	1

Overview of AF Engines by Weapon System and Original Equipment Manufacturer (Partial)

HISTORICAL PERSPECTIVE: OVERVIEW OF THE PROPULSION ENVIRONMENTAL WORKING GROUP (PEWG)

Although the Propulsion Environmental Working Group (PEWG) was formally chartered by the Joint Propulsion Coordinating Committee (JPCC) in 1994, its heritage can be traced back to Major John Orr's efforts to integrate environmental issues under the Safety subcommittee of the Aerospace Industry Association (AIA). Lessons learned from qualification of materials for engine applications from a safety perspective demonstrated the importance of sharing lessons learned related to environmental issues across multiple engine systems – often times the concerns were similar and solutions could be leveraged through establishing a mechanism for cross-feed.

In 1993, then, the unchartered PEWG supported the Air Force Propulsion Product Group's efforts to eliminate Ozone Depleting Substances (ODSs) and reduce EPA-17 material use. Successes achieved under this group include sharing lessons learned, eliminating the use of chlorinated solvents from engines, and beginning a project to eliminate lead-containing Dry Film Lubricants (DFLs) from all engines. The DFL initiative, started by the PEWG, is today a JG-APP project (see related story on page 6).

The current organizational chart for the PEWG is provided in Figure 1. The PEWG reports directly to the Joint Propulsion Coordinating Committee (JPCC) which includes Mr. Robert May Jr., AF Propulsion Product Group Manager, Mr. Robert Prine, Navy Director of Propulsion & Power Research & Engineering, Mr. Dennis Powelson, Army Chief of the Propulsion Technology Division. PEWG members include six OEMs, the Joint Services, all affected depots & shipyards, and turbine engine operating commands (see Figure 2). The PEWG chairperson, Major Blane Wampler, serves as a facilitator to ensure the exchange of environmental and hazardous material (HAZMAT) information between PEWG team members and other DoD organizations. Some of the specific DoD points of contact for the PEWG are listed on page 9.

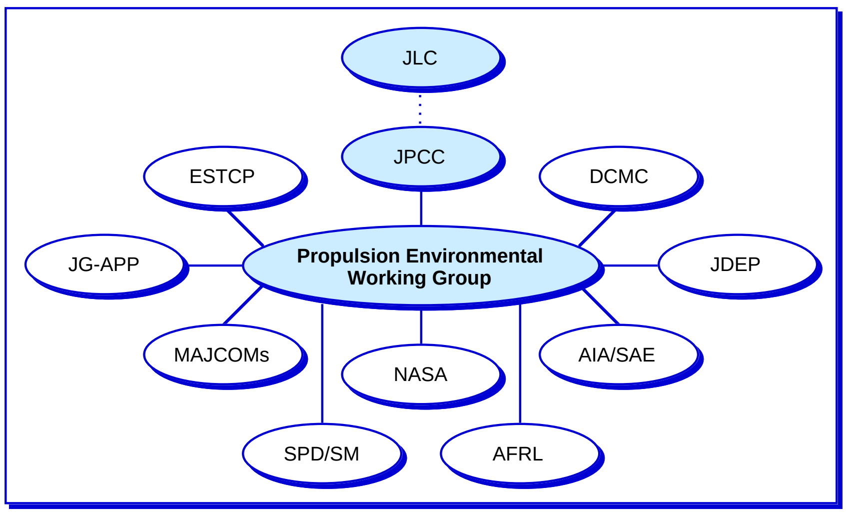


Figure 1. Overview of the PEWG's Organizational Structure

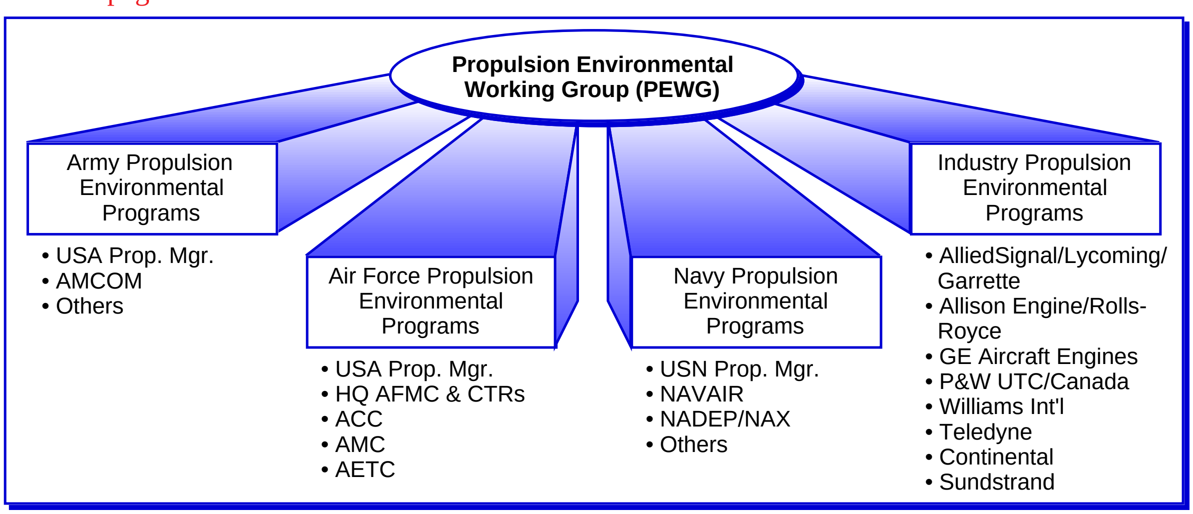


Figure 2. Overview of the DoD and Industry Membership to the PEWG

The chartered responsibilities of the PEWG, which include sharing lessons learned, advising team members on HAZMAT issues and assisting engine teams in complying with applicable environmental policies, are summarized in Figure 3. PEWG members meet biannually to share lessons learned and update each other on the status of cooperative projects (see Figure 4). Details related to some of the cooperative PEWG projects have been summarized on pages 4 through 9. The next meeting is scheduled at AlliedSignal Corporation in January 1998.

- Provide an open forum to exchange information on candidate technologies for elimination of HAZMATs.
- Assist and advise team members in decisions concerning HAZMAT issues, and assist in ensuring that all potential hazards are identified, evaluated, and prevented/controlled to the greatest extent possible.
- Assist all engine teams in complying with applicable government/Air Force environmental policies, and environmental local, state, and federal laws and regulations. Additional duties include enabling the engine team to aid their contractors in executing successful HAZMAT management programs, with emphasis placed on elimination of HAZMATs used in production, maintenance, and operation of engine systems.
- Assist in ensuring the completion of required programmatic environmental documentation, including Environmental Assessments (EAs) or Environmental Impact Statements (EISs).
- Establish ad hoc and standing subcommittees, as required, to perform technical assessment or reviews on topics of mutual interest/purpose for the team members.

Figure 3. Chartered Objectives for the PEWG

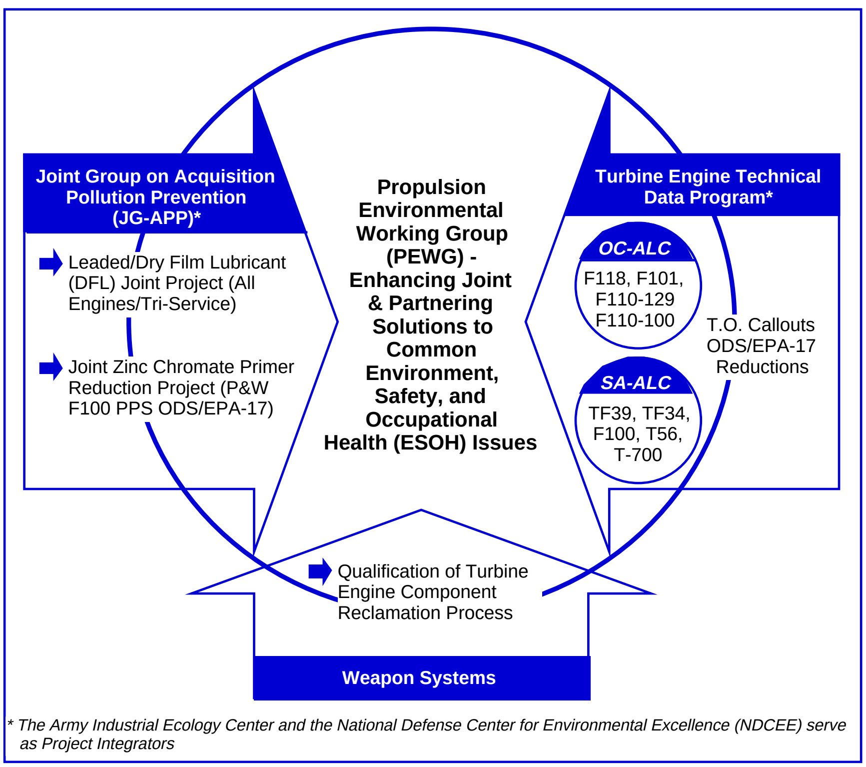


Figure 4. Overview of Joint Initiatives Facilitated by the PEWG Between Its Members

For further information regarding the upcoming PEWG meeting and/or PEWG activities, please contact Major Blane Wampler at DSN 785-2596. ■

SUMMARY OF PEWG PROJECTS

PEWG'S TURBINE ENGINE TECHNICAL DATA PROGRAM

One of the PEWG's earliest joint initiative has been the Turbine Engine Technical Data Program. Initiated in 1993, the project was designed to provide the Air Logistic Centers (ALCs) with recommendations for eliminating Class I ODS usage and reducing the use of EPA-17 chemicals in the maintenance of aircraft turbine engines. The effort has included screening Technical Orders (TOs) to determine where regulated substances are called out, determining the requirements that drive the use of the substance, identifying qualified replacements or evaluating/testing potential alternatives to replace regulated substances where no qualified replacements are currently available. The key to the success of this effort has been involving the Original Equipment Manufacturer (OEM) in identifying an alternative and using the experience at the ALCs to either accept or reject the identified alternative.

The original effort was first initiated by the Propulsion Product Group (PPG) at SA-ALC for the TF39 (C-5 aircraft) and the TF34 (A-10 aircraft) engines. A team, comprising of the PEWG, HSC/YAL (formally HSC/YAQ), SA-ALC, National Defense Center for Environmental Excellence (NDCEE), and General Electric, began to qualify common Air Force accepted depot preferred alternatives. As a part of this effort, the team created a repository known as the Propulsion HAZMAT Database, maintained by NDCEE, to store all information generated to find alternatives. The database includes all requirements, descriptive narratives, and data on recommended alternatives. The effort started at SA-ALC but then was expanded to include F110-129 (F-16C/D aircraft) and F118 (B-2 aircraft) engines maintained at OC-ALC.

The PEWG is currently sponsoring on-going similar projects for the T56, F100, F101 and F110-100 engines. Using lessons learned from the efforts to date and the knowledge base of the OEMs, the PEWG continues to support the Turbine Engine Technical Data Program. Additionally, the PEWG is a partner in the OC-ALC task to reduce or eliminate perchloroethylene use at Tinker AFB.

The current status and details related to the findings from the completed tasks of the PEWG's Turbine Engine Technical Data Program have been summarized in Figure 5. The most common EPA-17 chemical callouts for engine repair and maintenance have been methyl ethyl ketone (MEK) and perchloroethylene (PERC). Common substitutes to EPA-17 callouts in engine repair and maintenance TOs are provided on page 9.

ALC	Engine/Aircraft	Status of Initiative	OEM	Findings/Conclusion
SA-ALC	TF39 (C-5)	Completed	GE	• Identified all ODS and vapor degreasing callouts in the 15 TOs required to maintain the TF engine. • Application specific requirements for each callout were developed and environmental friendly alternatives were found. • All 561 alternatives (166 ODS and 395 vapor degreasing) were accepted with the need for qualification testing.
	TF34 (A-10)	Completed	GE	• Search for 24 TF34 TOs was completed and identified 355 ODSs and 202 vapor degreasing callouts. • Environmentally friendly accepted alternatives were found for all 355 ODSs and 202 vapor degreasing callouts. Alternatives were accepted without the need for qualification testing.
	T56 (C-130)	In Process	Allison	• Search has been completed for 16 TOs for Class I ODS and EPA-17 solvents. Approximately 225 callouts have been identified and alternatives are currently being researched.
	F100 (F-15/F-16)	In Process	Pratt & Whitney	• Search has been completed for 155 TOs for Class I ODS and EPA-17 solvents. Approximately 303 callouts have been identified and alternatives are currently being researched.
	T-700 (HH-60)	Completed	GE	• Search for Class I ODSs and specific EPA-17 chemicals has been completed and identified alternatives accepted.
OC-ALC	F110-129 (F-16 C/D)	Completed	GE	• Search for 63 TOs for Class I ODS and seven specific EPA-17 chemicals. Team identified 713 ODS callouts and 182 EPA-17 callouts.
	F118 (B-2)	Completed	GE	• Search for 53 TOs identified 472 ODS callouts and 641 EPA-17 callouts. • Original Equipment Manufacturer-Recommended Alternatives were accepted for all callouts except four vapor degreasing applications using perchloroethylene. Test & Evaluation Plans were developed to test alternatives to these applications at OC-ALC (see discussion under "Current On-Going Activities and Projects" in Figure 10 on page 10).
	F101 (B-1)	In Process	GE	• Currently 52 TOs are being searched for Class I ODS and EPA-17 solvents.
	F110-100 (F-16)	In Process	GE	• Search has been completed for 36 TOs for Class I ODS and EPA-17 solvents. Approximately 603 callouts have been identified. GE is going through an internal approval process for the alternatives selected prior to presentation to the government for approval.

Figure 5. Summary of Projects Conducted Under the Turbine Engine Technical Data Program

For further information regarding this initiative, please contact Major Blane Wampler at DSN 785-2596. ■

OVERVIEW OF THE PEWG/JG-APP DRY FILM LUBRICANT PROJECT

One of the joint activities between the PEWG and the Joint Group for Acquisition Pollution Prevention (JG-APP) is the Dry Film Lubricant (DFL) project. DFLs are used to lubricate metal surfaces under operating conditions or in environments where conventional lubricants are not satisfactory. DFLs serve as the primary lubricant in many sliding applications or as an antiseize coating for threaded parts and other assemblies which may not move for long periods of time. They also serve as antigalling/antifretting coatings for closely mated parts subjected to vibrational movements. Typical application categories for DFLs in aircraft engines have been summarized in Figure 6.

Application Category	Description of Requirements for DFLs
LG: Low temperature antigalling/ antifretting applications (up to 850°F)	DFL are used to protect part surfaces against sliding and oscillating wear.
HG: High temperature antigalling/ antifretting applications (850°F to 1400°)	DFL are used to protect part surfaces against sliding and oscillating wear.
LS: Low temperature antiseizing applications (up to 850°F)	DFL are applied to threaded fasteners at assembly to facilitate subsequent disassembly.
HS: High temperature antiseizing applications (850°F to 1400°F)	DFL are applied to threaded fasteners at assembly to facilitate subsequent disassembly.
AD: Short term assembly aid applications	DFL are used during assembly to prevent seizing and protect parts from nicks and scratches. DFLs for this application are usually applied by aerosol spray and are allowed to briefly air dry prior to assembly.

Figure 6. Aircraft Engine Applications That Require DFLs

Project Background & Integration into JG-APP Methodology: In 1996, GE Aircraft Engines and the PEWG began identifying DFLs as targets for hazardous material reduction/elimination. In August 96, a draft test plan developed by the PEWG was used as the basis to develop the DFL Joint Test Protocol (JTP) under Phase II (Technical) of the six-phase JG-APP Methodology. The JTP, which was completed in Sept 97, contains the tests necessary to qualify potential alternatives to lead-containing DFLs for use in and on aircraft engines. The JTP requirements were identified by the Original Equipment Manufacturers (OEMs) and defense system representatives based on the application categories discussed earlier.

Based on general knowledge of the range of operating conditions and required performance characteristics, National Defense Center for Environmental Excellence (NDCEE) initially identified a list of lead-free DFL and antiseize pastes. A preliminary screening criteria (see Figure 7) was developed by consensus of the technical representatives and applied to screen this initial DFL alternatives list. In August 97, the technical representatives

Candidate DFL Property	Acceptable Characteristics
Ingredients	lead (Pb) content below 100 ppm
	zero (0) chromium (Cr); zero (0) chromium (Cd); zero (0) antimony trioxide (Sb_2O_3)
	Volatile Organic Compound (VOC) content below 500 grams per liter for products supplied as bulk liquid VOC content below 880 grams per liter for products supplied in aerosol cans
	No carcinogens, with the exception that ethyl alcohol and quartz are acceptable
Coefficient of Friction	$\leq$ 0.13 for low temperature applications; $\leq$0.20 for high temperature applications
Applied Film Thickness	0.3 to 0.8 mils (0.0003 to 0.0008 inch)
Number of Components	One (1)
Shelf Life	$\geq$ six (6) months
Required Surface Prep.	Grit blast and clean with aqueous cleaner of non-ozone depleting solvent(s)
Form as Supplied	Bulk liquid or aerosol (in can); pastes will not be considered
Application Method	Spray, dip, or brush; products that *must* be applied by the vendor of product (no licensing of process possible) will not be considered
Commercial Availability	Products in late development stage may be considered on a case-by-case basis

Figure 7. Criteria Used to Screen Initial List of Dry Film Lubricant Alternatives

discussed the reduced DFLs alternatives list and selected candidate substitutes for initial testing after considering such issues as ease of use and environmental, safety, and health concerns.

DFL Project Status Summary & Points of Contact: Figure 8 summarizes the current status of the DFL project and describes the joint activities between the PEWG and the JG-APP to identify and qualify alternatives for use across multiple engines.

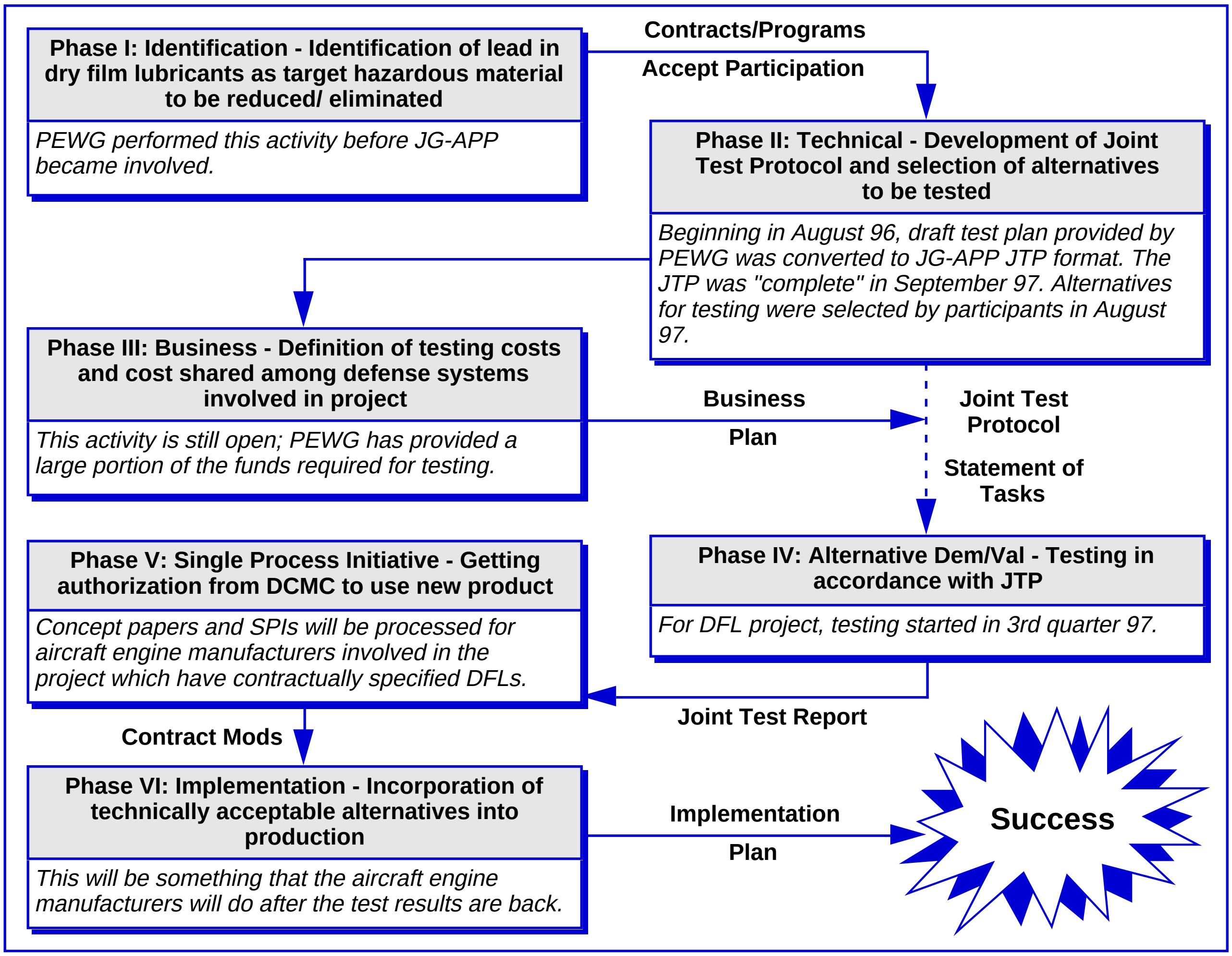


Figure 8. Summary of Current Status of the JG-APP/PEWG DFL Project

For further information related to this joint project, please contact Major Blane Wampler (PEWG) at DSN 785-2596 or Mr. Bob Hill (JG-APP) at DSN 986-3687. ■

OVERVIEW OF PROJECT TO QUALIFY TURBINE ENGINE COMPONENT RECLAMATION PROCESS

The objective of a newly sponsored PEWG project, managed by the Joint Strike Fighter (JSF) Engine Integrated Product Team (IPT), is to qualify a production scale process for the reclamation of scrap turbine engine airfoils. Turbine airfoils are made of cast superalloys which contain both foundry revert and virgin alloy. Foundry revert consists of gates, risers, scrap casting and other pieces of the specified alloy that have been generated within the airfoil investment casting foundry or returned to the foundry by the Original Equipment Manufacturer (OEM) or by depot facilities due to some nonconformance during the airfoil machining process. Replacing a portion of the virgin alloy content with lower cost external scrap, generated outside the investment casting foundry, reduces the amount of the virgin alloy added to the stream. An overview of the methodology that will be used to qualify the process is summarized in this article.

Project Description: Figure 9 summarizes the tasks to be conducted under this project and include the following:

- procure, visually/physically sort, and clean scrap blades
- generate scrap consolidation heat
- conduct preliminary process demonstration
- conduct full scale demonstration and engine test

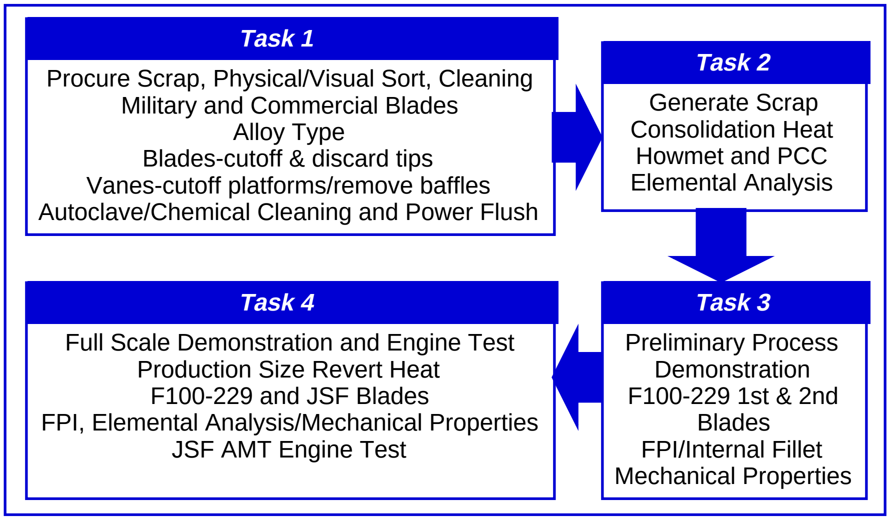
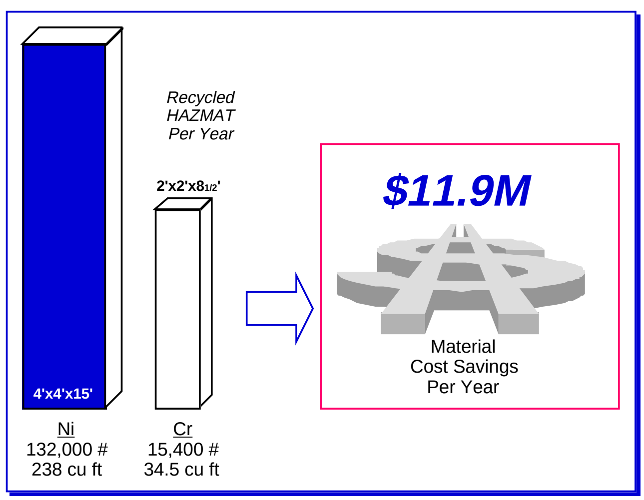


Figure 9. Qualification of Turbine Engine Component Reclamation Process

Initially the OEM will procure scrap turbine airfoils from commercial and military engine design. Mass Spectrometry or an equivalent process will be used to type the alloy and confirm its pedigree. Any ceramic coating on turbine blades and vanes will be removed by either grit blasting, shot peening, or autoclaving in a caustic solution. All parts will then be high pressure water flushed to loosen or remove any non metallic buildup due to engine operation. The cleaned airfoils and vanes will be charged into a vacuum furnace for melting. Preliminary process demonstration will involve F100-229 1st stage and 2nd stage blades. Based on the results of the full scale demonstration, approximately 1/2 set of the Joint Strike Fighter (JSF) superblades will be subsequently coated and fully machined and engine tested. The results generated through this project will be used to obtain approval for incorporating the use of reclaimed engine operated airfoils into alloy stream production for all future F100, F119, and JSF turbine airfoils.

Pollution Prevention Benefits: If implemented across USAF engine programs, the potential pollution prevention benefits associated with this project include the following:

- Recycling of EPA-17 materials (Ni and Cr) and hence reduced demand for these materials.
- Affirmative procurement benefits by stimulating a market for recycled materials.
- Reduced life cycle costs due to the following initiatives:
  - recycling 132,000 lbs. Ni; 15,400 lbs. Cr and 72,600 lbs. of CO, Re, Ta, Y and other metals;
  - reducing demand for EPA-17 materials since 50% materials may be revert/scrap;
  - eliminating cutting operations at the ALCs (2200 lbs. of HAZMAT reduction per year);
  - using existing production lines at component manufacturing plants so that no new equipment purchase are necessary and no new hazardous wastes are generated;
  - achieving savings of $11.9M in material cost per year by recycling 880,000 components per year;
  - supporting project multiple programs that includes all OEMs.



For additional information regarding this project, please contact Major Blane Wampler at DSN 785-2596. ■

EPA-17 or ODC Chemical	Summary of Recommended Alternatives (Point of use application determines alternatives used)
Methyl Ethyl Ketone	Acetone; Denatured Alcohol; Ethyl Alcohol; Isopropyl Alcohol; P-D-680, Type II or III
Perchloroethylene	Acetone; Actrel 3349; CT-2; Isopar L; Isopropyl Alcohol
Trichlorotrifluoroethane	Acetone; Denatured Alcohol; Isopropyl Alcohol; P-D-680, Type II or III
Methylene Chloride	Acetone; Actrel 3349; CT-2; Denatured Alcohol; Isopar L; Isopropyl Alcohol
1,1,1-Trichloroethane	Acetone; Isopropyl Alcohol
Toluene	Acetone; Isopropyl Alcohol
Trichloroethylene	P-D-680, Type II or III
Xylene	Isopropyl Alcohol

PEWG Chairperson (AF)	
Maj Blane L. Wampler	ASC/LPA
Army	
Mr. Dennis Powelson	USA Prop. Mgr.
Mr. William Alvarez	AMCOM-COM
Mr. Larry Pasterick	AMSTA-AR-ET
Mr. Ram Krishnan	TACOM-TARDEC
Air Force	
Mr. Robert May, Jr.	USAF PPGM
Mr. Ron McAtee	SA-ALC/LR
Mr. Aaron Friesenhahn	SA-ALC/LPE
Mr. Ted Mollman	OC-ALC/LPAR
Navy	
Mr. Robert Prine	USN Prop. Mgr.
Mr. Hank Birdsong	USN-CNO
Mr. Gordon Ingmire	NAVAIR
Mr. Bill Graf	NADEP/NAX

PEWG Points of Contact

IMPACT OF ENVIRONMENTAL CONSIDERATION ON TRADITIONAL PLATING PROCESSES FOR ENGINE MAINTENANCE AND REPAIR

For years, the metal finishing industry has relied on chromium, cadmium, and nickel for plating operations due to their engineering properties. These properties include corrosion resistance, wear resistance, and aesthetic appeal. Today, chromium, cadmium, and nickel metals and their compounds are targeted for reduction/ elimination since they have been listed as EPA-17 chemicals and also have stringent effluent discharge limits. Specific details related to the use of these plating processes as well as silver plating are provided below.

Chromium Plating has traditionally been the most common plating process used by the Air Force for engine maintenance/repair. Wear resistance is the primary property provided by this process to engine maintenance activities. Since chromium is a targeted EPA-17 chemical, currently different forms of metal sprays are more commonly substituted for chromium plating since these processes mimic the hardness and wear resistance of chrome. Currently, several studies are underway to examine the use of High Velocity Oxygen Fuel (HVOF) Plasma Spray.

Nickel Plating is sometimes used as a substitute for chromium plating. However, nickel is also a targeted EPA-17 chemical. For engine maintenance activities, electroytic nickel plating is used in low stress situations where repair build up is needed. Electroless nickel plating is used for repair such as a rotating part where hardness or increasing wear resistance is the primary goal. The process is used for unusual configurations or internal areas for wear protection.

Cadmium Plating is commonly used for repair on older engines. New engines have eliminated the need for cadmium plating due to a change in base material alloy. Cadmium plating is used in lower temperatures for corrosion protection. Due to the toxicity of cadmium, ion vapor deposition (IVD) of aluminum is a common substitute process. In this process, aluminum in its vapor state is condensed to form a coating. IVD generates significantly less hazardous waste and environmental releases than conventional plating. Other substitutes for cadmium includes zinc and tin alloy plating.

Silver Plating: is used to provide lubricity and corrosion resistance at temperatures above the capability of conventional solid film lubricants. Silver plating has been used as a solid lubricant in splines, gear boxes etc. ■

PROPULSION PRODUCT GROUP'S SUCCESS STORIES AT THE AIR LOGISTICS CENTERS (ALCs)

OVERVIEW OF OC-ALC PROPULSION PRODUCT GROUP'S POLLUTION PREVENTION INITIATIVES

Oklahoma City Air Logistics Center's Propulsion Product Group (OC-ALC/LP) supports engine repair and maintenance activities for the F101, F108, F110, TF33, TF30, and F107 and F112 missile engines. In support of the Propulsion Product Group Manager's initiatives, OC-ALC/LP has completed revision of Technical Orders (TOs) to remove the requirements for using Class I ODSs, eliminated the use of Class I ODSs and reduced the use of EPA-17 chemicals by 66% from the 1992 baseline (see related PEWG project article on page 4 related to this effort).

The successes at OC-ALC/LP and current on going efforts in pollution prevention have been summarized in Figure 10. Notable successes include process changes associated with various plating processes, reduction in the use of methylene chloride and other chlorinated solvents for cleaning activities, and source reduction initiatives in the chemical cleaning area. The successes achieved at OC-ALC/LP in reducing the use of chlorinated solvents for cleaning/stripping operations and EPA-17 chemicals in plating operations are discussed further below.

Summary of Initiative to Reduce the Use of Chlorinated Solvents: OC-ALC has historically used perchloroethylene (PERC), methyl ethyl ketone (MEK), benzene, and methylene chloride for cleaning and stripping operations associated with engine maintenance and repair activities. Over the last few years, OC-ALC has reduced its use of vapor degreasers from eight to two units.

Current Status of Accomplishments

- Eliminated use of Class I ODSs.
- Eliminated use of Chromic acid and orthodichlorobenzene in Chemical Cleaning.
- Reduced Methylene Chloride usage in cleaning to bare minimum (5 tanks reduced to 2).
- Completed revision of Technical Orders to remove requirements for using Class I ODSs.
- Reduced use of EPA-17 chemicals by 2/3 from 1992 baseline.

Current Ongoing Activities and Projects

- **Substitution of Selected EPA-17 Chemicals from T.O.s:** screening and elimination (where feasible) of tetrachloroethylene/perchloroethylene), methylene chloride (dichloromethane), trichloroethylene, methyl ethyl ketone, benzene, toluene and xylene has been completed for F118 and F110-129 engine T.O.s. Currently, elimination of the same chemicals is underway for the F110-100 and F101-102 engine T.O.s.
- **Elimination/Reduction of Perchloroethylene:** activities are currently underway to eliminate/reduce the use of perchloroethylene from the following vapor degrease activities:
  1. Removing masking wax from interior of HTP blades.
  2. Cleaning prior to plasma spray and Borazon Plating.
  3. General plating wax removal.
- **Non-Cyanide Silver Plating:** prototyping use of a silver plating solution which does not contain cyanide.
- **Closed Loop Electroless Nickel:** remove contaminants from the electroless nickel solution by electrodialysis, thereby allowing reuse of the solution.
- **High Pressure Water Jet Stripping:** introduce high pressure (50,000 psi) water jet equipment, for stripping non-abradable plasma spray coatings.
- **Chemical Vapor Deposition:** environmentally friendly replacement for aluminide coatings on engine hot section parts.
- **Electromagnetic Powder Deposition:** potential replacement/alternative for chrome and nickel plating on engine components.

Processes Implemented

- **Pressure Spray Washing:** replaces vapor-degrease cleaning for most applications.
- **Carbon Dioxide Blasting:** used as a supplement to chemical cleaning and in place of laborious hand cleaning methods (e.g., wire wheel buffing, hand scraping.
- **Water Jet Cleaning/Stripping:** two units in operation (10,000 and 20,000 psi pressure). Uses include removal of abradable thermal spray coatings and stripping rubber coatings from engine cases.
- **Plating Alternatives -** initiatives include the following:
  1. Replace cadmium plating with zinc-nickel plating process and ion vapor deposition of aluminum process.
  2. Replace chrome plating on some components with plasma spray and high velocity oxy fuel.
  3. Replace nickel plating through use of twin wire arc spray on several components.

Figure 10. Summary of the OC-ALC Propulsion Group's Pollution Prevention Initiatives

One of the two remaining units is being replaced by a vacuum degreaser. Based on the successful implementation of this initiative, the other traditional unit will then also be replaced. TO changes have replaced the use of perchlorethylene with pressure spray washing and water jet cleaning/stripping in as many operations as applicable. For stripping activities requiring higher water pressure, OC-ALC is currently investigating the use of high pressure water jet stripping (on-going project). Additionally alternatives to perchloroetheylene are currently being tested for general plating wax removal, removing masking wax from interior of HTP blades, and cleaning prior to plasma spray and Borazon Plating. This initiative is the follow on activity to the TO revisions conducted for the F118 engine (see related article on page 5).

Overview of Plating Operations at OC-ALC: To support engine repair and maintenance activities, chrome, cadmium, electrolysis nickel, electrolytic nickel, silver, indium plating as, well as alodine anodize and various stripping processes (e.g., cadmium and chrome), have historically been conducted at OC-ALC.

Traditionally, environmental factors were not considered by design decision makers when evaluating materials and processes for maintaining corrosion and wear resistance on engine parts. Today, as plating engineers consider material and process changes to improve efficiencies, they have found that incorporating an environmental mindset into their decision making process, can enhance mission requirements while protecting human health and the environment.

Summary of Improvements to Plating Processes: Among the pollution prevention successes at OC-ALC has been the elimination of cadmium plating from all engine repair and maintenance activities. In 1991, cadmium plating, traditionally used for plating tie-rods on engines, was replaced with a zinc-nickel plating process, which comprises of 10% nickel and 90% zinc. This process change was made by qualifying the substitute for each specific application. In most situations, the new process has resulted in superior corrosion protection. The key to implementing this change was the enhanced corrosion protection achieved with the new process. Environmental enhancements associated with this material/process substitution included elimination of a highly toxic material (cadmium) and elimination of cyanide from the plating bath.

Other improvements in the plating processes at OC-ALC include changes to the chrome and nickel plating process. Chrome plating, traditionally used for bearing journals to provide hard abrasion wear resistance, is being prototyped/tested on a case-by-case basis for replacement with plasma spray and high velocity oxy fuel. Nickel plating, used to build up worn surfaces on major cases (diffusers, intermediate casing) to ensure precise machine fit, has been replaced with the use of twin wire arc spray on several components. Over fifty percent of the nickel plating workload has been moved to twin wire arc spray. Current on-going projects related to plating include the following: replacing aluminide coatings on engine hot section parts with chemical vapor deposition and evaluating potential replacement of chrome/nickel plating on engine components with Electromagnetic Powder Deposition.

For further information regarding OC-ALC/LP's pollution prevention initiatives, please contact Mr. Mike Patry at DSN 336-5185. ■

POLLUTION PREVENTION TECHNOLOGY INSERTION TO IMPROVE THE ELECTROLESS NICKEL PLATING PROCESS (ENP)

Electroless nickel plating (ENP) is used for engine repair and maintenance activities at both SA-ALC and OC-ALC. During the course of this process, the build up on contaminants eventually renders the ENP bath unusable because of deteriorating coating properties. As a result, a large volume of nickel bearing solution is discarded as waste because of buildup of various detrimental ions in the ENP.

In 1996, HSC/YAL initiated a program to identify a means for successfully rejuvenating spent electroless nickel baths. A trade off analysis completed by National Defense Center for Environmental Excellence (NDCEE) in

October 1996, concluded that the Electroless Nickel Dialysis Unit 20 (ENDU-20), manufactured by Zero Discharge Technologies, Inc., was the most viable cost effective solution.

The ENDU-20 uses a process that batch treats the electroless nickel bath via ion-exchange membranes. The membranes are stacked in cation-anion pairs up to 40 sets. Bath rejuvenation is achieved when the bath contaminants are moved more efficiently through the membrane than the chemicals that are returned in the bath, or recirculated into it, thus requiring fewer new chemicals to rejuvenate the bath. This reduces the contaminated bath solution that must be treated and then disposed.

After developing a comprehensive test plan, the ENDU-20 dialysis unit was tested at the NDCEE Demonstration Factory which houses a closed loop plating line. NDCEE tested the following three ENP chemistries: Niklad 794, Niklad 797, and Enplate ADP 300. Upon successful demonstration, the ENDU-20 was installed at OC-ALC. Installation of the unit is relatively simple and requires only one single phase 110V power outlet and water supply. The unit can be hooked via CVC (or flexible hose) to any water source. The operation of the unit is relatively simple and requires no special technical knowledge or skill.

The benefits associated with this process include the following:

- 20% reduced annual consumption of nickel (an EPA-17 material);
- 90% annual reduction on hazardous waste disposal;
- extended ENP bath life from 4 metal-turn-overs (MTO) to potentially 1000 MTOs;
- savings of approximately $27,000 a year in capital costs.

The above reductions are for OC-ALC's use only. The process has DoD wide application and could benefit the Army, Navy, or any other entity involved in metal plating.

For further information please contact Mr. Dan Carlee, HSC/YAL at DSN 240-5053. ■

GOING GREEN: INNOVATIONS IN PLATING OPERATIONS AT SA-ALC

In 1978, San Antonio Air Logistics Center (SA-ALC) established a 90,400 square feet facility to meet its operational needs. This facility supports all depot plating repair activities at Kelly AFB. Metal treatment is specifically provided for the F100, TF39, T56 and gas turbine engines, as well as other aircraft parts and new manufactured items that require plating. The facility processes approximately 25,000 parts per month and is supported by 105 production personnel, working three shifts. Additionally, a fully equipped laboratory of ten personnel support instrumental and wet analysis requirements.

SA-ALC Plating Laboratory Team Members
Front Row: Kimberly Chang, Francine Ramon, Lourdes Galarza, Juan Aquilar, Nancy Stapper, Patrick Swaggerty
Back Row: Mike Perez, Janice Grassel, Arthur Diaz, Fernando Chacon

Overview of the Plating Process: The facility can perform chrome, cadmium, nickel, electroless nickel and silver plating (see description of these processes on page 9). Other metal treatment processes include aluminum anodizing (chromic acid, sulfuric acid, and hardcoat), chemical conversion coating, corrosion treatment for magnesium, manganese phosphate, black oxide, IVD aluminum, solid film lubricant, passivation, nickel etch and acid pickle. The facility also has several stripping operations for removing thermal spray coatings. These coatings include Metco 443, 450, 204/461, tungsten carbide, molybdenum and diffused nickel aluminide.

Design for the Environment Considerations: Upon construction, the plating facility incorporated several design considerations to protect the environment. To begin with, the building was designed for complete chemical containment. All 273 tanks used for various aspects of the plating process are located on grating. All spills are drained through troughs to sumps in the basement. Rinse water, except cyanide, is deionized and recycled within the building. Additionally, a RO system provides ultrapure water for specific applications. The facility also has in-house blasting capabilities. Media waste from chromium and cadmium parts are segregated from the central waste media collection system. Emissions to the air are minimized by ventilating tanks through a push-pull to packed bed scrubber located outside the building.

Pollution Prevention Success Stories: The plating facility at SA-ALC continues to improve its processes and identify pollution prevention opportunities. Some of these recent success stories include the following:

- **Use of Ion Vapor Deposition of Aluminum for Cadmium Replacement -** the Air Force/Navy requires use of cadmium on T56 engine compressor parts. This material/process substitution has eliminated the use of an EPA-17 chemical (cadmium).
- **Implementation of a New Chrome Plating Line -** new equipment for chrome plating that will meet future National Emission Standards for Hazardous Air Pollutants (NESHAP) standards has been installed and is currently undergoing testing.
- **Installation of a New Electrolytic Nickel Line -** system was replaced due to significant corrosion on the plating line. The line has been refurbished to improve efficiency and safety.
- **Installation of a New Electroless Nickel Line -** this auto catalytic process requires no current for plating operations. The new solution used for plating reduces nickel waste. As a result, waste generation has been reduced from 3,000 gallons per month to less than 500 gallons per quarter.
- **Installation and Use of Compliant Vapor Degreaser -** parts washers have been installed in lieu of non compliant vapor degreasers for most applications. One such innovation has been the use of a compliant vapor degreaser for wax removal.

For further information regarding the pollution prevention initiatives and design for the environment considerations adopted in the plating facility at SA-ALC, please contact Ms. Nancy Stapper at DSN 945-3190 or 210-925-3190. ■

Ivadizer

New Chrome Plating Line

Electroless Nickel Automated Controllers

COMMUNITY CROSS-FEED

APPLIQUÉ - A ZERO VOC ALTERNATIVE TO AIRCRAFT TOPCOATS

Aeronautical Systems Center's Applied Technology Program announces another promising pollution prevention initiative. The environmental project "Appliqué" offers a high-tech alternative to presently used military aircraft topcoat paint systems.

According to Charles Valley, manager of the Applied Technology Program in ASC's Acquisition Environmental Management Directorate, "Appliqué" is a zero-volatile organic compound (VOC) film designed to be applied to a primered aircraft skin. This topcoat covering, which is similar to contact paper, replaces the traditional sprayed-on high-VOC topcoat paint. The film, manufactured by 3M, is a fluorinated polymer material with design characteristics similar to those of traditional paint topcoats, but without the hazardous materials. This process reduces the use of volatile organic compounds (VOCs) and, consequently, fosters Air Force pollution prevention initiatives toward protecting human health and the environment.

Current aircraft paint systems depend heavily on large volumes of VOCs and heavy metals, such as methylene chloride, methyl ethyl ketone, and chromium. These chemical compounds pose a serious threat to the environment and to the health of workers at aircraft maintenance depots.

Valley said, "This project is still in the testing phase, however, if the appliqué process proves successful, it will represent another milestone in replacing depot processes which rely on hazardous materials. This environmentally-friendly process also could represent a turning point in how supersonic military aircraft are painted during manufacture and maintenance cycles."

"Appliqué" has been used as decals on commercial airliners and tested as belly protection on military cargo aircraft. An F-15B fighter currently serves as the only existing Air Force test bed for appliqué flight testing being conducted at Boeing Aerospace in St. Louis, Missouri. Testing involves flying the "chase and target" aircraft at variable speeds within a normal flight envelope up to mach 1.65. Aircraft technicians cut the topcoat film, which has an adhesive backing, into specific shapes, and then position them over the aircraft surface to be covered. The appliqué can be used on most sections of an aircraft, except high temperature areas such as those adjacent to the engines. The Applied Technology Program manager said that initial tests have yielded positive results in the flight test program, as the material appears to be durable, and shows no signs of pealing away.

Success of ASC's Pollution Prevention initiatives places this organization as the leading Air Force agency for the "Appliqué" program. However, others within DoD, such as the Joint Strike Fighter program office, have closely monitored the Navy's efforts, which use an F/A-18 aircraft as the test bed for this technology. Engineers at Warner-Robins Air Logistics Center in Georgia also are investigating similar uses of the Appliqué technology on other aircraft.

The Applied Technology Program serves as a focal point for the development of pollution prevention projects. These projects assist the Air Force in identifying ways to eliminate the use and disposal of hazardous materials in the weapon system life cycle. Two strong advocates of the Paintless {*topcoat only*} Aircraft Program are Sherri W. Goodman, Deputy Under Secretary of Defense for Environmental Security, and Dr. William White, Chief Scientist at Warner-Robins Air Logistics Center. In a recent presentation, Goodman commented that this technology represents an environmental breakthrough for the military that has the potential to save the Defense Department billions of dollars. In a similar statement, Dr. White expressed his belief that the appliqué approach would be a tremendous benefit considering the magnitude of painting operations at his facility.

Valley said, "We're moving in the right direction, as the Applied Technology Program offers great returns on investment to the Air Force."

Article submitted by Mr. Dan Johnson, ASC/EMV. The text of this article appeared in the 3 Oct .97 issue of the Wright-Patterson AFB newspaper, "The Skywrighter." ■

INTRODUCTORY TOXICOLOGY COURSE AVAILABLE

A four hour introductory toxicology course is being offered by the Operational Toxicology Branch under the Human Effectiveness Directorate of the Air Force Research Laboratory (AFRL/HEST). The course addresses the scope of toxicology, general principles, types of toxicology studies, data interpretation, Tri-Service Toxicology capabilities, regulatory agencies and standards, the risk assessment process, Mil Standard 882 and material safety data sheets (MSDSs).

Dr. David Mattie and Maj Steve Bachowski conducted the initial class at Wright-Patterson AFB, Ohio on 25 July 1997 for members of the Aeronautical System Center Environmental Management Office (ASC/EM) and the base Bioenvironmental Engineering Office. Classes were held on 12 and 26 September 1997 for members of the Wright-Patterson AFB Environmental Management Office (88ABW/EM) and as makeup classes for ASC/EM and the base Bioenvironmental Engineering Office. Additional classes have been scheduled 14 and 21 Nov 1997 for 88 ABW/EM and ASC personnel. Classes are already half full.

AFRL/HEST is willing to offer the course to any individual or organization with an interest. TDY funds are limited and, therefore, funding would be required to travel. Contact Dr. David Mattie at DSN 785-3423 ext. 3105/Comm. (937) 255-3423 x3105 for further information. For individuals who are interested in learning about toxicology on their own, there is the National Institute of Health's Toxicology Tutor on the internet: <**http://sis.nlm.nih.gov/tox640/mainmenu.htm**>. ■

"CLOSED LOOP" RE-REFINED OIL PROGRAM

Defense Supply Center Richmond (DSCR) is taking another step towards accomplishing its mission of giving the customer "What it wants, when it wants it, and at the best value." This progressive new program called Closed-Loop involves re-refined oil with an added value – When the customer orders re-refined oil from DSCR, they will have pick-up of their used oil included as part of the service provided by our contractor. This is a great benefit to the customers who now have to deal with cumbersome disposal contracts, contract administration, delinquent contractors, environmental concerns surrounding disposals, and additional costs for disposal of used oil. In many instances, customers are paying for disposal of their used oil. A Closed-Loop program will help the customers as it will stop them from having to pay twice – once for buying re-refined oil and again for disposing of it.

The DSCR "Closed-Loop" program will do away with the need for separate contracts for disposing of used oil and with the hassle of administering such contracts, take environmental burdens off the customer, and save the customer money.

DSCR intends to offer 10W30 in accordance with a Commercial Item Description, 15W40 in accordance with a Commercial Item Description, and 15W40 in accordance with Military Specification MIL-L-2104. Another added advantage to this program will be the introduction of bulk deliveries in addition to the already established packaged offerings. This will give the customer more options in support of their missions.

Also, it is important to note that this program will specify that the used oil will go to a re-refiner for re-refining, vice to a burner. Although some bases currently "sell" their used oil to burners or simply burn in their own facilities, DSCR believes that this is not considered recycling. Executive Order 12873 specifies that "the Nation's interest is served when the Federal Government can make more efficient use of natural resources by maximizing recycling and preventing waste wherever possible." Burning used oil is not maximizing recycling and preventing waste because once oil is burned, it can no longer be used again. On the other hand, re-refining oil presents an indefinite recycling loop and therefore maximizes recycling of this precious product. It does this in two ways. First, the base stock oil is refined back to its original status and can be used again and again. Secondly, the "bottoms" removed during this refining process can be used in asphalt blends. Every effort is made to maximize recycling during the re-refining process.

The United States Postal Service and the National Park Service already participate in a closed-loop program with private industry and the USPS won the prestigious White House Closing the Circle Award for its use last year. We are confident our program will present all Federal activities with an opportunity to satisfy many motor oil related concerns.

To get on the mailing list for re-refined oil and the Closed-Loop Program, please e-mail or call Mrs. Robin Champ at DSCR: e-mail rchamp@dscr.dla.mil or phone (804) 279-4908/DSN 695-4908. ■

UPCOMING EVENTS

Date	Meeting	Location	POC	Phone/E-mail
04-06 Nov 1997	Weapon System P2 Center Working Group Conf. - 8th Joint Solutions to Common Problems	SMC, Aerospace Corporation Los Angeles, CA	LtCol Denton Crotchett	DSN 833-0293
05-07 Nov 1997	Cadmium and Chromium Alternatives: Information Exchange	Pittsburgh, PA	Ms. Teresa Kishlock	(814) 269-2800, e-mail: kishlock@ctc.com
10-12 Nov 1997	The Future of the U.S. and International Environmental Industry	The Capital Hilton, Washington, DC	Joan Hall & Associates LLC	(800) 547-6276
12-13 Nov 1997	International Conference on Ozone Protection Technologies	Baltimore Convention Center, Baltimore, MD	Ms. Heather Tardel	(703) 807-4052
13 Nov 1997	Acquisition Environmental & Health Protection Committee Meeting	Bldg. 14, Area B, Wright-Patterson AFB, OH	LtCol Gil Montoya	DSN 785-3059, ext. 308
17-19 Nov 1997	Pollution Prevention/Green Manufacturing Conference for Industry and Business	Marriott Marquis Hotel, Atlanta, GA	USEPA Reg. 4	(404) 562-9362
18-20 Nov 1997	The National Marketplace for the Environment Conference and Trade Show	Washington Convention Center, Washington, DC	National Marketplace for the Environment	(800) 334-3976 FAX (818) 906-0367
19-20 Nov 1997	Symposium on Sustainable Green Manufacturing	Plaza Hotel, Morristown, NJ	Ms. Donna Gorog	(973) 724-4666 or e-mail: dgorog@pica.army.mil
02-05 Dec 1997	8th Annual International Solvent Substitution Workshop	Radison Conf. Center, Scottsdale, AZ	Ms. Eileen Schmitz	(847) 234-2353
02-05 Dec 1997	9th Annual Chemical Emergency Preparedness and Prevention Conference	Pittsburgh, PA	USEPA Reg. 3	(610) 701-3080, internet: http://www.vtec2.com/cepp97.htm
03 Dec 1997	Weapon System P2 Center Working Group VTC	1100-1200 Eastern Time	Mr. Peter Logan	DSN 478-4536
08 Jan 1998	Weapon System P2 Center Working Group VTC	1230-1330 Eastern Time	Mr. Peter Logan	DSN 478-4536
27-29 Jan 1998	26th Annual Advanced Environmental/Readiness Operations Course (AEROC) Symposium	Main Auditorium, Bldg 775, Brooks AFB, TX	Col Tom Lubozynski	DSN 240-3831 or e-mail: lubozyns@usafsam.brooks.af.mil
04 Feb 1998	Weapon System P2 Center Working Group VTC	1100-1200 Eastern Time	Mr. Peter Logan	DSN 478-4536
22-27 Feb 1998	Air Combat Command (ACC) Environmental Training Symposium	Adams Mark Hotel Conference Center, Denver, CO	HQ ACC/CE	(757) 764-9775 FAX (757) 764-9369 or e-mail: symposium@HQaccCE.langley.af.mil

CORRECTIONS TO THE SEPT. 97 WSP2 MONITOR

The heading for SMC on page 11 is incorrect. The correct heading is Space and Missile Systems Center's (SMC's) Input.

Figure 2 on page 2 should have been "Old vs New ESOH Needs Identification Process at AETC" and not at AEDC. ■

THE MONITOR ON INTERNET

The Weapon System Pollution Prevention MONITOR is available on the Internet. The Monitor can be accessed from the ESOH Service Center Home Page at <http://www.brooks.af.mil/ESOH/esohhome.htm> or directly at <http://www.brooks.af.mil/HSC/EMP/Monitor/Monitor.html>. Current issues of the Monitor are in a Portable Document Format (PDF) file which requires a reader program for viewing or downloading. The Adobe Acrobat reader is available for downloading at no cost. ■