DEPARTMENT OF THE ARMY
U.S. ARMY CENTER FOR HEALTH PROMOTION AND PREVENTIVE MEDICINE
5158 BLACKHAWK ROAD
ABERDEEN PROVING GROUND, MARYLAND 21010-5422

REPLY TO ATTENTION OF

MCHB-TS-EHM

27 APR 1998

MEMORANDUM FOR Commander, U.S. Army Environmental Center, ATTN: SFIM-AEC-ECP (Mr. Eck), APG, MD 21010-5401

SUBJECT: Final Aviation Unit Maintenance Pollution Prevention Guide

1. Enclosed is a final copy of the Aviation Unit Maintenance Pollution Prevention Guide and a copy of the responses to the comments regarding the draft. The Guide will be posted on the USACHPPM Hazardous and Medical Waste Pollution Prevention Site at the following internet address: http://chppm-meis.apgea.army.mil/hmwp/p2_team.html.

2. Questions concerning this Guide may be referred to 1LT Lisa Strutz, DSN 584-8548, Commercial 410-671-8548, or Mr. Brian Jones, Pollution Prevention Team Leader, DSN 584-5229, Commercial 410-671-5229.

FOR THE COMMANDER:

2 Encls

Linda L. Baetz
LINDA L. BAETZ
Program Manager
Hazardous and Medical Waste

Readiness thru Health

AVIATION UNIT MAINTENANCE POLLUTION PREVENTION GUIDE

Prepared by:
U.S. Army Center for Health Promotion and Preventive Medicine
Aberdeen Proving Ground, Maryland 21010-5422

USACHPPM Project Number 37-EE-4823-96

Publish Date: April 1998

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

SECTION 1

INTRODUCTION

A. PURPOSE. The purpose of this pollution prevention (P2) guide is to identify opportunities to reduce pollution generated by unit-level aviation maintenance operations (AVUM). This guide also provides template calculations showing waste reduction estimates and economic analyses for each P2 opportunity. These calculations are based on material usages, waste generations, and disposal fees of an average *light infantry aviation unit maintenance facility. This P2 guide is* designed to serve only as a template for similar aviation activities. By replacing the assumed numbers with those from an actual facility, this P2 guide can be customized to provide specific potential waste reduction and cost estimations for use as a prioritization tool in implementing the P2 opportunities.

B. SCOPE. Since the U.S. Army does not have many fixed-wing aircraft in its inventory, they will not be included in this guide. This P2 guide pertains to all helicopter platforms; however, to maintain the brevity of this P2 guide, only the following aircraft are specifically addressed: Blackhawk (UH-60), Kiowa (OH-58), Iroquois (UH-1), and Cobra (AH-1). This P2 guide addresses the following major waste streams generated by a typical AVUM facility servicing the above-mentioned helicopters: oil, batteries, solvents, fuel, hydraulic fluid, rags, and aerosol cans. Local environmental compliance issues such as storage, transportation, and spill prevention are not covered in this P2 guide, and information can be obtained through the supporting installation's environmental office.

Table 1-1. Army Helicopter Platforms.

Helicopter Platforms	Function/Mission
Blackhawk (UH-60)	Utility
Kiowa (OH-58)	Observation
Iroquois (UH-1)	Utility
Cobra (AH-1)	Attack
Apache (AH-64)	Attack
Chinook (CH-47)	Cargo/Transport
Comanche (RAH-66)	Observation

C. FORMAT. Each of the subsequent sections of this guide addresses one of the above major waste streams. Part A of each section describes the operations a typical AVUM facility performs and provides template production numbers relating to that section's waste stream. Part B of each section discusses the P2 opportunities designed to reduce the specific waste stream. For each opportunity, the guide includes a background discussion on the technology involved, potential waste reduction estimates, and an economic analysis showing implementation costs, recurring costs, cost savings, and payback period. For those opportunities with a template payback period greater than 3 years, a 3-year payback period has also been calculated (i.e., how much waste would need to be generated for the opportunity to have a payback period of less than 3 years). Note that the costs used in this P2 guide are intended for example only, as true costs are subject to change. Part C contains a one-page table that summarizes each P2 opportunity identified. Part D provides relevant points of contact through which further information on P2 technologies, equipment, or reports can be obtained.

D. TECHNICAL ASSISTANCE. Technical assistance and guidance can be obtained from the following:

(1) CONUS, (a) Commander, USACHPPM, Hazardous and Medical Waste Program, Aberdeen Proving Ground-Edgewood Area, Maryland 21010-5422, DSN 584-3651, Commercial (410)-671-3651, FAX extension 5237.

(b) Commander, USA ARDEC, Industrial Ecology Center, ATTN: AMSTA-AR-ET, Picatinny Arensal, New Jersey 07806-5000, DSN 880-2044, Commercial (201)-724-2044, FAX extension 6759 or 2314.

(2) OCONUS, (a) Europe: Commander, USACHPPM-Europe, Environmental Health Engineering Division, CMR 402, APO AE 09180 (Landstuhl, Germany), DSN (314)-486-8556, Commercial 011-49-6371-86-8556, FAX extension 7198.

(b) Pacific: Commander, USACHPPM-Pacific, Environmental Health Engineering Division, Unit 45008, APO AP 96343 (Sagami, Japan), DSN (315)-268-4831, Commercial 011-81-3117-68-4831, FAX extension 4367.

E. TECHNICAL REFERENCES. The following references provide additional information.

(1) Tri-Service Pollution Prevention Opportunity Handbook, Naval Facilities Engineering Service Center, Port Hueneme, CA 93043-4370, March 1996.

(2) Environmental Products Catalogue: Alternatives, Recyclers, Aircraft Cleaners, and More, Defense Logistics Agency, December 1996.

(3) Technical Bulletin 43-0135, HQDA, 1 June 1994, Subject: Environmentally Safe Substances for Use with Communications-Electronics Equipment.

F. DISTRIBUTION. Local reproduction of this document is authorized and encouraged to maximize dissemination of the information provided.

SECTION 2

OIL MANAGEMENT

A. Template Operations

(1) Production.

- The AVUM shop is responsible for servicing 40 aircraft: 10 UH-60 Blackhawks, 10 OH-58 Kiowas, 10 UH-1 Iroquois, and 10 AH-1 Cobras.

- The oil in each aircraft is changed every 900 flight hours (except the UH-60, which is changed strictly upon the AOAP laboratory results) or approximately once per year.

(2) Material Requirements.

- Empty 55-gallon steel drums weighing approximately 55 pounds each are purchased through logistics for $25 each.

Table 2-1. Estimated Engine Oil Annual Material Costs.

Aircraft Type	Engine Oil NSN	Engine Oil Capacity	Unit Cost ($)	Cost per Change	Estimated Annual Cost
Blackhawk (UH-60)	9150-01-385-6780	14 quart (3.5 gallon)	7.11/quart (28.44/gallon)	$100.69	$1006.95
Kiowa (OH-58)	9150-01-385-6780	11.2 pint (1.4 gallon)	7.11/quart (28.44/gallon)	$39.81	$398.10
Iroquois (UH-1)	9150-00-985-7099	3.8 gallon	3.94/quart (15.76/gallon)	$59.89	$598.90
Cobra (AH-1)	9150-01-385-6780	3.4 gallon	7.11/quart (28.44/gallon)	$96.70	$967.00
Total Oil Volume (times factor of 10)		110.5 gallon	Total Annual Cost		$3143

Table 2-2. Estimated Transmission Oil Annual Material Costs.

Aircraft Type	Transmission Oil NSN	Transmission Oil Capacity	Unit Cost ($)	Cost per Change	Estimated Annual Cost
Blackhawk (UH-60)	9150-01-385-6780	7 gallon	7.11/quart (28.44/gallon)	$199.08	$1990.80
Kiowa (OH-58)	9150-01-209-2684	4 quart (1 gallon)	5.30/quart (21.20/gallon)	$21.20	$212.00
Iroquois (UH-1)	9150-00-782-2627	11 quart (2.75 gallon)	3.79/quart (15.16/gallon)	$41.69	$416.90
Cobra (AH-1)	9150-01-385-6780	2.25 gallon	7.11/quart (28.44/gallon)	$63.99	$639.90
Total Oil Volume (times factor of 10)		130 gallon	Total Annual Cost		$3,259.60

(3) *Waste Generation.*

- Based on Tables 2-1 and 2-2, 233.5 gallons of used oil are generated annually.

- Based on one oil change per year, 40 used oil filters are generated annually.

(4) Waste Disposal.

- Used oil is placed in a 200-gallon, concrete-bermed, aboveground storage tank and collected at no cost by an offsite used oil recycler once per month for refinement or fuel blending. While not presented as the model, in some cases the used oil may be burned onsite for energy recovery. Specific state requirements and oil contamination issues will have to be considered.

- Used oil filters are hot-drained (at or above 60°F) according to approved EPA methods. Once drained, they are placed in 55-gallon drums and disposed of as a non-regulated solid waste at a cost of $50 per ton.

- One 55-gallon drum of uncrushed filters (50 filters) weighs approximately 105 pounds. One 55-gallon drum of crushed filters (200 filters) weighs approximately 255 pounds.

- If the used oil is contaminated, the hazardous waste disposal cost is approximately $100 per 55-gallon drum. Laboratory fees for hazardous waste characterization can equal or exceed drum disposal costs.

B. Pollution Prevention Opportunities

(1) Used Oil Segregation.

(a) Description. Since the used oil recycler will only accept noncontaminated oil, it is important to keep the used oil free of other materials such as water, deicing fluid, gasoline, and solvents. In some cases, hydraulic fluid is acceptable to be mixed with synthetic oil. The post environmental office and the recycler should be consulted before beginning this practice. The best way to prevent contamination is to provide dedicated containers for used oil storage. The size of container necessary to store used oil depends on two things: how much used oil is generated at the facility, and how often it is collected by the recycling contractor. At the template facility, it is assumed that the oil recycler collects the used oil once per month. Since 240.5 gallons are generated each year, the monthly generation is approximately:

$$\frac{240.5\ gallon}{year} \ x \ \frac{1\ year}{12\ month} = \frac{20\ gallon}{month}$$

Therefore, a 55-gallon drum should be sufficient to hold the used oil generated each month as well as provide enough additional storage in case the recycler is a few days late for a scheduled pick-up or an unusual amount of engine overhauls are performed. Facilities with larger storage needs can use additional 55-gallon drums or larger bulk storage containers. Secondary containment should also be provided to prevent spills. (Note: if the used oil is determined to be a hazardous waste, no more than 55 gallons can be maintained onsite; therefore, the installation environmental office should be contacted for coordination.) One way to further ensure that other waste streams are not mixed with the used oil is to limit access to the container. If feasible, a lock should be placed on the container with keys given only to supervisory level personnel and/or personnel properly trained in waste handling and segregation. If a lock is not feasible, the container should at least be CLEARLY labeled as USED OIL ONLY.

(b) Potential Waste Reduction. Used oil segregation will not affect the amount of used oil being generated, but will affect how the used oil is disposed of. By maintaining good segregation, the oil will remain free of contaminants and be suitable for collection by the recycler. This ensures that the used oil will be put to beneficial use rather than having to be disposed of as an unusable waste.

(c) Economic Evaluation. Since segregation does not actually reduce the amount of waste generated, it has no direct economic benefit to the AVUM. However, it will provide savings from cost avoidance associated with disposing of oil that it is too contaminated to recycle. The following calculation shows how to estimate costs of disposing of contaminated oil as a hazardous waste. Although it is unlikely that all of a facility's oil would become too contaminated to recycle, this estimate serves to illustrate the costs of not segregating the used oil waste stream. The calculation is based on a hazardous waste disposal cost of $1.00 per pound and a specific gravity of oil equal to 0.89. Empty 55-gallon steel drums weigh approximately 55 pounds each and are purchased through logistics for $25 each. Five 55-gallon drums are needed to dispose of 240.5 gallons of used oil each year.

$$\left[\left(\frac{240.5\ gal}{year} \times \frac{8.34\ lb}{gal} \times \frac{0.89}{1}\right) + \left(\frac{55\ lb}{drum} \times \frac{5\ drum}{year}\right)\right]\frac{\$1}{lb} + \left(\frac{\$25}{drum} \times \frac{5\ drum}{year}\right) = \frac{\$2185.14}{year}$$

Thus, properly segregating the used oil has a potential saving from cost avoidance of $2185.14 per year.

(2) Oil Filter Crushing.

(a) Description. Oil filter crushing units use hydraulic pressure to crush and drain used oil filters quickly and easily. Crushed filters typically contain less oil than those which have been gravity hot-drained, which results in less oil being thrown away with the used filter. Also, crushed oil filters occupy about one-fourth the volume of uncrushed filters, which helps to conserve landfill space. The oil that is drained from crushed filters can be collected, stored, and managed with the used oil that has been drained from the aircraft.

(b) Potential Waste Reduction. Oil filter crushing units reduce the volume of used oil filters rather than the actual amount generated. As a result, used oil filter waste will not be reduced since the same number of oil filters will still be used. Therefore, 40 used oil filters would still be generated each year.

(c) Economic Evaluation.

i. <u>Implementation Costs</u>. The cost of a procuring and installing a small oil filter crushing unit is approximately $1,000.

ii. <u>Recurring Costs</u>. There are no recurring costs associated with this P2 opportunity as operation, maintenance, and labor costs are minimal.

iii. <u>Cost Savings Due to Reduced Disposal Fees</u>. Since the same number of used oil filters to be disposed of occupy one-fourth the volume, there will be a small cost savings due to disposal fee cost avoidance. The calculation is based on a non-regulated solid waste disposal cost of $50 per ton, where one 55-gallon drum of uncrushed filters (50 filters) weighs approximately 105 pounds and one 55-gallon drum of crushed filters (200 filters) weighs approximately 255 pounds.

$$[(\frac{105\,lb}{drum} x \frac{1\,drum}{50\,filter} x \frac{40\,filter}{year}) - (\frac{255\,lb}{drum} x \frac{1\,drum}{200\,filter} x \frac{40\,filter}{year})] x \frac{\$50}{2000\,lb} = \frac{\$.83}{year}$$

Thus, the cost savings due to reduced disposal fees is $.83 per year.

iv. <u>Cost Savings Due to Reduced Material Usage</u>. Since the same number of used oil filters to be disposed of occupy one-fourth the volume, there will be a small cost savings due to the reduced number of 55-gallon drums needed for storage and disposal. The calculation is based on a $25 purchase price per drum, where one drum of uncrushed filters holds approximately 50 filters and one drum of crushed filters holds approximately 200 filters. Crushing the oil filters would save the facility three extra drums to purchase every 4 years. Thus, annual savings from using three fewer drums is:

$$\frac{3\ drum}{4\ year} \times \frac{\$25}{drum} = \frac{\$18.75}{year}$$

v. Payback Period. The payback period is calculated by dividing the implementation cost by the cost savings as follows:

$$\frac{\$1{,}000}{\frac{\$.83}{year} + \frac{\$18.75}{year}} = 51.07\ year$$

Typically, projects with such long payback periods are not considered beneficial. However, since the initial cost of $1,000 is relatively small, the opportunity produces a reduction in waste volume, and it is easy to implement, filter crushing may deserve consideration as a good management practice regardless of the extended payback period. Combining the efforts with other AVUM facilities and/or motor pool will also decrease the payback period. Calculations to determine the volume of filters required to obtain a 3-year payback period are shown below.

$$year = \frac{\$1000}{w + y}; w = reduced\ disposal\ cost; y = reduced\ material\ cost\ (drums); f = no.\ of\ filte$$

$$w = [(\frac{105\ lb}{drum} \times \frac{1\ drum}{50\ filter} \times \frac{f}{year}) - (\frac{255\ lb}{drum} \times \frac{1\ drum}{200\ filter} \times \frac{f}{year})] \times \frac{\$50}{2000\ lb}$$

$$y = [(\frac{f}{year} \times \frac{1\ drum}{50\ filters}) - (\frac{f}{year} \times \frac{1\ drum}{200\ filters})] \times \frac{\$25}{drum}$$

Therefore, five 55-gallon drums per year (843 filters) are required for a 3-year payback period.

(3) Oil Filter Recycling.

(a) Description. Once used oil filters have been properly drained, they can generally be placed in the trash for disposal as a nonregulated solid waste (depending on local requirements). However, a more environmentally beneficial alternative would be to send the drained filters to the area Defense Reutilization and Marketing Office (DRMO) or independent contractor for disposition and sale as a scrap metal. A potential recycler's operations should be thoroughly reviewed prior to selection to ensure compliance with local, state, and/or Federal regulations, as the generator assumes environmental liability for all wastes. Many scrap metal recycling contractors will collect drained, used oil filters along with other scrap metals at no cost to the generator. Occasionally, the recycler will require that the paper elements be removed from the metal prior to collection. These paper elements can be blended and burned with used oils for energy recovery; in some instances, the filters can be smelted. While not discussed in this template, this separation can involve additional labor costs.

(b) Potential Waste Reduction. By including used oil filters as a scrap metal, they would no longer be disposed of as a nonregulated solid waste in a landfill. This helps conserve landfill space as well as resources, since the metal from the filters will be reprocessed into another product. At this template facility, oil filter recycling would divert 40 oil filters per year from a landfill to a recycler. Assuming each oil filter weighs 1 pound and the drum weighs 55 pounds, the annual reduction in waste disposal would be 95 pounds.

(c) Economic Evaluation. Recycling contractors usually collect scrap metal free of charge, and since the DRMO should already have procedures in place to recycle scrap metals, there should be no additional costs associated with implementing oil filter recycling. In addition, a small cost savings results from no longer disposing of the filters as a nonregulated solid waste. At $50 per ton for solid waste disposal, the following amount would be saved each year:

$$\frac{95\ lb}{drum} \times \frac{1\ drum}{year} \times \frac{\$50}{2000\ lb} = \frac{\$2.38}{year}$$

Although the dollar savings are minimal, filter recycling reduces costs and yields an immediate payback period as there are no recurring costs or additional labor involved.

C. Oil Management P2 Summary Chart

Table 2-3. Summary of Oil Management Pollution Prevention Opportunities.

P2 Opportunity	Effect on Waste Disposal		Initial Costs ($)	Recurring Costs ($)	Annual Cost Savings ($)	Payback Period (years)
	Waste Stream	Disposal Reduction				
Used Oil Segregation	Used Oil	240.5 gallon/year	0	0	2185.14	Immediate
Oil Filter Crushing	Used Oil Filters	0	1,000	0	19.58	51.07
Oil Filter Recycling	Used Oil Filters	40/year	0	0	2.38	Immediate

D. Points of Contact for P2 Equipment

Oil Filter Crushing Units*

Air Boy Sales and Mfg. Co.
P.O. Box 2649
Santa Rosa, CA 95405
(800) 221-8333
(707) 577-0500

Ben Pearson Tubemaster
(501) 534-6411

McNiel Corporation
(703) 771-8426

M-Tal Distributors, INC.
(813) 586-5115

Oberg International, Inc.
6120 195th St. N.E.
Arlington, WA 98223
(360) 435-9100

OTC Division, SPX Corporation
(507) 455-7006

Sensitive Environmental Systems Corp.
(703) 250-6700

Tech Oil Products, Inc.
4308 West Admiral Doyle Drive
New Iberia, LA 70560
(318) 367-6165

Tire Service Equipment
(602) 437-5020

Waste Control Systems, Inc
(410) 252-9360

*The listing of equipment manufacturers is for information only and does not imply an endorsement by this Center.

SECTION 3

BATTERY MANAGEMENT

A. Template Operations

(1) Production.

- The AVUM Support Activity is responsible for servicing 40 aircraft.

- The nickel-cadmium battery in each aircraft is changed 3 times per year for servicing and recharging. The average battery lifetime is 3 years, which results in 40 battery changes every 3 years or approximately 13 changes per year.

(2) Material Requirements.

- Each aircraft requires a nickel-cadmium battery that uses potassium hydroxide as an electrolyte. The batteries are purchased wet through the General Services Administration at about $950 each (different manufacturers and configurations will have varying costs).

(3) Waste Generation.

- 13 used nickel-cadmium batteries are generated each year.

(4) Waste Disposal.

- Used batteries are collected on wooden pallets in an area with adequate secondary containment and shelter from the weather. They are returned directly to the originating manufacturer for recycling. The batteries are not drained of the electrolyte before being sent to the manufacturer.

- Each battery weighs 25 pounds wet and is disposed of at a unit cost of $3.5/pounds. This results in the annual disposal of 325 pounds of battery waste at a cost of $1,137.50.

B. Pollution Prevention Opportunities: Nickel-Cadmium Battery Recycling.

(1) Description. Nickel-cadmium batteries are a hazardous waste when considered spent and no longer usable; however, most manufacturers will accept the spent batteries for recycling the nickel and cadmium for reuse in new batteries. *Generally the local DRMO has an established program for lead-acid batteries.* Thus, beginning a program for nickel-cadmium batteries should be fairly easy.

(2) Potential Waste Reduction. Although nickel-cadmium battery recycling would not reduce the number of used batteries generated, it would reduce the number of batteries being disposed of. This would help conserve hazardous waste landfill space as well as conserve resources, since the nickel-cadmium from the batteries would be recovered and reused in the manufacture of other products. In addition, (under most state regulations -- consult with the installation environmental office for specifics) the used batteries would no longer have to be manifested as a hazardous waste since they will be collected for reuse. At this template facility, battery recycling would divert 13 batteries per year from a hazardous waste landfill to a recycler. Assuming each battery weighs 25 pounds, the annual reduction in waste disposal would be 325 pounds.

(3) Economic Evaluation.

(a) Costs. Since most battery vendors collect spent batteries free-of-charge, there would be no implementation or recurring costs.

(b) Cost Savings. By no longer disposing of used batteries, the AVUM would no longer have to pay the hazardous waste disposal fees. This would result in an annual cost savings of $1137.50. However, the manufacturer requires that the shipper pays for the transportation cost to the recycling facility or about $2/pounds. Thus, the net annual cost savings is:

$$\frac{\$1137.50}{year} - \left(\frac{\$2}{lb} \times \frac{25\ lb}{battery} \times \frac{13\ battery}{year}\right) = \frac{\$487.50}{year}$$

(c) Payback Period. Since this P2 opportunity will result in a cost savings without any implementation or recurring costs, the payback period is immediate.

C. Battery Management P2 Summary Chart

Table 3-1. Summary of Battery Management Pollution Prevention Opportunities.

P2 Opportunity	Effect on Waste Disposal		Initial Costs ($)	Recurring Costs ($)	Annual Cost Savings ($)	Payback Period (year)
	Waste Stream	Disposal Reduction				
Nickel Cadmium Recycling	Nickel cadmium batteries	13 batteries	0	650	487.50	Immediate

D. Points of Contact for P2 Equipment*

INMETCO Inc.
Ellwood City, PA
(412) 758-2802

Marathon Power
Waco, TX
(817) 776-0650

*The listing of equipment manufacturers is for information only and does not imply an endorsement by this Center.

SECTION 4

SOLVENT MANAGEMENT

A. Template Operations

Since there are many different levels or classes of cleanliness required for different aircraft parts undergoing various repairs and inspections, a document is being developed through the U.S. Army Acquisition Pollution Prevention Support Office and the U.S. Army Center for Technical Exchange for solvent substitution. The U.S. Army Solvent Substitution Program Draft Standard Protocol for Selecting General Cleaning Agents and Processes, October 1996, presents a matrix for determining an efficient and environmentally preferred chemical designed for a specific part and cleaning level desired. In addition, the U.S. Army Aviation and Missile Command (Provisional) is rewriting many of the technical manuals (such as the UH-60 Blackhawk's) in response to the U.S. Environmental Protection Agency Class I ozone-depleting substances (ODSs) ban. As a result of these outside efforts, this section will only address the routine large-debris solvent cleaning conducted on small metal parts prior to additional cleaning, inspection, and/or placement back on the aircraft.

(1) Production.

- The AVUM shop is responsible for servicing 40 aircraft: 10 UH-60 Blackhawks, 10 OH-58 Kiowas, 10 UH-1 Iroquois, and 10 AH-1 Cobras.
- Large-debris parts cleaning takes place in two 30-gallon solvent washing sinks located in the hangar.

(2) Material Requirements.

- Each washing sink holds 30 gallons of PD-680 Type II, a solvent with a flash point of 140°F. These sinks are owned and maintained by an offsite contractor who comes once every 2 weeks to remove the used solvent and replace it with new (or recycled) solvent. While service contract schedules vary throughout the Army, 2 weeks is assumed for this example. Thus, the amount of solvent that the AVUM shop uses each year is:

$$\frac{30\ gallon}{tank} \times \frac{2\ tank}{change} \times \frac{1\ change}{2\ week} \times \frac{52\ week}{year} = \frac{1{,}560\ gallon}{year}$$

- The contractor services each tank at a cost of $130 per service. The annual contractor servicing cost is:

$$\frac{\$130}{tank\ service} \times \frac{2\ tank}{service} \times \frac{1\ service}{2\ week} \times \frac{52\ week}{year} = \frac{\$6{,}760}{year}$$

- PD-680 solvent, NSN 6850-00-274-5421, costs $13.31/5 gallon can or $118.04/ 55-gallon drum.

(3) Waste Generation.

- 1,560 gallons of used solvent are generated by the AVUM shop each year.

(4) Waste Disposal.

- Because the waste solvent has a flash point of 140°F, it is considered a hazardous waste and must be manifested as such before the contractor transports it off-post.

- The contractor takes the used solvent to a recycling facility where the solvent is distilled to remove any contaminants. The solvent is then suitable for reuse and is redistributed to its clients.

- Since all used solvent is handled by the contractor, the AVUM shop does not actually dispose of any solvent wastes; however, the generation amounts still count towards the installation's annual hazardous waste generation total.

Part B - Pollution Prevention Opportunities

(1) Contractor-Managed Solvent Filtration Units.

(a) Description. The AVUM's solvent service contractor offers optional filter packages that can be added to the solvent parts cleaning units currently in use. These filters are attached to the side of the parts cleaning unit and are connected to the unit's solvent circulation system. As solvent flows through the system, it passes through the filter package where contaminants, such as oil and solids, are removed, thereby extending the life of the solvent. This alternative is easily implemented by contacting the solvent service contractor and arranging to have the filter packages attached to the current parts washing units. Installation and management of the filters would be the responsibility of the service contractor; however, the installation is still ultimately responsible for any environmental liabilities associated with the generated waste.

(b) Potential Waste Reduction. The use of such filter attachments has shown to double the life of the solvent. As a result, the time between servicing could be doubled which would cut the amount of used solvent generation in half. By installing the filters in each of the two units, waste generation would be reduced by the following amount:

$$\frac{1{,}560\ gallon}{year} \times \frac{1}{2} = \frac{780\ gallon}{year}$$

(c) Economic Evaluation. On other Army installations that have implemented this opportunity, the service contractor has kept the contract price constant, figuring that the cost of installing and maintaining the filters would be offset by having to service the parts washing units only half as frequently. As a result, there is no cost associated with implementing this alternative and no economic savings.

(2) Increasing Contract Service Interval.

(a) Description. At the AVUM's current production rates, the solvent in the parts washing units is not used to the extent that it actually requires changing at the end of each 2-week service interval. Although the solvent does become somewhat dirty, it is still effective in cleaning parts and could be used many more times before it needs to be replaced with fresh solvent. However, because the contract is set for a 2-week service interval, the solvent from the AVUM shop is changed once every 2 weeks whether it needs it or not. One solution to help minimize the solvent waste generation would be to alter the contract by extending the service interval to once every 3 weeks. This would reduce the number of times each year that the washing units are serviced; thereby, reducing the amount of waste solvent being generated. If the current contract cannot be altered in this manner, once it expires, a new contract should be written to extend the service interval.

(b) Potential Waste Reduction. Adding an additional week between solvent services would reduce solvent waste generation to the following amount:

$$\frac{30\ gallon}{tank} \times \frac{2\ tank}{change} \times \frac{1\ change}{3\ week} \times \frac{52\ week}{year} = \frac{1{,}040\ gallon}{year}$$

which equates to a reduction of:

$$\frac{1{,}560\ gallon}{year} - \frac{1{,}040\ gallon}{year} = \frac{520\ gallon}{year}$$

(c) Economic Evaluation.

i. Cost Savings. Changing the service schedule from once every 2 weeks to once every 3 weeks would reduce the cost of the contract to the following amount:

$$\frac{\$130}{tank} \times \frac{2\ tank}{service} \times \frac{1\ service}{3\ week} \times \frac{52\ week}{year} = \frac{\$4{,}507}{year}$$

which equates to a reduction of:

$$\frac{\$6,760}{year} - \frac{\$4,507}{year} = \frac{\$2,253}{year}$$

ii. Payback Period. *Because this alternative results in a cost savings* without the need for an initial investment or recurring costs, the payback period is immediate.

(3) Solvent Distillation Units.

a. Description. Onsite solvent reclamation provides an alternative to relying upon off-site contractors for solvent management. Under the contractor-managed process, used solvent is collected from the parts washing sinks, transported offsite to be recycled into usable solvent, then transported back on-site to be placed in the parts washing sinks. The process for onsite reclamation is identical except that rather than transporting the used solvent offsite, it would be recycled onsite through the use of a distillation unit owned and operated by the AVUM. Solvent distillation units work by heating used solvent in a chamber and causing it to vaporize. As the solvent vaporizes, the contaminants in the solvent (dirt, grease, etc.) are left behind in the heating chamber. The unit then collects, cools, and condenses the solvent back to a liquid in a separate chamber. The condensed solvent is now free from contaminants and suitable for reuse, while the still bottoms (the contaminants left behind in the heating chamber) are collected and disposed of as a hazardous waste. The largest advantage to this alternative is that the used solvent would no longer have to be manifested for transport since it remains onsite at all times. Under the contractor-managed solvent process, even though the used solvent is being recycled, it appears as a waste stream in the *installation's annual hazardous waste generation report since it was manifested for* offsite transportation. With onsite reclamation, the need to manifest the used solvent is eliminated which, in turn, keeps the used solvent from appearing on the installation's hazardous waste generation report. Although this does not actually reduce the amount of used solvent generated, it does help reduce the paperwork associated with managing the used solvent. The largest disadvantage to this alternative is that it creates more responsibilities for the AVUM personnel. Since offsite solvent service contractors do not allow for onsite reclamation, AVUM personnel would have to cancel (or not renew) the offsite contract and assume all aspects of solvent management. These aspects include purchasing and maintaining parts washing sinks, purchasing and operating the solvent distillation unit, procuring replacement solvent, disposing of the still bottoms, and possibly obtaining an air permit (consult with the environmental office prior to initiation of this opportunity).

b. Potential Waste Reduction. As mentioned above, this alternative would not actually reduce the amount of used solvent generated by the AVUM; it would merely change the way solvent waste generation is reported. Since the used solvent would not be manifested, it would not be recorded as a waste generated the AVUM. However, since still bottoms would now be generated onsite (rather than at a contractor's reclamation facility), they would have to be manifested (and recorded) as a hazardous waste generated by the AVUM.

c. Economic Evaluation. Please note that this evaluation is based on distilling the used solvent from each parts washing unit once every 2 weeks. Since there are 2 parts washing units, the service schedules would be staggered such that during one week, personnel would distill solvent from parts washing unit #1, and during the following week, they would distill solvent from unit #2. This would result in the solvent distillation unit being used once per week.

i. Implementation Costs. Implementing this opportunity would entail purchasing solvent as well as procuring and installing one distillation unit and 2 parts washing sinks.

A. Solvent. Each solvent sink used by the AVUM holds 30 gallons of solvent. At $2.15 per gallon of PD-680, it would cost $64.39 (30 gallons x $2.15/gallon) to fill one of the sinks. Therefore, to fill both would cost $128.77.

B. Distillation Unit. Distillation units can be procured in a variety of solvent capacities (from units that process 2-3 gallons per day to those that can process 55 gallons or more). Since each parts washing tank at the AVUM holds 30 gallons, it would be most convenient to procure a unit that can distill this amount in a single shift. A reasonable price for a unit with a 30-gallon-per-day processing capacity is about $17,000. Assuming it takes one person a full day to install the unit (clearing space and hooking up a 220 volt electrical supply), at $25/hour for labor, installation would cost about $200 ($25 /hour x 8 hours). Therefore, the total cost for the distillation unit is estimated as $17,200.

C. Parts Washing Sinks. Since the solvent will no longer be managed by the service contractor, the AVUM will have to procure its own parts washing sinks. Assume that one parts washing sink with a 30 gallon capacity costs $700. Two parts washing sinks would, therefore, cost $1,400. Since these units would be replacing two nearly-identical parts washing units (the ones owned by the contractor) installation labor will be minimal. Assuming that it would only take 0.5 hour for one person to unpackage and position each unit (1 hour for both), installation would cost $25 using a labor cost of $25/hour (including overhead). Therefore, the total cost for the 2 parts washing sinks would be $1,425.

Thus, the total cost to implement this P2 opportunity would be $18,754

($128.77+ $17,200 + $1,425).

ii. Recurring Costs. Recurring costs would include replacing solvent lost to evaporation and dragout, disposing of still bottoms, servicing the parts washing sinks, and operating the distillation unit.

A. Solvent Replacement. Although the used solvent can be recycled and reused, losses will occur due to evaporation and dragout. As a result, new solvent would have to be purchased to replace that which has been lost. Assume that 10% of the solvent is lost during each 2-week solvent service cycle. Since each unit holds 30 gallons, this equates to 3 gallons of lost solvent per unit every 2 weeks. Due to the staggered service schedule (mentioned above), this equates to a total loss of 3 gallons each week. Therefore, during the course of one year, this amounts to a loss of 156 gallons of solvent (3 gallons x 52 weeks/year). At a cost of $2.15 per gallon, the annual cost of replacement solvent is $335.40.

B. Still Bottom Disposal. As mentioned above, the contaminants that are left behind in the distillation unit's heating chamber must be collected and disposed of as a hazardous waste. Assume that the contaminants comprise about 10% of the total volume of used solvent. Furthermore, assume that 30 gallons of solvent (per parts washing unit) have to be distilled at the end of each 2-week service cycle. Please note that these 30 gallons include a 10% loss of solvent due to evaporation/drag-out and a 10% volume gain due to the addition of contaminants. As a result, about 3 gallons of still bottoms would be generated during each distillation operation. Assuming the still bottoms have a specific gravity of 1, this would equate to about 25 pounds per distillation (3 gallon x 8.34 lb/gallon x 1). Since the distillation unit would be used once per week, this results in an annual still bottom generation of 1,300 pounds (25 lb x 52 weeks/year). Assuming it costs $1.00/pounds for the AVUM to dispose of a hazardous waste, still bottom disposal would cost $ 1,300 annually (1,300 lb x $1.00 lb).

C. Servicing Parts Washing Sinks. Assume that it takes one person 15 minutes to transfer the used solvent from a parts washing sink to the distillation unit and another 15 minutes to transfer the cleaned solvent back (for a total of 30 minutes). Assuming a labor cost of $10/hour (including overhead), performing this operation once per week would cost $260 per year ($10/hour x 30 minute/week x 1 hour/60 minute x 52 week/year).

D. Operating the Distillation Unit. Assume that it costs $5.00 per day in electrical costs to operate the distillation unit. Since the unit would be used once per week, *this would amount to an annual cost of $260.*

Therefore, the total annual recurring costs due to solvent replacement, still bottom disposal, servicing the parts washing units, and operating the distillation unit is $2,155.40 ($335.40. + $1,300 + $260 + $260).

iii. Potential Recurring Cost Savings. The only cost savings associated with implementing this alternative would be no longer having to pay the offsite contractor to maintain the solvent. This would save a total of $6,760 per year.

iv. Payback Period. The payback period is calculated by dividing the implementation costs by the difference between the recurring cost savings and the recurring costs as follows:

$$\frac{\$18{,}754}{\frac{\$6{,}760}{year} - \frac{\$2{,}155.40}{year}} = 4.07 \ year$$

v. Three-Year Payback Period. To obtain a 3-year payback period, the AVUM would have to have replaced about 4 contractor operated parts washing units with 4 of its own (rather than 2 parts washing units). This assumes that all other factors remain the same (each unit serviced once every 2 weeks, one distillation unit purchased, etc.). Assuming that all other factors remain the same, using 4 parts washing units rather than 2 would imply that the AVUM was servicing twice the current amount of aircraft (80 aircraft rather than 40). Please note that the payback period may also be improved by having several AVUMs at an installation share a single solvent distillation unit. Since this AVUM would only use the distillation unit 1 day per week, other maintenance activities could use it during the remaining 4 days. The implementation cost of purchasing and installing the unit could then be divided among the various activities, thereby improving the payback period.

C. Solvent Management P2 Summary Chart

Table 4-2. Summary of Solvent Management Pollution Prevention Opportunities.

P2 Opportunity	Effect on Waste Disposal		Initial Cost ($)	Recurring Cost ($)	Annual Cost Savings ($)	Payback Period (year)
	Waste Stream	Disposal Reduction				
Solvent Filtration	Spent Solvent	780 gallon/year	0	0	0	immediate
Increasing Contract Interval	Spent Solvent	520 gallon/year	0	0	$4,507	immediate
Solvent Distillation	Spent Solvent	0	18,754	2,155	6,760	4.07

D. POINTS OF CONTACT FOR P2 EQUIPMENT

Solvent Service Contractors*

Safety-Kleen
8403 Arlington Blvd Suite 100
Fairfax, VA 22031
(703) 876-6800

Technical POCs

Prospective Technology, Columbia, MD, (410) 381-5375.

AMSTA-DSA-PC-LR, U.S. Army Petroleum Center, DSN 977-6053.

Mr. In-Sik Rhee, U.S. Army Mobility Technology Center, DSN 654-1824.

*The listing of contractors is for information only and does not imply an endorsement by this Center.

SECTION 5

FUEL MANAGEMENT

A. Template Operations

(1) Production.

- The AVUM shop is responsible for servicing 40 aircraft: 10 UH-60 Blackhawks, 10 OH-58 Kiowas, 10 UH-1 Iroquois, and 10 AH-1 Cobras.

- The fuel in each aircraft, JP-8, is drained when determined contaminated from the preflight checklist or as needed for related maintenance procedures.

(2) Material Requirements.

- The fuel usages and capacities vary between the aircraft and are dependent on flight hours; therefore, an estimated 110 gallons per month of spent fuel is assumed for this template facility.

- Empty 55-gallon steel drums weighing approximately 55 pounds each are purchased through logistics for $25 each.

(3) Waste Generation.

- 110 gallons of spent fuel is generated monthly.

(4) Waste Disposal.

- Spent fuel is placed in 55-gallon drums and collected at no cost by an offsite recycler once per month for burning or fuel blending.

- If the waste fuel is contaminated (i.e. with water) and is rejected by the recycler, the hazardous waste disposal cost is approximately $100 per 55-gallon drum. Laboratory fees for hazardous waste characterization can equal or exceed drum disposal costs.

B. Pollution Prevention Opportunities

(1) Fuel Segregation.

(a) Description. Because the spent fuel recycler will accept only noncontaminated fuel, it is important to keep the fuel free of other materials such as excessive water, deicing fluid, gasoline, and solvents. The best way to prevent contamination is to provide dedicated containers for spent JP-8 storage. The size of container necessary to store spent fuel depends on two things: how much spent fuel is generated at the facility, and how often it is collected by the recycling contractor. At the template facility, it is assumed that the fuel recycler collects the spent fuel once per month. Since 110 gallons are generated each month, three 55-gallon drums should be sufficient to hold the spent fuel generated each month as well as provide enough additional storage in case the recycler is a few days late for a scheduled pick up or an unusual amount of maintenance is performed. Secondary containment should also be provided to prevent spills. Facilities with larger storage needs can use additional 55-gallon drums or larger, bermed, bulk storage containers. (Note: if the used fuel is determined to be a hazardous waste, no more than 55 gallons can be maintained onsite; therefore, the installation environmental office should be contacted for coordination.) One way to further insure that other waste streams are not mixed with the spent fuel is to limit access to the container. If feasible, a lock should be placed on the container with keys given only to supervisory level personnel and/or personnel properly trained in waste handling and segregation. If a lock is not feasible, the container should at least be CLEARLY labeled as SPENT JP-8 ONLY.

(b) *Potential Waste Reduction.* Spent fuel segregation will not affect the amount of spent fuel being generated, but will affect how the spent fuel is disposed of. By maintaining good segregation, the fuel will remain free of contaminants and suitable for collection by the recycler. This helps ensure that the spent fuel will be put to beneficial use rather than having to be disposed of as an unusable waste.

(c) Economic Evaluation. Since segregation does not actually reduce the amount of waste generated, it has no direct economic benefit. However, it will provide a cost avoidance associated with having to dispose of fuel that it is too contaminated to recycle or reuse. The following calculation estimates what it would cost to dispose of contaminated fuel as a hazardous waste. Although it is unlikely that all of a facility's fuel would become too contaminated to recycle, this estimate serves to illustrate the potentially costly effects of not segregating the spent fuel waste stream. The calculation is based on a hazardous waste disposal cost of $1.00 per pound and a specific gravity of fuel equal to 0.8. Empty 55-

gallon steel drums weigh approximately 55 pounds each and are purchased through logistics for $25 each.

$$\left[\left(\frac{1320\,gallon}{year} \times \frac{8.34\,lb}{gallon} \times \frac{0.8}{1}\right) + \left(\frac{55\,lb}{drum} \times \frac{24\,drum}{year}\right)\right]\frac{\$1}{lb} + \frac{\$25}{drum} \times \frac{24\,drum}{year} = \frac{\$10{,}72}{year}$$

Thus, properly segregating the used fuel has a potential cost avoidance of $10,727 per year.

(2) Downgrading Fuel.

(a) Description. Kerosene-based fuels, such as JP-8, that cannot meet use limits or aviation cleanliness standards can be downgraded for use in the diesel ground vehicles. This is possible because most ground vehicles do not require the same level of purity and can generally tolerate small volumes of water.

(b) Potential Waste Reduction. This opportunity does not actually reduce the amount of waste generated by the aircraft, but the disposition of that waste. Downgrading off-specification JP-8 to a diesel fuel allows 110 gallons per month or 1,320 gallons per year to be reused as a material in the ground vehicles.

(c) Economic Evaluation. Since downgrading does not actually reduce the amount of waste generated and the waste is collected at no cost, it has no direct economic benefit. However, it will provide a cost avoidance associated with having to purchase 1,320 gallons of fuel for the ground vehicles. The following calculation shows the potential saving in material costs for the ground vehicles, assuming that diesel costs $1.00/gallon.

$$\frac{1320\ gallon}{year} \times \frac{\$1.00}{gallon} = \frac{\$1320}{year}$$

Thus, this opportunity can save $1,320 in material costs annually with an immediate payback period.

(3) JP-8 Recycling.

(a) Description. Kerosene-based fuels, such as JP-8, that cannot meet use limits due to water and particulate contamination can be recycled for possible reuse as aviation fuel. A small recycling system consists of a filter separator, coalescer separator, collection tank, storage tank, and pumps. The filter cartridges remove the particulates and water from the fuel at a rate of 15 to 50 gallons per minute. Larger units are available with rates greater than 1,200 gallons per minute. After processing through the recycler, the fuel needs to be tested through a laboratory to ensure that it meets the MIL-T-83133 for JP-8 before it is used in any aircraft. The particulate and water removed from the fuel requires disposal as a hazardous waste.

(b) Potential Waste Reduction. This opportunity reduces the amount of waste generated by the AVUM by recycling the off-specification fuel. However, since the particulates and water still require hazardous waste disposal, the waste stream is not completely eliminated. For this template, assume that 110 gallons per month or 1,320 gallons per year of off-specification fuel is recycled and 10% remains contaminated with particulates and water.

(c) Economic Evaluation.

i. <u>Implementation Cost</u>. A small, 5-gallon-per-minute recycler will cost approximately $60,000.

ii. <u>Recurring Cost</u>. There is a $250 per month filter replacement and maintenance cost, or $3,000 annually. Assuming one batch of fuel is analyzed per month, the laboratory cost is $1,350 per month, or $16,200 per year. Also, the hazardous waste disposal cost of the particulates and water is about:

$$\frac{1320\ gallon}{year} \times 0.1 \times \frac{\$100}{55\ gallon} = \frac{\$240}{year}$$

Assuming 1 hour of labor per batch at $10/hour, the annual labor cost is:

$$\frac{1\ batch}{month} \times \frac{1\ hour}{batch} \times \frac{\$10}{hour} \times \frac{12\ month}{year} = \frac{\$120}{year}$$

Thus, the total recurring cost is $3,000 + $16,200 + $240 + $120 or $19,560 per year.

iii. Savings Due to Reduced Disposal Costs. Since the contractor is currently removing the spent fuel at no cost, there are no savings due to reduced disposal costs.

iv. Savings Due to Reduced Material Costs. By recycling the spent fuel, a cost avoidance associated with having to purchase additional gallons of fuel is realized. The following calculation shows the potential savings, assuming that JP-8 costs $0.77/gallon.

$$\frac{1320\ gallon\ -\ 132\ gallon}{year} \times \frac{\$0.77}{gallon} = \frac{\$914.76}{year}$$

Thus, this opportunity can save $915 in material costs annually.

v. Payback Period. The cost of this opportunity will never be recovered since the annual costs outweigh the savings. Typically, projects without realistic payback periods are not considered economically viable. Combining the P2 efforts with other AVUM facilities will decrease the payback period. Calculations to determine the volume of fuel required to obtain a 3-year payback period are shown below.

$$3\ year = \frac{\$60{,}000}{w - y},\ where\ w = reduced\ material\ cost;\ y = disposal\ cost;\ g = gallons$$

$$w = \left(\frac{g \times 0.9}{year}\right) \times \frac{\$0.77}{gallon}$$

$$y = \left(\frac{\$3000}{year} + \frac{\$16{,}200}{year} + \frac{\$120}{year}\right) + \left(\frac{0.1g}{year} \times \frac{\$100}{55\ gallon}\right)$$

Therefore, 76,920 gallons of spent fuel per year are needed to provide a 3-year payback period for this P2 opportunity.

C. Pollution Prevention Summary Chart

Table 5-1. Summary of Fuel Management Pollution Prevention Opportunities.

P2 Opportunity	Effect on Waste Disposal		Initial Cost ($)	Recurring Cost ($)	Annual Cost Savings ($)	Payback Period (year)
	Waste Stream	Disposal Reduction				
Fuel Segregation	Spent JP-8	1320 gal	0	0	10,727	immediate
Downgrading JP-8	Spent JP-8	1320 gal	0	0	1,320	immediate
Recycling JP-8	Spent JP-8	1188 gal	60,000	19,560	915	not economically feasible

D. Points of Contact for P2 Equipment*

Navy Environment Leadership Program
Naval Air Warfare Center
Lakehurst, NJ
(732)323-7138

Filterdyne
La Grange, GA
(800) 884-3009

Facet International, Inc.
Tulsa, OK
(800) 223-9910

*The listing of equipment manufacturers is for information only and does not imply an endorsement by this Center.

SECTION 6

HYDRAULIC FLUID MANAGEMENT - POLLUTION PREVENTION OPPORTUNITY SUMMARY

Hydraulic fluid management is an upcoming and ongoing pollution prevention area. Two opportunities that are currently under research are hydraulic fluid recycling and electronic particle counters for determining the purity of hydraulic fluid. While neither are currently approved for U.S. Army aircraft applications, the future may reveal their usefulness; therefore, these opportunities are summarized in the following sections.

(1) Hydraulic Fluid Recycling. Similar to fuel recycling (see Section 5), hydraulic fluid recycling removes the water and particulate contamination from the "dirty" hydraulic fluid allowing the fluid to be reused in aircraft. This process is currently approved for ground vehicles using MIL-H-46170 or MIL-H-6083 only. The U.S. Air Force is investigating the applications of recycled hydraulic fluid for use in aircraft. This study includes the MIL-H-83282, MIL-H-87257, and MIL-H-5606 used in Army aircraft.

(2) Electronic Particle Counters. A "patch" test is used to measure the amount of metallic and non-metallic particles which can build up in the hydraulic systems of aircraft. CFC-113 and MCF are used to dilute the hydraulic fluid so that it can flow through a filter, leaving behind the contaminants. Elimination of these ozone-depleting substances leaves PD-680 Type II as the only approved solvent for "patch" tests. PD-680 is not the best solution. It has increased drying times and demonstrated inaccurate color standards. Another method under review for unit activities is the electronic particle counter for determining the purity of hydraulic fluid. Electronic particle counting has been approved for use in determining the purity of hydraulic fluid at the depot level due to the cost and sophistication of the equipment. Portable equipment for unit activities is in prototype stage in the Navy.

(3) References and Points of Contact for P2 Opportunities.

The User's Guide for Recycling Military Hydraulic Fluid, Oct 1996, U.S. Army TACOM, Fort Belvoir, VA

Naval Facilities Engineering Service Center
Port Hueneme, CA
(805) 982-6514 or DSN 551-6514

SECTION 7

OTHER P2 OPPORTUNITIES

A. Template Operations. Other operations that generate waste include rags, and aerosol cans from painting, cleaning, and lubricating.

(1) Production.

- The AVUM shop is responsible for servicing 40 aircraft.
- Coveralls are washed once a week through a contract with a private laundry facility.
- The cloth rags are disposed of as a solid waste.
- Aerosol cans are used for touch up painting and spot lubrication.
- Uncrushed and unpunctured aerosol cans are containerized in 55-gallon drums and disposed of as a hazardous waste.

(2) Material Requirements.

- The AVUM operations use 50 pounds of cloth rags every 3 months. This results in an annual cost of $80 assuming the cost of GSA rags is about $20 per 50 pounds.
- 1,200 aerosol cans are used annually.

(3) Waste Generation.

- 200 pounds of used cloth rags are generated annually.
- 24 drums of uncrushed aerosol cans are generated annually. Approximately each 55-gallon drum will hold 50 uncrushed aerosol cans.

(4) Waste Disposal.

- 200 pounds of used cloth rags are disposed of as a solid waste each year at $50 per ton.
- One 55-gallon drum of uncrushed aerosol cans weighs approximately 105 pounds resulting in hazardous waste landfill cost of $300/drum or $7,200 annually.

- One 55-gallon drum of crushed aerosol cans (200 cans) weighs approximately 255 pounds.

- About 1,500 aerosol containers can be punctured and drained into one 55-gallon drum for disposal.

B. Pollution Prevention Opportunities

(1) Cloth Rag Laundering.

(a) Description. Laundering oily cloth rags with the coveralls instead of disposing of them will reduce the waste that is landfilled. Either contracting the laundering through a private company or coordinating with the installation quartermaster laundry to launder the articles will eliminate this waste stream from the AVUM shop.

(b) Potential Waste Reduction. Washing the oily rags with the coveralls eliminates 200 pounds/year from the solid waste stream.

(c) Economic Evaluation.

i. Implementation Cost. Since no additional equipment is required for this opportunity, there is no implementation cost.

ii. Recurring Cost. Assuming the contract or arrangement with the installation quartermaster laundry or another laundering facility charges $2 per load and two loads are needed per month, the contract cost is $48 per year.

iii. Savings Due to Reduced Disposal Costs. By eliminating the solid waste disposal of the oily rags, the resulting cost savings is:

$$\frac{200\ lb}{year} \times \frac{\$50}{2000\ lb} = \frac{\$5}{year}$$

iv. Savings Due to Reduced Material Costs. The cost of GSA rags is about $20 per 50 pounds. Assuming 50 pounds of rags lasts 3 months, the yearly cost savings due to reduced material cost is $80.

v. Payback Period. The payback period is immediate since this P2 opportunity has no implementation costs and will result in a cost savings of:

$$\frac{\$5}{year} + \frac{\$80}{year} - \frac{\$48}{year} = \frac{\$37}{year}$$

(2) Aerosol Can Puncturing.

(a) Description. Once aerosol cans have been used completely, they can be punctured, drained, and placed in the trash for disposal as a nonregulated solid waste (depending on local requirements) or sold as scrap metal via DRMO. Aerosol can puncturing equipment to augment a 55-gallon drum costs about $450 and the required filters, periodically replaced, are $100 each.

(b) Potential Waste Reduction. Puncturing aerosol cans eliminates the pressurization and allows the collection of any remaining liquid material within the can. Depending on the local regulations, this opportunity eliminates the hazardous waste disposal requirements of the 1,200 aerosol cans. Consult the installation environmental office before initiating this P2 opportunity as different states have varying points of view regarding this issue.

(c) Economic Evaluation.

i. Implementation Cost. Aerosol can puncturing equipment to augment a 55-gallon drum costs about $450.

ii. Recurring Cost. Assuming the filters are replaced quarterly at $100 each, a solid waste disposal cost of --

$$\frac{1200\ can}{year} \times \frac{255\ lb}{200\ can} \times \frac{\$50}{2000\ lb} = \frac{\$38.25}{year}$$

and a hazardous waste disposal cost of the drained liquids is about:

$$\frac{1200\ can}{year} \times \frac{drum}{1500\ can} \times \frac{\$100}{drum} = \frac{\$80}{year}$$

Also assuming each can requires 2 minutes of labor at $10/hour, the annual labor cost is:

$$\frac{2\ minute}{can} \times \frac{1{,}200\ can}{year} \times \frac{1\ hour}{60\ minute} \times \frac{\$10}{hour} = \frac{\$400}{year}$$

The total recurring cost is $38.25 + $80 + $400 or $518.25 annually.

iii. Savings Due to Reduced Disposal Costs. By eliminating the hazardous waste disposal of the aerosol cans, the resulting cost savings is:

$$\frac{1200\ can}{year} \times \frac{drum}{50\ can} \times \frac{\$300}{drum} = \frac{\$7200}{year}$$

iv. Savings Due to Reduced Material Costs. Since the same amount of aerosol cans are used, there is no savings from reduced material costs.

v. Payback Period. The payback period is roughly 3 weeks.

$$\frac{\$450}{\frac{\$7200}{year} - \frac{\$518.25}{year}} = 0.07\ year \approx 3\ week$$

(3) Aerosol Can Recycling

(a) Description. Once used aerosol cans have been properly punctured and drained, they can generally be placed in the trash for disposal as a nonregulated solid waste (depending on local requirements). However, a more environmentally beneficial alternative would be to send the punctured cans to the area DRMO or independent contractor for disposition and sales as a scrap metal. A potential recycler's operations should be thoroughly reviewed prior to selection to ensure compliance with local, state, and/or Federal regulations. Many scrap metal recycling contractors will collect crushed and drained aerosol cans, along with other scrap metals, at no cost to the generator.

(b) Potential Waste Reduction. By including aerosol cans as a scrap metal, they would no longer be disposed of as a nonregulated solid waste in a landfill. This helps conserve landfill space, as well as resources, since the metal from the filters will be reprocessed into another product. At this facility, aerosol can recycling would divert 1,530 pounds per year from a landfill to a recycler.

(c) Economic Evaluation. Recycling contractors usually collect scrap metal free of charge, and since the DRMO should already have procedures in place to recycle scrap metals, there should be no additional costs associated with implementing aerosol can recycling. In addition, a small cost savings results from no longer disposing of the aerosol cans as a nonregulated solid waste. At $50 per ton for solid waste disposal, the following amount would be saved each year:

$$\frac{1200\ can}{year} \times \frac{255\ lb}{200\ can} \times \frac{\$50}{2000\ lb} = \frac{\$38.25}{year}$$

Although the dollar savings are minimal, aerosol can recycling reduces costs and yields an immediate payback period.

C. Pollution Prevention Summary Chart

Table 7-1. Summary of Other Pollution Prevention Opportunities.

P2 Opportunity	Effect on Waste Disposal		Initial Cost ($)	Recurring Cost ($)	Annual Cost Savings ($)	Payback Period (year)
	Waste Stream	Disposal Reduction				
Cloth Rag Laundering	Cloth rags	200 lb	0	48	37	immediate
Aerosol Can Puncturing	Aerosol cans	1200 can	450	518	7200	0.07
Aerosol Can Recycling	Aerosol cans	1530 lb	0	0	38.25	immediate

D. Points of Contact for P2 Equipment*

American Gas Products, Inc.
Whittier, CA
(310) 693-2431

Beacon Engineering Company, Inc.
Jasper, GA
(706) 692-6411

*The listing of equipment manufacturers is for information only and does not imply an endorsement by this Center.

Aviation Unit Maintenance Pollution Prevention Guide
Response to Comments

Please note that as a result of incorporating comments into the final report, the page numbering has been slightly altered. Therefore, some of the comment locations (in the first column of the table below) may no longer apply to the final document.

LOCATION	REVIEWER	COMMENT	RESPONSE
General Comments	AMC	The guide contains some specific information regarding cost associated with a product. Since costs are very fluid, it is recommended that all costs be eliminated from this guide unless clearly stated they are used as examples for economic evaluations or mathematical modeling. If costing data must remain in the guide, a disclaimer should be entered stating that these costs are not static numbers and subject to change.	Concur. Disclaimer added.
General Comments, Pg 4-2 A	AMC	Due to a BRAC action , The U.S. Army Aviation and Troop Command (ATCOM) will be closing in early October 1997. Recommend that all referenced to ATCOM be changed to the U.S> Army Aviation and Missile Command (Provisional) [AMCOM(P)] unless referencing policy, regulation, action, or correspondence prior to ATCOM closure.	Concur. References updated.

General Comments	AMC	The Guide is written to be concise and reads as though it is assumed that the reader is well versed in hazardous/nonhazardous solid/liquid handling, storage, recycling, and disposal. The Guide should consider that may not be the case and should be written for the average person with an average knowledge of these issues. The work plan should include more discussion regarding how wastes should be stored prior to disposal or recycling, such as measures to prevent spills (i.e. the need for bermed storage areas for tanks/drums, double wall concrete tanks, etc). If this discussion is not part of the scope of the document, the need for these measures should be stated and sources for guidance or suppliers would be extremely helpful.	This document is intended to provide P2 opportunities to the average AVUM maintenance officer who should already be familiar with the waste compliance issues. The supporting installation's environmental office is the appropriate resource for local issues. A statement was added to address this.
General Comments; Pg 5-9, D; Pg 6-2, (3)	AMC	Each section was followed by a small listing of possible venders, contractors, or other government contacts regarding assistance or services. The inclusion of contact/vendors as done is helpful, especially, to someone new to this field. It would be worthwhile to expound in this list and identify the services, supplies, or information available for each entry. However, individuals change frequently, and listing specific POCs by name will probably result in the information being out of date by the time the guide id distributed or soon after. The POCs should be identified by organization, office, and office symbol; not by name.	The contact listing delineates the type of information available. In hopes of keeping the Guide a reasonable length, the brochure information is not provided. Specific POCs were changed to the appropriate office symbol.

Pg 1-2, B	AMC	The guide should address the CH-47. It is a fleet-wide asset and a real generator of waste materials.	To maintain the brevity of the guide only 4 types aircraft were specifically addressed in the example template, but the P2 opportunities should apply across the board.
Pg 1-2, B; Pg 4-2, A	AMC	Delete reference to W model of AH-1. The Marines have W models. Army reference should be limited to AH-1. Additionally, Huey is a nickname for the UH-1, the official name is Iroquois.	Concur. Updated.
Pg 1-2, C	AMC	The Department of the Army standard payback period for economic analysis of pollution prevention projects is now 5 years.	Funding through the Environmental Program Requirements Process still favors the shorter pay back periods, so three years was chosen as an example.
Pg 1-3, D	AMC	Add to (1) "USA ARDEC, Industrial Ecology Center, ATTN:AMSTA-AR-ET, Picatinny Arsenal, NJ 07806-5000, DSN 880-2044, CML 201-724-2044, FAX x 6759/2314.	Added.
Pg 1-3, E	AMC	Add a new paragraph prior to para E: TECHNICAL REFERENCES. (1) Handbook, Naval Facilities Engineering Service Center, Port Hueneme, CA 93043-4370, March 1996, Subject: Tri-Service Pollution Prevention Opportunity handbook. (2) Catalogue, Defense Logistics Agency, December 1996, Subject: Environmental Products: Chemical Alternatives, Recyclers, Aircraft Cleaners and More. (3) Technical Bulletin (TB) 43-0135, HQDA, 1 June 1994, Subject: Environmentally Safe Substances for Use with Communications-Electronics Equipment.	Added.

Pg 2-2, A (1), Table 2-1, Pg 2-3, Table 2-2	AMC	Delete reference to W model Cobra. Correct "Huey" to Iroquois".	Corrected.
Pg 2-3, 4	AMC	Add: Label tank as "Used Oil". Rational: IAW USEPA published guidance.	Addressed in Section 2-B.
Pg 2-4, B; PG 5-3, B(1)(a)	AMC	The second paragraph should clearly indicate that waste oil 55 gallon drums should have secondary containment. Even though a liquid material/waste is not considered a hazardous waste, all liquid materials/wastes must be stored so as to prevent spillage or contamination of soil, water, etc. The guide should state that oil can be stored in an approved fashion that would prevent or contain spillage such as a bermed area for tanks/drums, double wall (free standing) concrete tanks, etc.	A statement was added.
Pg 2-6, (c) iii	AMC	This section is unclear and confusing. The disposal of nonhazardous solid waste such as crushed and drained oil filters, are disposed of on a weight basis; not volume. It seems from the discussion that the value of crushing he filters is that the installation will have a smaller volume of solid waste to manage even though the weight of the filters will remain the same. The calculation provided yields the cost of disposal of the filters based on weight, nit volume reduction. This section should be corrected to address the decreased volume of the filters as the advantage.	The narrative portion describes the savings by weight due to the volume reduction or less packaging required.

Pg 2-8, (3)(a)	AMC	The suggestion regarding the recycling of the crushed oil filters as scrap metal is valuable if the filters can be recycled with the paper element. If segregation of the paper element is required, this option becomes cost prohibitive, if not impractical.	Concur.
Pg 3-2, A(4)	AMC	This section incorrectly indicates that the storage of used batteries containing electrolyte on pallets is an acceptable practice. This practice is not allowed without some sort of secondary containment to prevent spillage of the electrolyte and causing a contamination problem. The Guide must clarify that the storage of the used batteries with electrolyte is possible if adequate precautions are taken.	Secondary containment is always a good management practice, but only required if the battery is considered a waste
Pg 3-3, B(1)	AMC	Battery recycling is an excellent idea. However, the batteries must be drained of all electrolyte before they can be recycled. The electrolyte is considered a hazardous waste which the recyclers will not accept.	Draining the battery is typically dependent upon the recycler. If such is the case with all certified recyclers, then we would not recommend the recycling of those batteries due to increase cost and exposure.
Pg 3-3, (2)	AMC	Delete: "In addition ... collected for reuse." Replace with: "Batteries should be shipped IAW 49 CFR Sec 172.101 and 49 CFR Sec. 173.159 requirements. However, batteries for recycling under the "Universal Waste management" Rule (40 CFR 272) do not require a hazardous waste manifest, nor should be shipped as "hazardous waste (s), n.o.s.", nor should the proper shipping name be modified by adding the word "waste". Rational: IAW 40 CFR 273.52.	Concur; however, many states have the option of being more stringent, thus we refrain from listing a Federal requirement. A statement to consult the local environmental office was added.

Pg 3-5	AMC	Delete individual names of POCs. They change frequently.	Concur. Deleted.
Pg 4-2, A (2)	AMC	The scenario presented in this section does not seem accurate. When a contract is issued for parts washers, *such as through Safety Kleen*, the contractor is responsible for the washer and the solvent. The installation is the generator of the waste, but the contractor manages it. It is not clear why the AVUM (or installation) would be responsible for purchasing the solvent for a contractor owned/operated parts washer.	The AVUM in the example is not paying for the solvent. This information is provided here only because it is *commonly used throughout the* section.
Pg 4-4, 4-5	AMC	These pages discuss possible solvent substitutes for P-D-680. These substitutes have not been fully evaluated nor authorized by AMCOM(P) for use on Army aircraft. An ATCOM message dated 18 Dec 96 was sent to the field advising that only those materials called out in the aviation technical manuals are authorized for use. Some of the substitutes contain high levels of VOCs and all are *more expensive then* P-D-680. Recommend this section on solvent substitution be deleted.	This section has been deleted.

Pg 4-9, (4)(a)	AMC	The use of a solvent still to reclaim used solvent is a good idea. It has been implemented for solvent from painting operation with good success using recyclable solvents (i.e. solvents that do not contain nitrocellulose). The guide must also include that the installations must consider the air permitting requirements for these stills. In many cases, these stills are required to be permitted under State Air Discharge Regulations due to the concentration of the VOCs in the exhaust fumes.	Statement added.
Pg 4-14	AMC	Mr. Steve Schick, ATCOM is listed as a technical POC. Due to the BRAC closure of ATCOM and the organizational reassignment to AMCOM(P), Mr. Schick should not be listed as a POC.	Concur. Deleted.
Pg 5-5, 2(c)	AMC	The Guide recommends a very good idea regarding the reuse of "off-spec" aviation fuel as general diesel fuel.	Thanks.
General Comments	Army National Guard	UH-1s and AH-1s are no longer using ODDS. See All States letter dated 19 Aug 97 from Ken Winters (-7754). Aircraft have returned to the Army Oil Analysis Program (AOAP) method of oil sampling.	Concur. The phase has been deleted.
General Comments	Army National Guard	ODDS was equipped in UH-1s and AH-1s only, and that was only part of the fleet, not 100% across the board.	Concur. The phase has been deleted.
General Comments	Army National Guard	The oil management table 2-1 does not take into account that the UH-60 had two engines. The -23 or -18 series maintenance manuals do not specify an oil change at 900 hours.	Table has been updated and the UH-60 oil change reference has been changed to state that oil changes are determined by AOAP testing only.

General Comments	Army Reserve Command	Our only comment is that the document needs a glossary of terms. Otherwise, the Guide is excellent.	We feel the terms are throughly explained within the text and to keep the brevity of the guide, a glossary was not added.
Pg 3-3, 2	Army Forces Command	The text states that recycling nickel-cadmium (Ni-Cd) batteries would help reduce the number of batteries disposed of in hazardous waste landfills. However, Ni-Cd batteries can be managed as Universal Wastes (UW) under the Universal Waste Rule (UWR). The UWR reduced the paperwork, management, and costs of disposing UW. As such, the Ni-Cd batteries can be stored for up to one year, and shipped by a commercial transporter to a recycler using a standard bill of lading. The text correctly recommends recycling, but it should also mention the management of all batteries under the UWR.	We hesitate to mention the Universal Waste Rule to individual units on an installation because that installation assumes the role as the generator and is generally a large quantity generator. So, the longer storage time is not generally needed to accumulate enough batteries to make transportation more economically feasible. Additionally, the Universal Waste Rule still requires labeling and record keeping and we feel that individual units maintaining large stores of spent batteries is not a good management practice. The Universal Waste Rule is better applied at the installation level.
Pg 4-2, (2); Pg 4-7, (3)	Army Forces Command	The text states that parts washer sinks and solvent tanks are services every 2 weeks by an offsite contractor. However, the service schedule typically is every 6-8 weeks and sometimes up to 12 weeks. This section of the Guide should be revised to reflect longer service schedules.	This P2 Guide is designed as a template only to provide a modeling example. Ideally the AVUM Maintenance Officer would rework the guide to fit his/her particular situation. Also, in some instances, the solvent was serviced every 2 weeks.
Pg 4-14, D	Army Forces Command	The technical point of contact for the ATCOM is listed as Stephen Schick. Mr. Schick has been replaced by Mr. Tony Tornatore at DSN 490-2247.	Addressed in an earlier comment.

Pg 4-3	AEC	There is no mention of liability costs associated with the contractor disposing of the waste. The generator of a waste maintains ultimate responsibility for the waste. The AVUM, in this case, will be responsible for any liabilities and the associated costs of the waste.	It is true that the generator is ultimately responsible for the waste and that is stated in section 4.
Pg 4-4, B	AEC	You state the amount of used solvent generated by the shop is the same regardless of the type of solvent.... It would be more correct to state the amount of solvent used remains the same. However, the waste generated may be significantly reduced. If an AVUM uses 1 gallon of brand X to clean 10 widgets and 1 gallon of brand Y will clean 20 widgets, the unit will generate less waste. They still use the same 1 gallon but cut their waste in half.	Section has been deleted.
Pg 4-6, B	AEC	You state the use of these filters has shown to double the life of a solvent. However, if a solvent such as Breakthrough is used with a filter, the life of the solvent is significantly more than doubled.	Solvent life is dependent on the type of solvent and the filtration system. The P2 Guide is designed to be an example of what a typical AVUM may expect, but should be adapted to each AVUM's situation.
Pg. 4-9, A	AEC	you state "... keeps the used solvent from appearing on the installation hazardous waste generation report." The waste is still generated and therefore should be reported as such. (Reporting requirements are beyond my area of expertise, but you may want to research this area to be sure.) Furthermore, the AVUM may need to be permitted as a tretment facility to operate a distillation unit. This may result in inccreased cost (and headache) for the installation.	Only periodically will the solvent need to be manifested and by manifesting, the waste appears on the installation hazardous waste report. If the waste never leaves the post, but is recycled, then it is not considered to be generated.

Pg. 4-14	AEC	Steve Schick is no longer a POC for solvent substitution. Mr. Arun Gupte at the AMCOM Environmental Technology Team has replased him. His number is (205) 313-1711, DSN 897.	Updated by office symbol.
Pg. 4-5, C,v	AEC	The material costs are explained well. However, a common problem is the indirect costs are not thoroughly identified and quantified. You have included some of the indirect but did not account for the costs. Some of the indirect costs that should be quantified are: health and safety, labor, workers comp, medical monitoring, training, reporting/record keeping, spill related downtime, sampling and testing, waste storage and handling, internal audits and testing, and liability.	The document would lose focus on the P2 aspects by including all the indirect costs. Additionally, many of these cost remain unaffected by the P2 opportunities.
Pg 4-11	AEC	It would be a tremendous help to the readers if you stated some of your data sources. For example you state the disposal cost for still bottoms would be $1/LB. Where did you get this figure? We have been using a mich larger figure for the disposal of hazardous waste	This guide was intended as an example only as disposal rates vary across the country.
General	AEC	Any chance of the guide expanding to include examples for the 64 and 47 community? Those folks have an equally big problem and would benefit from some good examples.	The guide is intended to be used by all helicopter platforms, but only a few were addressed specifically in the guide to enhance its readability and brevity.