TACTICAL MOTOR POOL POLLUTION PREVENTION GUIDE

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SECTION 1

INTRODUCTION

A. Purpose. The purpose of this pollution prevention (P2) guide is to identify potential opportunities to reduce pollution generated by routine tactical vehicle maintenance operations. The guide also provides sample calculations showing waste reduction estimates and economic analyses for each P2 opportunity. These calculations are based on production rates, material usages, waste generations, and disposal fees of a sample motor pool created to provide an illustration of a typical vehicle maintenance facility. This P2 guide is meant to serve as a template for similar motor pools. By replacing the sample numbers with those from an actual facility, the discussion can be customized to provide potential waste reduction and economic estimations that can then be used as a prioritization and decision making tool for implementing P2 opportunities.

B. Scope. This P2 guide addresses the following wastestreams generated by routine tactical vehicle maintenance: engine oil, lead-acid batteries, coolant, solvent, hydraulic fluid, and fuel.

C. Format. Each of the seven subsequent sections of this guide (Sections 2-7) addresses one of the wastestreams and is organized into 5 parts (Parts A-E). Part A of each section is a description of the type of work the motor pool performs and provides sample production numbers relating to that section's wastestream. Part B of each section gives a discussion of potential P2 opportunities designed to reduce the relevant wastestream. For each opportunity, the guide provides a background discussion on the technologies/methods involved, potential waste reduction estimates, and an economic analysis that show implementation costs, recurring costs, cost savings, and payback period. The estimates provide two types of payback period calculations: (1) the payback period based on the sample motor pool's production and (2) the amount of production a motor pool would have to maintain in order to realize a 3-year payback period. Part C contains a one-page table that summarizes each P2 opportunity identified. Part D shows a material balance flow chart, and Part E provides relevant points of contact through which further information on P2 technologies, equipment, and reports can be obtained.

SECTION 2

OIL MANAGEMENT

A. Template Operations.

(1) Production.

- The motor pool is responsible for servicing ten M998 Series Vehicles, ten 5-Ton Trucks, ten Bradley Fighting Vehicles, and ten M1A1 Abrams Tanks.

- Since all of the vehicles are enrolled in the Army Oil Analysis Program, the oil in each vehicle is assumed to be changed annually for this template. The oil change frequency is dependent on the results of the oil testing and whether engine breakdowns are required.

(2) Material Requirements.

Table 2-1. Annual Engine Oil Requirements for Tactical Vehicles.

Vehicle Type	Gallons of Oil per Vehicle	Total Gallons per 10 Vehicles	Cost per Oil Change
M998 Series Vehicle	2	20	$60.40
5-Ton Truck	6.75	67.5	$203.85
Bradley Fighting Vehicle	7	70	$211.40
M1A1 Abrams Tank	6.25	62.5	$188.75
Annual Total:	22	220	$664.40

- Oil is purchased through the logistics at a cost of $3.02 per gallon.

- One new oil filter is required for every oil change. As a result, the total number of new oil filters needed is 40 per year.

- Oil filters are purchased through the logistics at an average cost of $3.00 each except those for the Abrams which cost $57.00.

- 55-gallon drums are purchased through the logistics at an average cost of $25 each.

(3) Waste Generation.

- 220 gallons of used oil and 40 used oil filters are generated each year.

(4) Waste Disposal.

- Used oil is placed in a 55-gallon drum and collected 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 on site for energy recovery. This option is generally facilitated by the installation's Director of Public Works. Specific Resource Conservation and Recovery Act and state requirements and oil contamination issues will have to be considered.

- If the used oil is contaminated, the hazardous waste disposal cost is approximately $1 per lb. Laboratory fees for hazardous waste characterization can equal or exceed drum disposal costs.

- Used oil filters are hot-drained (at or above 60^{o}F) according to approved EPA methods. Once drained, they are disposed of as a nonregulated solid waste at a cost of $50 per ton.

- One 55-gallon steel drum weighs approximately 55 lb when empty. One 55-gallon drum of uncrushed filters (50 filters) weighs approximately 105 lb. One 55-gallon drum of crushed filters (200 filters) weighs approximately 255 lb.

B. Oil Management P2 Opportunities.

(1) Used Oil Segregation.

(a) Description. Since the used oil recycler will only accept uncontaminated oil, it is important to keep the used oil free of other materials such as water, antifreeze, 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 accomplish proper segregation 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 motor pool, and how often it is collected by the recycling contractor. Note, if the used oil is contaminated and is to be disposed of as a hazardous waste, any amount greater than 55 gallons in storage must be transported to a less than 90-day hazardous waste storage area within 3 days. Some states may have more stringent requirements; therefore, the installation environmental office should be contacted for coordination. At the template facility, it is assumed that the oil recycler collects the used oil once per month. Since 220 gallons are generated each year, the monthly generation is approximately:

$$\frac{220\ gal}{year} \ x \ \frac{1\ year}{12\ months} = \frac{18.3\ gal}{month}$$

Therefore, one 55-gallon drum should be sufficient to hold the used oil generated each month and 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. Motor pools with larger storage needs can use additional 55-gallon drums or larger bulk storage containers such as concrete-protected aboveground tanks. One way to make sure that other wastestreams 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 or to personnel trained in waste handling and segregation. If a lock is not feasible, the container should 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 how the used oil is disposed of. By maintaining good segregation, the oil will remain free of contaminants and will be suitable for collection by the recycler. This helps ensure 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. Labor costs are also unaffected. However, it will provide savings from cost avoidance associated with having to dispose of oil that it is too contaminated to recycle. The following calculation shows an estimate of what it may cost to dispose 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 potentially costly effects of not segregating the used oil wastestream. 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 lb each and are purchased through logistics for $25 each. Four 55-gallon drums are needed to dispose of 220 gallons of used oil each year.

$$[(\frac{220\ gallon}{year} x \frac{8.34\ lb}{gallon} x \frac{0.89}{1}) + (\frac{55\ lb}{drum} x \frac{5drum}{year})] \frac{\$1}{lb} + (\frac{\$25}{drum} x \frac{5drum}{year}) = \frac{\$2032.97}{year}$$

Thus, properly segregating the used oil has a potential saving from cost avoidance of $2032.97 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 usually contain less oil than those that have been gravity hot-drained which results in less oil being thrown away along with the used filter. Also, crushed oil filters occupy about one-fourth the volume of uncrushed filters which helps conserve landfill space once they are disposed of. The oil that is drained from crushed filters can be collected, stored, and managed with the used oil drained from the vehicles.

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

(c) Economic Evaluation.

i. <u>Implementation Costs</u>. The cost of 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 lb and one 55-gallon drum of crushed filters (200 filters) weighs approximately 255 lb.

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

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 of the drums. 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 3 extra drums to purchase every 4 years. Thus, annual savings from using 3 fewer drums is:

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

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 motor pools will also decrease the payback period. Calculations to determine the volume of filters required to obtain a 3-year payback period are shown below.

$$3\text{-}year = \frac{\$1000}{w+y}; w = reduceddisposalcost; y = reducedmaterialcost(drums); f = no.offilters$$

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

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

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 regulations). However, a more environmentally beneficial alternative is to send the used and drained filters to the Defense Reutilization and Marketing Office (DRMO) or an 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 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.

(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 and end up in a landfill. This helps conserve landfill space and resources since the metal from the filters will be reprocessed into another product. At this motor pool, oil filter recycling would divert 40 oil filters per year from a landfill to a recycler. Assuming each oil filter weighs 1 lb and the 55-gallon drum weighs 55 lb, the annual reduction in waste disposal would be 95 lb. The 55 lb per 55-gallon drum should be added to the waste reduction for instances where the filters are being drummed prior to disposal as in this template.

(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 costs associated with implementing oil filter recycling. In addition, a small cost savings would result from no longer disposing of the filters as a nonregulated solid waste. At $50 per ton of solid waste disposal, the following amount would be saved each year:

$$\frac{1\ drum}{year} \times \frac{95\ lb}{drum} \times \frac{\$50}{2{,}000\ lbs} = \frac{\$2.38}{year}$$

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

(4) Suction Oil Change System.

(a) Description. A suction oil change system consists of a specially designed drain plug and a suction pump. When performing an oil change with a typical drain plug, the plug must be removed from the oil pan. The oil then drains out of the vehicle into a container and the plug is replaced. A suction plug, however, is designed with a spring-loaded valve on the inside. This allows for a hose (with a bayonet connector) to be placed directly onto the plug. The action of attaching the hose causes the valve to open, and the oil can be drawn directly from the vehicle to a central used oil container with the use of a suction pump. A suction plug is available for nearly all models of vehicles and is designed to replace the existing drain plug. Because the suction plug can be removed and replaced exactly like a typical drain plug, oil changes may be performed by either the suction method or the conventional method.

(b) Potential Waste Reduction. This alternative will not reduce the amount of used oil being generated by oil change operations. However, by using the suction procedure, the potential for leaks and spills to occur will be greatly reduced since the plug does not have to be removed and the oil can be transferred directly from the vehicle to the used oil container through an enclosed system. As a result, this can be viewed as an indirect environmental benefit.

(c) Economic Evaluation.

i. Implementation Costs. The cost of the suction pump required for this P2 opportunity would be approximately $500. The cost of the suction drain plugs themselves are approximately $4.25 each or $170 to equip all 40 vehicles. Therefore, the total implementation cost would be $170 + $500 = $670.

ii. Recurring Costs. There are no recurring costs associated with this opportunity.

iii. Cost Savings. This P2 opportunity does not affect the number of oil changes that must be performed on each vehicle; it only provides a more efficient method of accomplishing the task. As a result, this opportunity will not produce any cost avoidances associated with material/disposal reduction. However, the use of this system should reduce the time it takes to perform an oil change. Personnel will no longer have to drain the used oil into a temporary container and then transfer it to the used oil storage drum. Instead, the used oil can be pumped directly from the vehicle to the used oil storage drum. As a result, labor can be slightly reduced. Assume that 5 minutes can be saved from each oil change and that labor costs are $25 per hour (including all overhead). The labor cost savings are therefore estimated as:

$$\frac{40\ oil\ change}{year} \ x\ \frac{5\ minute}{oil\ change} \ x\ \frac{1\ hour}{60\ minute} \ x\ \frac{\$25\ labor}{hour} = \frac{\$83.33\ labor}{year}$$

iv. Payback Period. The payback period can be calculated by dividing the implementation cost by the cost savings as follows:

$$\frac{\$670}{\$83.33\ per\ year} = 8.04\ year$$

Typically, projects with such long payback periods are not considered beneficial. However, since the initial cost of $670 is relatively small, the opportunity is environmentally beneficial and it is easy to implement. Suction draining oil may deserve consideration as a good management practice regardless of the extended payback period. Combining the efforts with other motor pools will also decrease the payback period. Calculations used to determine the number of vehicles required to obtain a 3-year payback period are shown below.

$$3\text{-}year\ payback = \frac{w}{y}, where\ w = implementation\ cost;\ y = costsavings; v = vehicles$$

$$w = \$500 + \$4.25v$$

$$y = v\ x\ (\frac{1change}{year})\ x\ (\frac{5minute}{change})\ x\ (\frac{1hour}{minute})\ x\ (\frac{\$25}{hour})$$

Therefore, 250 vehicles serviced with the suction system are needed to obtain a 3-year payback period.

(5) Re-refined Motor Oil.

(a) Description. Re-refined motor oil approved by the Army's Mobility Technology Center-Belvoir is currently available through the Defense Supply Center Richmond. The re-refined oil meets the military specification MIL-L-2104 for use as tactical service engine oil in the M998 Series Vehicles, 5-Ton Trucks, and Bradley Fighting Vehicles (the M1A1 uses synthetic oil). The re-refined oil contains a 25% minimum re-refined base stock. Table 2-2 shows the national stock numbers.

Table 2-2. Re-refined Oil Material Costs.

NSN	Viscosity	Unit of Issue	Cost
9150-01-421-1427	15W40	quart	$1.37
9150-01-421-1424	15W40	5-gallon can	$18.60
9150-01-421-1432	15W40	55-gallon drum	$175.47

(b) Potential Waste Reduction. Using re-refined oil does not reduce the amount of oil generated; however, it provides a larger market base for re-refined oil which in turn reduces the depletion of natural resources.

(c) Economic Evaluation. There are no implementation costs or additional labor cost involved in using re-refined oil; however, re-refined oil costs $3.19 per gallon as opposed to $3.02 for virgin oil. Table 2-3 shows the cost difference.

Table 2-3. Cost Comparison Between Virgin and Re-refined Oil.

Vehicle Type	Total Gallons per 10 Vehicles	Cost per Virgin Oil Change	Cost per Re-refined Oil Change
M998 Series Vehicle	20	$60.40	$63.80
5-Ton Truck	67.5	$203.85	$215.33
Bradley Fighting Vehicle	70	$211.40	$223.30
M1A1 Abrams Tank	62.5	$188.75	$199.38
Annual Total:	220	$664.40	$701.81

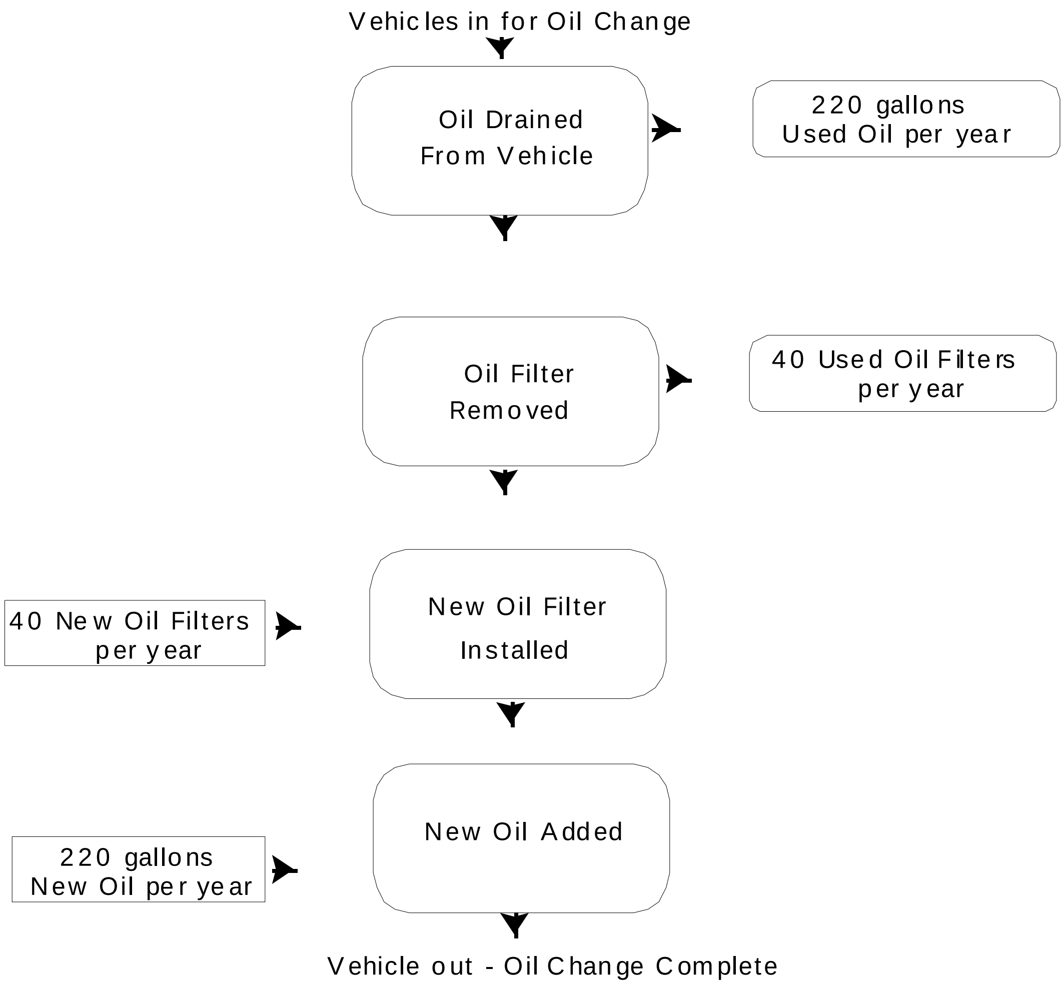
Since the re-refined oil is $0.17 more per gallon than the virgin oil, the additional cost for using re-refined oil is $37.41 per year.

C. Oil Management P2 Summary Chart

Table 2-4. Summary of Oil Management P2 Opportunities.

P2 Opportunity	Effect on Waste Disposal		Initial Costs ($)	Recurring Costs ($)	Annual Cost Savings ($)	Payback Period (years)
	Wastestream	Disposal Reduction				
Used Oil Segregation	Used oil	220	0	0	2032.97	Immediate
Oil Filter Crushing	Used Oil Filters	0	1,000	0	19.58	51.07
Oil Filter Recycling	Used Oil Filters	40 lb	0	0	79.00	Immediate
Suction Oil Plug	Used Oil	0	670	0	83.33	8.04
Re-refined Oil	Used Oil	0	0	37.41	0	N/A

D. Oil Management Material Balance Chart



E. Oil Management 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

Power Drain Oil Plug*

Advance Results Co., Inc.
3042 Scott Blvd.
Santa Clara, CA 95054
(800) 272-9898
(408) 986-0123

*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 motor pool is responsible for servicing ten M998 Series Vehicles, ten 5-Ton Trucks, ten Bradley Fighting Vehicles, and ten M1A1 Abrams Tanks.

- The batteries in each vehicle are changed once per year which results in 40 battery changes per year.

(2) Material Requirements.

Table 3-1. Lead-acid Battery Requirements.

Vehicle Type	Number of 12 Volt Batteries per Vehicle	Annual Cost per Vehicle	Annual Cost per 10 Vehicles
M998 Series Vehicle	2	$120	$1200
5-Ton Truck	4	$240	$2400
Bradley Fighting Vehicle	4	$240	$2400
M1A1 Abrams Tank	6	$360	$3600
Total:	16	$960	$9600

- Each 12-volt lead-acid battery is purchased through the logistics at $60 apiece. This results in an annual cost of $9,600.

(3) Waste Generation.

- 160 used lead-acid batteries are generated each year.

(4) Waste Disposal.

- Used batteries are collected on wooden pallets and periodically sent to the DRMO for disposal as a hazardous waste. The batteries are not drained of their acid before being sent to the DRMO.

- Each battery weighs 40 lb and is disposed of at a unit cost of $1.00/lb. This results in the annual disposal of 6,400 lb of battery waste at a cost of $6,400.

B. Battery Management P2 Opportunities.

(1) Lead-Acid Battery Recycling.

(a) Description. Many lead-acid battery vendors are willing to take back used lead-acid batteries for recycling. Although the recyclers are mainly interested in collecting the batteries' lead plates for reuse, they are willing to take the entire battery (including the electrolyte solution). As a result, draining the batteries before collection is not necessary. Typically, they need only be placed neatly onto pallets in the same manner they would be for collection by the DRMO.

(b) Potential Waste Reduction. Although lead-acid battery recycling would not reduce the amount of used batteries generated, it would reduce the number of batteries being disposed of. This would help conserve hazardous waste landfill space and conserve resources since the lead from the batteries would be recovered and reused in the manufacture of other products. In addition, (under most state regulations) the used batteries would no longer have to be manifested as a hazardous waste since they will be collected for reuse. At this motor pool, lead-acid battery recycling would divert 160 batteries per year from a hazardous waste landfill to a recycler. Assuming each battery weighs 40 lb, the annual reduction in waste disposal would be 6,400 lb.

(c) Economic Evaluation.

i. Costs. Since most battery vendors collect spent lead-acid batteries free-of-charge, there would be no implementation or recurring costs.

ii. Cost Savings. By no longer disposing of used lead-acid batteries, the motor pool would no longer have to pay the hazardous waste disposal fees. There is no additional labor associated with this P2 process. Therefore, this P2 opportunity would result in an annual cost savings of $6,400.

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

(2) Solargizer®.

(a) Description. The Solargizer battery management system is a commercially available battery conditioning device for use with standard 12-volt batteries. The Solargizer unit reverses and prevents sulphation which is the leading cause of decreased capacity and failure in lead-acid batteries. Sulphation occurs as sulphur molecules move between the electrolyte solution and the plates of a lead-acid battery. Over time, sulfates form on the lead plates and impede electron flow within the battery which not only causes the battery to lose its charge but also inhibits recharging attempts. This system consists of a solar-powered unit that uses pulses of solar energy to remove and prevent sulfur build up on the plates. The pulses of energy are transferred to the sulfur formations and energize the molecules enough to detach them from the battery plate and return them to solution. Electron flow through the battery is again sufficient to maintain a charge. The Fort Hood Battery Management Task Force tested these units on vehicles belonging to the 3/66 Armor Battalion, 2nd Armored Division, and found that this technology can increase the life expectancy of lead-acid batteries from an average of 1 year to an estimated minimum life of 5 years.

(b) Potential Waste Reduction. By extending battery life from approximately 1 year to a minimum of 5 years, the demand for new batteries and the amount of waste attributed to lead-acid battery usage will be reduced by at least 80%. As a result, used lead-acid battery generation should be decreased from an average of 6,400 lb per year to the following:

$$\frac{6{,}400 \text{ lb}}{\text{year}} \times (1 - 0.8) = \frac{1280 \text{ lb}}{\text{year}} \quad \text{(a 5,120 lb reduction)}$$

(c) Economic Evaluation.

i. <u>Implementation Costs</u>. The cost of one Solargizer unit is $150. Since the motor pool would have to purchase one unit for each vehicle, the total equipment cost would be:

$$\frac{\$150}{\text{Solargizer}} \times 40 \text{ Solargizer} = \$6{,}000$$

® The Solargizer is a registered trademark of the Pulse Tech Products Corporation, Irving, Texas.

Approximately 1 hour of labor is required to equip each vehicle; therefore, labor cost is:

$$40\ vehicle\ x\ \frac{1\ hour}{vehicle}\ x\ \frac{\$25}{hour} = \$1000$$

The total implementation cost is $7000.

ii. Recurring Costs. There are no recurring costs associated with this P2 option. The one-time purchase of the Solargizer unit is all that is required.

iii. Savings From Reduced Material Usage. Because the Solargizer system can increase a battery's life from 1 to 5 years, a savings of $60/battery can be achieved each year from the second to the fifth year (no savings the first year since the battery must be bought regardless of whether or not the Solargizer system is in use). The total annual cost savings (excluding the first year) would therefore be:

$$\frac{\$60}{battery}\ x\ \frac{160\ battery}{year} = \frac{\$9{,}600}{year}$$

iv. Savings From Reduced Disposal Costs. The motor pool spends $6,400 each year for used battery disposal. Since the battery lives would be extended with the use of the Solargizer equipment, $6,400 would be saved for every additional year the batteries remained in service.

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

$$\frac{\$7{,}000}{\$9{,}600\ /\ year\ +\ \$6{,}400\ /\ year} = 0.44\ year$$

® The Solargizer is a registered trademark of the Pulse Tech Products Corporation, Irving, Texas.

(3) Lazarus® System.

(a) Description. The Lazarus system is another pulse technology application (similar to the Solargizer system) which reverses and prevents sulphation in vehicle lead-acid batteries. The Lazarus system consists of a wall-mounted unit designed for use in battery shops with multiple battery charging systems using 10-battery bus bars. New battery chargers are now commercially available which greatly improve charging effectiveness. This is accomplished by slow charging batteries using battery bus bars that convey the battery's charging needs to the charger which prevents the batteries from becoming over or undercharged. According to tests conducted at Fort Hood by the Fort Hood Battery Management Task Force, use of the new battery charging system along with the Lazarus system can return approximately 80% of 'unserviceable' batteries back to their fully rated capacity. Both the charging unit and the Lazarus system are easy to operate and require minimal training in their usage.

(b) Potential Waste Reduction. The ability to reclaim 80% of the 'spent' batteries would result in an average annual waste reduction of:

$$\frac{6{,}400\ lb}{year} \times 80\% = \frac{5{,}120\ lb}{year}$$

(c) Economic Evaluation.

i. <u>Implementation Costs</u>. A battery charger capable of charging 10 batteries simultaneously will cost approximately $500. To utilize the charger fully, one 10-battery bus bar ($250) and one Lazarus unit ($1,500) would be required. The total equipment cost would then be:

$$\$500 + \$250 + \$1{,}500 = \$2{,}250$$

Approximately 3 hours of labor is required to set the equipment up and train on its operation; therefore, labor costs are:

$$3\ hour \times \frac{\$25}{hour} = \$75$$

Therefore, the total implementation cost is $2325.

®The Lazarus is a registered trademark of Pulse Tech Products Corporation, Irving, Texas.

ii. Recurring Costs. There are no recurring costs associated with this P2 option since labor costs are negligible. The one-time purchase of the charging unit and Lazarus system is all that is required.

iii. Savings from Reduced Material Usage. Because the Lazarus system can return approximately 80% of normally unserviceable batteries back to service, the motor pool would purchase 80% fewer batteries each year. The annual cost savings would be:

$$\frac{160\ battery}{year} \times 80\% \times \frac{\$60}{battery} = \frac{\$7{,}680}{year}$$

iv. Savings from Reduced Disposal Requirements. Since 80% fewer spent batteries would be generated each year, the following cost savings would result from not having to pay to dispose of them:

$$\frac{160\ battery}{year} \times 80\% \times \frac{40\ lb}{battery} \times \frac{\$1.00}{lb} = \frac{\$5{,}120}{year}$$

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

$$\frac{\$2{,}325}{\frac{\$7{,}680}{year} + \frac{\$5{,}120}{year}} = 0.18\ year$$

(4) Optima® Batteries.

(a) Description. The optima battery system incorporates lead-acid chemistry into a type of battery construction. Each 12-volt Optima battery is approximately the same size and weight as a regular 12-volt lead acid-battery. The inner components, however, are arranged differently which extends the life of the battery and helps prevent leaks even when the battery's casing has broken open. The Optima battery consists of six cells which are electrically connected. Each cell has two long plates (one positive and one negative) wound tightly together in a spiral configuration. The plates are separated by an absorbent, micro porous glass material which holds the electrolyte. The spiral configuration provides more structural strength as compared with the traditional configuration of a series of parallel positive and negative plates. As a result, the lead does not need to be strengthened by adding materials such as antimony and calcium to form a stronger lead alloy (as found in typical lead-acid batteries). The use of pure lead (instead of a lead alloy) reduces the amount of grid corrosion and extends the life of the battery. The Optima has been found to have a life of 3 to 5 years (as opposed to approximately 1 year for typical lead-acid batteries used in many Army operations). In addition, because the electrolyte is completely absorbed within the micro porous glass layers, it will not leak from the battery even if the casing becomes damaged. A 12-volt Optima battery can be installed into a vehicle exactly like a typical lead-acid battery.

(b) Potential Waste Reduction. Assume that an Optima battery will last 4 times longer than a typical lead-acid battery. As a result, Optima batteries would have to be purchased only once every 4 years rather than once per year like the current batteries being used. Therefore, over 4 years, only 160 Optima batteries would have to be purchased as compared with 640 batteries under the current system. Over those 4 years, the difference in battery usage would then be 480 less batteries for the Optima system. Prorating this to a 1-year time span (rather than 4 years) shows the following annual waste reduction (assuming each Optima battery weighs 40 lb):

$$\frac{480\ battery}{4\ year} = \frac{120\ battery}{year}$$

$$\frac{120\ battery}{year} \times \frac{40\ lb}{battery} = \frac{4{,}800\ lb}{year}$$

® The Optima is a registered trademark of Optima Batteries, Aurora, Colorado.

(c) Economic Evaluation.

i. Implementation Costs. Each Optima battery costs approximately $135. If the motor pool were to buy all 160 batteries, the total would be $21,600. Currently, the motor pool spends $9,600 per year on lead-acid batteries. To implement the Optima battery P2 alternative, the motor pool would have to spend $12,000 over what it is currently spending ($21,600 - $9,600).

ii. Cost Savings Due to Reduced Material Usage. As seen in the paragraph above, the implementation of Optima batteries would reduce the annual battery usage by an estimated 120 batteries per year. At a cost of $60 apiece with no additional labor expenses, this would save the motor pool the following amount per year:

$$\frac{120\ battery}{year} \ x\ \frac{\$60}{battery} = \frac{\$7{,}200}{year}$$

iii. Cost Savings Due to Reduced Disposal Fees. Using an average of 120 fewer batteries each year would directly lead to disposing of 120 fewer batteries per year which would reduce disposal fees by:

$$\frac{120\ battery}{year} \ x\ \frac{40\ lb}{battery} \ x\ \frac{\$1.00}{lb} = \frac{\$4{,}800}{year}$$

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

$$\frac{\$12{,}000}{\frac{\$7{,}200}{year} + \frac{\$4{,}800}{year}} = 1\ year$$

Since the estimated life of an Optima battery is 4 years and the payback period is 1 year, implementation of this alternative will save the motor pool $12,000 per year ($7,200 + $4,800) from the 2nd through the 4th years.

(5) Battery Consignment Program.

(a) Description. The Defense Logistics Agency, in coordination with the Defense Supply Center Richmond, has developed a battery consignment program through the Exide Corporation. This program is designed for lead-acid batteries adhering to MIL-B-62346C, type 6TL, and MIL-B-11188G, types 2HN and 4HN. The basis for this program is a one-for-one exchange of new and unserviceable batteries. The unserviceable batteries are handled and transported by Exide to a battery recycler for recycling. Exide will take the entire battery (including the electrolyte solution). As a result, draining the batteries before collection is not necessary. Typically, they need only be placed neatly onto pallets in the same manner they would be for collection by the DRMO.

(b) Potential Waste Reduction. Although lead-acid battery recycling would not reduce the amount of used batteries generated, it would reduce the number of batteries being disposed of. This would help conserve hazardous waste landfill space and conserve resources since the lead from the batteries would be recovered and reused in the manufacture of other products. In addition, (under most state regulations) the used batteries would no longer have to be manifested as a hazardous waste since they will be collected for reuse. At this motor pool, lead-acid battery recycling would divert 160 batteries per year from a hazardous waste landfill to a recycler. Assuming each battery weighs 40 lb, the annual reduction in waste disposal would be 6,400 lb.

(c) Economic Evaluation.

i. Costs. Since Exide will collect spent lead-acid batteries free-of-charge and the material cost is comparable, there would be no implementation or recurring costs.

ii. Cost Savings. By no longer disposing of used lead-acid batteries, the motor pool would no longer have to pay the hazardous waste disposal fees. There is no additional labor associated with this P2 process. Therefore, this P2 opportunity would result in an annual cost savings of $6,400.

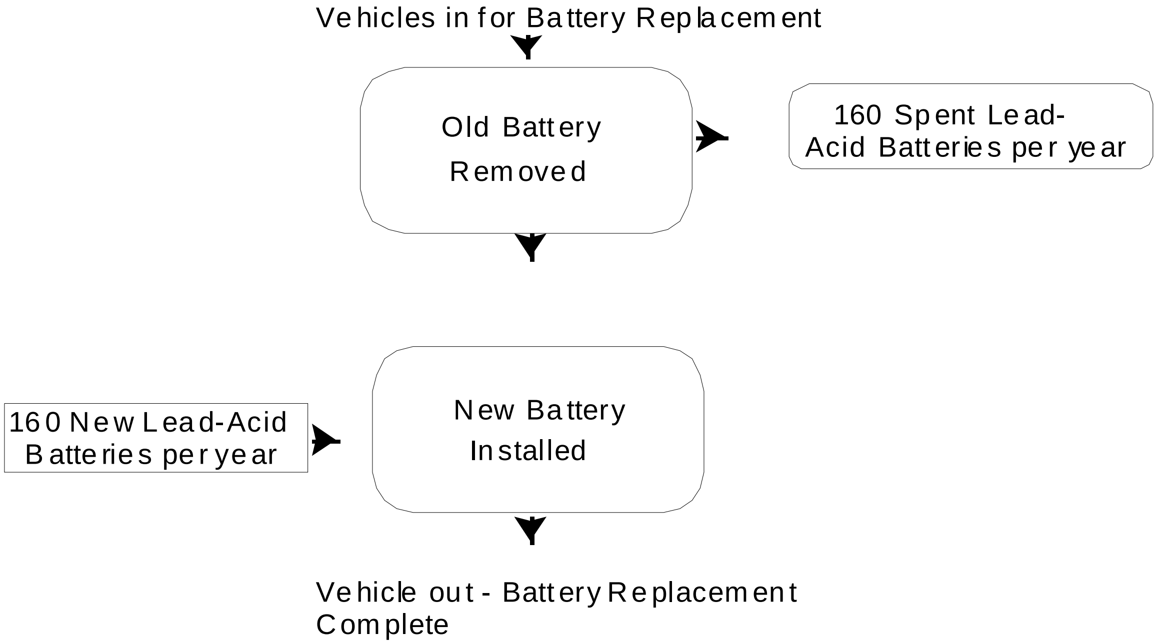
iii. Payback Period. Since this P2 opportunity will result in a cost savings without any implementation or recurring costs, the payback period is immediate.

C. Battery Management P2 Summary Chart

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

P2 Opportunity	Effect on Waste Disposal		Initial Costs ($)	Recurring Costs ($)	Annual Cost Savings ($)	Payback Period (years)
	Wastestream	Disposal Reduction				
Battery Recycling	Lead-Acid Batteries	6,400 lb	0	0	6,400	Immediate
Solargizer System	Lead-Acid Batteries	5,120 lb	7,000	0	16,000	0.44
Lazarus System	Lead-Acid Batteries	5,120 lb	2,325	0	7,680	0.18
Optima System	Lead-Acid Batteries	4,800 lb	12,000	0	12,000	1
Battery Consignment Program	Lead-Acid Batteries	6,400 lb	0	0	6,400	Immediate

D. Battery Management Material Balance Chart.



E. Points of Contact for P2 Equipment.*

Solargizer® Battery Management System

Pulse Tech Products Corporation
3131 Premier Drive
Irving, TX 75063
(800) 580-7554

Lazarus® Battery Management System

Pulse Tech Products Corporation
3131 Premier Drive
Irving, TX 75063
(800) 580-7554

Optima® Batteries

Optima Batteries
17500 E. 22nd Ave
Aurora, CO 80011
(303) 340-7440

DLA/DSCR Battery Consignment Progam

POC: Joe Cruise, DSN 695-6148

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

SECTION 4

COOLANT MANAGEMENT

A. Template Operations.

(1) Production.

- The motor pool is responsible for servicing ten M998 Series Vehicles, ten 5-Ton Trucks, ten Bradley Fighting Vehicles, and ten M1A1 Abrams Tanks.

- The coolant is flushed and replaced annually for each vehicle. This replacement is only necessary when the coolant no longer meets the required protection standards as determined by the antifreeze/battery tester and the reserve alkalinity test kit or when an engine breakdown is required.

- When adding new coolant to the system, a mixture of 1/2 antifreeze and 1/2 water is used.

- It is important to note that in this document the term 'antifreeze' refers to the chemical ethylene glycol, and the term 'coolant' refers to the mixture of antifreeze and water used in the vehicles.

(2) Material Requirements.

Table 4-1. Antifreeze Requirements.

Vehicle Type	Gallons of Coolant	Gallons of Antifreeze
M998 Series Vehicle	6.5	3.25
5-Ton Truck	11.75	5.88
Bradley Fighting Vehicle	7	3.5
M1A1 Abrams Tank	air cooled	n/a
Total:	24.75	12.38

- Based on the above quantities, the amount of antifreeze that the motor pool uses each year is:

$$10\ vehicle\ x\ \frac{12.83\ gallon}{system\ flush}\ x\ \frac{1\ system\ flush}{vehicleyear} = \frac{128.3\ gallon}{year}$$

- The motor pool purchases its antifreeze through logistics at a cost of $4.00

per gallon. The total annual amount that the motor pool spends for antifreeze is:

$$\frac{128.3 \text{ gallon}}{\text{year}} \times \frac{\$4.00}{\text{gallon}} = \frac{\$513.20}{\text{year}}$$

(3) Waste Generation.

- Each time a vehicle's coolant system is flushed the total water/antifreeze mixture is generated as a waste. Thus, the total annual amount of waste generation is:

$$10 \text{ vehicle} \times \frac{24.75 \text{ gallon}}{\text{system flush}} \times \frac{1 \text{ system flush}}{\text{vehicle year}} = \frac{247.50 \text{ gallon}}{\text{year}}$$

(4) Waste Disposal.

- The used coolant is collected in 55-gallon drums and periodically sent to the DRMO for disposal as a nonregulated waste. The cost for disposal is $0.25 per lb. The total annual disposal cost is estimated to be:

$$[(\frac{247.5 \text{ gallon}}{\text{year}} \times \frac{8.34 \text{ lb}}{\text{gallon}}) + (\frac{55 \text{ lb}}{\text{drum}} \times 4.5 \text{ drum})] \times \frac{\$0.25}{\text{lb}} = \frac{\$578}{\text{year}}$$

This estimate is based on the assumption that the antifreeze/water mixture has a specific gravity of 1 and, therefore, weighs approximately 8.34 lb per gallon.

B. Coolant Management P2 Opportunities.

(1) Coolant Recycling.

(a) Description. Commercially available coolant recycling units are available that can be used to bring spent coolant (MIL-A-46153 and MIL-A-11755) back to its original specifications for reuse. While different recycling units may use different types of technologies to accomplish this, coolant recycling involves removing contaminants (often through filtration or distillation) and restoring the coolant's properties with additives. It is important to note that while many coolant recycling units can restore commercial grade coolant back to its original specifications, only a few units are effective in restoring coolant to military specifications. In either case, chemical inhibitors that provide both corrosion and foaming protection must be added. Also, vehicle warranties should be reviewed prior to initiating this opportunity regarding the use of recycled antifreeze. In some cases, using recycled antifreeze voids portions of warranty. The "User's Guide for Recycling Military Antifreeze" published by the Belvoir Research, Development, and Engineering Center addresses which units are able to restore the coolant to military specifications. This report is referenced in part E of this section.

(b) Potential Waste Reduction. As mentioned above, the motor pool disposes of 247.5 gallons of used coolant each year. A filtration based recycling unit can eliminate this wastestream by recovering all of the spent coolant for reuse. However, because the filters must periodically be removed and replaced, they will create a new (although relatively insignificant) wastestream. Typically, the filters must be replaced after processing approximately 250 gallons of coolant. Since the motor pool uses 247.5 gallons of coolant each year, only one filter will be needed annually. If the process uses distillation (not presented in this template) to recycle the antifreeze, the still bottoms and process water would require testing and possible disposal as a hazardous waste.

(c) Economic Evaluation.

i. Implementation Costs. The cost of purchasing and installing a coolant recycling unit is estimated to be approximately $10,000.

ii. Recurring Costs. Recurring costs will result from having to purchase replacement filters and various additives. At approximately $10 per filter, using 1 filter per year will cost $10. Typically, additives account for approximately 1 ounce per quart of coolant. Since this motor pool uses 247.5 gallon of coolant each year, the required amount of additives is estimated to be 15.5 gallon. The additives cost approximately $60 per gallon, thus the recurring cost for purchasing coolant additives is:

$$\frac{15.5\ gallon}{year} \times \frac{\$60}{gallon} = \frac{\$930}{year}$$

The total recurring costs are therefore, $10 + $930 = $940 per year.

iii. Cost Savings Due to Reduced Material Usage. By implementing coolant recycling, the motor pool will no longer have to purchase large amounts of new antifreeze (only the additives described above and minimal virgin antifreeze to adjust the pH levels of the recycled coolants). Since the motor pool uses 128.3 gallons of antifreeze each year at a cost of $4.00 per gallon, the annual cost savings will be:

$$\frac{128.3\ gallon}{year} \times \frac{\$4.00}{gallon} = \frac{\$513.20}{year}$$

iv. Cost Savings Due to Reduced Disposal Fees. Since all of the coolant will be reused, it will no longer require disposal. This will result in an annual savings of $578 (the current disposal cost). Also, because an extra 15.5 gallons of additive will be included in the coolant each year, it seems that excess coolant will be produced and would, therefore, require disposal. However, it is typically found that the extra volume of the additives replaces coolant losses due to evaporation, and minor leaks and spills. As a result, it is estimated that there will be no additional coolant requiring disposal.

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

$$\frac{10{,}000}{\frac{\$513.20}{year} + \frac{\$578}{year} - \frac{\$940}{year}} = 66.1\ year$$

Typically, projects with such long payback periods are not considered beneficial. However, since the initial cost of $10,000 is moderate and the opportunity is environmentally beneficial and easy to implement, efforts to combine resources with other motor pools will decrease the payback period. Calculations used to determine the number of vehicles required to obtain a 3-year payback period are shown below.

$$3\text{-}year\ payback = \frac{\$10{,}000}{w - y};\ where\ w = cost\ saving,\ y = recurring\ cost,\ c = coolant(gallon)$$

$$w = \left(\frac{\frac{c}{2}}{year} x \frac{\$4}{gallon}\right) + \left[\left[\left(\frac{c}{year} x \frac{8.34lb}{gallon}\right) + \left(\frac{55lb}{55gallon} xc\right)\right] x \frac{\$0.25}{lb}\right]$$

Therefore, 5,698 gallons of coolant need to be generated annually to obtain a 3-year payback period.

$$y = \frac{0.0625gallon\ additive}{gallon\ coolant} x \frac{c}{year} x \frac{\$60}{gallon\ additive}$$

(2) Coolant Segregation.

(a) Description. If used coolant is going to be recycled, it is important to keep it free of excess contaminants such as oil and solvents. The best way to accomplish this is to provide dedicated plastic or plastic lined containers for the used coolant until it can be recycled and placed back into the vehicles. The plastic inhibits the leaching of metals into the mixture. The size of container necessary to store the coolant depends on two things: how much used coolant is generated at the motor pool, and how often it is recycled. For this template, it is assumed that the used coolant will be recycled in batches once every two weeks. Since 247.5 gallons are generated each year, the amount to be recycled every two weeks is approximately:

$$\frac{247.5 \text{ gallon}}{\text{year}} \ x \ \frac{1 \text{ year}}{12 \text{ month}} \ x \ \frac{1 \text{ month}}{2 \text{ batch}} = \frac{10.3 \text{ gallon}}{\text{batch}}$$

Therefore, a single 55-gallon drum should be sufficient to hold the used coolant generated each half-month and provide enough additional storage in case the recycling schedule has to be lengthened. In addition, another dedicated 55-gallon drum should be used to hold the recycled coolant until it can be placed back into the vehicles. Motor pools with larger storage needs can use additional drums or bulk storage containers such as double-walled aboveground tanks. One way to make sure that other wastestreams are not mixed with the coolant is to limit access to the container. If feasible, a lock should be placed on the container with access given only to supervisory level personnel and/or to personnel trained in waste handling and segregation. If a lock is not feasible, the containers should at least be clearly labeled as USED COOLANT ONLY and RECYCLED (CLEAN) COOLANT ONLY.

(b) Potential Waste Reduction. Material segregation will not affect the amount of used coolant being generated, but the way in which it is disposed. By maintaining good segregation, the coolant will remain free of contaminants and be suitable for recycling. This helps ensure that the coolant will be put to beneficial reuse 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 help avoid costs associated with having to dispose of coolant that it is too contaminated to recycle.

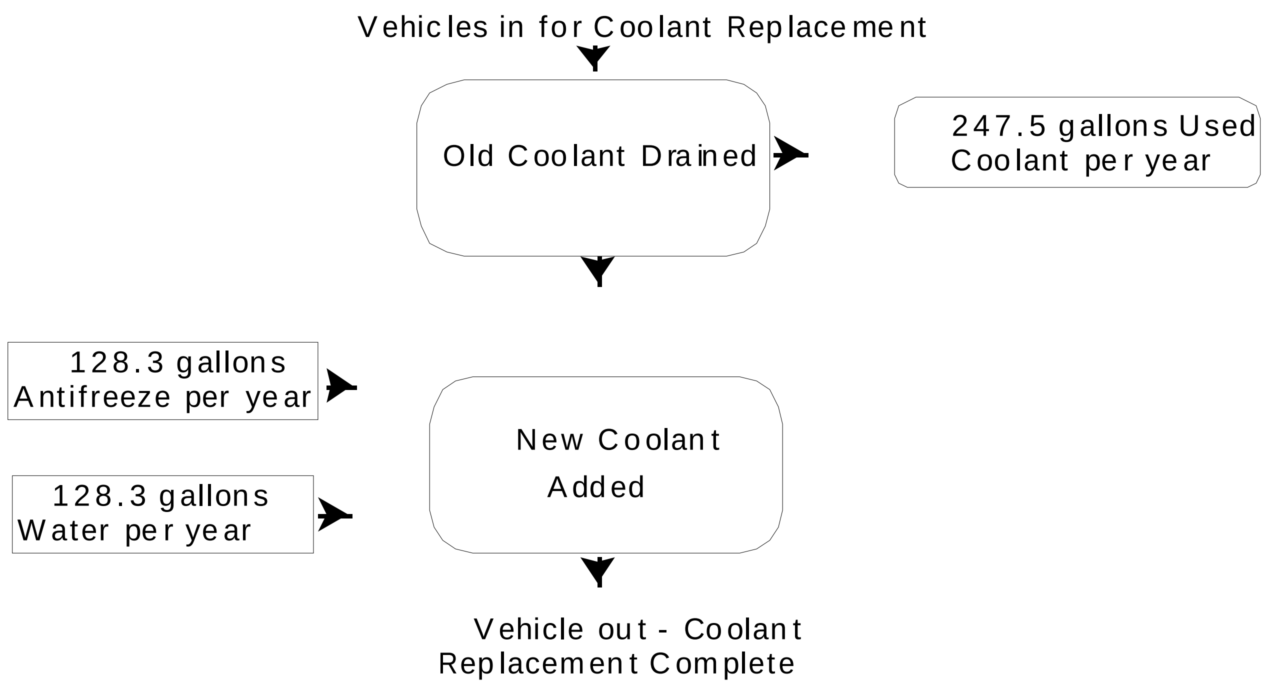
C. Coolant Management P2 Summary Chart.

Table 4-2. Summary of Coolant Management P2 Opportunities.

P2 Opportunity	Effect on Waste Disposal		Initial Costs ($)	Recurring Costs ($)	Annual Cost Savings ($)	Payback Period (years)
	Wastestream	Disposal Reduction				
Coolant Recycling	Used Coolant	247.5 gallon	10,000	940	1,091	66.1
	Used filters	1[1]				
Coolant Segregation[2]	Used Coolant	0	0	0	0	NA

Notes: 1. This wastestream will actually be created as a result of implementing the P2 opportunity.
2. This is a good management practice that neither reduces a specific amount of waste generation nor cost any money to implement.

D. Coolant Management Material Balance Chart.



E. Coolant Management Points of Contact for P2 Equipment.

Coolant Recycling Unit Manufacturers*

Kasco Fuel Maintenance Corp.
4481 Beech Rd
Temple Hills, MD 20748
(301) 423-5888

Finish-Thompson Inc.
921 Greengarden Road
Erie, PA 16501
(814) 455-4478

Antifreeze Recycling Users Guide

Mobility Technology Center-Belvoir
ATTN: AMSTA-RBF
110115 Gridely RD STE 128
FT Belvoir, VA 22060-5843
POC: Ms. Maria Goetz
(703) 704-1610 or
DSN 654-1619

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

SECTION 5

SOLVENT MANAGEMENT

A. Template Operations.

As there are many different levels or classes of cleanliness required for different 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. 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 vehicle.

(1) Production.

- The motor pool is responsible for servicing ten M998 Series Vehicles, ten 5-Ton Trucks, ten Bradley Fighting Vehicles, and ten M1A1 Abrams Tanks.

- Parts cleaning takes place in one of two 30-gallon solvent washing sinks located in the motor pool.

(2) Material Requirements.

- Each washing sink holds 30 gallons of PD-680 Type II, a solvent with a flash point of 140^{o}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. The amount of solvent that the motor pool uses each year is:

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

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

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

- 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 motor pool each year. Assuming a specific gravity of 0.8, this equates to an annual generation of 10,408 lb (1,560 gallon x 8.34 lb/gallon x 0.8).

(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 offpost.

- 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 motor pool does not actually dispose of any solvent wastes; however, the generation amounts still count towards the installation's annual hazardous generation total.

B. Solvent Management P2 Opportunities.

(1) Solvent Substitution.

(a) Description. Guidance has been disseminated by the U.S. Army Petroleum Center and the U.S. Army Mobility Technology Center for the substitution of PD-680 Type II.[1] Table 5-1 lists the current substitutions authorized for replacement of PD-680 in motor pool operations.

Table 5-1. Authorized Substitutions for PD-680.

Product	NSN	Unit of Issue	Cost ($)
Breakthrough	6850-01-378-0679	5-gallon can	179.96
	6850-01-378-0666	55-gallon drum	1181.72
Electron 296	6850-01-375-5553	5-gallon can	101.04
	6850-01-375-5555	55-gallon drum	766.38
Skysol 100	6850-01-381-4423	5-gallon can	212.24
	6850-01-381-4401	55-gallon drum	1519.77
Skysol	6850-01-381-4420	5-gallon can	155.75
	6850-01-381-4404	55-gallon drum	1180.64
PF	7930-01-328-2030	5-gallon can	55.12
	7930-01-328-4058	55-gallon drum	524.16

(b) Potential Waste Reduction. Although the amount of used solvent generated by the motor pool is the same regardless of the type of solvent, by using an authorized substitute, the hazardous characteristics of the waste will be reduced from the RCRA classification as a hazardous waste, depending on the metals concentration, to a nonregulated waste (depending on local regulations). Thus, through chemical substitution, the motor pool can eliminate a hazardous wastestream of 1,560 gallon/year.

[1] APC Technical Advisory Message #88 121800Z, August 1996, Use of Unauthorized Cleaning Solvents.

(c) Economic Evaluation.

i. Implementation Costs. Typically, the agreement between the solvent contractor and the motor pool (or, more commonly, the entire installation) can be changed to require the use of solvent substitutes. This can usually be done at any point in the contract and should be at no cost to the motor pool or installation. If the current contract cannot be altered in this manner, once it expires, a new contract should be written to use a less hazardous solvent substitute.

ii. Recurring Costs. As the possibility of additional charges due to higher material cost may reflect in the contract cost, the following estimate is calculated. Assuming that the substitution, PF, is used, the difference in cost per 55-gallon drum is:

$$\frac{\$524.26}{drum} - \frac{\$118.04}{drum} = \frac{\$406.22}{drum}$$

Therefore, the potential annual additional material cost is:

$$\frac{1560\ gallon}{year} \ x\ \frac{\$406.22}{55\ gallon} = \frac{\$11{,}521.88}{year}$$

iii. Cost Savings Due to Reduced Disposal Fees. Assuming that the contractor will reuse the substitute in the same manner as the original solvent, there are no cost savings due to reduced disposal fees.

iv. Cost Savings Due to Reduced Material Usage. As the same quantities of solvent are used, there is no cost savings associated with reduced material usage.

v. Payback Period. Since there are no direct cost savings or implementation costs associated with this opportunity, there is no payback period. The possible additional $11,521.88 per year for the substitute is significant; however, no manifesting is required for this waste and worker hazard and environmental liability is reduced.

(2) Contractor-Managed Solvent Filtration Units.

(a) Description. The motor pool'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 complete responsibility of the service contractor.

(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:

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

(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.

(3) Increasing Contract Service Interval.

(a) Description. At the motor pool'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 motor pool 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.

(4) Aqueous Parts Washers**.**

(a) Description**.** Aqueous parts washers use a combination of hot water and detergent (instead of solvents) to remove contaminants from parts. They range in cost from $3,000 to $21,000. In addition, most systems are equipped with mechanisms that separate oil and solids from the cleaning solution which allows a batch of detergent to be used repeatedly before becoming too soiled to be effective. Wastes from this cleaning process include steam, oil, and solids/sludge. Because the cleaning solution can be used repeatedly, the quantity of waste is typically much less than that generated by the manual solvent sink cleaning applications. Hot water parts washers are available in many different sizes, from ones that accommodate small parts to those that are able to contain entire engines. One possible disadvantage to hot water parts washing is the potential for corrosion. When parts are cleaned in PD-680 solvent, a small amount of the solvent remains on the part and protects it from corrosion. When hot water is used, the parts are left completely bare, thereby increasing the potential for corrosion. However, this problem can be eliminated through the use of rust inhibitor compounds that can be added to the water/detergent cleaning solution.

(b) Potential Waste Reduction**.** By replacing the solvent parts washing units with aqueous parts washers, the motor pool could eliminate all 10,408 lb of used solvent generated per year. However, the hot water parts washing units will generate some wastes themselves (although not as much as the solvent washing sinks). These wastes include oil and particulates washed from the parts. Most hot water parts washers are equipped with oil skimmers that separate and collect any oil that has been washed off of the parts. Any particulates that get washed off of the parts settle to the bottom of the washer tank and are periodically removed as sludge. The cleaning solution itself is used continuously; new water/detergent only has to be added to replace that which has evaporated. The oil that is collected from the skimmer may be able to be combined with the other used oil generated by the motor pool (although it should be tested at least once to establish a waste profile). The particulate/sludge however, will probably have to be disposed of as a hazardous waste. Assuming that each hot water parts washing unit generates about 5 lb (around 1/2 of a gallon) of sludge per month, the total annual hazardous waste generation from each unit would be 60 lb/year (5 lb/month x 12 month/year). Therefore, the total from both units combined would be 120 lb/year. Compared to the 10,408 lb generated by the solvent washing sinks, this is a significant reduction.

(c) Economic Evaluation.

i. Implementation Costs. Since this motor pool only cleans small parts, it should only require 2 small aqueous parts washing units. Small aqueous parts washing units with a 20-gallon detergent capacity are available for around $3,000 (or 2 for $6,000). Because they require a 220-volt electrical outlet and a steam pipe vented outdoors, there may be an additional installation cost. Assuming it takes 2 people 1 full day (8 hours) to install the utilities for these units, at a labor cost of $25/hour (including overhead), installation would cost $400 (2 x $25/hour x 8 hour). Therefore, the total implementation cost would be about $6,400.

ii. Recurring Costs. Recurring costs include the cost of purchasing detergent and rust inhibitor as well as the electrical costs of using the units.

(aa) Purchasing Detergent. Assume that detergent costs $20 per gallon and about 1/8 gallon is needed once every 2 days for each unit. If there are 250 working days in a year, the amount of detergent needed would be 15.6 gallon/year (1/8 gallon x 250/2). Therefore, detergent would cost about $312 per year per unit or $624 per year for both.

(bb) Purchasing Rust Inhibitor. Assume that rust inhibitor costs $30 per gallon and about 1/16 gallon is needed once every 2 days for each unit. If there are 250 working days in a year, the amount of rust inhibitor needed would be about 7.8 gallon/year (1/16 gallon x 250/2). Therefore, rust inhibitor would cost about $234 per year per unit or about $468 per year for both.

(cc) Electrical Costs. Assume that it costs about $1.5 per day to operate each unit. Assuming 250 working days per year, it would cost $375 per year to operate each unit or about $750 per year to operate both.

(dd) Total Recurring Costs. The total annual costs associated with this opportunity is $1,842 ($624 + $468 + $750).

iii. Potential Recurring Cost Savings. Recurring cost savings result from no longer having to pay for the solvent service contract. This would, therefore, save the motor pool $6,760 per year.

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

$$\frac{\$6,400}{\$6,760\ /\ year\ -\ \$1,842\ /\ year} = 1.3\ year$$

(5) Solvent Distillation Units.

(a) Description. Onsite solvent reclamation provides an alternative to relying upon offsite 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 onsite 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 motor pool. 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 wastestream in the installation's 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 motor pool personnel. Since offsite solvent service contractors do not allow for onsite reclamation, motor pool 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, and disposing of the still bottoms.

(b) Potential Waste Reduction. As mentioned above, this alternative would not actually reduce the amount of used solvent generated by the motor pool; 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 motor pool. 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 motor pool.

(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.

(aa) Solvent. Each solvent sink used by the motor pool holds 30 gallons of solvent. At $2.15 per gallon, it would cost $64.50 (30 gallon x $2.15/gallon) to fill one of the sinks. To fill both would, therefore, cost $129.

(bb) 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 motor pool 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 hour). Therefore, the total cost for the distillation unit is estimated as $17,200.

(cc) Parts Washing Sinks. Since the solvent will no longer be managed by the service contractor, the motor pool 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 half an hour for one person to unpack 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.

(dd) Total Implementation Cost. The total cost to implement this P2 opportunity would be $18,754 ($129 + $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.

(aa) 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. 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 1 year, this amounts to a loss of 156 gallons of solvent (3 gallon x 52 week/year). At a cost of $2.15 per gallon, the annual cost of replacement solvent is $335.40.

(bb) 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 this 30 gallons includes 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 lb 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 lb (25 lb x 52 week per year). Assuming it costs $1.00/lb for the motor pool to dispose of a hazardous waste, still bottom disposal would cost $1,300 annually.

(cc) Servicing Parts Washing Sinks. For this template, 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 $25 per hour, performing this operation once per week would cost $650 per year ($25/hour x 30 minute/week x 1 hour/60 minute x 52 week/year).

(dd) Operating the Distillation Unit. Assume that it costs $5 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.

(ee) Total Recurring Costs. The total annual recurring costs due to solvent replacement, still bottom disposal, servicing the parts washing units, and operating the distillation unit is $2,545.40 ($335.40 + 1,300 + 650 + 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:

$$\frac{\$18{,}754}{\frac{\$6{,}760}{year} - \frac{\$3{,}146}{year}} = 4.45\ year$$

v. Three-Year Payback Period. The following calculations show the number of spent solvent tanks required to obtain a 3-year payback period.

$$3 - year = \frac{I}{S - C}; where I = implementation cost, S = savings, C = recurring cost, t = tanks$$

$$I = (t x \frac{\$64.50}{tank}) + \$17{,}200 + (\frac{\$700}{tank} x t) + (\frac{\$17.50}{tank} x t)$$

$$S = \frac{\$130}{tank} x t x \frac{1 service}{2 week} x \frac{52 week}{year}$$

$$C = (\frac{0.1t}{week} x \frac{52 week}{year} x \frac{\$64.50}{tank}) + (\frac{0.1t}{week} x 52 week over year x \frac{250.2 lb}{tank} x 1 x \frac{\$1}{lb}) + (\frac{0.25 hour}{tank} x t x \frac{\$25}{hour} x \frac{52 week}{year})$$

Therefore, the motor pool would have to replace five 30-gallon contractor-managed solvent tanks with 5 tanks of their own assuming that all other factors remain the same (i.e., each tank serviced every 2 weeks, one distillation unit purchased, etc.). The payback period may also be improved by having several motor pools at an installation share a single solvent distillation unit.

C. Solvent Management P2 Summary Chart.

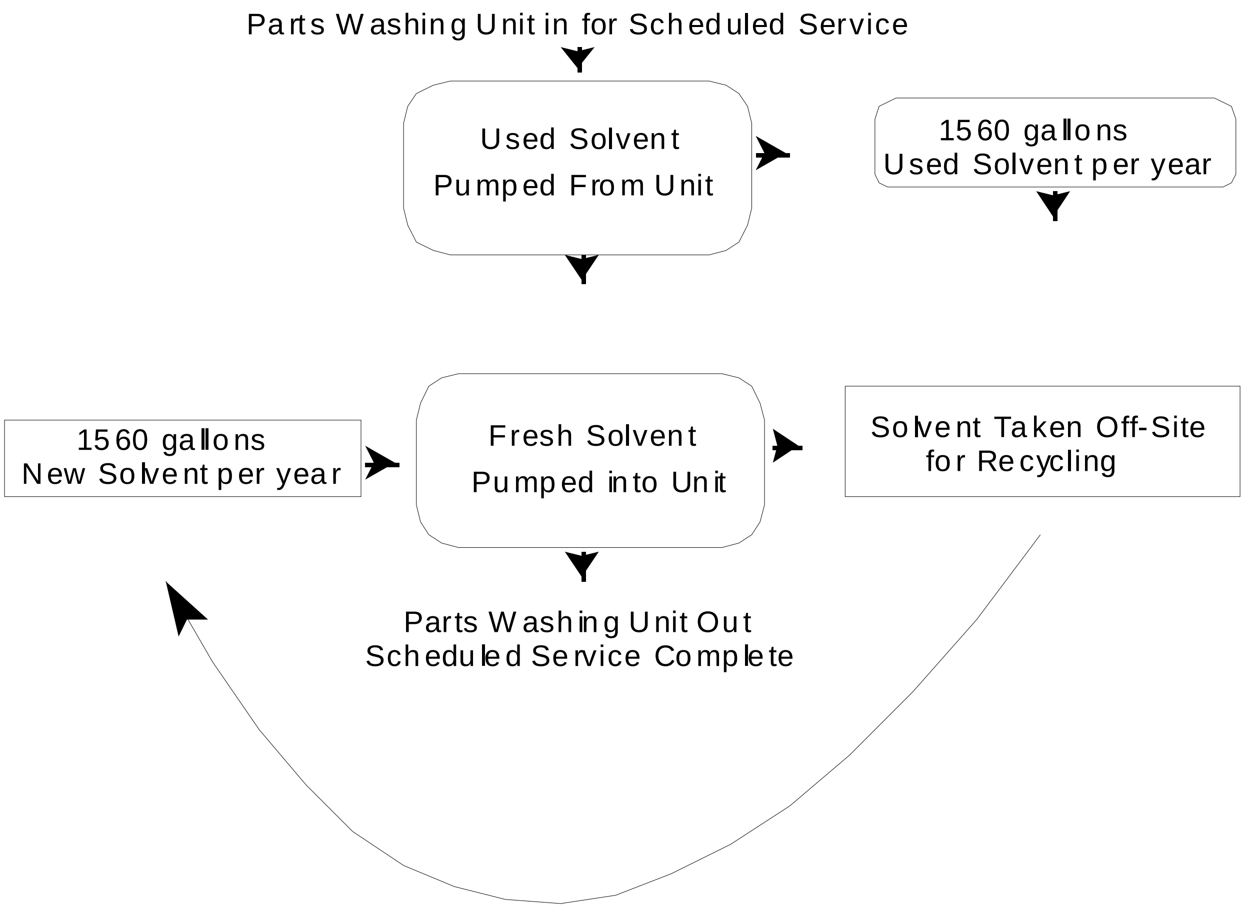
Table 5-2. Summary of Solvent Management P2 Opportunities.

P2 Opportunity	Effect on Waste Disposal		Initial Costs ($)	Recurring Costs ($)	Annual Cost Savings ($)	Payback Period (years)
	Wastestream	Disposal Reduction				
Solvent Substitution[1]	Spent Solvent	0	0	0	0	NA
Solvent Filtration	Spent Solvent	780 gallon	0	0	0	0
Increase Service Interval	Spent Solvent	520 lb	0	0	4,507	0
Aqueous Parts Washer	Spent Solvent	1560 gallon	6,400	1,842	6,760	1.3
	Soil/Sludge	(120)[1] lb				
Distillation Unit	Spent Solvent	---[2]	18,754	2,545	6,760	4.45
	Still Bottoms	---[2]				

Notes: 1. This wastestream will actually be created as a result of implementing the P2 opportunity.

2. Please note that this opportunity changes how these wastestreams are recorded as being generated by an installation (rather than changing the amount actually being generated). Offsite reclamation shows the installation generating spent solvent but no still bottoms (still bottoms are generated, but are generated offsite at a contractor's facility). Onsite reclamation, however, shows no spent solvent generation (since it is reused on site) but does show the installation generating still bottoms as a result of the recycling process.

D. Solvent Management Material Balance Chart.



E. Solvent Management Points of Contact for P2 Equipment*

Solvent Service Contractors

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

Aqueous Parts Washers

Better Engineering Mfg., Inc.
8361 Town Center Court
Baltimore, MD 21236-4964
(410) 931-0000

American Metal Wash, Inc.
360 Euclid Ave. PO BOX 265
Canonsburg, PA 15317
(412) 746-5738

Solvent Distillation Units

Finish Thompson, Inc.
921 Greengarden Rd.
Erie, PA 16501-1591
(814) 455-4478

PBR Industries
400 Farmingdale Rd.
West Babylon, NY 11704
(516) 226-2930

Solvent Recovery Systems, Inc.
240022 Yoakum
Huffman, TX 77336
(713) 324-3254

Parts Washing Sinks

PBR Industries
400 Farmingdale Rd.
West Babylon, NY 11704
(516) 226-2930

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

SECTION 6

HYDRAULIC FLUID MANAGEMENT

A. Template Operations.

(1) Production.

- The motor pool is responsible for servicing ten M998 Series Vehicles, ten 5-Ton Trucks, ten Bradley Fighting Vehicles, and ten M1A1 Abrams Tanks.

- Since all of the vehicles are enrolled in the Army Oil Analysis Program, the hydraulic fluid in each vehicle is assumed to be changed annually for this template. The hydraulic fluid change frequency is dependent on the results of the hydraulic fluid testing and whether engine breakdowns are required.

(2) Material Requirements.

Table 6-1. Annual Engine Hydraulic Fluid Requirements for Tactical Vehicles.

Vehicle Type	Gallons of Hydraulic Fluid per Vehicle	Total Gallons per 10 Vehicles	Cost per Hydraulic Fluid Change*
M998 Series Vehicle	N/A	N/A	N/A
5-Ton Truck	8	80	$720
Bradley Fighting Vehicle	N/A	N/A	N/A
M1A1 Abrams Tank	20	200	$1,800
Annual Total:	28	280	$2,520

* Petroleum and synthetic-based hydraulic fluid is purchased through logistics at an average cost of $9 per gallon.

(3) Waste Generation.

- 280 gallons of used hydraulic fluid are generated each year.

(4) Waste Disposal.

- Used hydraulic fluid is placed in a 55-gallon drum and collected by an off-site used hydraulic fluid recycler once per month for refinement or fuel blending.

- If the used hydraulic fluid is contaminated, the hazardous waste disposal cost is approximately $1 per lb. Laboratory fees for hazardous waste characterization can equal or exceed drum disposal costs.

B. Hydraulic Fluid Management P2 Opportunities.

(1) Hydraulic Fluid Segregation.

(a) Description. Since the hydraulic fluid recycler will only accept uncontaminated hydraulic fluid, it is important to keep the hydraulic fluid free of other materials such as water, antifreeze, 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 accomplish this is to provide dedicated containers for hydraulic fluid storage. The size of container necessary to store hydraulic fluid depends on two things: how much hydraulic fluid is generated at the motor pool, and how often it is collected by the recycling contractor. Note, if the hydraulic fluid is contaminated and is to be disposed of as a hazardous waste, any amount greater than 55 gallons in storage must be transported to a less than 90-day hazardous waste storage area within 3 days. Some states may have more stringent requirements; therefore, the installation environmental office should be contacted for coordination. At the template facility, it is assumed that the hydraulic fluid recycler collects the hydraulic fluid once per month. Since 280 gallons are generated each year, the monthly generation is approximately:

$$\frac{280\ gallon}{year} \times \frac{1\ year}{12\ month} = \frac{23.3\ gallon}{month}$$

Therefore, one 55-gallon drum should be sufficient to hold the hydraulic fluid generated each month and 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. Motor pools with larger storage needs can use additional 55-gallon drums or larger bulk storage containers such as concrete-protected aboveground tanks. One way to make sure that other wastestreams are not mixed with the hydraulic fluid 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 or to personnel trained in waste handling and segregation. If a lock is not feasible, the container should be CLEARLY labeled as HYDRAULIC FLUID ONLY.

(b) Potential Waste Reduction. Hydraulic fluid segregation will not effect the amount of hydraulic fluid being generated, but how the hydraulic fluid is disposed of. By maintaining good segregation, the hydraulic fluid will remain free of contaminants and will be suitable for collection by the recycler. This helps ensure that the hydraulic fluid 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. Labor costs are also unaffected. However, it will provide savings from cost avoidance associated with having to dispose of hydraulic fluid that it is too contaminated to recycle. The following calculation shows an estimate of what it may cost to dispose of contaminated hydraulic fluid as a hazardous waste. Although it is unlikely that all of a facility's hydraulic fluid would become too contaminated to recycle, this estimate serves to illustrate the potentially costly affects of not segregating the hydraulic fluid wastestream. The calculation is based on a hazardous waste disposal cost of $1.00 per pound and a specific gravity of hydraulic fluid equal to 0.9. Empty 55-gallon steel drums weigh approximately 55 lb each and are purchased through logistics for $25 each. Five 55-gallon drums are needed to dispose of 280 gallons of hydraulic fluid each year.

$$[(\frac{280\ gallon}{year} x \frac{8.34\ lb}{gallon} x \frac{0.9}{1}) + (\frac{55\ lb}{drum} x \frac{5 drum}{year})] \frac{\$1}{lb} + (\frac{\$25}{drum} x \frac{5 drum}{year}) = \frac{\$2501.68}{year}$$

Thus, properly segregating the hydraulic fluid has a potential saving from cost avoidance of $2502 per year.

(2) Hydraulic Fluid Recycling.

(a) Description. Hydraulic fluid recycling removes the water and particulate contamination from the "dirty" hydraulic fluid allowing the fluid to be reused in tactical vehicles. This process is currently approved for ground vehicles using MIL-H-46170 or MIL-H-6083 only. These recycling systems employ a variety of technologies from micronic filtration to vacuum distillation. However, none of the systems could indicate when a sufficient level of cleaning has been reached. To compensate for this, the U.S. Army TACOM has required that each batch be analyzed for water content and particle count or be processed for an extended period of time (8 hours for moderately contaminated fluid and 12 hours for heavily contaminated fluid). Guidance provided in the U.S. Army TACOM's "User's Guide for Recycling Military Hydraulic Fluid", October 1996, describes in detail the operational and processing requirements for the use of hydraulic fluid recyclers. For this template, the worst-case or 12-hour processing time per batch is assumed.

(b) Potential Waste Reduction. As previously mentioned, the motor pool disposes of 280 gallons of used hydraulic fluid each year. A filtration-based recycling unit can eliminate this wastestream by recovering all of the spent hydraulic fluid for reuse. However, because the filters must periodically be removed and replaced, they will create a new (although relatively insignificant) wastestream. Typically, the filters must be replaced after processing approximately 200 gallons of hydraulic fluid. Since the motor pool uses 280 gallons of hydraulic fluid each year, only 1.4 filters will be needed annually. If the process uses distillation (not presented in this template) to recycle the hydraulic fluid, the still bottoms and process water would require testing and possible disposal as a hazardous waste.

(c) Economic Evaluation.

i. Implementation Costs. The cost of purchasing and installing a hydraulic fluid recycling unit is estimated to be approximately $12,000.

ii. Recurring Costs. Recurring costs will result from having to purchase replacement filters and 25% of the original hydraulic fluid amount. At approximately $275 per filter, the annual cost is:

$$\frac{\$275}{filter} x \frac{1.4 filter}{year} = \frac{\$385}{year}$$

Also, the 25% virgin hydraulic fluid is required to restore the foaming inhibitors in the recycled hydraulic fluid; thus, the recurring cost for purchasing virgin hydraulic fluid is:

$$0.25x\frac{280gallon}{year}x\frac{\$9}{gallon} = \frac{\$630}{year}$$

If the sampling process per batch was adopted in lieu of the extended processing time, an additional laboratory fee would have to be factored into the recurring cost. The total recurring cost for this template is: $385 + $630 = $1015 per year.

iii. Cost Savings Due to Reduced Material Usage. By implementing hydraulic fluid recycling, the motor pool will reduce the purchase of new hydraulic fluid by 75% (25% is added to the recycled hydraulic fluid for the foaming inhibitors), but all of the hydraulic fluid can be reused. Since the motor pool uses 280 gallons of hydraulic fluid each year at a cost of $9 per gallon, the annual cost savings will be:

$$\frac{280\ gallon}{year}\ x\ \frac{\$9}{gallon} = \frac{\$2520}{year}$$

iv. Cost Savings Due to Reduced Disposal Fees. Since the hydrualic fluid recycler collected the spent hydraulic fluid at no charge, there is no cost savings due to reduced disposal fees.

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

$$\frac{12,000}{\frac{\$2520}{year} - \frac{\$1015}{year}} = 8\ year$$

Typically, projects with such long payback periods are not considered beneficial. However, since the initial cost of $12,000 is moderate and the opportunity is environmentally beneficial and easy to implement, efforts to combine resources with other motor pools will decrease the payback period. Calculations used to determine the number of vehicles required to obtain a 3-year payback period are shown below.

$$3\text{-}year = \frac{12{,}000}{S - C}, where S = savings; C = cost; g = gallons$$

$$C = \left(\frac{\$275}{filter} x \frac{filter}{200 gallon} xg\right) + \left(0.25 gx \frac{\$9}{gallon}\right)$$

$$S = gx \frac{\$9}{gallon}$$

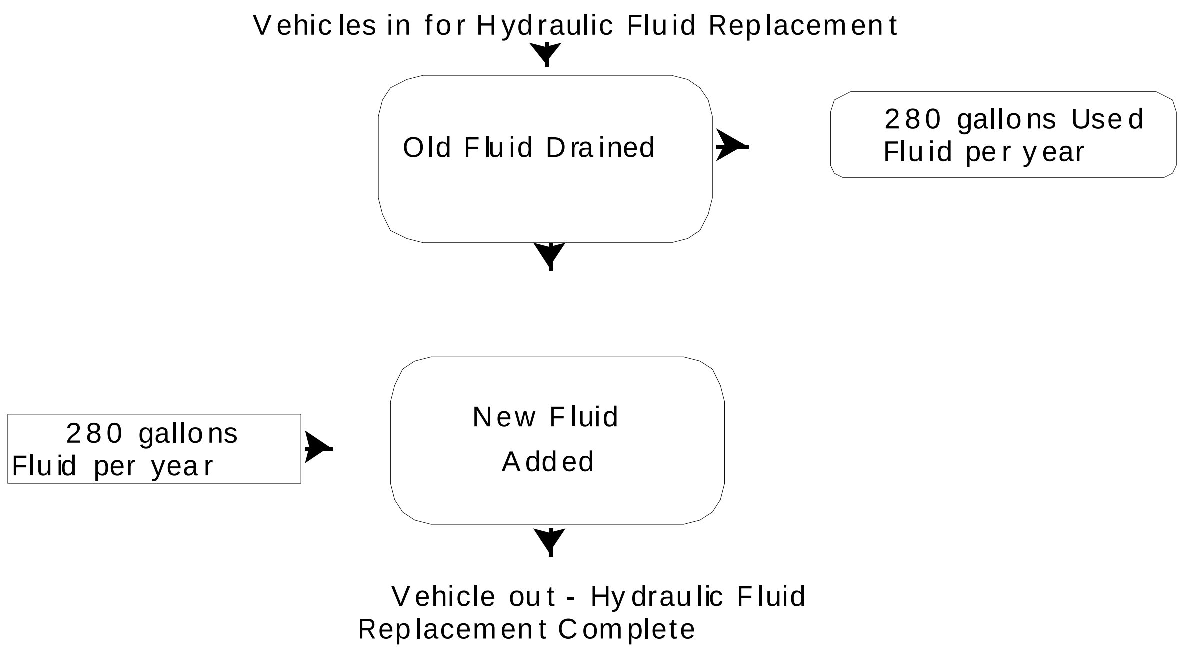
Therefore, to obtain a 3-year payback period, 744 gallons of spent hydraulic fluid need to be generated annually.

C. Hydraulic Fluid Management P2 Summary Chart.

Table 6-2. Summary of Hydraulic Fluid Management P2 Opportunities.

P2 Opportunity	Effect on Waste Disposal		Initial Costs ($)	Recurring Costs ($)	Annual Cost Savings ($)	Payback Period (years)
	Wastestream	Disposal Reduction				
Hydraulic Fluid Segregation	Spent Hydraulic Fluid	0	0	0	0	Immediate
Hydraulic Fluid Recycling	Spent Hydraulic Fluid	280 gallon	12,000	1015	2520	8 year

D. Hydraulic Fluid Management Material Balance Chart.



E. Hydraulic Fluid Management Points of Contact for P2 Equipment*

TF Purifiner, Inc.
3020 High Ridge Rd, Suite 100
Boynton Beach, FL 33426
(800) 488-0577

Pall Aeropower Corp.
6301 49th St. North
Pinellas Park, FL 34665
(813) 522-3111

Petronetics, Inc.
64 bridge Rd
Islandia, NY 11722
(516) 454-7600

Next Step Filtration/Filmax
1835 Edward Dr.
Library, PA 15129
(412) 833-4680

Clarus Technologies Corp.
2015 Alpine Way, Suite A
Bellingham, WA 98226
(800) 671-1514

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

SECTION 7

FUEL MANAGEMENT

A. Template Operations.

(1) Production.

- The motor pool is responsible for servicing ten M998 Series Vehicles, ten 5-Ton Trucks, ten Bradley Fighting Vehicles, and ten M1A1 Abrams Tanks.

- The fuel in each tactical vehicle, JP-8, is drained when determined contaminated from the preventive maintenance checklist or as needed for related maintenance procedures. While diesel fuel is still being utilized in many vehicles, the Army is moving towards a single fuel concept where JP-8 is being used in all tactical and ground support vehicles. Therefore, this template will focus on the JP-8 P2 opportunities.

(2) Material Requirements.

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

- Empty 55-gallon steel drums weighing approximately 55 lb apiece 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. While not presented as the model, in some cases, the used fuel may be burned on site for energy recovery. This option is generally facilitated by the installation's Director of Public Works. Specific state requirements and fuel contamination issues will have to be considered.

- If the waste fuel is contaminated, the hazardous waste disposal cost is approximately $1 per lb. Laboratory fees for hazardous waste characterization can equal or exceed drum disposal costs.

B. Fuel Management P2 Opportunities.

(1) Fuel Segregation.

(a) Description. Because the spent fuel recycler will only accept non-contaminated 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 separate, dedicated containers for spent JP-8 and diesel storage. The size of container necessary to store spent fuel depends on two things: how much spent fuel (and of which types) 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 of JP-8 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. Facilities with larger storage needs can use additional 55-gallon drums or larger, bermed, bulk storage containers. One way to further ensure that other wastestreams are not mixed with the spent fuel is to limit access to the containers. If feasible, a lock should be placed on the containers 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 containers should at least be CLEARLY labeled as SPENT JP-8 ONLY and SPENT DIESEL ONLY.

(b) Potential Waste Reduction. Spent fuel segregation will not affect the amount of spent fuel being generated but, how the spent fuel is disposed of. By maintaining good segregation, the fuel will remain free of contaminants and be 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 shows estimates of 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 affects of not segregating the spent fuel wastestream. The calculation is based on a hazardous waste disposal cost of $1 per lb and a specific gravity of fuel equal to 0.8. Empty 55-gallon steel drums weigh approximately 55 lb apiece and are purchased through logistics for $25 each.

$$[(\frac{110gallon}{month} x \frac{8.34lb}{gallon} x \frac{0.8}{1}) + (\frac{55lb}{drum} x 2drum over month)] \frac{\$1}{lb} + (\frac{\$25}{drum} x \frac{2drum}{month}) = \frac{\$893}{month} or \frac{\$10,716}{year}$$

Thus, properly segregating the spent fuel has a potential cost avoidance of $10,716 per year.

(2) Downgrading Fuel.

(a) Description. Kerosene-based fuels, such as JP-8, that cannot meet use limits or cleanliness standards can be downgraded for use in the diesel 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 tactical vehicles, but the disposition of that waste. Downgrading off-specification JP-8 to a diesel fuel allows 110 gallons per month or 1320 gallons per year to be reutilized as a material in the diesel 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 1320 gallons of fuel for the ground vehicles. The following calculation shows the potential saving in material costs for the diesel vehicles, assuming that JP-8 costs $0.77/gallon.

$$\frac{1320\ gallon}{year} \times \frac{\$0.77}{gallon} = \frac{\$1016.40}{year}$$

Thus, this opportunity can save $1016 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 specification 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 1200 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 tactical vehicles. 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 the motor pool by recycling the off-specification fuel. However, since the particulates and water still require hazardous waste disposal, the wastestream is not completely eliminated. For this template, assume that 110 gallons per month or 1320 gallons per year of off-specification fuel is recycled and 10% is determined to be particulates and water.

(c) Economic Evaluation.

i. Implementation Cost. A small, 5 gallon per minute recycler costs $60,000.

ii. Recurring Cost. There is a $250 per month filter replacement and maintenance cost, or $3000 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

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

Thus, the total recurring cost is $3000 + $16,200 + $240 or $19,440 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 beneficial. Combining the P2 efforts with other motor pool or aviation facilities will decrease the payback period. Calculations to determine the volume of fuel required to obtain a 3-year payback period are shown below.

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

$$x = \left(\frac{no\ gallon - (0.1\ x\ no\ gallon)}{year}\right)\ x\ \frac{\$0.77}{gallon}$$

$$y = \frac{\$3000 + \$16{,}200}{year}\ x\ \frac{no\ gallon}{year}\ x\ 0.1\ x\ \frac{\$100}{55\ gallon}$$

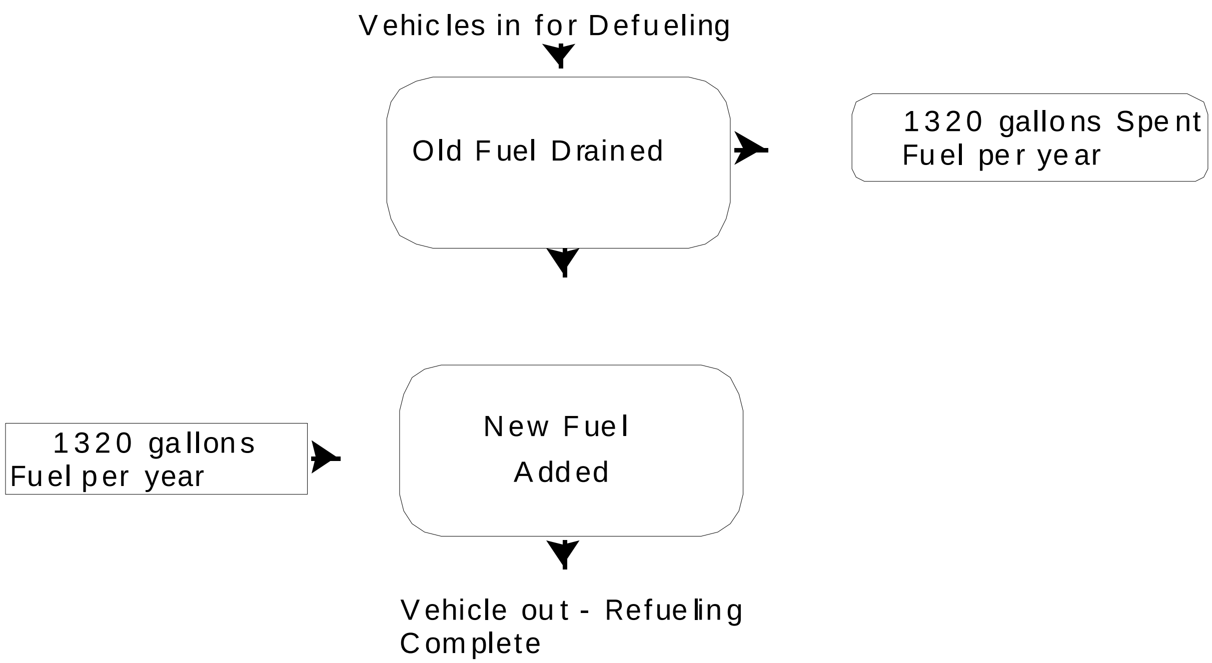
Therefore, 96,618 gallons of spent fuel per year are needed to provide a 3-year payback period for this P2 opportunity.

C. Pollution Prevention Summary Chart.

Table 7-1. Summary of Fuel Management P2 Opportunities.

P2 Opportunity	Effect on Waste Disposal		Initial Cost ($)	Recurring Cost ($)	Annual Cost Savings ($)	Payback Period (year)
	Wastestream	Disposal Reduction				
Fuel Segregation	Spent JP-8	1320 gallon	0	0	0	immediate
Downgrading JP-8	Spent JP-8	1320 gallon	0	0	1016	immediate
Recycling JP-8	Spent JP-8	1188 gallon	60,000	19,560	915	not economically feasible

D. Fuel Management Material Balance Chart.



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