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FLEET MOTOR POOL POLLUTION PREVENTION GUIDE

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The pollution prevention (P2) guide identifies potential opportunities to reduce pollution generated by routine fleet vehicle maintenance operations; provides sample calculations showing waste reduction estimates and economic analyses for each P2 opportunity; serves as a template for similar motor pools; covers 4 major waste streams, engine oil, lead-acid batteries, coolant, and parts cleaning solvent.

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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 fleet vehicle maintenance operations. This 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 that was 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 which can then be used as a prioritization and decision making tool for implementing P2 opportunities.

B. SCOPE. This pollution prevention guide addresses four of the major waste streams generated by routine fleet vehicle maintenance: engine oil, lead-acid batteries, coolant, and parts cleaning solvent.

C. FORMAT. Each of the four subsequent sections of this guide (Sections 2-5) addresses one of the four major waste streams 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 waste stream. Part B of each section gives a discussion of potential P2 opportunities designed to reduce the relevant waste stream. For each opportunity, the guide provides a background discussion on the technologies and methods involved, potential waste reduction estimates, and an economic analysis that shows implementation costs, recurring costs, cost savings, and payback period. The estimates provide 2 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 of each section contains a one-page table that summarizes each of the P2 opportunities identified. Part D is a material balance diagram that shows the process flow and the materials used/wastes generated during each stage of the process. Part E provides relevant points of contact through which further information on P2 technologies, equipment, and reports can be obtained.

SECTION 2

OIL MANAGEMENT

PART A - MOTOR POOL OPERATIONS

1. PRODUCTION.

- The motor pool is responsible for servicing 100 GSA vehicles such as cars, pickup trucks, and vans.
- The oil in each vehicle is changed 4 times per year which results in 400 oil changes per year.

2. MATERIAL REQUIREMENTS

- Each vehicle holds an average of 5 quarts (1.25 gallons) of oil. Therefore, at 400 changes per year, the total amount of new oil needed each year is 500 gallons.
- Oil is purchased through the GSA at a cost of $4.00 per gallon.
- One new oil filter is required for every oil change. As a result, the total amount of new oil filters needed each year is 400 per year.
- Oil filters are purchased through the GSA at a cost of $2.00 each.

3. WASTE GENERATION

- 500 gallons of used oil is generated each year (about 3,336 lbs assuming a specific gravity of 0.8)
- 400 used oil filters are generated each year which results in about 400 lbs of used filter waste annually (assuming each filter weighs about 1 pound).

4. WASTE DISPOSAL

- Used oil is placed in a 55 gallon drum and collected by an off-site used oil recycler once per month at no cost to the motor-pool (the recycler collects the oil for free since it earns revenue by reselling the recycled oil).
- Used oil filters are hot-drained (at or above 60°F). Once drained, they are placed in 55 gallon drums and disposed of as a non-regulated solid waste at a cost of $50 per ton (about $10 per year based on 400 filters at 1 lb each).

PART B - POLLUTION PREVENTION OPPORTUNITIES

1. USED OIL SEGREGATION

a. Description. Because the used oil recycler will only accept non-contaminated oil, it is important to keep the used oil free of other materials such as water, antifreeze, and solvents. The best way to accomplish this 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. At the sample motor pool, it is assumed that the oil recycler collects the used oil once per month. Since 500 gallons are generated each year, the monthly generation is approximately:

$$\frac{500\ gal}{year} \times \frac{1\ year}{12\ months} = \frac{42\ gal}{month}$$

Therefore, a single 55 gallon drum should be sufficient to hold the used oil generated each month as well as provide enough additional storage in case the recycler is a few days late for a scheduled pick-up. Motor pools with larger storage needs can use additional drums or bulk storage containers such as concrete-protected above ground tanks. One way to make sure that other waste streams are not mixed with the used oil is to limit access to the container. If feasible, a lock should be placed on the container with keys given only to supervisory level personnel or to personnel trained in waste handling and segregation. If a lock is not feasible, the container should at least be CLEARLY labeled as USED OIL ONLY.

b. Potential Waste Reduction. Used oil segregation will not affect the amount of used oil being generated but, rather, the way in which the used oil is disposed. By maintaining good segregation, the oil will remain free of contaminants and 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. However, it will help avoid costs associated with having to dispose of oil that becomes contaminated (since used oil recyclers will not typically collect contaminated oil, it would have to be disposed of as a hazardous waste). The following calculations show estimates of what it would cost to dispose of contaminated oil as a hazardous waste. Although it is unlikely that all of a motor pool's oil would become too contaminated to recycle, these estimates serve to illustrate the potentially costly affects of not segregating the used oil waste stream. The calculations are based on a hazardous waste disposal cost of $1.00 per pound and a specific gravity of oil equal to 0.8.

$$\frac{500\ gallons}{year} \ x\ \frac{8.34\ lbs}{gallon} \ x\ \frac{0.8}{1} \ x\ \frac{\$1.00}{lb} = \frac{\$3,336}{year}$$

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 which have been gravity drained which results in less oil being thrown away along with the used filter. Crushed oil filters are about a quarter the volume of non-crushed filters which help conserve landfill space once they are disposed of. The oil that is drained from crushed filters can be collected and stored with the used oil that has been drained from the vehicles' oil pans.

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 MOTOR POOL will still require the same number of filters to be used. Therefore, 400 used oil filters would still be generated each year.

c. Economic Evaluation.

(1) Implementation Costs. The cost of procuring and installing a small oil filter crushing unit is approximately $1,000.

(2) Recurring Costs. The only recurring cost associated with this initiative is the labor resulting from the additional time it takes to crush the filters before disposing of them. Assuming it takes 30 seconds to crush one oil filter and labor costs $25 per hour, the total cost of crushing 400 oil filters is $83.33 per year.

(3) Potential Recurring Cost Savings. Because crushed used oil filters take less space than uncrushed filters, motor pool personnel can fit more crushed filters into a disposal drum. Since the weight of each drum is included in the $50 per ton solid waste disposal fee, disposing of fewer drums will result in a cost savings. In addition, by lowering the number of drums required for disposal, the motor pool will save money in purchasing fewer drums.

Reduced Disposal Fees. Assume that 75 uncrushed oil filters and 225 crushed filters can fit into a single 55 gallon drum. Each year, the motor pool would therefore require 6 drums to dispose of 400 uncrushed oil filters and 2 drums to dispose of 400 crushed filters. As a result, oil filter crushing would save the motor pool from having to dispose of 4 extra drums per year. Assuming that each drum weighs 25 lbs, the savings that result from having to dispose of 4 fewer drums is $2.5 per year based on a $50 per ton solid waste disposal fee.

Reduced Drum Procurement. Assuming each drum costs about $25, the annual savings from purchasing 4 fewer drums is $100 per year.

Total Cost Savings. The total annual cost savings is $102.5 ($2.5 + $100).

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

$$\frac{\$1,000}{\$102.5/yr - \$83.33/yr} = 52\ years$$

Typically, projects with such a long payback period 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.

(5) Three Year Payback Period. For this project to have a 3 year payback period the motor pool would have to generate approximately 17,000 used oil filters (or service a fleet of approximately 4,250 vehicles). However, this assumes that only one filter crusher would be used for all 17,000 filters which may not be feasible.

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 non-regulated solid waste (depending on local requirements). However, a more environmentally beneficial alternative would be to send the used and drained filters to the DRMO for consideration as a scrap metal. Many scrap metal recycling contractors will collect drained, used oil filters along with other scrap metals at no cost to the generator.

b. Potential Waste Reduction. By including used oil filters as a scrap metal, they would no longer be disposed of as a non-regulated solid waste and end up in a landfill. This helps conserve landfill space as well as resources since the metal from the filters will be re-processed into another product. At this motor pool, oil filter recycling would divert 400 oil filters per year from a landfill to a recycler. Assuming each oil filter weighs 1 lb, the annual reduction in waste disposal would be 400 lbs.

c. Economic Evaluation.

(1) Implementation Costs. Recycling contractors usually collect scrap metal free of charge; and the DRMO should already have procedures in place to recycle scrap metals. As a result, there should be no additional costs associated with having to store used oil filters for recycling since the DRMO usually supplies activities with scrap metal recycling bins. Also, there should not be any additional labor costs since throwing used filters in a scrap metal bin would not take any longer than throwing them in a solid waste dumpster.

(2) Recurring Costs. Using the assumptions in the paragraph above, there are no recurring costs associated with this pollution prevention initiative.

(3) Potential Recurring Cost Savings. A small amount of cost savings would result from no longer disposing of the filters as a non-regulated solid waste. At $50/ton of solid waste disposal, the following amount would be saved each year:

$$\frac{400\ filters}{year} \times \frac{1\ lb}{filter} \times \frac{1\ ton}{2{,}000\ lbs} \times \frac{\$50}{ton} = \frac{\$10}{year}$$

(4) Payback Period. Although the cost savings are minimal, filter recycling saves more money than it costs to implement which gives it an immediate payback period.

(5) Three Year Payback Period. The payback period for this pollution prevention initiative is independent of the number of used oil filters generated (the payback period will be immediate no matter how many filters generated). As a result there is no 3 year payback period; the payback is always immediate.

4. BY-PASS OIL FILTERS

a. Description. Typical motor oils must be changed routinely due to the accumulation of small particles in the oil and the breakdown of oil additives. Bypass oil filters are designed to remove these smaller particles which pass through normal filters, thereby extending the life of the oil. Bypass oil filters are installed in the engine compartment of a vehicle and are used in addition to the vehicle's regular oil filter. These filter units can remove particles as small as 1 micron in size and can extend the life of existing engine oil indefinitely. The normal oil filter must still be changed periodically (about half as often as usual) and the bypass filter cartridge should be changed according to manufacturer's recommendations (approximately once per year is a typical estimate). Although the oil should never have to be changed under this system, new oil must occasionally be added to replace that which has been lost during the filter changes. This regular addition of oil is sufficient to maintain the proper levels of oil additives. One disadvantage to installing such filters on commercial vehicles is that these vehicles are not usually equipped with an additional filter port. As a result, an additional port would have to be added by drilling a hole. Therefore, before implementing this alternative, it is important to review manufacturer warranty information to be sure that adding an additional filter would not violate any of the terms in the warranty.

b. Potential Waste Reduction.

(1) Used Oil. Implementing this opportunity would nearly eliminate the generation of used oil resulting from routine vehicle oil changes. The only used oil generated would be the oil that drains from the filters as they are changed. Assuming that each oil filter holds up to [illegible] of a quart of oil, and personnel change 200 primary oil filters each year and 100 bypass filter cartridges each year, the

$$\frac{\text{‰ quart}}{\text{filter change}} \times 300 \text{ filter changes} \times \frac{1 \text{ gallon}}{4 \text{ quarts}} = 38 \text{ gallons}$$

amount of used oil generated would be reduced to:

(2) Used Oil Filters. By implementing this opportunity, the primary oil filters will only need to be changed half as often. Therefore, instead of 400 primary oil filter changes per year, only 200 oil filter changes per year would be required (and only 200 used oil filters would be generated).

(3) Bypass Filter Cartridges. This P2 opportunity would introduce used bypass filter cartridges as a new waste stream generated by the motor pool. Since the bypass filter cartridges should be changed about once per year, 100 used cartridges will be generated each year (since the motor pool services 100 vehicles).

c. Economic Evaluation.

(1) Implementation Costs. Bypass filter units for automotive and light truck use cost about $75. The actual unit need only be purchased one time although replacement filter cartridges would have to be purchased at each filter replacement (about once per year). The initial cost of purchasing all 100 vehicles with bypass oil filters would be $7,500. In addition, there will be a significant cost associated with installing the filters since most commercial vehicles are not equipped with an additional oil filter port (as described above). Assuming installation takes 3 hours per vehicle and labor costs $25 per hour, it would cost $7,500 to install the filters on 100 vehicles. This gives a total implementation cost of $15,000.

(2) Recurring Costs. The cost of the replacement filter cartridges are approximately $5. Since 100 cartridges must be replaced each year, the annual filter procurement cost would be $500. In addition, assuming it takes ½ hour to replace the cartridge and labor costs $25 per hour, installation costs would be $1,250 per year. This gives a total recurring cost of $1,750 per year.

(3) Potential Recurring Cost Savings. This pollution prevention opportunity will yield cost savings due to reduced oil and oil filter purchasing as well as decreased labor costs since motor pool will perform fewer oil changes.

Reduced Oil Procurement. As discussed above, oil usage will be reduced from 500 gallons to 38 gallons which is a difference of 462 gallons. At approximately $4 per gallon, the savings associated with purchasing 462 fewer gallons of oil per year is $1,848 per year.

Reduced Oil Filter Procurement. Also as discussed above, 200 fewer primary oil filters would be used per year. At $2 per oil filter, the savings from purchasing 200 fewer would be $400. It is important to note that this opportunity would also reduce the costs associated with disposing of these materials once they were used. However, since used oil is collected by a recycling contractor free-of-charge, there are no costs savings associated with disposal.

Reduced Oil Changing Labor. This P2 opportunity also generates cost savings since 200 fewer primary oil filter changes will occur each year. Assuming each oil change take ½ an hour and labor costs $25 per hour, this amounts to an annual cost savings of $2,500 per year.

Total Recurring Cost Savings. The total recurring cost savings associated with this opportunity is $4,748 ($1,848 + $400 + $2,500).

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

$$\frac{\$15,000}{\$4,748/yr - \$1,750/yr} = 4.6\ years$$

(5) Three Year Payback Period. Because the implementation costs are a function of how many fleet vehicles are serviced, the payback period will take 5 years regardless of how many vehicles the motor maintains. Therefore there is no 3 year payback period (it is always 5 years).

5. POWER DRAIN OIL CHANGE SYSTEM

a. Description. The Power Drain 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 Power Drain 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 Power Drain plug is available for nearly all models of automobile and is designed to take the place of the existing drain plug. Because the Power Drain plug can be removed and replaced exactly like a typical drain plug, oil changes may be performed by either the Power Drain method or the conventional method.

b. Potential Waste Reduction. This alternative will not reduce the amount of used oil being used or generated by oil change operations. However, by using the Power Drain procedure, the potential for leaks and spills to occur will be 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. This also reduces the likelihood of contaminating the used oil with other waste liquids such as antifreeze, solvent, and water. As a result, this can be viewed as an indirect environmental benefit.

c. Economic Evaluation.

(1) Implementation Costs. The cost of the suction pump required for this P2 opportunity would be approximately $500. The cost of the Power Drain Plugs themselves are approximately $4.25 each or $425 to equip all 100 vehicles. Therefore, the total implementation cost would be $425 + $500 = $925.

(2) Recurring Costs. There are no recurring costs associated with this opportunity assuming that the new plugs are installed at a regularly scheduled oil change. This way, there would be no additional labor required to install the plugs since, during the oil change procedure, workers would merely place the new plug back into the oil pan rather than placing the old plug back into the pan.

(3) Potential Recurring 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 amount of 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 oil changes performed without the Power Drain plug take ½ hour and that changes with the plug take 15 minutes. As a result, 15 minutes can be saved from each oil change. Assuming a labor cost of $25 per hour (including overhead), this amounts to a labor cost savings of $2,500 per year.

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

$$\frac{\$925}{\$2{,}500\,/\,yr} = 0.4\,years$$

(5) Three Year Payback Period. For this project to have a 3 year payback period, the motor pool would require a fleet of only 7 vehicles (assuming all other factors remained the same). Therefore, this pollution prevention opportunity has a 3 year payback period or less for motor pools servicing 7 or more vehicles.

6. ARMY OIL ANALYSIS PROGRAM.

a. Description. Most Army installations include their tactical vehicles in the Army Oil Analysis Program (AOAP) which is typically operated within the installation's Directorate of Logistics. The goal of this program is to reduce the Army's oil usage by optimizing each individual vehicle's oil changing requirements. This goal is achieved by taking oil samples from each tactical vehicle and analyzing it in a laboratory to determine if it should be changed. In the past, personnel changed a vehicle's oil according to how far the vehicle was driven or how many hours it had been in operation. While such milestones were a good rule of thumb, they did not indicate whether or not the oil actually *needed* to be changed. In many cases, the oil in these vehicles could still have been used for a much longer period before needing to be changed. The AOAP has, in most vehicles' cases, reduced the number of oil changes required by closely monitoring the condition of each vehicle's oil and changing it only when necessary. Although the AOAP was initially structured to service tactical vehicles, several Army installations have extended the program's service to include fleet vehicles such as those maintained by the DPW and GSA motor pools. In so doing, these installations have been able to extend the period between its fleet vehicle oil changes and, subsequently, reduce their oil usage.

b. Potential Waste Reduction. Because different vehicles are built and used in various ways, it is difficult to determine exactly how the AOAP could affect a motor pool's oil change requirements. As a result, the calculations in this section are based completely on the assumption that using the AOAP could extend each vehicle's oil change period from once every 3 months to once every 4 months. This equates in a 75% reduction of vehicle oil changes performed per year. Therefore, rather than generating 500 gal of used oil and 400 oil filters per year, the motor pool would only generate 375 gal of used oil and 300 oil filters (a reduction of 125 gallons of used oil and 100 used oil filters).

c. Economic Evaluation.

(1) Implementation Costs. Because the AOAP should already be established at the motor pool's host installation, there would be no implementation costs.

(2) Recurring Costs. Recurring costs would include the labor associated with taking oil samples from each vehicle on a periodic basis (it is assumed that the actual laboratory analysis costs would be covered under the AOAP's operating costs rather than having to be paid for by the motor pool). Assuming that personnel take bi-monthly oil samples (6 per year) from each of the 100 vehicles, sampling takes 15 minutes each time, and labor costs $25 per hour (including overhead), it would cost the motor pool the following amount in labor each year:

$$\frac{6\ samples/vehicle}{year} \times 100\ vehicles \times \frac{5\ \text{min}}{sample} \times \frac{1\ hr}{60\ \text{min}} \times \frac{\$25}{hr} = \frac{\$1{,}250}{year}$$

(3) Potential Recurring Cost Savings. Recurring cost savings would result from purchasing less oil and fewer oil filters, disposing of fewer oil filters, and performing fewer oil changes.

Procuring Less Oil. As described above, this opportunity could reduce oil usage by about 125 gallons. At a cost of $4.00 per gallon, this would result in a cost savings of $500 per year.

Procuring Fewer Oil Filters. As described above, this opportunity could reduce oil filter usage by about 100 oil filters. At a cost of $2.00 each, this would result in a cost savings of $200 per year.

Disposing of Fewer Oil Filters. Oil filter disposal costs $50 per ton. Assuming each used oil filter weighs 1 pound, disposing of 100 fewer oil filters would save $2.5 per year.

Performing Fewer Oil Changes. This opportunity could reduce the number of oil changes performed from 400 to 300 each year. Assuming it takes one half of an hour to perform an oil change at a labor cost of $25 per hour (including overhead), performing 100 fewer oil changes would save $1,250.

Total Recurring Cost Savings. The total annual cost savings associated with this opportunity is about $1,953 ($500 + $200 + $2.5 + $1,250).

(4) Payback Period. Since there are no implementation costs and the recurring cost savings outweigh the recurring costs, the payback period is immediate.

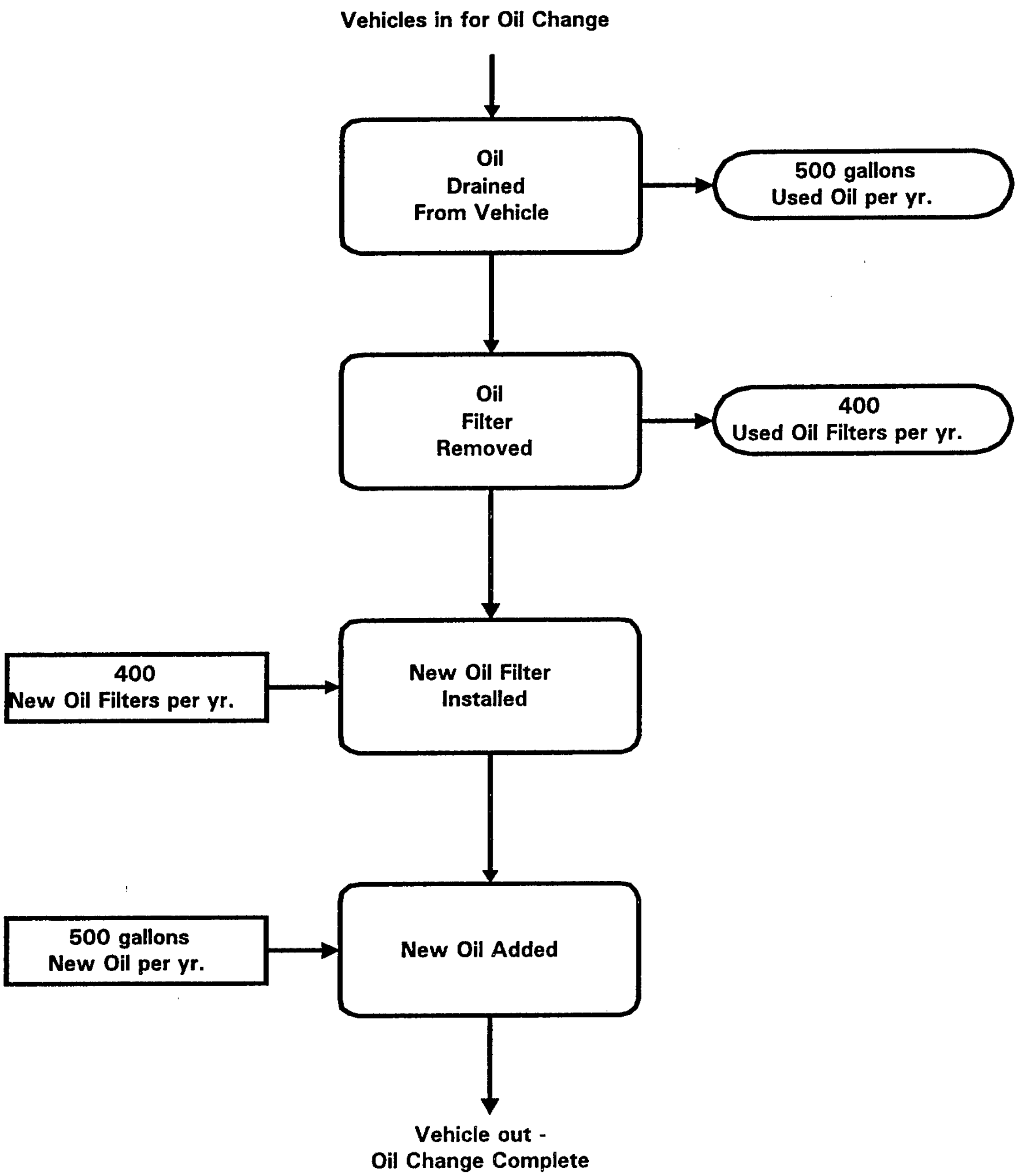
(5) Three-Year Payback Period. Regardless of how many vehicles serviced by the motor pool, the payback period is always immediate.

PART C - OIL MANAGEMENT SUMMARY CHART

Table 1. Summary of Oil Management Pollution Prevention Opportunities.

P2 Opportunity	Effect on Waste Disposal		Initial Costs ($)	Recurring Costs ($)	Annual Cost Savings ($)	Payback Period (years)
	Waste Stream	Disposal Reduction				
Used Oil Segregation	Used oil	0	0	0	0	NA
Oil Filter Crushing	Used Oil Filters	0	1,000	0	0	None
Oil Filter Recycling	Used Oil Filters	400 lbs	0	0	10	Immediate
By-Pass Oil Filters	Used Oil	462 gal	15,000	1,750	4,758	4.6
	Used Oil Filters	200 lbs				
	By-pass cartridges	(100 lbs)[1]				
Power Drain Oil Plug	Used Oil	0	925	0	2,500	0.4
Oil Analysis Program	Used Oil	125 gal	0	1,250	1,953	Immediate
	Used Oil filters	100 lbs				

Notes: 1. ()'s indicate that this waste stream will actually be created as a result of implementing the P2 opportunity.



PART D - MATERIAL BALANCE CHART

PART E - 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

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

Oberg International, Inc.
6120 195th St. N.E.
Arlington, WA 98223
(206) 435-9100

Bypass Oil Filters

Enviro Filtration
4719 Roosevelt Street
Gary, IN 46048
(219) 884-7963

TF Purifiner
3020 High Ridge Road, Suite 100
Bounton Beach, FL 33426
(800) 488-0577

Power Drain Oil Plug

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

SECTION 3

BATTERY MANAGEMENT

PART A - MOTOR POOL OPERATIONS

1. PRODUCTION.

- The motor pool is responsible for servicing 100 GSA vehicles such as cars, pickup trucks, and vans.
- The battery in each vehicle is changed once per year which results in 100 battery changes per year.

2. MATERIAL REQUIREMENTS

- Each vehicle requires one 12-volt lead-acid battery which is purchased through the GSA at $60 apiece. This results in an annual cost of $6,000.

3. WASTE GENERATION

- 100 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 lbs and is disposed of at a unit cost of $1.00/lb. This results in the annual disposal of 4,000 lbs of battery waste at a cost of $4,000 (since the motor pool generates 100 used batteries each year).

PART B - POLLUTION PREVENTION 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). As a result, it is not necessary to drain the batteries before collection. 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 as well as 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 100 batteries per year from a hazardous waste landfill to a recycler. Assuming each battery weighs 40 lbs, the annual reduction in waste disposal would be 4000 lbs.

c. Economic Evaluation.

(1) Implementation Costs. Since most battery vendors collect spent lead-acid batteries free-of-charge, there would be no implementation costs.

(2) Recurring Costs. Since most battery vendors collect spent lead-acid batteries free-of-charge, there would be no recurring costs.

(3) Cost Savings. By no longer disposing of used lead-acid batteries, the motor pool could realize an annual cost savings of $4,000.

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

(5) Three-Year Payback. The payback period will always be immediate regardless of how many batteries used.

2. SOLARGIZER SYSTEM.

a. Description. The Solargizer battery management system is a commercially available battery conditioning device for use with standard 12 volt (v) 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 re-charging attempts. This system consists of a small solar powered unit (permanently mounted on the vehicle) 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 FT 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 one year to an estimated minimum life of five years. However, because this estimate has not yet been confirmed, this document uses a more conservative estimate of a 3 year battery life.

b. Potential Waste Reduction. By extending battery life from approximately one year to 3 years, the demand for new batteries and the amount of waste attributed to lead-acid battery usage will be reduced by at least 3 times. As a result, used lead-acid battery generation should be decreased from an average of 4,000 lbs per year to the following:

$$\frac{4{,}000\ lbs}{year}\ /\ 3 = \frac{1333\ lbs}{year}\quad (a\ 2{,}667\ lb\ reduction)$$

c. Economic Evaluation.

(1) Initial Costs. The cost of one Solargizer unit is $150. Since the motor pool would have to purchase one unit for each of its 100 vehicles, the total purchase cost would be $15,000. In addition, installation labor costs would total $625 (assuming it takes 15 minutes to install a Solargizer at $25 per hour). Therefore, the entire implementation costs would amount to $15,625.

(2) Recurring Costs. There are no recurring costs associated with this pollution prevention option. The one time purchase of the Solargizer unit is all that is required.

(3) Potential Recurring Cost Savings. Cost savings will result from having to procure fewer batteries as well as disposing of fewer batteries.

Procuring Fewer Batteries. Because the Solargizer system can increase a battery's life from 1 to 3 years, a savings of $60/battery (for all 100 batteries) can be achieved each year from the second to the fifth years (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 $6,000 per year.

Disposing of Fewer Batteries. The motor pool spends $4,000 each year for used battery disposal. Since the battery lives would be extended with the use of the Solargizer equipment, $4,000 would be saved for every additional year the batteries remained in service.

Total Recurring Cost Savings. The total annual cost savings associated with this opportunity is $10,000 ($6,000 + $4,000).

(4) Payback Period. The payback can be calculated by dividing the implementation costs by the cost savings. One year is added to reflect the fact that the batteries will eventually become spent even with the Solargizer system in use. Costs would then result for their replacement and disposal.

$$\frac{\$15{,}625}{\$10{,}000\,/\,yr} + 1\ year = 2.6\ years$$

(5) Three-Year Payback Period. The payback period for this opportunity is independent of the number of batteries serviced by the motor pool. As a result, the payback period would be about 2.6 (or 3.6) years regardless of the number of Solargizer units purchased and used. Therefore, there is no 3-year payback.

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 in conjunction with 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-charged or under-charged. 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 about 75% of "unserviceable" batteries back to their fully rated capacity. However, it has not been determined if this recovery rate can be consistently maintained. As a result, estimates in this document are based on a more conservative recovery rate of 50%. 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 50% of the "spent" batteries would result in an average annual waste reduction of:

$$\frac{4{,}000\ lbs}{year} \times 50\% = \frac{2{,}000\ lbs}{year}$$

c. Economic Evaluation.

(1) Implementation Costs. A battery charger capable of charging 10 batteries simultaneously costs about $500. To fully utilize the charger, one 10-battery bus bar ($250) and one Lazarus unit ($1,500) would be required. Assuming installation takes 2 people one full day (8 hours) and installation labor costs $25 per hour, the implementation costs would also include $400 for installation. Therefore, the total implementation costs would be $500 + $250 + $1,500 + $400 = $2,650

(2) Recurring Costs. Since the Lazarus system is used in the same manner as other battery charging equipment, there should be no affect on the amount of labor required to implement this alternative. In addition, the system does not require any foreseeable maintenance costs. As a result, there are no recurring costs associated with the Lazarus battery recharging system.

(3) Potential Recurring Cost Savings. Cost savings will result from having to procure fewer batteries as well as having to dispose of fewer batteries.

Procuring Fewer Batteries. As discussed above, it is estimated that the Lazarus system can return about 50% of normally unserviceable batteries back to service. Since the motor pool uses 100 batteries per year, this will save about 50 batteries. At a cost of $60 per battery, this will save the motor pool about $3,000 per year.

Disposing of Fewer Batteries. If the motor pool were to use 50 fewer batteries each year, it would dispose of 50 fewer batteries each year. Assuming each battery weighs 40 lbs and disposal fees are $1.00 per pound, this would save the motor pool about $2,000 per year.

Total Recurring Cost Savings. The total annual cost savings associated with this opportunity is $5,000 ($3,000 + $2,000).

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

$$\frac{\$2,650}{\$5,000\,/\,yr} = 0.5\,yrs$$

(5) Three-Year Payback Period. Maintaining a fleet of 18 vehicles would produce a 3-year payback period (assuming all other aspects remained the same). Therefore, the payback would be 3 years or less if the motor pool services 18 or more vehicles.

4. OPTIMA BATTERIES.

a. Description. The optima battery system incorporates lead-acid chemistry into a new type of battery construction. Each 12-volt Optima battery is about 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 6 cells which are electrically connected together. 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, microporous glass material which holds the electrolyte. The spiral configuration provides more structural strength as compared to 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 (rather then a lead alloy) reduces the amount of grid corrosion which thereby extends the life of the battery. The Optima has been found to have a life of 3 to 5 years (as opposed to about 1 year for typical lead-acid batteries used in many Army operations). In addition, because the electrolyte is completely absorbed within the microporous glass layer, it will not leak from the battery even if the casing becomes damaged. A 12-volt Optima battery can be installed 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 the course of 4 years, only 100 Optima batteries would have to be purchased as compared to 400 batteries under the current system. Over those 4 years, the difference in battery usage would then be 400-100=300 batteries less for the Optima system. Three hundred batteries over 4 years averages to 75 batteries per year which, at 40 lbs per battery, gives an annual waste reduction of 3,000 lbs (75 batteries x 40 lbs/battery) per year.

c. Economic Evaluation.

(1) Implementation Costs. Each Optima battery costs about $125. Purchasing Optima batteries for all 100 vehicles would, therefore, cost $12,500. Currently, the motor pool spends $6,000 per year on lead-acid batteries. To implement the Optima battery P2 alternative, the motor pool would have to spend $6,500 over what it is currently spending ($12,500 - $6,000). There would be no labor costs associated with installing the Optima batteries if they were installed at the time the old batteries are due to be replaced.

(2) Recurring Costs. There are no annual recurring costs associated with this opportunity.

(3) Potential Recurring Cost Savings. Recurring cost savings will result from procuring fewer batteries as well as disposing of fewer batteries.

Procuring Fewer Batteries. As seen in paragraph 2 above, the implementation of Optima batteries would reduce the annual battery usage by an estimated 75 batteries per year. At a cost of $60 apiece, this would save the motor pool $4,500 per year.

Disposing of Fewer Batteries. Using an average of 75 fewer batteries each year would directly lead to disposing of 75 fewer batteries per year. This would save $3,000 per year since each battery weighs 40 lbs and disposal fees are $1.00 per pound.

Total Recurring Cost Savings. The total annual cost savings associated with this opportunity is $7,500 ($4,500 + $3,500).

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

$$\frac{\$6{,}500}{\$7{,}500\,/\,yr} = 0.9\,years$$

Since the estimated life of an Optima battery is 4 years and the payback period is just less than 1 year, implementation of this alternative will save the motor pool $7,500 per year ($4,500 + $3,000) from the 2nd through the 4th years.

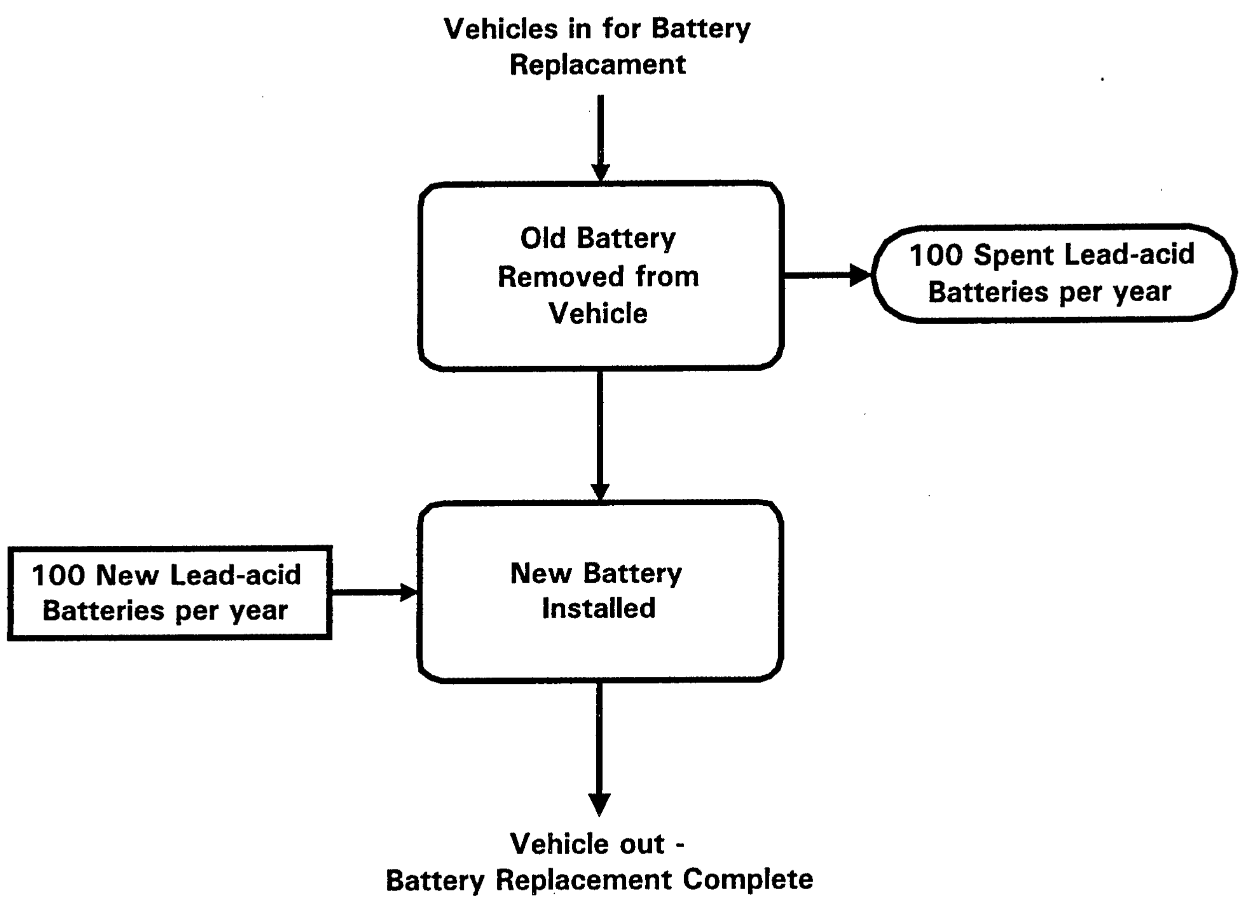
(5) Three Year Payback Period. The payback period for this option will be constant regardless of how many batteries the motor pool service. As a result, the payback period will always be 0.9 years (there is no 3-year payback period).

PART C - BATTERY MANAGEMENT SUMMARY CHART

Table 2. Summary of Battery Management Pollution Prevention Opportunities.

P2 Opportunity	Effect on Waste Disposal		Initial Costs ($)	Recurring Costs ($)	Annual Cost Savings ($)	Payback Period (years)
	Waste Stream	Disposal Reduction				
Battery Recycling	Lead-acid Batteries	4,000 lbs	0	0	4,000	immediate
Solargizer System	Lead-acid Batteries	2,667 lbs	15,625	0	10,000	2.6
Lazarus System	Lead-acid Batteries	2,000 lbs	2,650	0	5,000	0.5
Optima System	Lead-Acid Batteries	3,000 lbs	6,500	0	7,500	0.9

PART D - MATERIAL BALANCE CHART



PART 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

SECTION 4

COOLANT MANAGEMENT

PART A - MOTOR POOL OPERATIONS

1. PRODUCTION.

- The motor pool is responsible for servicing 100 GSA vehicles such as cars, pickup trucks, and vans.
- The coolant system is flushed and the coolant replaced two times per year for each vehicle.
- When adding new coolant to the system, a mixture of ½ antifreeze and ½ 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 that is used in the vehicles.

2. MATERIAL REQUIREMENTS

- Each vehicle holds an average of 5 gallons of coolant. Since the coolant is a mixture of equal parts of water and antifreeze, the amount of antifreeze in each vehicle is therefore 2.5 gallons. Based on these quantities, the amount of antifreeze that the motor pool uses each year is:

$$100\ vehicles \times \frac{2.5\ gallons}{system\ flush} \times \frac{2\ system\ flushes}{vehicle\ /\ year} = \frac{500\ gallons}{year}$$

- The motor pool purchases its antifreeze through the GSA at a cost of $6.00 per gallon. The total annual amount that the motor pool spends for antifreeze is:

$$\frac{500\ gallons}{year} \times \frac{\$6.00}{gallon} = \frac{\$3,000}{year}$$

3. WASTE GENERATION

✍ Each time a vehicle■s coolant system is flushed, 5 gallons coolant is generated as a waste. The total annual amount of waste generation is:

$$100\ vehicles \times \frac{5\ gallons}{system\ flush} \times \frac{2\ system\ flushes}{vehicle\ per\ year} = \frac{1{,}000\ gallons}{year}$$

4. WASTE DISPOSAL

✍ The used coolant is collected in 55-gallon drums and periodically sent to the DRMO for disposal as a non-regulated waste. The cost for disposal is $50 per ton. The total annual disposal cost is estimated to be:

$$\frac{1{,}000\ gal}{year} \times \frac{8.34\ lbs}{gal} \times \frac{1\ ton}{2{,}000\ lbs} \times \frac{\$50}{ton} = \frac{\$209}{year}$$

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

PART B - POLLUTION PREVENTION OPPORTUNITIES

1. COOLANT RECYCLING.

a. Description. Commercially available coolant recycling units are available that can be used to bring spent coolant back to it original specifications so it can be reused. While different recycling units may use different types of technologies to accomplish this, coolant recycling basically involves removing contaminants (often through filtration) and restoring the coolant's properties with additives. It is important to note that while many coolant recycling units are able to restore commercial grade coolant back to its original specifications, only a few units are effective in restoring coolant to military specifications. Therefore, before purchasing a recycling unit, one must determine whether or not it will be used to service tactical vehicles. A report 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 5 of this section.

b. Potential Waste Reduction. As mentioned above, the motor pool disposes of 1,000 gallons of used coolant each year. A recycling unit will be able to completely eliminate this waste stream 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) waste stream. Typically, the filters must be replaced after processing about 250 gallons of coolant. Since the motor pool uses 1000 gallons of coolant each year, 4 filters per year would be generated (1000 gal/year divided by 250 gallons per filter). Assuming that each used filter weighs 5 lbs, this would amount to a total used generation of 20 lbs/yr.

c. Economic Evaluation.

(1) Implementation Costs. The cost of purchasing and installing a coolant recycling unit is estimated to be about $10,000 including installation labor.

(2) Recurring Costs. Recurring costs will result from having to purchase replacement filters as well as various additives.

Purchasing Filters. At approximately $10 per filter, using 4 filters per year will cost around $40.

Purchasing Additives. Typically, additives account for about 10 percent of the amount of antifreeze in the coolant mixture. Since this motor pool uses 500 gallons of antifreeze each year, the required amount of additives is estimated to be 50 gallons. Assuming that additives cost about as much as pure antifreeze ($6.00 per gallon), the recurring cost for purchasing coolant additives is $300 per year (50 gallons per year x $6.00 per gallon).

(3) Potential Recurring Cost Savings. Annual cost savings from this opportunity include purchasing less antifreeze as well as spending less on used coolant disposal fees.

Purchasing Less Antifreeze. By implementing coolant recycling, the motor pool will no longer have to purchase new antifreeze (only antifreeze additives described above). Since the motor pool uses 500 gallons of antifreeze each year at a cost of $6.00 per gallon, the annual cost savings will be $3,000/yr.

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 $209 (the current disposal cost). Also, because an extra 50 gallons of additives will be included in the coolant each year, it would seem 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.

Total Recurring Cost Savings. The total annual cost savings associated with this alternative is $3,209 ($3,000 + $209).

(4) Payback Period. The payback period is calculated by dividing the implementation cost by the cost savings minus the recurring costs as follows:

$$\frac{\$10,000}{\$3,209 - \$340} = 3.5 \text{ years}$$

(5) Three-Year Payback Period. To achieve a payback period of 3 years or less, the motor pool would have to service a minimum of 116 vehicles rather than 100. This assumes that all other factors remain the same.

2. MATERIAL 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 containers for the used coolant until it can be recycled and placed back into the vehicles. 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. At the sample motor pool, it is assumed that the used coolant will be recycled in batches once every two weeks. Since 1000 gallons are generated each year, amount to be recycled every two weeks is approximately:

$$\frac{1000\ gal}{year} \ x \ \frac{1\ year}{12\ months} \ x \ \frac{1\ month}{2\ batches} = \frac{42\ gal}{batch}$$

Therefore, a single 55 gallon drum should be sufficient to hold the used coolant generated each half-month as well as 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 above ground tanks. One way to make sure that other waste streams 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, rather, the way in which it is disposed of. 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.

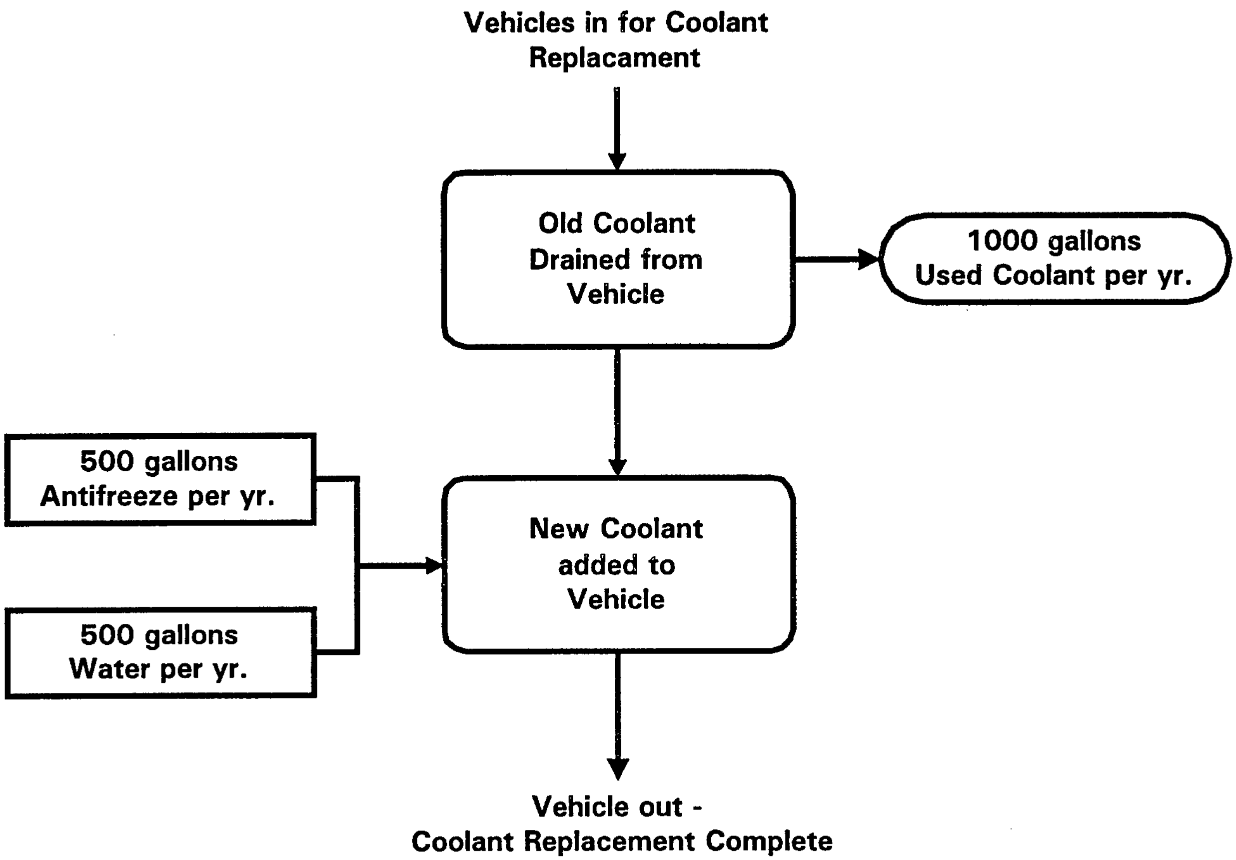
PART C - COOLANT MANAGEMENT SUMMARY CHART

Table 3. Summary of Coolant Management Pollution Prevention Opportunities.

P2 Opportunity	Effect on Waste Disposal		Initial Costs ($)	Recurring Costs ($)	Annual Cost Savings ($)	Payback Period (years)
	Waste Stream	Disposal Reduction				
Coolant Recycling	Used Coolant	4,000 lbs	10,000	340	3,209	3.5
	Used recyc. filters	(20)[1] lbs				
Material Segregation[2]	Used Coolant	0 lbs	0	0	0	NA

Notes: 1. ()'s indicate that this waste stream 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.

PART D - MATERIAL BALANCE CHART



PART E - POINTS OF CONTACT FOR P2 EQUIPMENT

Coolant Recycling Unit Manufacturers

BG Products Inc.
P.O. Box 1282
Wichita, KA 67201
(316) 256-2682

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

Antifreeze Recycling Users Guide

Belvoir Research, Development & Engineering Center
Materials , Fuels, and Lubricants Laboratory
POC: Dwayne Davis
(703) 704-3720 or
DSN 654-3720

SECTION 5

SOLVENT MANAGEMENT

PART A - MOTOR POOL OPERATIONS

1. PRODUCTION.

- The motor pool is responsible for servicing 100 GSA vehicles such as cars, pickup trucks, and vans.
- As a part of routine maintenance, small metal parts must often be cleaned/degreased before they can be worked on and/or placed back into the vehicles. 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 Type I Stoddard Solvent (also known as PD680 solvent) with a flash point of 105°F. These sinks are owned and maintained by an off-site 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:

$$\frac{30\ gal}{tank\ change} \ x\ 2\ tanks\ x\ \frac{1\ change}{2\ weeks}\ x\ \frac{52\ weeks}{year} = \frac{1{,}560\ gal}{year}$$

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

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

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 lbs (1,560 gal x 8.34 lbs/gal x 0.8).

4. WASTE DISPOSAL

- Because the waste solvent has a flash point of less than 140°F, it is considered a hazardous waste and must be manifested as such before the contractor transports it off-post.
- The contractor takes the used solvent to a recycling facility where the solvent is distilled to remove any contaminants. The solvent is then suitable for reuse and is redistributed to its clients.
- Since all used solvent is handled by the contractor, the motor pool does not actually dispose of any solvent wastes.

PART B - POLLUTION PREVENTION OPPORTUNITIES

1. SOLVENT SUBSTITUTION.

a. Description. Most solvent service contractors offer various degreasing solvent formulations to their customers including a Type II Stoddard Solvent. The main difference between the Type II and the TYPE I currently being used is the flashpoint. While the Type I has a flash point equal to 105°F, the Type II has one of 145°F. Because of the higher flash point, the Type II solvent may no longer be considered a hazardous waste once it has been used (unless it had been mixed with something that caused its flash point to drop below 140°F or it contains other hazardous constituents). As a result, used Type II solvent may not have to be manifested before leaving post. Also, because of the higher flash point, it presents less of a hazard to workers and to the environment should any happen to be released. One potential disadvantage is that Type II solvent is a slightly weaker solvent which may require a little extra time for workers to clean heavily soiled parts. In addition to the solvent substitution discussed above, the Mobility Training Command (MTC), located at Fort Belvoir, is investigating various PD680 solvent substitutes. Information on their progress can obtained by contacting the engineering office at DSN 656-6023.

b. Potential Waste Reduction. Although the amount of used solvent generated by the motor pool would be the same regardless of the type of solvent used, by using Type II solvent, the hazardous quality of the waste would be reduced and the waste may no longer be classified as hazardous (depending on the presence of other hazardous constituents). By down-grading the waste from hazardous to non-regulated, the motor pool will have eliminated a hazardous waste stream.

Please note that is it important to examine the MSDS of any Type II Stoddard solvent as well as perform a TCLP analysis to determine how the used solvent should be classified. Although most used Type II Stoddard solvents will have a flash point above 145°F, they may still contain constituents such as trichloroethylene and tetrachloroethylene in concentrations above regulatory levels.

C. Economic Evaluation. 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 Type II Stoddard Solvent. This can usually be done at any point in the contract and should be at no cost to the motor pool or installation.

2. SOLVENT FILTRATION UNITS.

a. Description. The motor pool's solvent service contractor offers optional filter packages that can be added to the 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 been 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 could be reduced by 5,204 lbs (10,408 lbs divided by 2).

c. Economic Evaluation. On other Army installations that have implemented this opportunity, the service contractor has kept the contract price constant; explaining 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, it is estimated that there is no cost or cost savings associated with implementing this alternative. However, the cost of many solvent service contracts is negotiable. Therefore, an installation may be able to negotiate a lower contract price if it changes to parts cleaning units equipped with filters.

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 gets 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 and, therefore, reduce the amount of waste solvent being generated. If the current contract can not be altered in this manner, once it expires, a new contract could 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:

$$\frac{30\ gal}{tank\ change} \times 2\ tanks \times \frac{1\ change}{3\ weeks} \times \frac{52\ weeks}{year} = \frac{1{,}040\ gal}{year}$$

Reducing the annual solvent waste generation from 1,560 gal to 1,040 gal equates to an annual reduction of 520 gal (1,560 gal - 1,040 gal). Assuming the solvent has a specific gravity of 0.8 and water weighs 8.34 lbs/gal, this equates to a reduction of 3,469 lbs per year (520 gal x 8.34 lbs/gal x 0.8).

c. Economic Evaluation.

(1) Implementation Costs. There is no implementation cost associated with this alternative.

(2) Recurring Costs. There are no recurring costs associated with this alternative.

(3) Potential Recurring Cost Savings. Changing the service schedule from once every 2 weeks to once every 3 weeks would reduce the cost of the contract

$$\frac{\$130}{\textit{tank service}} \; x \; 2 \; \textit{tanks} \; x \; \frac{1 \; \textit{service}}{3 \; \textit{weeks}} \; x \; \frac{52 \; \textit{weeks}}{\textit{year}} = \frac{\$4,507}{\textit{year}}$$

to the following amount:

Reducing the annual solvent contract cost from $6,760 to $4,507 equates to an annual reduction of $2,253 ($6,760 - $4,507).

(4) Payback Period. Because this pollution prevention opportunity results in a recurring cost savings with no implementation costs or recurring costs, the payback period is immediate.

(5) Three-Year Payback Period. The payback period is immediate regardless of how many parts cleaning units the motor pool uses. Therefore, there is no 3-year payback period.

4. HOT WATER PARTS WASHING.

a. Description. Hot water parts washers are similar to dishwashers. They use a combination of water and detergent to remove contaminants from parts. 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 PD680 solvents, 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 both solvent parts washing units with hot water washing units, the motor pool could eliminate all 10,408 lbs 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 particulate 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 particulate that gets washed off of the parts settles to the bottom of the washer's tank and can be periodically removed as sludge. The cleaning solution itself is used continuously; and 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 lbs (around [illegible] of a gallon) of sludge per month, the total annual hazardous waste generation from each unit would be 60 lbs/yr (5 lbs/month x 12 months/yr). Therefore, the total from both units combined would be 120 lbs/year. Compared to the 10,408 lbs generated by the solvent washing sinks, this is a significant reduction.

c. Economic Evaluation.

(1) Implementation Costs. Since this motor pool only cleans small parts, it should only require 2 small hot water parts washing units. Small hots water 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 vent that lead 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/hr (including overhead), installation would cost $400 (2 x $25/hr x 8 hours). Therefore, the total implementation cost would be about $6,400.

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

Purchasing Detergent. Assume that detergent costs $20 per gallon and about 1/8 of a 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 gal/yr (1/8 gal x 250/2). Therefore, detergent would cost about $312 per year per unit or $624 per year for both.

Purchasing Rust Inhibitor. Assume that rust inhibitor costs $30 per gallon and about 1/16 of a 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 gal/yr (1/16 gal x 250/2). Therefore, rust inhibitor would cost about $234 per year per unit or about $468 per year for both.

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.

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

(3) 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.

(4) 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:

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

(5) Three-Year Payback Period. The 1.3 year payback period above is based on a one-to-one substitution of hot water parts washers for solvent parts washers. Therefore, if a one-for-one substitution were made for any number of units and all other factors remained the same, the payback period would always be 1.3 years.

5. ON-SITE SOLVENT RECLAMATION.

a. Description. On-site solvent reclamation provides an alternative to relying upon off-site contractors for solvent management. Under the contractor-managed process, used solvent is collected from the parts washing sinks, transported off-site to be recycled into usable solvent, then transported back on-site to be placed in the parts washing sinks. The process for on-site reclamation is identical except that rather than transporting the used solvent off-site, it would be recycled on-site 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 manifested for transport since it remains on-site at all times. Under the contractor-managed solvent process, even though the used solvent is being recycled, it appears as a waste stream in the installation's biennial hazardous waste generation report since it was manifested for off-site transportation. With on-site 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 off-site solvent service contractors do not allow for on-site reclamation, motor pool personnel would have to cancel (or not renew) the off-site 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 on-site (rather than at a contractor's reclamation facility), they would have to be mannifested (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.

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

Solvent. Each solvent sink used by the motor pool holds 30 gallons of solvent. At $6.00 per gallon, it would cost $180 (30 gal x $6.00/gal) to fill one of the sinks. To fill both would, therefore, cost $360.

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 gal 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/hr for labor, installation would cost about $200 ($25 /hr x 8 hr). Therefore, the total cost for the distillation unit is estimated as $17,200.

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 unpackage and position each unit (1 hour for both), installation would cost $25 using a labor cost of $25/hr (including overhead). Therefore, the total cost for the 2 parts washing sinks would be $1,425.

Total Implementation Cost. The total cost to implement this P2 opportunity would be $18,985 ($360 + $17,200 + $1,425).

(2) 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.

Solvent Replacement. Although the used solvent can be recycled and reused, losses will occur due to evaporation and dragout. As a result, new solvent would have to be purchased to replace that which has been lost. Assume that 10% of the solvent is lost during each 2-week solvent service cycle. Since each unit holds 30 gallons, this equates to 3 gallons of lost solvent per unit every 2 weeks. Due to the staggered service schedule (mentioned above), this equates to a total loss of 3 gallons each week. Therefore, during the course of one year, this amounts to a loss of 156 gallons of solvent (3 gallons x 52 weeks/yr). At a cost of $6.00 per gallon, the annual cost of replacement solvent is $936.

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 lbs per distillation (3 gal x 8.34 lbs/gal x 1). Since the distillation unit would be used once per week, this results in an annual still bottom generation of 1,300 lbs (25 lbs x 52 weeks.yr). Assuming it costs $1.00 / lb for the motor pool to dispose of a hazardous waste, still bottom disposal would cost $ 1,300 annualy (1,300 lbs x $1.00.lb).

Servicing Parts Washing Sinks. Assume that it takes one person 15 minutes to transfer the used solvent from a parts washing sink to the distillation unit and another 15 minutes to transfer the cleaned solvent back (for a total of 30 minutes). Assuming a labor cost of $25 per hour (including overhead), performing this operation once per week would cost $650 per year ($25/hr x 30 min/wk x 1 hr/60 min x 52 wk/yr).

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

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 $3,146 ($936 + 1,300 + 650 + 260).

(3) Potential Recurring Cost Savings. The only cost savings associated with implementating this alternative would be no longer having to pay the off-site contractor to maintain the solvent. This would save a total of $6,760 per year.

(4) 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:

$$\frac{\$18,985}{\$6,760 - \$3,146} = 5 \text{ years, } 3 \text{ months}$$

(5) Three-Year Payback Period. To obtain a 3-year payback period, the motor pool would have to have replaced about 4 contractor operated parts washing units with 4 of its own (rather than 2 parts washing units). This assumes that all other factors remain the same (each unit serviced once every 2 weeks, one distillation unit purchased, etc.). Assuming that all other factors remain the same, using 4 parts washing units rather than 2 would imply that the motor pool was servicing twice the current amount of vehicles (200 vehicles rather than 100). Please note that the payback period may also be improved by having several motor pools at an installation share a single solvent distillation unit. Since this motor pool would only use the distillation unit 1 day per week, other maintenance activities could use it during the remaining 4 days. The implementation cost of purchasing and installing the unit could then be divided among the various activities; thereby improving the payback period.

PART C - SOLVENT MANAGEMENT SUMMARY CHART

Table 4. Summary of Solvent Management Pollution Prevention Opportunities.

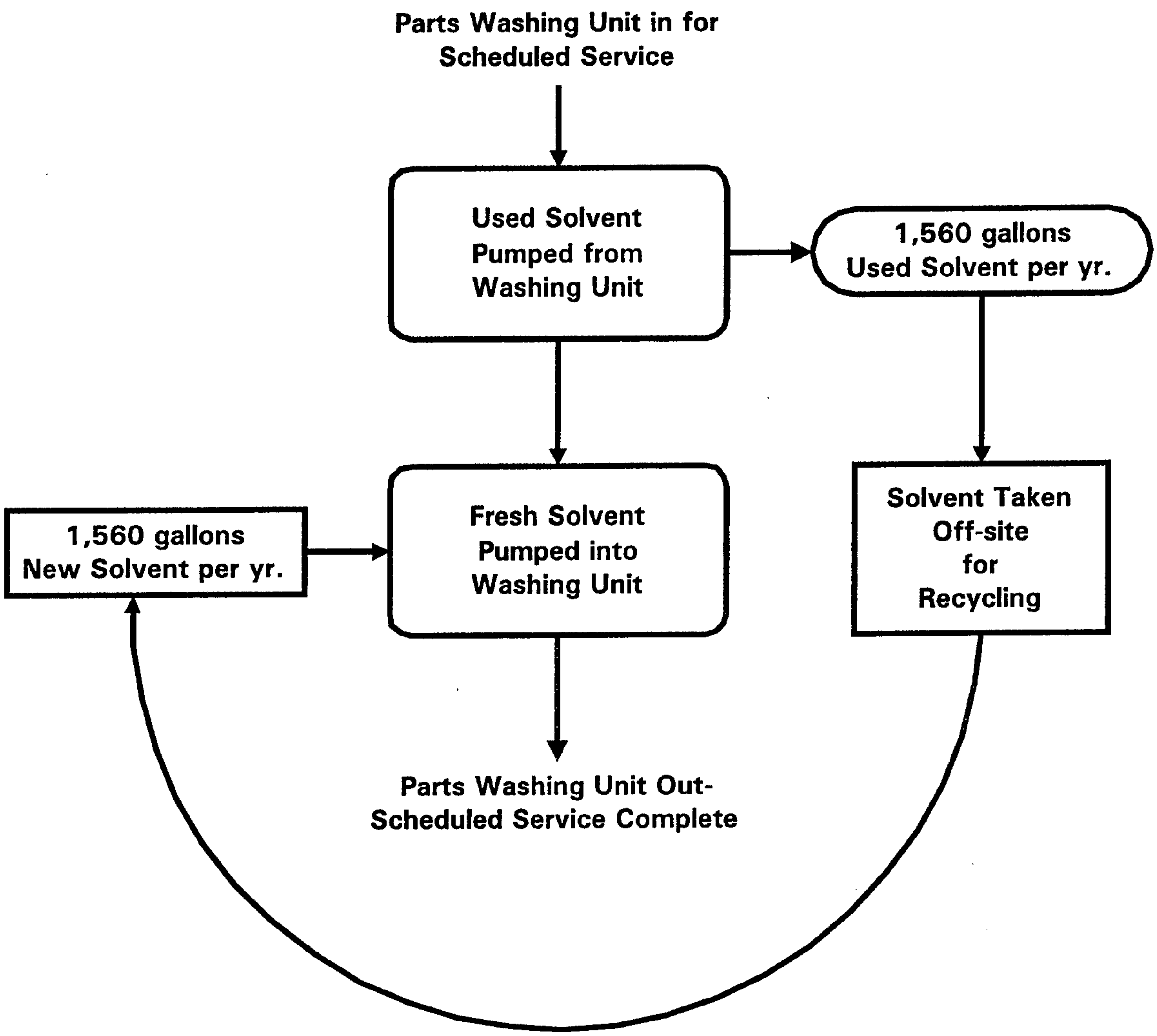
P2 Opportunity	Effect on Waste Disposal		Initial Costs ($)	Recurring Costs ($)	Annual Cost Savings ($)	Payback Period (years)
	Waste Stream	Disposal Reduction				
Solvent Substitution[1]	Spent Solvent	0 lbs	0	0	0	NA
Solvent Filtration	Spent Solvent	780 gal	0	0	0	immediate
Increase Service Interval	Spent Solvent	520 lbs	0	0	4,507	immediate
Hot Water Parts Washing Units	Spent Solvent	10,408 lbs	6,400	1,842	6,760	1.3
	Soil / Sludge	(120)[2] lbs				
On-Site Solvent Reclamation	Spent Solvent	---[3]	18,985	3,146	6,760	5.2
	Still Bottoms	---[3]				

Notes: 1. This is a good management practice that neither reduces a specific amount of waste generation nor cost any money to implement.

2. ()'s indicate that this waste stream will actually be created as a result of implementing the P2 opportunity.

3. Please note that this opportunity changes how these waste streams are recorded as being generated by an installation (rather than changing the amount actually being generated). Off-site reclamation shows the installation generating spent solvent but no still bottoms (still bottoms are generated, but are generated off-site at a contractor's facility). On-site 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.

PART D - MATERIAL BALANCE CHART



PART E - POINTS OF CONTACT FOR P2 EQUIPMENT

Solvent Service Contractors

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

Water-Based Parts Washing Unit Manufacturers

Better Engineering Mfg., Inc.
8361 Town Center Court
Baltimore, MD 21236-4964
(410) 931-0000
(800) 229-3380

American Metal Wash, Inc.
360 Euclid Avenue
P.O. Box 265
Canonsburg, PA 15317
(412) 746-5738

Solvent Distillation Unit Manufacturers

Solvent Recovery Systems, Inc.
24022 Yoakum
Huffman, TX 77336
(713) 324-3254
(800) 367-5773

PBR Industries
143 Cortland Street
Lindenhurst, NY 11757
(800) 842-1630
(516) 226-2930

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

Parts Washing Sink Manufacturers

PBR Industries
143 Cortland Street
Lindenhurst, NY 11757
(800) 842-1630
(516) 226-2930