POLLUTION PREVENTION ALTERNATIVES FOR PUBLIC WORKS CENTER (TRANSPORTATION) WASTE FLUIDS AT NAVAL STATION MAYPORT

by

Southern Research Institute
Birmingham, AL 35255
and
Pacific Environmental Services, Inc.
Mason, OH 45040

EPA Contract No. 68-D2-0062
Work Assignment 1/32, Task 2

PROJECT OFFICER

N. Theresa Hoagland
Sustainable Technology Division
National Risk Management Research Laboratory
Cincinnati, Ohio 45268

NATIONAL RISK MANAGEMENT RESEARCH LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
CINCINNATI, OHIO 45268

CONTACT

Terri Hoagland is the EPA contact for this report. She is presently with the newly organized National Risk Management Research Laboratory's new Sustainable Technology Division in Cincinnati, OH (formerly the Risk Reduction Engineering Laboratory). The National Risk Management Research Laboratory is headquartered in Cincinnati, OH, and is now responsible for research conducted by the Sustainable Technology Division in Cincinnati.

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FOREWORD

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This publication has been produced as part of the Laboratory's strategic long-term research plan. It is published and made available by EPA's Office of Research and Development to assist the user community and to link researchers with their clients.

E. Timothy Oppelt, Director
National Risk Management Research Laboratory

ABSTRACT

This report summarizes the recommended pollution prevention alternatives resulting from an investigation of operations at the Public Works Center - Transportation Division (PWC-T) at Naval Station Mayport, located near Jacksonville Beach, Florida. The PWC-T provides maintenance support for vehicles and other pieces of equipment that are used at the Naval Station.

This report recommends that an oil sampling and by-pass filtration pilot study be initiated on two large pieces of equipment, such as a bulldozer and a road grader. The pilot study is recommended to confirm that the number of motor oil changes, and hence motor oil usage, can be reduced significantly through implementation of an oil sampling program and installation of by-pass filtration units on each piece of equipment. The study also recommends that an antifreeze recycling unit be obtained by the PWC-T to evaluate the merits of recycling the spent radiator fluid and reducing waste generation. Finally, the report recommends that an automatic parts washer be obtained for testing by the PWC-T to replace the four parts washing stations used to manually clean parts with the PD-680 solvent.

This report was submitted in fulfillment of Contract Number 68-D2-00062 by Southern Research Corporation and Pacific Environmental Services, Inc. under the sponsorship of the U.S. Environmental Protection Agency. This report covers a period from 7/27/94 to 9/30/94; work was completed as of 9/30/94.

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Each of these alternatives are recommended because of their potential to reduce pollution as well as the economic advantages and cost savings that they generate. Table 1.1 presents each of the pollution prevention alternatives identified as well as those that are recommended for implementation.

TABLE 1.1: SUMMARY OF POLLUTION PREVENTION ALTERNATIVES FOR THE NAVAL STATION MAYPORT PWC-T

Source of Waste Stream	Alternative Identified	Recommended Alternative	Notes
Motor Oil	Oil Sampling		
	By-pass Filtration	*	Includes oil sampling
	Synthetic Oils		
Hydraulic Fluid	By-pass Filtration		
	Batch Recycling		
Transmission Fluid	By-pass Filtration		
	Batch Recycling		
Antifreeze	Recycling	*	
Parts Washing	Automatic Parts Washer	*	

* Recommended alternative

2.0 INTRODUCTION

Since 1988, EPA's Waste Reduction Evaluations at Federal Sites (WREAFS) Program has identified and promoted pollution prevention opportunities at Federal facilities, including the Department of Defense (DoD) facilities in each of the three services and the U.S. Coast Guard. This project is one of a series of pollution prevention studies conducted under WREAFS. It was funded under the Department of Defense Strategic Environmental Research and Development Program (SERDP).

The purposes of this project were to: 1) develop a PPOA for non-aqueous liquid wastes generated by the Public Works Center - Transportation (PWC-T) at Naval Station Mayport and 2) investigate base-wide rag usage at the Naval Station to determine how and where waste rags are generated. The non-aqueous liquid wastes studied were used motor oil, hydraulic fluid, transmission fluid, antifreeze, and waste solvent from the washing of parts at the PWC-T. This report presents the results of the PPOA for the non-aqueous liquid wastes. The results of the waste rag investigation are reported in a separate report, which is entitled "Investigation of Waste Rag Generation at Naval Station Mayport".

Including the executive summary (Chapter 1) and the introduction (Chapter 2), the report contains six chapters. Chapter 3 describes the different non-aqueous liquids, including solvent for parts cleaning, used at the PWC-T and how they are generated, handled, and disposed. Chapter 4 presents pollution prevention alternatives that could be utilized to reduce the generation of non-aqueous liquid wastes at the PWC-T. The chapter discusses the benefits and problems created by implementation of each alternative. Chapter 5 discusses the economic costs and benefits of selected alternatives presented for PWC-T fluids and parts washing. Finally, Chapter 6 summarizes the pollution prevention alternatives considered and recommends selected alternatives for either implementation or pilot study to confirm the conclusions reached in the report. Chapter 6 also includes the contacts at various companies who have indicated a willingness to work with the PWC-T in implementing the recommended alternatives.

3.0 POLLUTION SOURCES INVESTIGATED

The mission of Naval Station Mayport is to provide support services for U.S. Navy ships and helicopters that operate from the Mayport, Florida Naval facility. A significant portion of the Naval Station's mission is to provide maintenance services for the airborne and sea-going vessels stationed at or visiting Mayport as well as hundreds of pieces of equipment that support the aircraft and ships. Support equipment includes automobile and truck fleets, road and light construction equipment, aircraft ground support equipment, and marine support equipment.

The Transportation Division of the Public Works Center (PWC-T) encompasses a wide range of vehicle maintenance operations at Naval Station Mayport. The PWC-T's mission is to provide maintenance service for the equipment used to support both shore-based operations and the ships which frequent the Naval Station. The PWC-T provides maintenance for a variety of equipment including light and heavy duty trucks, automobiles, buses, bulldozers, road graders, cranes, fork lifts, power generators, overhead hoists, and other heavy equipment used throughout the Naval Station. Currently, the PWC-T supports 671 pieces of equipment which in turn support 12 ships based at Mayport.

3.1 GENERAL DESCRIPTION

Activities that generate waste liquids within the PWC-T are typical of many automobile maintenance and repair shops. These activities involve the periodic replacement of motor oil, hydraulic fluid, transmission fluid, and antifreeze, and the cleaning of parts removed from the vehicle for repair. Most of the activities at the PWC-T generate liquid wastes, with negligible air emissions. Parts washing, however, generates both air emissions and liquid wastes. Air emissions occur when the solvent is sprayed on to the parts placed in the wash tray and when parts are improperly drained of solvent. Liquid wastes are generated as the solvent becomes dirty through repeated use.

3.2 LIQUID WASTE GENERATION, HANDLING, AND DISPOSAL

3.2.1 Liquid Waste Generation

The waste liquids generated at the PWC-T are motor oil, hydraulic fluid, transmission fluid, antifreeze, and waste solvent from parts cleaning. The amount of these non-aqueous liquids handled by the PWC-T is a direct function of the volume of equipment serviced. Purchase records indicate that 2,838 gallons of motor oil, 564 gallons of hydraulic fluid, 206 gallons of transmission fluid, and 441 gallons of antifreeze were purchased by PWC-T in 1993. Approximately 2,640 gallons of PD-680 (a petroleum-based, non-chlorinated solvent) are purchased through Safety Kleen each year to maintain the four parts washing stations located in the PWC-T area. These purchase records can be used to approximate the amount of waste liquids generated at the PWC-T. (Some small amount may be lost due to spills.)

As noted previously, the Mayport PWC-T currently services 671 different pieces of equipment to support approximately 12 ships. Base consolidations over the next several years, however, are anticipated to increase the number of ships that Mayport will be required to support to approximately 33. At a minimum, this is expected to double the number of pieces of equipment PWC-T will be required to maintain and, in turn, to double or at least significantly increase the amount of waste liquid generated at the PWC-T.

The non-aqueous liquid wastes that are generated at the PWC-T are primarily the result of both scheduled and unscheduled maintenance activities. Military specifications require that preventative maintenance be performed at certain, calendar-based intervals to maintain the equipment in good condition. Repairs are also performed on equipment as a result of breakdowns or accidents.

Unlike the generation of the spent motor oil, hydraulic and transmission fluids, and antifreeze, which occurs as these fluids are replaced within the vehicle, waste solvent is generated as the result of cleaning parts from the vehicles. The PWC-T at Mayport utilizes four 55 gallon solvent parts washers to clean various mechanical parts taken from the different pieces of equipment (see Figure 3.1). The parts washers use PD-680, a petroleum-based solvent with ingredients such as Stoddard Solvent and/or mineral spirits. Solvent is normally replaced on a monthly basis by Safety Kleen, with which PWC-T has a service contract.

3.2.2 Handling of Waste Liquids

With the exception of antifreeze and the waste solvent from parts cleaning, the waste liquids that are removed from each piece of equipment are placed in two 400 gallon bowsers located outside the PWC-T maintenance facility. Spent antifreeze is stored in barrels. The waste liquids are hand carried in open top containers to either the bowsers or the disposal barrels by individual personnel after they are removed from a particular piece of equipment.

The solvent washers recirculate PD-680 from the solvent drum to the solvent tray where the parts are cleaned. A hose is used by personnel to direct the solvent on to the part as it is manually washed. The waste solvent is collected is collected in small buckets, which are them emptied into 55-gallon drums located at each of the four parts washing stations. PWC-T personnel do not handle the waste solvent; it is collected by personnel from Safety Kleen.

3.2.3 Disposal of Waste Liquids

Except for the waste solvent from parts cleaning, all of the non-aqueous liquid wastes are collected and sold to an outside contractor for resale as fuel or refinery

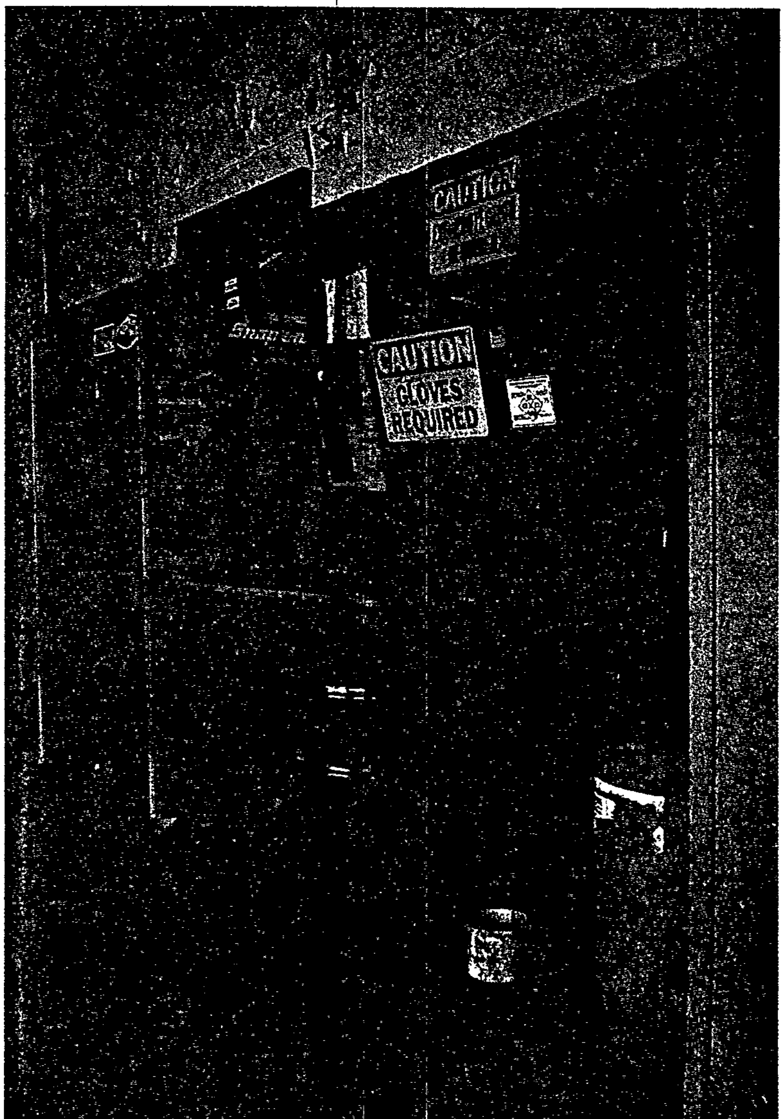

FIGURE 3.1: SAFETY KLEEN PARTS WASHING STATION

feedstock. Used motor oil, hydraulic fluid, and transmission fluid are typically sold for $0.22 per gallon, depending on the purchaser and the amount of water contamination. The Naval Station pays $0.50 per gallon to dispose of waste antifreeze. As noted above, the waste solvent is collected by Safety Kleen. The PWC-T currently pays Safety Kleen $3,300 per year to collect and replace the waste solvent based on four units being serviced each month.

4.0 POLLUTION PREVENTION ALTERNATIVES

This chapter presents pollution prevention alternatives that could be utilized to reduce the generation of non-aqueous liquid wastes at the Naval Station Mayport PWC-T. The chapter discusses the benefits and problems created by implementation of each alternative.

4.1 PUBLIC WORKS CENTER - TRANSPORTATION

During the visit to the PWC-T, the assessment team observed evidence of a concerted effort by staff to reduce waste generation at the facility. Several ongoing practices support a pollution prevention ethic and reduced waste generation. For example, motor oil is dispensed in one quart containers to limit the potential for spills that might otherwise occur from an alternative dispensing system in which open buckets are used to transfer the motor oil. Also, a computerized system is in place to keep an inventory of all fluid materials. This allows for the tracking of usage rates and minimizing the quantity of material in stock. Nonetheless, additional opportunities were identified to make further progress in waste reduction. These alternatives can be classified into three general categories: 1) better operating practices, 2) methods to extend the life of the fluids, and 3) process or product substitutions.

Many operations at the PWC-T can benefit from implementation of better operating practices. Although several of these practices are currently in place, a comprehensive listing is provided below:

- Personnel Practices
    - Utilize good housekeeping methods
    - Provide employee training related to steps to prevent pollution
    - Provide employee incentives to promote pollution prevention

- Procedural Measures
  - Document the receipt and dispensation of fluids
  - Implement strict material handling, storage, tracking, and inventory control procedures
  - Schedule work to minimize the potential for spills
- Loss Prevention Procedures
  - Develop spill prevention procedures
  - Consider pollution prevention in the development of preventative maintenance procedures
  - Develop emergency preparedness plans to define the steps necessary to clean up potential spills

Development of procedures to implement each of these practices should be considered to reduce pollution generated by the PWC-T. For more specific information related to these improved operating practices, refer to the EPA publication Guides to Pollution Prevention: The Automobile Repair Industry (October 1991)[1].

The specific pollution prevention alternatives identified that are the focus of this report are discussed below. These alternatives are specific to the PWC-T operations and for each type of fluid. The alternatives are presented by fluid type.

4.1.1 Motor Oil

The most significant PWC-T non-aqueous liquid waste is used motor oil. This is generated primarily through scheduled preventative maintenance oil changes. The oil changes occur at specific, calendar-based intervals defined by the operating manuals for each piece of equipment. Motor oil is an essential ingredient to provide lubrication for the equipment supported by the PWC-T, eliminating its use is not feasible. The most significant pollution prevention opportunity for motor oil is to extend its useful life. Extending the useful life of motor oil can be accomplished by one of three methods: 1) periodic testing to determine if the oil continues to meet manufacturer and military specifications; 2) improved filtration to extend the oil's useful life; and 3) using a synthetic oil substitute, which has a longer working life.

4.1.1.1 Oil Sampling

Oil sampling is an accepted procedure that has been used for many years by operators of large industrial equipment. This procedure can be used by the PWC-T to extend oil life instead of relying on the normal procedure of changing the oil at the scheduled "rule-of thumb" intervals of 6 months or 6000 miles, for example. By utilizing oil sampling, the oil can remain in the vehicle until it fails to meet the specified qualifications. Once the oil fails to meet these specifications, it must be removed from the vehicle. An example oil analysis report that would be generated by this type of analysis is shown in Figure 4.1.

4.1.1.2 Improved Filtration

Improved filtration can also extend the life of the oil by removing contaminants in the oil that might cause damage to the engine. Extensive field studies have shown that motor oil itself does not wear out, but merely becomes contaminated over time. This is due to inadequate filtration provided by factory installed filters, which ultimately requires that the oil be replaced. Contaminants that foul the oil and cause damage to the engine include particles below 15 microns in size, water, acids, antifreeze (from leakage), and fuel soot.

Two potential alternatives for the removal of these contaminants were investigated: 1) filtering batches of spent fluid that have been drained from the engine due to failure to meet specifications and 2) improving in-line filtration within the engine so that the fluid is filtered continuously.

Based on this investigation, batch processing of the oil after it has been removed from the vehicle is not a viable recycling alternative. This is due to the fact that corrosive acids and other reaction products, which are created at the high combustion temperatures

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3032 09 CRI5 E

DESCRIPTION
MAKE DETROIT MODEL 671
UNIT SERIAL NO.

OIL BRAND SHELL
OIL TYPE ROTELLA-40WT
FUEL TYPE DIESEL

NUMBER COPIES 2
TYPE SERVICE 2+

SAMPLE DATA

LAB#	DATE TAKEN/ TESTED	HRS/MI OIL UNIT
3100	30SEP93	249H
	15OCT93	8815H
14466	17NOV93	455H
	30NOV93	9021

SPECTRO-CHEM OIL ANALYSIS (VALUES EXPRESSED IN PARTS PER MILLION (PPM) BY WEIGHT)

IRON	CHROMIUM	LEAD	COPPER	TIN	ALUMINUM	NICKEL	SILVER	MANGANESE	SILICON	BORON	SODIUM	MAGNESIUM	CALCIUM	BARIUM	PHOSPHORUS	ZINC	MOLYBDENUM	ANTIMONY	VANADIUM	CADMIUM
48	1	19	95	1	1	0	0	1	9	70	7	1053	395	1	1099	1238	0	0		
49	0	11	73	0	1	0	0	1	8	45	10	788	1015	1	1032	1200	0	0		

PHYSICAL PROPERTY DATA

FLASH	FUEL % Vol.	VIS 40°C cSt	VIS 100°C cSt	WATER % Vol.	SOLIDS % Vol.	GLYCOL
410+	<1	N/A	14.8	0	0.2	NEG
410+	<1	N/A	14.8	0	0.3	NEG

ADDITIONAL CUSTOMER TESTS

LAB#	PBN
3100	7.8
14466	7.9

SPECIAL TESTS AND FEEDBACK

LAB# ANALYSIS RECOMMENDATIONS

LAB# ANALYSIS RECOMMENDATIONS

3100 COPPER LEVEL IS HIGH - POSSIBLY FROM THE PRESENCE OF AN ADDITIVE. RECOMMEND RESAMPLE AT NORMAL INTERVAL.

14466 RESULTS OF TESTS PERFORMED INDICATE NO CORRECTIVE ACTION REQUIRED.

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WHEN CORRECTIVE ACTION IS INDICATED, PLEASE ADVISE RESULTS OF YOUR FINDINGS AND CORRECTIVE ACTION TAKEN ON ENCLOSED FORM.

Since services are based on samples and information supplied by others, and since corrective action, if any, is necessarily taken by others, these services are rendered without any warranty or liability of any kind beyond the actual amount paid for the services.

A7-100

FIGURE 4.1: EXAMPLE OIL SAMPLE ANALYSIS

and pressures present in an engine, can not be filtered out of the oil after they have been created using current filtration technology. Once the acids have been formed, the only feasible way to reuse the oil is to re-process it through the separation processes located at a refinery. Furthermore, none of the oil filtration vendors contacted claimed that their filtering units could restore unacceptable oil drained from an engine to its original state and none recommended that a batch processing operation be attempted, even though they could build a device to do so. They recommend further use of the batch-filtered oil be limited to burning as a fuel or selling to a recycling operation. On the other hand, there was consensus among those contacted that prevention of the formation of these compounds is the only way to ensure that they are not present in the oil. Consequently, batch processing of the oil after it is removed from the vehicle is not recommended. In order to maintain the quality of the motor oil within the vehicle, an improved in-engine filtration system is the preferred option. The "by-pass" filtration systems sold and used by many commercial and military fleets were evaluated. A general discussion of this type system is given below.

4.1.1.2.1 By-pass Filtration System. Several by-pass filtration systems have been shown to safely extend the life of motor oils through filtration and supplementation of depleted motor oil additives. These systems have been installed and tested by other military organizations such as Eglin Air Force Base in Fort Walton Beach, Florida and Hickam Air Force Base in Honolulu, Hawaii[2,3]. The State of North Carolina is also considering by-pass filtration to reduce used oil volumes generated by their fleet operations[4]. In addition to lowering the volumes of motor oil needed, implementation of by-pass filtration has been shown to extend engine life and reduce maintenance costs since the engine continuously operates on cleaner oil.

By-pass filtration systems typically require that a by-pass filter be installed on the equipment (e.g., a diesel engine) to allow for slow but effective filtration of the oil (see Figures 4.2 and 4.3). Installation involves creating a loop containing the additional filter for the engine oil to cycle through and clean. Typical installations take a portion of the oil

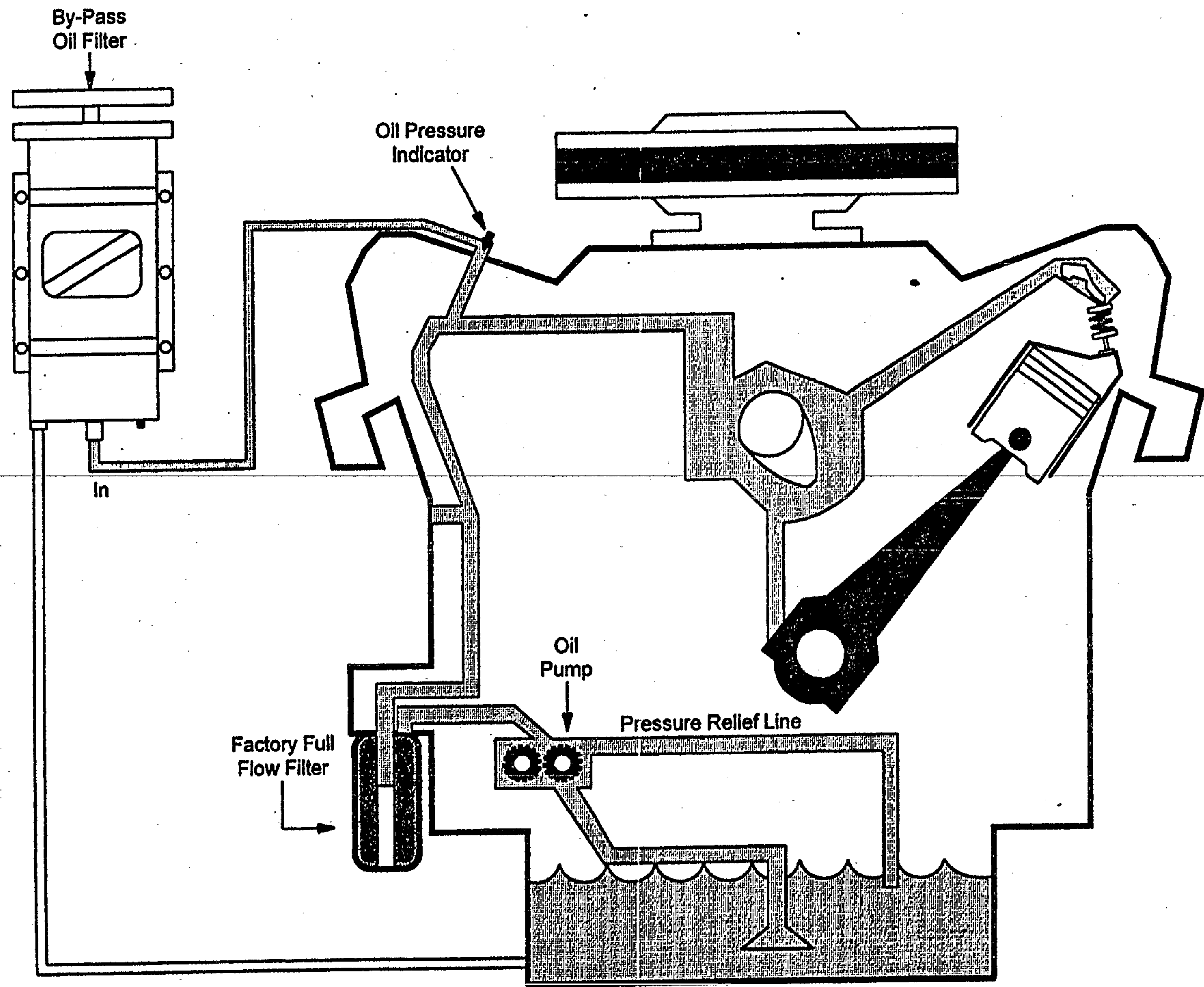


FIGURE 4.2: BY-PASS FILTER INSTALLATION SCHEMATIC

FIGURE 4.3: EXAMPLE BY-PASS FILTRATION INSTALLATIONS

out of the engine at the oil pressure gauge point, direct it through the by-pass filter, and then return it to the engine at the oil pan sump. The by-pass filter is designed to recover smaller size particles, while the existing factory installed "spin-on" filter is left in place to recover larger particles (greater than 15 microns). The by-pass filtration systems require that the oil be sampled to confirm that no metals or contaminants have escaped filtration. The purpose of the oil sampling is to allow the user to customize this schedule over time depending on the results of the analysis program. Vendors recommend that oil sampling initially occur at the same interval that the oil would normally be changed. If sample analyses continue to show clean oil, the sampling interval may be lengthened. Filter elements should also be changed at the same interval as the sampling. By-pass filtration systems have generally led to continued lengthening of the oil change interval and reduced costs. Several examples were identified where the life of the motor oil was safely extended for up to 500,000 miles on commercial trucks. Historical data has shown that adding a new quart of oil each time a filter element is replaced appears to maintain the additives necessary for acceptable oil quality.

The only additional wastes generated by implementation of by-pass filtration are waste filters. In addition to the reduction in waste that will occur as a result of the implementation of by-pass filtration, maintenance costs associated with the engine wear caused by dirty motor oil should be reduced significantly since the engine will now continuously operate on clean motor oil. Specific costs and benefits of by-pass filtration are discussed in detail for each vendor which was identified in Chapter 5.

4.1.1.3 Synthetic Oils

Synthetic oil substitutes exist that may be used to reduce the frequency of oil changes even further. These oils are marketed as superior products to conventional motor oil because they maintain their lubricating characteristics for longer periods of time. Use of a synthetic oil is therefore another option that might be considered in conjunction with oil sampling and by-pass filtration.

4.1.2 Hydraulic Fluid

As with motor oil, hydraulic fluid is essential to the operation of equipment and, therefore, its use cannot be eliminated. Extension of the life of hydraulic fluid through implementation of a fluid sampling program and an enhanced filtration (or recycling) program is, therefore, the only viable pollution prevention option. Once again, the two methods for implementing an enhanced filtration program are by-pass and batch filtration.

4.1.2.1 By-pass Filtration

Implementation of by-pass filtration is effectively identical to that for motor oil. (Refer to Section 4.1.1.1 for a discussion of by-pass filtration.) This technique, in conjunction with fluid sampling, should allow the hydraulic fluid to remain in the system for much longer periods of time.

4.1.2.2 Batch Recycling

Unlike motor oil, batch recycling of hydraulic fluid is feasible because of the lack of a combustion process that produces unfilterable contaminants. In fact, hydraulic fluids are currently being batch filtered by ground support personnel who provide maintenance for the aircraft that fly at the Naval Station. The Navy's military specifications[5] recognize batch recycling as a viable alternative for hydraulic fluid and list Pall Aeropower Corporation (see Figure 4.4) and Hydraulics International, Inc. as the vendors capable of providing the hydraulic fluid filtration equipment. The Pall unit is used at Mayport. Transfer of this technology is, therefore, a logical alternative for the hydraulic fluid used at the PWC-T.

Several options should be considered to evaluate implementation of batch filtering of hydraulic fluid at the PWC-T. They are: 1) purchase a recycling unit strictly for operations at the PWC-T; 2) utilize the filtration equipment already owned by Ground Support Operations; or 3) set up a batch recycling operation for all spent hydraulic fluid at the Naval Station.

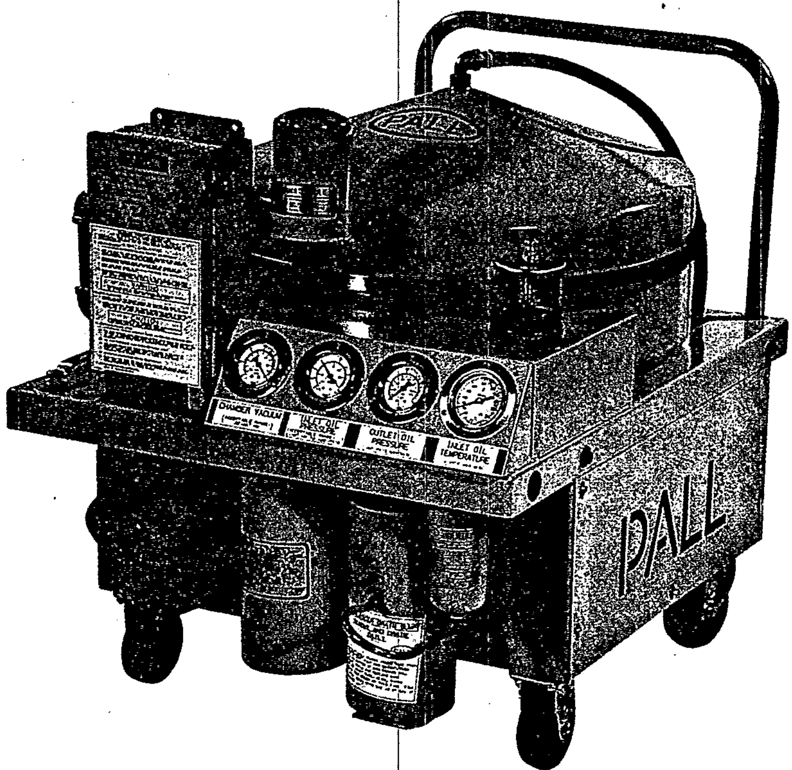


FIGURE 4.4: PLM PORTABLE FLUID PURIFIER

The first option is to purchase a stand-alone unit for recycling of both fluids at the PWC-T. This option would require the unit to be justified based solely on the fluids that are used at the PWC-T. This option would be the simplest to implement but would require that the PWC-T generate a large enough volume of fluids to justify the purchase. This will be difficult since less than 600 gallons of hydraulic fluid are generated each year. The second option would be the least expensive to implement since the PWC-T would utilize equipment that has already been purchased. The only costs would be labor to operate the device and any additional operational costs such as filter element replacement. The final option would be simpler to justify because of the higher volume of fluids that would be processed. The option would require, however, that a central collection and distribution operation be established to administer the recycling center. This could lead to increased administrative and labor costs to transfer, process, and redistribute the fluids.

Costs and benefits of each of the options discussed above are included in Chapter 5, with the exception of establishing a centralized recycling center. Evaluation of this alternative requires investigating and quantifying the volume of fluids that might be available for recycling from other Commands and is beyond the scope of this investigation.

4.1.3 Transmission Fluid

The pollution prevention alternatives for transmission fluid are identical to those discussed above for hydraulic fluids. The major difference between these two fluids is that transmission fluid is replaced much less frequently. Transmission fluid is less subject to contamination and requires change-out less often. Consequently, the volume of waste transmission fluid generated is much lower than for the other non-aqueous fluid wastes generated by the PWC-T. Although the options presented for hydraulic fluids should also be valid for transmission fluids, the cost/benefit analysis found in Chapter 5 reflects the lower volumes of waste transmission fluid generated.

4.1.4 Antifreeze

Pollution prevention alternatives for antifreeze are limited, but effective. Since antifreeze must be used to avoid problems associated with winter freezing and summer boiling of engine coolant, the no-use option is not feasible. Viable substitutes for ethylene glycol are limited and have not been tested adequately to justify their use. Recycling offers the best demonstrated alternative for reducing the amount of spent antifreeze that must be disposed.

Recycling of antifreeze requires that any heavy metals be removed and the non-corrosive properties be restored through the addition of a corrosion inhibitor. Several manufacturers have equipment available to recycle antifreeze. Methods to recycle the fluid include distillation, chemical filtration, and ion-exchange processes. The processes can be accomplished either while the coolant is in the vehicle or after the fluid has been removed from the vehicle (see Figures 4.5 and 4.6). General Motors has bestowed its "Mark of Excellence" on 11 in-shop coolant recycling systems from seven companies in its latest round of tests. (GM system approval means that the recycled coolant meets recognized standards and can be used in GM vehicles serviced under warranty.) A detailed discussion of the each manufacturer's product as well as life-cycle cost analyses are included in Section 5.1.3. Information on another glycol recycler not listed in the General Motors report is also included.

4.1.5 Parts Washing

There are two alternatives to the use of PD-680 as a parts washing solvent at the PWC-T: 1) substitution of a non-petroleum based solvent for PD-680 and 2) purchase of an alternative parts washing system, such as Better Engineering's Jet Washer. A list of possible substitutes for PD-680 usage at the PWC-T is being compiled by the Naval Surface Warfare Center in Annapolis, MD. The Naval Surface Warfare Center is managing a project to identify and make recommendations for alternatives to PD-680 use throughout the Navy. Since a final report is not available at this time, no specific alternatives are listed here. (The Naval Surface Warfare Center expects to forward a copy of the final report

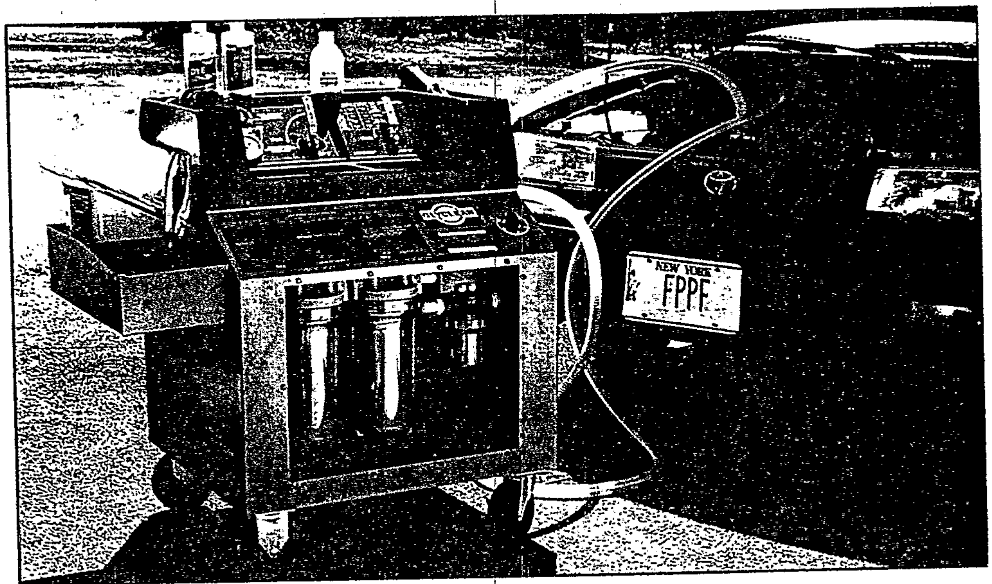


FIGURE 4.5: IN-VEHICLE RECYCLING OF ANTIFREEZE

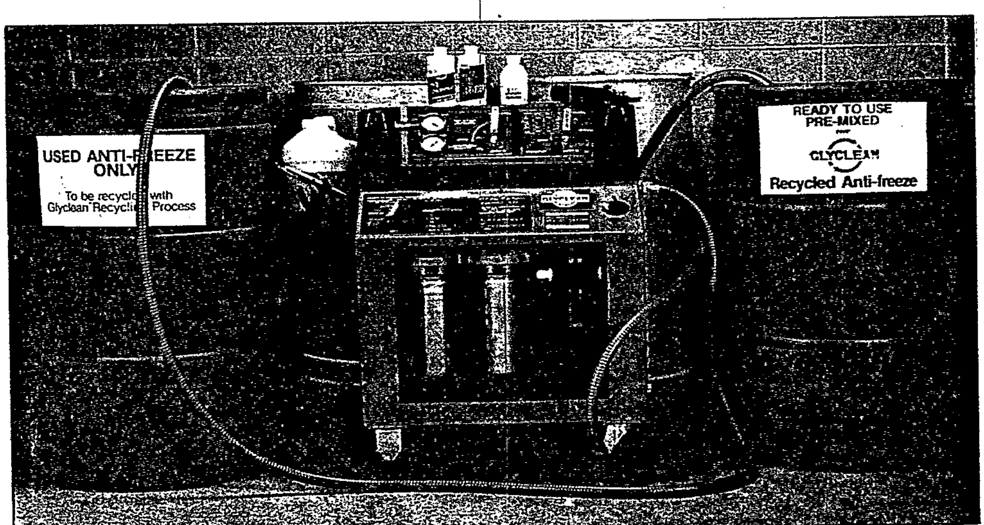


FIGURE 4.6: BATCH RECYCLING OF ANTIFREEZE

to the PWC-T when it is issued.) The second alternative to PD-680 parts washing is based on Navy military specifications that refer to the Better Engineering Jet Washer as an acceptable alternative to solvent-based parts washing. It is discussed below.

4.1.5.1 <u>Better Engineering Jet Washer</u>

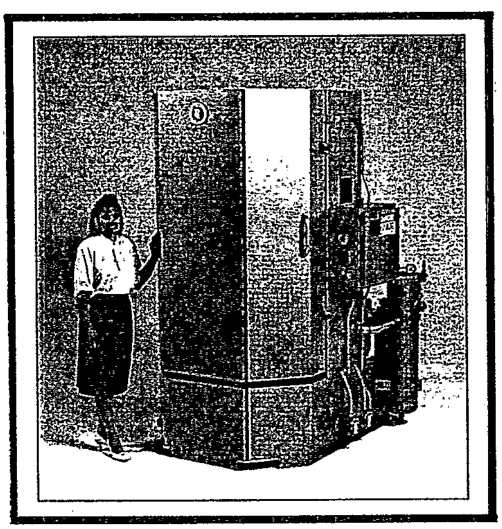
The Better Engineering Jet Washer cleans parts placed on a rotating turntable by blasting a hot (130 °F to 200 °F) biodegradable detergent and water solution at a rate of 50-200 gallons per minute (gpm) on to the parts. After the solution hits the parts, it is filtered and recycled. The force of the spray jets, the heat, and the detergent combine to strip oil, grease, carbon, and other contaminants in 1 to 15 minutes. The operator removes the cleaned parts from the washer; parts usually flash dry immediately.

Installation of a Better Engineering Jet Washer has the following benefits when compared to the current use of PD-680 for parts washing: 1) reduces hazardous waste production; 2) reduces personnel exposure to solvent and fumes; 3) reduces labor costs associated with parts cleaning; and 4) eliminates the Safety Kleen service fees. Figure 4.7 shows the Better Engineering parts washer recommended for the PWC-T.

Better Engineering Jet Washers have been tested in Air Force, Army, and Navy installations nationwide, and are widely accepted. General Motors uses the device to clean fuel injector parts for its engines. Literature identified related to military applications included a memorandum from the Utah National Guard documenting a three week trial of the Better Engineering parts washer at the Surface Maintenance Shop[6]. The demonstration results supported the manufacturer's claims, "and in fact, cleaning performance far exceeded (Maintenance Shop) personnel expectations." During the three week demonstration, the unit was used continuously. Testing of effluents revealed that the gray water phase could be disposed in the sanitary sewer and the oil phase (composed of the oil removed from each part) could be disposed as used oil. Three weeks of nearly continuous operation generated only 250 cc of sediment, which had to be disposed as hazardous waste. Further investigation found that the Navy's military specification specifies " a

M-300LX-P

Inside Working Dimensions:	
Height	60"
Turntable Diameter	37"
Turntable Area	1075 sq. in.
Overall Dimensions:	
(width/depth/height)	57" x 59" x 92"
Tank Size:	
Main Tank	100-gal.
Purifier	25-gal.
Turntable Weight Capacity	1500 lbs.
Standard Power Source	240V, 3 phase
Full Load Amps	65
Pump Motor:	
Type	Vertical
Size	7.5 H.P.
Output	150 GPM / 60 PSI
Heat Source	18 kw
Heat Up Time	1 - 1/2 hr.
Portable	No



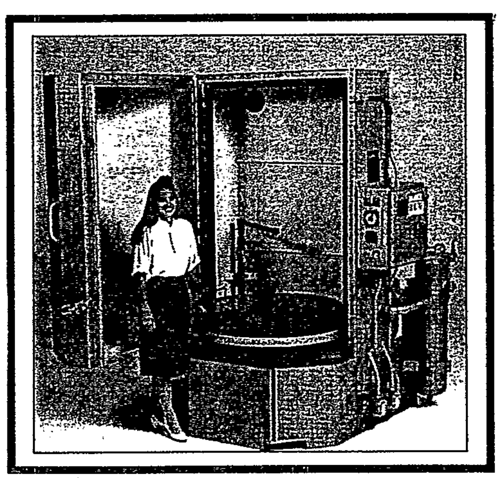


FIGURE 4.7: BETTER ENGINEERING JET WASHER - MODEL M-300X-P

system 'equal to' the Better Engineering Aqueous Parts Washer." Based on these and other comments from users, the Better Engineering system appears to be an excellent alternative to PD-680 parts washing.

4.2 REFERENCES FOR CHAPTER 4

1. Guides to Pollution Prevention: The Automobile Repair Industry. United States Environmental Protection Agency. EPA/625/7-91/013. Office of Research and Development. Washington, DC. October 1991.

2. Telecon between Greg Pagett of Pacific Environmental Services, Inc. and Wayne Fucumoto at Hicham Air Force Base in Honolulu, Hawaii. Discussed the use of by-pass filtration on equipment at the Base. July 13, 1994.

3. Telecon between Greg Pagett of Pacific Environmental Services, Inc. and Rich Richards at Eglin Air Force Base in Fort Walton Beach, Florida. Discussed the use of by-pass filtration on equipment at the Base. July 19, 1994.

4. Telecon between Greg Pagett of Pacific Environmental Services, Inc. and Jim Parker and John Burns at the North Carolina Department of Transportation - Equipment and Inventory Control in Raleigh, North Carolina. Discussed pending antifreeze recycling and by-pass filtration plans for their fleet equipment. July 13, 1994.

5. Telecon between Greg Pagett of Pacific Environmental Services, Inc. and Keith Konop of the Navy Procurement Office in Lakehurst, New Jersey. Discussed the Navy's pollution prevention plans which include purchasing hydraulic purifiers, particle counters (to replace PATCH test), glycol recyclers, parts washers, and plastic media blasters. June 13, 1994.

6. Memorandum from Dr. John L. Crane, Jr., Environmental Resources Manager at the Utah National Guard to Governor Norman H. Bangerter related to a pilot study of the Better Engineering parts washer. May 21, 1992.

7. Various telecons between Greg Pagett of Pacific Environmental Services, Inc. and the following vendors of by-pass filtration equipment: Gulf Coast Filters; Fil-Max; Enviro Filtration; TF Purifiner. Discussions were related to the costs and benefits of implementing by-pass filtration. June - August 1994.

8. Telecons between Greg Pagett of Pacific Environmental Services, Inc. and Morris Johnson of Pall Aeropower related to the Pall Hydraulic purifier currently used by the Navy. June - August 1994.

9. Telecons between Greg Pagett of Pacific Environmental Services, Inc. and Matthew J. Kelly at Better Engineering related to the Better Engineering Jet Washer. June - August 1994.

10. Telecon between Greg Pagett of Pacific Environmental Services, Inc. and Mary Jo Bebrick at the Naval Surface Warfare Center related to the study underway to identify substitutes to PD-680 usage in the Navy. June 21 and August 23, 1994.

5.0 COSTS AND BENEFITS OF POLLUTION PREVENTION ALTERNATIVES

This chapter provides a discussion of the costs and benefits associated with the use of selected pollution prevention alternatives for each waste stream identified in Chapter 4. The base case and associated assumptions with current operations are compared to each pollution prevention alternative. The costs used for each analysis are commercial costs and do not include any discounts that the Navy may be able to negotiate with a particular vendor. This assumption was made since the purchase of equipment for the PWC-T would be made by the contractor that services the equipment and not by the Navy itself. If the Navy elects to purchase the equipment and allow the contractor to use it, capital costs and the resulting paybacks should be much more attractive. For relative analysis purposes, however, the paybacks calculated provide an adequate method of comparing one vendor's product to another.

5.1 PUBLIC WORKS CENTER - TRANSPORTATION

5.1.1 Motor Oil

This section presents the costs and benefits of each of the by-pass filtration systems identified for motor oil. Because of the wide variety of equipment serviced by the PWC-T (and hence the wide variety of annual motor oil usage), two analyses were performed. The first is for a bulldozer, which represents one of the largest motor oil capacities (48 quarts) of any piece of equipment serviced by the PWC-T. The second analysis is for an automobile, which represents one of the smallest oil capacities (4 quarts).

Table 5.1 identifies the assumptions associated with the base case for both the bulldozer and automobile analyses. Both base cases assume an oil cost of $0.69 per quart, used oil revenue of $0.22 per gallon, and labor costs of $14 per hour. Full flow filter costs refer to replacement of the original equipment "spin on" filter, which comes with

TABLE 5.1: MOTOR OIL BY-PASS FILTRATION COST/BENEFIT ANALYSIS: BASE CASE ASSUMPTIONS

Vehicle	Annual Costs					Revenue	Total Costs (Annual Costs - Revenue)
	New Oil	Disposal Costs	Full Flow Filter	Down-Time	Labor	Used Oil	
Bulldozer	$132.48	$2.00	$80	$200	$56	$10.56	$459.92
Automobile	$5.52	$1.00	$10	$20	$28	$0.44	$64.08

Assumptions:

Item	Bulldozer	Automobile
Oil Capacity (quarts)	48	4
No. of oil changes per year	4	2
Cost of new oil ($/quart)	$0.69	$0.69
Revenue from used oil ($/quart)	$0.055	$0.055
Full flow filter ($/filter)	$20	$5
Full flow filter disposal ($/filter)	$0.50	$.50
No. of filters per oil change	1	1
Downtime Cost ($/hour)	50	10
Labor Rate ($/hr)	14	14
Hours to change oil (hr/oil change)	1	1

each piece of equipment. The base case assumptions yield annual costs of $459.92 for each bulldozer and $64.08 for each automobile.

Table 5.2 presents the alternate case assumptions and resultant payback associated with installing by-pass filtration for the bulldozer analysis. The automobile analysis is shown in Table 5.3. The tables identify the assumptions, the first year costs, and continuing annual costs associated with installation of the by-pass filter system. The information is listed alphabetically by vendor.

Several assumptions for each of the alternate cases require further explanation. Labor cost, labor requirements, oil cost, and disposal costs were obtained from PWC-T documents and personnel. Oil analysis costs were estimated from an informal survey taken of various sampling vendors (Conam Inspection; Fram Filters; Filmax Filtration) to yield the $7 per sample cost. The actual cost will depend on the number of samples that are sent to a particular lab.

For the bulldozer analysis, paybacks less than 3 years for each vendor were estimated. (The payback is the time required for savings generated by the alternate case to equal the capital investment.) The single most important factor in generating the quick payback is the cost associated with equipment downtime. The analysis assumes that there is a cost to the PWC-T of $50 for every hour that the bulldozer is out of service. The downtime cost savings makes up about half of the annual savings with by-pass filtration. Even without the downtime assumption, the by-pass filtration system yields paybacks of less than five years. Paybacks of less than five years are usually acceptable for capital investments of this magnitude. Installation of by-pass filtration for the bulldozer example is estimated to lower annual disposal volumes by 75 percent.

For the automobile analysis, the results are not as attractive as for the bulldozer. Paybacks of more than 30 years were calculated based on the assumptions, which can safety be assumed to be greater than the life of the automobile. The paybacks are much

TABLE 5.2: MOTOR OIL BY-PASS FILTRATION COST/BENEFIT ANALYSIS: BULLDOZER ALTERNATE CASE ASSUMPTIONS

Vendor	Annual Costs							Revenue[h] (from used oil)	Total Costs (Costs less revenue)		Payback (yrs)
	Filtration Unit Cost[a]	New Oil[b]	Filter Disposal[c]	Full flow filter[d]	Downtime[e]	Labor[f]	Sampling + New Filters[g]		First Year[i]	Subsequent Annual Costs	
Enviro Filtration	$226	$33.12	$1.50	$20	$50	$14	$116	$2.64	$457.98	$231.98	1.0
Fil-max	$463	$33.12	$1.50	$20	$50	$14	$69	$2.64	$647.98	$184.98	1.7
Gulf Coast	$675	$33.12	$1.50	$20	$50	$14	$22	$2.64	$812.98	$137.98	2.1
TF Purifiner	$845	$33.12	$1.50	$20	$50	$14	$56	$2.64	$1,016.98	$171.98	2.9

[a] Cost of by-pass filtration unit (including a by-pass filter) plus installation
[b] Assumes capacity of 48 quarts, one oil change per year, and new oil cost of $0.69 per quart
[c] Assumes disposal of 2 by-pass and one full flow filter per year at a cost of $0.50 per filter
[d] Assumes one new full flow filter per year at a cost of $20 per filter
[e] Assumes 1 hour of downtime for oil change, one oil change per year, and a downtime cost of $50 per hour
[f] Assumes 1 hour of labor to change the oil, one oil change per year, and a labor cost of $14 per hour
[g] Includes vendor-specific costs for replacement filters and $14 per year for sampling oil based on 2 samples per year at $7 per sample
[h] Based on 48 quarts of used oil per year sold at $0.055 per quart
[i] Includes filtration unit cost

TABLE 5.3: MOTOR OIL BY-PASS FILTRATION COST/BENEFIT ANALYSIS: AUTOMOBILE ALTERNATE CASE ASSUMPTIONS

Vendor	Annual Costs							Revenue[h] (from used oil)	Total Costs (Annual cost less revenue)		Payback (yrs)
	Filtration Unit Cost[a]	New Oil[b]	Filter Disposal[c]	Full flow filter[d]	Down-time[e]	Labor[f]	Sampling + New Filters[g]		First Year[i]	Subsequent Annual Costs	
Enviro Filtration	$168	$2.76	$1.50	$5	$10	$14	$32	$0.22	$233.04	$65.04	-
Fil-max	$463	$2.76	$1.50	$5	$10	$14	$69	$0.22	$565.04	$102.04	-
Gulf Coast	$500	$2.76	$1.50	$5	$10	$14	$16	$0.22	$551.04	$51.04	38
TF Purifiner	$329	$2.76	$1.50	$5	$10	$14	$30	$0.22	$392.04	$63.04	316

[a] Cost of by-pass filtration unit (including a by-pass filter) plus installation
[b] Assumes capacity of 4 quarts, one oil change per year, and new oil cost of $0.69 per quart
[c] Assumes disposal of 2 by-pass and one full flow filter per year at a cost of $0.50 per filter
[d] Assumes one new full flow filter per year at a cost of $5 per filter
[e] Assumes 1 hour of downtime for oil change, one oil change per year, and a downtime cost of $10 per hour
[f] Assumes 1 hour of labor to change the oil, one oil change per year, and a labor cost of $14 per hour
[g] Includes vendor-specific costs for replacement filters and $14 per year for sampling oil based on 2 samples per year at $7 per sample
[h] Based on 4 quarts of used oil per year sold at $0.055 per quart
[i] Includes filtration unit cost

longer for several reasons: 1) the small oil capacity and less frequent changes cause oil savings to be significantly lower; and 2) the downtime assumption is much lower for automobiles since they are not as critical a piece of equipment. Therefore, although the technology exists for automobile by-pass filtration, the economic analysis for installing this on individual vehicles is not attractive.

Because of the significant difference in paybacks calculated for the bulldozer and automobile, it is apparent that by-pass filtration is favorable for equipment with large oil capacities but has diminishing returns for smaller pieces of equipment. In determining which pieces of equipment should be considered for by-pass filtration, three key economic variables should be considered: 1) oil price; 2) quarts of oil used per year; and, 3) downtime costs. To assist in this evaluation, Figures 5.1, 5.2, and 5.3 were prepared to demonstrate the relationship of these three variables to payback. (NOTE: These figures also show hydraulic and transmission fluid curves. See Section 5.1.2.1.)

The figures are plots of payback in years versus quarts of motor oil used per year (i.e, oil capacity times the number of changes). The analysis was based on the costs associated with purchasing and installing the Gulf Coast by-pass filter. The figures can provide "screening analysis" quality results for the range of equipment serviced by the PWC-T. If five years is assumed to be the maximum acceptable payback period, the figures provide a means of determining which devices warrant a detailed calculation to confirm that by-pass filtration is justifiable. The graphs are also useful if a maximum payback of other than five years is desired. To determine the payback of installing by-pass filtration on a specific device, first select the appropriate downtime cost for the device ($10, $25, or $50/hour). Next, determine the volume of oil (quarts) used per year. With these values, an approximate payback can be read from the graphs based on the price of the oil. If the downtime cost is $10 per hour, the graph indicates that about 75 quarts of motor oil per year is the minimum annual volume of oil used to generate a five year payback. This drops to about 60 quarts per year for the $25 per hour case and to 47 quarts for the $50 per hour case.

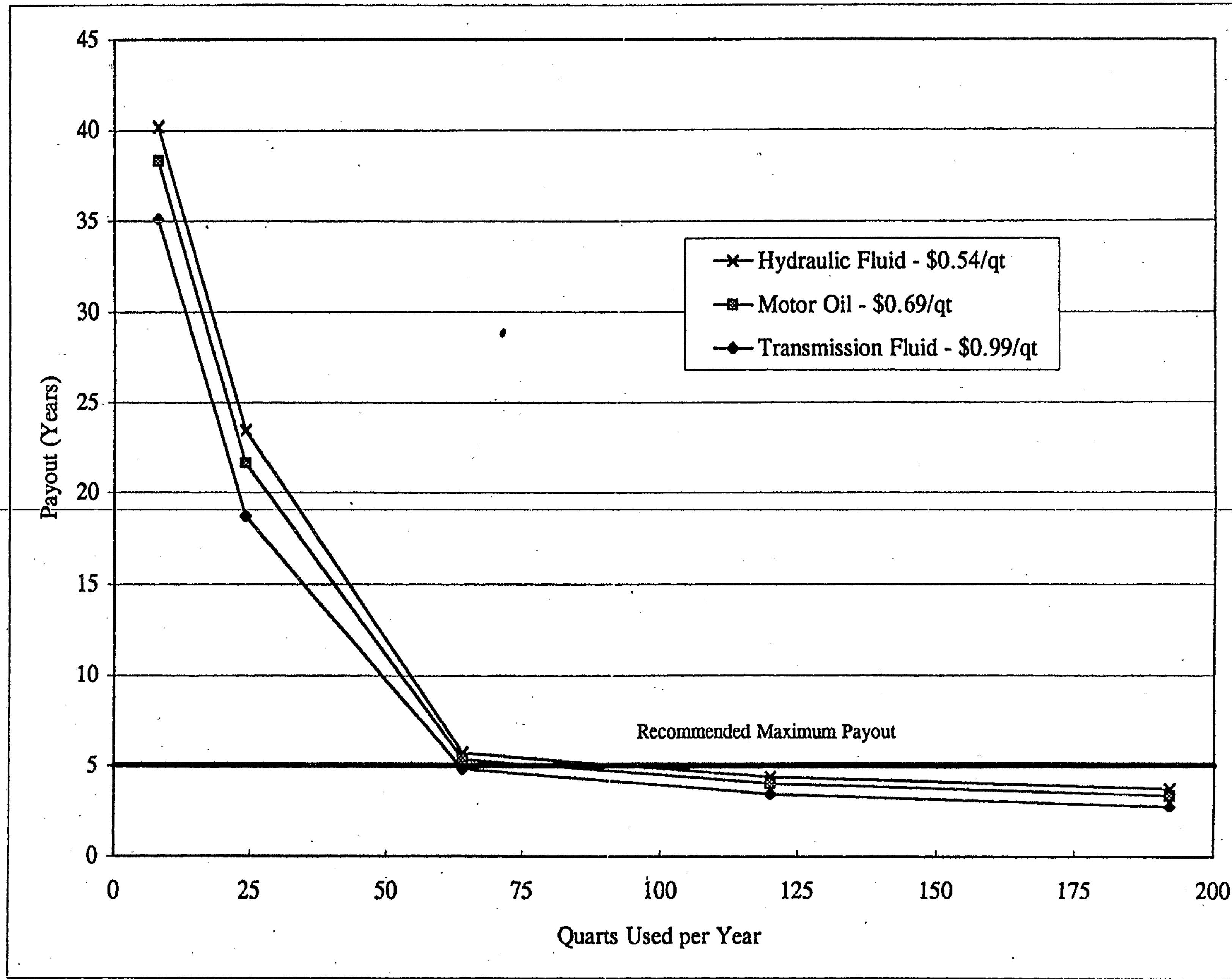


Figure 5.1: Gulf Coast By-Pass Filtration:

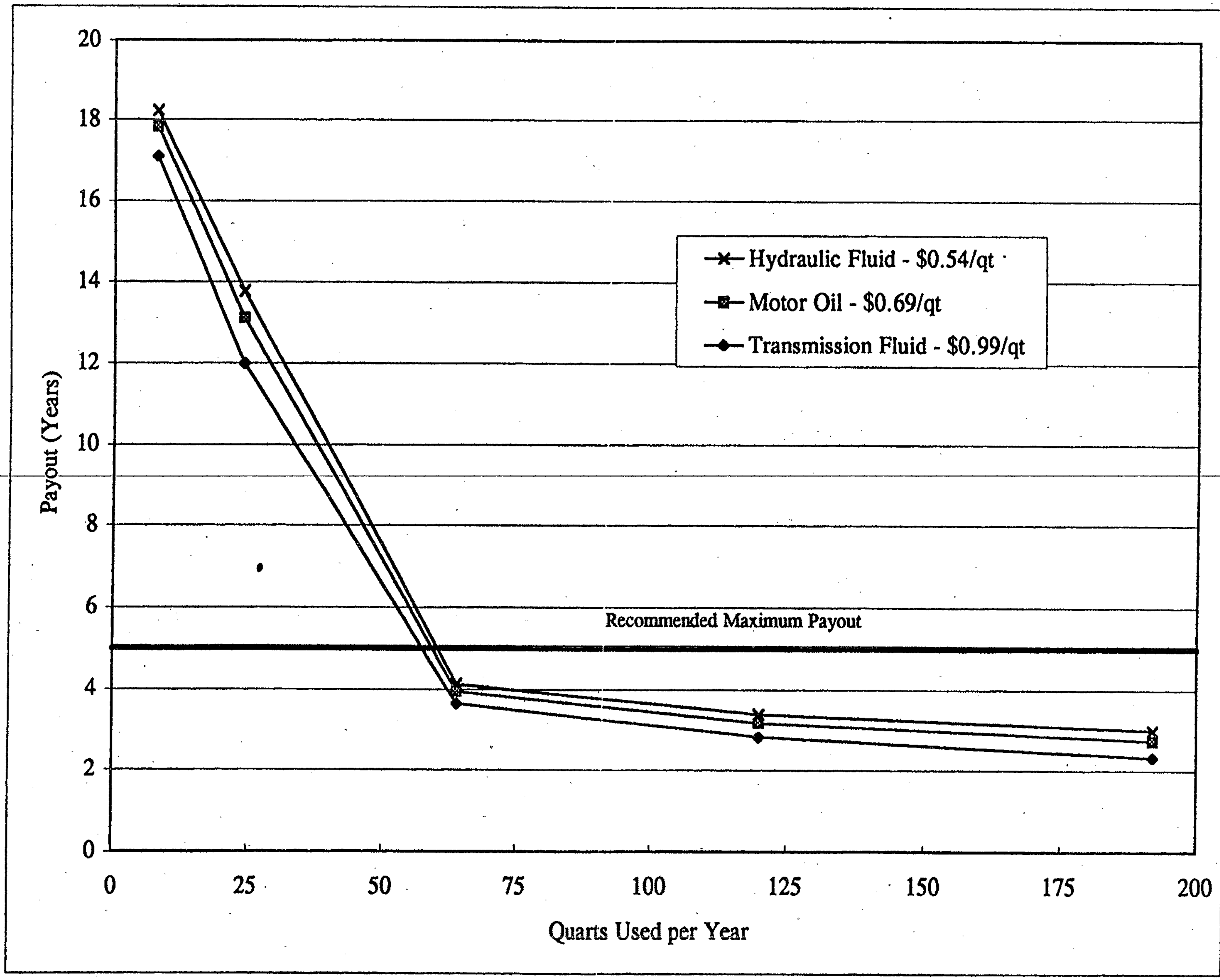


Figure 5.2: Gulf Coast By-Pass Filtration:

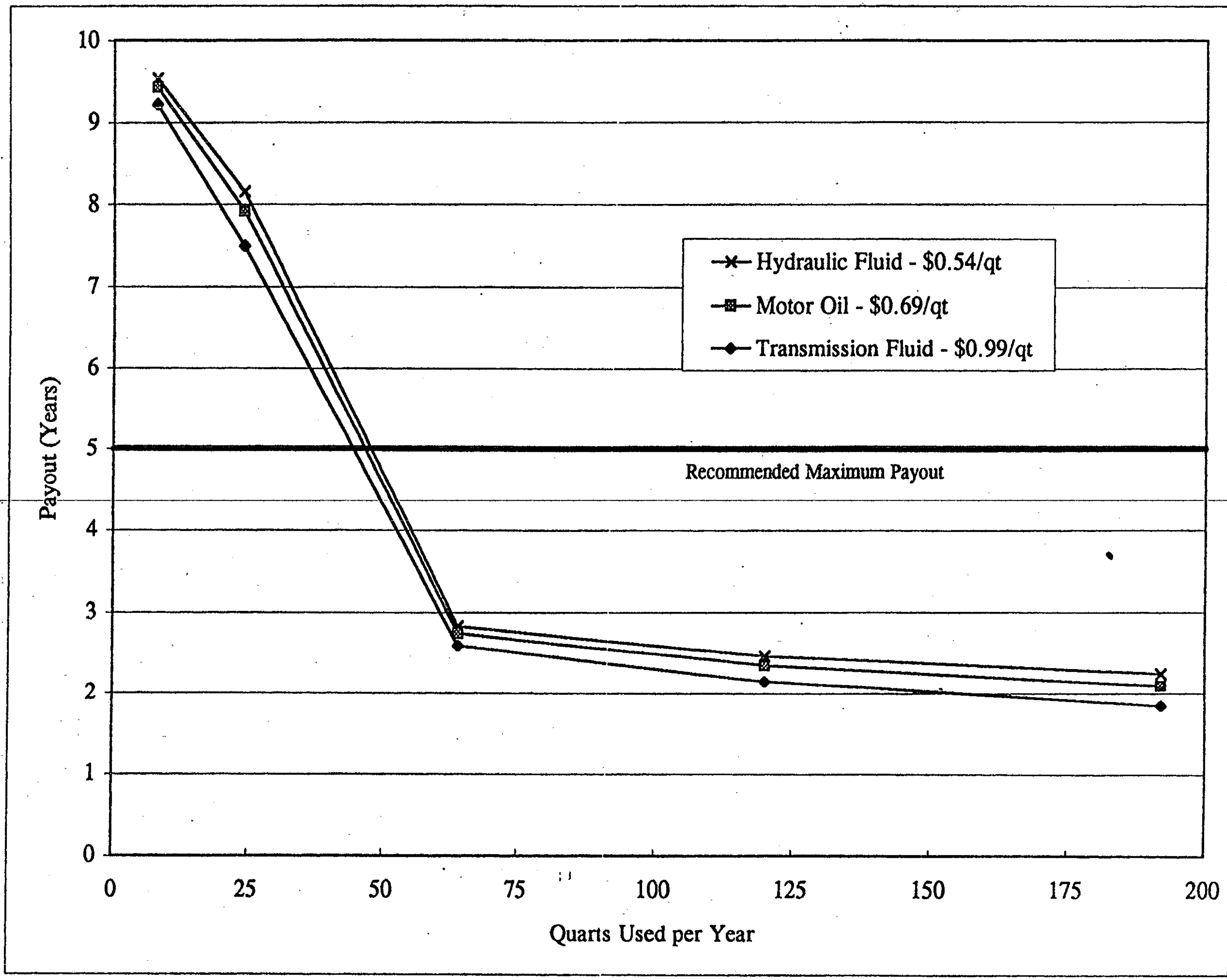


Figure 5.3: Gulf Coast By-Pass Filtration:

5.1.2 Hydraulic And Transmission Fluids

By-pass and batch filtration are the two pollution prevention alternatives recommended for both hydraulic and transmission fluids. The batch filtration analysis is further divided into two options: 1) purchase a recycling unit strictly for operations at the PWC-T; and 2) utilize the filtration equipment already owned by Ground Support Operations. This section presents the costs and benefits associated with by-pass filtration systems as well as the two batch filtration options for both hydraulic and transmission fluids.

5.1.2.1 By-Pass Filtration

The assumptions for by-pass filtration are the same as those for the motor oil analysis, except that hydraulic fluid costs the PWC-T $0.54 per quart and transmission fluid costs $0.99 per quart. This compares with the $0.69 per quart cost for motor oil. Otherwise, assumptions such as used fluid revenue, labor costs, and sampling costs, etc. utilized for the motor oil analysis are identical. As with the motor oil analysis, the larger devices (such as bulldozers) are easier to justify whereas small devices, such as automobiles, are not. Because of the similarities with the motor oil analysis, curves for both $0.54 and $0.99 per quart fluid have been included in Figures 5.1, 5.2, and 5.3 so that approximate paybacks for the installation of hydraulic or transmission fluid by-pass filtration can be determined. Based on the graphs, the minimum annual usage of hydraulic fluid needed for each downtime cost is as follows: $10 per hour - 90 quarts; $25 per hour - 62 quarts; $50 per hour - 50 quarts. For transmission fluid, the minimum requirements are: $10 per hour - 65 quarts; $25 per hour - 58 quarts; $50 per hour - 45 quarts. Based on this analysis, only devices that have large hydraulic or transmission fluid capacities, such as the bulldozer or road grader, appear to be good candidates for by-pass filtration.

5.1.2.2 Batch Recycling

The base case assumptions for batch hydraulic fluid recycling are presented in Table 5.4. Based on the analysis, base case annual costs are approximately $3,874 per year. The assumptions and calculations for the alternate case is presented in Table 5.5.

TABLE 5.4: HYDRAULIC FLUID BATCH RECYCLING COST/BENEFIT ANALYSIS: BASE CASE ASSUMPTIONS

Annual Costs					Annual Revenue	Total Costs
Hydraulic Fluid	Filter Disposal	Full Flow Filter	Down-Time	Labor		
$1,218.24	$20	$200	$2,000	$560	$124.08	$3,874.16

Assumptions:

Item	Value
Hydraulic fluid used per year, gallon	564
Cost of new hydraulic fluid, $/gallon	$2.16
Revenue from used hydraulic fluid, $/gallon	$0.22
Full flow filter, $/filter	$5
Full flow filter disposal, $/filter	$0.50
No. of filters purchased/disposed per year	40
Downtime cost, $/hr	$50
Labor rate, $/hr	$14
Hours to change fluid, hr/year	40

TABLE 5.5: HYDRAULIC FLUID BATCH FILTRATION COST/BENEFIT ANALYSIS: ALTERNATE CASE

Capital Cost	Annual Costs						Revenue	Total Net Annual Costs	Pay-back
	Hydraulic Fluid	Filter Disposal plus sampling	Full Flow Filter	Down-Time	Labor	Annual Operating Costs			
$14,320	$243.65	$40.50	$200	$2,000	$560	$2,229.50	$24.82	$5,249	--

Assumptions:

Item	Value
Pall Unit Cost	$14,320
Hydraulic fluid used per year, gallons	112.8[a]
Cost of new hydraulic fluid, $/gallon	$2.16
Revenue from used hydraulic fluid, $/gallon	$0.22
Full flow filter, $/filter	$5
Full flow filter disposal, $/filter	$0.50
No. of full flow filters per year	40
No. of filtration unit filters per year	13
Sampling, number of times per year	2
Cost per sample	$7
Downtime cost, $/hr	$50
Labor rate, $/hr	$14
Hours to change fluid, hr/year	40
Pall Unit annual operating costs (includes cost of 13 filtration unit filters)	$2,229.50

[a] Represents an 80 percent reduction in the consumption of hydraulic fluid from the base case.

The annual cost for the alternate case is approximately $5,250 per year. The single largest expense in the alternate case costs are annual replacement of 13 filters required by the Pall filter unit. These filters cost over $2,200 to replace. This added cost completely wipes out the savings realized by reducing the volume of hydraulic fluid used. Because of the high maintenance costs associated with the Pall unit, the batch recycling alternative is not attractive. Since the transmission fluid analysis is identical except for the slightly higher fluid price of $0.99 per quart, the result (not shown) is also unattractive.

5.1.3 Antifreeze

Recycling of antifreeze has the most potential for PWC-T to reduce significantly the amount of spent antifreeze that needs to be disposed. There are several manufacturers who have developed readily-acceptable systems to recycle antifreeze.

Table 5.6 is a summary of antifreeze recycling units for which General Motors (GM) has bestowed its Mark of Excellence. Naval Station Mayport currently pays $2.77 per gallon to purchase antifreeze and $0.50 per gallon to dispose the waste, for a total cost of $3.27 per gallon. Comparing the $3.27 current cost to purchase and dispose versus the total operating cost per gallon found in Table 5.6 shows that nine of the eleven units which GM has accepted would result in a savings versus the current practice.

Manufacturers estimate a reduction in fluid disposal volumes of approximately 80 percent. For the PWC-T, that would mean reducing the 441 gallon-per-year volume to about 60 gallons per year.

Note that the costs for recycling are the same regardless of the method use to recycle the fluid (i.e., in-vehicle recycling or batch recycling). Consequently, a separate analysis was not performed. The PWC-T contractor manager indicated that batch recycling would be preferred because of the time required to process the fluids. The contractor manager indicated that maintenance turnaround times on some equipment can be critical, and the antifreeze recycler in the batch mode would, therefore, be preferable.

TABLE 5.6: ENGINE COOLANT RECYCLING EQUIPMENT OVERVIEW

COMPANY:	KLEER-FLO	KLEER-FLO	Wynns	Wynns	Kent Moore-Prestone	ACTIV	ACTIV	Finish Thompson	Finish Thompson	BG Products	Prestone /AFT	FPPF
Model	AF100	AF250	Du-All	Mark X	ProClean	CR2001	CR5001	BE-15	BE-55	Cool'r Clean'r System	Mobile Service	Gly-clean
Process	Chem Pre-treatment Filtration	Ultra Filtration	Chemical Filtration	Chemical Filtration	Chem Pre-treatment Filtration-Ion Exchange	Vacuum Distillation	Vacuum Distillation	Vacuum Distillation	Vacuum Distillation	Ion Exchange	Filtration / Centrifugation	Filtration/ Aeration/ Chemical Inhibition
Process Rate	30 gal/hr	5-7 gal/hr	45 gal/hr	1 Vehicle/90 mins.	45 gal/hr	2 gal/hr	5 gal/hr	1 gal/hr	4 gal/hr	1 vehicle/30 mins. or 120 gal/hr	300 gal/hr	36 gal/hr
Power Requirements	Shop Air	115V, 15 Amp	12 VDC @ 10 Amps	Shop Air	Shop Air	208-240V, 1-Phase	208-240V, 3-Phase	220V, 1-Phase-17 Amps	240V, 3-Phase-40 Amps	110V-10 Amps	None to facility	Shop Air
UL or Equivalent	Not Required	LA-ETL	Not Required	Not Required	Not Required	June '93	June '93	CSA #lr82102-8	CSA-Mar '93	UL-Jan '93	Not Required	Not Required
Maintenance	Pre-filter, 2/480 gal. @ $11.00 ea. Final filter, 1/480 gal. @ $79.00	Pre-filter, 1/100 gal. @ $11.00 Ultrafiltration Membrane, 1/3000 gal @ $679.00	2 Filters/ 45 gal, inc. w/ Chemical additives/ inhibitor kit	2 Filters/ 7 Vehicles $6.67/Filter Included with Chemical Treatment Kit	2 Pleated Filters & 1 Act Carbon/480 gal. @ $90.50/set 1-Ion Exchange Resin Cartridge/2000 gals @ $103.75	1 Pre-filter/64 gal @ $2.23 Post Filter/64 gal @ 11.23 Antifoam-$48.09/960 gals	1 Pre-filter/160 gal @ $2.23. 2 Post Filters/160 gals. @ $22.46/pair Antifoam-$48.09/960 gals	None	None	Filter set with activated carbon core/20 vehicles or 60 gals @ $48.00 Activated carbon/ 150 vehicles or 450 gals. @ $35.00 Resin Regeneration	None	2 filters/ 10 vehicles @ $6.30 each

TABLE 5.6: ENGINE COOLANT RECYCLING EQUIPMENT OVERVIEW

COMPANY:	KLEER-FLO	KLEER-FLO	Wynns	Wynns	Kent Moore-Prestone	ACTIV	ACTIV	Finish Thompson	Finish Thompson	BG Products	Prestone /AFT	FPPF
Inhibitor/ Chemical	Prestone	Dearborn Chemical	Dearborn Chemical-Wynn Oil Co.	Wynn Oil Co.	Prestone	Prestone	Prestone	Prestone	Prestone	Dearborn Chemical	Prestone	FPPF Chemical
Treatment Cost **	$1.89/gal	$.99/gal	$2.38/gal	$5.14/gal	$1.85/gal	$.65/gal Power $ .20/gal	$.65/gal Power $.23/gal	$.75/gal Power $.24/gal	$.75/gal Power $.24/gal	$1.87/gal	NA	$0.85/gal
Hazardous Waste	None	Spent Filters 1-2% coolant concentrate $.11/gal	Spent Filters $.02/gal	Spent Filters $.04/gal	None	Liquid - still bottom Approx. 3% by vol. $.18/gal	Liquid - still bottom Approx. 3% by vol. $.18/gal	Liquid - still bottom Approx. 3% by vol. $.18/gal	Same as BE-15 $.18/gal.	Spent Filters $0.2/gal	None	None
Cost/Gal, Materials	$2.40	$1.33	$2.38	$5.18/gal	$2.09/gal	$1.05/gal	$1.03/gal	$.99/gal	$.99/gal	$3.19/gal	$2.50/gal	$1.48/gal
Equipment Cost	$3,900	$5,695	$2,495	$1,995	$3,555	$7,855	$19,457	$5,058	$13,501	$8,750	NA	$3,700
Payback* (Years)	10.16	6.66	6.36	No Payback	6.83	8.02	19.70	5.03	13.43	248	0	4.69

* Based on $3.27 per gallon current cost

Example calculation: $3900 / [($3.27 - $2.40) per gal savings] * 441 gal/yr = 10.16 year payback

** Assumption: 50/50 - Water/Glycol ratio

NOTES:

These data are based on information as provided by respective equipment manufacturers as of December 1992.
Warranty on all Equipment: 1 Year Parts & Labor
This matrix does not include the cost of labor as a factor, but labor cost differences between systems are expected to be small.
The mobile service (AFT) and approved offsites (currently - PRS) would require no additional labor.

This would allow equipment to be returned to service more quickly, while processing the spent antifreeze at a more convenient time.

5.1.4 Parts Washing

Only one alternative for parts washing at PWC-T has been evaluated, and that is the Better Engineering Jet Washer. The costs and benefits of this alternative are discussed below.

5.1.4.1 Better Engineering Parts Washer

The PWC-T contractor manager indicated that the largest part that required cleaning would be an automobile transmission that is approximately three feet long. Based on this size, the PWC-T would need the Better Engineering Jet Washer Model No. 300LX-P, which has a 37" turntable diameter. The unit retail cost is $17,995. Operating costs are approximately $2.50 for each day for soap and electricity, assuming continuous operation. Based on the Utah study, an 80 percent reduction in labor hours for parts cleaning was realized. Labor costs were assumed to be $14 per hour. Based on typical hazardous waste handling cost, annual costs to dispose of the hazardous waste generated by the unit were assumed to be no more than $500. As seen in Table 5.7, replacement of the PD-680 system with a parts washer yields a payback period of approximately 1.8 years. Sensitivity analysis indicates that a five-year payback is achieved if only 10 minutes per day is saved in labor expenses.

TABLE 5.7: BETTER ENGINEERING PARTS WASHER COST ANALYSIS: BASE AND ALTERNATE CASES

BASE CASE

Safety Kleen Cost[a]	Labor[b]	Total Annual Costs
$3,300	$10,220	$13,520

[a] PWC-T pays Safety Kleen $3300 per year to provide and maintain 4 parts cleaning stations which use the PD-680 solvent
[b] Assumes 2 hours per day cleaning parts manually with PD-680 at a labor cost of $14 per hour, 365 days per year

ALTERNATE CASE

Unit Capital Cost[a]	Annual Costs			Total Costs		Payback (yrs)
	Operating[b]	Disposal[c]	Labor[d]	First Year[e]	Subsequent Annual Costs	
$17,995	$912.50	$500	$2,044	$21,451.50	$3,456.50	1.8

[a] Better Engineering unit cost
[b] Assumes $2.50 per day (for soap and electricity), 365 days per year
[c] Assumes a maximum annual hazardous waste disposal cost of $500
[d] Assumes an 80 percent reduction in labor hours from base case (i.e., from 2 hours per day to 0.4 hours per day), 365 days per year, and a labor cost of $14 per hour
[e] Includes unit cost

6.0 RECOMMENDED POLLUTION PREVENTION ALTERNATIVES

This chapter summarizes the pollution prevention alternatives recommended for implementation at the Naval Station Mayport PWC-T. Chapter 6 also includes recommendations for testing and implementing the preferred pollution prevention alternative which may include establishing a pilot study to confirm the recommendations.

6.1 PUBLIC WORKS CENTER - TRANSPORTATION

6.1.1 Motor Oil

The PWC-T should implement a pilot study to confirm that an oil analysis program coupled with installation of by-pass filtration is effective in reducing pollution as well as generating cost savings for the Naval Station. The pilot study can also be used to determine the correct length of time between oil changes for equipment maintained by the PWC-T. The PWC-T should evaluate several of the by-pass filtration systems commercially available. Because of the large difference in paybacks between large capacity equipment (bulldozer) and small equipment (automobile), the evaluation should begin with the larger equipment, such as the bulldozer and the road grader. It is recommended that by-pass filtration systems be purchased from Gulf Coast Filters and Filmax and installed in conjunction with the oil sampling program. Gulf Coast is recommended because of the excellent responses related to oil quality and filtration system simplicity received from the references contacted. Filmax is recommended because of its low payback. Filmax has also agreed to install and operate the filtration system at no cost to the PWC-T in order to demonstrate the effectiveness of their system. The Gulf Coast contact is Charlie Sims at (601) 832-1663; the Fil-Max contact is Steve Muza at (412) 833-4962.

Because paybacks were calculated in excess of 30 years, installation of by-pass filters on individual automobiles or trucks should be evaluated on a case-by-case basis. Factors that could make by-pass filtration more attractive for automobiles and trucks include: 1) more frequent oil changes than those assumed due to the vehicle's working environment; or 2) higher downtime assumptions for the vehicle. Without changes in the automobile analysis assumptions, by-pass filtration in not recommended for this type of equipment.

6.1.2 Hydraulic And Transmission Fluids

As with motor oil, sampling of both hydraulic and transmission fluids should be implemented as a means of extending the life of these fluids before removing them from the equipment. Batch recycling of used hydraulic and transmission fluids is unrealistic because of the low volumes of fluid generated and the high maintenance costs associated with the batch recycling units. By-pass filtration is viable only if the volume of fluids used for a particular device are high enough. It is recommended that the results of the by-pass filtration pilot study for motor oil be used as the basis for determining if by-pass filtration is appropriate for either hydraulic or transmission fluid systems. These fluids are also good candidates for a base-wide recycling program.

6.1.3 Antifreeze

Antifreeze recycling should be implemented at the PWC-T. It is recommended that the Glyclean model be tested to determine if it meets the needs of the PWC-T and provides the operational flexibility necessary. The Glyclean model is recommended for several reasons: 1) the payback is the most attractive of the eleven models investigated; 2) the model is widely accepted within the automobile repair industry; and 3) a Glyclean system was recently purchased by the Navy Exchange and is now available at Mayport. The unit is located at the auto service station on Massey Avenue. PES recommends that the PWC-T evaluate the unit at the auto service station or obtain another unit from the manufacturer. Mr. Rob Roth at FPPF (makers of the Glyclean Unit) indicated that Mr. Joe Cook (1-912-246-9721) is available to demonstrate the unit for the PWC-T personnel. Mr. Roth also agreed to provide the unit to the PWC-T for up to two weeks to allow adequate time to evaluate the unit before a purchase decision is made.

6.1.4 Parts Washing

A single Better Engineering Jet Washer (or similar unit) should be pilot tested to replace the four PD-680 parts washers currently being used at the PWC-T. Installation of a parts washer will result in a significant drop in the generation of wastes, even though Safety Kleen is currently responsible for this waste. The parts washer will also reduce personnel exposure to solvent and fumes and will payback in less than two years. Mr. Matthew J. Kelly at Better Engineering (1-800-229-3380) has agreed to supply the PWC-T with a small unit at no charge for one month so that the equipment can be tested by the PWC-T personnel to confirm that it will adequately perform the cleaning tasks required.

6.2 Summary

Table 6.1 presents each of the pollution prevention alternatives identified in this report as well as those that are recommended for implementation. The recommendations for implementation were based on the potential of the alternative to reduce pollution as well as the economic advantages and cost savings that are generated. If these recommendations are found to be appropriate through each pilot study and are fully implemented throughout PWC-T, generation of non-aqueous fluid wastes from the PWC-T should be significantly reduced.

TABLE 6.1: SUMMARY OF POLLUTION PREVENTION ALTERNATIVES FOR THE NAVAL STATION MAYPORT PWC-T

Fluid	Alternative Identified	Recommended Alternative	Notes
Motor Oil	Oil Sampling		
	By-pass Filtration	*	Includes oil sampling
	Synthetic Oils		
Hydraulic Fluid	By-pass Filtration		
	Batch Recycling		
Transmission Fluid	By-pass Filtration		
	Batch Recycling		
Antifreeze	Recycling	*	
Parts Washing	Automatic Parts Washer	*	

* Recommended alternative