U.S. Army Center for Health Promotion and Preventive Medicine

WEAPONS CLEANING POLLUTION PREVENTION GUIDE

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SECTION I
INTRODUCTION

1-1. **Purpose**. The purpose of this pollution prevention (P2) guide is to --

a. Identify potential opportunities to reduce pollution generated by routine weapons cleaning maintenance operations at the soldier and unit level.

b. Assist installation environmental personnel in establishing P2 procedures at unit level weapons maintenance operations and the direct support (DS)/general support (GS) level.

c. Provide sample calculations showing waste reduction estimates and economic analyses for each P2 opportunity. These calculations are based on production rates, material usage, waste generation, and disposal fees of a simulated typical weapons cleaning maintenance activity.

d. Serve as a template for similar weapons cleaning operations at company size units as they establish their own P2 programs.

An additional section describing weapons cleaning related activities at DS/GS level maintenance activities is also included as Section III. By replacing the sample numbers with those from an actual facility, the discussion can be customized to provide the commander with valuable management and decision making tools that forecast potential waste reduction and economic estimations. These calculations can then be used for prioritizing goals and assist in decision making for implementing various P2 opportunities.

1-2. **Applicability**. This P2 guide applies to all personnel assigned or attached to or under operational control (OPCON) of an armory detachment and/or field unit during field and contingency operations involving small arms weaponry. This guide does not focus on specific DS/GS level weapons maintenance operations; however, this topic will be covered in a general form in Section III.

1-3. **Scope**. The focus of this P2 guide will be on the *cleaning* aspect of weapons maintenance, as this constitutes the major portion of maintenance at the unit level and is also the most significant activity that generates pollution. Specifically, this guide pertains primarily to the following weaponry: M16A2 rifle and variants such as M16A2/M203 and M4 carbine, M9

Use of trademark and company names does not imply endorsement by the U.S. Army, but is intended only to assist in identification of a specific product.

pistols, M60 and M249 machine guns, and 60mm mortar. The procedures and techniques outlined in this guide can also be applied to the following weapon systems as prescribed by unit armorers:

a. M2, Machine Gun
b. M240, Machine Gun
c. M24, Rifle, sniper
d. M700, Rifle, sniper
e. M500, Shotgun
f. M590, Shotgun
g. M1911A1, Pistol
h. mortar, 81mm
i. mortar, 4.2 inch

This P2 guide addresses the major waste streams generated by routine small arms maintenance operations: used petroleum-based compounds and hazardous chemicals such as greases and oils, parts/surface cleaning solvent, and items contaminated with these chemicals. Most of these wastes will be generated by routine maintenance of any or all of the weapons systems listed above. This guide will also briefly discuss P2 opportunities for solid waste streams such as packaging waste, metal banding, wood, paper, cardboard, and plastic. These waste streams are not so prevalent at weapons maintenance operations at the battalion level or below; however, they may be present during large quantity equipment issue or turn-in, and unit armorers should be prepared to deal with them.

1-4. **Format**. The subsequent sections of this guide will address the main waste streams associated with the different levels of maintenance. Section II is devoted strictly to maintenance at the unit, crew, and operator level. This section heavily focuses on weapons cleaning. Section III describes operations at the DS/GS level of maintenance. This section does NOT focus on the cleaning aspect (except for dip pans and solvent parts washers), since this should be done properly at the unit level, but instead emphasizes the municipal solid waste aspect of weapons maintenance.

Part 1 of each section describes the processes of armory work and weapons maintenance a field unit performs. Also shown here are sample production numbers relating to that section's waste stream. A diagram which shows the materials entering the process, wastes leaving the process, the specific steps of the process, and the initial and final product of the process is also contained in this part. Part 2 of each section discusses potential P2 opportunities designed to reduce the relevant waste stream. For each opportunity, a background discussion on the technologies and methods involved, and potential waste reduction estimates is provided. Each P2 opportunity will be based on one of the following three techniques: product substitution, good management

practices, or alternative technologies.

1-5. **Definitions and Environmental Terms.**

a. Weapons Maintenance. For the purpose of this document, this term will primarily refer to the act of *cleaning* a weapon system using various tools, rags, patches, swabs, and chemicals. Weapons maintenance may also refer to the act of replacing broken parts or generating packaging materials from shipping/receiving of weapons and parts.

b. Pollution Prevention (P2). An effort intended to reduce the quantity, volume, or toxicity of the wastes generated while saving money during the execution of certain processes such as weapons maintenance. Pollution prevention typically involves developing a plan and implementing it as part of the commander's intent. In this plan, major waste streams are identified and various techniques are used to reduce these waste streams. These techniques are generally found in one of the following three forms: product substitution, good management practices, and alternative technologies. No P2 plan will be successful without the diligent efforts and emphasis of the commander.

c. Characterization. The act of identifying what types of chemicals are in a waste stream and determining if these chemicals are in any way hazardous, toxic, poisonous, dangerous, or otherwise regulated by Federal or state governments. Characterization may involve taking samples and is usually done by the installation environmental office. This can be rather expensive, often costing over $1000.00 per sample. Sometimes common sense and general knowledge of the process and chemicals used are enough to characterize a waste stream, or at least reduce the cost of sampling.

d. Waste Stream. A single type of material product that is generated from a specific process that is no longer of use with regards to its intended purpose. A single process may have several waste streams coming off of it. In the case of unit level weapons maintenance, these waste streams would be: patches and swabs contaminated with chemicals, oily rags, and metal pieces from parts replacement or broken tools.

e. Hazardous Material (HM). An HM is any material that, based on either chemical or physical characteristics (e.g., corrosive, explosive, flammable, reactive, toxic), is capable of posing an unreasonable risk to human health or the environment if improperly disposed of, handled, stored, or transported. Any material regulated by potential foreign Host Nation authorities as hazardous is also considered an HM.

f. Hazardous Waste (HW). An HW is any discarded HM (solid, liquid, or gas) that has no further value to the user, cannot be re-used or recycled, or is potentially harmful to human health or the environment because of its quantity, concentration, or biological, chemical, or physical characteristics.

1-6. **Environmental Perspective.**

a. Process Description. The main mission of an armory is to provide secure storage of weapons while ensuring the highest state of readiness for a unit by properly maintaining weapons such as rifles, pistols, machine guns, mortars, and other small arms. The process cycle for weapons maintenance is --

(1) Weapons are received from troops finishing field exercises;

(2) Weapons are then cleaned by the operators under the supervision of unit leaders and the armorer;

(3) Necessary repairs are performed; and

(4) Weapons are stored until they are used again.

Typically, deployable units may execute this process about two times per week. A figure is given in each section to show the steps involved in the process, the materials entering, and wastes generated by this process for maintenance processes at various levels.

b. Waste Generation. Table 1 of Section II shows sample data on wastes generated at a typical arms room for a company-sized unit during a single cleaning process (consisting of three iterations of cleaning, as described later). Table 2 of Section II summarizes the amount of waste generated (qty/yr or lb/yr) by the same unit over the course of one year. Similar waste generation data can be obtained by interviewing soldiers, leaders, and unit armorers from various units. Because of the variability in the amounts of waste generated at the DS/GS levels of maintenance (Section III of this report), no such tables have been provided. Installation environmental personnel should collect their own data and use the tables in Section II as a model to perform useful calculations. Similar waste generation data can be obtained by interviewing soldiers, leaders, and unit armorers from various units.

1-7. **Responsibilities.**

a. Commander.

(1) Maintains overall responsibility for proper management of HM/HW.

(2) Appoints squadron HM/HW managers.

b. Executive Officer.

(1) Ensures that maintenance personnel properly manage HM/HW.

(2) Ensures that sufficient HW collection containers are available.

(3) Coordinates with the support platoon for removal of HW containers.

c. Company Commander/First Sergeant. Ensures that junior leaders and soldiers have a basic understanding of the policies and procedures for proper HM/HW management.

d. Platoon Leaders and Noncommissioned Officers. Ensures commander's intent is followed and enforced.

e. Battalion/Squadron S-4.

(1) Monitors the amount of HM on-hand to ensure that subordinate units are not stockpiling HM.

(2) Procures appropriate containers for collection and disposal of HW.

f. Battalion/Squadron HW Manager.

(1) Coordinates all aspects of HW management, to include HW collection, transportation, storage, and disposal.

(2) Develops site-specific procedures for proper HM/HW management during each field and contingency operation.

(3) Completes appropriate HW turn-in documents.

(4) Ensures that applicable Material Safety Data Sheets (MSDSs) are available for HMs during field and contingency operations.

(5) Conducts daily inspections of HM/HW storage areas.

g. Support Platoon.

(1) Supplies HM down to the company level.

(2) Retrogrades HW from the company to battalion storage area.

(3) Maintains a log of all HW stored in the battalion storage area.

(4) Assists the company HW managers in completing appropriate turn-in documents for HW generated by the company.

(5) Coordinates with the brigade HW manager for turn-in of HW.

h. Soldier.

(1) Becomes familiar with policies and intent of unit environmental standing operating procedures (SOPs) and P2 initiatives.

(2) Implements waste minimization techniques and procedures established by unit leadership.

i. Defense Reutilization and Marketing Office (DRMO). Provides assistance regarding all aspects of HW disposal during field and contingency operations.

j. Directorate of Public Works (DPW) or Directorate of Engineering and Housing (DEH) and/or Environment and Natural Resources.

(1) Provides technical guidance in the areas of HM/HW management and spill response procedures.

(2) Conducts frequent inspections and provides on-the-spot training to units to ensure adherence to installation environmental policies and P2 initiatives.

1-8. **Technical Assistance.** Technical assistance and guidance can be obtained from one of the following U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) activities. Further assistance can be obtained from the offices responsible for sustainment, acquisition, fielding and maintaining the various weapons systems as outlined in Appendix B.

a. CONUS: Commander, USACHPPM, Hazardous and Medical Waste Program, Aberdeen Proving Ground-Edgewood Area, MD 21010-5422, DSN (312) 584-3651, Commercial (410)

671-3651, FAX extension 5237.

b. CONUS: Commander, USACHPPM-West, Environmental Health Engineering Division, U.S. Army Garrison - Aurora, CO 80045-5001, DSN (312) 943-3737, Commercial (303) 361-3737.

c. CONUS: Commander, USACHPPM-North, Environmental Health Engineering Division, Fort George G. Meade, MD 20755-5225, DSN (312) 923-7403, Commercial (301) 677-7403.

d. CONUS: Commander, USACHPPM-South, Environmental Health Engineering Division, Fort McPherson, GA 30330-5000, DSN (312) 367-3332, Commercial (404) 464-3332.

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

f. OCONUS Pacific: Commander, USACHPPM-Pacific, Environmental Health Engineering Division, Unit 45008, APO AP 96338-5008 (Sagami, Japan), DSN (315) 268-4831, Commercial 011-81-3117-68-4831, FAX extension 4367.

1-9. **Distribution**. Local reproduction of this document is authorized and encouraged to maximize dissemination of the information provided.

SECTION II
UNIT AND OPERATOR LEVEL MAINTENANCE

2-1. **Process Description**. A description of typical weapons cleaning at the field or unit level of maintenance is shown in Figure 1. Normally weapons are used for training or combat, where they become "dirty" from soil and from deposits of metals and residue from firing operations. These weapons are then taken apart or disassembled, generally cleaned overall once to remove most of what is making it dirty, then reassembled. This process is generally repeated two more times. This cleaning process generally involves using the following materials: cleaning/ *lubricating/preservative compound (CLP), rags, patches, cotton swabs, and an assortment of* specialized weapons cleaning tools. Other chemical products, such as carburetor cleaner and WD-40, are often used to aid in the cleaning process. Waste products are typically solid in nature and include soiled reusable rags, dirty swabs and patches, and possibly some damaged metal parts. All of these waste products may be contaminated with CLP or other cleaning agents used by the soldier.

As an example, a typical arms room may have the following weapon systems: 100ea. M16A2 Rifles, 19ea. M203/M16A2 Rifle/Grenade Launchers, 18ea. M249 SAW, 6ea. M60 Machine Gun, 2ea. 60mm Mortar, 11ea. M9 pistol, and 24ea. M4 Carbine. These numbers are based on actual counts made at light infantry company-sized arms rooms. Of course these numbers will change with each unit according to its Modified Table of Organization and Equipment (MTO&E).

Tables 1 and 2 of this section show typical waste generation data associated with weapons cleaning processes. The values and parameters of these tables can be altered, and the same calculation techniques shown in this document can be performed on the new values given for a specific instance.

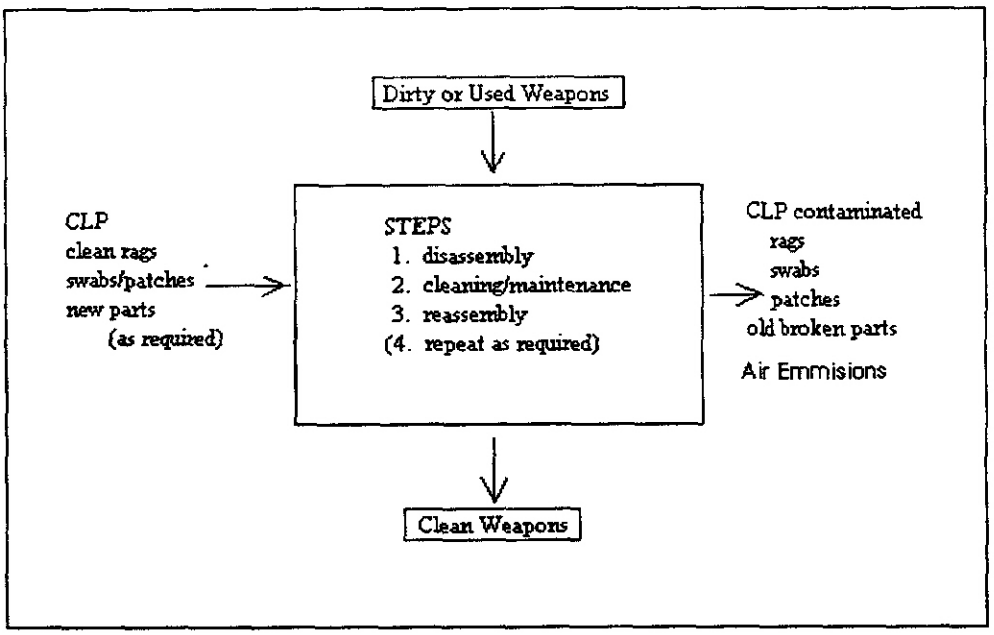

Figure 1. Typical Practices Process Diagram For Unit and Operator Level Maintenance

TABLE 1. TYPICAL WASTES GENERATED DURING EACH CLEANING PROCESS (3 iterations)

Process	Material In	Quantity In	Waste Out	Quantity Out	Disposition
M16A2	patches, 1x1	30 ea.	patches with CLP	30 ea.	trash
	swabs	25 ea.	swabs with CLP	25 ea.	trash
	rag	2 ea.	rag with CLP	2 ea.	trash
	replacement parts	0.5 oz.	broken parts	0.5 oz.	trash
M203/M 16A2	patches, 1x1	30 ea.	patches with CLP	30 ea.	trash
	patches, 2x2	12 ea.	patches with CLP	12 ea.	trash
	swabs	35 ea.	swabs with CLP	35 ea.	trash
	rag	3 ea.	rag with CLP	3 ea.	trash
	replacement parts	0.75 oz.	broken parts	0.75 oz.	trash
M249	patches, 1x1	35 ea.	patches with CLP	35 ea.	trash
	swabs	30 ea.	swabs with CLP	30 ea.	trash
	rag	3 ea.	rag with CLP	3 ea.	trash
	replacement parts	1 oz.	broken parts	1 oz.	trash

M60	patches, 2x2	25 ea.	patches with CLP	25 ea.	trash
	swabs	30 ea.	swabs with CLP	30 ea.	trash
	rag	3 ea.	rag with CLP	3 ea.	trash
	replacement parts	1 oz.	broken parts	1 oz.	trash
60 mm	patches, 2x2	10 ea.	patches with CLP	10 ea.	trash
	swabs	35 ea.	swabs with CLP	35 ea.	trash
	rag	5 ea.	rag with CLP	5 ea.	trash
	replacement parts	1 oz.	broken parts	1 oz.	trash
M9	patches, 2x2	10 ea.	patches with CLP	10 ea.	trash
	swabs	15 ea.	swabs with CLP	15 ea.	trash
	rag	1 ea.	rag with CLP	1 ea.	trash
	replacement parts	0.25 oz.	broken parts	0.25 oz.	trash
M4	patches	30 ea.	patches with CLP	30 ea.	trash
	swabs	25 ea.	swabs with CLP	25 ea.	trash
	rag	2 ea.	rag with CLP	2 ea.	trash
	replacement parts	0.5 oz.	broken parts	0.5 oz.	trash

ASSUMPTIONS:

1a. There are 500 patches (1x1) containing CLP in 1 lb. of waste
1b. A 2x2 patch = four each, 1x1 patches in volume and weight
2. There are 400 swabs containing CLP in 1 lb. of waste
3. There are 8 rags containing CLP in 1 lb. of waste
4. A patch consists of either a 1" x 1" or 2" x 2" square of target cloth
5. A rag consists of a 12" x 12" square of various cloth materials
6. Replacement part weights are for any part which becomes broken; estimates are an average amount of metal that must be replaced on a weapon system whenever maintenance is performed.
7. Weapons are cleaned twice per week, with three iterations conducted per cleaning. Material usage listed in the outline above includes the total amount used for all three iterations.
8. Weapons are used 35 weeks out of a typical year.

KEY CALCULATIONS:

***How many pounds of CLP-contaminated patches are generated by a typical company size unit in one year?**

30 patch,(1x1)/M16A2/clean x 100ea. M16A2 = 3000patch/clean
+ 30 patch,(1x1)/M203-M16A2/clean x 19ea. M203 = 570 patch/clean
+ 4 (1x1/2x2) x 12 patch,(2x2)/M203/clean x 19ea. M203 = 912 patch/clean
+ 35 patch,(1x1)/M249/clean x 18ea. M249 = 630 patch/clean
+ 4 (1x1/2x2) x 25 patch,(2x2)/M60/clean x 6ea. M60 = 600 patch/clean
+ 4 (1x1/2x2) x 10 patch,(2x2)/60mm/clean x 2ea. 60mm = 80 patch/clean
+ 4 (1x1/2x2) x 10 patch,(2x2)/M9/clean x 11ea. M9 = 440 patch/clean
+ 30 patch,(1x1)/M4/clean x 24ea. M4 = 720 patch/clean

6952 patches, 1" x 1" equivalent used during each cleaning process

$$\frac{35\text{ wk}}{\text{yr}} \times \frac{2\text{ cleans}}{\text{wk}} \times \frac{6952\text{ patch}}{\text{clean}} \times \frac{1\text{ lb}}{500\text{ patches}} = \underline{\textbf{973 lb/yr waste patches}}$$

***How many pounds of CLP-contaminated swabs are generated by a typical company size unit in one year?**

25 swab/M16A2/clean x 100ea. M16A2 = 2500swab/clean
+ 35 swab/M203-M16A2/clean x 19ea. M203 = 665 swab/clean
+ 30 swab/M249/clean x 18ea. M249 = 540 swab/clean
+ 30 swab/M60/clean x 6ea. M60 = 180 swab/clean
+ 35 swab/60mm/clean x 2ea. 60mm = 70 swab/clean
+ 15 swab/M9/clean x 11ea. M9 = 165 swab/clean
+ 25 swab/M4/clean x 24ea. M4 = 600 swab/clean

4720 swabs used during each cleaning process

$$\frac{35\text{ wks}}{\text{yr}} \times \frac{2\text{ cleans}}{\text{wk}} \times \frac{4720\text{ swabs}}{\text{clean}} \times \frac{1\text{ lb}}{400\text{ swabs}} = \underline{\textbf{826 lb/yr waste swabs}}$$

***How many CLP-contaminated rags are generated by a typical company size unit in one year?**

2 rags/M16A2/clean x 100ea. M16A2 = 200 rags/clean
+ 3 rags/M203-M16A2/clean x 19ea. M203 = 57 rags/clean
+ 3 rags/M249/clean x 18ea. M249 = 54 rags/clean
+ 3 rags/M60/clean x 6ea. M60 = 18 rags/clean
+ 5 rags/60mm/clean x 2ea. 60mm = 10 rags/clean
+ 1 rags/M9/clean x 11ea. M9 = 11 rags/clean
+ 2 rags/M4/clean x 24ea. M4 = 48 rags/clean
---
398 rags used during each cleaning process

$$\frac{35\text{ wk}}{\text{yr}} \times \frac{2\text{ cleans}}{\text{wk}} \times \frac{398\text{ rags}}{\text{clean}} = \underline{\textbf{27,860 rags/yr}}$$

$$\frac{27{,}860\text{ rags}}{\text{yr}} \times \frac{\text{lb}}{8\text{ rags}} = \underline{\textbf{3482 lb/yr rags containing CLP}}$$

***How many pounds of scrap metal from parts repair and replacement are generated by a typical company size unit in one year?**

0.5 oz. parts/M16A2/clean x 100ea. M16A2 = 50 oz. parts/clean
+ 0.75 oz. parts/M203-M16A2/clean x 19ea. M203 = 14.25 oz. parts/clean
+ 1.0 oz. parts/M249/clean x 18ea. M249 = 18 oz. parts/clean
+ 1.0 oz. parts/M60/clean x 6ea. M60 = 6 oz. parts/clean
+ 1.0 oz. parts/60mm/clean x 2ea. 60mm = 2 oz. parts/clean
+ 0.25 oz. parts/M9/clean x 11ea. M9 = 2.75 oz. parts/clean
+ 0.5 oz. parts/M4/clean x 24ea. M4 = 12 oz. parts/clean
---
105 oz. metal parts produced during each cleaning process

$$\frac{35\text{ wk}}{\text{yr}} \times \frac{2\text{ cleans}}{\text{wk}} \times \frac{105\text{ oz. parts}}{\text{clean}} \times \frac{\text{lb}}{16\text{ oz.}} = \underline{\textbf{459 lb/yr scrap metal parts}}$$

TABLE 2. SUMMARY OF WASTE GENERATED BY TYPICAL UNIT OVER ONE YEAR

Waste Stream	Quantity Generated/yr.
Patches containing CLP	973 lb/yr
Swabs containing CLP	826 lb/yr
Rags containing CLP	27,860 rags/yr or 3482 lb/yr
Scrap Metal Parts	459 lb/yr

2-2. **P2 Initiatives.** P2 initiatives may be implemented using one or more of the following techniques: product substitution, good management practices, and alternative technologies. Below, we have selected eight common waste streams and classified them into two main categories - Solvents/Lubricants (with five main waste streams) and Solid Waste (with three main waste streams).

a. Solvent and Lubricant Management. For most small arms weapons maintenance, a chemical known as CLP should be the only substance applied to a weapon system by an operator

or armorer. Breakfree is the most common commercial brand name for CLP, although some units may find the same substance produced by Royal or Velsicol. By nature of their complex design, most small arms in the Army's inventory require particular care with regards to what chemicals are used in the cleaning process. Many products will tend to degrade the weapons performance and capabilities, either by not performing a required cleaning function or by actually damaging critical components of the weapon system. CLP is the substance of choice for all weapons cleaning performed at the unit level, as discussed in applicable weapons maintenance technical manuals. Presently, CLP must adhere to MIL-L-63460D (Amendment 6, July, 1995). This military specification has been certified as a "perfomance specification" and is therefore commonly refered to as MIL-PRF-63460D(6). CLP is specially designed to perform three essential cleaning processes of unit level weapons maintenance: cleaning as solvent; lubrication by providing a specialized coating such as PTFE or Teflon®[1] in Breakfree, and preservation from minor rust and corrosion. Although Breakfree is by far the most common brand of CLP procured by the Army, Teflon is not required by MIL-PRF-63460D(6), and is not a constituent of CLP's produced by Royal and Velsicol. CLP is specifically designed to accomplish many of the required chemical maintenance processes on the weapons systems. For instance, the M16A2 rifle upper receiver is constructed of a porous metal frame. Frequent cleaning of this frame is required of the operator as many pores become exposed and are easily filled with carbon and brass residue.

Common automotive carburetor cleaner is often improperly used to quickly and effectively remove the carbon and metal residue in the receiver. However, this receiver was specifically designed to be coated by a film of lubricant and preservative to allow the low-tolerance bolt group to operate easily and freely. Carburetor cleaner and other strong solvents destroy and completely remove this lubricant and preservative film thereby allowing a significant increase in the friction between moving metal parts. This increases the wear and tear on the weapons and also heightens the probability of a weapons malfunction during combat or training.

Breakfree is designed to deposit a fine coating of Teflon as it is applied to the metal surface. The porous surface allows for semi-permanent bonding between the metal and Teflon particles. As repeated applications of Breakfree are performed, the Teflon coating builds to an adequate thickness for proper operation of the weapon. Other weapon systems are similarly designed and strict adherence to procedures outlined in the operators manuals is essential. Other CLP compounds are similary designed to deposit a fine layerer of lasting lubricant and preservative.

®Teflon is a registered trademark of E.I. DuPont de Nemours & Co., Inc., Wilmington, DE.

[1] Teflon is not a required constituent of CLP according to MIL-PRF-63460D(6).

Most of the P2 initiatives associated with these solvents and lubricants will be best achieved by using the Good Management Practice technique. An example of product substitution and an alternative technology will also be shown.

A new system for cleaning small arms that is becoming commonplace at many installations is the use of Inland Technologies' Inc. IT-48WC (NSN 4250-01-397-2539) using a compound known as Break through. Research conducted at FT Belvoir's Mobility Technology Center and the U.S. Army Petroleum Center (APC) found:

(a.) Breakthrough to be non-hazardous and bio-degradable,

(b.) 75% reduction in labor associated with weapons cleaning,

(c.) Improved working conditions due to the safety of the solvent, and

(d.) Implementation payback of 0.7 years (1.3 yrs excluding labor)

Further information can be obtained on this opportunity by Referencing FT Belvoir's Mobility Technology Center and the U.S. Army Petroleum Center (APC)'s November 7, 1996 Technical Advisory Message #92.

(1) Bore Solvents - Product Substitution. Before the advent of CLP, weapons cleaning involved a multiple application process of different chemicals. The first step in this old process was to remove all carbon fouling and residue after a weapon had been fired by using any one of a multitude of bore solvents. Examples of some of these products commonly included carburetor cleaner, government issue "Bore Solvent," and bore cleaners readily available on the civilian market. Many of these solvents are hazardous and can be very costly to dispose of, especially if one considers fines for improperly discarded or abandoned waste. These solvents were designed for use in the barrel and cartridge chamber of the weapons system; however, they were commonly used to clean the entire weapon. These solvents are commonly found in unit arms rooms and in soldiers individual cleaning kits. They are still being used on a frequent basis despite the procedures outlined in operators manuals which specify the use of CLP. These substances are sometimes slightly more effective at removing burnt-on carbon than the CLP that is currently in the Army Supply System; however, they are often used improperly.

The cost of improper use of these substances is somewhat intangible, but may include any of the following: a stiff fine by regulators for improper disposal, storage and handling; significantly increased costs for local purchasing of the material; loss of training time and value due to weapons malfunctioning; and even soldiers lives in a combat situation. All unauthorized bore cleaners and solvents found in unit arms rooms should be properly characterized by installation

environmental personnel and turned in for disposal. Special permission should be given, by exception only, by DS/GS level armorers in cooperation with installation environmental personnel if units wish to use such chemicals. Soldiers should be prohibited from purchasing and using these substances on their assigned weapon systems without proper approval.

In summary, only CLP meeting MIL-PRF-63460D should be used by soldiers and unit armorers for weapons maintenance involving simple cleaning. CLP meeting this performance specification is not hazardous (i.e. does not contain constituents that would make this material a waste when it is no longer usable according to the Resource Conservation and Reclamation Act (RCRA) and applicable amendments), and as it will usually be found in the form of residue on a patch, swab or rag, can be discarded in the regular trash, especially if certain precautions are taken. All other CLP should be considered hazardous, unless evidence can show that the waste is not hazardous (according to RCRA).

(2) CLP Stock Inspection - Good Management Practice. Despite the recent elimination of the hazardous constituents of CLP, many units still carry the older, hazardous CLP in their unit inventories. All CLP containers should be inspected to ensure that their date of manufacturing is after December 1993 and is compliant with MIL-PRF-63460D. CLP manufactured prior to this date may contain chemical constituents such as barium sulfonate and trichloroethylene (TCE). These two chemical residues used for cleaning may be HW. Unused material that does not comply with this performance specification should be turned-in through the unit supply system to the DRMO as a precautionary measure to prevent improper use or disposal. CLP manufactured after this date is nonchlorinated, does not contain barium or TCE, and is not hazardous in most areas when disposed.

(3) CLP Minimization - Good Management Practice. Typical weapons maintenance calls for three iterations of the cleaning process to ensure weapons have an ample coating of lubricant and preservative on metal surfaces requiring this substance. Many parts of a weapon require very little, if any, CLP. Soldiers commonly use as much as three times or more the amount of CLP required during weapons cleaning. Proper cleaning an M16A2 rifle only requires one-half ounce or less of CLP. Some ways to minimize the amount of CLP used by a soldier include:

(a) Using hot water to remove dirt and other debris acquired in the field. Soapy water with a good rinse will also be useful in removing the most stubborn of debris. Complete drying or use of rust inhibitors is essential part of using water in the cleaning process. Environmental officers and units should check with local direct and general support offices before implementing cleaning techniques and procedures that use water;

(b) After thoroughly drying the weapon system, only **one** coating of CLP (instead of the

normal three coats) is required to preserve the integrity of the metal components of the equipment from rust and corrosion;

(c) This coating should be very fine. This will prevent the weapon from collecting dust and other debris in the oil, thereby allowing water containing matter to come into contact with the metal surfaces of the weapon; and,

(d) Many parts of Army weapon systems do not require a coating of CLP and may be significantly damaged if CLP is excessively applied.

As an example, CLP should not be applied to the plastic hand-guards, pistol grip, or butt stock of an M16A2, nor should CLP be used in cleaning the gas tube and operating mechanism of any weapon as serious malfunctioning could occur. Minimizing CLP usage in this way will result in a significant reduction in the amount of CLP-contaminated rags generated as well as a reduction in the amount of material used. Unless it is known for sure that a container is of the new, non-hazardous CLP, a generator of CLP-contaminated material must assume that it is hazardous and comply with applicable regulations and installation policies. This can be determined by contacting the installation environmental office which is usually part of the post DPW or Directorate of Environment and Safety.

(4) Solvent Basins - Good Management Practice. Solvent basins should never be used by unit armorers or soldiers for operator, crew, and unit level cleaning of small arms. The technical manuals outlining weapons cleaning at these levels do not authorize their use. If these solvent basins are permitted for use on an exception basis, several practices should be adhered to in order to minimize their impact to the environment. Only non-hazardous or reduced hazard solvents such as PD 680 Type II should be used. Containers should be kept closed at all times. Reusable brushes and gloves should be used and parts should be removed from the solvent slowly to prevent solvent from being carried away from the basin (drag out). Only parts that are compatible with the solvent should be placed into the liquid (for example, plastic hand-guards and pistol grips are not usually compatible with most solvents). Solvent basin cleaning operations in weapons cleaning are generally associated with DS/GS level maintenance, and even there they are not commonly used. Again, solvent basins should not be used at the unit level for weapons cleaning.

(5) Aqueous-Based Parts Jet Washers - An Alternative Technology. For units that require the use of parts washer or solvent basins and have permission to use them, an aqueous (water)-based system is recommended. Aqueous-based washers are small hot-water parts washers that can be used like a dishwasher to clean a number of parts at one time (in automatic mode) or may be used like a solvent sink to manually clean individual parts. The cleaning solution which contains water and detergent is continuously recycled, and it only requires replenishment due to evaporation and/or drag-out. In addition, these units are equipped with

mechanisms that allow the captured oil and dirt to be separated and removed from the cleaning solution. Environmental officers and units should check with local direct and general support offices before implementing cleaning techniques and procedures that use water.

One possible disadvantage to hot-water parts washing units is the potential for corrosion. With petroleum-based solvents (such as Safety-Kleen), oil in the solvent coats the part and protects it from corrosion. When hot water is used (instead of an oil-based solvent), the parts are left almost completely bare, thereby increasing the potential for corrosion. However, this problem can be eliminated through the use of rust inhibiting compounds that can be added to the water and detergent cleaning solution in the washing unit's tank. The addition of a rust inhibiting compound, although recommended, is not required if the weapons are immediately dried and applications of CLP are administered.

(a) Technical Evaluation. Aqueous parts washers should not be implemented until clearance is received from the appropriate Preventive Maintenance or Sustainment Office in Appendix B. Since these units are roughly the same size as the standard parts washing units, they could be placed at any former unit location.

(b) Environmental Evaluation. Because these systems are water-based, the cleaning solution contains neither volatile organic compounds (VOCs) nor hazardous air pollutants (HAPs). Therefore, the cleaning solution does not introduce such compounds into the environment as it evaporates (unlike petroleum-based solvents). In addition, the only wastes these systems generate are oil and solids/sludge (the cleaning solution itself is used continuously). As a general guideline, when initially filling a hot-water parts washer, it requires about 2 gallons of detergent to be placed into the unit's tank (along with the 20 gallons of water). Detergent and water are periodically added to replenish that lost to evaporation and drag-out. About 20% of the water must be replaced each day, and about 2 cups of detergent are added once every 2 days.

Aqueous-based washers are normally equipped with oil/water separators that segregate any oil that has been washed from the parts. Any particulate matter that gets washed off of the parts settles to the bottom of the washer's tank and is periodically removed as sludge. Oil that is collected from the separator may be combined with the other used oil generated by the maintenance facility (although it should be tested at least once to establish a waste profile). The soil/sludge, however, may be disposed of as an HW (depending on the contaminants that get washed off of the parts). If each unit generates 4 lb (about 2 gallon) of sludge per month, the total annual potential HW generation from each washer is about 48 lb.

(c) Economic Evaluation.

1. Implementation Costs. The costs associated with initially implementing this pollution prevention opportunity include purchasing the hot-water parts washing unit and initially filling its tank with the required amount of detergent.

Procurement. Aqueous-based parts washers typically cost about $2500.00.

Detergent. As mentioned above, initially filling the unit's tanks requires 2 gallons of detergent to be mixed with 20 gallons of water. At $20.00 per gallon, the detergent costs $40.00 per jet washer unit.

Total Implementation Costs. The total implementation cost (per unit) is about $2540.00 ($2500.00 + $40.00)

2. Recurring Costs. Recurring costs include the cost of keeping the unit filled with cleaning solution (and rust inhibitor) and potential waste sludge disposal fees.

Cleaning Solution. As mentioned above, about 2 cups (0.03125 gallons) of detergent should be added to the unit every 2 days. Since there are 250 working days in a year, the annual amount of detergent required is about 4 gallons (0.03125 gal x 250/2). At a cost of $20.00 per gallon, the total annual detergent cost is $80.00.

Rust Inhibitor. Assume that 1/8 cup (0.00195 gallons) of rust inhibitor is added to the unit every 2 days. Since there are 250 working days per year, the amount of rust inhibitor required is 0.25 gallons per year (0.00195 x 250/2). At a cost of $30.00 per gallon, the annual recurring cost for purchasing rust inhibitor is about $7.32.

Disposal Fees. If each aqueous-based parts washer generates 48 lb of HW sludge per year and disposal costs $0.50/lb, total annual disposal fees should amount to $24.00.

Total Recurring Costs. The total annual cost associated with maintaining each aqueous-based parts washer is $111.32 ($80.00 + $7.32 + $24.00).

3. Recurring Cost Savings. Recurring cost savings is calculated by determining the difference between the annual cost of operating the old equipment and the annual cost of operating new equipment. This figure is useful for calculating a payback period. Data from various installations shows that operating a 20-gallon Safety-Kleen solvent basin typically costs about $550.00/yr. When compared to the cost to operate a commensurately-sized aqueous-based parts washer at $111.32, this is a savings of $438.68/yr per unit.

4. Payback Period. The payback period is a useful value in that it tells the decision

maker if changing a procedure or the type of equipment they are using will ultimately be economically beneficial. The payback period for replacing a Safety-Kleen parts washer or solvent basin with an aqueous-based parts jet washer is calculated below by dividing the implementation cost of the new equipment by the recurring cost savings.

$$\frac{\$2540.00}{\$438.68/yr} = 5.8 \text{ yr}$$

b. Municipal Solid Waste Management. Typically, weapons cleaning operations generate relatively little municipal solid waste when compared to other day-to-day operations conducted by deployable units, such as operating a mess hall. The largest source of solid waste will be in the form of packaging materials, however, this would only occur on a rare basis. The most common source will be the used cloth materials such as cleaning patches, swabs, and rags containing oily residue from routine weapons cleaning.

(1) Reusable Shop Towels - Good Management Practice. Units using a water wash system and requiring drying procedures or employing larger weapon systems such as machine guns and mortars may find a large requirement for towels. Many installations have contracts with local launderers and towel providers for vehicle maintenance operations that are ready made for units desiring such a program for weapons cleaning operations. Such a program is cost effective and provides an ample supply of towels for cleaning operations. These towels carry away much of the oily residues from the weapon systems that would otherwise find their way into the regular trash stream, but instead are properly disposed of by the contractor. Reusable shop towels should not be laundered by the units in washing machines with standard detergent.

(a) Technical Evaluation. Overall, this initiative would require minimal procedural changes for the unit and would not have adverse effects upon normal operations. Procedural changes that would have to be implemented at the unit include no longer disposing of used rags. Instead, the unit would use dedicated containers to accumulate and store rags for the contractor that would take the old ones away. If no contract for rags recycling is currently in place, one would need to be implemented. Another option is to use the post laundry facility (if one exists).

(b) Environmental Evaluation. By laundering and reusing rags, a typical company-sized unit would decrease used rag disposal by about 3500 lb/yr (as was shown above). For an installation with 75 such units, this would reduce the amount of rags disposed of by as much as 262,000 lb/yr.

(c) Economic Evaluation.

1. Implementation Costs. There would be no implementation costs associated with this P2 initiative. Accumulation containers are normally provided by the contractor, and payment of the contractor is normally done on a per/month or per/year basis.

2. Recurring Costs. Recurring costs associated with rag recycling include the cost of the service contract which typically costs about $0.25/lb rags or less. For an installation that generates 262,000 lb rags/yr this would cost as much as $65,625/yr.

3. Recurring Cost Savings. Recurring cost savings would result from not having to purchase rags on the market and no longer having to pay some municipal waste disposal fees.

Rag purchase. Rags are normally purchased in 50- to 100-lb bundles. A typical price for rags purchased in this fashion is about $0.50/lb. Assuming that a clean rag weighs about half as much (16 new rags per pound) as a dirty or oily one (earlier we assumed 8 soiled rags weigh about 1 lb), this would mean 131,000 lb of new rags would need to be purchased to replace 262,000 lb dirty rags generated and discarded. In this scenario it would cost the installation $65,500/yr to purchase new rags.

Rag disposal. At a disposal rate of $0.10/lb, the disposal of 262,000 lb/yr would cost the installation $26,200/yr.

Total recurring cost savings. Elimination of rag purchase ($65,500) and rag disposal ($26,200) would save the installation about $91,700/yr.

4. Payback Period. Since there are no implementation costs and the cost savings is greater than the recurring costs, the payback period is immediate, saving a typical installation about $26,075/yr ($91,700 - $65,625).

(2) Used Patches, Swabs, and Rags - Good Management Practice. This is probably the only solid waste stream generated by weapons cleaning process at the unit level. The typical maintenance session of three iterations of cleaning of an M16A2 rifle will generate as much as 30 used patches (1"x 1"), 25 Q-tip type cotton swabs, and 2 rags about 12 inches square. As was shown above, a typical unit will generate almost a ton of this residue in a year (973 lb patches/yr + 826 lb swabs/yr = 1800 lb/yr). Assuming this waste will contain a great deal of CLP, perhaps as much as 50% of its weight, some of the CLP will evaporate and become air emission. The current MIL SPEC (MIL-PRF-63460D) does not allow the use of ozone-depleting substances in CLP; however, there are still some volatile constituents in CLP that are currently being produced. Breakfree, a popular manufacturer of CLP, contains about 11.5% VOC mineral spirits which is 50% exempted from reporting for air regulations. For management decision making purposes, we can assume that about all of this VOC will become air emission. For a unit that generates 1800 lb of used swabs and patches per year, 900 lb of this will be CLP, 11.5% of

which (about 104 lb) will volatilize. For an installation of about 75 company-sized units that will perform these weapons cleaning procedures, this equates to about 7,760 lb of VOC emitted every year. As a good management practice, patches and swabs contaminated with CLP should be securely wrapped and bagged in air-tight plastic bags or containers, and treated as a combustable material. This will significantly reduce the amount of air emissions released to the environment. Great care should be taken that hazardous solvents and old CLP (manufactured before December 1993) are not used in the cleaning process and placed into the regular trash, as this could result in a heavy fine by the state or Federal EPA.

(3) Replaced Weapons Parts - Good Management Practice. A unit armorer will often replace metal parts on weapon systems. These parts, along with broken weapons cleaning tools such as brushes and cleaning rods, should not be placed in the regular trash stream for many reasons. These parts are often made of high quality steel that can be recycled; parts recovered from trash dumpsters have caused the Army bad press in the past; and the weight of metal in the regular trash significantly impacts the cost of trash removal by the installation. A typical company may generate as much as 459 lb of scrap metal per year from weapons maintenance. For an installation of 75 company-sized units performing weapons maintenance, this will equate to about 17 tons of scrap metal - just from replacing broken, damaged, and worn parts. This material may cost as much as $0.10/lb for trash removal versus up to $0.25/lb paid by recyclers. Steel is one of the last, highly profitable items that can be recycled.

SECTION III
DIRECT AND GENERAL SUPPORT LEVEL MAINTENANCE

3-1. **Process Description**. This section of the guide is designed to stand alone; however, it will be very helpful to refer to Section II to understand what happens with weapons cleaning prior to weapons arriving at this level of maintenance. Figure 2 describes a typical weapons cleaning process at the direct support (DS) and general support (GS) level of maintenance. Normally, weapons are brought to this level of maintenance when specialized repairs are required that cannot be performed at the unit level. Most DS/GS shops do not allow weapons turned in for repair to be dirty in any way. However, these shops occasionally conduct cleaning operations. Sometimes this involves the detailed techniques described in Section II of this P2 guide, but more often cleaning at the DS/GS level is done with a dip in the solvent tank. The steps used to conduct DS/GS level maintenance are --

a. Weapon is disassembled;

b. Weapon is inspected and cleaned, as required;

c. Weapon is repaired; and

d. Weapon is reassembled.

The cleaning portion of this process is generally not repeated, as it was for operator and unit level maintenance. The cleaning process involves the use of the following materials: cleaner/lubricant/preservative (CLP), rags, patches, cotton swabs, and an assortment of specialized weapons cleaning tools. Other chemical products, such as carburetor cleaner and WD-40, are sometimes used at the DS/GS level of maintenance. Since the armorers at this level are very qualified, there are normally no procedural issues associated with using these materials. Installation environmental personnel should be aware of any unusual substances being used by DS/GS level armorers and examine each of the chemicals individually to determine the types of waste generated. Waste products from the process occurring at this level of maintenance are typically solid in nature and include soiled rags, dirty swabs and patches, and damaged metal parts. All of these waste products may be contaminated with CLP or other cleaning agents used by the armorers.

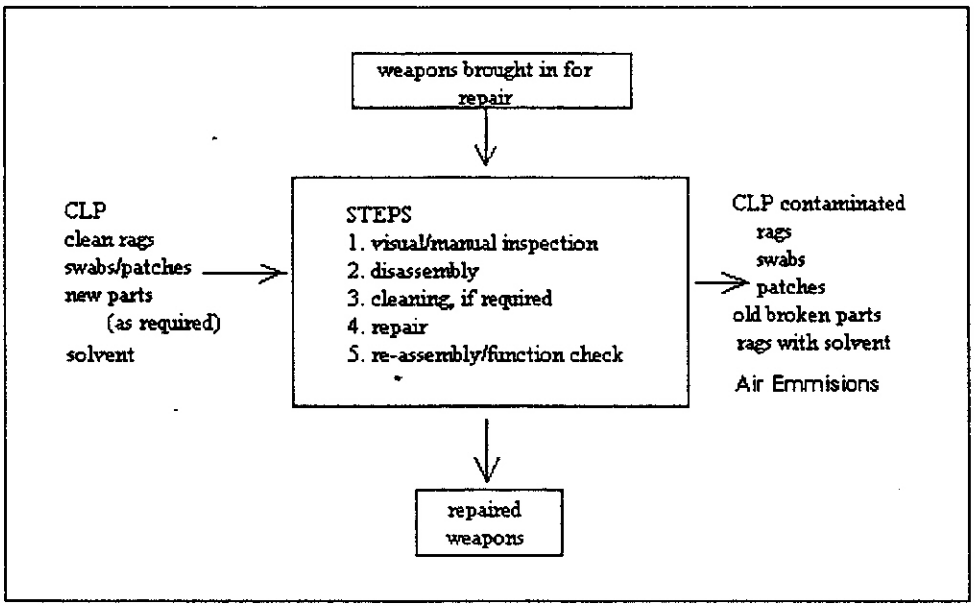

Figure 2. Typical Practices Process Diagram For DS/GS Level Maintenance

We shall assume a DS or GS level type of operation for an installation will be required to process and repair the following quantities of weapons *per day*: 10ea. M16A2, 2ea. M16A2/M203, 2ea. M249, and 2ea. M60. Of course these quantities will vary depending on the type of units on the installation and the nature of their mission and training. These numbers will, however, be useful as an example to assist an installation environmental officer in performing his own calculations. The numbers are based on interviews with personnel who have worked at such facilities.

3-2. **P2 Initiatives**. P2 initiatives may be implemented using one or more of the following techniques: product substitution, good management practices, and alternative technologies. Below, we have selected seven common waste streams and classified them into two main categories - Solvents/Lubricants (with four main waste streams) and Solid Waste (with three main waste streams).

a. Solvent and Lubricant Management. For most small arms weapons maintenance, a chemical known as CLP should be the only substance applied to a weapon system by an operator or armorer. Breakfree is the most common commercial brand name for CLP, although some units may find the same substance produced by Royal or Velsicol. By nature of their complex design, most small arms in the Army's inventory require particular care with regards to what chemicals are used in the cleaning process. Many products will tend to degrade the weapons performance and capabilities, either by not performing a required cleaning function or by actually damaging critical components of the weapon system. CLP is the substance of choice for all weapons cleaning performed at the unit level, as discussed in applicable weapons maintenance technical manuals. Currently, CLP must adhere to MIL-PRF-63460D. CLP is specially designed to perform three essential cleaning processes of unit level weapons maintenance: cleaning as solvent, lubrication by providing a fine coating on metal surfaces, and protecting from minor rust and corrosion. CLP is specifically designed to accomplish many of the required chemical maintenance processes on the weapons systems. For instance, the M16A2 rifle upper receiver is constructed of a porous metal frame. Frequent cleaning of this frame is required of the operator as many pores become exposed and are easily filled with carbon and brass residue.

Common automotive carburetor cleaner is often used to quickly and effectively remove the carbon and metal residue in the receiver. However, this receiver was specifically designed to be coated by a film of lubricant and preservative to allow the low-tolerance bolt group to operate easily and free. Carburetor cleaner destroys and completely removes this lubricant and preservative film thereby allowing a significant increase in the probability of a weapons malfunction during combat or training.

Breakfree is designed to deposit a fine coating of this required Teflon as it is applied to the metal surface. The porous surface allows for semi-permanent bonding between the metal and

Teflon particles. As repeated applications of Breakfree are performed, the Teflon coating builds to an adequate thickness for proper operation of the weapon. Other weapon systems are similarly designed and strict adherence to procedures outlined in the operators manuals is essential. Other CLP's deposit fine coatings of lubricant and preservative in a manner similar to that of Breakfree.

Most of the P2 initiatives associated with this solvents and lubricant will be best approached by using the Good Management Practice technique. An example of product substitution and an alternative technology will also be shown.

(1) CLP, Grease, and Bore Solvent Management. Chemicals in this category will be maintained and used at the DS/GS level of maintenance; however, their use will be very infrequent and random when compared to use of these chemicals at the unit level. This is mainly because the primary function of DS/GS level weapons maintenance is not one of *cleaning weapons*, but rather one of repair. When waste is generated from processes using these chemicals or items becoming contaminated with them, reference should be made to section II of this P2 guide which outlines procedures and techniques useful in managing these substances.

(2) Parts Washers - Alternative Technologies. Several DS/GS activities find the use of parts washers an effective means of quickly cleaning weapons when they are brought in for major repairs, especially when large quantities are involved. These solvent-based parts washing units remove dirt, oil, and grease from various types of small parts. Units are usually self-contained stations consisting of a solvent reservoir and a sink. Maintenance personnel wash parts in the sink section while a pump continuously recirculates the solvent from the reservoir. The solvent is usually a petroleum-based, PD 680 Type II solvent with a flashpoint of about 150° Fahrenheit. Eventually, the solvent in each unit becomes laden with contaminants and has to be changed. A DS/GS maintenance operation normally has one or more of these washers that are part of an installation-wide program where the washers are maintained by a contractor. Typically, such a setup is owned and solvent changed out by a contractor such as Safety-Kleen. The contractor is responsible for replacing the solvent in each unit according to a predetermined service schedule. Each time contractor personnel replace the solvent, they also remove the used solvent for offsite recycling and/or disposal. Since the used solvent is taken offpost, it has to be manifested as a hazardous waste (HW) which counts against an installation's HW generation figures even though the solvent may eventually be recycled.

A new system for cleaning small arms that is becoming commonplace at many installations is the use of Inland Technologies' Inc. IT-48WC (NSN 4250-01-397-2539) using a compound known as Break through. Research conducted at FT Belvoir's Mobility Technology Center and the U.S. Army Petroleum Center (APC) found:

(a.) Breakthrough to be non-hazardous and bio-degradable,

(b.) 75% reduction in labor associated with weapons cleaning,

(c.) Improved working conditions due to the safety of the solvent, and

(d.) Implementation payback of 0.7 years (1.3 yrs excluding labor)

Further information can be obtained on this opportunity by Referencing FT Belvoir's Mobility Technology Center and the U.S. Army Petroleum Center (APC)'s November 7, 1996 Technical Advisory Message #92.

In section II we outlined the technical, environmental, and economic feasibility of an aqueous-based parts washer. Another P2 alternative is the use of a solvent substitution-based parts washing unit, which is discussed here. A similar analysis can be performed on these technologies to compare their feasibility with existing systems. These alternative technologies have been shown to reduce HW generation for some processes by as much as 90%, with aqueous-based parts washers being the best in this area. The following paragraph analyzes the benefits of changing typical, existing Safety-Kleen parts washers with substituted solvent parts washers.

(3) Solvent Parts Washers - A Solvent Substitution. The major differences between the substituted solvent system and the Safety-Kleen system are the type of solvent used and the ability of the solvent to be re-used. The Safety-Kleen system uses a PD 680 Type II solvent while other systems use a less hazardous, PD 680 substitute which is recirculated through a filter to remove particulate contamination. In addition, according to one manufacturer of substituted solvent systems, because the solvent is continuously filtered, it never has to be changed. Solvent only has to be periodically added to replace that which has been lost to evaporation and drag-out. Therefore, the only waste generated from the substituted solvent systems would be a result of periodically replacing the filter cartridges. However, no long-term data exists for its use or maintenance. As a result, for the purpose of providing conservative estimates, this P2 guide assumes that the solvent will be changed once per year and the filters changed quarterly.

(a) Technical Evaluation. This initiative is relatively easy to implement since the solvent substitution washing units are about the same size and use the same basic operating procedures as standard parts washing Safety-Kleen units. As a result, implementation would only be a matter of removing the existing units and putting the substituted solvent units in their place. Since both types of units are about the same size and operate with the same electrical requirements, there were no additional installation requirements. Furthermore, since both types of systems are used in the same manner, there were no additional training requirements associated with different parts washing procedures.

(b) Environmental Evaluation. Most substituted solvent systems use an approved PD

680 solvent substitute (approved by the Fort Belvoir Research, Development, and Engineering Center) which contains neither volatile organic compounds (VOCs) nor hazardous air pollutants (HAPs). In addition, because personnel replace the solvent in the units only once per year (as opposed to once every 4-12 weeks for the Safety-Kleen units), this opportunity results in less HW generation. With a 20-gallon capacity and annual solvent change-out, each substituted solvent unit normally generates 133 lb of used solvent per year (based on a specific gravity of 0.8). In addition, annual filter waste would amount to 12 lb assuming that used filter cartridges weigh 3 lb and are changed quarterly. Therefore, each substituted solvent unit only generates 145 lb of HW per year.

(c) Economic Feasibility.

1. Implementation Costs. Substituted solvent units typically cost about $1,500.00.

2. Recurring Costs. Recurring costs include the cost of: new solvent (to replace that lost to evaporation, drag-out, and annual replacement), filter cartridges, HW disposal fees (of used solvent and used filter cartridges), and maintenance labor.

Evaporation/Drag-out Replacement. Since each unit holds 20 gallons and 15% is lost due to evaporation and drag-out each month, it requires a total of 36 gallons of replacement solvent per year. At $5.00 per gallon, this costs $180.00 per year.

Annual Replacement. Since each unit holds 20 gallons, it requires 20 gallons of replacement solvent to refill the unit after its annual cleaning. At $5.00 per gallon, this costs $100.00 per year.

Filter Cartridges. Since personnel change filter cartridges quarterly, each substituted solvent unit requires 4 new filter cartridges per year. At $10.00 per cartridge, this costs $40.00 per year.

Disposal Fees. As stated above, each substituted solvent unit generates 133 lb of used solvent per year and 12 lb of used filters per year for a total annual HW generation of 145 lb. With a disposal fee of $0.45 per lb, this would cost $65.25 per year.

Labor Costs. Assuming it takes 15 minutes to change a filter, it would take a total of 60 minutes to change the filter 4 times over the course of 1 year. In addition, assume that it takes 1 hour to perform the annual solvent replacement. This gives a total of 2 hours per year of maintenance for each unit. At $25.00/hr (labor costs including overhead), this would result in annual labor costs of $50.00.

Total Costs. The total annual recurring cost for maintaining each substituted solvent unit is therefore $435.25.

3. Recurring Cost Savings. Recurring cost savings is calculated by determining the difference between the annual cost of operating the old equipment and the annual cost of operating new equipment. This figure is useful for calculating a payback period. Data from various installations shows that operating a 20-gallon Safety-Kleen solvent basin typically costs about $550.00/yr. When compared to the cost to operate a commensurately sized substituted solvent parts washer at $435.00, this is a savings of $115.00/yr per unit.

4. Payback Period. The payback period is a useful value in that it tells the decision maker if changing a procedure or the type of equipment they are using will ultimately be economically beneficial. The payback period for replacing a standard parts washing unit or solvent basin with a substituted solvent parts washer is calculated below by dividing the implementation cost of the new equipment by the recurring cost savings.

$$\frac{\$1500.00}{\$115.00/\text{yr}} = 13.0 \text{ yr}$$

A payback period greater than 5 years is usually considered excessive, and the initiative would not be implemented. However, the purpose of these calculations in this P2 guide is to demonstrate how to do the cost analysis, not to document cost effectiveness.

b. Municipal Solid Waste Management. Typically weapons cleaning operations generate very little municipal solid waste. The largest source of solid waste would be in the form of packaging materials; however, this would only occur on an intermittent basis. The most common source would be the used cloth materials such as cleaning patches, swabs, and rags containing oily residue from routine weapons cleaning. Additionally, a significant amount of scrap metal is generated from replacing broken and worn parts.

(1) Packaging Materials. Packaging materials are not normally involved in the weapons cleaning process; however, they are directly related to the process as the unit armorer is often required to unpackage weaponry when receiving shipments. Although this is not the most frequent source of solid waste, it is the largest stream related to weapons cleaning. The following refuse is often produced during such operations: paper, plastic shrink wrap, styrofoam peanuts and foam padding, wood crates, cardboard boxes and containers, plastic containers, metal banding, ammo cans, pallets, and wire ties with lead seals. Many of the containers and crates have significant re-use value, even by the unit itself. These items should not be discarded.

Pallets and excess containers should be turned-in to the Defense Reutilization and Marketing Office (DRMO) via the unit supply system. Cardboard and paper should be recycled through the installation recycling center. Scrap wood should not be used for composting as it often contains preservatives that keep it from properly decomposing. This wood should be designated as construction debris and can be used as fill material. Wire ties with lead seals should be recycled through the DRMO. Plastic containers could be recycled at the installation recycling center. Styrofoam peanuts and foam padding could be saved and used for future outbound shipments by the unit. Unless cut into small pieces, metal bands should not be saved as scrap metal as they cause great difficulty at the scrap-yard grinders. Instead, these items could be sent to the DRMO for re-use on smaller packages. Material that is no longer useable for its intended purpose should be sent to the installation's recycling facility.

(2) Used Patches, Swabs, and Rags. This is probably the only solid waste stream generated by the weapons cleaning process at the unit level; however, the amount of waste generated in this stream at the DS/GS level is much smaller than typical line units. Installation environmental personnel should conduct a brief study of the DS/GS level maintenance operations to determine the amount and frequency of generation of this waste stream. With the data gained in this study, one can then use similar calculations to those in section II of this P2 guide. Since the amount of this waste stream is subject to the standards enforced by the DS/GS level armorers that accept weapons for cleaning, the amount generated will be extremely variable, depending on the installation. Care must be taken to ensure patches, swabs, and rags contaminated with hazardous chemicals are not being place into and disposed of with this waste stream.

(3) Replaced Weapons Parts. A unit armorer will often replace metal parts on weapon systems. These parts, along with broken weapons cleaning tools such as brushes and cleaning rods, should not be placed in the regular trash stream for many reasons. These parts are often made of high quality steel that can be recycled. Parts recovered from trash dumpsters have caused the Army bad press in the past. The weight of metal in the regular trash significantly impacts the cost of trash removal by the installation. A typical DS/GS level weapons maintenance operation may generate as much as 20 lb of scrap metal per day. This material may cost as much as $0.05/lb for trash removal versus up to $0.25/lb paid by recyclers. If we assume that a typical DS/GS level maintenance facility operates 250 days per year, the cost savings of not throwing the metal into the regular trash will be about $250.00 (20 lb/day x 250 days x $0.05/lb). The savings earned by recycling will be $1250.00 (20 lb/day x 250 days x $0.25/lb) for a total cost savings of $1500.00 ($250.00 + $1250.00). Steel is one of the last, highly profitable items that can be recycled.

(4) Reusable Shop Towels - Good Management Practice. Units using a water wash system and requiring drying procedures or employing larger weapon systems such as machine guns and mortars may find a large requirement for towels. Many installations have contracts with local launderers and towel providers for vehicle maintenance operations that are ready made

for units desiring such a program for weapons cleaning operations. Such a program is cost effective and provides an ample supply of towels for cleaning operations. These towels carry away much of the oily residues from the weapon systems that would otherwise find their way into the regular trash stream, but instead are properly disposed of by the contractor. Reusable shop towels should not be laundered by the units in washing machines with standard detergent.

(a) Technical Evaluation. Overall, this initiative would require minimal procedural changes for the unit and would not have adverse effects upon normal operations. Procedural changes that would have to be implemented at the unit include no longer disposing of used rags, instead using dedicated containers to accumulate and store rags for the contractor that would take the old ones away. If no contract for rags recycling is currently in place, one would need to be implemented.

(b) Environmental Evaluation. By laundering and reusing rags a typical company size unit would decrease used rag disposal by about 3500 lb/yr (as was shown above). For an installation with 75 such units, this would reduce the amount of rags disposed of by as much as 262,000 lb/yr.

(c) Economic Evaluation.

1. Implementation Costs. There would be no implementation cost associated with this P2 initiative. Accumulation containers are normally provided by the contractor, and payment of the contractor is normally done on a per/month or per/year basis.

2. Recurring Costs. Recurring costs associated with rag recycling include the cost of the service contract which typically costs about $0.25/lb. rags or less. For an installation that generates 262,000 lb rags/yr this would cost as much as $65,625/yr.

3. Recurring Cost Savings. Recurring cost savings would result from not having to purchase rags on the market and no longer having to pay some municipal waste disposal fees.

Rag purchase. Rags are normally purchased in 50- to 100-lb bundles. A typical price for rags purchased in this fashion is about is about $0.50/lb. Assuming that a clean rag weighs about half as much (16 new rags per pound) as a dirty or oily one (earlier we assumed 8 soiled rags weigh about 1 lb), this would mean 131,000 lb of new rags would need to be purchased to replace 262,000 lb of dirty rags generated and discarded. In all, it would cost the installation $65,500/yr to purchase new rags.

Rag disposal. At a disposal rate of $0.10/lb the disposal of 262,000 lb/yr would cost the installation $26,200/yr.

Total recurring cost savings. Elimination of rag purchase ($65,500) and rag disposal ($26,200) would save the installation about $91,700/yr.

4. Payback Period. Since there are no implementation costs and the cost savings is greater than the recurring costs, the payback period is immediate, saving a typical installation about $26,075/yr ($91,700 - $65,625).

APPENDIX A

PRODUCT INFORMATION

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
(800) 842-1630

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

Inland Technology, Inc.
401 East 27th St.
Tacoma, WA 98421
(800) 552-3100
(206) 383-1177

APPENDIX B

WEAPONS MAINTENANCE CONTACT INFORMATION

Preventive Maintenance Offices

For all small arms:
Office of the Deputy for Systems Acquisition, ATTN: AMSTA-DSA-SA (LTC W. Irish), DSN 880-6560, Picatinny Arsenal, NJ

For mortar systems:
Office of the Deputy for Systems Acquisition, ATTN: AMSTA-DSA-MO (LTC K. Eisele), DSN 880-3636, Picatinny Arsenal, NJ

Sustainment

For most other small arms:
U.S. Army Tank-automotive and Armament Command - Armament and Chemical Acquisition and Logistics Activity, ATTN: AMSTA-AC-ASI (Mr. Joe Colarusso), DSN 793-4491, rock Island, IL

For mortar systems:
U.S. Army Tank-automotive and Armament Command - Armament and Chemical Acquisition and Logistics Activity, ATTN: AMSTA-AC-FATM (Mr. James Hayes), DSN 793-3229, Rock Island, IL