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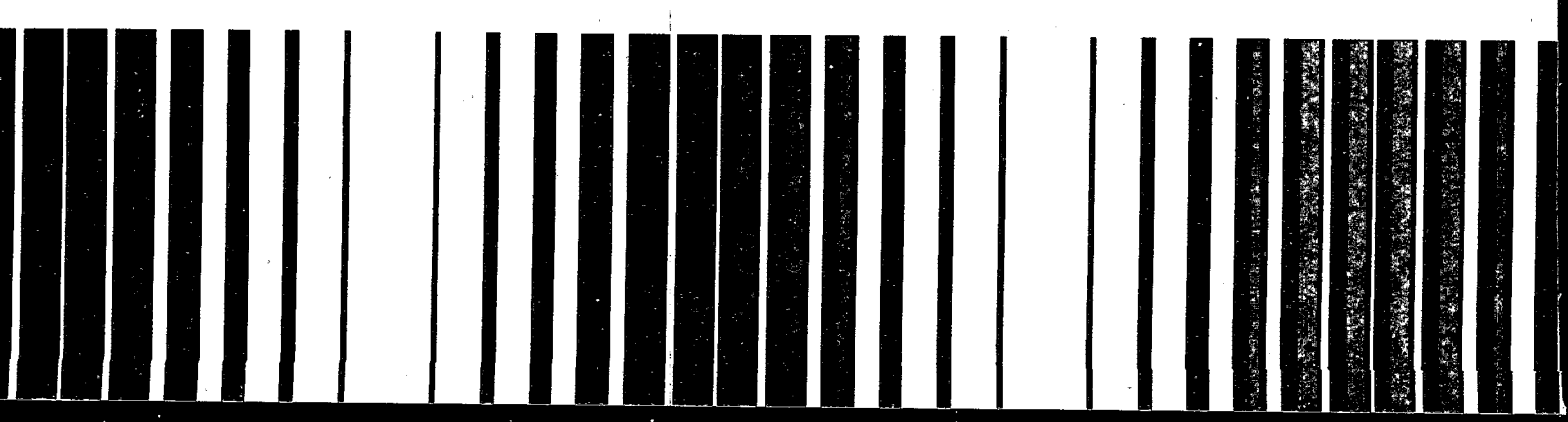
Guides to Pollution Prevention

The Mechanical Equipment Repair Industry



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GUIDES TO POLLUTION PREVENTION:
The Mechanical Equipment Repair Industry

RISK REDUCTION ENGINEERING LABORATORY
AND
CENTER FOR ENVIRONMENTAL RESEARCH INFORMATION
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
CINCINNATI, OHIO 45268

NOTICE

This guide has been subjected to U.S. Environmental Protection Agency peer and administrative review and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the U.S. Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

This document is intended as advisory guidance only to mechanical equipment repair shops in developing approaches for pollution prevention. Compliance with environmental and occupational safety and health laws is the responsibility of each individual business and is not the focus of this document.

Worksheets are provided for conducting waste minimization assessments of equipment repair shops. Users are encouraged to duplicate portions of this publication as needed to implement a waste minimization program.

FOREWORD

This guide provides an overview of mechanical equipment repair processes that generate waste and presents options for minimizing waste generation through source reduction and recycling. Waste generated by mechanical equipment repair shops differs from that generated by other industrial groups in that generally only small quantities of each type of waste are generated and the waste consists primarily of waste oil and spent solvent. Reducing the generation of this waste will benefit both equipment repair shops through cost savings and the environment by reducing releases.

ACKNOWLEDGMENTS

This guide is based in part on waste minimization assessments conducted by Ralph Stone and Company, Los Angeles, California, for the California Department of Health Services (DHS) and the U.S. Environmental Protection Agency. Contributors to these assessments include Ben Fries of the California Department of Toxic Substances Control; the owners and staff of the repair shops that participated in this study; and government, university, and waste exchange respondents to requests for information. Much of the information in this guide was provided originally to the California DHS by Ralph Stone and Company in *Waste Audit Study: Mechanical Equipment Repair Shops*, (May 1990). Battelle Memorial Institute edited and expanded this version of the waste minimization assessment guide under subcontract to EPA (USEPA Contract 68-C0-0003). Battelle personnel contributing to this guide include Bob Olfenbuttel, work assignment manager; Tom Bigelow and Leslie Hughes, task leaders; Larry Smith and Herm Nack, technical engineers; and Bea Weaver, production editor.

Teresa Harten of the U.S. Environmental Protection Agency, Office of Research and Development, Risk Reduction Engineering Laboratory, was the project officer responsible for the preparation and review of this guide. Other contributors and reviewers include Ken Smith, Machine Tool Rebuilders, Inc.; Dick Betz, Mid-State Machinery, Inc.; Chris Donaghy, Columbus Electrical Works; Kenneth Palmer, Ralph Stone and Company, Inc.; and Ben Fries, California Department of Toxic Substances Control.

CONTENTS

SECTION 1
INTRODUCTION

This guide is designed to provide the mechanical equipment repair industry with waste minimization options. It also provides worksheets for carrying out waste minimization assessments for mechanical equipment repair shops. It is envisioned that this guide will be used by mechanical equipment repair shops and regulatory agency representatives, industry suppliers, and consultants.

In the following sections of this manual you will find:

- A profile of the mechanical equipment repair industry and the processes used in it (Section 2)
- Waste minimization options for the industry (Section 3)
- Waste minimization assessment guidelines and worksheets (Section 4)
- Appendices, containing
  - — Case studies of waste generation and waste minimization practices in the industry
  - — Where to get help: additional sources of information.

The worksheets and the list of waste minimization options were developed through assessments of several repair shops in California commissioned by the California Department of Health Services (DHS 1990). Waste generation and management practices were surveyed, and existing and potential waste minimization options were characterized.

Overview of Waste Minimization

Waste minimization is a policy specifically mandated by the U.S. Congress in the 1984 Hazardous and Solid Wastes Amendments to the Resource Conservation and Recovery Act (RCRA). As the federal agency responsible for writing regulations under RCRA, the U.S. Environmental Protection Agency (EPA) has an interest in ensuring that new methods and approaches are developed for minimizing hazardous waste and that such information is made available to the industries concerned. This guide is one of the approaches EPA is using to provide industry-specific information about hazardous waste minimization. The options and procedures outlined can also be used in efforts to minimize other wastes generated in a business.

In the working definition used by EPA, waste minimization consists of source reduction and recycling. Of the two approaches, source reduction is usually considered preferable to recycling. While a few states consider treatment of waste an approach to waste minimization, EPA does not, and thus treatment is not addressed in this guide.

Waste Minimization Opportunity Assessment

EPA has developed a general manual for waste minimization in industry. The *Waste Minimization Opportunity Assessment Manual* (USEPA 1988) tells how to conduct a waste minimization assessment and develop options for reducing hazardous waste generation at a facility. It explains the management strategies needed to incorporate waste minimization into company policies and structure, how to establish a company-wide waste minimization program, conduct assessments, implement options, and make the program an ongoing one.

In 1992, EPA published the *Facility Pollution Prevention Guide* (USEPA 1992) as a successor to the *Waste Minimization Opportunity Assessment Manual.* While the *Waste Minimization Opportunity Assessment Manual* concentrated primarily on the waste types covered in the Resource Conservation and Recovery Act (RCRA), the *Facility Pollution Prevention Guide* deals with "multimedia" pollution prevention. It is intended to help small- to medium-sized production facilities develop broad-based, multimedia pollution prevention programs. Methods of evaluating,

adjusting, and maintaining the program are described. Later chapters deal with cost analysis for pollution prevention projects and with the roles of product design and energy conservation in pollution prevention. Appendices consist of materials that will support the pollution prevention effort: assessment worksheets, sources of additional information, examples of evaluative methods, and a glossary.

A Waste Minimization Opportunity Assessment (WMOA), sometimes called a waste minimization audit, is a systematic procedure for identifying ways to reduce or eliminate waste. The four phases of a waste minimization opportunity assessment are planning and organization, assessment, feasibility analysis, and implementation. The steps involved in conducting a waste minimization assessment are outlined in Figure 1 and presented in more detail below. Briefly, the assessment consists of a careful review of a plant's operations and waste streams and the selection of specific areas to assess. After a particular waste stream or area is established as the WMOA focus, a number of options with the potential to minimize waste are developed and screened. The technical and economic feasibility of the selected options are then evaluated. Finally, the most promising options are selected for implementation. The following sections describe these steps in more detail.

PLANNING AND ORGANIZATION PHASE

Essential elements of planning and organization for a waste minimization program are getting management commitment for the program, setting waste minimization goals, and organizing an assessment program task force.

ASSESSMENT PHASE

The assessment phase involves a number of steps:

- Collect process and facility data
- Prioritize and select assessment targets
- Select assessment team
- Review data and inspect site
- Generate options
- Screen and select options for feasibility study.

Collect Process and Site Data

The waste streams at a facility should be identified and characterized. Information about waste streams may be available on hazardous waste manifests, National Pollutant Discharge Elimination System (NPDES) reports, routine sampling programs, and other sources.

Developing a basic understanding of the processes that generate waste at a facility is essential to the WMOA process. Flow diagrams should be prepared to identify the quantity, types, and rates of waste generating processes. Also, preparing material balances for the different processes can be useful in tracking various process components and identifying losses or emissions that may have been unaccounted for previously.

Prioritize and Select Assessment Targets

Ideally, all waste streams in a facility should be evaluated for potential waste minimization opportunities. If resources are limited, however, the plant manager may need to concentrate waste minimization efforts in a specific area. Such considerations as quantity of waste, hazardous properties of the waste, regulations, safety of employees, economics, and other characteristics need to be evaluated in selecting target streams or operations.

Select Assessment Team

The team should include people with direct responsibility for and knowledge of the particular waste stream or area of the facility being assessed. Equipment operators and purchasers and people involved in routine waste management should not be ignored.

Review Data and Inspect Site

The assessment team evaluates process data in advance of the inspection. The inspection should follow the target process from the point where raw materials enter to the point where products and wastes leave. The team should identify the suspected sources of waste. This may include the production processes; maintenance operations; and storage areas for raw

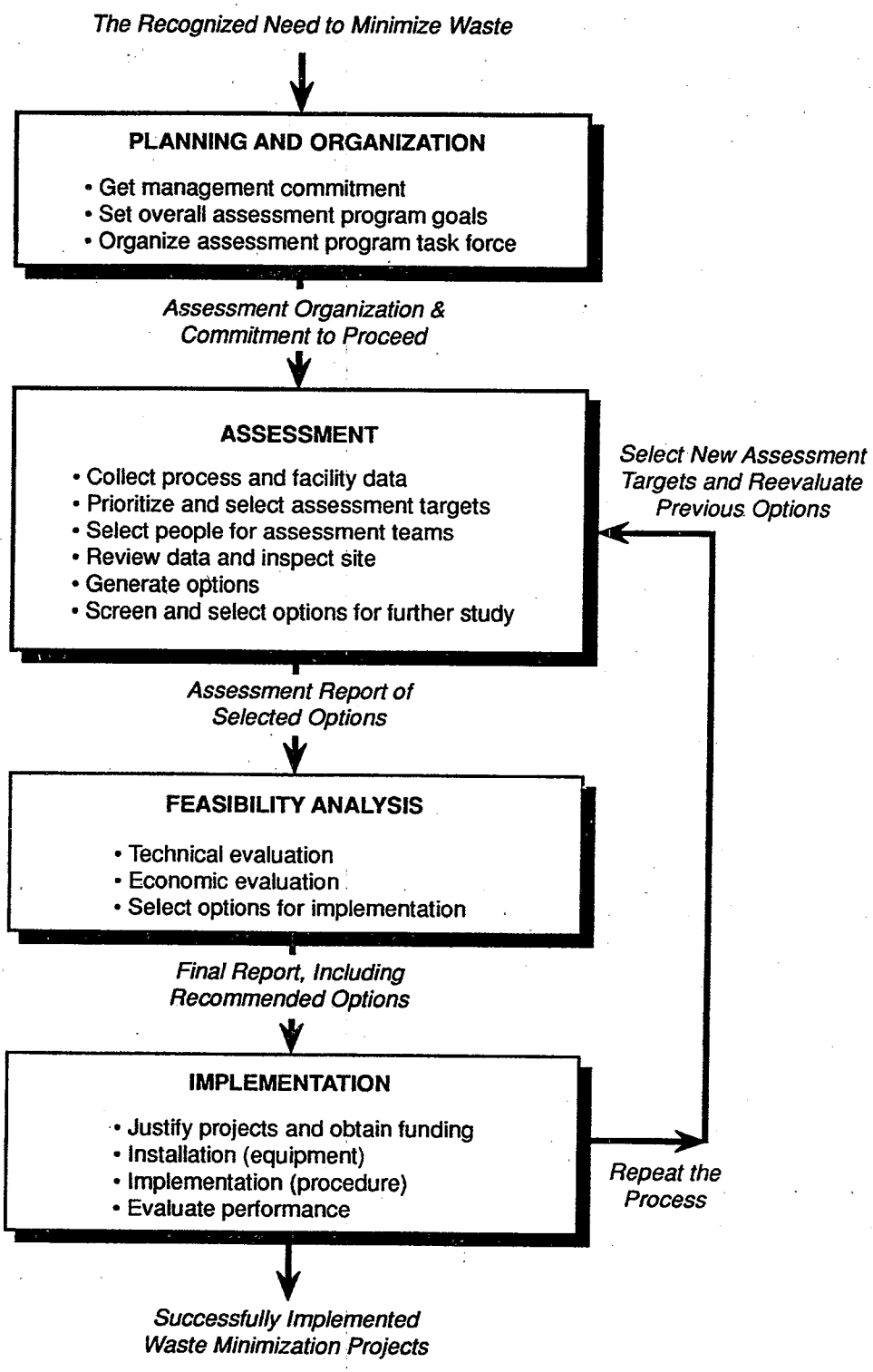

Figure 1. The Waste Minimization Assessment Procedure

materials, finished products, and work in progress. The inspection may result in the formation of preliminary conclusions about waste minimization opportunities. Full confirmation of these conclusions may require additional data collection, analysis, and/or site visits.

Generate Options

The objective of this step is to generate a comprehensive set of waste minimization options for further consideration. Since technical and economic concerns will be considered in the later feasibility step, no options are ruled out at this time. Information from the site inspection, as well as from trade associations, government agencies, technical and trade reports, equipment vendors, consultants, plant engineers, and operators may serve as sources of ideas for waste minimization options.

Both source reduction and recycling options should be considered. Source reduction may be accomplished through good operating practices, technology changes, input material changes, and product changes. Recycling includes use and reuse of water, solvents, and other recyclable materials, where appropriate.

Screen and Select Options for Further Study

This screening process is intended to select the most promising options for a full technical and economic feasibility study. Through either an informal review or a quantitative decision-making process, options that appear marginal, impractical, or inferior are eliminated from further consideration.

FEASIBILITY ANALYSIS PHASE

An option must be shown to be technically and economically feasible in order to merit serious consideration for adoption at a facility. A technical evaluation determines whether a proposed option will work in a specific application. Both process and equipment changes need to be assessed for their overall effects on waste quantity and product quality.

An economic evaluation is carried out using standard measures of profitability, such as payback period, return on investment, and net present value. As in any project, the cost elements of a waste minimization project can be broken down into capital costs and operating costs. Savings and changes in revenue and waste disposal costs also need to be considered, as do present and future cost avoidances. In cases of increasingly stringent government requirements, actions that increase the cost of production may be necessary.

IMPLEMENTATION PHASE

An option that passes both technical and economic feasibility reviews should be implemented. The project can be turned over to the appropriate group for execution while the WMOA team, with management support, continues the process of tracking wastes and identifying other opportunities for waste minimization. Periodic reassessments may be conducted to see if the anticipated waste reductions were achieved. Data can be tracked and reported for each implemented idea in terms such as pounds of waste per production unit. Either initial investigations of waste minimization opportunities or the reassessments can be conducted using the worksheets in this manual.

References

DHS. 1990. *Waste Audit Study: Mechanical Equipment Repair Shops.* Prepared by Ralph Stone and Company, Inc. for Alternative Technology Section, Toxic Substances Control Division, California Department of Health Services.

USEPA. 1992. *Facility Pollution Prevention Guide.* U.S. Environmental Protection Agency, Office of Research and Development, Washington, D.C., EPA/600/R-92/088.

USEPA. 1988. *Waste Minimization Opportunity Assessment Manual.* U.S. Environmental Protection Agency, Hazardous Waste Engineering Research Laboratory, Cincinnati, EPA/625/7-88/003.

SECTION 2
MECHANICAL EQUIPMENT REPAIR INDUSTRY PROFILE

Industry Description

The Standard Industrial Classification (SIC) 76, Miscellaneous Repair Services, covers shops providing repairs for a broad range of equipment types. All of these repair activities require similar processes such as cleaning and degreasing; paint removal and application; and metal welding, cutting, shaping, and finishing. To produce an efficient and useful guide that fully represents the activities in SIC 76, 10 different groups of equipment repair service areas received detailed attention. These areas are:

- Boilers
- Coin metered equipment
- Commercial appliances
- Commercial lawn mowers and chain saws
- Commercial refrigerators, air conditioning, refrigeration, and freezer equipment
- Electric motors, generators, and transformers
- Industrial machinery and tools
- Equipment installed and utilized by millwrights
- Rental yard equipment
- Welding equipment.

Process Description

A wide variety of processes are used in repair shops. Table 1 relates the ten equipment repair shop SIC categories to the repair operations performed in each category. Oil and grease removal and engine, parts, and equipment cleaning are responsible for the majority of waste generated in this industry. Typical chemicals and materials used in these processes fall into the following categories:

- Acids
- Alkalies
- Cleaning solvents
- Degreasers
- Detergents
- Cutting oils
- Engine oil, lubricants
- Paint reducers, thinners, paints
- Refrigerants
- Spill absorbents
- Varnish and varnish solvents
- Welding, soldering supplies.

Chemicals are stored on work benches in repair areas, in metal cabinets that are either locked or unlocked, or on industrial shelving in open or specially enclosed areas that also may be locked or unlocked. Certain types of repairs may be done in the field, and chemicals may be transported in vehicles for this work. Generally, only a small inventory of chemicals is stored, and new supplies are ordered as required. Often managers are unaware of how to dispose of obsolete chemicals.

Waste stream flow diagrams are useful tools for generating waste minimization options. Figures 2 through 12 are based on assessments performed by the California DHS (1990) and provide examples of flowchart formats that can be used for equipment repair operations.

Waste Description

Waste generated by mechanical equipment repair shops differs from the waste generated by other industrial groups in that only small quantities of waste are generated and only waste oil and spent solvent are generated in appreciable amounts. The quantities and types of waste generated are often seasonal.

Table 1. Commercial/Industrial Equipment Repair Shop Operations

Repair Operation	Repair Shop Category									
	Boiler Repair and Cleaning	Coin Metered Equipment Repair	Commercial Appliance Repair	Commercial Lawn Mower Repair	Commercial Refrigerator, AC, Refrigeration, and Freezer Repair	Electric Motor, Generator, and Transformer Repair	Industrial Machinery and Tool Repair	Millwright Operations	Rental Yard Equipment Repair	Welding Equipment and Welding Repair
Acid Cleaning	•		•		•			•		
Armature or Stator Rewinding and Coil Winding						•				
Burn Oven						•				
Cutting (Metals)	•			•	•	•	•	•	•	•
Dishwashing						•				
Drilling (Metals)	•			•	•	•	•	•	•	
Electric Motor Repair		•	•		•	•	•	•	•	
Engine, Parts, and Equipment Cleaning (external)	•	•	•	•	•	•	•	•	•	•
Grinding	•		•	•	•	•	•	•	•	•
Milling and Machining	•			•		•	•	•	•	
Oil and Grease Removal (internal)		•	•	•	•	•	•	•	•	•
Paint Removal and Preparation	•	•	•			•	•		•	•
Painting	•	•	•		•	•	•	•	•	•
Refrigerant Recharging			•		•					
Refurbishing									•	
Rust Removal	•	•	•		•	•	•	•	•	•
Sand or Plastic Pellet Blasting						•	•			
Spray Booth, Spray Gun, and Brush Cleaning	•	•	•						•	
Steam Cleaning					•	•	•	•	•	
Varnishing						•				
Welding and Soldering	•	•	•	•	•	•	•	•	•	•

DHS, 1990.

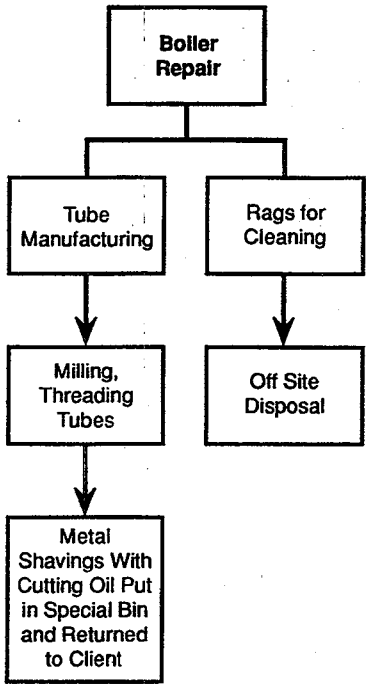

Figure 2. Waste Stream Flowchart for Boiler Repair

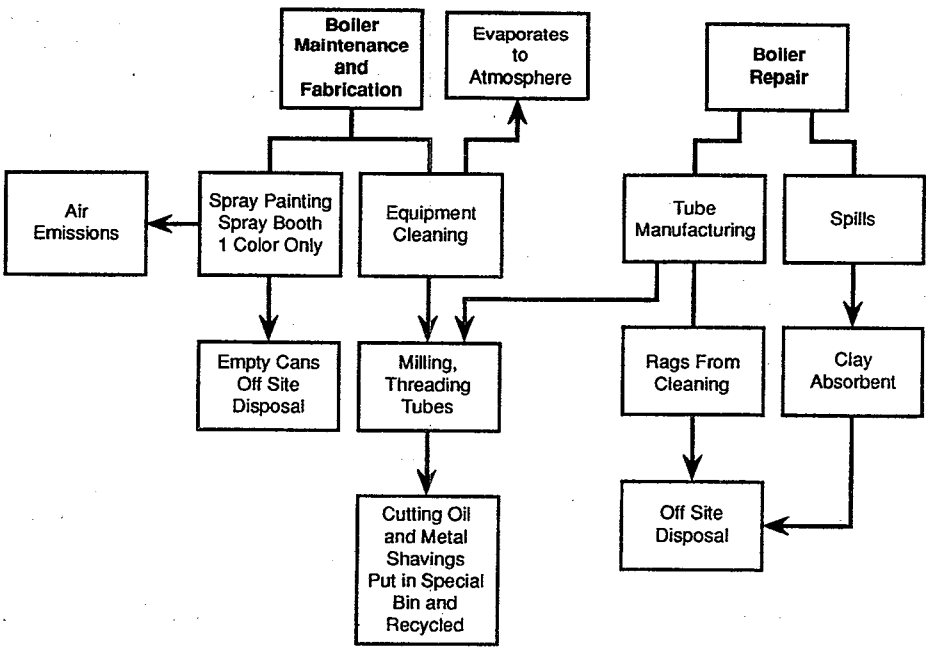

Figure 3. Waste Stream Flowchart for Boiler Repair and Fabrication

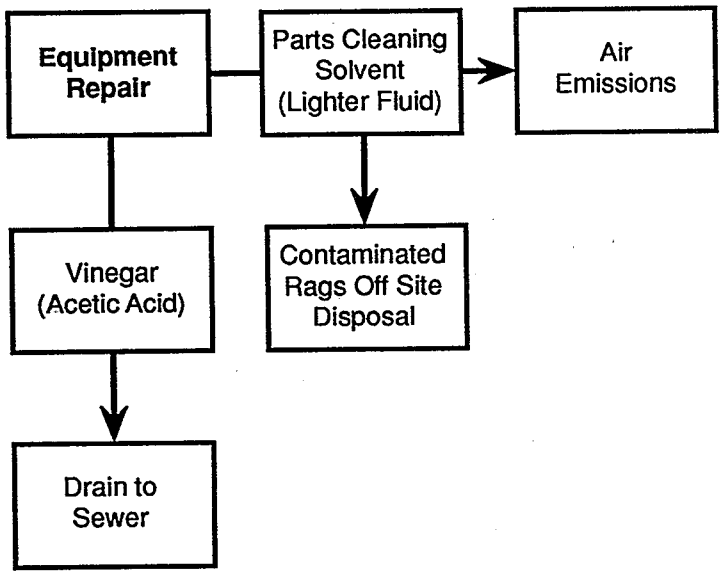

Figure 4. Waste Stream Flowchart for Appliance Repair

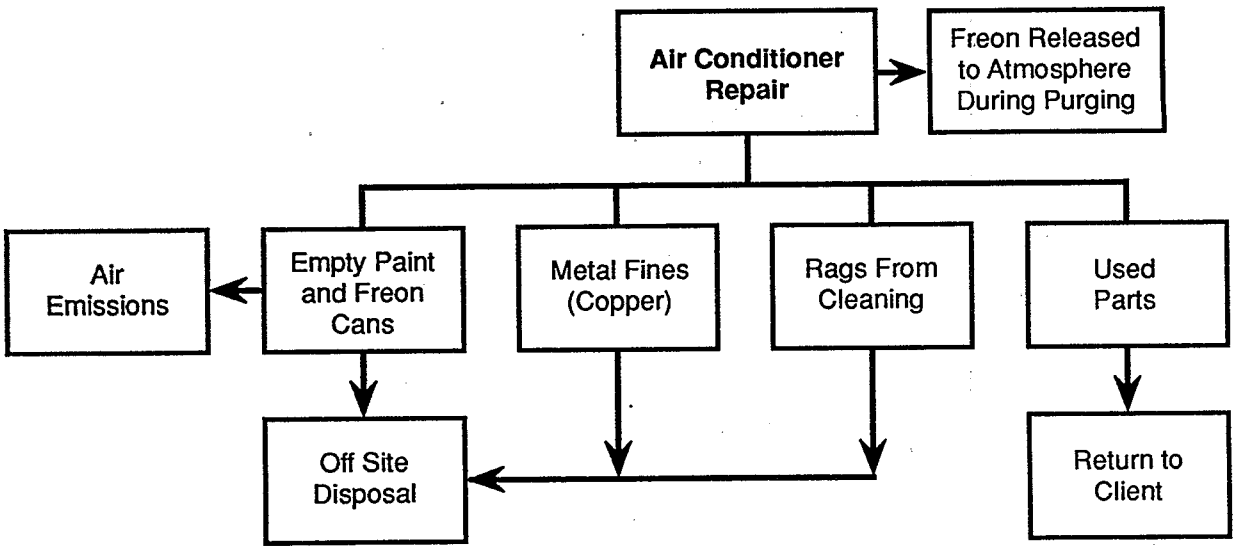

Figure 5. Waste Stream Flowchart for Air Conditioner Repair

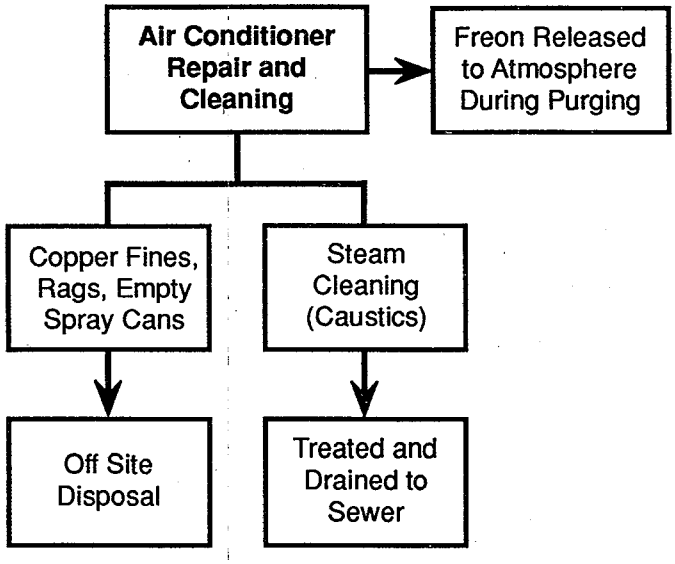

Figure 6. Waste Stream Flowchart for Air Conditioner Repair and Cleaning

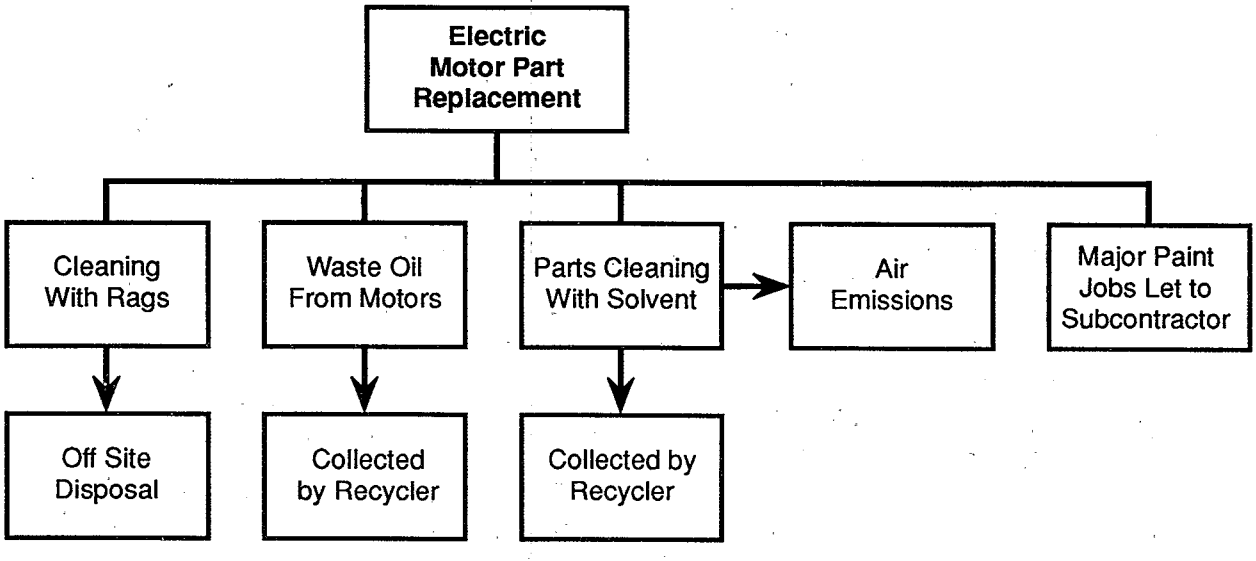

Figure 7. Waste Stream Flowchart for Electric Motor Part Replacement

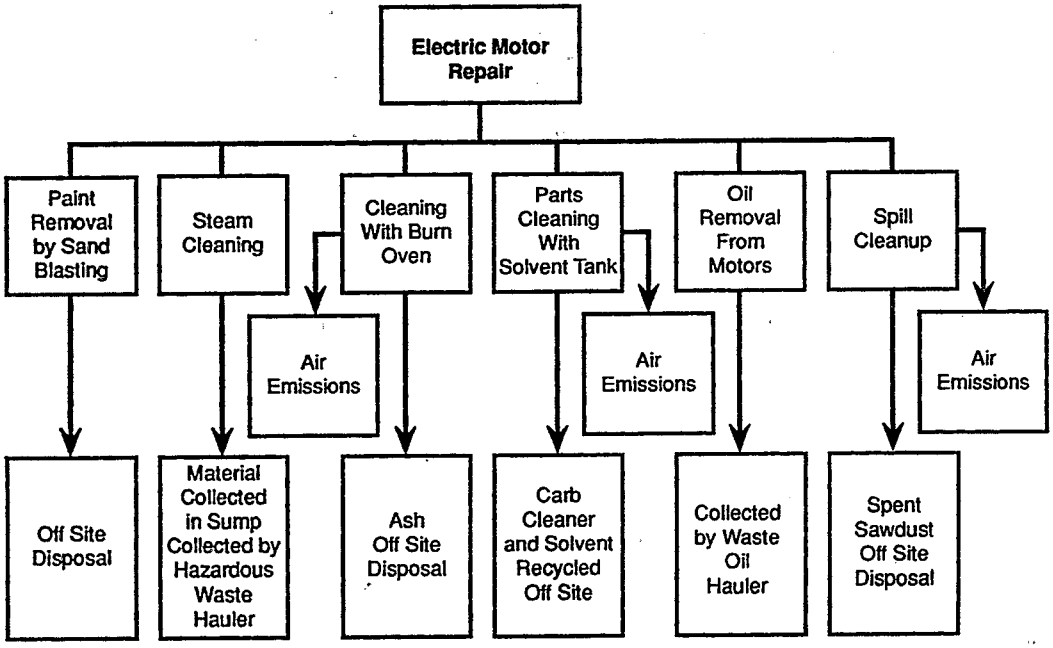

Figure 8. Waste Stream Flowchart for Electric Motor Repair

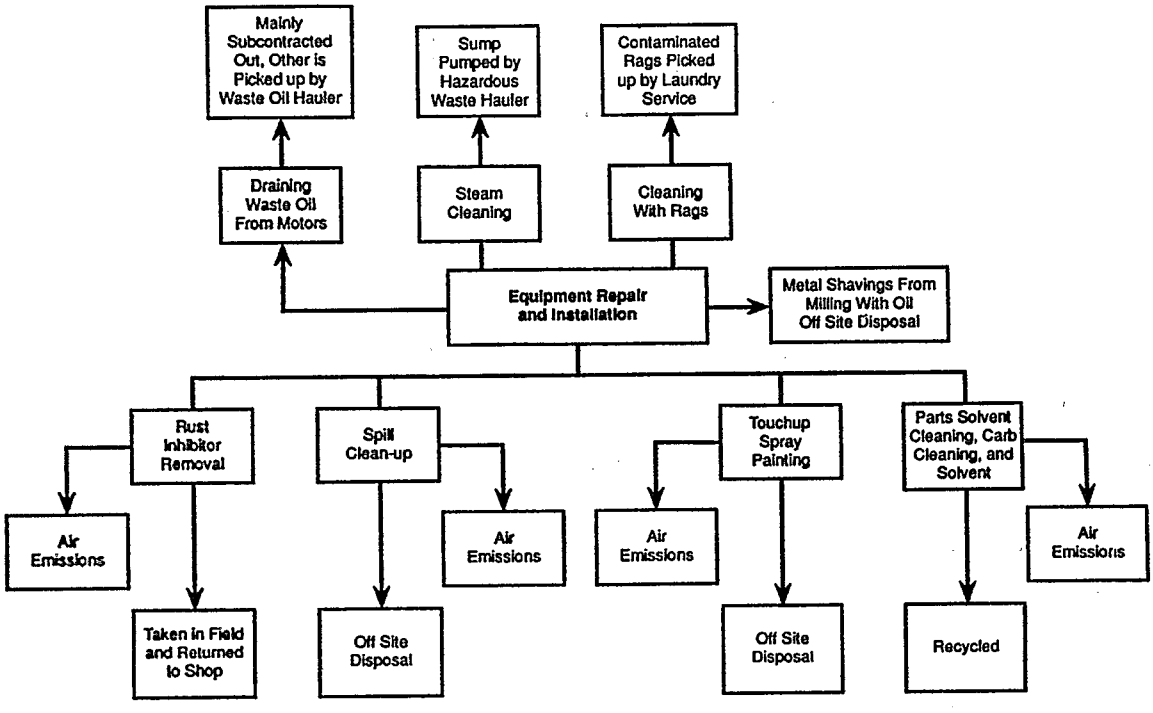

Figure 9. Waste Stream Flowchart for Equipment Repair and Installation

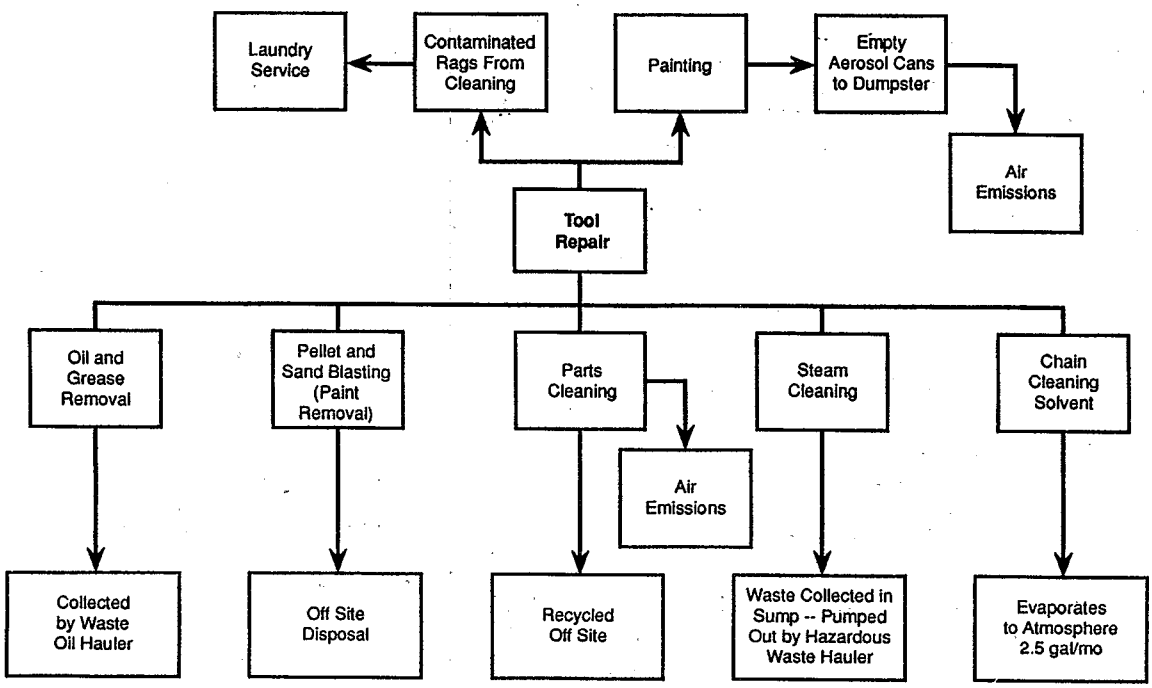

Figure 10. Waste Stream Flowchart for Tool Repair

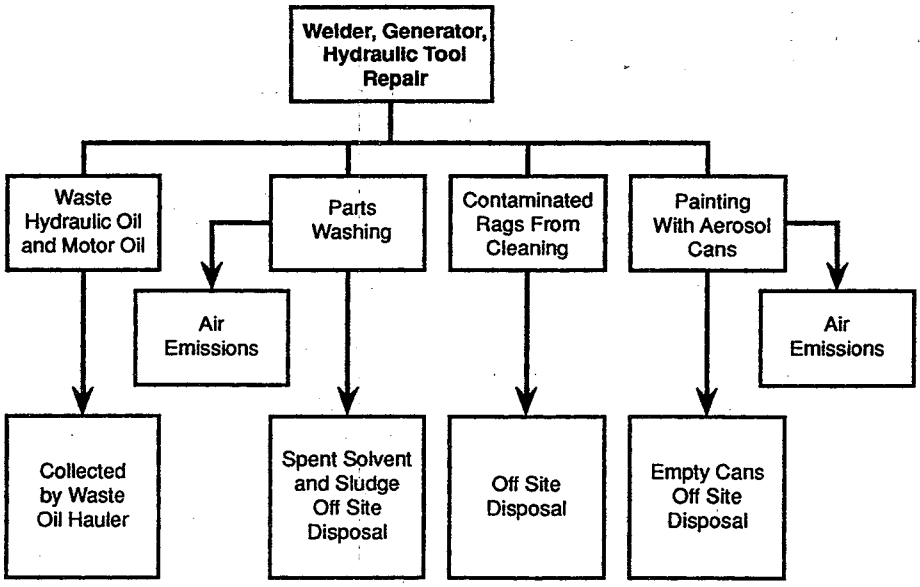

Figure 11. Waste Stream Flowchart for Welder, Generator, Hydraulic Tool Repair

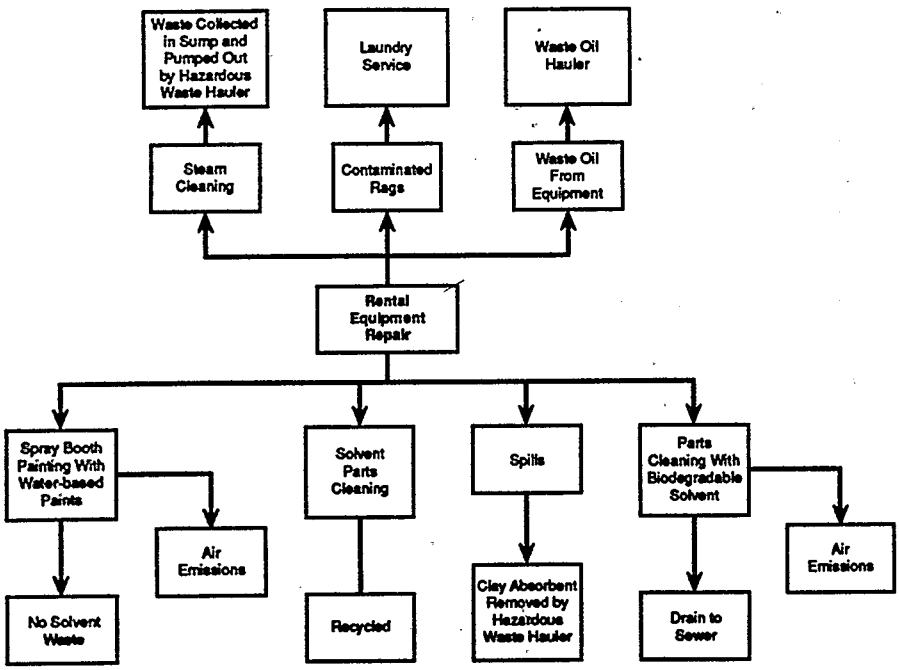

Figure 12. Waste Stream Flowchart for Rental Equipment Repair

The repair operations listed in Table 1 can be put into the six main groupings discussed below. Waste generated by these operations can be classified as ignitable waste, spent solvents, strong acids and alkalies, and "other."

CLEANING ENGINES, PARTS, OR EQUIPMENT

Cleaning engines, parts, and equipment creates the largest volume of waste for the industry. Common procedures include using leased solvent tanks, steam cleaning, using a dishwasher, wiping with rags, manual cleaning with acids (e.g., to clean boiler tubes, air conditioner coils, and steam irons), and mechanical cleaning with wire brushes.

Many of the solvents used in this industry are chlorinated, especially those used in tool repair and electric motor repair shops. Chlorinated hydrocarbon solvents include 1,1,1,trichloroethane, dichlorobenzene, perchlorethylene, and methylene chloride. Non-haloganated solvents include xylene, toluene, MEK, and benzene. Commercial solvents often contain mineral spirits.

Regulated waste includes spent solvents, solvent still bottoms, unneutralized acid and alkali, material collected in sumps, and contaminated rags.

REMOVING OIL AND GREASE

Removing oil and grease from inside equipment generates a large volume of waste in this industry. Waste oil, either motor or hydraulic, may be removed from engines, motors, welders, hoists, and winches. All oil is recyclable and is easily removed by a waste oil hauler. Some shops, such as millwright operations, subcontract the removal of oil from equipment. Used oil may contain heavy metals (such as lead, barium, cadmium, arsenic, chromium, and zinc) and halogenated organics (including PCBs and solvents).

PAINTING

Paint and rust removal techniques include sanding, sand blasting, milling, burn ovens, solvent tanks, or liquid paint removal. The latter method is the least desirable because of the chemicals involved. The amount of water generated is generally small. Liquid paint removal may or may not be hazardous, depend-

ing on the method used and the paint's heavy metal content.

Paint is applied in spray booths or with aerosol paint cans. Spray painting represents a small percentage of the total operations performed. Waste includes empty aerosol cans that may not be completely empty and solvents from spray booth maintenance. The volume of solvent waste from spray-booth operations is minimal because shops tend to have self-maintaining spray booths that require very little solvent cleaning.

METAL WORKING

Metal working may be defined as cutting, drilling, grinding, milling, and machining to fabricate or refurbish an equipment part. Waste containing a non-water-base cutting oil, a soluble oil (emulsion), or a synthetic fluid may be hazardous. The waste is placed in a dumpster or collected for recycling.

REFRIGERANT CHARGING

Chlorofluorocarbons are used by air conditioner repair shops to refill or purge air conditioning systems. No solid hazardous waste results. However, release of Freon 22 to the atmosphere has a harmful effect on the atmospheric ozone layer.

WELDING AND SOLDERING

Welding is used to repair broken equipment parts and rebuild shafts and has other general uses. Soldering is used to connect wires and terminals in motors. Oxygen, acetylene, MAPP (methyl acetylenepropadiene mixture), welding and soldering fluxes, solder, and welding rods are utilized in these two operations. Waste is minimal and includes solder drip and splash and spent welding rods.

Waste Storage

Waste generated by repair shops includes waste oil, spent solvent, contaminated rags, spent absorbent, and sump waste. In the California DHS study, tool repair, rental equipment, and electric motor repair shops appeared to generate the highest volumes of hazardous waste. Within these three categories, the size of the repair shop affected the volume of waste generated. Maximums of 55 gallons of used oil, 100 gallons of cleaning solvent, and 4,000 rags were generated each month. These numbers included waste from repairs not related to mechanical equipment (DHS 1990).

Hazardous waste is usually stored in either 55-gallon drums or storage tanks that are either above or below ground. These tanks vary in size from 15 gallons to 600 gallons. Leased solvent tanks vary from 8 gallons to 55 gallons. Aboveground waste storage tanks are kept inside the repair shop, outdoors, or in a storage shed. Surface cover below the aboveground tanks is cement, asphalt, or soil. Some repair shops have a bermed storage area.

References

DHS. 1990. *Waste Audit Study: Mechanical Equipment Repair Shops.* Prepared by Ralph Stone and Company, Inc. for Alternative Technology Section, Toxic Substances Control Division, California Department of Health Services.

SECTION 3
WASTE MINIMIZATION OPTIONS FOR MECHANICAL EQUIPMENT REPAIR SHOPS

Introduction

Waste minimization includes source reduction and recycling activities that reduce the amount and/or the toxicity of the waste (Table 2). Waste from the equipment repair industry is generated from residue in the equipment being repaired, spent cleaning solvents, and stripped paint containing heavy metals. The waste is primarily spent solvent, sump sludge, sand blasting materials, and refrigerant. Some equipment repairs, and thus the waste generated, may be seasonal (e.g., for air conditioners and lawn mowers).

Implementing waste minimization options can have impacts on air quality and wastewater treatment operations. Environmental, health, and safety aspects must be considered in selecting a waste minimization strategy.

Because equipment repair operations are flexible and usually independent of each other, source reduction and recycling are facilitated by the fact that they may be implemented with minimal expense and disturbance to the operation as a whole.

In addition, mechanical equipment repair shops should continually educate themselves to keep abreast of improved waste-reducing, pollution-preventing technology. Information sources about such technology include trade associations and journals, chemical and equipment suppliers, equipment expositions, conferences, and industry newsletters. By implementing better technology, companies can often take advantage of the dual benefits of reduced waste generation and a more cost-efficient operation.

Economics

Until recently, operators of small mechanical equipment repair shops were not overly concerned with the cost of waste disposal. However, the situation is changing. The cost of raw materials is increasing as a result of general economic pressures or, in the case of hazardous solvents or CFCs, as a result of environmental concerns. Waste disposal costs for both hazardous and nonhazardous wastes are also increasing. It is now essential for small business owners and employees to develop programs to reduce or eliminate waste throughout the operation. Reducing waste can improve a company's competitive position, while keeping the workplace and the community clean.

The most direct way to profit from waste reduction is to reduce the use of hazardous materials. Techniques for reducing waste will vary from simple to complex. Simple housekeeping improvements such as controlling material losses, repairing leaks, keeping solvent tanks covered, and preventing or controlling spills are inexpensive and can produce quick benefits.

Table 2. Waste Minimization Options

Source Reduction	Recycling and Resource Recovery
Good housekeeping	Recycling scrap metal
Chemical substitution	Leasing solvent recovery tanks
Reducing solvent use	Recycling oil and spent solvent
Process substitution	Recycling refrigerants

Other changes will require more time and effort. For example, changing to a water-based paint may require working with a customer to obtain approval for the new material.

Waste minimization often produces economic rewards. Cost reductions may appear as immediate savings directly on the balance sheet or as anticipated savings based on avoided future costs. Waste management costs can be reduced as a result of

- Less waste handling and disposal equipment
- Less waste storage space and thus more productive shop space
- Less waste for transportation and disposal
- Less paperwork for environmental reporting.

Reducing the amount and toxicity of materials handled on site increases the likelihood of compliance with environmental laws. Less waste also means less potential for future liability for environmental cleanup. Significant costs can be incurred for cleanup of a facility before it can be sold or for cleanup of an offsite waste disposal facility.

Another source of liability is worker exposure to hazardous materials. Eliminating or reducing solvents and similar hazardous materials has the dual benefit of improving worker safety and morale and reducing the risk of lawsuits. Thus, waste minimization can reduce insurance costs and increase productivity.

Waste disposal is a controversial issue, and most communities strongly oppose opening a new waste disposal facility in their area. Waste minimization is, therefore, attractive to the public. A facility using an effective waste minimization program is more likely to be perceived as a good neighbor. The improved atmosphere should help in maintaining a competitive workforce and in attracting new employees.

Source Reduction

Source reduction usually occurs within a process. Examples of source reduction options in the repair shop industry include good housekeeping (such as spill prevention and preparedness), chemical substitution or elimination, and process change.

GOOD HOUSEKEEPING

Good housekeeping is a general term for materials management, storage, and handling practices aimed at minimizing waste. Good housekeeping involves low-cost management practices to reduce disposal and raw material costs. Developing a company culture focused on cutting waste is an important element of waste minimization.

Keeping track of inventory and scheduling orders can cut down on waste materials. A well-designed central dispensing point for materials reduces waste. Central dispensing can eliminate use of small containers and waste of partially used materials in containers. It can also help control spills.

Good control of inventory helps minimize the number of material types used and improves segregation of incompatible materials. Using fewer types of solvents, for example, decreases the complexity of waste recycling. A shop using both freon and 1,1,1-trichloroethane could use one or the other instead or switch to an aqueous-based material. Segregation of incompatible materials like aqueous and nonaqueous waste also makes recycling easier.

The following guidelines are useful in maintaining a well-organized inventory:

- Control Inventory—Assign to one person the responsibility of checking in, dating, and labeling new materials. He or she should also organize and inspect existing stock. If it is practical for your shop, this "stockroom attendant" can also be responsible for ordering and issuing materials, especially those with a limited shelf life. Make certain that the oldest material is used first ("first-in, first-out" material use).
- Control Access—If it is not practical to use your "stockroom attendant" to issue raw materials, limit access to only those employees who are trained in hazardous materials handling and who understand the importance of a "first-in, first-out" policy.
- Control Storage—Inspect your storage area periodically for improper labels, leaky containers, dripped materials, and aged materials. If your shop is large (for example, six or more

solvent sinks, and/or two or more hot tanks) and uses large amounts of raw material, you may choose to inspect the area as frequently as twice a month.

- Control Spills—To reduce spills, use a gravity spigot to dispense bulk liquid materials. A pump (motorized or hand pump) is another dispensing method. At the very least, always use a spout and funnel when transferring liquids.

- Control Design—If possible, arrange your raw materials storage area with access to the front and back of shelving so new materials can be placed behind older stock.

The distributors of your raw materials should supply Material Safety Data Sheets (MSDS), which contain important information about material hazards and potential waste generation. In some cases, materials cause hazardous conditions if mixed (for example, chlorine bleach and acid). Material segregation helps avoid the dangerous reactions that occur if incompatible materials are mixed.

Recording inventory helps track the performance of your suppliers. Good records can assist in identifying raw materials that frequently result in poor quality products. Because low quality products result in waste generating rework, a new supplier should be found.

A variety of options can be used to collect spilled fluids. For example, rags, sorbent pads, or loose sorbent, such as clay or sawdust in trays or bags, can be used. If rags or pads are used instead of loose material, recycling is possible. Rags can be laundered for reuse. Pads can be passed through a roller extractor to recover the fluid for reprocessing and the pads for reuse.

CHEMICAL OR PROCESS SUBSTITUTION

Solvent replacement presents an opportunity for chemical substitution in the mechanical equipment repair industry. The most likely areas for solvent replacement are painting and parts cleaning.

If product performance requirements allow, new paint formulas can reduce the quantity of hazardous materials used. Solvent-based paints can be replaced with water-based paints. This substitution eliminates volatile organic solvents in the paint and in painting equipment cleanup. Paints based on pigments containing hazardous metals such as chromium, lead, or cadmium should be avoided.

Organic solvents are often used to remove old paint. Abrasive blasting methods are good replacements for solvent stripping in many applications. Nonsolvent paint removal options include blasting with plastic beads, sodium bicarbonate slurry, or dry ice pellets. High temperature paint removal methods may also be useful for paint removal.

Organic solvents are widely used for general cleanup. In many cases, the solvent can be eliminated. Large or heavily soiled parts can be cleaned in a high flow power washer using a water-based detergent solution. Small, lightly soiled parts can be cleaned with an aqueous detergent in a rotary screw washer or an ultrasonic bath.

If solvent cleaning cannot be avoided, solvent losses should be minimized. Solvent tanks should be covered to decrease evaporation of the solvent. Tanks equipped with a pump should be operated only when parts are being washed. In addition, solvents can be filtered to extend useful life.

Process equipment is cleaned periodically with rags and solvent. If possible, the solvent should be replaced with an aqueous cleaner. If alternatives are not available, waste may be minimized by training workers to use the least amount of solvent needed to accomplish the cleaning. It may also be possible to reuse old or filtered solvent from a high quality, low soil cleaning operation for a less demanding general cleaning operation.

Recycling and Resource Recovery

Many mechanical equipment repair shops can realize waste minimization and economic benefits from material recycling and recovery.

Scrap metal from used parts such as copper, aluminum, or lead can be sold to a reprocessor. Metal shavings, fines, and scraps from machining operations are also good candidates for recycling. If no local

recycler is available, it may be beneficial to contact a waste exchange (see Appendix B for listings).

As discussed above, solvent spills can be collected by sorbent pads. The collected fluid is recovered by compressing the pad between two counter-rotating rollers. The fluid can then be recovered for reuse. Fluids can also be recovered by draining parts removed for maintenance. For example, oil filters should be drained before disposal.

Most organic solvents have low boiling points and can be recycled by distillation either on site or by an off-site facility. Water-based materials can be recycled and metalworking fluids can be filtered and treated for reuse.

Package units are available to collect and reprocess chlorofluorocarbons (CFCs) from refrigeration systems. Recycling CFCs reduces cost and prevents CFCs from entering the atmosphere.

Reference

DHS. 1990. *Waste Audit Study: Mechanical Equipment Repair Shops.* Prepared by Ralph Stone and Company, Inc. for Alternative Technology Section, Toxic Substances Control Division, California Department of Health Services.

SECTION 4
GUIDELINES FOR USING THE WASTE MINIMIZATION ASSESSMENT WORKSHEETS

The worksheets provided in this section are intended to assist repair shops in systematically evaluating waste generating processes and in identifying waste minimization opportunities. These worksheets include only the assessment phase of the procedure described in the EPA *Waste Minimization Opportunity Assessment Manual* and also in the EPA *Facility Pollution Prevention Guide.* A comprehensive waste minimization assessment includes planning and organization, gathering background information, a feasibility study on specific waste minimization options, and an implementation phase. For a full description of waste minimization assessment procedures, refer to the EPA manual.

Table 3 lists the worksheets that are provided in this section. After completing the worksheets, the assessment team should evaluate the applicable waste minimization options and develop an implementation plan.

Table 3. List of Waste Minimization Assessment Worksheets

Number	Title	Description
1.	Waste Generating Processes	Form for listing waste generating processes
2.	Waste Sources	Form for listing specific waste types
3.	Waste Minimization: Material Handling	Questionnaire on material handling techniques and inspections
4.	Option Generation: Material Handling	Options for minimizing waste material handling
5.	Waste Minimization: Material Substitution	Questionnaire on process operations
6.	Option Generation: Material Substitution	Options for substituting process materials
7.	Waste Minimization: Management Practices	Questionnaire on management practices
8.	Option Generation: Management Practices	Options for implementing management practices
9.	Waste Minimization: Reuse and Recovery	Questionnaire on reuse and recovery
10.	Option Generation: Reuse and Recovery	Options for reusing and recovering process materials

Shop _____	Waste Minimization Assessment	Prepared by _____
		Checked By _____
Date _____	Proj. No. _____	Sheet ____ of ____ Page ____ of ____

WORKSHEET
1

WASTE GENERATING PROCESSES

Process	Waste Type	Quantity Per Week	Comment
Acid Cleaning			
Armature or Stator Rewinding and Coil Winding			
Burn Oven (Paint Removal or Parts Cleaning)			
Cutting (Metals)			
Dishwashing			
Electric Motor Repair			
Engine, Parts, and Equipment Cleaning			
Grinding			
Milling and Machining			
Oil and Grease Removal			
Paint Removal and Preparation			
Painting			
Refrigerant Recharging			
Refurbishing			
Rust Removal			
Sand or Plastic Pellet Blasting			
Spray Booth, Spray Gun, and Brush Cleaning			
Steam Cleaning			
Varnishing			
Welding and Soldering			

Are air emissions produced and, if so, list them and their status? (Include CFCs and solvent emissions)

_____

What happens to materials and chemicals that are left over when working on a field job?

☐ Returned to Shop ☐ Left at Job Site ☐ Disposed of in Dumpster ☐ Abandoned

	Yes	No
Are waste streams segregated to avoid cross-contamination and, if so, how?	☐	☐
_____		
Is fuel or electricity being used in any of the processes?	☐	☐

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WORKSHEET
2

WASTE SOURCES

Waste Source: Material Handling	Significance at Plant		
	Low	Medium	High
Off-Spec Materials			
Obsolete Raw Materials			
Spills & Leaks (Liquids)			
Spills (Powders)			
Empty Container Cleaning			
Container Disposal (Metal)			
Container Disposal (Paper)			
Pipeline/Tank Drainage			
Trash			
Other			
Waste Source: Process Operations			
Caustic Cleaners			
Solvent Cleaners			
Aqueous Cleaners			
Carburetor Cleaners			
Brake/Hydraulic Fluids			
Engine Oils and Lubricants			
Gear Oil/Grease			
Metalworking Fluids			
Engine Coolant (Ethylene Glycol)			
Paint			
Paint Solvents			
Lacquer Solvents			
Varnish Solvents			
Welding and Soldering Fluxes			
Refrigerants			
Acids			
Alkalies			
Spill Absorbants			
Other			

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WORKSHEET
3A

WASTE MINIMIZATION: Material Handling

A. GENERAL HANDLING TECHNIQUES

Are off-specification material wastes generated because the material has exceeded its shelf life?	☐ Yes ☐ No
Are materials properly stored and inventoried?	☐ Yes ☐ No
How often is an inventory performed to identify an accumulation of materials?	_____
Are materials restocked regularly?	☐ Yes ☐ No
Does the company use a first-in first-out material use policy to prevent materials from deteriorating in storage?	☐ Yes ☐ No
Does the company minimize inventory to prevent material degradation due to prolonged storage?	☐ Yes ☐ No
Are MSDSs available?	☐ Yes ☐ No
Are incompatible materials stored together?	☐ Yes ☐ No
Are inventory controls used to assure that chemicals in a container are completely used prior to opening a new container?	☐ Yes ☐ No
Are empty containers returned to the supplier?	☐ Yes ☐ No
Are empty containers empty according to 40 CFR 261.7 so they can be handled as a nonhazardous solid waste?	☐ Yes ☐ No
Does the plant generate waste due to spills during material handling or storage?	☐ Yes ☐ No
If yes, describe the frequency of these spills.	_____
Are personnel trained to ensure proper handling and storage of materials?	☐ Yes ☐ No
Is spill containment provided to minimize the amount of cleanup materials used to contain and clean up spills?	☐ Yes ☐ No

Describe spill containment used in material storage areas. _____

_____

_____

_____

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WORKSHEET
3B

WASTE MINIMIZATION: Material Handling

B. DRUMS, CONTAINERS, AND PACKAGES

Are drums, packages, and containers inspected for damage before being accepted? ☐ Yes ☐ No

Are employees trained in ways to safely handle the types of drums and packages received? ☐ Yes ☐ No

Are stored items protected from damage, contamination, or exposure to rain, snow, sun and heat? ☐ Yes ☐ No

Does the layout of the facility result in heavy traffic through the raw material storage area? (Heavy traffic increases the potential for contaminating raw materials with dirt or dust and for causing spilled materials to become dispersed throughout the facility.) ☐ Yes ☐ No

Can traffic through the storage area be reduced to prevent accidents? ☐ Yes ☐ No

Are employees properly trained in handling spilled raw materials? ☐ Yes ☐ No

Are spill absorbants recycled? ☐ Yes ☐ No

Describe handling procedures for damaged items: _____

What measures are employed to prevent the spillage of liquids being dispensed? _____

When a spill of liquid occurs in the facility, what cleanup methods are employed (e.g., wet or dry)? Also discuss the way in which the resulting wastes are handled: _____

Would different cleaning methods allow for direct reuse or recycling of the waste? (explain): _____

Do you try to order smaller containers of infrequently used materials to avoid disposing of large quantities of unused obsolete materials? ☐ Yes ☐ No

Have you tried to order larger containers of frequently used materials to reduce the number of small containers that must be cleaned and disposed of? ☐ Yes ☐ No

Are all empty bags, packages, and containers that contained hazardous materials segregated from those that contain nonhazardous wastes? ☐ Yes ☐ No

Describe the method currently used to dispose of this waste: _____

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WORKSHEET
3C

WASTE MINIMIZATION: Material Handling

C. INSPECTIONS

Does the company have a formal inspection program? ☐ Yes ☐ No

How often are inspections of the chemical storage area, process areas, and waste treatment areas conducted? _____

Are malfunctions in equipment or leaks in storage vessels and piping corrected immediately? ☐ Yes ☐ No

Are identified malfunctions followed up to ensure that they are corrected? ☐ Yes ☐ No

Are inspections logged and are logs maintained in permanent records? ☐ Yes ☐ No

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WORKSHEET
4

OPTION GENERATION: Material Handling

Meeting Format (e.g., brainstorming, nominal group technique) _____

Meeting Coordinator _____

Meeting Participants _____

Suggested Waste Minimization Options	Currently Done Y/N?	Rationale/Remarks on Option
A. General Handling Techniques		
Quality Control Check		
Test Age-Dated Material (if expired) for Effectiveness		
Return Obsolete Material to Supplier		
Minimize Inventory		
Computerize Inventory		
Formal Training		
Solvent Tanks Covered		
B. Drums, Containers, and Packages		
Raw Material Inspection		
Proper Storage/Handling		
Reduced Traffic		
Spilled Material Reuse		
Cleanup Methods to Promote Recycling		
Appropriate Purchase Sizes		
Waste Segregation		
C. Inspections		
Formal Inspections		
Maintenance Inspections		
Inspection Logs/Follow-Up		

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WORKSHEET
5

WASTE MINIMIZATION: Material Substitution

Can solvent cleaning be replaced by a bake oven or aqueous cleaning methods? ☐ Yes ☐ No

If yes, has substitution been tried? ☐ Yes ☐ No

Discuss the results: _____

Can solvent-based paints be replaced by water-based paints? ☐ Yes ☐ No

If yes, has material substitution been tried? ☐ Yes ☐ No

Discuss the results: _____

Can solvent paint strippers be replaced by nonsolvent method? ☐ Yes ☐ No

If yes, has material substitution been tried? ☐ Yes ☐ No

Discuss the results: _____

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WORKSHEET
6

OPTION GENERATION: Material Substitution

Meeting Format (e.g., brainstorming, nominal group technique) _____

Meeting Coordinator _____

Meeting Participants _____

Suggested Waste Minimization Options	Currently Done Y/N?	Rationale/Remarks on Option
Substitution/Reformulation Options		
Replace Cleaning Solvents		
Replace Solvent Paints		
Replace Paint Strippers		

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WORKSHEET
7

WASTE MINIMIZATION: Management Practices

Are records kept of individual wastes with their sources of origin and eventual disposal? (This can aid in pinpointing large waste streams and focus reuse efforts.) ☐ Yes ☐ No

Are the operators provided with detailed operating manuals or instruction sets? ☐ Yes ☐ No

Are all operator job functions well defined? ☐ Yes ☐ No

Are regularly scheduled training programs offered to operators? ☐ Yes ☐ No

Are there employee incentive programs related to waste minimization? ☐ Yes ☐ No

Does the facility have an established waste minimization program in place? ☐ Yes ☐ No

If yes, is a specific person assigned to oversee the success of the program? ☐ Yes ☐ No

Discuss goals of the program and results: _____

_____

_____

Has a waste minimization assessment been performed at the facility in the past? ☐ Yes ☐ No

If yes, discuss: _____

_____

_____

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WORKSHEET
8

OPTION GENERATION: Management Practices

Meeting Format (e.g., brainstorming, nominal group technique) _____

Meeting Coordinator _____

Meeting Participants _____

Suggested Waste Minimization Options	Currently Done Y/N?	Rationale/Remarks on Option
Keep Records of Waste Sources and Disposition		
Waste/Materials Documentation		
Provide Operating Manuals/Instructions		
Employee Training		
Increased Supervision		
Provide Employee Incentives		
Increase Plant Sanitation		
Establish Waste Minimization Policy		
Set Goals for Source Reduction		
Set Goals for Recycling		
Conduct Annual Assessments		

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WORKSHEET
9

WASTE MINIMIZATION: Reuse and Recovery

Do you return waste solutions to the manufacturer for recycling?	☐ Yes	☐ No
Do you recycle the materials on site?	☐ Yes	☐ No
Are cleaning solutions recycled?	☐ Yes	☐ No
Are ethylene glycol coolants recycled?	☐ Yes	☐ No
Are metalworking fluids recycled?	☐ Yes	☐ No
Are chlorofluorocarbon refrigerants recycled?	☐ Yes	☐ No
Are metal wastes recycled?	☐ Yes	☐ No
Have you contacted waste exchange services or commercial brokerage firms regarding wastes?	☐ Yes	☐ No
Are many different solvents used for cleaning?	☐ Yes	☐ No
If too many small-volume solvent waste streams are generated to justify on-site distillation, can the solvent used for equipment cleaning be standardized?	☐ Yes	☐ No
Is spent cleaning solvent reused as thinner or initial wash?	☐ Yes	☐ No
Has on-site distillation of the spent solvent ever been attempted? (On-site recovery of solvents by distillation is economically feasible for as little as 8 gallons of solvent waste per day.)	☐ Yes	☐ No
If yes, is distillation still being performed?	☐ Yes	☐ No

If no, explain: _____

Discuss other wastes that you are currently recycling and by which means: _____

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WORKSHEET
10

OPTION GENERATION: Reuse and Recovery

Meeting Format (e.g., brainstorming, nominal group technique) _____

Meeting Coordinator _____

Meeting Participants _____

Suggested Waste Minimization Options	Currently Done Y/N?	Rationale/Remarks on Option
Material Recycling		
Cleaning Solutions		
Coolants		
Metalworking Fluids		
CFC Refrigerants		
Copper, Aluminum, Lead, or Other Metals		

Appendix A
MECHANICAL EQUIPMENT REPAIR SHOP ASSESSMENTS: CASE STUDIES OF SHOPS

In 1990, the California Department of Health Services commissioned a waste minimization study, *Waste Audit Study: Mechanical Equipment Repair Shops*, that included assessments of 12 mechanical equipment repair shops. The objectives of the study were to:

- Conduct assessments of three to six commercial and industrial equipment repair shops to determine waste minimization alternatives
- Prepare a model to be used by repair shops to assess their own waste minimization options.

Because very little information was obtained in a preliminary survey of six shops, the number of shops assessed was increased to 12. Thirty-five telephone interviews were also conducted.

The relatively small amount of waste generated by this industrial sector restricts the types of waste minimization techniques that may be employed. However, several options are available that will have a beneficial impact on air quality, municipal sewer systems, and the health and safety of workers and the public. This appendix contains the results of the waste reduction assessments of the repair shops studied.

Results of waste reduction assessments provide valuable information about the potential for incorporating waste reduction technologies into equipment repair shop operations. This appendix presents summaries of the results of the assessments performed by California DHS at such operations. The summaries presented are largely unedited and should not be taken as recommendations of the USEPA; they are provided as examples only. The inclusion of trade names should not be taken as endorsement of particular products, but merely reflects the findings of the California DHS about actual practices found at the companies assessed.

The original assessments may be obtained from:

Mr. Benjamin Fries
California Department of
Toxic Substances Control
714/744 P Street
Sacramento, CA 94234-7320
(916) 324-1807.

SUMMARY OF FIELD ASSESSMENTS

Boiler Repair Shop A

This boiler repair shop has approximately 250 employees and performs repair work mainly on site for an electric company. Boiler tube acid cleaning is subcontracted. Most of the tool and shop equipment repair is done by another subcontractor. The repair work performed mainly entails tube replacement.

Metal shavings from milling that contain cutting oil are placed in a special bin on site for disposal. All hazardous waste generated on site is disposed of by the client and, therefore, no information is available on waste disposal. It was recommended that the shop launder dirty rags to minimize waste. Overall, very little waste was generated by this shop.

Boiler Repair Shop B

This boiler repair shop has fabricated and repaired boilers using the same basic technology for the past 68 years. The shop employs 13 people. Forty percent of its work involves repair to boilers, with 70 percent of the work being done in the field.

A spray booth is used periodically to paint new boilers. Five gallons of paint are used monthly. The spray booth equipment is self-maintaining, and very little solvent is required for cleaning because only one color is used. A small amount of solvent is kept in a container for cleaning the nozzle.

Repair and maintenance of old boilers includes cleaning tubes with wire brushes, cutting and threading new tubes using a nonhazardous cutting oil. Cutting torches and welding equipment are used. Boiler tubes are cleaned with wire brushes.

Few rags are used and they are disposed of in a dumpster. In addition, the empty paint cans and 20 pounds of spent clay absorbent per month are also disposed of in the dumpster. All metal waste is sold to a recycler, including the metal and aluminum shavings containing the nonhazardous cutting oil.

Prior to painting, the metal surfaces are cleaned with a solvent. Twenty gallons are used per month. It was recommended that a less hazardous metal cleaning solvent be used and that rags be laundered.

Appliance Repair Shop

This one-person commercial and domestic appliance repair shop conducts 10 percent of its repair work on commercial equipment. Even if this shop were to operate at a 100 percent commercial repair level, generation of hazardous waste would not be significant. Parts are replaced in malfunctioning equipment and some gear cleaning is performed in certain parts replacement operations. Used parts are left in a box at the rear of the shop to be picked up for recycling.

A weak acid (acetic acid) is used to clean commercial steam irons and coffee pots. The spent acid, which is probably close to neutral pH, is diposed of to the local sewer district. One-half gallon of acetic acid (vinegar) is used per month.

Because very little hazardous waste was generated, it was not necessary for the shop to improve waste management. It was recommended, however, that a less flammable solvent than lighter fluid be used as a parts cleaning solvent.

Lawnmower Repair Shop

This two-person lawnmower and chainsaw repair shop does 75 percent commercial repairs and 25 percent domestic repairs. It is a well-run shop, with excellent housekeeping procedures and up-to-date waste disposal technology. Waste oil is collected and taken to a service center. Parts cleaning and carburetor cleaning tanks are leased. Rags are laundered weekly. Minimal waste is put into the dumpster or down the drain.

Wastes produced include 5 gallons of carburetor cleaner changed every 3 months (no cost available) and 10 gallons of solvent changed monthly ($27.00); 20 gallons of used oil, which is taken to a service center (free); and 25 to 30 contaminated rags, which

are laundered weekly (no cost available). Monthly disposal costs are under $100.00.

Parts that are washed with carburetor cleaner should be properly drained prior to rinsing with water. Some minor concrete staining was observed in the used oil collection area. Care should be taken to avoid spillage when transferring oil to a 15-gallon storage tank. The quantity of metal shavings generated and mixed with cutting oil is minimal.

Air Conditioning Repair Shop A

This air conditioning repair shop has a fleet of 13 trucks and does all repairs in the field. Twenty percent of the repairs involve commercial equipment. Parts replacement, Freon recharging, spray paint touchup, copper tubing cutting, and soldering are the main processes performed by this shop. Rags and empty canisters are placed in the dumpster monthly.

Waste minimization could be instituted by designing Freon canisters that can be refilled. A replacement for paint canisters would help to reduce the release of aerosol into the atmosphere.

Air Conditioning Repair Shop B

This shop repairs air conditioners and heaters, and installs air ducts and air conditioners. It has a staff of three to four and generates minimal hazardous waste.

Motors and compressors are returned for rebuilding, and used parts are recycled as scrap metal. Contaminated rags are laundered. Coils and condensers are steam cleaned. A corrosive cleaner containing potassium hydroxide and sodium metasilicate is also used. Spray paint aerosols are used for touchup work.

In the shop storeroom are several containers of obsolete cleaning chemicals, scale inhibitors, and rust inhibitors. No MSDSs were available for these or any other chemicals, and the owner and shop manager were unaware of their existence.

Refillable Freon cans would reduce the volume of material being deposited in a municipal dump. A replacement for the spray canisters' aerosol would reduce atmospheric emissions.

Good housekeeping procedures were in effect. It was recommended that MSDS sheets be obtained for all hazardous chemicals used on site and that the obsolete chemicals be lab packed and disposed of by a licensed hazardous waste hauler.

Electric Motor Repair Shop A

Electric motors, welders, generators, and winches are repaired by this electric repair shop, which employs ten people. No rewinding operations are performed in house. Waste streams result from internal oil and grease removal from motor winches, hoists, and welders (55 gal/month) and solvent from cleaning the parts of electric motors, generators, and welders (15 gal/month).

Specialized paints (which may be classified as polyurethane, enamel, insulator, and gasket coat) are used in electric motor repair to protect various parts. All paints are applied from aerosol spray cans. A special selection of oils and greases are also required for different equipment parts. Many of the chemicals from the inventory were purchased by the previous owner. The repair shop is in the process of replacing them with less hazardous chemicals as the old stock is used up.

The shop recently implemented waste minimization by converting to a solvent recycling program. Prior to this time, waste solvents and sludge were mixed with used oil. Solvents previously used for spray booth painting have been eliminated since the shop now subcontracts this work. In addition, chemicals, especially oils, are ordered in smaller containers and smaller quantities to avoid waste.

Housekeeping practices can be improved by disposing the 25 pounds of spent absorbent, by laundering the 25 pounds of dirty rags produced per month, and by berming areas where chemical drip occurs.

Electric Motor Repair Shop B

This large repair shop employs 75 to 80 people. Approximately 50 percent of the work is outside electrical construction. In-house repairs involve motor testing, cleaning, dismantling, stripping, rewinding, and painting. Space within the shop is allocated to each process. The chemical inventory in this shop

was very diverse and included chemicals used in rewinding and in field repairs.

Most of the aerosol cans (which are specialized cleaners, paints, potting resins, sealants, and lubricants) contain hazardous materials. Examples include CRC Cable Clean (1,1,1 trichloroethane, 96 percent), CO Contact Cleaner (trichlorotrifluoroethane, 96.5 percent), CRC Electrical Quality Silicone (1,1,1 trichloroethane, 97 percent), Dolph Spray AC-29-7S (xylene, 9.24 percent; MEK, 9 percent; methylene chloride, 22 percent), and Brownell Red Insulator (xylene, 15 percent; toluene, 5 percent; MEK, 10 percent; methylene chloride, 20 percent).

Paint removal, which was previously performed with Marine Grade Paint and Varnish Remover (methylene chloride, 66 percent; 1,1,1 trichloroethane, 8 percent), has been replaced by sand blasting or using a burn oven.

The repair shop has converted from heavy solvent usage to steam cleaning for cleaning motors. Although the cost is slightly higher for the steam cleaning operation, the owner does not have to contend with worker exposure to chemicals and the liability that results from hazardous waste disposal. Process time is longer with steam cleaning.

The shop is well run, with excellent housekeeping procedures. Waste oils and scrap metals are recycled. Rags are laundered.

Tool Repair Shop

This pneumatic equipment repair shop repairs and rents hoists, winches, and assorted tools. Approximately 10 percent of the repairs pertain to rental tools. Six people perform the repairs at assigned stations within the shop.

A wide variety of greases were observed in the storage area as a result of the many different requirements in repairing motors and hoists. This shop has the unique problem of having to use many different colors of paint to identify equipment for various contractors. The manager has expressed concern over the high number of spray cans used, but he is unable to come up with a solution since so many different colors are applied and a spray booth system would not be suitable.

Paint and rust are removed by either sand blasting with plastic pellets, sanding, or milling. Five solvent sinks and a carburetor cleaner drum used for parts cleaning were recently installed. Prior to this, solvents were mixed with the used oil.

Steam cleaning is performed on certain equipment. The wastewater goes directly to the drain. Use of detergent is minimal.

The shop is well run, clean, and has excellent housekeeping procedures. However, a sump should be constructed for the steam cleaning unit to collect hazardous material. Workers have a tendency to leave solvent sink pumps on when they are not being used. Solvent evaporation could be reduced by shutting off the pump when the sink is not in use.

Millwright Repair Shop

Millwrights are machinery movers and erectors. They erect, assemble, level, and align new and old equipment. Not many millwrights venture into this field as their only business. Generally, trucking and millwright operations are combined.

At the repair shop surveyed for this assessment, repairs to equipment being installed are generally done at the job site. Boiler repair and cleaning are subcontracted, as are any major paint jobs. Special parts are fabricated in the repair shop. Many of the chemicals reported pertain to vehicle maintenance. Very little of the chemicals used and waste generated arises from actual equipment repair. Spent absorbent, metal shavings with cutting oil, and empty cans are disposed in the dumpster. Less than 5 gallons per month of used oil are generated from equipment. Since processes that generate hazardous waste (i.e., spray painting) are subcontracted, this millwright does not generate much hazardous waste. A leased solvent sink and a laundry service for contaminated rags further reduces waste.

Rental Repair Shop A

This diverse welding equipment/rental repair shop specializes in tools and equipment for boiler and refinery repairs. The shop rents, repairs, and rebuilds

welders; generators; hoists; and hydraulic, pneumatic, and electric tools. Spray paint cans are used to touch up equipment, and major paint jobs are subcontracted. Minimal waste is generated from repairs and rebuilding. The shop, however, needs to address its solvent disposal procedure and method of rag disposal. A solvent tank should be leased, and contaminated rags should be laundered. The waste oil drum should be covered and labelled, and a concrete pad and berm should be constructed to support it.

Rental Repair Shop B

This shop rents heavy earth-moving equipment, as well as lifts, generators, tools, and pumps. It has incorporated several waste minimization activities. These include replacing oil-based paints with water-based paints in the spray booth operation, renting solvent tanks, laundering rags, and eliminating spray cans and brake cleaning fluid. Overall, this operation was very well run.

Appendix B
WHERE TO GET HELP: FURTHER INFORMATION ON POLLUTION PREVENTION

Additional information on source reduction, reuse and recycling approaches to pollution prevention is available in EPA reports listed in this section, and through state programs and regional EPA offices (listed below) that offer technical and/or financial assistance in the areas of pollution prevention and treatment.

Waste exchanges have been established in some areas of the U.S. to put waste generators in contact with potential users of the waste. Twenty-four exchanges operating in the U.S. and Canada are listed. Finally, relevant industry associations are listed.

U.S. EPA Reports on Waste Minimization

Facility Pollution Prevention Guide. EPA/600/R-92/088.*

Waste Minimization Opportunity Assessment Manual. EPA/625/7-88/003.*

Waste Minimization Audit Report: Case Studies of Corrosive and Heavy Metal Waste Minimization Audit at a Specialty Steel Manufacturing Complex. Executive Summary. EPA No. PB88-107180.**

Waste Minimization Audit Report: Case Studies of Minimization of Solvent Waste for Parts Cleaning and from Electronic Capacitor Manufacturing Operation. Executive Summary. EPA NO. PB87-227013.**

Waste Minimization Audit Report: Case Studies of Minimization of Cyanide Wastes from Electroplating Operations. Executive Summary. EPA No. PB87-229662.**

Report to Congress: Waste Minimization, Vols. I and II. EPA/530-SW-86-033 and -034 (Washington, D.C.: U.S. EPA, 1986).***

Waste Minimization—Issues and Options, Vols. I-III. EPA/530-SW-86-041 through -043. (Washington, D.C.: U.S. EPA, 1986.)***

The Guides to Pollution Prevention manuals* describe waste minimization options for specific industries. This is a continuing series which currently includes the following titles:

Guides to Pollution Prevention: Paint Manufacturing Industry. EPA/625/7-90/005.

Guides to Pollution Prevention: The Pesticide Formulating Industry. EPA/625/7-90/004.

Guides to Pollution Prevention: The Commercial Printing Industry. EPA/625/7-90/008.

Guides to Pollution Prevention: The Fabricated Metal Industry. EPA/625/7-90/006.

Guides to Pollution Prevention for Selected Hospital Waste Streams. EPA/625/7-90/009.

Guides to Pollution Prevention: Research and Educational Institutions. EPA/625/7-90/010.

Guides to Pollution Prevention: The Printed Circuit Board Manufacturing Industry. EPA/625/7-90/007.

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* Available from EPA CERI Publications Unit (513) 569-7562, 26 West Martin Luther King Drive, Cincinnati, OH, 45268.

** Executive Summary available from EPA, CERI Publications Unit, (513) 569-7562, 26 West Martin Luther King Drive, Cincinnati, OH, 45268; full report available from the National Technical Information Service (NTIS), U.S. Department of Commerce, Springfield, VA, 22161.

*** Available from the National Technical Information Service as a five-volume set, NTIS No. PB-87-114-328.

Guides to Pollution Prevention: The Pharmaceutical Industry. EPA/625/7-91/017.

Guides to Pollution Prevention: The Photoprocessing Industry. EPA/625/7-91/012.

Guides to Pollution Prevention: The Fiberglass Reinforced and Composite Plastic Industry. EPA/625/7-91/014.

Guides to Pollution Prevention: The Automotive Repair Industry. EPA/625/7-91/013.

Guides to Pollution Prevention: The Automotive Refinishing Industry. EPA/625/7-91/016.

Guides to Pollution Prevention: The Marine Maintenance and Repair Industry. EPA/625/7-91/015.

Guides to Pollution Prevention: The Metal Casting and Heat Treating Industry.

Guides to Pollution Prevention: Mechanical Equipment Repair Shops.

Guides to Pollution Prevention: The Metal Finishing Industry.

U.S. EPA Pollution Prevention Information Clearing House (PPIC): *Electronic Information Exchange System (EIES)—User Guide, Version 1.1.* EPA/600/9-89/086.

Waste Reduction Technical/ Financial Assistance Programs

The EPA Pollution Prevention Information Clearinghouse (PPIC) was established to encourage waste reduction through technology transfer, education, and public awareness. PPIC collects and disseminates technical and other information about pollution prevention through a telephone hotline and an electronic information exchange network. Indexed bibliographies and abstracts of reports, publications, and case studies about pollution prevention are available. PPIC also lists a calendar of pertinent conferences and seminars, information about activities abroad, and a directory of waste exchanges. Its Pollution Prevention Information Exchange System (PIES) can be accessed electronically 24 hours a day without fees.

For more information contact:

PIES Technical Assistance
Science Applications International Corp.
8400 Westpark Drive
McLean, VA 22102
(703) 821-4800

or

U.S. Environmental Protection Agency
401 M Street S.W.
Washington, D.C. 20460

Myles E. Morse
Office of Environmental Engineering and Technology Demonstration
(202) 475-7161

Priscilla Flattery
Pollution Prevention Office
(202) 245-3557

The EPA's Office of Solid Waste and Emergency Response has a telephone call-in service to answer questions regarding RCRA and Superfund (CERCLA). The telephone numbers are:

(800) 242-9346 (outside the District of Columbia)

(202) 382-3000 (in the District of Columbia)

The following programs offer technical and/or financial assistance for waste minimization and treatment.

Alabama

Hazardous Material Management and Resource Recovery Program
University of Alabama
P.O. Box 6373
Tuscaloosa, AL 35487-6373
(205) 348-8401

Department of Environmental Management
1751 Federal Drive
Montgomery, AL 36130
(205) 271-7914

Alaska
Alaska Health Project
Waste Reduction Assistance Program
431 West Seventh Avenue, Suite 101
Anchorage, AK 99501
(907) 276-2864

Arizona
Arizona Department of Economic Planning and Development
1645 West Jefferson Street
Phoenix, AZ 85007
(602) 255-5705

Arkansas
Arkansas Industrial Development Commission
One State Capitol Mall
Little Rock, AR 72201
(501) 371-1370

California
Alternative Technology Section
Toxic Substances Control Division
California State Department of Health Services
714/744 P Street
Sacramento, CA 94234-7320
(916) 324-1807

Pollution Prevention Program
San Diego County Department of Health Services
Hazardous Materials Management Division
P.O. Box 85261
San Diego, CA 92186-5261
(619) 338-2215

Colorado
Division of Commerce and Development Commission
500 State Centennial Building
Denver, CO 80203
(303) 866-2205

Connecticut
Connecticut Hazardous Waste Management Service
Suite 360
900 Asylum Avenue
Hartford, CT 06105
(203) 244-2007

Connecticut Department of Economic Development
210 Washington Street
Hartford, CT 06106
(203) 566-7196

Delaware
Delaware Department of Community Affairs & Economic Development
630 State College Road
Dover, DE 19901
(302) 736-4201

District of Columbia
U.S. Department of Energy
Conservation and Renewable Energy
Office of Industrial Technologies
Office of Waste Reduction, Waste Material Management Division
Bruce Cranford CE-222
Washington, DC 20585
(202) 586-9496

Pollution Control Financing Staff
Small Business Administration
1441 "L" Street, N.W., Room 808
Washington, DC 20416
(202) 653-2548

Florida
Waste Reduction Assistance Program
Florida Department of Environmental Regulation
2600 Blair Stone Road
Tallahassee, FL 32399-2400
(904) 488-0300

Georgia
Hazardous Waste Technical Assistance Program
Georgia Institute of Technology
Georgia Technical Research Institute
Environmental Health and Safety Division
O'Keefe Building, Room 027
Atlanta, GA 30332
(404) 894-3806

Environmental Protection Division
Georgia Department of Natural Resources
205 Butler Street, S.E., Suite 1154
Atlanta, GA 30334
(404) 656-2833

Guam
Solid and Hazardous Waste Management Program
Guam Environmental Protection Agency
IT&E Harmon Plaza, Complex Unit D-107
130 Rojas Street
Harmon, Guam 96911
(671) 646-8863-5

Hawaii
Department of Planning & Economic Development
Financial Management and Assistance Branch
P.O. Box 2359
Honolulu, HI 96813
(808) 548-4617

Idaho
IDHW-DEQ
Hazardous Materials Bureau
450 West State Street, 3rd Floor
Boise, ID 83720
(208) 334-5879

Illinois
Hazardous Waste Research and Information Center
Illinois Department of Energy and Natural Resources
One East Hazelwood Drive
Champaign, IL 61820
(217) 333-8940

Illinois Waste Elimination Research Center
Pritzker Department of Environmental Engineering
Alumni Memorial Hall, Room 103
Illinois Institute of Technology
3201 South Dearborn
Chicago, IL 60616
(312) 567-3535

Indiana
Environmental Management and Education Program
School of Civil Engineering
Purdue University
2129 Civil Engineering Building
West Lafayette, IN 47907
(317) 494-5036

Indiana Department of Environmental Management
Office of Technical Assistance
P.O. Box 6015
105 South Meridian Street
Indianapolis, IN 46206-6015
(317) 232-8172

Iowa
Center for Industrial Research and Service
Iowa State University
Suite 500, Building 1
2501 North Loop Drive
Ames, IA 50010-8286
(515) 294-3420

Iowa Department of Natural Resources
Air Quality and Solid Waste Protection Bureau
Wallace State Office Building
900 East Grand Avenue
Des Moines, IA 50319-0034
(515) 281-8690

Waste Management Authority
Iowa Department of Natural Resources
Henry A. Wallace Building
900 East Grand
Des Moines, IA 50319
(515) 281-8489

Iowa Waste Reduction Center
University of Northern Iowa
75 Biology Research Complex
Cedar Falls, IA 50614
(319) 273-2079

Kansas
Bureau of Waste Management
Department of Health and Environment
Forbes Field, Building 730
Topeka, KS 66620
(913) 269-1607

Kentucky
Division of Waste Management
Natural Resources and Environmental Protection Cabinet
18 Reilly Road
Frankfort, KY 40601
(502) 564-6716

Kentucky Partners
Room 312 Ernst Hall
University of Louisville
Speed Scientific School
Louisville, KY 40292
(502) 588-7260

Louisiana
Department of Environmental Quality
Office of Solid and Hazardous Waste
P.O. Box 44307
Baton Rouge, LA 70804
(504) 342-1354

Maine
State Planning Office
184 State Street
Augusta, ME 04333
(207) 289-3261

Maryland
Maryland Hazardous Waste Facilities Siting Board
60 West Street, Suite 200 A
Annapolis, MD 21401
(301) 974-3432

Massachusetts
Office of Technical Assistance
Executive Office of Environmental Affairs
100 Cambridge Street, Room 1904
Boston, MA 02202
(617) 727-3260

Source Reduction Program
Massachusetts Department of Environmental Quality Engineering
1 Winter Street
Boston, MA 02108
(617) 292-5982

Michigan
Resource Recovery Section
Department of Natural Resources
P.O. Box 30028
Lansing, MI 48909
(517) 373-0540

Minnesota
Minnesota Pollution Control Agency
Solid and Hazardous Waste Division
520 Lafayette Road
St. Paul, MN 55155
(612) 296-6300

Minnesota Technical Assistance Program
1313 5th Street, S.E., Suite 207
Minneapolis, MN 55414
(612) 627-4646
(800) 247-0015 (in Minnesota)

Mississippi
Waste Reduction & Minimization Program
Bureau of Pollution Control
Department of Environmental Quality
P.O. Box 10385
Jackson, MS 39289-0385
(601) 961-5190

Missouri
State Environmental Improvement and Energy Resources Agency
P.O. Box 744
Jefferson City, MO 65102
(314) 751-4919

Waste Management Program
Missouri Department of Natural Resources
Jefferson Building, 13th Floor
P.O. Box 176
Jefferson City, MO 65102
(314) 751-3176

Nebraska
Land Quality Division
Nebraska Department of Environmental Control
Box 98922
State House Station
Lincoln, NE 68509-8922
(402) 471-2186

Hazardous Waste Section
Nebraska Department of Environmental Control
P.O. Box 98922
Lincoln, NE 68509-8922
(402) 471-2186

New Jersey
New Jersey Hazardous Waste Facilities Siting Commission
Room 514
28 West State Street
Trenton, NJ 08625
(609) 292-1459
(609) 292-1026

Hazardous Waste Advisement Program
Bureau of Regulation and Classification
New Jersey Department of Environmental Protection
401 East State Street
Trenton, NJ 08625
(609) 292-8341

Risk Reduction Unit
Office of Science and Research
New Jersey Department of Environmental Protection
401 East State Street
Trenton, NJ 08625
(609) 292-8341

New Mexico
Economic Development Department
Bataan Memorial Building
State Capitol Complex
Santa Fe, NM 87503
(505) 827-6207

New York
New York Environmental Facilities Corporation
50 Wolf Road
Albany, NY 12205
(518) 457-4222

North Carolina
Pollution Prevention Pays Program
Department of Natural Resources and Community Development
P.O. Box 27687
512 North Salisbury Street
Raleigh, NC 27611-7687
(919) 733-7015

Governor's Waste Management Board
P.O. Box 27687
325 North Salisbury Street
Raleigh, NC 27611-7687
(919) 733-9020

Technical Assistance Unit
Solid and Hazardous Waste Management Branch
North Carolina Department of Human Resources
P.O. Box 2091
306 North Wilmington Street
Raleigh, NC 27602
(919) 733-2178

North Dakota
North Dakota Economic Development Commission
Liberty Memorial Building
State Capitol Grounds
Bismarck, ND 58505
(701) 224-2810

Ohio
Division of Hazardous Waste Management
Division of Solid and Infectious Waste Management
Ohio Environmental Protection Agency
P.O. Box 1049
1800 Watermark Drive
Columbus, OH 43266-0149
(614) 644-2917

Oklahoma
Industrial Waste Elimination Program
Oklahoma State Department of Health
P.O. Box 53551
Oklahoma City, OK 73152
(405) 271-7353

Oregon
Oregon Hazardous Waste Reduction Program
Department of Environmental Quality
811 Southwest Sixth Avenue
Portland, OR 97204
(503) 229-5913
(800) 452-4011 (in Oregon)

Pennsylvania
Pennsylvania Technical Assistance Program
501 F. Orvis Keller Building
University Park, PA 16802
(814) 865-0427

Center of Hazardous Material Research
Subsidiary of the University of Pittsburgh Trust
320 William Pitt Way
Pittsburgh, PA 15238
(412) 826-5320
(800) 334-2467

Puerto Rico
Government of Puerto Rico
Economic Development Administration
Box 2350
San Juan, PR 00936
(809) 758-4747

Rhode Island
Hazardous Waste Reduction Section
Office of Environmental Management
83 Park Street
Providence, RI 02903
(401) 277-3434
(800) 253-2674 (in Rhode Island)

South Carolina
Center for Waste Minimization
Department of Health and Environmental Control
2600 Bull Street
Columbia, SC 29201
(803) 734-4715

South Dakota
Department of State Development
P.O. Box 6000
Pierre, SD 57501
(800) 843-8000

Tennessee
Center for Industrial Services
University of Tennessee
Building #401
226 Capitol Boulevard
Nashville, TN 37219-1804
(615) 242-2456

Bureau of Environment
Tennessee Department of Health and Environment
150 9th Avenue North
Nashville, TN 37219-5404
(615) 741-3657

Tennessee Hazardous Waste Minimization Program
Tennessee Department of Economic and Community Development
Division of Existing Industry Services
7th Floor, 320 6th Avenue, North
Nashville, TN 37219
(615) 741-1888

Texas
Texas Economic Development Authority
410 East Fifth Street
Austin, TX 78701
(512) 472-5059

Utah
Utah Division of Economic Development
6150 State Office Building
Salt Lake City, UT 84114
(801) 533-5325

Vermont
Economic Development Department
Pavilion Office Building
Montpelier, VT 05602
(802) 828-3221

Virginia
Office of Policy and Planning
Virginia Department of Waste Management
11th Floor, Monroe Building
101 North 14th Street
Richmond, VA 23219
(804) 225-2667

Washington
Hazardous Waste Section
Mail Stop PV-11
Washington Department of Ecology
Olympia, WA 98504-8711
(206) 459-6322

West Virginia
Governor's Office of Economics and Community Development
Building G, Room B-517
Capitol Complex
Charleston, WV 25305
(304) 348-2234

Wisconsin
Bureau of Solid Waste Management
Wisconsin Department of Natural Resources
P.O. Box 7921
101 South Webster Street
Madison, WI 53707
(608) 267-3763

Wyoming
Solid Waste Management Program
Wyoming Department of Environmental Quality
Herschler Building, 4th Floor, West Wing
122 West 25th Street
Cheyenne, WY 82002
(307) 777-7752

Waste Exchanges

Alberta Waste Materials Exchange
Mr. William C. Kay
Alberta Research Council
P.O. Box 8330
Postal Station F
Edmonton, Alberta
CANADA T6H 5X2
(403) 450-5408

British Columbia Waste Exchange
Ms. Judy Toth
2150 Maple Street
Vancouver, B.C.
CANADA V6J 3T3
(604) 731-7222

California Waste Exchange
Mr. Robert McCormick
Department of Health Services
Toxic Substances Control Program
Alternative Technology Division
P.O. Box 942732
Sacramento, CA 94234-7320
(916) 324-1807

Canadian Chemical Exchange*
Mr. Philippe LaRoche
P.O. Box 1135
Ste-Adele, Quebec
CANADA J0R 1L0
(514) 229-6511

Canadian Waste Materials Exchange
ORTECH International
Dr. Robert Laughlin
2395 Speakman Drive
Mississauga, Ontario
CANADA L5K 1B3
(416) 822-4111 (Ext. 265)
FAX: (416) 823-1446

Enstar Corporation*
Mr. J. T. Engster
P.O. Box 189
Latham, NY 12110
(518) 785-0470

Great Lakes Regional Waste Exchange
400 Ann Street, N.W., Suite 204
Grand Rapids, MI 49504
(616) 363-3262

Indiana Waste Exchange
Dr. Lynn A. Corson
Purdue University
School of Civil Engineering
Civil Engineering Building
West Lafayette, IN 47907
(317) 494-5036

Industrial Materials Exchange
Mr. Jerry Henderson
172 20th Avenue
Seattle, WA 98122
(206) 296-4633
FAX: (206) 296-0188

Industrial Materials Exchange Service
Ms. Diane Shockey
P.O. Box 19276
Springfield, IL 62794-9276
(217) 782-0450
FAX: (217) 524-4193

Industrial Waste Information Exchange
Mr. William E. Payne
New Jersey Chamber of Commerce
5 Commerce Street
Newark, NJ 07102
(201) 623-7070

Manitoba Waste Exchange
Mr. James Ferguson
c/o Biomass Energy Institute, Inc.
1329 Niakwa Road
Winnipeg, Manitoba
CANADA R2J 3T4
(204) 257-3891

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*For-Profit Waste Information Exchange

Montana Industrial Waste Exchange
Mr. Don Ingles
Montana Chamber of Commerce
P.O. Box 1730
Helena, MT 59624
(406) 442-2405

New Hampshire Waste Exchange
Mr. Gary J. Olson
c/o NHRRA
P.O. Box 721
Concord, NH 03301
(603) 224-6996

Northeast Industrial Waste Exchange, Inc.
Mr. Lewis Cutler
90 Presidential Plaza, Suite 122
Syracuse, NY 13202
(315) 422-6572
FAX: (315) 422-9051

Ontario Waste Exchange
ORTECH International
Ms. Linda Varangu
2395 Speakman Drive
Mississauga, Ontario
CANADA L5K 1B3
(416) 822-4111 (Ext. 512)
FAX: (416) 823-1446

Pacific Materials Exchange
Mr. Bob Smee
South 3707 Godfrey Boulevard
Spokane, WA 99204
(509) 623-4244

Peel Regional Waste Exchange
Mr. Glen Milbury
Regional Municipality of Peel
10 Peel Center Drive
Brampton, Ontario
CANADA L6T 4B9
(416) 791-9400

RENEW
Ms. Hope Castillo
Texas Water Commission
P.O. Box 13087
Austin, TX 78711-3087
(512) 463-7773
FAX: (512) 463-8317

San Francisco Waste Exchange
Ms. Portia Sinnott
2524 Benvenue #35
Berkeley, CA 94704
(415) 548-6659

Southeast Waste Exchange
Ms. Maxie L. May
Urban Institute
UNCC Station
Charlotte, NC 28223
(704) 547-2307

Southern Waste Information Exchange
Mr. Eugene B. Jones
P.O. Box 960
Tallahassee, FL 32302
(800) 441-SWIX (7949)
(904) 644-5516
FAX: (904) 574-6704

Tennessee Waste Exchange
Ms. Patti Christian
226 Capital Boulevard, Suite 800
Nashville, TN 37202
(615) 256-5141
FAX: (615) 256-6726

Wastelink, Division of Tencon, Inc.
Ms. Mary E. Malotke
140 Wooster Pike
Milford, OH 45150
(513) 248-0012
FAX: (513) 248-1094

U.S. EPA Regional Offices

Region 1 (VT, NH, ME, MA, CT, RI)
John F. Kennedy Federal Building
Boston, MA 02203
(617) 565-3715

Region 2 (NY, NJ, PR, VI)
26 Federal Plaza
New York, NY 10278
(212) 264-2525

Region 3 (PA, DE, MD, WV, VA, DC)
841 Chestnut Street
Philadelphia, PA 19107
(215) 597-9800

Region 4 (KY, TN, NC, SC, GA, FL, AL, MS)
345 Courtland Street, N.E.
Atlanta, GA 30365
(404) 347-4727

Region 5 (WI, MN, MI, IL, IN, OH)
230 South Dearborn Street
Chicago, IL 60604
(312) 353-2000

Region 6 (NM, OK, AR, LA, TX)
1445 Ross Avenue
Dallas, TX 75202
(214) 655-6444

Region 7 (NE, KS, MO, IA)
756 Minnesota Avenue
Kansas City, KS 66101
(913) 236-2800

Region 8 (MT, ND, SD, WY, UT, CO)
999 18th Street
Denver, CO 80202-2405
(303) 293-1603

Region 9 (CA, NV, AZ, HI, GU)
75 Hawthorne Street
San Francisco, CA 94105
(415) 744-1305

Region 10 (AK, WA, OR, ID)
1200 Sixth Avenue
Seattle, WA 98101
(206) 442-5810

Industry & Trade Associations

Air Conditioning and Refrigeration Institute
1501 Wilson Boulevard, 6th Floor
Arlington, VA 22209
(703) 524-8000

American Welding Society
P.O. Box 351040
550 LeJeune Road, NW
Miami, FL 33135
(305) 443-9353

National Board of Boilers and Pressure Vessel Inspectors
1055 Crupper Avenue
Columbus, OH 43229
(614) 888-8320

National Electrical Manufacturing Association
2101 L Street, NW
Washington, DC 20037
(202) 457-8400

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United States
Environmental Protection Agency
Center for Environmental Research Information
Cincinnati, OH 45268

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