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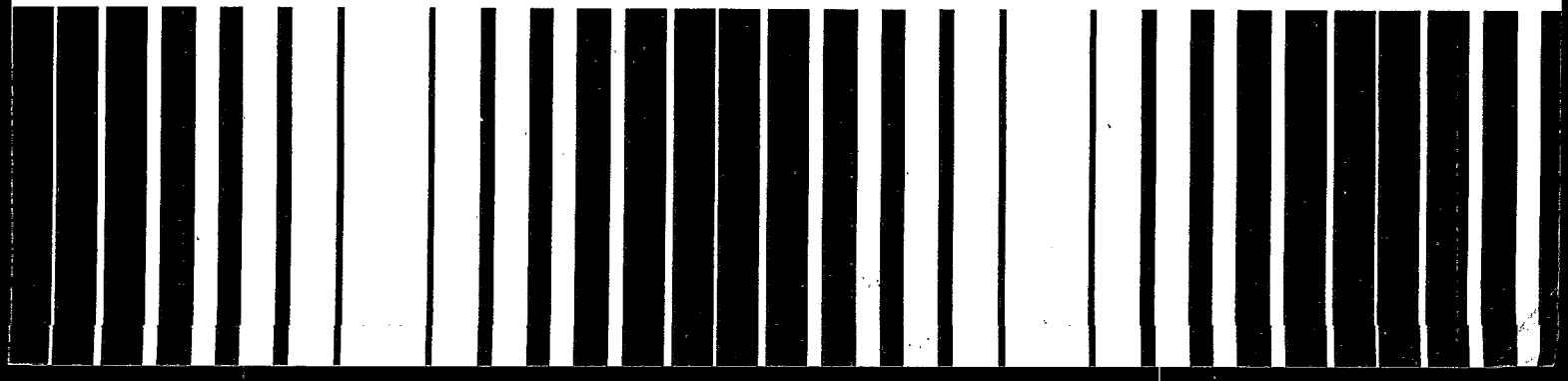
Guides to Pollution Prevention

The Automotive Refinishing Industry



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Guides to Pollution Prevention

The Automotive Refinishing Industry

Risk Reduction Engineering Laboratory
and
Center for Environmental Research Information
Office of Research and Development
U.S. Environmental Protection Agency
Cincinnati, OH 45268

Notice

This guide has been subjected to the U.S. Environmental Protection Agency's peer and administrative review and approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

This document is intended as advisory guidance only to automotive refinishers 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 automotive refinishing operations. Users are encouraged to duplicate portions of this publication as needed to implement a waste minimization program.

Foreword

This report provides many waste minimization options for reducing wastes generated by the automotive refinishing industry. It also includes case studies of six California shops and worksheets to assist automotive refinishers in performing waste minimization self-assessment. Some of the major options for reducing waste include:

Source reduction. Rigid inventory control should be implemented to as great a degree as possible, since this tends to reduce solvents/thinner use and waste generation. Operator training in ways to reduce overspray should be provided. In addition, the use of high transfer efficiency spray equipment and enclosed gun cleaning systems is recommended. Improved housekeeping measures can reduce wastes in many shops. These include covering solvent containers to reduce evaporation and using dry cleanup methods to collect filler dust. Refinishers should also consider using alternative coatings such as low-solvent or water-borne paints, since this not only minimizes waste but reduces VOC emissions. Vehicles received at the facilities should be examined for leaking automotive fluids. Drip pans should be placed under these leaks to avoid spills on the floor which tend to be washed into drains.

Recycling. All waste solvents/thinners and oils should be recycled. At the shops described in the Appendix A case studies, most thinner recycling is done through the solvent supplier and is part of the purchase price of the solvent. Large companies might consider installing in-house recycling equipment.

Contents

Acknowledgments

This guide is based on waste minimization assessments conducted by SCS Engineers for the California Department of Health Services (DHS) under the direction of Benjamin Fries, DHS Toxic Substances Control Program, Alternative Technology Division. Additional information was taken from waste minimization assessments performed by Jacobs Engineering Group Inc. (Jacobs) for the City of Santa Monica (CSM) under the direction of Brian Johnson, CSM Water/Wastewater Division, Department of General Services. Jacobs edited and developed this version of the waste minimization assessment guide, under subcontract to PEI Associates (USEPA Contract 68-D8-0112). Michael S. Callahan, P.E., was the author. 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 document. Rodney Marsh of SCS Engineers, Fred Russell, P.E., and Billy Hamblin of Collision Specialist, Rob Rebensal of Superior Body and Fender, and Doug Davis of Akzo Coatings served as reviewers.

Section 1
Introduction

This guide is designed to provide automotive refinishers with waste minimization options appropriate for their industry. It also provides worksheets designed to be used for a waste minimization assessment of an automotive refinishing shop, to develop an understanding of the waste generation processes and to suggest ways that the waste may be reduced.

The guide is designed primarily for use by automotive refinishers. Others who may find this document useful are operators of vehicle fleets, regulatory agency representatives, and consultants. In the following sections of this report you will find:

- An overview of the automotive refinishing industry (Section 2);
- Waste minimization options for automotive refinishers (Section 3);
- Waste minimization assessment worksheets (Section 4);
- Appendices, containing:
  - Case studies of six automotive refinishing shops. Also included are completed waste minimization assessment worksheets for a hypothetical shop.
  - Where to get help: Regional EPA offices and other sources.

The worksheets and the list of waste minimization options were developed through assessments of six Southern California area automotive shops as commissioned by the California Department of Health Services (Calif. DHS 1987). The firms' operations and waste generation and management practices were surveyed, and their existing and potential waste minimization options were characterized. Economic analyses were performed on selected options. Additional information was developed from the assessment of a Southern California automotive refinishing shop commissioned by the City of Santa Monica Department of General Services (CSM 1989)

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 environmentally 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 Assessments

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. 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 on-going one.

A Waste Minimization Opportunity Assessment (WMOA) 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 illustrated in Figure 1 and are presented in more detail on the following page. 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.

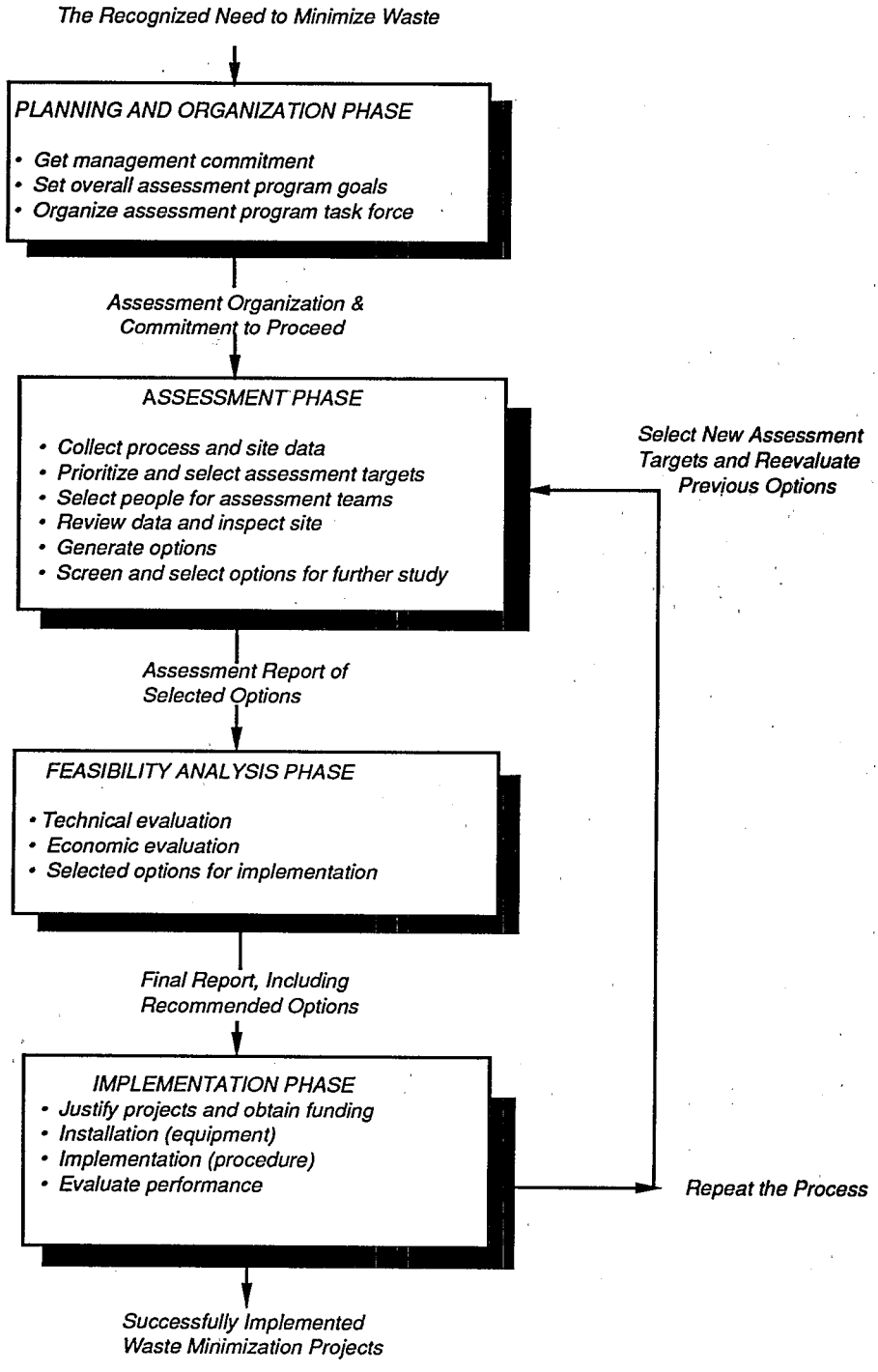

Figure 1. The Waste Minimization Assessment Procedure.

Planning and Organization

Essential elements of planning and organization for waste minimization are: getting management commitment; setting waste minimization goals; and organizing an assessment task force.

Assessment Phase

The assessment involves a number of steps:

1. Collect process data
2. Prioritize and select assessment targets
3. Select assessment team
4. Review data and inspect site
5. Generate options
6. Screen and select options for feasibility study

Collect process data. The waste streams at a shop or plant 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 is essential to waste minimization. Flow diagrams should be prepared to identify the quantity, types, and rates of waste generated. Preparing material balances for various processes can be useful in tracking various process components and identifying losses and emissions that may have been unaccounted for previously.

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

Select assessment team. The team should include people with direct responsibility and knowledge of the particular waste stream or area of the plant.

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 the shop or plant to the points where products and wastes leave. The team should identify the suspected sources of waste. This may include the production process; maintenance operations; and storage areas for raw materials, finished product, 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 trade associations, government agencies, technical and trade reports, equipment vendors, consultants, and 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 waste, and reclamation.

Screen and select options for further study. This screening process is intended to select the most promising options for 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 consideration.

Feasibility Analysis

An option must be shown to be technically and economically feasible in order to merit serious consideration for adoption. 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. Also, any new products developed through process and/or raw material changes need to be tested for market acceptance.

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 also need to be considered.

Implementation

An option that passes both technical and economic feasibility reviews should then be implemented. It is up to the assessment team, with management support, to continue the process of tracking wastes and identifying opportunities for waste minimization by way of periodic reassessments. Either such ongoing reassessments or an initial investigation of waste minimization opportunities can be conducted using this manual.

References

Calif. DHS. 1987. *Waste audit study: automotive paint shops.* Report prepared by SCS Engineers, Long Beach, CA for the California Department of Health Services, Alternative Technology Section, Toxic Substances Control Division, January 1987.

CSM. 1989. *Hazardous waste minimization audits of automotive repair and refinishing facilities.* Prepared by Jacobs Engineering Group Inc. Pasadena, CA, for the City of Santa Monica Department of General Services. September 1989.

USEPA. 1988. *Waste minimization opportunity assessment manual.* EPA 625/7-88/003. Prepared by Jacobs Engineering Group Inc. Pasadena, CA, for the U.S. Environmental Protection Agency Hazardous Waste Engineering Research Laboratory, Cincinnati, OH.

Section 2
Automotive Refinishing Industry Profile

Industry Description

The automotive refinishing industry as addressed in this guide comprises the industry classifications that include top and body shops and paint shops (SIC 7531 and 7535). The establishments in this industry are engaged in general automotive and body repair with particular focus on collision repair and painting. The heaviest concentrations of these shops are near urban centers and in industrial areas.

The automotive paint and body industry can be divided into two distinct subsets. The first consists of shops that work only on collision repair, frame adjustments and body painting. Most of the wastes generated by this segment of the industry are associated with the painting operation, including: toxic and ignitable thinners, toxic paint and primer wastes, paint sludges and oil- and solvent-contaminated rags, empty cans with paint and thinner residues, contaminated paint booth filters, sanding dusts, and masking paper.

The second group of shops performs mechanical repair and maintenance work as well as collision repair. In addition to the above-noted wastes, these shops produce other waste streams which include waste oils, oil filters, engine/hydraulic fluids, antifreeze, and corrosive wastes from lead batteries.

Overview of Waste Generation

To perform collision repair, body shops use a wide range of equipment, chemicals, and raw materials. Available services include welding, filling dents with plastics or fiberglass ("Bondo"), body section adjustments, alignments, and painting.

Body repair work cannot be performed without the use of welding equipment and blow torches. This equipment is used extensively in body shops and has various uses, including welding, cutting, and heating to shrink and expand metals, to forge or shape metal, and to solder. A welding and cutting job requires equipment such as an oxygen cylinder, acetylene cylinder, welding torch, gas pressure regulators, and steel filler rods. The flame produced when the two gases are mixed together is hot enough to melt, bond, and repair most commercial metals. With the exception of pressurized gases, little or no chemical usage is associated with this process.

To repair both minor and major auto body damage, hydraulic equipment and hand tools are used to restore damaged sections, assemblies, and parts to their original positions and shapes. Equipment such as jacks and lifts generates enormous pulling and pushing forces. These heavy hydraulic machines can straighten bent frames, align hoods and fenders, and adjust panels. Oil is essential to the proper operation of these machines. Regular fluid changes and repair to equipment generate negligible amounts of spent fluids, which are recycled with other waste oil generated on site.

When dented, some areas on an automobile body are not accessible for repair with the use of hydraulic equipment. These areas can be repaired with polyester fiberglass reinforced body filling. These are used by adding a hardener or catalyst to the filler material and layering it in the area of the dent. The material, which is mixed on a glass or steel plate, is applied to the damaged area. Once the dent has been completely filled, the excess dried material is sanded down flush with the rest of the body. The major residual waste generated is fiberglass and plastic dust that collects on the floor during sanding operations. This material is either collected and deposited into refuse dumpsters, or rinsed into drains during routine washdowns.

Paint operations generate the largest volume of hazardous waste from this industry. Painting is often performed inside a spray booth and all exhaust passed through dry filters. Dirty filters may be hazardous due to solvent loading from wet paint and the presence of pigments containing heavy metals. While dry filters are used to capture particulate air emissions due to overspray, control of organic air emissions is not common. Leftover paint and dirty thinner resulting from equipment cleaning are the largest waste streams.

Additional hazardous wastes are generated from service operations. Services conducted in conjunction with body repair can include oil changes, fluid replenishment, and radiator repairs. These activities generate hazardous wastes such as waste oil, oil filters, engine and hydraulic fluids, wastes from radiator flushing, used batteries, and contaminated rags.

Based on a limited survey, the average automotive painting shop paints all or part of 600 cars annually. The average shop uses about 360 gallons of solvents and thinners annually and generates about 240 gallons of mixed wastes (solvent, thinner, paint, hardeners, catalysts, and reducers). Monthly waste generation rates for six companies, shown in Table 1, range between 5 and 37 gallons per month. The amount of

automotive fluid wastes (transmission fluid, antifreeze, oil) handled each month ranged from 0 to 17 gallons (Calif. DHS 1987).

Waste Management

The industry uses basically two methods of chemical and hazardous waste storage. In some shops, all of the thinners, new chemicals, and wastes are stored together in a designated covered area. The drums are placed on asphalt, concrete, or steel floors. The remaining shops store their drums indoors but scatter them around the shop at the points of highest use.

Excess paint, paint sludge, and thinner mixtures are poured into 55-gallon drums or other containers for storage. The paint sludges and solids settle to the bottom, leaving a liquid layer of thinner on top. The waste drum is subsequently removed by a hauler to a reclamation or disposal facility.

Some shops utilize the services of a reclamation facility for the removal of wastes. This service is part of a turnkey operation provided by the thinner supplier. The purchase of thinner includes the cost of delivery, waste hauling, recycling, and disposal. The waste is hauled to a licensed treatment, storage, and disposal (TSD) facility for reclamation. The service collects from a number of small-quantity hazardous waste generators in a given area. This renders reclamation economically feasible for this industrial segment. The owner does not have to contract for purchase and disposal separately.

Several studies have described the prevailing waste management and disposal practices in the industry. These include outdoor drum storage on open soil, filters and paint cans being disposed of in on-site solid waste dumpsters, and waste thinners being discharged into the sewer or disposed of on open ground (SCAG 1982). The California DHS assessments conducted in 1987 found no evidence of open-soil drum storage or large-quantity thinner discharges into the sewer or onto open ground. One shop owner admitted to pouring waste oil along one side of his facility as a means of weed control; however, he discontinued this practice some years ago when warned of the associated hazards.

A potential for waste disposal mismanagement exists in the handling of paint cans with associated residues, paint equipment filters, oil filters, and small amounts of engine fluids. Almost without exception, cans and filters were disposed of in on-site refuse dumpsters, to be removed during weekly municipal waste collections. When small amounts of engine fluid are generated, they are allowed to drain onto the floor. These include anti-freeze from damaged radiators, brake fluids, transmission fluids, etc. The residues are then either absorbed with a type of floor drying agent, which is subsequently disposed of in the dumpster, or rinsed down drains or sewers without prior treatment during routine washdowns.

References

Calif. DHS. 1987. *Waste audit study: automotive paint shops.* Report prepared by SCS Engineers, Long Beach, CA for the California Department of Health Services, Alternative Technology Section, Toxic Substances Control Division. January 1987.

SCAG. 1982. *Ground water quality management plan, San Fernando Valley Basin. Industry survey and development of best management practices.* Final Report. Prepared by SCS Engineers for the Southern California Association of Governments. August 1982.

Table 1. Monthly Hazardous Waste Generation for Six Auto Refinishing Companies

Company	Number of Employees	Business Volume (No. Cars)	Thinner/Paint Sludge (Gal)[a]	Empty Paint Cans	Hydraulic Fluid (Gal)
A	6	50-75	5	5-7	0
B	13	100	37	5-10	0
C	13	55	20	20-30	2
D	9	30-40	30	25-35	0
E	7	30	17	25-35	0
F	3	25	5	25	0

[a]Thinner/paint sludge also includes additives of hardeners, catalysts, and reducers.
Source: Calif. DHS 1987.

Section 3
Waste Minimization Options for Automotive Refinishers

This section discusses recommended waste minimization methods for automotive refinishing shops. These methods are based on accounts published in the literature and through industry contacts. The primary waste streams associated with automotive refinishing are listed in Table 2 along with recommended control methods. Waste streams include body repair wastes, paint application wastes, and shop cleanup wastes. A discussion of waste minimization methods for shop cleanup wastes, which include handling of automotive fluids leaking from damaged cars, is presented in the EPA pollution prevention guide for automotive repairs (USEPA 1991).

The waste minimization methods listed in Table 2 can be classified generally as source reduction, which can be achieved through material substitution, process or equipment modification, or better operating practices, or as recycling. Better operating practices are procedural or shop policies that result in a reduction of waste. They include:

- Waste stream segregation
- Personnel practices
  - Management initiatives
  - Employee training
  - Employee incentives
- Procedural measures
  - Documentation
  - Material handling and storage
  - Material tracking and inventory control
  - Scheduling
- Loss prevention practices
  - Spill prevention
  - Preventive maintenance
  - Emergency preparedness
- Accounting practices
  - Apportion waste management costs to departments that generate the waste

Better operating practices apply to all waste streams. In addition, specific better operating practices that apply to certain waste streams are identified in the appropriate sections that follow.

The following waste minimization measures are aimed at reducing the generation of wastes associated with body repair and paint applications. For ways to reduce waste associated with the handling of various automotive fluids, the reader is referred to the EPA pollution prevention guide for automotive repair (USEPA 1991).

In addition to the specific recommendations provided below, rapidly advancing technology makes it important that shops continually educate themselves about improvements that are waste reducing and pollution preventing. Information sources to help inform companies about such technology include trade associations and journals, chemical and equipment suppliers, equipment expositions, conferences, and industry newsletters. By keeping abreast of changes and implementing applicable technology improvements, shops can often take advantage of the dual benefits of reduced waste generation and a more cost efficient operation.

Body Repair

Polyester/fiberglass filler is used to fill in dents that cannot be removed by mechanical methods. After filling and hardening, the filler is sanded to create a smooth surface. Filler dust collects on the shop floor and is either swept up and disposed of in the trash or washed down the storm drain. Ways to reduce this waste include rigid inventory control and use of dry cleanup methods.

Rigid inventory control. Rigid inventory control is often an effective way of reducing the indiscriminate use of raw materials. In one shop, records are kept on the amount of "Bondo" each worker checks out from the storeroom. These records can be checked against the number of cars the worker repairs, and wasteful use of materials can be quickly spotted. This type of information is very useful in determining trouble spots or problem areas that need careful attention. Comparison of usage rates among workers and facilities allows a manager to determine if the problem is worker-related (correct procedures improperly performed) or facility-related (improper procedures specified and implemented) (CSM 1989).

Use of dry cleanup methods. Shops that operate a clarifier unit to remove oil, grease, and solids from sewer discharges should use dry collection methods such as sweeping or vacuuming for filler dust. Clarifier sludges may be classified as a hazardous waste and the introduction of non-hazardous solids into the clarifier needlessly increases sludge volumes and disposal costs. Combination sanding and dust collection systems are commercially available, but they are reportedly very expensive. For shops performing wet sanding, use of a "wet-

Table 2. Waste Minimization Options for Automotive Refinishing

Waste Generating Activity	Waste	Waste Minimization Option
Body repair	*Filler waste*	*Rigid inventory control to minimize Bondo use.*
	Sand Dust	*Sweep or vacuum up; don't flush to street or clarifier*
Painting	*Paint waste*	*Rigid inventory control to reduce thinner use.* *Better housekeeping to reduce leaks and spills* *Mix paint according to need.* *Use high transfer efficiency equipment.* *Provide operator training.* *Practice proper equipment cleaning methods, use enclosed cleaners.* *Recycle solvent offsite by means of thinner leasing agreements.* *Recycle solvent onsite.* *Contact waste exchanges.* *Make leftover paint available to customer.*
	VOC emissions	*Use high transfer efficiency equipment.* *Use enclosed cleaning devices.* *Use low VOC coatings.*
	Booth filters	*Use high transfer efficiency equipment.* *Use styrofoam filters.*
Shop Cleanup	*Various*	*Manage waste automotive fluids properly (see the EPA automotive repair pollution prevention guide for specific options).*

vac" to collect and pick up the filler particles might be a viable option.

Paint Application

Paint application wastes include leftover paints, dirty thinner due to cleaning of spray guns and paint cups, air emissions of volatile organic compounds (VOCs) and pigments, and dirty spray booth filters. Ways to reduce these wastes include rigid inventory control; better housekeeping practices; mixing paint according to need; better operator training; proper cleaning methods; recycling solvents on and off site; and waste exchanges. Also, options for minimizing waste in paint application include giving leftover paint to customers; using alternative coatings; and using styrofoam filters. (Editor's note: giving away leftover paint is not waste minimization if the customer throws the paint away instead of using it.)

Rigid inventory control. Rigid inventory control provides a very effective means of source reduction at virtually no cost to the operator. This alternative can be implemented in several ways. The owner may monitor employee operations and make verbal or written comments on product usage and suggested limits. In larger shops where monitoring of employees is not a viable alternative, the owner or manager can limit access to storage areas containing raw materials. This inaccessibility forces the employee to stretch the use of raw materials farther. Moreover, through this practice, the owner/manager can monitor the use of raw materials.

Not surprisingly, there is a high positive correlation between the amount of paint thinner used and the amount of waste generated. There is a hypothetical minimum amount of thinner that is essential to paint an average car; thinner use above that amount may be presumed to be waste. Figure 2 shows the relationship between thinner used and waste generated for the six firms assessed in the California DHS study.

While it is difficult to generalize because each firm's thinner usage varies, Figure 2 shows a potential savings through more stringent inventory control and restrictions on thinner use. The best shop shows 0.3 gallon thinner use per car, with 0.1 gallon ending up as waste. The worst case shows 1.1 gallons per car, with 0.9 gallon as waste. At 50 cars per month and $5.50 per gallon, the difference between the two shops' thinner use amounts to 480 gallons, or $2,640 annually. The waste disposal cost at $2 per gallon would add another $960 annually.

Better housekeeping practices. Basic housekeeping techniques can be very effective as a means of source reduction. There are a wide variety of methods available to control and minimize leaks which can be implemented easily at no cost to the operator. Specific approaches to drum location, material transfer methods, leak collection, and drum transport can effectively limit product loss.

There are two predominant patterns of drum location. If inventory control is necessary to minimize product usage, drums should be stored together in an area of limited accessibility, such as indoor/outdoor sheds, "flammable" lockers, or locking storage rooms. If employees take individual responsibility for regulating product used and if inventory control is not a problem, it may be more effective to separate drums and place them at points of highest use in the facility. This

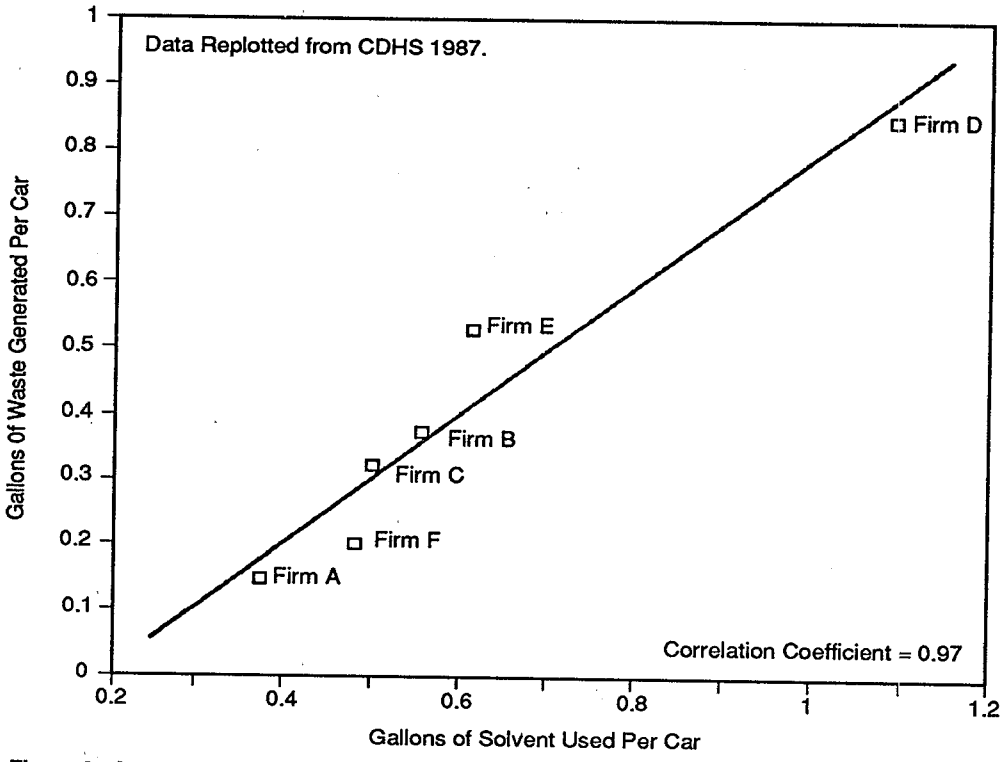

Figure 2. Automotive Refinishing Waste Generation Versus Solvent Use.

alternative reduces the chance of product leaks and spills during transport from storage to work areas.

The potential for accidental spills and leaks is highest at the point of transfer of thinners from bulk drum storage to process equipment. Spigots or pumps should always be used to transfer waste materials to storage containers. Material should never be poured directly from drums to smaller containers.

Evaporation is a material loss that can be controlled through the use of tight-fitting lids, spigots and other appurtenances. The reduction of evaporation will increase the amount of available material and result in lower solvent purchase cost.

If drum transport or movement is necessary, it is essential that drums be moved correctly to preserve the integrity of the containers and to prevent damage or punctures. Drums should be lifted by means of powered equipment or hand trucks. Under no circumstances should drums be tipped or rolled, even when empty. Negligent transport procedures will cause drum damage, particularly to seams, which could lead to leaks or ruptures during future use.

Mix paint according to need. In the practice of automotive refinishing, many operators prepare a fixed amount of paint for each job (e.g., one pint or quart). Any paint not used for the job is considered to be a hazardous waste and must be disposed of as such. In particular, for small jobs, which are most common, the amount of paint prepared will often exceed the amount of paint actually applied.

Most small cars can be painted entirely with one quart of paint; touch-ups and damage repair would use substantially less than one quart. Availability of variously graded sizes of paint mixing and sprayer cups would enable operators to use the equipment best suited to the size of a particular job. Varying paint cup sizes could be an effective means of source reduction in two important ways. It would limit overmixing of paint to be used on a specific project, and decrease the amount of solvent needed for equipment cleanup when doing spot painting and small jobs.

A disadvantage of mixing smaller quantities is that color matching becomes more difficult. As the amount of paint mixed decreases, weighing accuracy becomes more critical. Special attention would need to be given to the purchase, installation, maintenance, and use of higher precision weighing equipment.

Use high transfer efficiency equipment. Another way to reduce VOC emissions is to reduce the amount of paint sprayed for a given job. The standard method of applying paint is the air spray gun. Typical transfer efficiency is on the order of 20 to 40 percent. Many of the newer spray application systems have transfer efficiencies greater than 65 percent. Since with lower efficiency, more paint is wasted, higher efficiency systems are being promoted for use. In a recent study (SDAPCD 1989), nine different spray painting techniques that are currently in use were studied. The nine techniques include: air-atomized conventional (AAC); airless conventional (ALC); air-assisted airless (AAL); high volume, low pressure (HVLP) turbine; high volume, stepped down

low pressure (HVSDLP); low pressure, low volume (LPLV); thin film atomization (TFA); air-atomized electrostatic (AAE); and airless electrostatic (ALE). Automotive refinishing is generally performed by manual spray painting using conventional air-atomization/spray equipment.

A comparison of the methods showed that HVLP turbine, HVSDLP, LPLV, and TFA appeared to be potential candidates for replacement of AAC in the automotive refinishing industry. One automotive refinisher in the San Diego area reported very favorable results with an HVLP turbine system. Paint usage had been reduced by one-third and the finish quality was very good to excellent. The firm has experienced no operational problems with the equipment and it reported that overall operating costs were very similar to those incurred with conventional air-atomized systems. In another study (CSM 1989), the shop reported that High Volume Low Pressure (HVLP) spray guns were tested but that the resulting paint job suffered from "halo" effects when spraying metal flake paints. Operator training has been reported to be a key element in the successful conversion to a high efficiency system. Given the regulatory drive to reduce VOC emissions from automotive refinishing operations, high transfer efficiency spray guns will see increasing use in the near-term future.

Airless and air-assisted systems have found some use in the automotive refinishing industry for undercarriage, utility, and truck equipment refinishing where the finish quality requirements are less severe. Electrostatic spray painting techniques are also seldom used for automotive refinishing due to problems in painting recessed areas (Faraday cage effect), matching the existing coating, and appearance problems in the application of metallic paints. For spraying of non-metallic paints, electrostatic painting has been used for low-cost, full-body painting and utility vehicle painting.

Better operator training. Often overlooked, transfer efficiency is also a function of operator skill and training. Operators may be very skilled at producing high quality finishes but be poorly trained in the ways of reducing paint usage. Operators should be trained not to arc the spray gun and blow paint into the air. The practice of maintaining a fixed distance from the painted surface while triggering the gun should be encouraged. Air pressure (often set too high) should be well regulated. When the pressure is set too high, most of the paint bounces off the car and forms a fog. The proper adjustment of air pressure can increase transfer efficiency by 30 to 60 percent. Table 3 is a fault analysis for conventional air spraying operations.

Proper cleaning methods. In reducing solvent use, greater attention should be paid to the methods employed in equipment cleaning. Paint cups should first be scraped free of residual paint using a plastic spatula and then rinsed with solvent. The practice of filling the cup with solvent, stirring until the paint dissolves, and then repeating the procedure as needed should be discouraged. New Teflon-lined metal paint cups are available, which should provide for easier cleaning.

The typical way of cleaning a spray gun is to fill the spray cup with solvent and then spray the solvent into the booth filters or into the air. This results in a large waste of thinner and considerable air emissions. To recover the thinner for reuse and prevent undue air emissions, an enclosed gun cleaning station should be used. Thinner is sprayed through the gun and into the cleaning station where it is condensed for recovery and reuse. To simplify operation, the cleaning station uses compressed air instead of electricity to produce refrigeration/condensation. Several air quality agencies are requiring the use of enclosed spray gun cleaners at automotive refinishing shops.

Recycle solvent off site. Sludges from drum cleanup and thinner recovery from solvent-based paints contain as much as 50 percent organic thinners such as volatile hydrocarbons, ketones, esters, and alcohols, and about five percent inorganic pigments. It has been estimated that one gallon of sludge is generated for every 120 gallons of solvent-based paint product used (Stoddard 1981).

Processes for recycling thinners are well established and widely used. Small quantity generators and those generators that do not possess the technical expertise, or find it uneconomical to recycle contaminated thinners on site, usually send thinner wastes to commercial recyclers for recovery. Commercial recyclers have versatile distillation processes and can handle large volumes and varieties of thinners. Generally, thinner recyclers recover 70 to 80 percent of the incoming spent thinners into reusable products (Stoddard 1981). Reclaimed thinners are often sold back to the generators after the thinners are reconstituted.

In general, suppliers who offer recycling services include the cost of waste collection and recycling in the price of their thinner. This increases the thinner cost, but effectively eliminates separate hauling and disposal or recycle costs. It also reduces the administrative burden on the owner or manager of the auto painting firm.

Thinner from supplier/recyclers typically costs about $2 per gallon more than comparable products from non-recycling suppliers. Based on the California DHS assessments, the average auto painting firm generates 0.67 gallons of waste per gallon of thinner purchased. Based on a strict interpretation of these numbers, using a supplier/recycler is less expensive than purchasing from non-recycling suppliers if disposal costs exceed $165 per drum. Inclusion of administrative burden and potential liability in cost estimates would lower this break-even disposal cost.

Recycle solvent on site. Several alternatives are available to operators who wish to conduct recycling processes on site. Gravity separation is inexpensive and relatively easy to implement by allowing the thinner/sludge mixture to separate under quiescent conditions. The clear thinner can then be decanted using a drum pump and used for equipment cleaning, reducing requirements for purchased wash thinner. Use of reclaimed thinner for formulating primers and base coats is possible, but might create problems if the thinner is not sufficiently pure.

Table 3. Fault Analysis for Spray Painting

Defect	Cause
Dimpled surface ("Orange peel")	Gun distance from work to close. This can also be due to too high or too low a spray pressure, wrong choice of reducer solvent.
Sagging of film ("Curtaining")	Excessive application of paint, poor overlap of sprays, improper atomization, or improper formulation, particularly of thinner. Excessive spray pressure may also cause sagging.
Bubbles and cratering ("Fisheyes")	Water or oil contamination of air supply, excessive spray gun pressure, low air pressure, heavy application of paint.
Dusting and roughness	Too high atomizing pressure, too low fluid pressure, wrong choice of reducer.
Excessive overspray	Failure to release trigger of the gun when not aiming at object, bad aiming of spray, excessive fluid pressure.

For the larger-quantity generators in the auto body repair and painting industry, on-site distillation may provide a more cost-effective alternative. The batch distillation of all high-grade thinner wastes can virtually eliminate the need for purchasing lower quality thinners for use in preliminary painting operations and cleanup. From 5 gallons of paint and thinner wastes, the operator can reclaim 4-1/2 gallons of thinner, with 1/2 gallon left as sludge. This ratio varies depending on operations. Addition of a commercial additive to the 1/2 gallon of paint sludge yields a viscous material which can be used as underseal.

In one study, the shop painted 365 cars per month, purchased 3,900 gallons of recycled thinner per year at a cost of $5.05 per gallon and generated 4,380 gallons of thinner waste per year at a disposal cost of $1.85 per gallon. This amounted to an operating cost of $27,800 per year (excluding any on-site labor). For an on-site recycling system, the potential savings of $13,260 per year are estimated as shown in Table 4. On-site recycling for this shop has very attractive economics, given that most recycling systems sized to handle the amount of waste generated would cost $7,000 to $10,000 to purchase and install. This equates to a payback period of less than one year (CSM 1989).

On the negative side, a shop involved in on-site recycling would be incurring all of the increased environmental and safety risks normally associated with recycling of flammable solvents. Another potential problem is that two-component paints will react and polymerize. Once reacted, the resulting waste may be too viscous to pump, leading to higher disposal costs in some cases. Table 5 lists the advantages, disadvantages, benefits, and difficulties associated with on-site recycling (Calif. DHS 1986).

To avoid the problems usually associated with the disposal of solvent-bearing paint wastes, the Southern California Finishers and Fabricators Association (SCFFA) has implemented an incineration/recycling program. At a cost of $420 per drum, the SCFFA contractor (Allure Industries of Vancouver, B.C.) will pick up the waste, incinerate it and recycle titanium dioxide pigment. The most interesting aspect of this arrangement is that Allure Industries prefers waste hig in solids.

Use waste exchange. Waste exchanges (listed in Appendix B) provide another waste removal alternative for autc body and painting companies. Waste exchanges are organizations that manage or arrange the transfer of wastes between industries, such that one producer's waste material might be another industry's feedstock. Most exchanges exist as information clearinghouses, which provide information on waste availability. Opportunities exist for the direct transfer (without processing) of waste solvents from industries requiring ultra-high-purity solvents (e.g., the electronics industry) to industries that do not have such stringent purity requirements (e.g., the machinery and painting industries). Waste solvents are available through the waste exchanges, which could potentially be used as a substitute for new wash thinner. In addition, several generators have recently found new opportunities to ship residual still bottoms to cement industries for use as supplemental fuels.

Give leftover paint to the customer. Some shops may choose to give leftover paint to the customer for touch-up, feeling that this enhances good will as well as reducing the shop's paint waste. However, this practice should be limited to customers who have expressed an interest in using the paint, since it merely transfers a hazardous waste to a municipal waste if the customer throws the paint out as trash.

Another disadvantage is that the usefulness of this option depends entirely on the type of paint being sprayed. With many of the newer catalytically-polymerized paints, freshly mixed paint has a shelf life of only a few hours. Right-to-know laws in many states might require that the ingredients be labeled on the bottle. The issue of liability should be addressed before a shop gives paint to a customer.

Use alternative coatings. There are four basic types of paint used in automotive refinishing: acrylic lacquer, synthetic enamel, acrylic enamel, and catalyzed acrylic enamel. A fifth type, color and clear polyurethane, is used primarily in truck-fleet finishes. Painting usually proceeds with application of a primer/surfacer followed by one or more coats of

Table 4. Economic Analysis for an On-Site Still

Process 4,380 gallons of thinner waste at a cost of $1.25 per gallon (includes all utilities, materials, and labor). Recover 3,500 gallons (80% recovery) of wash grade thinner.	*$ 5,480*
Purchase 400 gallons of virgin thinner make-up at a cost of $5.05 a gallon.	*2,020*
Send 880 gallons of sludge to an off-site incinerator at a cost of $8.00 per gallon (some of this material could be used as an underseal if mixed with proper additives).	*7,040*
TOTAL ANNUAL COST OF ON-SITE RECOVERY	*$14,540*
CURRENT COST OF OFFSITE DISPOSAL	*27,800*
NET SAVINGS (EXCLUDING CAPITAL COST OF RECYCLING UNIT)	*$13,260*

paint. To achieve a high gloss finish, many cars are painted with a color base coat followed by a clear top coat. Since several coatings of various compatible materials may be required to achieve a desired finish, coating materials are often referred to as "systems."

The quantity or amount of VOC emissions is related to the type of paint used since each material varies in solvent content and the number of coats necessary for a high quality finish. Acrylic lacquers are typically thinned with solvent by 125 to 150 percent. To achieve enough buildup for sanding and buffing, at least four or five double coats are applied.

With synthetic enamels, solvent thinning amounts to 15 to 33 percent. Since enamel dries to a gloss and is not sanded, only two or three medium coats are required. Base coat/top coat systems usually require two or three coats of each.

Three ways to minimize or eliminate VOC emissions from automotive refinishing operations are to substitute solvent-based paint with water-borne paint, use high-solids paints, or switch from high solvent to medium solvent paints. The following sections discuss these approaches.

The availability of water-borne paints for the automotive refinishing industry is still quite limited. The automotive paint manufacturing industry is working on the development of

Table 5. Qualitative Analysis of On-Site Recycling

Advantages	Disadvantages
Less waste leaving the shop.	*Capital outlay for recycling equipment.*
Owner's control of reclaimed solvent's purity.	*Liabilities for worker health, fires, explosions, leaks, spills, and other risks as a result of improper equipment operation.*
Reduced liability and cost of transporting waste off-site.	*Possible need for operator training.*
Reduced reporting (manifesting).	*Additional operating and maintenance costs.*
Possible lower unit cost of reclaimed solvent.	
Benefits	**Difficulties**
Favorable economics for recovery (e.g., reduced solvent requirements).	*Loss of solvent during distillation process.*
Reduction in disposal costs.	*Low solvent recovery efficiency.*
Reduction in reporting (manifesting).	*Installation problems.*
Lower liability.	*Maintenance problems.*

such paint formulations, but it will still be several years before they become widely available. Water-borne primers, however, are already available. Advantages of the application of water-borne paints are: reduction of VOC emissions; reduction of the hazardous nature of the paint residues; reduced personnel safety hazard; and the ability to clean the equipment with water. Disadvantages are: limited availability; the need for spray painting equipment to be corrosion resistant; and the requirement for costly heated drying booths to reduce drying time. Much research is needed in the area of developing water-based systems (primer, base coat, top coat) as opposed to individual water-borne paints, before their use will be practical.

High-solids paints are gradually becoming available for the automotive refinishing industry and these have the advantage of reducing VOC emissions by up to 75 percent. The main disadvantage of high-solids coatings is the increase in paint viscosity. To overcome this, an in-line heater is required to raise the temperature of the high-solids paint, effectively reducing its viscosity to the range suitable for paint spraying applications.

At one shop, switching from lacquer to enamel-based paints resulted in a reduction of VOC emissions (CSM 1989). Lacquer paints typically contain 70 to 90 volume percent solvent (excluding water) while enamels contain 55 to 75 volume percent solvent (excluding water). In addition to reduced solvent content, enamels reportedly are less prone to react with the polyester/fiberglass filler and discolor or yellow. This problem is common when spraying lacquers and requires that the car be repainted. The replacement of lacquers with enamels should reduce or eliminate this occurrence and hence reduce waste generation due to repainting.

Use styrofoam filters. Replacement and disposal of dirty spray booth filters is currently performed by the thinner supplier/recycler. Filters must be disposed of as hazardous waste if they contain wet paint (i.e., solvents), due to their potential flammability. Filters may also be hazardous due to their potential toxicity if the overspray contains lead or chromium pigments. To reduce filter waste, a cleanable styrofoam filter element has been developed. When dirty, the filter can be blown clean with compressed air and reused (removed paint would require collection and still be classified as hazardous if it contained lead or chromium compounds). When the filter is no longer reusable, it can be disposed of with dirty thinner waste by dissolving it in the drum of waste thinner. Before using this filter, shops should check with their thinner recycler to determine if dissolved styrofoam will interfere with their dirty thinner recycling operation.

Shop Cleanup Wastes

The human aspects of industrial activity can be very important in waste reduction. Often termed "good operating practices" or "good housekeeping," these methods can be very effective in reducing the amount of shop cleanup wastes generated. Typical wastes include dirty rags, sawdust, clarifier sludges, area washdowns, and disposal of out-dated supplies. Good housekeeping methods include improved employee training, management initiatives to increase employee awareness of the need for and benefits of waste minimization, and preventive maintenance to reduce the number of leaks and spills that occur. Additional ways to reduce or minimize waste are discussed in the EPA pollution prevention guide for automotive repair shops (USEPA 1991).

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Section 4
Waste Minimization Assessment Worksheets

The worksheets provided in this section are intended to assist automotive refinishing 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 *Waste Minimization Opportunity Assessment Manual*. For a full description of waste minimization assessment procedures, please refer to the EPA manual. Table 6 lists the worksheets that are provided in this section and provides a short description of each. After completing the worksheets, the assessment team should evaluate the applicable waste minimization options and develop an implementation plan.

Table 6. List of Waste Minimization Assessment Worksheets

Number	Title	Description
1.	Waste Sources	Typical wastes generated at automotive refinishing facilities.
2a.	Waste Minimization: Material Handling	Questionnaire on procedures used for handling drums, containers, and packages.
2b.	Waste Minimization: Material Handling	Questionnaire on procedures used for bulk liquid handling.
3.	Option Generation: Material Handling	Waste minimization options for other material handling operations.
4a.	Waste Minimization: Body Repair/Paint Application	Questionnaire on procedures used for body repair and paint application.
4b.	Waste Minimization: Paint Application	Continuation of questionnaire on procedures used for paint application.
5.	Option Generation: Body Repair/Paint Application	Waste minimization options for body repair and paint application.
6.	Waste Minimization: Shop Cleanup	Questionnaire on procedure used for shop cleanup.
7.	Option Generation: Shop Cleanup	Waste minimization options for shop cleanup.

Firm _____ Site _____ Date _____	**Waste Minimization Assessment** Proj. No. _____	Prepared By _____ Checked By _____ Sheet 1 of 1 Page 1 of 9

WORKSHEET 1

WASTE SOURCES

Shop Clean-Up	**Significance at Shop**		
	Low	**Medium**	**High**
Obsolete raw materials			
Spills & leaks (liquids & powders)			
Dirty rags & sawdust			
Area wash water			
Clarifier sludges			
Container disposal			
Pipeline/tank drainage			
Evaporative losses			
Note: *For a discussion of waste minimization options for reduction of shop clean-up wastes, see the EPA pollution prevention guide for the automotive repair industry.*			
Body Repair			
Left over filler			
Sanding dust			
Painting			
Left over paint			
Dirty wash thinner			
Empty containers			
VOC air emissions			
Particulate emissions			
Dirty booth filters			

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Firm _____ Site _____ Date _____	**Waste Minimization Assessment** Proj. No. _____	Prepared By _____ Checked By _____ Sheet 1 of 2 Page 2 of 9

WORKSHEET
2a

WASTE MINIMIZATION: Material Handling

A. 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 they properly trained in handling of spilled raw materials? ❑ yes ❑ no

Is there a formal personnel training program on raw material handling, spill prevention, proper storage techniques, and waste handling procedures? ❑ yes ❑ no

Describe handling procedures for damaged items: _____

_____

_____

How often is training given and by whom? _____

_____

_____

Is obsolete raw material returned to the supplier? ❑ yes ❑ no

Is inventory used in first-in first-out order? ❑ yes ❑ no

Is the inventory system computerized? ❑ yes ❑ no

Does the current inventory control system adequately prevent waste generation? ❑ yes ❑ no

What information does the system track? _____

_____

_____

Are stored items protected from damage, contamination, or exposure to rain, snow, sun and heat? ❑ yes ❑ no

Is the dispensing of raw materials supervised and controlled? ❑ yes ❑ no

Are users required to return empty containers before being issued new supplies? ❑ yes ❑ no

Do you maintain and enforce a clear policy of using raw materials only for their intended use? ❑ yes ❑ no

Firm _____	Waste Minimization Assessment	Prepared By _____
Site _____		Checked By _____
Date _____	Proj. No. _____	Sheet 2 of 2 Page 3 of 9

WORKSHEET
2b

WASTE MINIMIZATION:
Material Handling

B. BULK LIQUIDS HANDLING

What safeguards are in place to prevent spills and avoid ground contamination during the filling of storage tanks?

- High level shutdown/alarms ❑
- Flow totalizers with cutoff ❑
- Secondary containment ❑
- Other ❑

Describe the system: _____

_____

_____

Are air emissions from solvent storage tanks controlled by means of:

Conservation vents	❑ yes	❑ no
Nitrogen blanketing	❑ yes	❑ no
Absorber/Condenser	❑ yes	❑ no
Other vapor loss control system	❑ yes	❑ no

Describe the system: _____

_____

_____

Are all storage tanks routinely monitored for leaks? If yes, describe procedure and monitoring frequency for above-ground/vaulted tanks: _____

_____

_____

Underground tanks: _____

_____

_____

How are the liquids in these tanks dispensed to the users? (i.e., in small containers or hard piped.) _____

_____

_____

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: _____

_____

_____

Firm _____ Site _____ Date _____	**Waste Minimization Assessment** Proj. No. _____	Prepared By _____ Checked By _____ Sheet 1 of 1 Page 4 of 9

WORKSHEET

3

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. Drums, Containers, and Packages		
Raw Material Inspection		
Proper Storage/Handling		
Return Obsolete Material to Supplier		
Minimize Inventory		
Computerize Inventory		
Formal Training		
Waste Segregation		
B. Bulk Liquids Handling		
High Level Shutdown/Alarm		
Flow Totalizers with Cutoff		
Secondary Containment		
Air Emission Control		
Leak Monitoring		

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Firm _____ Site _____ Date _____	**Waste Minimization Assessment** Proj. No. _____	Prepared By _____ Checked By _____ Sheet 1 of 2 Page 5 of 9

WORKSHEET
4a

WASTE MINIMIZATION:
Body Repair & Paint Application

A. BODY REPAIR

Do you generate large quantities of waste filler? ❑ yes ❑ no

Are your workers supervised/trained so they do not mix more filler than required? ❑ yes ❑ no

Do you currently employ rigid inventory controls to minimize product use? ❑ yes ❑ no

Do you discourage the use of hoses to flush filler dust to the sewer or clarifier? ❑ yes ❑ no

Are sweep brooms or vacuum units available for your workers to use? ❑ yes ❑ no

Explain how you minimize waste from auto body repair: _____

_____

_____

B. PAINT APPLICATION

Do you generate large quantities of waste paint or thinner? ❑ yes ❑ no

Do you currently employ rigid inventory controls to minimize material use? ❑ yes ❑ no

Do you use more than 1/2 gallons of thinner per car? ❑ yes ❑ no

If yes, discuss how implementing more rigid controls could be accomplished in your shop: _____

_____

Is the volume of paint mixed based on the surface area to be painted? ❑ yes ❑ no

Does the design of your mixing equipment prevent you from mixing smaller batches of paint? ❑ yes ❑ no

Do you provide customers with leftover paint (enamel or lacquer only) for touch-up use? ❑ yes ❑ no

Are operators trained to use their equipment properly so as to minimize overspray? ❑ yes ❑ no

Are they periodically retrained? ❑ yes ❑ no

What measures have you taken to reduce the generation of waste paint: _____

_____

_____

Firm _____ Site _____ Date _____	**Waste Minimization Assessment** Proj. No. _____	Prepared By _____ Checked By _____ Sheet 2 of 2 Page 6 of 9

WORKSHEET 4b

WASTE MINIMIZATION: Body Repair & Paint Application

B. PAINT APPLICATION – continued

Who provides this training and how often is it given? _____

_____

Do your operators use large amounts of solvent to clean equipment? ❑ yes ❑ no

Do they scrape out paint cups before rinsing? ❑ yes ❑ no

Have you tried using or do you use an enclosed cleaning system? ❑ yes ❑ no

What was the effect: _____

_____

_____

Do you contract with an off-site thinner supplier/recycler? ❑ yes ❑ no

Do you decant dirty thinner and use it as an initial wash thinner? ❑ yes ❑ no

Do you paint more than 50 cars per month? ❑ yes ❑ no

If yes, have you looked at on-site recycling systems? ❑ yes ❑ no

Have you tried to list your waste with a certified waste exchange? ❑ yes ❑ no

Please discuss any measures you have taken to recycle paint/thinner waste: _____

_____

_____

Have you investigated the use of low VOC paints? ❑ yes ❑ no

Have you investigated the use of high transfer efficiency spray equipment? ❑ yes ❑ no

If yes, did it reduce the amount of paint sprayed? ❑ yes ❑ no

Did it affect finish quality/customer satisfaction? ❑ yes ❑ no

Have you investigated the use of styrofoam booth filters? ❑ yes ❑ no

Discuss your success/failure with these options: _____

_____

_____

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Firm _____ Site _____ Date _____	**Waste Minimization Assessment** Proj. No. _____	Prepared By _____ Checked By _____ Sheet 1 of 1 Page 7 of 9

WORKSHEET

5

OPTION GENERATION:
Body Repair & Paint Application

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. Body Repair		
Mix filler according to need		
Employ rigid inventory control		
Sweep up or vacuum dust		
B. Paint Application		
Employ rigid inventory controls		
Mix paint according to need		
Give customer touch-up paint		
Train operators to minimize overspray		
Scrape out paint cups before rinsing		
Use an enclosed cleaning system		
Contract with a thinner supplier/recycler		
Install on-site recycling equipment		
List waste with waste exchange		
Use low VOC coatings		
Use high transfer efficiency equipment		
Use cleanable styrofoam filters		

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Firm _____ Site _____ Date _____	Waste Minimization Assessment Proj. No. _____	Prepared By _____ Checked By _____ Sheet 1 of 1 Page 8 of 9

WORKSHEET
6

WASTE MINIMIZATION:
Shop Clean-Up

In addition to automotive refinishing, do you perform automotive repairs? (If yes, please refer to the EPA pollution prevention guide for automotive repair shops.) ❑ yes ❑ no

Are drip pans placed under leaking cars to reduce the need for floor cleaning? ❑ yes ❑ no

Are dirty parts removed and placed on a drip pan instead of directly on the shop floor? ❑ yes ❑ no

Are all work bays kept clean and neat? ❑ yes ❑ no

Do your workers wipe up small spills of fluids as soon as they occur? ❑ yes ❑ no

Do you have an award program for workers who keep their work bays clean (i.e. prevent leaks and spills)? ❑ yes ❑ no

How are spilled fluids recovered and disposed of? _____

_____

_____

Do you use a laundry service to clean your rags and uniforms? ❑ yes ❑ no

If no, how are they handled? _____

_____

_____

Do you use a biodegradable detergent for cleaning shop floors? ❑ yes ❑ no

Have you tried using a steam cleaner in place of chemical cleaners? ❑ yes ❑ no

Do you discharge area washdown wastewater to a POTW or industrial sewer instead of to the storm drain? ❑ yes ❑ no

If no, how is this wastewater handled: _____

_____

_____

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Firm _____	Waste Minimization Assessment	Prepared By _____
Site _____		Checked By _____
Date _____	Proj. No. _____	Sheet 1 of 1 Page 9 of 9

WORKSHEET
7

OPTION GENERATION:
Shop Clean-Up

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

Meeting Coordinator _____

Meeting Participants _____

Suggested Waste Minimization Options	Currently Done Y/N?	Rationale/Remarks on Option
Use Drip Pans		
Wipe Up Spills (Cotton Rags)		
Keep Bays Clean		
Award Program		
Use Laundry Service		
Use Biodegradable Detergents		
Use Steam Cleaners		
Discharge to POTW/Industrial Sewer		

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Appendix A
Automotive Refinishing Shop Assessments: Case Studies of Shops A, B, C, D, E, and F

In 1987, the California Department of Health Services (DHS) commissioned a waste minimization study of automotive refinishing shops. The objectives of the waste minimization assessments were to:

- Gather site-specific information concerning the generation, handling, storage, treatment, and disposal of hazardous waste;
- Evaluate existing waste reduction practices;
- Develop recommendations for waste reduction through source control, treatment, and recycling techniques; and
- Assess costs and benefits of existing and recommended waste reduction techniques.

The first step in conducting the assessments was selecting and contacting several shops to solicit voluntary participation in the study. Selection emphasized small business, which generally lack the financial and/or internal technical resources to perform a waste reduction assessment.

This Appendix summarizes the results of the assessments of six automotive refinishing shops (here identified as A, B, C, D, E, and F). Included are the practices already in use at the shops that have successfully reduced waste generation from past levels. The original assessments may be obtained from Mr. Benjamin Fries at:

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

In addition, the results of the waste minimization assessments were used to prepare waste minimization assessment worksheets to be completed by other automotive refinishers in a self-assessment process. Examples of these worksheets follow the Shop F assessment.

Company A Assessment

Company A represents the medium-sized segment of independent operators in the auto painting industry. This company employs seven full-time workers and has a relatively large volume of business ranging between 50 and 75 cars per month. Company A provides complete auto body repairs, which include welding, alignments, frame and body adjustments, and auto painting. Most of the painting done at this shop consists of spot repairs to collision-damaged vehicles. Mechanical work is done only in association with body structure repairs.

Chemical Usage

Raw materials utilized at this shop include paints, wax and grease remover, two grades each of paint thinner, surface primer, retarder, reducers, and small amounts of oil used for shop machinery and vehicle maintenance.

Waste Generation

Waste generation rates at this company are among the lowest amounts recorded during on-site interviews. Excluding oil, all wastes are deposited in one 55-gallon storage drum, which is filled at a rate of about 9 gallons per month. Waste oil from shop equipment is generated at a rate of 6 gallons per month, which is deposited at a local service station.

Operations generate minimal amounts of waste due to rigid inventory controls and several source reduction techniques. A parts cleaner is used, which recycles separated solvent liquids for cleaning equipment. Paint sludges are also allowed to settle out of high-grade spent thinner so that thinner can be reused on priming and base coats.

Wash thinners and waste thinners are both stored in 55-gallon drums, with high-grade thinner in a 15-gallon can. The remainder of the products is stored in gallon cans with paints in pint- and quart-sized containers. All raw materials and wastes are stored indoors, with spigots and pumps on drums, and funnels on storage containers. Spills are recovered with floor absorbent and disposed of with nonhazardous refuse after paint residues have been removed.

Waste Minimization - Current Practices and Recommendations

The following recommendations are suggested for waste minimization at Company A:

1. Source Reduction. This company currently employs a number of source reduction practices that have resulted in a minimum quantity of waste generated per vehicle serviced. Wastes have been minimized through the use of stringent inventory control practices and a minimum quantity of thinner used to clean equipment.

2. Disposal of Excess Paint. Excess paint is currently minimized through stringent inventory control. Residues from painting operations are disposed of in the waste thinner drum during equipment cleaning operations. Wastes can be reduced further by giving excess paint to customers for use as touch-up paint.

3. Improved Housekeeping Practices. Product losses can be controlled by using tight-fitting lids to minimize evaporation. Small quantities of solvent used to wash equipment were observed in small containers with open tops. If lids are used, evaporation of materials will be reduced, further extending the usefulness of thinner.

4. Spill Migration Prevention. Drums of new and waste materials should be stored to prevent off-site migration of spills or leaks. Floor drains adjacent to drum storage areas should be sealed to prevent spill intrusion.

Implementing the above practices can result in a 5 percent reduction in the usage of new thinner, reducing costs by approximately $200 per year. Savings due to decreased disposal costs were not estimated.

Company B Assessment

Company B represents the larger independent operations in the automotive paint and body industry. This company employs 13 workers and has a business volume of approximately 100 cars per month. Company B provides body and fender repair, frame adjustments, front and rear suspension alignments, and auto painting. Mechanical work on engines and drive trains is only done in association with body repair.

Chemical Usage

Chemicals used at this shop include two grades of lacquer thinner, enamel reducer, isocyanate (a type of hardener), a catalyst, and polyester resin. These products are mixed together during paint operations. Thinners are stored in 30- or 55-gallon drums indoors on cement. High-grade thinner is basically used on a once-through basis. The remainder of the raw materials is stored in pint-, quart-, or gallon-sized cans and kept in a designated paint mixing area. Hand pumps and spigots are used to transfer thinner from drums to smaller containers for shop use.

Waste Materials

The largest quantity of waste generated is due to cleaning of equipment after painting. A single waste stream consisting of paint-contaminated thinner is generated at a rate of about 35 gallons per month. Wastes are deposited in a 55-gallon drum stored adjacent to new materials in the shop area.

Company B installed a distiller to help reduce the amounts of waste generated by painting operations, but at the time of the assessment, the new equipment had not yet been in use long enough to determine the impact on waste generation and minimization. The owner anticipates that the distiller will eliminate the need to purchase lower grade thinners for equipment cleanup. High-grade purchased thinner will be used on top coats. Thinner wastes generated from paint operations are recycled through distillation and used as wash thinner. The distiller is equipped to recycle 5 gallons of waste per use and yield 4.5 gallons of wash thinner and 1/2 gallon of paint sludge. The sludge can also be combined with additives to be used as underseal. In practice, the distiller should dramatically reduce thinner consumption and generation, and also provide a usable end product from the associated paint sludges.

Waste Minimization - Current Practices and Recommendations

The following recommendations are suggested for waste minimization at Company B:

1. Source Reduction. As a result of on-site reclamation practices and the use of sludge generated from the distillation process, this facility generates no waste requiring disposal. This means that 100 percent reduction of hazardous waste is possible for some auto paint shops. A reduction in the quantity of material requiring distillation can be achieved through source reduction practices such as inventory control.

2. Segregate Excess Paint Waste from Thinner Waste. A higher quality recycled thinner could be obtained from on-site reclamation by segregating excess paint from thinner waste. This excess paint could be added to the sludge from the recycling system and be used as underseal. An alternative would be to give excess paint to customers for use as touch-up paint.

By implementing these recommendations, Company B can reduce consumption of new thinner by 10 to 20 percent. Annual cost savings attributable to a decrease in the quantity of thinner purchased is estimated between $350 and $700 per year. Savings realized by reduction of hazardous waste disposal costs were not estimated.

Company C Assessment

Company C represents a medium-sized operation in the automotive paint and body industry. This company currently employs 13 workers, and paints or repairs about 55 cars per month. Company C provides complete collision repair such as welding, mechanical work, body repair, and painting. This company is different from most of the other shops in this industry, since it performs more extensive vehicle maintenance operations.

Chemical Usage

Chemicals used at this shop form a more extensive list than most shops due to its extended repair services. Raw materials such as acrylic lacquer thinner, acrylic enamel paints, degreasing solvents, oil, transmission fluid, brake/hydraulic fluids, and antifreeze are used on a daily basis.

Many of the above-mentioned chemicals are used to replenish fluid levels in cars without requiring fluid removal; therefore, very little waste automotive fluid is handled. The most predominant waste streams are paint and thinner residues, waste oil, and antifreeze from radiator flushing. These combined groups of wastes are generated in equal amounts at a rate of about 20 gallons per month. Thinners are used on a once-through basis only with no reuse.

Most solvent, oil, and engine fluids are stored in 55-gallon drums, with the remainder of the products kept in 5-gallon drums or pint-sized and quart-sized cans. All drums and containers are stored indoors with tightly sealed lids and spigots or pumps. The materials are not stored in one area, but rather are dispersed around the shop at points of highest use. The pint-sized and quart-sized paint cans are stored inside several metal cabinets.

Waste Generation

The largest volume of waste at Company C is paint thinner, generated at a rate of 20 gallons per month. Paint thinner, waste solvent, and waste oils are removed off site through the services of a reclamation facility. Used batteries are collected and stored for subsequent removal by a salvage company.

Similar to new materials, wastes are stored in several areas of the shop, adjacent to areas of highest use. Wastes are stored in 55- or 30-gallon drums indoors on concrete. Wastes are transferred to drums from smaller containers using funnels. Floor washings are performed periodically to remove accumulated debris. Runoff is flushed into one of several floor drains located throughout the shop area. A clarifier is connected to floor drains to intercept any contaminants that may be rinsed down shop drains. Clarifier effluent is discharged to the sanitary sewer. Small spills appeared to be fairly common; the material was absorbed with floor dry and deposited in a refuse dumpster.

Waste Minimization - Current Practices and Recommendations

The following recommendations are suggested for waste minimization at Company C:

1. Improved Housekeeping Practices. Product losses can be reduced through the use of tight-fitting caps and seals on containers and waste drums. Funnels should be used whenever possible to minimize spillage. Company C was the only shop that had extensive areas of unpaved soil. Areas between buildings were predominantly packed dirt. Laying concrete between adjacent building areas could help reduce airborne dust at work locations and contain spills and drips for ease of cleanup.

2. Source Reduction. Source reduction practices can be readily implemented at this company. Such practices include the minimization of thinner used to clean equipment. Thinner use can be minimized through stringent inventory control. Another source reduction practice would be to decant and reuse gravity-separated solvent for cleaning equipment. A follow-up wash with clean material will ensure that equipment is adequately cleaned.

3. Disposal of Excess Paint. The most obvious practice for the minimization of paint requiring disposal is to mix smaller quantities of paint. However, as it is often not possible to predict the exact quantity of paint required for each job, the generation of excess paint is inevitable. Excess paint should be disposed of in a separate waste paint container or given to customers to be used as touch-up paint. Disposal to a waste thinner drum would diminish the quality of the thinner, preventing its reuse as wash thinner. Therefore, this practice is discouraged.

4. Spill Migration Prevention. Drums of new and waste materials should be stored in such a manner that off-site migration of any spills or leaks is prevented. Floor drains adjacent to drum storage areas should be sealed to prevent spill intrusion.

By implementing source reduction and housekeeping practices, it is estimated that a 20 to 25 percent reduction in new thinner usage can be achieved. This reduction translates to an estimated annual cost savings between $600 and $750. Additional savings from reduction of hazardous waste disposal costs were not estimated.

Company D Assessment

Company D is a medium-sized independent operation in the automotive paint and body industry. This company employs nine full-time workers, and has a business volume of approximately 30 to 40 cars per month. This particular operation consisted of two shops located on one city block. The main shop is used for body repair and for preparing vehicles for painting. The second shop is used for painting operations only. Because these shops are physically separated, only the painting operations were assessed. Company D provides complete collision repair, frame and suspension adjustments, and painting. As in most other auto body shops, mechanical work on engines and drive trains is done only in association with body repair.

Chemical Usage

Chemicals used at the painting shop include enamel reducer, two grades of thinner, and small amounts of motor oil for shop vehicle maintenance. The enamel reducer and thinners are combined with the pigments during painting operations. The use and quantity of these materials depends on the type of paint applied (enamel or lacquer), type of finish required, and specifications for the particular color applied.

Thinners are stored in 55-gallon drums, with the remainder of the paints and chemicals stored in pint-, quart-, and gallon-sized containers. All drums and cans are stored indoors with tightly sealed lids and spigots or pumps. The materials are not stored in one area, but instead are scattered around the paint shop.

Waste Generation

Hazardous waste generated at this shop consists of waste thinner, spent paint booth filters, and small quantities of waste oil. The major quantity of waste is thinner generated during equipment cleaning operations. Waste thinner is generated at a rate of approximately 30 gallons per month and is stored in a 55-gallon drum. Based on the volume of business, this generation rate is higher than the other companies that were assessed. This high waste generation rate can be attributed to the use of thinner on a once-through basis only, with minimal product reuse.

Wastes are recycled through a lacquer supply company, which charges a unit price for transport and delivery of raw material supplies and reclamation of generated wastes. Company D is also using a new type of styrofoam paint booth filters, which can be dissolved into the waste thinner when it becomes saturated with paint contaminants. Most of the other facilities use conventional booth filters, which are disposed of with the nonhazardous refuse. The styrofoam filter could possibly be made a requirement to reduce the contamination of municipal refuse. However, the effect of styrofoam on the recyclability or incinerability of the waste thinner must be investigated.

Small amounts of waste oil are generated at a rate of about 7 gallons per month. Motor oil is used for shop vehicles only and is recycled through an adjacent service station.

Waste Minimization - Current Practices and Recommendations

The following recommendations are suggested for waste minimization at Company D:

1. Source Reduction. When compared with other facilities, this company generates a fairly large quantity of waste for each vehicle painted. Source reduction practices such as decanting dirty thinner from the waste drum and using it for initial cleanup of the equipment should be implemented to minimize the volume of waste generated.

2. Improved Housekeeping Practices. Through the implementation of housekeeping practices, material losses through spillage and evaporation can be minimized. Spillage can be reduced by using hand pumps and funnels during material transfers; evaporation can be minimized by using lids.

3. Segregation of Excess Paint Wastes from Thinner Wastes. Contamination of thinner can be reduced by segregating excess paint wastes from thinner wastes. Excess paint can be saved and given to customers for use as touch-up paint.

4. Spill Migration Prevention. Drums of new and used materials should be stored in such a manner that off-site migration of any spills or leaks is prevented. Floor drains located adjacent to storage areas should be sealed.

By implementing these recommended practices, it is estimated that at least a 50 percent reduction in new thinner usage can be achieved at Company D. At a cost of $6 per gallon, this reduction in thinner usage translates to an estimated cost savings of $1,300 per year.

Company E Assessment

Company E represents the smaller independent operation in the automotive paint and body industry. This company employs seven workers, and has a business volume of approximately 30 cars per month. Company E provides auto body repair and painting. Most of the painting done at this company is spot repairs to collision-damaged vehicles. Mechanical work on engines and drive trains is only done in association with body repair.

Chemical Usage

The chemicals used at this shop include lacquer thinner, Bondo, oil, antifreeze, and paints. The thinner and oil are both stored in 55-gallon drums. Paints are all stored in cans ranging from pint to gallon size. All drums and containers are stored indoors, with tightly sealed lids and spigots or pumps. The drums are stored in various locations around the shop at points of highest use. All paint materials are stored in a lockable storage/paint mixing area.

Waste Generation

The most predominant waste streams consist of thinners with paint sludges and spent oils. These are both generated at a rate of roughly 20 gallons per month. Thinners are used on a once-through basis only, with no reuse. Radiators on damaged vehicles are often punctured and broken resulting in fluid loss before the vehicle enters the facility. Once repairs are completed, new antifreeze is added to the empty reservoir. Bondo, a putty-like raw material, generates waste fiberglass in the form of dust when sanded. This dust settles very slowly, but is eventually collected in shop sweepings or rinsed down drains during wash-downs. In general, this shop is kept very clean and well organized; it is undoubtedly swept and washed down on a routine basis.

Waste Minimization - Current Practices and Recommendations

The following recommendations are suggested for waste minimization at Company E:

1. Source Reduction. The quantity of hazardous waste generated and utilization of new material can be reduced through the implementation of source reduction practices. These practices include rigid inventory control and reuse of spent material such as dirty thinner for initial equipment cleaning.

2. Improved Housekeeping Practices. Although housekeeping practices at this shop are excellent, additional practices may reduce leakage, spillage, and losses through evaporation. All containers used for new materials and thinner should be equipped with tight-fitting lids except during times of use. Drip pans can be used to collect leaks associated with engine damage.

3. Segregation of Wastes. By segregating excess paints from waste thinner, a higher quality waste thinner can be obtained. Waste thinner can then be reused in preliminary equipment washings.

4. Spill Migration. New materials and wastes are stored on cement in covered areas at this shop. However, runoff from spills and leaks can potentially migrate off site due to the topography of the shop. Efforts to control potential spills and leaks should be implemented and floor drains adjacent to storage areas should be secured or sealed. The generator should verify that on-site storage of new materials and wastes is being done in accordance with state, federal, and local regulations.

By implementing the above practices, it is estimated that a 10 to 15 percent reduction in the use of new thinner can be attained. This reduction will result in a cost savings of $400 to $600 per year, not including savings in disposal costs.

Company F Assessment

Company F was the smallest of the six independent automotive paint and body operators interviewed during this study. This company employs three full-time workers, and has a business volume of approximately 25 vehicles per month. Company F provides auto body structural repair and painting services only. The majority of this company's work entails minor body repairs and spot painting using enamel paints almost exclusively. No mechanical work that would generate fluid wastes is performed.

Chemical Usage

The chemicals used in this shop form a somewhat less extensive list than some shops, because no oils or engine fluids are used or generated on site. Raw materials such as enamel reducer, enamel catalyst, and two grades of lacquer thinner are used on a daily basis.

Both new thinner and stored wastes are kept in 55-gallon drums. Both of these containers have appropriate material transfer devices such as spigots, pumps, or funnels. Drums are stored in a locked, steel-bottomed, outdoor storage shed. Drums are grounded to an adjacent water pipe to eliminate the risks of generating sparks near flammable products. Paints are stored in quart- or pint-sized cans, with the remainder of the raw materials in 1- or 15-gallon containers. These materials are all stored indoors in a segregated paint mixing area.

Waste Generation

Company F generates two predominant waste streams. One is composed of a mixture of paints, thinners, catalysts, and reducers. These compounds are mixed together in a 55-gallon storage drum and are generated at a total rate of about 5 gallons per month. Wastes are removed every 3 months by a lacquer supplier for the purposes of recycling. The supplier provides both new solvent and waste removal, which are included in a total service cost. The second waste stream is composed of paint residues, which are mixed for each individual project. One partially filled can of paint is generated for each car painted. When the vehicle is finished, the extra paint is given to the customer to use for touch-up work.

Waste streams generated at this shop are very modest. The owner uses rigid inventory control and many basic housekeeping techniques, such as thinner reuse for cleanup and base coats, which substantially reduce the amounts of waste generated. These programs have been effective in minimizing waste streams and increasing economic returns at Company F.

Waste Minimization - Current Practices and Recommendations

Very few recommendations can be offered to this company to minimize waste generation. Inventory control and reuse practices are implemented to reduce the quantity of thinner utilized at the facility. Excess paints are segregated from thinner wastes and given to customers for use as touch-up paint. Housekeeping practices are implemented to minimize spillage and leakage.

Firm FENDER BENDERS Site Date 4/30/91	Waste Minimization Assessment Proj. No.	Prepared By DB Checked By Sheet 1 of 1 Page 1 of 9

WORKSHEET 1

WASTE SOURCES

Shop Clean-Up	Significance at Shop		
	Low	Medium	High
Obsolete raw materials	X		
Spills & leaks (liquids & powders)	X		
Dirty rags & sawdust	X		
Area wash water	X		
Clarifier sludges	X		
Container disposal		X	
Pipeline/tank drainage	X		
Evaporative losses	X		
Note: *For a discussion of waste minimization options for reduction of shop clean-up wastes, see the EPA pollution prevention guide for the automotive repair industry.*			
Body Repair			
Left over filler	X		
Sanding dust	X		
Painting			
Left over paint	X		
Dirty wash thinner		X	
Empty containers		X	
VOC air emissions	X		
Particulate emissions	X		
Dirty booth filters	X		

htm/auto-ref/ws1

Firm FENDER BENDERS Site Date 4/30/91	Waste Minimization Assessment Proj. No.	Prepared By DB Checked By Sheet 1 of 2 Page 2 of 9

WORKSHEET
2a

WASTE MINIMIZATION:
Material Handling

A. 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 they properly trained in handling of spilled raw materials?	☒ yes	☐ no
Is there a formal personnel training program on raw material handling, spill prevention, proper storage techniques, and waste handling procedures?	☒ yes	☐ no

Describe handling procedures for damaged items: Return to vendor

How often is training given and by whom? Train new people during first week by Shop manager

Is obsolete raw material returned to the supplier?	☐ yes	☒ no
Is inventory used in first-in first-out order?	☒ yes	☐ no
Is the inventory system computerized?	☐ yes	☒ no
Does the current inventory control system adequately prevent waste generation?	☒ yes	☐ no

What information does the system track?

Are stored items protected from damage, contamination, or exposure to rain, snow, sun and heat?	☒ yes	☐ no
Is the dispensing of raw materials supervised and controlled?	☒ yes	☐ no
Are users required to return empty containers before being issued new supplies?	☐ yes	☒ no
Do you maintain and enforce a clear policy of using raw materials only for their intended use?	☒ yes	☐ no

Firm FENDER BENDERS	Waste Minimization Assessment	Prepared By DB
Site		Checked By
Date 4/31/91	Proj. No.	Sheet 2 of 2 Page 3 of 9

WORKSHEET 2b

WASTE MINIMIZATION: Material Handling

B. BULK LIQUIDS HANDLING

What safeguards are in place to prevent spills and avoid ground contamination during the filling of storage tanks?

- High level shutdown/alarms ☐
- Secondary containment ☐
- Flow totalizers with cutoff ☐
- Other ☐

Describe the system: No bulk handling - use only 55-gallon drums or smaller containers

Are air emissions from solvent storage tanks controlled by means of:

Conservation vents	☐ yes	☐ no
Nitrogen blanketing	☐ yes	☐ no
Absorber/Condenser	☐ yes	☐ no
Other vapor loss control system	☐ yes	☐ no

Describe the system: N/A

Are all storage tanks routinely monitored for leaks? If yes, describe procedure and monitoring frequency for above-ground/vaulted tanks: N/A

Underground tanks: N/A

How are the liquids in these tanks dispensed to the users? (i.e., in small containers or hard piped.) N/A

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:

htm/auto-rel/ws2b

Firm FENDER BENDERS Site Date 4/30/91	Waste Minimization Assessment Proj. No.	Prepared By DB Checked By Sheet 1 of 1 Page 4 of 9

WORKSHEET
3

OPTION GENERATION:
Material Handling

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

Meeting Coordinator

Meeting Participants

Suggested Waste Minimization Options	Currently Done Y/N?	Rationale/Remarks on Option
A. Drums, Containers, and Packages		
Raw Material Inspection	Y	
Proper Storage/Handling	Y	
Return Obsolete Material to Supplier	N	Investigate with supplier
Minimize Inventory	Y	
Computerize Inventory	N	
Formal Training	Y	
Waste Segregation	Y	
B. Bulk Liquids Handling	N/A	
High Level Shutdown/Alarm		
Flow Totalizers with Cutoff		
Secondary Containment		
Air Emission Control		
Leak Monitoring		

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Firm FENDER BENDERS Site Date 4/31/91	Waste Minimization Assessment Proj. No.	Prepared By DB Checked By Sheet 1 of 2 Page 5 of 9

WORKSHEET
4a

WASTE MINIMIZATION:
Body Repair & Paint Application

A. BODY REPAIR

Do you generate large quantities of waste filler?	☐ yes	☒ no
Are your workers supervised/trained so they do not mix more filler than required?	☒ yes	☐ no
Do you currently employ rigid inventory controls to minimize product use?	☐ yes	☒ no
Do you discourage the use of hoses to flush filler dust to the sewer or clarifier?	☒ yes	☐ no
Are sweep brooms or vacuum units available for your workers to use?	☒ yes	☐ no

Explain how you minimize waste from auto body repair: _____

B. PAINT APPLICATION

Do you generate large quantities of waste paint or thinner?	☒ yes	☐ no
Do you currently employ rigid inventory controls to minimize material use?	☐ yes	☒ no
Do you use more than 1/2 gallons of thinner per car?	☒ yes	☐ no

If yes, discuss how implementing more rigid controls could be accomplished in your shop: Limit amount of thinner issued to ½ gallon per car painted

Is the volume of paint mixed based on the surface area to be painted?	☒ yes	☐ no
Does the design of your mixing equipment prevent you from mixing smaller batches of paint?	☐ yes	☒ no
Do you provide customers with leftover paint (enamel or lacquer only) for touch-up use?	☐ yes	☒ no
Are operators trained to use their equipment properly so as to minimize overspray?	☒ yes	☐ no
Are they periodically retrained?	☐ yes	☒ no

What measures have you taken to reduce the generation of waste paint: Mix small batches

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Firm FENDER BENDERS Site Date 4/30/91	Waste Minimization Assessment Proj. No.	Prepared By DB Checked By Sheet 2 of 2 Page 6 of 9

WORKSHEET
4b

WASTE MINIMIZATION:
Body Repair & Paint Application

B. PAINT APPLICATION – continued

Who provides this training and how often is it given? Manager demonstrates methods to new people during first week on job.

Do your operators use large amounts of solvent to clean equipment?	☒ yes	☐ no
Do they scrape out paint cups before rinsing?	☐ yes	☒ no
Have you tried using or do you use an enclosed cleaning system?	☐ yes	☒ no

What was the effect: _____

Do you contract with an off-site thinner supplier/recycler?	☒ yes	☐ no
Do you decant dirty thinner and use it as an initial wash thinner?	☐ yes	☒ no
Do you paint more than 50 cars per month?	☐ yes	☒ no
If yes, have you looked at on-site recycling systems?	☐ yes	☐ no
Have you tried to list your waste with a certified waste exchange?	☐ yes	☒ no

Please discuss any measures you have taken to recycle paint/thinner waste: None

Have you investigated the use of low VOC paints?	☒ yes	☐ no
Have you investigated the use of high transfer efficiency spray equipment?	☐ yes	☒ no
If yes, did it reduce the amount of paint sprayed?	☐ yes	☐ no
Did it affect finish quality/customer satisfaction?	☐ yes	☐ no
Have you investigated the use of styrofoam booth filters?	☒ yes	☐ no

Discuss your success/failure with these options: Now use only styrofoam filters.

htm/auto-ref/ws4

Firm FENDER BENDERS	Waste Minimization Assessment	Prepared By DB
Site		Checked By
Date 4/30/91	Proj. No.	Sheet 1 of 1 Page 7 of 9

WORKSHEET 5

OPTION GENERATION: Body Repair & Paint Application

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

Meeting Coordinator D. BENDER

Meeting Participants A. FENDER, J. SMITH

Suggested Waste Minimization Options	Currently Done Y/N?	Rationale/Remarks on Option
A. Body Repair		
Mix filler according to need	Y	
Employ rigid inventory control	N	AF to investigate
Sweep up or vacuum dust	Y	
B. Paint Application		
Employ rigid inventory controls	N	AF to investigate
Mix paint according to need	Y	
Give customer touch-up paint	N	Give paint only when asked
Train operators to minimize overspray	Y	
Scrape out paint cups before rinsing	N	Instruct painters to do this
Use an enclosed cleaning system	N	
Contract with a thinner supplier/recycler	Y	
Install on-site recycling equipment	N	
List waste with waste exchange	N	
Use low VOC coatings	Y	
Use high transfer efficiency equipment	N	DB will investigate
Use cleanable styrofoam filters	Y	

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Firm FENDER BENDERS Site Date 4/30/91	**Waste Minimization Assessment** Proj. No.	Prepared By DB Checked By Sheet 1 of 1 Page 8 of 9

WORKSHEET
6

WASTE MINIMIZATION:
Shop Clean-Up

In addition to automotive refinishing, do you perform automotive repairs? (If yes, please refer to the EPA pollution prevention guide for automotive repair shops.)	☐ yes	☒ no
Are drip pans placed under leaking cars to reduce the need for floor cleaning?	☐ yes	☒ no
Are dirty parts removed and placed on a drip pan instead of directly on the shop floor? N/A	☐ yes	☐ no
Are all work bays kept clean and neat?	☒ yes	☐ no
Do your workers wipe up small spills of fluids as soon as they occur?	☒ yes	☐ no
Do you have an award program for workers who keep their work bays clean (i.e. prevent leaks and spills)?	☐ yes	☒ no

How are spilled fluids recovered and disposed of? _____

Do you use a laundry service to clean your rags and uniforms?	☒ yes	☐ no

If no, how are they handled? _____

Do you use a biodegradable detergent for cleaning shop floors?	☒ yes	☐ no
Have you tried using a steam cleaner in place of chemical cleaners?	☐ yes	☒ no
Do you discharge area washdown wastewater to a POTW or industrial sewer instead of to the storm drain?	☒ yes	☐ no

If no, how is this wastewater handled: _____

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Firm FENDER BENDERS	Waste Minimization Assessment	Prepared By DB
Site		Checked By
Date 4/30/91	Proj. No.	Sheet 1 of 1 Page 9 of 9

WORKSHEET 7

OPTION GENERATION: Shop Clean-Up

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

Meeting Coordinator D. BENDER

Meeting Participants A. FENDER, J. SMITH

Suggested Waste Minimization Options	Currently Done Y/N?	Rationale/Remarks on Option
Use Drip Pans	N	Not a big problem
Wipe Up Spills (Cotton Rags)	Y	
Keep Bays Clean	Y	
Award Program	N	Consider publicity poster
Use Laundry Service	Y	
Use Biodegradable Detergents	Y	
Use Steam Cleaners	N	Too expensive now
Discharge to POTW/Industrial Sewer	Y	

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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.

U.S. EPA Reports on Waste Minimization

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.* NTIS 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.* NTIS 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: The 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

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 Marine Repair Industry. EPA/625/7-91/015

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

*Executive Summary available from EPA, CERI Publications Unit, 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. PB87-114328.

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

Waste Reduction Technical/Financial Assistance Program

The EPA Pollution Prevention Information Clearinghouse (PPIC) was established to help reduce industrial pollutants through technology transfer, education, and public awareness. PPIC collects and disseminates technical and other information on 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) 424-9346 (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
Resources Recovery Program
University of Alabama
P.O. Box 6373
Tuscaloosa, AL 35487-6373
(205) 348-8401

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

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

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

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

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
Floyd Towers East, Suite 1154
205 Butler Street
Atlanta, GA 30334
(404) 656-2833

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

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

Illinois Waste Elimination Research Center
Pritzker Department of Environmental Engineering
Alumni Building, Room 102
Illinois Institute of Technology
3200 South Federal Street
Chicago, IL 60616
(313)567-3535

Indiana
Environmental Management and Education Program
Young Graduate House, Room 120
Purdue University
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
205 Engineering Annex
Iowa State University
Ames, IA 50011
(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

Kansas
Bureau of Waste Management
Department of Health and Environment
Forbesfield, 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

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

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

Maryland Environmental Service
2020 Industrial Drive
Annapolis, MD 21401
(301) 269-3291
(800) 492-9188 (in Maryland)

Massachusetts
Office of Technical Assistance
Executive Office of Environmental Affairs
100 Cambridge Street, Room 1094
Boston, MA 02202
(617) 727-3260

Source Reduction Program
Massachusetts Department of Environmental Protection
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
Box 197 Mayo
420 Delaware Street S.E.
University of Minnesota
Minneapolis, MN 55455
(612) 625-9677
(800) 247-0015 (in Minnesota)

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

New Hampshire
New Hampshire Department of
Environmental Services
Waste Management Division
6 Hazen Drive
Concord, NH 03301-6509
(603) 271-2901

New Jersey
New Jersey Hazardous Waste Facilities
Siting Commission
Room 614
28 West State Street
Trenton, NJ 08608
(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) 984-6070

New York
New York State Environmental Facilities Corporation
50 Wolf Road
Albany, NY 12205
(518) 457-3273

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

Governor's Waste Management Board
325 North Salisbury Street
Raleigh, NC 27611
(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

Ohio
Division of Solid and Hazardous Waste Management
Ohio Environmental Protection Agency
P.O. Box 1049
1800 WaterMark Drive
Columbus, OH 43266-1049
(614) 481-7200

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

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

Center of Hazardous Material Research
320 William Pitt Way
Pittsburgh, PA 15238
(412) 826-5320

Bureau of Waste Management
Pennsylvania Department of Environmental Resources
P.O. Box 2063
Fulton Building
3rd and Locust Streets
Harrisburg, PA 17120
(717) 787-6239

Rhode Island
Office of Environmental Coordination
Department of Environmental Management
83 Park Street
Providence, RI 02903
(401) 277-3434
(800) 253-2674 (in Rhode Island only)

Ocean State Cleanup and Recycling Program
Rhode Island Department of Environmental Management
9 Hayes Street
Providence, RI 02908-5003
(401) 277-3434
(800) 253-2674 (in Rhode Island)

Center for Environmental Studies
Brown University
P.O. Box 1943
135 Angell Street
Providence, RI 02912
(401) 863-3449

Tennessee
Center for Industrial Services
102 Alumni Hall
University of Tennessee
Knoxville, TN 37996
(615) 974-2456

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

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
Herchler 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
Post Office 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
Post Office Box 942732
Sacramento, CA 94234-7320
(916) 324-1807

Canadian Chemical Exchange*
Mr. Philippe LaRoche
P.O. Box 1135
Ste-Adele, Quebec
CANADA JOR ILO

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 201 A
Grand Rapids, MI 49505
(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
Post Office 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

*For-Profit Waste Information Exchange

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

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 Blvd.
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
Post Office 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
Post Office Box 960
Tallahassee, FL 32302
(800) 441-SWIX (7949)
(904) 644-5516
FAX: (904) 574-6704

Tennessee Waste Exchange
Ms. Patti Christian
226 Capital Blvd., 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)
26 Federal Plaza
New York, NY 10278
(212) 264-2525

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

Region 4 (KY, TN, NC, SC, GA, FL, AL, MS)
345 Courtland Street, NE
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)
75 Hawthorne
San Francisco, CA 94105
(415) 744-1305

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

United States
Environmental Protection
Agency

Center for Environmental Research
Information
Cincinnati, OH 45268

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