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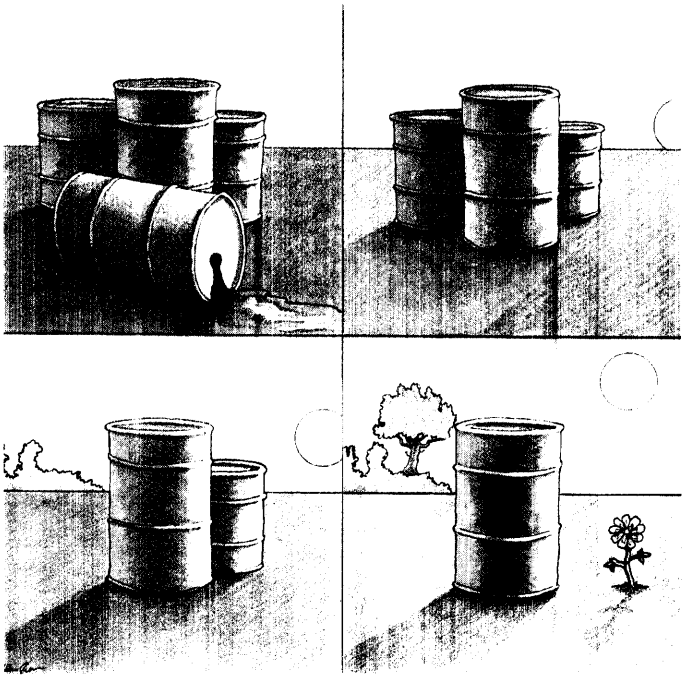
Waste Minimization

Environmental Quality with Economic Benefits



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WASTE MINIMIZATION

Environmental Quality with Economic Benefits

U.S. Environmental Protection Agency
Office of Solid Waste and Emergency Response
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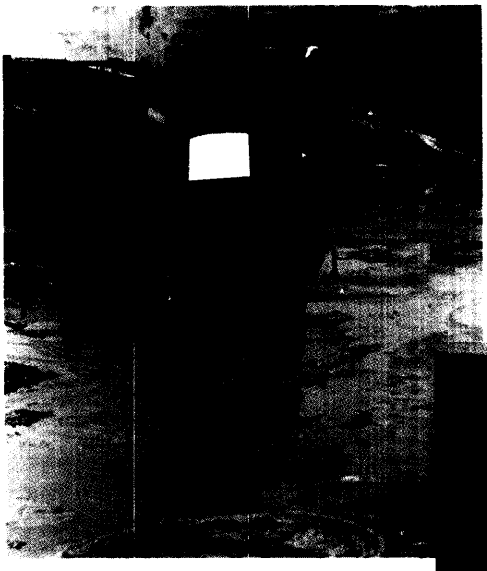
Washington, D.C. 1990



1976

During the 1970s, the seriousness of the hazardous waste problem became apparent. In 1976, Congress passed the Resource Conservation and Recovery Act—the first law to deal on the national level with hazardous waste.

1980

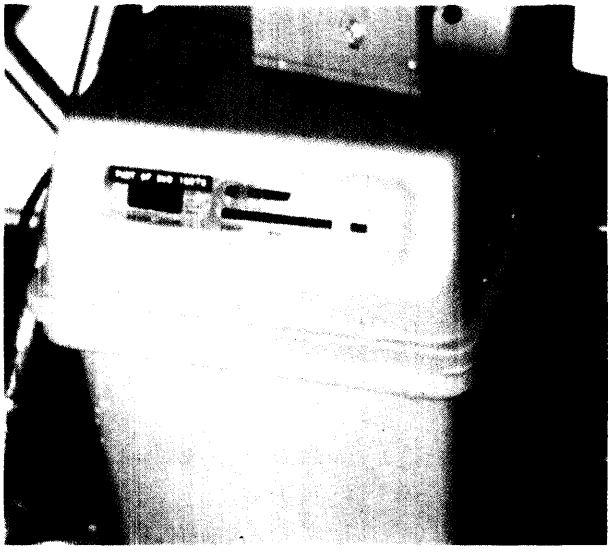
By 1980, EPA had established a regulatory program requiring "cradle-to-grave" management of hazardous waste. The program set forth design requirements for hazardous waste landfills, including liners and leak detection systems.

1984

By 1984, it had become clear that even well-regulated land disposal could cause environmental damage. Landfill liners can leak, possibly creating future cleanup problems. Treatment methods such as incineration will reduce but not eliminate the need for land disposal.

The Resource Conservation and Recovery Act (RCRA), as amended, 1984

Over the past decade, we have learned that the nation's hazardous waste problems cannot be cured by simply burying waste in the land. In recent years, Congress and EPA have emphasized effective treatment of hazardous waste prior to its land disposal. Treatment alone, however, will not necessarily remedy our hazardous waste problems. It is essential that we first minimize the generation and subsequent need for treatment, storage, and disposal of hazardous waste. This concept, called "waste minimization," is essential for ensuring a healthful environment for us all.



1986 *Relying on treatment and establishing strict controls on land disposal cannot fully solve our hazardous waste problems. We also must strive to minimize the amount of hazardous waste generated in the first place. This silver recovery unit both reduces the amount of waste that must be treated or disposed of and enables photo processors to turn a profit on the recovered silver.*

Waste Minimization

[illegible] reduction to the extent [illegible] hazardous waste that is gener[illegible] frequently treated, stored, or disposed of. In addition to waste regulated under RCRA, EPA encourages the minimization of all wastes that pose risks to human health and the environment. Waste minimization techniques focus on source reduction or recycling activities that reduce either the volume or the toxicity of hazardous waste generated. Unlike many waste treatment methods, waste minimization can be practiced at several stages in most industrial processes. Like all innovative solutions to waste management problems, waste minimization requires careful planning, creative problem solving, changes in attitude, sometimes capital investment, and, most important, a real commitment.

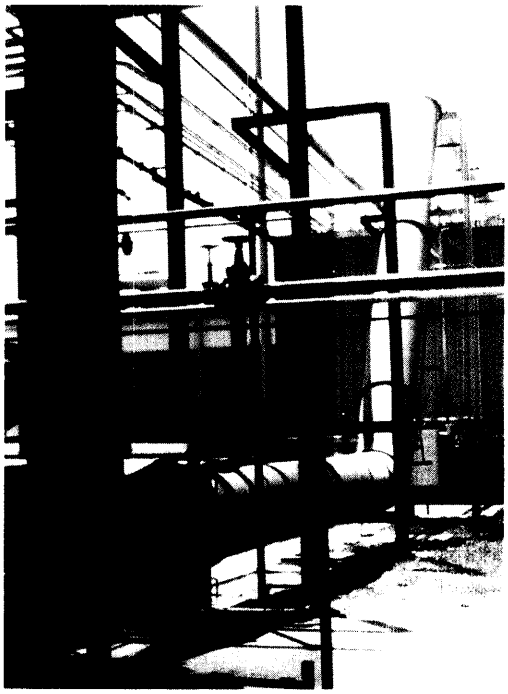
The payoffs for this commitment, however, can be great. Waste minimization can save money—often substantial amounts—through more efficient use of valuable resources and reduced waste treatment and disposal costs. Waste minimization also can reduce a generator's hazardous-waste-related financial liabilities: the less waste generated, the lower the potential for negative environmental effects. Finally, taking the initiative to reduce hazardous waste is good policy. Polls show that reducing toxic chemical risk is the public's primary environmental concern. Waste minimization can pay off tangibly when local residents are confident that industry is making every effort to handle its wastes responsibly.

Waste Minimization Pays

A leading chemical company established a program in 1987 that reduced waste generated at the company's facilities by more than 100,000 tons. This has saved an estimated $250 million through savings on reformulated products, conserved materials and energy, and the ability to delay or completely eliminate the purchase of pollution control equipment.

Incentives and Obstacles

Industries and other hazardous waste generators across the country are making progress toward reducing and recycling wastes, but much more could be done. The incentives are great, but, too often, so are the obstacles.



This vapor recovery unit traps escaping fumes from a printing press area in the adjoining plant. The trapped vapors then condense, forming reclaimed solvent, which is stored in a tank until it is reused.

[illegible] waste volumes is the high and escalating cost of other forms of hazardous waste management. Land disposal, which once cost as little as $10 per ton of waste, now costs at least $240 per ton. Disposal sites are in short supply, and prices keep rising. Another important incentive is that Congress has directed EPA to phase out the land disposal of certain types of untreated wastes. Under the Agency's land disposal restrictions program, mandated in the 1984 RCRA amendments, many untreated wastes that were previously sent to landfills will now be incinerated or otherwise treated at costs many times higher than those for land disposal. And these costs are only part of the overall picture. Other costs include waste storage expenses, transportation fees, administrative and reporting burdens, potential financial liabilities from accidental releases, and insurance (which, for many generators, may not even be available).

Working against these strong incentives are a number of practical obstacles that must be removed before waste minimization can reach its potential. Eliminating these impediments will be a high priority for the Agency over the next several years.

Information Is Scarce

Many companies that genuinely want to reduce their wastes do not have access to the information they need to make appropriate decisions. Identifying waste minimization opportunities can demand specialized engineering knowledge that many small- or medium-sized

[illegible] need access to [illegible] especially data on the cost-effec[illegible] of various waste minimization techniques. Improved information dissemination is one of the most important steps to encouraging waste minimization.

Product Quality Must Not Suffer

Reducing waste at the source may mean changing the way that products are made. Care must be taken not to risk the quality of established products.

Process Modification Saves $10 Million per Year

[illegible] The company's original process [illegible] gallons of [illegible] along with nonchlorinated waste solvents [illegible] to be [illegible]. The new process enables the firm not only to reduce the amount of [illegible] but also to burn the waste solvents in the company's powerhouse. Steam generated by the burning of the waste solvents is used in the manufacturing process, thereby saving the company more than $10 million per year in fuel oil.

Competing Pressures

Waste generators are struggling to keep up with emerging hazardous waste regulations. Over the next few years, many generators will be making long-term commitments to phase out land disposal and to adopt waste treatment processes. For many managers, waste minimization may not seem as urgent as meeting these regulatory deadlines. Because information is not always readily accessible and because process changes may be required, action is too easy to postpone. For waste minimization to gain acceptance among managers, they must realize how it can help meet their regulatory obligations, pay off in economic benefits, and improve their image with the public by demonstrating a commitment to environmental quality.

EPA's Report to Congress on Waste Minimization

The Resource Conservation and Recovery Act (RCRA) emphasizes the preeminence of source reduction and recycling as a strategy for managing solid waste. As early as 1976, the year RCRA was passed by Congress, EPA developed a formal hierarchy for waste management that listed source reduction as the preferred management option, followed, in order of preference, by onsite and offsite recycling, treatment, and, last, land disposal.

A Pennsylvania die manufacturer uses 1,1,1-trichloroethane to clean and degrease machine parts. Prior to installing this solvent recovery unit, the company shipped the contaminated solvent offsite for reclamation and then purchased reclaimed solvent at $.80 per gallon and virgin 1,1,1-trichloroethane at $4.50 per gallon.

In 1984, reflecting increased national concern over the hazardous waste problem, Congress directed EPA to report on whether it might be desirable or feasible to develop mandatory requirements, such as national regulations, to compel adoption of waste minimization techniques. In 1986, EPA responded with its report to Congress on waste minimization.

This report explored various technical, economic, and policy issues pertinent to hazardous waste source reduction and recycling, and concluded that mandatory programs would not be desirable or feasible at this time. EPA is continuing to collect and analyze data from generators and other sources to assess further the need for statutory authority on waste minimization. These findings will provide the basis for a followup report to Congress in 1990. In this report EPA will evaluate whether existing incentives have been sufficient to promote waste minimization, or whether some form of mandatory program is seen as necessary to implement the national waste minimization policy.

Using this solvent recovery unit, the company now reclaims solvent onsite at a cost of $.04-$.10 per gallon. In addition, the company's purchase of virgin 1,1,1-trichloroethane has dropped from two 55-gallon drums each month to two 55-gallon drums every 6 months, a savings of nearly $5,000 per year

[illegible] report to Congress that a [illegible] program is not desirable at this time was based on three key factors. First, mandatory programs would second-guess industry's production decisions, quite possibly leading to counterproductive results. Second, mandatory programs would be difficult and expensive to design and administer. Third, generators already face strong economic incentives to reduce their wastes. A regulatory program would take time to develop, and many industries might postpone any action until mandatory requirements were spelled out. The time for making constructive source reduction and recycling decisions is now, while industry is making long-term decisions on how to respond to the land disposal restrictions program and other revisions in the hazardous waste law.

EPA's report to Congress stressed that the most constructive role government can assume is to promote voluntary waste minimization by providing information, technology transfer, and assistance to waste generators. Since the States deal firsthand with generators, EPA believes the States should play the central role in fostering knowledge about waste minimization. Through waste minimization outreach programs, EPA will provide technical materials and guidance as well as information resulting from research efforts and other sources. EPA is also developing a nonbinding waste minimization policy statement to provide guidance to generators who must certify and report information to EPA on their waste minimization activities.

Examples of Waste Minimization in Other Countries

- One of the largest chemical manufacturers in the Netherlands uses waste segregation, removal of solvents in water solutions by distillation, and other source reduction measures to reduce the company's annual wastewater output by 80 percent.

- In Sweden, a major pharmaceutical producer initiated a program to recycle approximately 10,000 tons of hazardous waste solvents per year through the company's onsite distillation plant, thereby reducing by 60 percent the amount of solvent waste that was shipped offsite for disposal.

Waste Minimization in Other Countries

EPA's waste minimization strategy parallels those in Europe and Japan. All of them rely on cooperative, voluntary efforts. All of them stress the importance of low-pollution source reduction and recycling technologies, waste exchange (one company's waste being used as another's feedstock), and information sharing. As in the United States, these countries operate on a two-tier system: states, provinces, or prefectures deal directly with waste

[illegible] provide direction [illegible] surveyed in an EPA study of [illegible] waste reduction practices have rejected the notion of mandatory performance standards or other regulatory approaches. Several countries have committed significant resources toward working with generators to reduce waste volumes.

Waste Minimization Practices in Other Countries

	JAPAN	CANADA	GERMANY	SWEDEN	NETHERLANDS	DENMARK
TAX INCENTIVES						
Waste End Taxes			●		●	●
Tax Incentives	●	●	●			
ECONOMICS						
Price Support System for Recycling			●		●	
Government Grants as Subsidies	●	●	●	●	●	●
Low Interest Loans	●		●			
TECHNICAL ASSISTANCE						
Information and Referral Service	●	●	●		●	●
Site Consultation	●	●				
Training Seminars		●	●			●
R&D ASSISTANCE						
Technical Development Labs				●	●	●
Demonstration Projects	●	●	●	●		
Industrial Research			●	●	●	
PERMITS AND PLANS						
National Waste Management Plans					●	
Waste Reduction Agreements	●					
Waste Reduction as a Part of Permits				●		
WASTE EXCHANGE						
Regional Waste Exchanges	●	●	●		●	●
PUBLIC INFORMATION						
Focus on Corporate Image	●					
Focus on Consumer Practices			●			

Source: Foreign Practices in Hazardous Waste Minimization (Medford, Mass.: Center for Environmental Management, Tufts University, 1986).

Setting up an Industry Program

[illegible] each company should adopt its own general program for waste minimization, and, wherever possible, define that program formally in a written document. It should also develop an implementation plan for each of its facilities or subunits and periodically review, revise, and update its program to reflect changing conditions. While a waste minimization program can target regulated hazardous waste, it can also easily incorporate effective reductions of other types of pollution.

Suggested Steps of a Waste Minimization Assessment

- Prepare background material for the assessment.
- Conduct a preassessment visit to identify candidate waste streams.
- Select waste streams for detailed analysis.
- Conduct a detailed site visit to collect data on selected waste streams and controls and related process data.
- Develop a series of potential waste minimization options.
- Undertake preliminary option evaluations (including development of preliminary cost estimates).
- Rank options by:
  - waste reduction effectiveness;
  - extent of current use in the industry;
  - potential for future application at the facility.
- Present preliminary results to plant personnel along with a ranking of options.
- Prepare a final report, including recommendations to plant management.
- Develop an implementation plan and schedule.
- Conduct periodic reviews and updates of assessments.

Conducting Waste Minimization Assessments

An effective first step in setting up a waste reduction program is to perform a waste minimization assessment, sometimes referred to as a "waste minimization audit." Conducted by in-house staff or an independent outside expert, a waste minimization assessment is simply a structured review of a facility's potential opportunities

Waste minimization assessments are an effective means of identifying opportunities for source reduction and recycling.

[illegible] attempt to [illegible] all waste streams and processes at once.

Many State programs promote and support waste minimization assessments as a central element of their waste minimization programs. All facilities that generate hazardous waste can benefit, and operations that generate large volumes of waste and/or highly toxic waste can benefit greatly. Substantial and continuing waste reductions have also been achieved through the information gained from conducting waste assessments. Waste minimization assessments identify and characterize waste streams, the production processes that are responsible for generating each particular stream, and the amount of waste generated by each.

Case Study of a Waste Minimization Assessment

In 1986, EPA sponsored a waste minimization assessment at an electric arc furnace steel-making facility. The assessment team examined waste minimization options, including source reduction and resource recovery, for the company's corrosive and heavy metal wastes. The assessment revealed that calcium fluoride (fluorspar) in the sludge generated during neutralization of the pickling line wastewater could be economically recovered. Previously, the company had disposed of the sludge and purchased 1,000 tons of fluorspar per year as flux material for the steel-making process. The waste minimization option identified by the assessment team will save the company $100,000 per year in costs avoided to purchase fluorspar, and a further $70,000 per year because of a 30 percent reduction in the volume of sludge to be disposed of.

The results of a waste minimization assessment enable companies to identify cost-effective approaches to reduce the volume and toxicity of waste generated. They can then make more informed decisions on how to allocate resources to source reduction and recycling programs. While some capital investment may be required, returns can be analyzed in terms of payback periods and opportunity costs.

Involving Production Staff

The key difference between waste minimization and other environmental programs is that the essential decisionmakers are often on the production rather than on the environmental compliance side of the organization. While many environmental controls can be simply added to existing production processes, waste minimization usually happens within the production process itself. For example, recycling decisions require input from production staff, since waste often must be pretreated or otherwise modified to permit in-house

[illegible] techniques and recycling opportunities.

Integrating Costs

Hazardous waste disposal costs have increased rapidly and will continue to do so in the foreseeable future as generators compete for scarce treatment and disposal capacity. Because process engineers in many industrial plants are not required to consider "fully loaded" waste management expenses (such as treatment and disposal, transportation, tracking, management overhead, insurance, and energy and raw material expenses) as part of their production costs, they may be making process design and operation decisions that seem cost-effective within a discrete process, but that are actually inefficient from the company's overall financial perspective.

Keeping Accurate Records

An important step in setting up waste minimization programs is to maintain accurate records on existing waste generation rates and management costs, particularly for the major hazardous waste streams that will be targets for source reduction or recycling and that may have been subject to waste minimization assessments as part of the company's overall waste minimization program.

Working with State Programs

Some States have already instituted waste minimization technical assistance and outreach programs; others are initiating or expanding their efforts. States can help generators of all types, private and public, by providing technical guidance, helping to find qualified engineers to conduct waste assessments, serving as conduits for obtaining the latest information on waste minimization techniques, and putting companies with similar needs in contact with each other. Although companies must protect the confidentiality of their business information, they may, in many instances, benefit from sharing or trading expertise or experience with State waste minimization programs as intermediaries. States can also help publicize a company's waste minimization efforts.

[illegible] programs such as recycling [illegible] preferences. In some [illegible] programs are administered by nongovernmental groups such as universities and nonprofit organizations. Some of these programs are listed in this pamphlet.

An electronics plant installed this electrolytic metal recovery cell to recover copper from waste generated in the production of telephone switching equipment. The process produces a better quality copper deposit on the cell's cathode plates, where the copper collects in half-inch-thick sheets. The cell recovers 75 pounds of copper per week, which is sold for $.50 per pound—a total of about $2,000 per year. The use of the cell also has eliminated 1 drum of sludge per week, saving an additional $4,000 per year.

Waste Minimization Approaches and Techniques

Generally, waste minimization techniques can be grouped into four major categories: inventory management and improved operations, modification of equipment, production process changes, and recycling and reuse. Such techniques can have applications across a range of industries and manufacturing processes, and can apply to hazardous as well as nonhazardous waste.

Many of these techniques involve source reduction—the preferred option on EPA's hierarchy of waste management. Others deal with on- and off-site recycling. The best way to determine how these general approaches can fit a particular company's needs is to conduct a waste minimization assessment, as discussed above. In practice, waste minimization opportunities are limited only by the ingenuity of the generator. In the end, a company looking carefully at bottom-line returns may conclude that the most feasible strategy would be a combination of source reduction and recycling projects.

The approaches discussed and illustrated below provide waste minimization examples for generic and specific processes. Several of these will be the subject of EPA technology transfer documents (see inside front cover).

Good Management Practices Mean Different Things to Different Firms

By improving the methods for analyzing raw materials and products, a textile fibers plant in Tennessee reduced the amount of waste solvent generated from 7,000 gallons to 2,400 gallons per year.

Changing the reactor rinse and cleaning procedures on its truck-loading strainers has enabled a California chemical plant to reduce by 93 percent the amount of organics in its resin-manufacturing operation. Instead of allowing the phenol used in the manufacturing process to drip into the plant's sewage treatment system as a hose drains it from trucks, the company now flushes the hose with water, and the water-phenol mixture is recovered for reuse in a separate treatment system.

Waste Minimization Approaches and Techniques

Inventory Management and Improved Operations

- Inventory and trace all raw materials.
- Purchase fewer toxic and more nontoxic production materials.
- Implement employee training and management feedback.
- Improve material receiving, storage, and handling practices.

Modification of Equipment

- Install equipment that produces minimal or no waste.
- Modify equipment to enhance recovery or recycling options.
- Redesign equipment or production lines to produce less waste.
- Improve operating efficiency of equipment.
- Maintain a preventive maintenance program.

Production Process Changes

- Substitute nonhazardous for hazardous raw materials.
- Segregate wastes by type for recovery.
- Eliminate sources of leaks and spills.
- Separate hazardous from nonhazardous wastes.
- Redesign or reformulate end products to be less hazardous.
- Optimize reactions and raw material use.

Recycling and Reuse

- Install closed-loop systems.
- Recycle onsite for reuse.
- Recycle offsite for reuse.
- Exchange wastes.

Better Operating Practices

One of the best means of reducing wastes is through better operating or housekeeping practices—that is, ways to make existing processes work more efficiently, and thereby generate less waste. Better operating practices can involve anything from finding a more efficient way to handle a particular hazardous waste to making fundamental changes in the way a company thinks about waste management.

Better operating practices are specific to each facility and to each waste-generating process, but general themes include the following:

Personnel Practices

Heightened awareness by employees of the need for waste minimization is essential. Training programs, for example, are ways to generate ideas and establish employees' commitment.

Evaporative recovery systems can minimize the volume of waste from metal-plating baths and recycle plating solutions by recovering 90-95 percent of the plating solution lost through dragout. The operating cost of the recovery system is only $.08 per gallon, while the dragout sludge hauling and disposal costs are close to $1.00 per gallon. With only 5-10 percent of the dragout requiring waste treatment, waste handling and disposal costs have been reduced significantly.

[illegible] their content may even [illegible] toxic constituents, isolating liquid fractions, or keeping hazardous streams from nonhazardous waste, generators can sometimes save substantial amounts of money on disposal or find new opportunities for recycling and reuse.

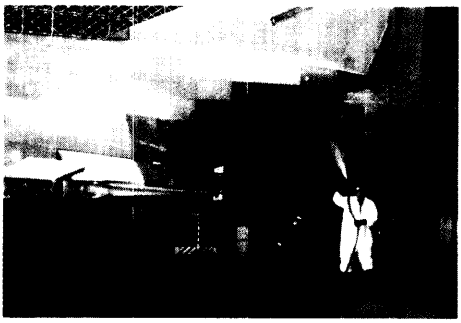
Better Standard Procedures

Large quantities of hazardous waste may be generated through spills, improper storage practices, inefficient production startup or shutdown, scheduling problems, lack of emergency procedures and preventive maintenance, or poorly calibrated pollution control devices. New standard procedures manuals, better inventory control, and routine training and retraining sessions can help eliminate this inadvertent waste generation and provide significant companywide source reduction benefits.

During standard equipment-cleaning operations, hospitals, universities, and research centers, as well as many small- and medium-sized businesses, such as metal finishers and furniture manufacturers, generate small amounts of waste solvents. These waste solvents can be recycled for reuse in cleaning operations using small, commercially available recovery units. Depending on the commercial value and amount of solvent recovered, the pay-back time for recycling equipment can be as short as 1 year. Since transportation costs can be very high, even businesses that use only low volumes of solvents may find it more economical to recycle their waste solvents onsite rather than ship the wastes offsite for recovery or disposal.

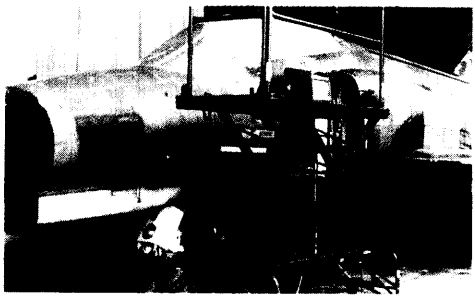
[illegible] many leftover waste [illegible] waste generated through [illegible] abrasion) and equipment [illegible] hazardous.

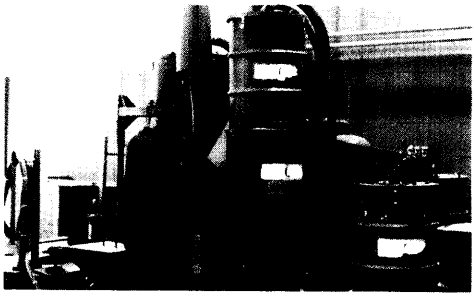
One of the most direct means of reducing paint-related hazardous waste is to use low-toxicity paints, such as those that are water-based products or do not contain heavy metals. Changing to water-based paints helps to reduce the use of organic solvents that later must be managed as hazardous waste and that also can be a source of air pollution.



Another approach to reducing waste from painting operations is to employ mechanical paint stripping. Companies that substitute such processes as bead blasting or cryogenic coating removal can avoid the use of hazardous caustics and solvents.

The Department of Defense has developed a new technique called Plastics Media Blasting to strip paint from military aircraft. In this process, small plastic beads are air blasted at the aircraft's surface, removing the paint by abrasion. This method requires less time and generates less hazardous waste than traditional wet paint stripping. On the basis of a test, the DOD estimates that the time required to strip an F-4 fighter has been reduced from 340 to 40 hours and that the amount of hazardous waste has been reduced from 10,000 pounds of wet sludge per aircraft to 320 pounds of dry paint chips and decomposed plastic media per aircraft.





As stain is sprayed onto a piece of furniture, the water curtain in the booth traps the excess stain and solvent residue. The water is recycled back to the wet booth and reused.

[illegible] spray, controlling paint quality to avoid defective batches that require stripping and repainting, and scheduling and sequencing paint operations more efficiently to reduce cleanup frequency.

Improved Paint Applications Programs

An electric company uses a water-based electrostatic paint system instead of a conventional organic solvent paint system. This has resulted in improved quality of application, decrease of downtime from 3 percent to 1 percent, reduction in the generation of aromatic waste solvent by 95 percent, reduction in paint sludge by 97 percent, and increase of efficiency with up to 95 percent recovery and reuse of paint. The new system reduced hazardous waste disposal costs and decreased personnel and maintenance costs by 40 percent.

An automobile manufacturer modified its paint storage and transfer system to be totally enclosed with full recirculation, resulting in less frequent and easier cleanups and improvement in paint quality.

More Effective Metal Parts Cleaning

Metal parts cleaning is an essential process for many large and small industries as well as a wide variety of businesses involved in the manufacture, repair, and maintenance of metal parts and equipment. Potentially hazardous substances used in metal parts cleaning can be minimized by reducing the volume or the toxicity of the cleaning agents used. Either method can save money as well as reduce hazardous waste. Generic approaches to minimize waste from metal parts cleaning include source control and substitution of cleaning agents.

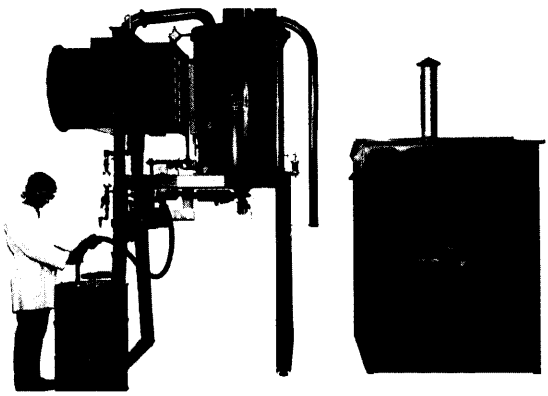
Substitute cleaning processes can include using abrasives in grease less or water-based binders, thus eliminating the need for subsequent caustic-based cleaning to remove the binder. Plants can also substitute abrasive-free, water-based cleaning compounds for solvent cleaners in many processes, thereby reducing air emissions from solvents.

Ion exchange metal-recovery units are used to remove heavy metals from aqueous residues generated by electroplating, metal-finishing, electronics manufacturing, and metal-refining processes. Ion exchange systems are commercially available, are relatively compact, and use little energy.

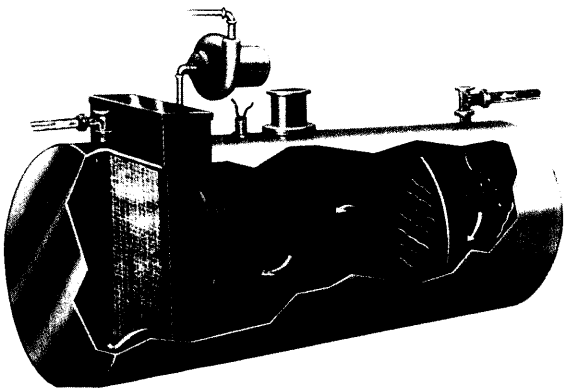
A high efficiency vapor degreaser removes lubricants and oil substances in this metal parts cleaning operation. This totally enclosed system, which collects solvent vapors and recycles them back to the cleaning operation, also reduces potential solvent air emissions.

[illegible] the [illegible] allow for inspection and [illegible] and prevent product contamination. This often generates hazardous waste, especially in chemical-processing related industries.

Two approaches to minimizing waste from process equipment cleaning are reducing the frequency of cleanups and reducing the quantity and toxicity of waste. For example, to reduce the frequency of cleanups, specialty chemical plants might schedule their batch processes to make a full year's run of a single chemical all at once, rather than interspersing it with batches of other products. Other plants might install more corrosion-resistant pipes and vats that can tolerate less frequent washing without risking product quality.



Acetone is used at this Ohio fiber glass manufacturing plant to clean and rinse molds and finished fiber glass panels for use on mass transit buses. A cost of $225 per gallon for acetone coupled with high disposal costs for the waste solvent caused the company to turn to onsite solvent recovery. The plant now uses two solvent recovery units that reclaim 45 gallons of acetone per day at a cost of $.04 to $.10 per gallon. The recovery units, which have a typical pay-back period of 1 year, allow the reclaimed solvent to be reused immediately. Not only has the company reduced its waste volume by 90 percent, it has also substantially decreased the amount of virgin acetone it must purchase.



Oil-water separators can be sized to accommodate different types of pollutant discharges from petroleum- and nonpetroleum-based industries. As oily influent flows into the separator, oil is removed and recovered and clean effluent is discharged. The heavy solids settle to the bottom and are periodically removed.

[illegible] company [illegible] its reactor vessels in two steps: the first rinse generates a small quantity of highly concentrated waste that can be recycled for additional rinsing, while the second, full-volume rinse finishes the cleaning and generates a much lower toxicity waste than before.

Examples of Other Waste Minimization Processes

Chemical Firm Reduces Acid Disposal Problem
The chemical and pigments department of a major chemical company in Kentucky manufactures freon. Low-quality hydrochloric acid, generated as a manufacturing byproduct, was previously disposed of in injection wells. The company recently installed a new freon manufacturing process that produces high-quality hydrochloric acid. By installing the new process and building an additional acid storage facility, the company now is able to sell approximately 22 million pounds per year of acid that was previously discarded.

Reverse Osmosis Removes Cyanide from Rinse Water
A polymer products operation in Arizona uses reverse osmosis to eliminate the discharge of cyanide-containing rinse water from one of the company's four plating units. The process, which concentrates the cyanide and separates it from the rinse water, reduces the environmental impact of the discharge and conserves valuable plating materials and water treatment chemicals.

Use of Waste Exchanges

A waste exchange is a matchmaking operation based on the idea that one company's waste may be another company's feedstock. Waste exchanges are private- or government-funded organizations that can help bring together generators of hazardous waste with companies that can use the waste as feedstocks or substitute materials in their operations. The goal of waste exchanges is to minimize waste disposal expenses and to maximize the value of reusable manufacturing byproducts.

[illegible] for the purpose of recycling waste material back into manufacturing processes. They are usually nonprofit organizations that receive most of their funds from governmental agencies. Material exchanges, unlike information exchanges, take actual physical possession of the waste and may initiate or actively participate in the transfer of wastes to the users. They are usually privately owned companies that operate for profit.

Actual Examples from a Waste Exchange Catalog

Formaldehyde-Surplus. Formaldehyde solution. Potential Use: embalming fluid. Type 1: Contains 25% formaldehyde with 10% glycerine, 10% alcohols (ethanol, isopropanol, methanol) and distilled water by wet wt. Type 2: Contains 25% formaldehyde with 25%-35% alcohols (ethanol, isopropanol, methanol) and distilled water by wet wt. 165,000 gals. in 15 gal. drums/plastic carboys in steel drums. One time. Independent analysis (specification) availiable. PA

1,1,1-trichloroethane. 1,1,1-trichloroethane from asphalt extractions. Contains 90% 1,1,1-trichloroethane with 10% asphalt and 1% oil. 220 gals. in drums available. Quantities vary. Thereafter 220 gal/yr. Sample available. PA

Paraffin Wax. Paraffin wax from clean-out of chewing gum base mixers. Fully refined. Potential use: firelogs, crayons, etc. Contains traces of gum base and calcium carbonate. 80,000 lbs. in 50 gal. drums. Quantities continuous. Thereafter 40,000 lbs/qtr.

While any type of waste can be listed in a waste exchange, certain materials are more likely than others to be recycled. Most transactions involve relatively "pure" wastes that can be used directly with minimal processing. Solvents, organics, acids, and alkalies are most frequently recycled. Metals from metal-bearing wastes, sludges, and solutions also may be recovered economically.

Waste exchanges are located throughout the country, but computerized central listing services are now the best first step in finding the most convenient one (see inside back cover).

Looking to the Future

[illegible] in response to [illegible] RCRA will ban the land disposal of many untreated hazardous wastes, forcing generators to explore other options. Treatment technologies can assume much of the waste management burden from land disposal, but treatment is expensive, and, at least in the near term, capacity is limited. EPA's strategy to minimize the generation of hazardous waste will help reduce or eliminate regulated wastes that are now managed by treatment or land disposal as well as other wastes that pose risks to human health and the environment.

Waste minimization is one of the few areas where national environmental goals and industry's economic interests clearly coincide. For generators, the benefits include reduced costs, liabilities, and regulatory burdens associated with hazardous waste management. For the general public, waste minimization pays off in an improved environment.

Because of these shared interests, EPA is promoting voluntary action on the part of industry. The only formal waste minimization requirement under RCRA is that industries certify that they have waste minimization programs of their own design in place. To support this, EPA will publish a non-binding waste minimization policy statement reflecting the Agency's ideas on what an effective voluntary program might include. EPA is also revising its biennial reporting requirements to provide generators with checklists with which to describe their activities and report their progress.

Waste minimization promotes environmental quality.

[illegible] management system [illegible] be [illegible] throughout all of EPA's pollution control programs. Consequently, EPA's waste minimization program will initially focus on RCRA hazardous waste. The overall Agency strategy will, however, address multimedia opportunities and will include an information clearinghouse, a national data base, research and technology transfer, and support for State programs.

EPA's technology transfer program will provide information to industry on methods to prevent waste generation by changing industrial processes, materials, and operations. One of the Agency's first projects is to issue a detailed manual on how to conduct a waste minimization assessment. This will be followed by a 15-minute videotape illustrating the step-by-step process, with examples of how different firms have profited from these assessments. EPA is also producing a computerized bibliography on waste minimization and a series of technology transfer documents on a variety of subjects. In addition, the Agency is developing a series of guidance materials for 18 different types of industries that tend to generate small quantities of hazardous waste. All of these materials will be available through State waste minimization programs.

Waste minimization clearly provides opportunities to deal more efficiently and effectively with wastes that are hazardous to human health and the environment. These opportunities are unique in that they provide immediate financial rewards to industry, increased waste management flexibility to generators, and reduced pressures on the nation's existing treatment and land disposal capacity. Now is the time to investigate and take practical steps toward waste minimization, before major commitments are made for treatment and disposal options. Over the longer term, the benefits of source reduction and recycling will be key incentives for generators to integrate waste minimization techniques into their overall hazardous waste management programs.

State Hazardous Waste Agencies

Alabama

Alabama Department of Environmental Management
1751 Dickenson Drive
Montgomery, AL 36130
(265) 271-7730

HAMMARR Regulation Information Service
University of Alabama
P.O. Drawer G, University Station
Tuscaloosa, AL 35487
(205) 348-6100

Alaska

Alaska Health Project
Waste Reduction Assistance Program
431 West 7th Avenue, Suite 101
Anchorage, AK 99501
(907) 276-2864

Department of Environmental Conservation
3220 Hospital Drive
P.O. Box O
Juneau, AK 99811-1800
(907) 465-2666

Arizona

Department of Environmental Quality
2005 N. Central Avenue
Phoenix, AZ 85004
(602) 257-2318

Arkansas

Arkansas Industrial Development Commission
No. 1 Capitol Mall
Little Rock, AR 72201
(501) 682-7322

Hazardous Material Training Center/UAMS
4301 W. Markham St., Mail Stop 638
Little Rock, AR 72205
(501) 661-5766

California

Alternative Technology Section
Department of Health Services
P.O. Box 942732
Sacramento, CA 94234
(916) 324-1807

Colorado

Department of Health
4210 E. 11th Avenue
Denver, CO 80220
(303) 331-4841

Connecticut

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

Local Assistance and Coordination
Connecticut Department of Environmental Protection
165 Capital Avenue
Hartford, CT 06106
(203) 566-3437

Delaware

Hazardous Waste Management Branch
Delaware Department of Natural Resources and Environmental Control
P.O. Box 1407
Dover, DE 19903
(302) 736-3689

Florida

Waste Reduction Assistance Program
DER/Division of Waste Management
2600 Blair Stone Road
Tallahassee, FL 32399-2400
(904) 488-0300

Georgia

Hazardous and Industrial Waste Management Program
Georgia Institute of Technology
O'Keefe Building
Atlanta, GA 30332
(404) 894-3806

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

Hawaii

Hazardous Waste Program
Hawaii Department of Health
P.O. Box 3378
Honolulu, HI 96801
(808) 548-8834

Idaho

Bureau of Hazardous Materials
450 West State Street
Boise, ID 83720
(208) 334-5878

Illinois

Illinois Hazardous Waste Research and Information Center
1808 Woodfield Drive
Savoy, IL 61874
(217) 333-8940

Waste Reduction Unit
Illinois Environmental Protection Agency
2200 Churchill Road
P.O. Box 19276
Springfield, IL 62794
(217) 781-6760

Indiana

Department of Environmental Management
Office of Solid and Hazardous Waste
105 South Meridian Street
P.O. Box 6015
Indianapolis, IN 46206-6015
(317) 232-8857

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

Environmental Management and Education Program (EMEP)
Center for Public Policy
Room 120, Young Graduate House
Purdue University
West Lafayette, IN 47906
(317) 494-5036

Iowa

Small Business Assistance Center
112 Latham Hall
University of Northern Iowa
Cedar Falls, IA 50614
(319) 273-2079

Iowa Department of Natural Resources
Wallace State Office Building
Des Moines, IA 50319
(515) 281-8489

Kansas

Department of Health and Environment
Forbes Field
Topeka, KA 66620
(913) 296-1698

Kentucky

Department for Environmental Protection
18 Reilly Road
Frankfort, KY 40601
(502) 564-2150

Kentucky Partners
University of Louisville
Ernst Hall
Louisville, KY 40292
(502) 588-7260

Louisiana

Department of Environmental Quality Solid and Hazardous Waste
625 N. Fourth Street, 6th Floor
Baton Rouge, LA 70804
(504) 342-1216

Department of Environmental Quality Policy and Planning
625 N. Fourth Street, 5th Floor
Baton Rouge, LA 70804
(504) 342-1255

Maine

Department of Environmental Protection
State House Station 17
Augusta, ME 04333
(207) 289-7838

Maryland

Maryland Environmental Services
2020 Industrial Drive
Annapolis, MD 21401
(301) 974-7281

Hazardous Waste Program
Department of the Environment
2500 Broening Highway
Baltimore, MD 21224
(301) 631-3343

Massachusetts

Asst. Commissioner for Waste Reduction
Department of Environmental Quality and Engineering
One Winter Street, 5th Floor
Boston, MA 02108
(617) 292-5765

Department of Environmental Management
Office of Safe Waste Management
100 Cambridge Street, Room 1904
Boston, MA 02202
(617) 727-3260

Michigan

Office of Waste Reduction
Department of Commerce
106 W. Allegan, Suite 111
P.O. Box 30004
Lansing, MI 48909
(517) 335-1178

Department of Natural Resources
P.O. Box 30028
Lansing, MI 48909
(517) 373-4735

Minnesota

MnTAP (Minnesota Technical Assistance Program)
University of Minnesota
Box 197 Mayo
420 Delaware Street, SE
Minneapolis, MN 55455
(612) 625-4949

Minnesota Pollution Control Agency
Hazardous Waste Section
520 Lafayette Road
St. Paul, MN 55155
(612) 296-7284

Mississippi

MSU Chemical Engineering
P.O. Drawer CN
Mississippi State, MS 39762
(601) 325-2480

Environmental Protection Council
P.O. Box 10385
Jackson, MS 39209
(601) 961-5276

Missouri

Missouri EIERA
P.O. Box 744
Jefferson City, MO 65102
(314) 751-4919

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

Montana

Department of Health
Solid and Hazardous Waste Bureau
Cogswell Building
Helena, MT 59620
(406) 444-2821

Nebraska

Department of Environmental Control
301 Centennial Mall South
Lincoln, NE 68509
(402) 471-4217

Nevada

Department of Conservation and Natural Resources
Waste Management Division
201 South Fall Street
Carson City, NV 89710
(702) 885-5872

New Hampshire

Department of Environmental Services
Waste Management Division
6 Hazen Drive
Concord, NH 03301-6509
(603) 271-3449

New Jersey

Department of Environmental Protection
Division of Hazardous Waste Advisement
401 East State Street
Trenton, NJ 08625
(609) 633-0737

Department of Environmental Protection
Office of Science and Research
401 East State Street, CN-409
Trenton, NJ 08627
(609) 984-6072

Hazardous Waste Commission
28 West State Street, Room 614
Trenton, NJ 08608
(609) 292-1459

New Mexico

Department of Environmental Improvement
Hazardous Waste Bureau
1190 St. Francis Drive
Santa Fe, NM 87504
(505) 872-2835

New York

Waste Minimization Section
Division of Hazardous Substances Regulation
Department of Environmental Conservation
50 Wolf Road
Albany, NY 12233-7253
(518) 485-8400

State Environmental Facilities Corp.
50 Wolf Road
Albany, NY 12205
(518) 457-4132

North Carolina

North Carolina Pollution Prevention Program
Department of Environment, Health and Natural Resources
P.O. Box 27687
Raleigh, NC 27611-7687
(919) 733-7015

Hazardous Waste Branch
Division of Health Services
Department of Human Services
P.O. Box 2091
Raleigh, NC 27602
(919) 733-2178

Ohio

Division of Solid and Hazardous Waste Management
P.O. Box 1049
Columbus, OH 43266
(614) 644-2956

Ohio Technology Transfer Organization
65 E. State Street, Suite 200
Columbus, OH 43066
(614) 466-4286

Oklahoma

Waste Management Service
Oklahoma State Department of Health
P.O. Box 53551
Oklahoma City, OK 73152
(405) 271-7047

Oregon

Department of Environmental Quality
Hazardous and Solid Waste Division
811 S.W. Sixth Avenue
Portland, OR 97204
(503) 229-6165

Pennsylvania

Department of Environmental Resources
Bureau of Waste Management
P.O. Box 2063
Harrisburg, PA 17120
(717) 787-6239

Center for haxardous Materials Research
University of Pittsburgh
320 William Pitt Way
Pittsburgh, PA 15238
(412) 826-5320

PENNTAP (Pennsylvania Technical Assistance Program)
The Pennsylvania State University
1527 William Street
University Park, PA 16802
(814) 865-1914

Rhode Island

Office of Environmental Coordination
Department of Environmental Management
9 Hayes Street
Providence, RI 02903
(401) 277-3434

Center for Environmental Study
Brown University
135 Angell Street
P.O. Box 1943
Providence, RI 02912
(401) 863-3499

South Carolina

Department of Health and Environmental Control
Solid and Hazardous Waste Management
2600 Bull Street
Columbia, SC 29201
(803) 734-5200

Tennessee

Center for Industrial Services
The University of Tennessee
226 Capitol Blvd. Bldg., Suite 401
Nashville, TN 37219-1804
(615) 242-2456

Department of Health and Environment
150 Ninth Avenue North
Nashville, TN 37219
(615) 741-3657

Texas

Hazardous and Solid Waste Management
Texas Water Commission
1700 North Congress Avenue
P.O. Box 13087, Capital Station
Austin, TX 78711
(512) 463-7761

Vermont

Department of Environment and Conservation
Hazardous Materials Management
103 South Main Street
Waterbury, VT 05676
(802) 244-8702

Virginia

Waste Minimization Program
Department of Waste Management
101 North 14th Street
Richmond, VA 23219
(804) 225-2667

Washington

Waste Reduction and Recycling
Solid and Hazardous Waste Program
Department of Ecology
Mail Stop PV-11
Olympia, WA 98504
(206) 459-6302

West Virginia Department of Natural Resources
Division of Waste Management
1201 Greenbrier Street
Charleston, WV 25311
(304) 348-5935

Wisconsin Department of Natural Resources
SW/3
P.O. Box 7921
Madison, WI 53707
(608) 267-3763

Wyoming Solid Waste Management Program
Wyoming Department of Environmental Quality
122 W. 25th Street
Cheyenne, WY 82002
(307) 777-7752

U.S. EPA Region VIII
Hazardous Waste Management Division
Denver Place (8HWM-RI)
999 18th Street, Suite 500
Denver, CO 80202-2405
(303) 293-1795

Further Information on Waste Minimization

Hazardous Waste Exchanges

California Waste Exchange
Department of Health Services
Toxic Substances Control Division
Alternative Technology Section
714/744 P Street
P.O. Box 942732
Sacramento, CA 94234-7320
(916) 324-1807 (Robert McCormick)

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

Great Lakes Waste Exchange
400 Ann Street, N.W., Suite 201-A
Grand Rapids, MI 49504-2054
(616) 363-3262 (Jeffrey Dauphin)

Idaho Waste Exchange
Idaho Department of Environmental Quality
Hazardous Materials Bureau
450 West State Street
Boise, ID 83720
(208) 334-5879 (Vicki Jewell)

Indiana Waste Exchange
Purdue University
School of Civil Engineering
West Lafayette, IN 47907
(317) 494-5063 (Dr. Lynn Corsonam)

Industrial Materials Exchange (IMEX)
Seattle—King County Environmental Health
172 20th Avenue
Seattle, WA 98122
(206) 296-4633 (Jerry Henderson)
Fax: (206) 296-0188

Industrial Material Exchange Service (IMES)
P.O. Box 19276
2200 Churchill Road, #24
Springfield, IL 62794-0276
(217) 782-0450 (Diane Shockey)
Fax: (217) 524-4193

*For-profit waste information exchange

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

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

Northeast Industrial Waste Exchange (NIWE)
90 Presidential Plaza, Suite 122
Syracuse, NY 13210
(315) 422-6572 (Lewis Cutler)
Fax: (315) 442-9051

Pacific Materials Exchange (PME)
S. 3707 Godfrey Blvd.
Spokane, WA 99204
(509) 623-4244 (Bob Smee)

Resource Exchange Network for
Eliminating Waste (RENEW)
Texas Water Commission
P.O. Box 13087
Austin, TX 78711-3087
(512) 463-7773 (Hope Castillo)
Fax: (512)463-8317

San Francisco Waste Exchange
2524 Benvenue #435
Berkeley, CA 94704
(415) 548-6659 (Portia Sinnot)

Southeast Waste Exchange (SEWE)
Urban Institute
Department of Civil Engineering
University of North Carolina
Charlotte, NC 28223
(704) 547-2307 (Maxie May)

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

Wastelink Division of TENCON, Inc.
140 Wooster Pike
Milford, Ohio 45150
(513) 248-0012 (Mary E. Malotke)
Fax: (513) 248-1094

Canadian Waste Exchanges

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

British Columbia Waste Exchange
2150 Maple Street
Vancouver, BC, Canada V6J 3T3
(604) 731-7222 (Lynn Deegan)

Canadian Chemical Exchange*
P.O. Box 1135
Ste-Adele, PQ, Canada J0R 1L0
(514) 229-6511 (Phillipe LaRoche)

Canadian Waste Materials Exchange (CWME)
ORTECH International
Sheridan Park Research Community
2395 Speakman Drive
Mississauga, ON, Canada L5K 1B3
(416) 822-4111 ext. 265 (Bob Laughlin)

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

Ontario Waste Exchange
ORTECH International
Sheridan Park Research Community
2395 Speakman Drive
Mississauga, ON, Canada L5K 1B3
(416) 822-4111 ext. 512 (Linda Varangu)

Peel Regional Waste Exchange
Regional Municipality of Peel
10 Peel Center Drive,
Brampton, ON, Canada L6T 4B9
(419) 791-9400 (Glen Milbury)

Other Waste Exchanges

Union Chemical Laboratories
Industrial Technology Research Institute
321, Kuang Fu Road, Sec. 2
Hsinchu, Taiwan (Republic of China) 30042
(Ai-Lun Huang, Assoc. Researcher)

Leads on Possible Exchanges

Tennessee Waste Exchange

Ontario Waste Management Corporation
Waste Exchange

Defunct Exchanges

Alabama Waste Exchange
University of Alabama
P.O. Box 870203
Tuscaloosa, AL 35487-0203
(205) 348-5889 (William J. Herz)
Fax: (205) 348-8573

Western Waste Exchange
Arizona State University
Center for Environmental Studies
Krause Hall
Tempe, AZ 85287-1201
(602) 965-1858 (Dr. Nicholas Hild)

EPA Waste Minimization Information Sources

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

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

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

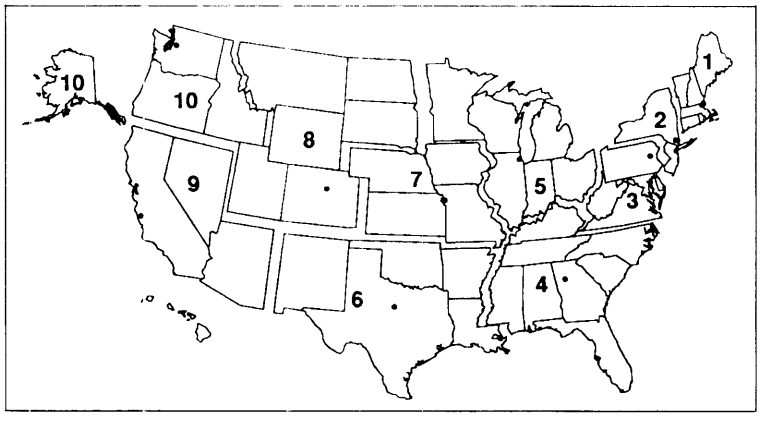
EPA Pollution Prevention Policy (Federal Register, January 26, 1989).

EPA Guidance to Hazardous Generators on the Elements of a Waste Minimization Program (Federal Register, June 12, 1989).

EPA Pollution Prevention Clearinghouse (call RCRA Hotline—1-800-424-9346.

EPA Manual on Waste Minimization Opportunity Assessments, Manual.

EPA Video—"Less is More: Pollution Prevention is Good Business" (call RCRA Hotline—1-800-624-9346).



U.S. EPA REGIONAL OFFICES

EPA REGION 1
John F. Kennedy Building
Boston, MA 02203
(617) 565-3715

EPA REGION 2
26 Federal Plaza
New York, NY 10278
(212) 264-2657

EPA REGION 3
841 Chestnut Street
Philadelphia, PA 19107
(215) 597-9800

EPA REGION 4
345 Courtland Street, NE
Atlanta, GA 30365
(404) 347-4727

EPA REGION 5
230 South Dearborn Street
Chicago, IL 60604
(312) 353-2000

EPA REGION 6
1445 Ross Avenue
Dallas, Texas 75202
(214) 655-6444

EPA REGION 7
726 Minnesota Avenue
Kansas City, KS 66101
(913) 551-7000

EPA REGION 8
999 18th Street
Denver, CO 80202-2405
(303) 293-1603

EPA REGION 9
1235 Mission Street
San Francisco, CA 94103
(415) 556-6322

EPA REGION 10
1200 Sixth Avenue
Seattle, WA 98101
(206) 442-1200

U.S. EPA
Office of Solid Waste
401 M Street, SW
Washington, DC 20460

RCRA/Superfund Hotline
(800) 424-9346 or
TDD (800) 553-7672
(in Washington, DC,
382-3000 or TDD 475-9652)