
Hazardous Waste Minimization Manual

for Small Quantity Generators

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DISCLAIMER

This manual has been prepared to provide general information and guidance on waste minimization practices and suggested compliance requirements under the Resource Conservation and Recovery Act (RCRA) and other related state and Federal acts.

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Dear Ed:

It gives me great pleasure to inform you that The Center for Hazardous Materials Research is a winner of the 1988 EPA's Center for Environmental Learning Award. The hazardous waste minimization manual that The Center for Hazardous Materials Research (CHMR) developed for small quantity generators deserves to be recognized for the improvements which will result from its use throughout the Commonwealth, Region III, and hopefully the nation.

EPA's Center for Environmental Learning (CEL) was established in the fall of 1986 to improve the public's understanding of current and emerging policy issues and to increase opportunities for the public to communicate with the Agency.

Of the 74 nominations submitted in 1988, the Awards Committee believed the manual CHMR developed exemplifies the reason for the establishment of this Award. The distribution of 1,000 copies of the manual, the inclusion of its step-by-step process in seminars, and the continued use of the manual by businesses and CHMR's hotline speaks to the on-going and long term value of your efforts.

The Awards Committee felt the leadership role that CHMR has undertaken in the area of hazardous materials research constitutes a significant contribution to environmental education in the six States in Region III. I commend you for your accomplishments and wish you success in your future work.

Sincerely,

A handwritten signature in dark ink, appearing to read "James M. Seif".

James M. Seif
Regional Administrator

GLOSSARY

BDAT	best demonstrated available technology
BDC	business development corporation
BOD	biological oxygen demand
CCP	commercial chemical products
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CHMR	Center for Hazardous Materials Research
CRS	central recovery system
DOD	Department of Defense
DOT	Department of Transportation
EDA	Economic Development Administration
EP	extraction procedure
EPCRA	Emergency Planning and Community Right-to- Know Act
FHA	Farmer's Home Administration
HOC	halogenated organic compounds
HSWA	Hazardous and Solid Waste Amendments
IPM	integrated pest management
LEPC	local emergency response commission
MCI	manufacturing chemical intermediates
MSDS	Material Safety Data Sheet
NA	North American
NPDES	National Pollution Discharge Elimination System
NPV	net present value
OPPE	Office of Policy, Planning, and Evaluation (U.S. EPA)
OSHA	Occupational Safety and Health Administration
PBP	payback period
POTW	publicly owned treatment work
PA DER	Pennsylvania Department of Environmental Resources
PENNTAP	Pennsylvania Technical Assistance Program
RCRA	Resource Conservation and Recovery Act
SARA	Superfund Amendments and Reauthorization Act
SBA	Small Business Administration
SBIC	small business investment company
SERC	state emergency response commission
SIC	Standard Industrial Classification
SQG	small quantity generator
TPQ	threshold planning quantity
TSCA	Toxic Substances Control Act
UN	United Nations
U.S. EPA	United States Environmental Protection Agency
UST	underground storage tank

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1.0 INTRODUCTION

1.1 Why Is Waste Minimization Important?

The proper management of hazardous materials and waste is one of the biggest issues facing all Americans. Virtually every industrial and manufacturing process involves hazardous materials or produces hazardous waste. From an economic standpoint, the management of hazardous materials may lead to spiraling costs that can drastically affect any organization and its ability to compete in the market place. There is also the issue of protecting public health and the environment.

Why is hazardous waste minimization so important?

- Waste minimization is very important because business is facing a crisis in the handling, transportation, and disposal of hazardous wastes.
- Nationally, the number of hazardous waste disposal facilities has substantially decreased.
- Regulators are restricting the use of landfills.
- Transportation and disposal costs are rising.
- Substantial long-term liability is associated with handling and disposal of hazardous waste.

Why minimize? Initially, many companies implemented waste reduction options because of new pollution regulations and the rising cost or unavailability of landfills. However, nearly all these companies later realized other, more important benefits, including:

- lower operating costs from the substitution of less expensive raw materials;

-
- lower energy costs through the use of newer, more efficient equipment;
 - improved product quality;
 - increased safety from reduced employee exposure to hazardous materials; and
 - improved public image—the less waste you produce, the less your business is viewed as a contributor to environmental problems.

Thousands, even millions, of dollars are being saved, not just in disposal costs, but in reduced expenditures on energy, fuel, water, and raw materials. In other words, waste reduction is economically as well as ecologically sound. It's simply good business.

Numerous case studies indicate that the sound management of resources results in simultaneous economic and ecological benefits regardless of the size of an organization. These case studies show that:

- waste reductions can range from 20 to 98 percent,
- payback periods for waste minimization investments typically range from immediate to 5 years, and
- firms which handle fewer hazardous materials reduce hazards to their workers and the environment—and experience fewer long-term liability and victim compensation claims.

The Minnesota Mining and Manufacturing Corporation (3M) has been a leader in implementing what they call their *Pollution Prevention Pays* program. In the first 9 years of the 3P program, 1,200 employee suggestions were approved, and together they helped the company save \$192 million. At the same time, 3M estimates

that they have shrunk their level of potential hazardous waste discharge by 50 percent, and plans to cut its current levels by another 50 percent during the next 5 years.

1.2 The New National Waste Management Strategy—Begin with Waste Minimization

Over the past two decades, Americans have developed an increased awareness of the harmful effects to human health and the environment from uncontrolled releases of pollutants and hazardous substances. Initially this led to a national waste management strategy which emphasized control and cleanup of pollution by hazardous substances **after** they are generated and no longer serve a productive function. Usually, hazardous industrial wastes are not destroyed by pollution control methods. Rather, they are put into the land, water, or air where they disperse and migrate.

Now the nation is turning its attention to preventing hazardous waste problems by cutting down on the generation of hazardous waste at its source. The following national policy on waste reduction was included in the Resource Conservation and Recovery Act, as amended by the U.S. Congress in November 1984:

The Congress hereby declares it to be the national policy of the United States that, wherever feasible, the generation of hazardous waste is to be reduced or eliminated as expeditiously as possible. Waste nevertheless generated should be treated, stored, or disposed of so as to minimize the present and future threat to human health and the environment.

As a result, a new recommended strategy for waste management has evolved. This new strategy includes waste minimization as the first important step to be considered in the overall approach to waste management. In summary, the following new hierarchy for waste management decision-making is developing as the new national policy for waste management.

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- First, consider **source reduction** options—any activity that reduces or eliminates the generation of a hazardous waste within a process.
 - Next, consider **recycling**. This is the use, reuse, or reclamation of a waste either on- or off-site after it is generated by a particular process.
 - Next, consider beneficially using waste for **energy recovery**. Some specific wastes can be beneficially used as a fuel under carefully controlled conditions to recover their energy value.
 - Next, consider **treatment** to reduce the toxicity of hazardous waste.
 - Finally, and only as a last resort, consider **land disposal**.

This new national strategy on waste management is further emphasized by the following Generator's Certification statement included on the Uniform Hazardous Waste Manifest, which must be signed by all hazardous waste generators who ship hazardous wastes off-site for treatment, storage, or disposal.

If I am a large quantity generator, I certify that I have a program in place to reduce the volume and toxicity of waste generated to the degree I have determined to be economically practicable and that I have selected the practicable method of treatment, storage, or disposal currently available to me which minimizes the present and future threat to human health and the environment, OR, if I am a small quantity generator, I have made a good faith effort to minimize my waste generation and select the best waste management method that is available to me and that I can afford.

On August 4, 1988, the United States Environmental Protection Agency (U.S. EPA) established a Pollution Prevention Office reporting directly to the Assistant Administrator for the Office of Policy, Planning, and Evaluation (OPPE).

The Pollution Prevention Office will be service oriented. Its functions include: stimulating public awareness through outreach activities; assisting other EPA offices in their programs; coordinating outreach to the states and supporting development of state programs; establishing a strategy for collecting, analyzing, and disseminating data; identifying research needs; creating incentives and identifying barriers to pollution prevention; and developing general policies and strategies pertaining to source reduction.

In addition, U.S. EPA created an Agency-wide Pollution Prevention Advisory Committee comprised of office directors and senior regional managers. It will be co-chaired by the Assistant Administrator for OPPE and one of the committee members.

Finally, U.S. EPA's Office of Research and Development created a Waste Minimization Branch within the newly created Waste Minimization Destruction and Disposal Research Division in its Cincinnati, Ohio Research Laboratory.

1.3 How to Use this Manual

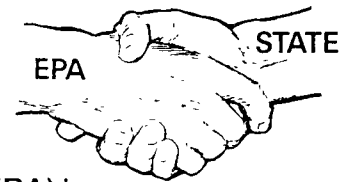
This manual has been prepared to provide businesses with practical information on how to approach and implement a hazardous waste minimization program. The intended audience for this manual is comprised of owners, managers, and responsible officials of businesses and organizations that are small quantity generators (SQGs) of hazardous waste. Answers are provided to commonly asked questions such as these:

- What are the advantages of waste minimization?
- How does waste minimization relate to the worker and community Right-to-Know laws?
- How do I get started on a waste minimization program?
- How do I conduct a waste audit?
- What specific waste minimization practices can I use?

- How can I finance my waste minimization program?
- How can I get more help on waste minimization and on my hazardous waste problems?

The illustration on the next page explains how to use this manual to obtain the information you need.

1.4 The Difference Between U.S. EPA and State Environmental Regulatory Agencies



The United States Environmental Protection Agency (U.S. EPA) is the Federal agency responsible for enforcing the Federal environmental laws such as the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), otherwise known as Superfund.

The state environmental regulatory agencies are responsible for enforcing the state environmental laws such as a state's solid waste management act. Under such state acts, the state environmental regulatory agency has RCRA regulations similar to those of the U.S. EPA.

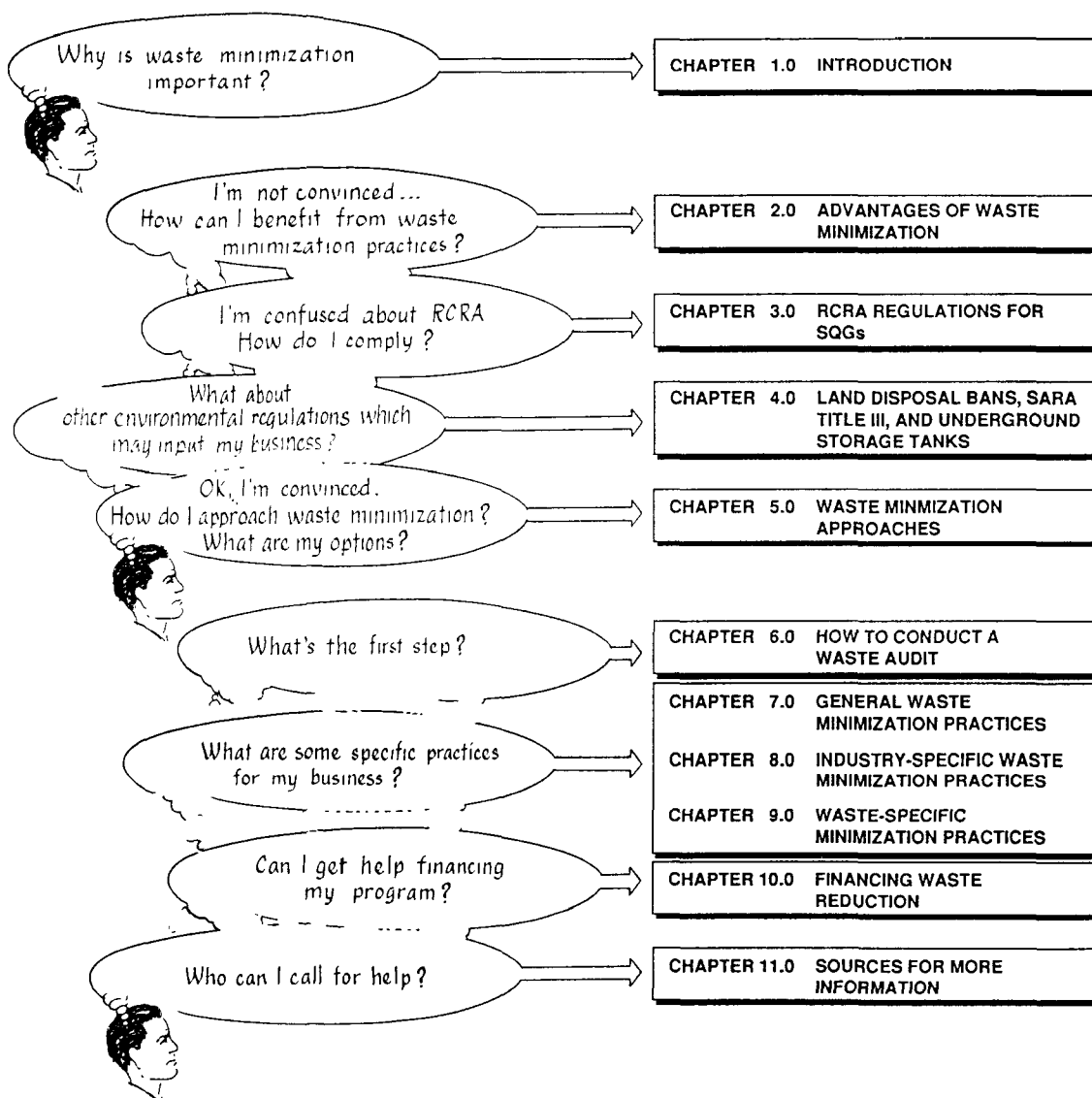
In many states, the state agency has been delegated the responsibility to administer the Federal RCRA program under U.S. EPA oversight. This means that:

- most RCRA permits are issued by the state agency,
- most RCRA notifications and reports must be sent to the state agency, and
- most RCRA inspections are performed by state agency personnel.

How to Use This Manual

If Your Question Is . . .

Refer to . . .



State regulatory requirements must be at least as stringent as the Federal requirements (exceptions sometimes occur when a Federal regulation was recently changed and made more stringent, and the state regulation has not yet been revised to keep up with the Federal standards). You have to comply with the most stringent requirements whether they are Federal or state. In any case, the U.S. EPA retains primary responsibility for:

- research and development,
- education and training,
- technology transfer,
- policy and regulation developments in response to revisions of the Federal laws, and
- oversight of state programs where the states have been delegated authority to administer the Federal RCRA program.

1.5 Definitions of Some Important Terms

Before proceeding, you should become familiar with the following definitions.

Waste minimization means the reduction, to the extent feasible, of hazardous waste that is generated or subsequently treated, stored, or disposed. It includes any source reduction or recycling activity undertaken by a generator that results in either (1) the reduction of total volume or quantity of hazardous waste, or (2) the reduction of toxicity of hazardous waste, or both, so long as the reduction is consistent with the goal of minimizing present and future threats to human health and the environment.

Source reduction refers to the reduction or elimination of waste generation at the source, usually within a process. Source reduc-

WHAT IS HAZARDOUS WASTE



tion measures can include some types of treatment processes, but they also include process modifications, feedstock substitutions or improvements in feed-stock purity, various housekeeping and management practices, increases in the efficiency of machinery, and even recycling within a process. Source reduction implies any action that reduces the amount of waste exiting from a process.

Recycling refers to the use or reuse of a waste as an effective substitute for a commercial product, or as an ingredient or feedstock in an industrial process. It also refers to the reclamation of useful constituent fractions within a waste material — or removal of contaminants from a waste to allow it to be reused. Recycling refers to the use, reuse, or reclamation of a waste, either on- or off-site, after it is generated by a particular process.

RCRA solid waste has been defined by RCRA as any *discarded material* not specifically excluded by the Act. A *discarded material* is any material (solid, liquid, or contained gas) which is abandoned (disposed, burned, or incinerated), recycled, or considered inherently waste-like. Because it is difficult to devise a definition that distinguishes between product-like and waste-like sludges and by-products, U.S. EPA will evaluate these materials individually when they are recycled to determine if the RCRA rules apply.

Hazardous waste is defined by RCRA as a solid waste (including liquids and gases) which may:

- cause or significantly contribute to an increase in mortality or in serious illness, or
- pose a substantial hazard to human health or the environment when improperly managed.

The definition of hazardous wastes can be found in Title 40 of the U.S. Code of Federal Regulations (CFR) Section 261.3. By definition, wastes are hazardous if they are (1) *listed* (specifically named) or (2) if they exhibit any of four hazardous waste *characteristics* (ignitability, corrosivity, reactivity, or extraction procedure

[EP] toxicity). Mixtures of a solid waste and a *listed* hazardous waste are also considered hazardous.

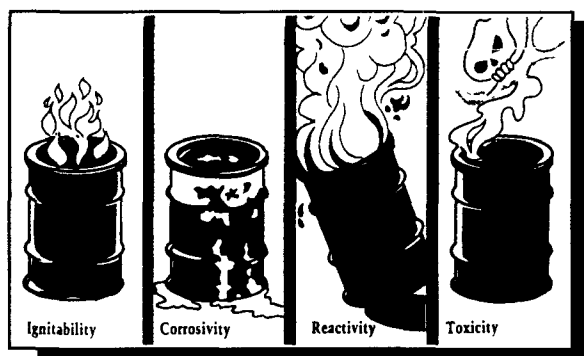
Listed hazardous waste is defined as any waste which appears on any one of the following three lists of hazardous wastes contained in RCRA:

- the **F** lists of hazardous wastes from non-specific sources (e.g., waste water treatment sludges from electroplating operations),
- the **K** list of hazardous wastes from specific sources (e.g., bottom sediment sludge from the treatment of waste waters from wood preserving),
- the **U** and **P** lists of discarded commercial chemical products, including products that do not meet precise manufacturing specifications, their containers, and spill residues.
 - The products on the **U** list are called *toxic wastes* (e.g., vinyl chloride).
 - Those on the **P** list are called *acute hazardous wastes* (e.g., cyanides).

Characteristic hazardous waste is a waste which may not appear on one of the U.S. EPA lists, but is considered hazardous if it has one or more of four characteristics:

- Ignitability
- Corrosivity
- Reactivity
- EP (Extraction Procedure) Toxicity

*For further details, see
Section 3.6.1 and the Appendices*



Acutely hazardous waste has been defined by the U.S. EPA as waste so dangerous in small amounts that it is regulated the same way as large amounts of other hazardous wastes. Acutely hazardous wastes, for example, may be generated from certain pesticides or dioxin-containing wastes. Those wastes included on the **P** list of hazardous wastes have been identified as *acutely hazardous wastes*.

2.0 ADVANTAGES OF WASTE MINIMIZATION

2.1 Overview

The many incentives for waste minimization, although interrelated, fall into three categories:

- Economic — money can be saved, or a profit made.
- Regulatory — fewer compliance requirements with reduced waste.
- Good public image — by showing concern for the environment, the safety and health of workers, and the surrounding community.

Many business owners and operators see a close relationship between the increasing waste management costs for industry and rising health and environmental concern by society. The resulting economic pressures are encouraging industry to be more efficient in the management of its waste, including its toxic and hazardous substances.

Numerous case studies indicate that the sound management of resources results in simultaneous economic and ecological benefits regardless of the size of an organization.

Thousands, even millions, of dollars are being saved, not just in reduced disposal costs, but in reduced expenditures on energy, fuel, water, and raw materials. If less waste is produced, there is less potential for damage to the environment. Consequently, waste reduction is sound economically as well as ecologically. It's simply good business.

2.2 Economic Incentives: Specific Cases

2.2.1 Direct Profits from Environmental Compliance

In 1979, the U.S. EPA told a metal finishing company that if they did not comply with water quality standards within 2 years, the Agency would close the plant. For 40 years prior to the U.S. EPA notice,

the company had been discharging its waste stream, containing high concentrations of nickel, zinc, and cyanide, into a nearby marsh. The company implemented a waste minimization program in order to achieve environmental compliance.

Specifically, this firm replaced its old, single-pass waste treatment system with a batch treatment system, keeping all of the waste in on-site holding tanks until the liquid waste could be treated.

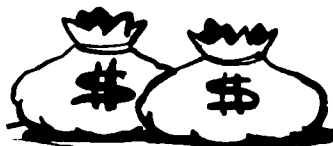
Not only did this company come into environmental compliance, but it also turned a considerable profit. The company now:

- saves an average of 11,500 gallons of water per day,
- saves \$58,460 annually in waste disposal costs,
- saves \$29,400 annually in pollution control equipment costs,
- saves \$10,200 annually in personnel and maintenance costs, and
- avoids the legal liability associated with hazardous waste disposal in a landfill.

This example is just one of the many waste minimization success stories. The following pages will identify some further incentives for developing and implementing a waste minimization program.

2.2.2 Reduced Costs Through Better Management and Efficiency

The less a firm wastes, the more efficient its operation. Your total operating costs can be significantly reduced by minimizing your waste generation. In addition, many companies have experienced improved production capacity and product quality, as well as savings in expenditures for utilities and raw materials. Reduced costs can be accomplished through better management and a more efficient use of raw materials. Here are some examples.



- The Hamilton Beach Division of Scovill, Inc. manufactures small electric appliances. Scovill tested a water-soluble synthetic cleaner as a possible substitute for the 1,1,1-trichloroethane organic solvent degreaser at one of its plants. The cleaner is manufactured by the Cincinnati Milacron Company of Cincinnati, Ohio. They found the cleaner suitable for some of their applications, and have been able to reduce their 1,1,1-trichloroethane use by 30 percent. The Scovill plant reports a \$12,000 annual savings from this substitution.
- ITT Telecom reduced the quantity of waste solvents they generate by replacing a solvent based, photo resist system with an aqueous-based system. Previously, organic solvents such as 1,1,1-trichloroethane and methylene chloride were used to develop and strip the photo resist from the circuit board. The aqueous-based system uses water-miscible solvents from the glycol-ether family. The new system reduces hazardous waste generation and also improves product quality while reducing production time.
- A fiberglass coating company which generated waste acetone during process equipment cleanup now has 70 percent of that acetone recovered by off-site recycling. The recycled acetone costs 10 percent less than virgin acetone, thus reducing the cost of production. In addition, waste disposal costs have been eliminated, saving the company thousands of dollars annually.
- The Stanadyne Company undertook a comprehensive and systematic review of their electroplating processes in order to reduce or eliminate waste generation. Their efforts have resulted in a broad spectrum of activities which have saved the firm money and minimized pollution—a total waste reduction of 46 percent has been realized. Some of these activities included:

-
- A sulfuric/peroxide bright dip was substituted for a chromic acid bright dip for cleaning brass and copper parts which have been brazed together. This substitution reduced overall sludge production.
 - The concentrations of chemicals used in the cyanide, copper and chrome plating baths were reduced. By running the potassium cyanide concentration at 2.5 instead of 3.5 ounces per gallon, the cyanide dragout concentration has been reduced by 28 percent, without any adverse effect on plating quality. In the chrome baths, the chromic acid levels are maintained at about 29 instead of 32 ounces per gallon. This 9 percent reduction results in savings due to reduced raw material requirements.
 - A rack to minimize dragout was redesigned.
 - A simple dragout recovery system was installed on the nickel plating machine for zinc die-castings. Less than \$1,000 was invested for a storage tank. This system saves the firm \$4,200 worth of nickel per year, and reduces the generation of nickel sludge by 9,500 pounds per year.
 - Items to be electroplated are inspected to eliminate defective parts before they enter the plating process. Since plating a defective part creates the same amount of waste as plating a good one, the elimination of defective parts from the plating operation results in direct waste reduction.

2.2.3 Reduced Treatment, Transportation, and Disposal Costs

A successful waste minimization program can help your business reduce the amount of money it spends on treating, transporting, and disposing of hazardous wastes. The combination of new laws and regulations, and the increasing cost of liability insurance, have caused a dramatic increase in the cost of hazardous waste management. With increasing disposal costs, waste minimization

is providing an economical alternative to the treatment, transportation, and disposal of hazardous wastes.

- The Rexham Corporation facility in Greensboro, North Carolina, is involved in the manufacture and printing of specialized product labels. Rexham installed a Cardinal distillation unit to reclaim n-propyl alcohol from their waste solvent for a total installed cost of \$16,000. The distillation unit recovers 85 percent of the solvent in the waste stream, resulting in a savings of \$15,000 per year in virgin solvent costs, and in a \$22,800 savings in hazardous waste disposal costs.
- The Daly-Herring Company manufactures pesticides and generates pesticide dust from two major production systems. The firm replaced the single baghouse with two separate vacuum-air-baghouse systems specific to the two production lines at a total cost of \$9,600. The collected materials are no longer contaminated by alternate waste streams, and each is recycled back to the process where it was generated. They have eliminated over \$9,000 in annual disposal costs, and estimate that the recovered material is worth more than \$2,000 per year.
- The Emerson Electric Company's waste management program reduced raw material costs by \$642,000 per year, water costs by \$2,200 per year and waste disposal costs by \$52,700 per year through process modifications and material recovery. This program has increased productivity, reduced operating costs, and minimized waste generation rates. Some examples follow.
 - An automated electroplating system has reduced process chemical usage by 25 percent, process batch dumps by 20 percent, and waste water treatment costs by 25 percent.
 - The replacement of a solvent-based painting system with a water-based electrostatic immersion painting system has reduced waste solvent and waste paint solids generation by over 95 percent.

2.2.4 Income Derived Through Sale or Reuse of Waste

It is sometimes said that one company's waste is another's resource. This is often true, as the various waste exchanges throughout the country have proven. Profits can be realized when firms sell their wastes as by-products to other firms which can use them as raw materials. Additionally, many wastes can be reused, sometimes as fuels (as in the case of waste solvents), or as recycled raw materials within the process itself.

- An office furniture manufacturer now saves \$100 per week in solvent costs by reusing about 85 percent of its waste lacquer thinner. The company invested in a small solvent recovery unit, which paid for itself in about 1 year. The other 15 percent of the waste lacquer thinner which is not suitable for reuse is used as fuel. The waste is burned in the plant's wood-chip fueled boiler. This has eliminated their hazardous waste disposal costs.
- A manufacturer of small electric appliances requires 1,1,1-trichloroethane solvent to degrease metal stampings. Solvent wastes are collected in 55-gallon drums; the drums are housed in a storage building designed to contain spills. Ashland Chemical Company was contracted to recycle the waste by distilling the 1,1,1-trichloroethane. Substituting the recycled solvent for the virgin product has reduced their overall raw material costs at one plant by \$5,320 per year. This plant also eliminated all of its previous waste disposal costs, estimated to be about \$3,000 per year.
- At a label printing company, waste toluene from printing press cleanup has been eliminated by segregating the solvent according to the color and type of ink cleaned from the press. Each segregated batch of toluene is then reused for thinning the same color ink.

2.2.5 Reduced Costs for Waste Water Treatment

The cost of meeting waste water treatment standards can be extremely high. Increasingly stringent pretreatment and effluent limitations are forcing many industries to install costly waste water treatment facilities. Both capital and operating expenses for these facilities are escalating rapidly. By judiciously minimizing their waste, many companies can significantly reduce this expense.

- In order to meet environmental standards, a textile dye and finishing plant reduced its phosphorus discharge by reevaluating its production process. Rather than build expensive waste treatment systems to remove phosphorus, the company instead modified its existing processes and substituted non-phosphorus-containing chemicals. Such chemicals as hexametaphosphate and phosphoric acid were eliminated from the production process. As a result, the phosphorus discharge levels were reduced without any capital expenditures for waste water treatment to remove phosphorus.
- A film developing unit at 3M's Electronics Products Division was discharging waste water contaminated with 1,1,1-trichloroethane. In order to recycle the solvent and to remain in compliance with process waste water discharge regulations, 3M installed a decanter system that provides gravity separation of the solvent from the water. The decanter system cost \$4,000, including installation, and has saved the company \$12,000 in its first year by reducing the amount of new solvent and makeup water required for the developing unit.

2.2.6 Lower Risks for Spills, Accidents, and Emergencies

The use of hazardous materials, and the generation, handling, and management of hazardous waste entails a certain amount of risk. Hazardous substance spills, accidents, and emergencies can cost small businesses thousands of dollars. These risks can be

reduced with the proper management of the hazardous materials used, and the minimization of those which are wasted.

- A dye company was able to improve its safety program by appointing a committee made up of safety, medical, legal, and technical experts from within the company. This committee screened all chemicals used at the plant, as well as those used in the development of new products on the basis of their relative safety in use, fire potential, and hazard to the environment. This management tool has saved the company countless man-hours in reduced accidents and spill clean up costs.

2.2.7 Lower Long-Term Liability and Insurance Costs

According to RCRA, a hazardous waste generator is responsible for its waste from “cradle to grave.” In other words, once you generate a waste, you are legally responsible for it forever. In addition, Federal and state laws have established the precedent that generators of hazardous waste are at least partially responsible for the cleanup of wastes which have leaked from disposal sites containing their waste. This kind of financial responsibility can potentially cost small quantity hazardous waste generators substantial sums of money.

This responsibility translates into what many insurance experts now call the “liability crisis.” The liability insurance premiums for firms producing hazardous waste have increased by hundreds of percent in the last 5 years due largely to the increase in law suits against hazardous waste generators involved in accidental spills and leaking disposal sites.

One possible way to eliminate or reduce this expense is to eliminate or reduce the cause of the liability—the generation of hazardous waste. By minimizing the hazardous waste you generate, you can reduce your long-term liability.

- A diesel engine manufacturer initiated a program which ensures that all products entering the plant are screened by a review committee. This committee attempts to reduce the

number of hazardous materials entering the plant, and thus reduce the amount which leaves the plant as waste. As a result, this firm has reduced the cost of complying with environmental and worker safety regulations, as well as waste management, long-term health care, and liability costs.

- Vulcan Automotive Equipment Ltd. remanufactures used automotive engines. The cleaning process was modified by replacing the inorganic caustic cleanser with a high-velocity "aluminum shot" system. The new system has improved the overall appearance of the business and has substantially reduced health hazards to the workers. All by-products of the new process are recycled. Total cost of the system was approximately \$80,000 and an estimated annual savings of \$40,000 is expected. The new aluminum shot system increases productivity and improves the final product.

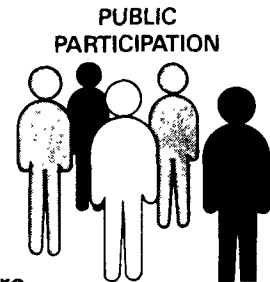
2.3 Regulatory Incentives

New Federal laws and regulations limit waste management alternatives by eliminating or greatly restricting land-based disposal. As a result, generators of hazardous waste will be forced to examine other waste management alternatives, including waste minimization.

In addition to the outright ban of certain disposal options and increasing costs of all waste disposal, the amount of managerial work required to comply with environmental regulations can become extremely expensive to small business. By minimizing the generation of hazardous waste, these compliance requirements can be reduced as well.

- A specialized printing firm is involved in the production of product labels. The company has already installed a distillation unit which recovers 85 percent of the solvent in the waste stream, and they are now planning to add another unit to recover the remaining 15 percent. The residue resulting from the second distillation unit should be non-hazardous waste that can be sent to a sanitary landfill. The new unit is

especially appealing because it will allow the plant to become declassified as a hazardous waste generator.



2.4 Improved Public Image

While the strongest incentives for reducing waste generation are undoubtedly economic and regulatory, many companies are setting up waste minimization programs out of sensitivity to public concern over toxic chemicals. This type of corporate good citizenship is perceived to have long-term benefits, such as good relations between plants and local communities, as well as between companies and the general public.

In addition to reducing costs and increasing profits, an efficient hazardous waste minimization program can:

- improve safety;
- reduce the amount of wastes for disposal, consequently reducing environmental impacts on the community; and
- reduce the number of hazardous materials used in the workplace.

These three factors add up to one important business tool—an improved public image. Hazardous waste is a controversial topic, and most communities are vehemently opposed to the disposal of hazardous wastes in their localities. By reducing the amount of hazardous waste you generate, you can show the public and your potential customers that you are making an effort to curtail the pollution of our land and ground water.

The public always looks favorably upon companies with good safety records. In addition, a safe working environment will tend to attract more new employees than a less-safe job site. Since a waste minimization program can lead to improved on-the-job safety, such an improvement can only help to attract new employees and improve public relations.

Finally, with the inception of the Federal Emergency Planning and Community Right-to-Know Act of 1986 (SARA Title III), there are established requirements regarding emergency planning and "community right-to-know" reporting on hazardous and toxic chemicals. The community right-to-know provisions will help to increase the public's knowledge and access to information on the presence of hazardous chemicals in their communities and releases of these chemicals into the environment.

The general public, in particular, is usually uneasy with the presence of hazardous chemicals in their neighborhoods. A reduction in the use of hazardous chemicals can improve a company's relationship with its community neighbors.

3.0 RCRA REGULATIONS FOR SMALL QUANTITY GENERATORS

3.1 Introduction

This chapter is designed to help businesses determine if they are small quantity generators of hazardous waste. In addition, proper storage, shipment, treatment, and disposal procedures are discussed.

3.2 What Is a Small Quantity Generator (SQG)?

In 1976, Congress passed the Resource Conservation and Recovery Act (RCRA), which directed the U.S. Environmental Protection Agency (U.S. EPA) to develop and implement a program to protect human health and the environment from improper hazardous waste management practices.

U.S. EPA first focused on large companies which generate the greatest portion of hazardous waste. Establishments producing less than 1,000 kilograms (2,200 pounds) of hazardous waste in a calendar month, known as small quantity generators (SQGs), were exempted from most of the hazardous waste regulations published by U.S. EPA in May 1980.

In November 1984, the Hazardous and Solid Waste Amendments (HSWA) to RCRA were signed into law. With these amendments, Congress directed the U.S. EPA to establish new requirements that would bring small quantity generators who generate less than 1,000 kilograms (kg) of hazardous waste in a calendar month into the regulatory system. U.S. EPA issued final regulations for these small quantity generators on March 24, 1986. Most of the requirements became effective September 22, 1986.

3.3 Types of Businesses Most Likely to Produce Small Quantities of Hazardous Wastes

Types of businesses most likely to produce small quantities of hazardous wastes include:

- vehicle maintenance firms,

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- metal manufacturers and metal finishers (including electroplating and printed circuit boards),
 - construction companies,
 - printing companies,
 - photographic processors, and
 - laundries and dry cleaners.

Other businesses affected by the SQG RCRA regulations include educational and vocational shops, analytical and clinical laboratories, and pesticide applicators. The most common hazardous wastes produced by SQGs are:

<i>Typical types of hazardous waste</i>	<i>Examples</i>
Acids/bases	Various acids, ammonium hydroxide, sodium hydroxide
Ignitable wastes	Acetone, n-butyl alcohol, ethyl ether, methyl alcohol, xylene
Solvents	Perchloroethylene, isopropyl or ethyl alcohol, trichloroethylene
Pesticides	Aldicarb, aldrin, DDT, dieldrin
Spent plating wastes	Cyanide, heavy metals, solvents
Ink sludges	Ink sludges with chromium or lead
Reactives	Hypochlorites, sulfides
Lead acid batteries	Lead dross, spent acid
Dry cleaning residues	Spent filter cartridges, solvent distillation residues

3.4 Regulatory Requirements for Small Quantity Generators

In March 1986, the Federal regulations for hazardous waste management were modified to bring businesses that generate small amounts of hazardous waste into the regulatory system. The 1986 rules set new requirements for those generators that generate less than 1,000 kilograms (about 2,200 lb) of hazardous waste in a calendar month.

According to the Federal regulations, there are two categories of SQGs:

- generators of no more than 100 kg/mo—known as “conditionally exempt small quantity generators,” and
- generators of between 100 and 1,000 kg/mo—known as “non-exempt small quantity generators.”

Table 3-1 provides a brief summary of the regulatory requirements for these two categories of SQGs.

The following sections provide answers to some commonly asked questions concerning the RCRA regulations for SQGs such as “How do I determine how much hazardous waste I generate?” “What is my generator category?” and “How do I comply with the various RCRA requirements?”

3.5 Exemptions

Federal and state regulations provide some specific exemptions from the hazardous waste management requirements for certain wastes. These exemptions can be very important because they usually provide the flexibility necessary to encourage waste recycling.

Table 3-1. RCRA Regulatory Requirements for Small Quantity Generators.

<i>Requirement</i>	<i>Less than 100 kg/mo</i>	<i>100-1,000 kg/mo</i>
Determine quantity of hazardous waste generated	Required	Required
Obtain EPA I.D. number	-	Required
Observe accumulation time or quantity limits	Required	Required
Observe storage facility criteria	-	Required
Prepare and plan for accidents or emergencies	-	Required
Properly label and package shipments	-	Required
Ship wastes with a manifest	-	Required
Use a licensed transporter	-	Required
Ship to an approved treatment, storage, or disposal facility	Required	Required
Keep records	-	Required

3.5.1 On-Line Recycling

Hazardous wastes which are reclaimed continuously on site without storing the waste prior to reclamation (e.g., continuous, on-line recycling of certain solvents) are exempt from all hazardous waste management requirements. However, any residue removed from the reclaiming equipment must be handled according to all the requirements set forth in this manual.

3.5.2 On-Site Reclaiming Preceded by Waste Accumulation and Storage

Hazardous wastes which are reclaimed on site but which are also accumulated for any period of time before reclaiming (e.g., batch recovery of spent solvents in a solvent distillation unit) are subject to the following hazardous waste management requirements.

- The hazardous wastes being reclaimed must be included in the calculation to determine how much hazardous waste is generated (see Section 3.6.3).
- The hazardous wastes being reclaimed must be handled according to the "storage facility criteria" described in Section 3.7.3.
- The reclaiming process itself is not subject to any hazardous waste management requirements and does not need a permit.
- Any residue removed from the reclaiming process is a hazardous waste and must be handled according to all the requirements set forth in this manual (except that the residue need not be included in the calculation to determine quantity of hazardous waste generated because it was already counted in the hazardous waste fed into the reclaiming process).

3.5.3 Off-Site Reclaiming

If hazardous wastes are shipped off-site to a commercial reclaimer, such hazardous wastes are subject to all of the hazardous waste management requirements set forth in this manual. However, under certain special conditions (fully described in Section 3.8.5), these wastes may be exempt from the requirements to ship such wastes with a manifest.

3.5.4 Used Oil

Used oil is a common waste stream and an important potential source of resource conservation. However, it is also potentially harmful to human health and the environment if it is disposed of improperly.

Typically, used crankcase oil from vehicles fueled by leaded gasoline would meet the toxicity definition due to the presence of heavy metal contaminants. Lubricants and coolants may also pick up toxic contaminants, depending on the equipment and materials they contact during use. Finally, reported past practices of blending hazardous wastes—such as spent solvents—with used oil have further increased concern over the potential harmful effects from the improper management of used oil.

For these reasons, the current U.S. EPA regulations on used oil include:

- U.S. EPA has issued special requirements for used oil burned for energy recovery in boilers and industrial furnaces. Such used oil is termed “used oil fuel” and includes any fuel produced from used oil by processing, blending, or other treatment.
- U.S. EPA initially decided not to list used oil intended for recycling as a hazardous waste. However, this decision was rejected by the courts on October 7, 1988, and U.S. EPA is reconsidering its regulation and will issue management standards for recycled oil in the future.
- U.S. EPA has not yet determined whether to regulate used oil bound for disposal as a hazardous waste. However, because serious environmental problems result from improper disposal of used oil, EPA intends to regulate these activities under RCRA or through an approach combining RCRA and the Toxic Substances Control Act (TSCA).

SQGs who generate used oil must therefore determine whether their used oil is to be:

-
- burned for energy recovery,
 - recycled, or
 - discarded.

Guidelines for Used Oil Fuel Burned for Energy Recovery

Generators and marketers of used oil fuel must comply with the following guidelines.

- **Do not** mix other hazardous wastes—such as spent solvents—with used oil fuel. Such mixtures are regulated as hazardous wastes and subject to special requirements for burning hazardous wastes for energy recovery. Used oil containing more than 1,000 ppm of total halogens is presumed to be a hazardous waste.
- Used oil fuel exceeding any of the specifications below is subject to the requirements for an “off-specification” used fuel oil.

<i>Contaminant/property</i>	<i>Allowable level</i>
Flash point	100°F, minimum
Arsenic	5 ppm, maximum
Cadmium	2 ppm, maximum
Chromium	10 ppm, maximum
Lead	100 ppm, maximum
Total halogens (e.g., chlorine)	4,000 ppm, maximum

- Off-specification used oil fuel may be sold to industrial burners only.
- Persons who market off-specification used oil fuel must notify EPA of their activities and include in that notification copies of the burner’s certificate of compliance. Any off-specification used oil fuel that is shipped must be invoiced.

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- Blending of off-specification used oil fuel to meet specifications is permitted as long as blenders notify EPA of their activities and keep copies of analyses or other information used to determine that the fuel meets specifications.
 - On-specification used oil fuel may be sold to anyone. Most marketers of used oil fuel (e.g., persons who collect used oil from generators and produce used oil fuel from these used oils, and persons who collect and distribute used oil fuel to burners) must have an analysis performed to show that the allowable levels given in the previous table are not exceeded. Such marketers must keep records of that analysis, as well as the date, quantity, and name of the facility receiving their shipments of on-specification used oil. These records must be kept for 3 years. (**Note:** Generators and collectors who transport used oil are not marketers unless they market the used oil directly to a person who burns it for energy recovery.)

May Used Oil Be Used for Road Oiling?

Applying used oil to unpaved roadways for either dust control or surface stabilization is considered unacceptable practice by some state agencies. In those states, only used oil which has been re-refined to remove or reduce contaminants may be used for these purposes, provided it meets Federal and state department of transportation specifications.

3.5.5 Other Recyclable Materials

The “recyclable materials” exempted from all Federal hazardous waste regulations are:

- scrap metal,
- industrial ethyl alcohol that is reclaimed, and
- spent lead-acid batteries and used batteries (or used battery cells) that are reclaimed. (However, batteries bound for disposal are subject to all hazardous waste management regulations.)

3.6 Commonly Asked Questions About Hazardous Waste and Compliance

3.6.1 Is My Waste Hazardous?

You may not be certain that your particular wastes are hazardous. This determination can be made by pursuing the following steps (see also Figure 3-1):

Step 1: Check to See if Your Waste Is Specifically Excluded from the Definition of a RCRA Solid Waste or a RCRA Hazardous Waste.

Your waste may not be regulated under RCRA. Certain specific wastes such as fly ash waste, flue gas emission control waste, certain spent sulfuric acid waste, cement kiln dust waste, and drilling fluids are specifically excluded from the definition of a RCRA solid waste or RCRA hazardous waste. A complete list of such wastes which are specifically excluded under RCRA is provided in Appendix 12.1.

Step 2: Check to See if Your Waste Is Included on U.S. EPA's Specific Lists of Hazardous Wastes Found in 40 CFR Part 261.

These lists are provided in Appendix 12.2 of this manual and include:

- the **F** list of hazardous wastes from non-specific sources (for example, spent halogenated solvents used in degreasing such as trichloroethylene—40 CFR 261.31);
- the **K** list of hazardous wastes from specific sources (for example, waste water treatment sludge from the production of iron blue pigments—40 CFR 261.32);
- discarded Commercial Chemical Products or Manufacturing Chemical Intermediates (CCP/MCI), off-specification CCP/MCI, container or inner liner used to hold a CCP/MCI,

or any residue resulting from the cleanup of a spill of a CCP/MCI listed in either (40 CFR 261.33);

- the **P** list of acutely hazardous substances such as nickel cyanide or tetraethyl lead; or
- the **U** list of toxic substances such as benzene or mercury.

The **P** and **U** lists are intended primarily for large-scale producers and users of chemical products. However, smaller operations may also generate this type of waste if they use pure grade chemical products. If your waste is a commercial chemical product (or a manufacturing chemical intermediate) that appears on the **P** or **U** lists, then it is a hazardous waste.

In a comment to this portion of the regulations (see 40 CFR 261.33 provided in Appendix 12.2), the U.S. EPA explains that the term "commercial chemical product or manufacturing chemical intermediate" refers to a material which is the pure grade of the chemical or all formulations in which the chemical "is the sole active ingredient." Some wastes, such as manufacturing process wastes, merely contain some quantities of a chemical appearing on the **P** or **U** list. If this is the case, check the **F** and **K** lists. If your waste is described on these lists, then it is a hazardous waste. Otherwise, check Steps 3 and 4 that follow.

STEP 3: Check to See if Your Waste Is Ignitable, Corrosive, or Reactive

If you cannot find your waste described in the lists of hazardous wastes given in Step 2, check the container labels and Material Safety Data Sheets (MSDSs) for information on the nature of the chemicals used in the waste. You can also contact the manufacturer or distributor who should have more details on the chemicals contained in their products. Characteristics such as flash point, reactions when mixed with other substances, explosive temperature, and disposal information can often be obtained from these information sources. Use this information to determine whether or

not the waste meets the definition of corrosivity, ignitability, or reactivity contained in the regulations and included in Appendix 12.3. If your waste does meet one of these characteristics, it is hazardous. If you are still unsure that your waste meets one of these characteristics, you can submit it to a testing laboratory for this determination.

Step 4: Check to See if Your Waste Is EP Toxic

If you cannot find your waste in the lists, and it does not meet the definition of either corrosivity, ignitability, or reactivity, you must ensure that it is not toxic. Contaminants that make wastes toxic are listed in the regulations (40 CFR 261.24) and are included in Appendix 12.4. If your waste could contain one of these contaminants, you will need the services of a testing laboratory to determine the degree of toxicity of your wastes. Talk to your hauler, trade association, state regulatory agency, disposal site owner, or other businesses for names of reliable laboratories, or use the sources of help listed in Chapter 11 of this manual. Your waste will be tested according to accepted procedures, and you will be notified of the toxicity of your wastes.

Figure 3-1 will help you determine if your waste is hazardous.

3.6.2 Are Any Hazardous Wastes Exempted from the Hazardous Waste Management Requirements?

Federal and state regulations provide some specific exemptions from the hazardous waste management requirements for certain wastes. These exemptions can be very important because they usually provide the flexibility necessary to encourage waste recycling. Such exemptions may include:

- hazardous waste which is reclaimed,
- used oil,
- other recyclable materials such as lead-acid batteries, and
- hazardous waste treated in a "totally enclosed treatment facility," "elementary neutralization unit," or a "waste water treatment unit."

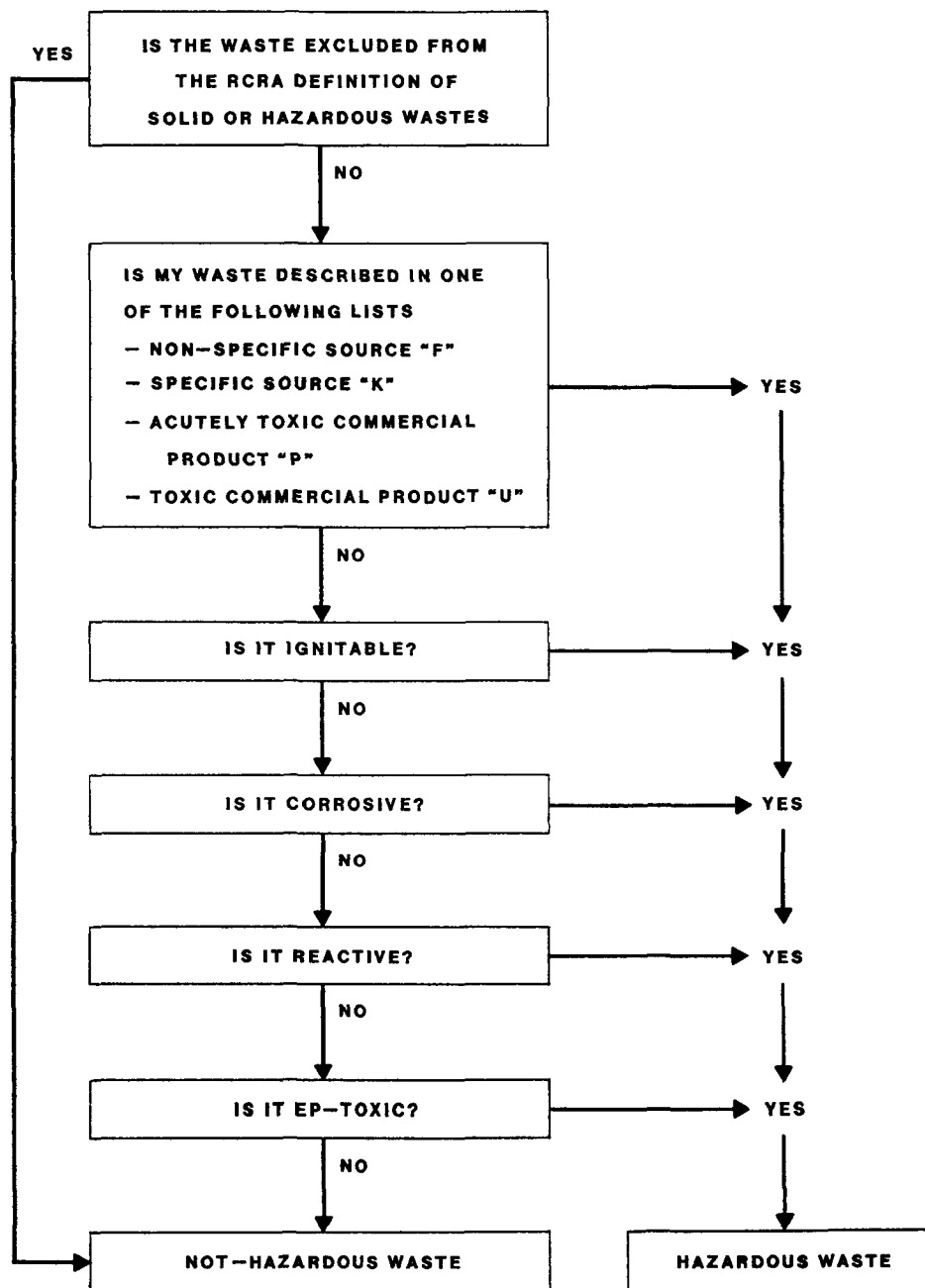


Figure 3-1. Flow chart to determine if a waste is hazardous

3.6.3 How Do I Determine How Much Hazardous Waste I Generate?

To determine how much hazardous waste you generate (which is used to determine your generator category), you must add the weights of all the hazardous wastes your business generates in a month. Appendix 12.6 summarizes the kinds of wastes you must count to determine your generator status.

3.6.4 Should I Include Empty Containers?

Any hazardous waste remaining in an empty container is not subject to regulation when the container is empty according to the following definitions.

- A container which has held a liquid or a solid is empty if all wastes have been removed that can be removed using the practices commonly employed to remove materials from that type of container—e.g., pouring, pumping, and aspirating—and no more than 1 inch of residue remains on the bottom of the container.
- A container that has held a compressed gas is empty when the pressure in the container approaches atmospheric.
- A container that has held waste identified as “acute hazardous” waste (the P list— see Section 3.6.1 and Appendix 12.2) is empty when the container has been triple rinsed using a solvent capable of removing that waste.

3.6.5 How Much Waste Must My Business Produce to Be Regulated Under the New RCRA Requirements?

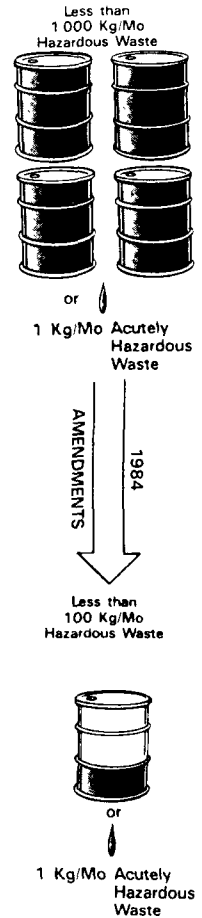
Key: 1 drum = about 200 kg = about 440 lb = about 55 gal

According to the Federal regulations there are three categories of hazardous waste generators.

- Generators of no more than 100 kg/mo—If you generate no more than 100 kg (about 220 lb or 25 gal) of hazardous waste and no more than 1 kg (about 2 lb) of acutely

hazardous waste in any calendar month, you are a “conditionally exempt, small quantity generator” and the Federal hazardous waste laws require you to:

- identify all hazardous waste you generate, and
 - send this waste to a hazardous waste facility or a facility approved by the state for industrial or municipal wastes.
- 100-1,000 kg/mo generators—If you generate more than 100 and less than 1,000 kg (between 220 and 2,200 lb, or about 25 to under 300 gal) of hazardous waste and no more than 1 kg of acutely hazardous waste in any month, you are a “non-exempt, small quantity generator” and the Federal hazardous waste laws require you to:
 - get a U.S. EPA I.D. number;
 - comply with storage time, quantity, and handling requirements;
 - prepare for accidents and emergencies;
 - ship your wastes using a licensed hauler after your wastes have been properly prepared for shipping and you have prepared a hazardous waste manifest, and
 - ensure that your wastes are treated, stored, or disposed of in a licensed hazardous waste management facility.
 - Generators of 1,000 kg/mo or more—If you generate 1,000 kg (about 2,200 lb or 300 gal) or more of hazardous waste, or more than 1 kg of acutely hazardous waste in any month, you are a “large quantity generator” and the Federal regulations require you to:
 - comply with all applicable hazardous waste management rules.



3.6.6 What Must I Do if I Am Regulated Under the New RCRA Requirements?

If you have determined that you produce hazardous wastes, you must:

- get a U.S. EPA I.D. number—an application form 8700-12 must be submitted to the U.S. EPA; and
- properly treat and/or dispose of your wastes on your premises **only** if you are permitted, licensed, or registered to treat, store, or dispose of hazardous wastes (see Section 3.9.2);
or
periodically ship your wastes off your premises for treatment or disposal. Effective September 22, 1986, small quantity generators who send their wastes off site for storage, treatment, or disposal must ensure that the hazardous waste management facility has a RCRA permit or is authorized under RCRA to manage hazardous waste. You can determine this by contacting either your environmental regulatory agency or by calling the CHMR Hotline at (800) 334-CHMR.

A concise summary of specific RCRA requirements for SQGs is provided in Section 3.4.

3.6.7 Should I Notify EPA When I Revise Any of My Hazardous Waste Management Activities?

Even though you may already have an EPA I.D. number, a revised "Notification of Hazardous Waste Activity" form must be submitted if:

- your generator category changes (e.g., from small quantity generator to large quantity generator),
- you install hazardous waste recycling equipment or otherwise begin to recycle hazardous waste on site (only required by some states),

- you begin to market “off-specification used oil fuel” (see Section 3.5.4), or
- you generate new or different hazardous wastes other than those identified in the latest submittal.

3.7 Commonly Asked Questions About On-Site Storage of Hazardous Wastes

3.7.1 May I Accumulate Hazardous Wastes at the Point of Generation in “Satellite” Accumulation Areas?

You may accumulate as much as 55 gallons of hazardous waste or 1 quart of acutely hazardous waste in containers at or near any point of generation where wastes initially accumulate (referred to as “satellite” accumulation areas) which is under the control of the operator of the process generating the waste. You must use appropriate containers as described in Section 3.8.4.

You must transfer the full containers from these “satellite” accumulation areas to the central facility accumulation area within 3 days after you have accumulated as much as 55 gallons of hazardous waste or 1 quart of acutely hazardous waste.

The 180-day (or 270-day) accumulation time limits set forth in Section 3.7.2 do not apply to wastes accumulated in such “satellite” areas until these wastes are transferred to the central facility accumulation area.

3.7.2 May I Store My Hazardous Wastes at My Facility and for How Long?

According to the Federal regulations, you are allowed to accumulate and store hazardous wastes at a central facility accumulation/storage area on your site subject to certain limitations. If you exceed the following time or quantity limits, you will be considered a storage facility and you must obtain a RCRA storage permit and meet all of the RCRA storage requirements.

Generators of No More than 100 kg/mo

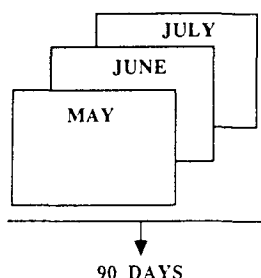
There are no Federal time limits for storage of wastes as long as you never accumulate 1,000 kg. If you accumulate 1,000 kg, you will then be treated the same as the 100-1,000 kg group except that the 180-day clock starts after you reach 1,000 kg. To avoid additional requirements, **do not accumulate more than 1,000 kg on site.**

Generators of 100-1,000 kg/mo

You must remove your wastes within 180 days after you begin accumulating wastes. The 180-day clock starts when the first waste goes into storage in the central facility accumulation/storage area. (See Section 3.7.1 for accumulation time allowances for "satellite" accumulation areas.) You must never accumulate more than 6,000 kg.

If you must transport wastes more than 200 miles, the 180-day clock becomes a 270-day clock under Federal regulations. Also under Federal regulations, you are allowed to petition for a 30-day extension if conditions beyond your control force you to hold wastes beyond the allowed time limits.

Generators of 1,000 kg/mo or More



You must properly ship, treat, or dispose of your wastes within 90 days after you begin accumulating the waste in storage. The 90-day clock begins when the first waste goes into storage in the central facility accumulation/storage area. (See Section 3.7.1 for accumulation time allowances for "satellite" accumulation areas.) However, the Federal regulations allow you to petition for an extension if circumstances beyond your control force you to store wastes past the 90-day deadline.

3.7.3 How Should I Store Hazardous Wastes at My Facility?

As hazardous wastes can cause serious harm to humans and the environment, extreme care must be exercised in their handling. Be sure that any containers holding hazardous wastes:

-
- are in good condition, hold the proper volume, and do not leak;
 - are compatible with the waste to be contained in them (i.e., will not react with the waste and will not be corroded by the waste);
 - are only opened to add or to remove waste and are stored in such a manner as to avoid leakage;
 - are washed completely before storage and do not contain residue which may react with the waste;
 - are kept separated from containers which hold other hazardous wastes which could cause dangerous chemical reactions; and
 - comply with the requirements in Section 3.8.4 for containers used to accumulate wastes which are then used to ship those wastes off site.

Storage areas should have these features:

- a base capable of containing leaks, spills, and accumulated rainfall until these are detected and removed;
- methods to remove leaks from the storage area; and
- adequate containment capacity to hold a spill amounting to the volume of the largest container, or 10 percent of the total volume of all containers, whichever is greater.

In addition to the foregoing guidelines for storage containers and design of storage areas, the following operational guidelines should be followed.

- Mark each container with the date accumulation begins, and label each container with the words, "Hazardous Waste."

- If wastes are being segregated, clearly mark each container to identify the waste which is to be stored in that container.
- If waste oil is also accumulated on site, clearly mark the waste oil accumulation tank and post a sign prohibiting mixing of hazardous wastes in the waste oil.
- If possible, accumulation containers should be kept within a locked area permitting access only by authorized personnel. Wastes discarded in these containers should also be recorded.
- Inspect the storage site weekly for leaks and container deterioration.
- Containers which hold ignitable or reactive wastes must be stored at least 50 feet from the property line of the facility.
- Prepare for and prevent accidents.
- Plan for emergencies.

3.7.4 How Should I Prevent Accidents and Plan for Emergencies?

Hazardous waste generators are required to ensure that the facility takes the precautions necessary to prevent any accidental release to the environment and provides procedures to respond to any accidents or emergencies that may occur.

Contingency Plans and Emergency Procedures

As a minimum, the following contingency plans and emergency procedures must be included.

- Designate someone as the primary Emergency Coordinator. One or two back-up Coordinators should also be designated. These individuals must be familiar with the requirements and be on site (or on call) at all times.

- Next to the telephone, post the:
 - names and telephone numbers of the Emergency Coordinators,
 - location of fire extinguishers and spill control equipment, and
 - phone number of the fire department or instructions for activating the emergency response communication or alarm system.
- Ensure and document that all employees are trained and thoroughly familiar with proper waste handling and emergency procedures.

Facility Description

Each Contingency Plan should contain information regarding preparedness, prevention, and contingency at each facility including:

- a review of the types of hazards present;
- the exact locations of hazardous waste generating operations within the facility;
- the locations of hazardous waste storage areas;
- the methods of waste storage;
- any emergency equipment available at the facility and its location;
- the locations of entrances, exits, stairways, elevators, etc.; and
- an approximation of the number of employees on site during regular work hours and non-business hours.

Emergency Coordinator Responsibilities

The Emergency Coordinator or his designee must respond to any emergencies. The applicable responses follow.

- In the event of a fire, call the fire department and attempt to extinguish it using a fire extinguisher.
- In the event of a spill, contain the flow of hazardous waste to the extent possible. As soon as practicable, clean up the hazardous waste and any contaminated materials or soil.
- In the event of a fire, explosion, or other release which could threaten human health outside the facility or when the generator has knowledge that a spill has reached surface water, the generator must immediately notify the National Response Center using the 24-hour toll free number (800) 424-8802. The report to the National Response Center must include the:
 - name, address, and U.S. EPA I.D. number of the generator;
 - date, time, and type of incident (e.g., spill or fire);
 - quantity and type of hazardous waste involved in the incident;
 - extent of injuries, if any; and
 - estimated quantity and disposition of recovered materials, if any.

It is important to avoid potential risks in this area. If you have a serious emergency and you must call your local fire department, or you have a spill that extends outside your plant or that could reach surface waters, **immediately call the National Response Center, (800) 424-8802, and give them the information they request.** You will be advised if the call was not necessary. **However, anyone who is required to call—and does not—is subject to a \$10,000 fine, a year imprisonment, or both.**

3.7.5 Can I Store Hazardous Wastes in Underground Storage Tanks (USTs)?

On July 14, 1986, the U.S. EPA substantially revised the hazardous waste management requirements for tanks containing hazardous wastes (40 CFR Part 264, Subpart J -Tank Systems...see 51 FR 25470, July 14, 1986).

With a few exceptions, all UST systems containing hazardous wastes must eventually be equipped with secondary containment. These revised regulations also specify that all hazardous waste tank systems without secondary containment must comply with the following until such time as secondary containment is provided:

- Provide for controls to prevent spills.
- Provide overfill protection.
- Annually inspect cathodic protection system.
- Perform a tank integrity leak test annually.

In September 1988, the U.S. EPA published new regulations for storage of hazardous substances (petroleum products and certain hazardous commercial chemical products, not waste) in USTs. The rule calls for tougher new requirements for tanks installed after December 1988 and for a phased-in system of leak detection, leak prevention, and corrosion protection for existing tanks based on age.

For more information on the new UST regulations for storage of hazardous substances see Chapter 4.0

3.8 Commonly Asked Questions About Packaging, Labeling, and Shipping Wastes Off-Site

3.8.1 How Do I Ship Hazardous Wastes Off My Premises?

Under current Federal law, you should proceed as follows.

TRANSPORTER



1. Contact a company in the business of accepting hazardous wastes for treatment or disposal. The company's facility must be authorized by U.S. EPA or the state to manage hazardous wastes. Be certain the facility knows the type of hazardous wastes you have and is authorized to take them. Otherwise, the wastes could be returned to you.
2. Contact a hauler to transport your hazardous wastes to the treatment or disposal facility you have chosen. Be certain the hauler knows the type of hazardous wastes you have and can transport them safely—small quantity generators are required to offer hazardous wastes to U.S. EPA-identified hazardous waste haulers only. These haulers must meet certain requirements specified in the regulations.

In some states, haulers who operate within the state are regulated by and are required to have a license from the state regulatory agency.

You can request your hauler to document or otherwise provide evidence that they have a U.S. EPA identification number, and where applicable, a state license, and are operating within the limits of the regulations.

3. Prepare your waste for shipment. Properly package and label your wastes and prepare the manifest form (see following sections).
4. Transport your hazardous wastes to a landfill or other treatment or disposal facility that is permitted, licensed, or registered by the state or U.S. EPA to accept those kinds of wastes.

If you need assistance in finding a hauler, authorized landfill, or commercial facility in your area, call the CHMR Hotline, (800) 334-CHMR, or contact your state environmental regulatory agency, the National Solid Waste Management Association, (202) 659-4613, the Governmental Refuse Collection and Disposal Association at (301) 585-2898, or your own trade association.

Under RCRA, shipments of some hazardous wastes (primarily used/dead automobile batteries) are exempted from most requirements if they are being sent to a recycling or reclamation establishment (see Section 3.5.5.).

3.8.2 How Should I Label My Waste Containers for Shipment Off-Site?

Federal and most state hazardous waste regulations include many requirements for specific labeling of hazardous wastes which are shipped off-site.

All containers used to store hazardous wastes or which may be used to ship hazardous wastes off-site must exhibit the "Hazardous Waste" label shown in Figure 3-2. All containers must be labeled to show:

- accumulation start date,
- facility's EPA I.D. number,
- manifest document number (Section 3.8.5),
- proper DOT shipping name of the substance,
- UN (United Nations) or NA (North American) number for the substance, and
- the EPA waste I.D. number for the substance.

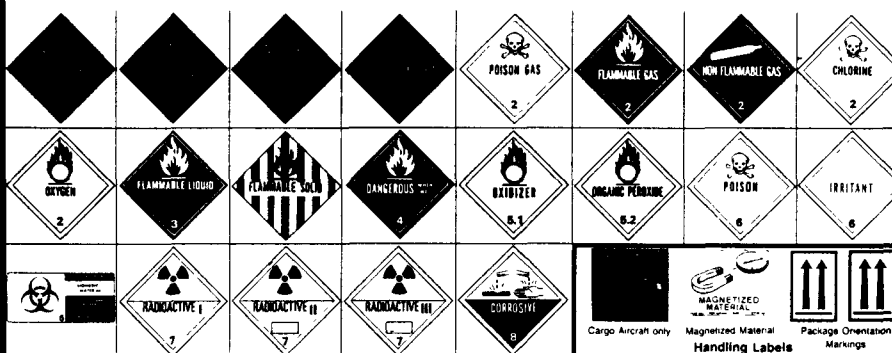
All information must be completed with waterproof ink. All containers must also be labeled with the required DOT warning label (see Figure 3-3) to indicate the nature of the contents, such as "flammable" or "poison."

HAZARDOUS WASTE	
FEDERAL LAW PROHIBITS IMPROPER DISPOSAL	
IF FOUND, CONTACT THE NEAREST POLICE, OR PUBLIC SAFETY AUTHORITY, OR THE U.S. ENVIRONMENTAL PROTECTION AGENCY	
PROPER D.O.T. SHIPPING NAME _____ UN OR NA# _____	
GENERATOR INFORMATION:	
NAME _____	
ADDRESS _____	
CITY _____ STATE _____ ZIP _____	
EPA ID NO. _____	EPA WASTE NO. _____
ACCUMULATION START DATE _____	MANIFEST DOCUMENT NO. _____
HANDLE WITH CARE!	
CONTAINS HAZARDOUS OR TOXIC WASTES	
STYLE WM-6	

Figure 3-2. Hazardous waste label.

Hazardous Materials Warning Labels

DOMESTIC LABELING



General Guidelines on Use of Labels

(CFR Title 49 Transportation Parts 100-177)

- Labels illustrated above are normally for domestic shipments. However, some air carriers may require the use of International Civil Aviation Organization (ICAO) labels.
- Domestic Warning Labels may display UN Class Number, Division Number (and Compatibility Group for Explosives only) (Sec. 172.407(g)).
- Any person who offers a hazardous material for transportation MUST label the package, if required (Sec. 172.400(a)).
- The Hazardous Materials Tables, Sec. 172.101 and 172.102, identify the proper label(s) for the hazardous materials listed.
- Label(s) when required must be printed on or affixed to the surface of the package near the proper shipping name (Sec. 172.406(a)).
- When two or more different labels are required display them next to each other (Sec. 172.406(c)).
- Labels may be affixed to packages (even when not required by regulations) provided each label represents a hazard of the material in the package (Sec. 172.401).

Check the Appropriate Regulations

Domestic or International Shipment

UN Class Numbers

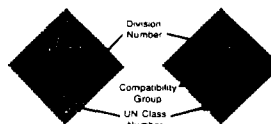
- Class 1—Explosives
- Class 2—Gases (compressed, liquefied or dissolved under pressure)
- Class 3—Flammable liquids
- Class 4—Flammable solids or substances
- Class 5—Oxidizing substances
 - Division 5.1 Oxidizing substances or agents
 - Division 5.2 Organic peroxides
- Class 6—Poisonous and infectious substances
- Class 7—Radioactive substances
- Class 8—Corrosives
- Class 9—Miscellaneous dangerous substances

INTERNATIONAL LABELING



EXAMPLES OF INTERNATIONAL LABELS

- These are examples of international labels not presently used for domestic shipments.
- Text, when used internationally, may be in the language of the country of origin.
- Most of the domestic labels (illustrated above) may be used internationally.



EXAMPLES OF EXPLOSIVE LABELS

- The NUMERICAL DESIGNATION represents the CLASS or DIVISION.
- ALPHABETICAL DESIGNATION represents the COMPATIBILITY GROUP (for Explosives Only).
- DIVISION NUMBERS and COMPATIBILITY GROUP combinations can result in over 30 different Explosives labels (see IMDG Code/ICAO).

For complete details refer to one or more of the following:

- Code of Federal Regulations Title 49 Transportation Parts 100-199 [All Modes]
- International Civil Aviation Organization (ICAO) Technical Instructions for the Safe Transport of Dangerous Goods by Air [Air]
- International Maritime Organization (IMO) Dangerous Goods Code [Water]
- Transportation of Dangerous Goods Regulations of Transport Canada [All Modes]



U.S. Department of Transportation
Research and Special Programs
Administration

Washington, DC 20590

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3.8.3 How Do I Determine the DOT Description?

The DOT description includes the proper shipping name, the hazard class, and the United Nations (UN) or North American (NA) identification number required for shipping hazardous materials (including hazardous wastes). This information is found in the Hazardous Materials Table of the Department of Transportation regulations (49 CFR Section 172.101).

If you are not familiar with these requirements, you can obtain information and assistance from the U.S. Department of Transportation (DOT) Materials Transport Bureau, your state transportation department, your trade association or by calling the CHMR Hazardous Materials Hotline, (800) 334-CHMR.

3.8.4 How Should I Package My Hazardous Wastes for Shipment Off-Site?

Hazardous wastes must only be offered for transport in packages that comply with DOT requirements for containers used to ship hazardous wastes. The DOT requirements are designed to prevent leaks or other releases of hazardous materials during transport.

Typical Packaging Acceptable for Shipping Most Hazardous Wastes

Typically, the following packaging is acceptable for most hazardous wastes shipped from SQGs.

- Acid or caustic wastes. If the waste is an acid or a caustic, the following DOT specification drums are acceptable:
 - DOT Specification "34" polystyrene drums.
 - DOT Specification "37P" steel drum with polyethylene liners.

- DOT Specification "6D" or 37M" non-reusable cylindrical steel overpacks with inside DOT Specification "2S," "2SL," or "2U" polyethylene packaging.
- DOT Specification "21P" fiber drum overpack with inside DOT Specification "2S," "2SL," or "2U" polyethylene packaging.
- Flammable and other wastes. If the waste is not an acid or a caustic, usually a 55-gallon steel drum meeting DOT Specifications "5," "5A," "5B," "5C," "17C," or "17E" is acceptable. For **liquid** wastes, use a **non-removable** head drum with a maximum 2.3-inch opening.

For any hazardous wastes requiring packaging to meet DOT specifications other than those listed above, you should contact your state's Department of Transportation or the CHMR Hazardous Materials Hotline—(800) 334-CHMR.

Containers that are designed by the manufacturer to meet DOT specifications are marked with the applicable specification number. For example, you may see the specification "17E" stamped on certain 55-gallon drums. In determining whether a container is marked according to DOT specifications, you may accept the manufacturer's certification, specification, or exemption marking.

Packaging Small Items for Shipment Off-Site (Lab Packs)

Drums which have been filled with "small items" are commonly referred to by the hazardous waste disposal industry as "lab packs." A few hazardous waste management contractors will handle lab packs for processing and disposal which would eliminate the need for SQGs to open, empty, and accumulate the contents of such "small items" in segregated containers on site.

The specific packaging, handling, and disposal approaches vary depending on the contractor. Some contractors require that the contractor personnel actually come onto your site to package the small items into lab packs for shipment. Disposal options range

from facilities which incinerate or bury the entire lab pack, to facilities which “depackage” the lab pack and further process its contents.

In general, lab packs must be packaged as follows:

- Outside packaging must be a DOT specification “removable head” metal or fiber drum.
- Each outside packaging may only contain one hazard class (e.g., ignitable or corrosive), and the drum construction materials must be chemically compatible with the materials being packaged.
- Inside packaging must be either glass packaging not exceeding 1 gallon or metal or plastic packaging not exceeding 5 gallons.
- Inside packaging of liquid must be surrounded by compatible absorbent material capable of absorbing the total liquid contents.

The specific packaging requirements for your lab packs should be reviewed with your lab pack disposal contractor.

Reuse of Containers

Generally, the regulations authorize one-time use of the product container for shipping the waste. Reuse of containers (e.g., drums used to ship products—such as solvents or lubricating oils, which have been emptied of those raw materials, and which are now available to be used for accumulating and shipping wastes) is allowed so long as the containers are:

- acceptable DOT specification drums for the waste to be shipped;
- in good condition and free of rust, damage, or leaks;
- do not contain any incompatible residues; and

- do not carry any old marking labels that incorrectly identify the contents.

While it may be convenient to reuse containers, you should be very careful to avoid putting materials in a container that may react in undesirable or unknown ways with the material that was previously in the container. Reuse of containers that have not been thoroughly cleaned can result in combining incompatible wastes to produce toxic vapors or explosions as well as waste mixtures that are even more dangerous than the individual substances.

3.8.5 What Is a Hazardous Waste Manifest?

The hazardous waste manifest form must be completed before transporting hazardous waste off-site. This form becomes a written record of the disposal of your hazardous waste. For treatment, storage, or disposal within a state, the state's manifest form must be used. For shipments outside the state, the receiving state's form or the U.S. EPA Uniform Hazardous Waste Manifest must be used.

Small quantity generators (SQGs) are now required to fully complete the manifest and keep a file of manifest copies that are signed and returned to the SQG by the storage, treatment, or disposal facility. These copies must be kept on file for 3 years.

Contact your state environmental regulatory agency or your Regional U.S. EPA office for additional copies of the manifest. You may also purchase copies of the manifest from some commercial printers, or obtain copies from some treatment, storage, or disposal facilities.

How to Complete a U.S. EPA Manifest Form

Sections of the U.S. EPA Uniform Hazardous Waste Manifest form (see Figures 3-4 and 3-5) that must be completed include the following.

-
-
- **Item 1 — EPA Identification Number.** Enter your EPA I.D. number in the space provided (see Figure 3-4).

Item 1 also asks for a five-digit manifest document number. You should use a consecutive numbering system in which the first shipment from the facility in 1989, for example, is assigned the manifest document number "89001," the second shipment is assigned the number "89002," etc.

- **Item 2 — Page 1 of ____.** Indicate the total number of original pages (not carbon copies) you are using. For example, the first page (EPA Form 8700-22) plus the number of Continuation Sheets (EPA Form 8700-22A, see Figure 3-5) if any.
- **Items 3 and 4 — Generator's Name and Mailing Address.** Enter the name, mailing address, and telephone number of the generator. The address should be the location that will manage the returned manifest forms.
- **Items 5 through 8 — Transporters' Names and U.S. EPA I.D. Numbers.** Enter the name and U.S. EPA I.D. number of the transporter in Items 5 and 6. If the waste will be transferred to a second transporter during shipment, the same information for the second transporter must be provided in Items 7 and 8. If more than two transporters are used, enter each additional transporter's company name and U.S. EPA I.D. number in Items 24-27 on the Continuation Sheets (EPA Form 8700-22A, see Figure 3-5). Each continuation sheet has space to record two additional transporters.
- **Items 9 and 10 — Designated Facility Name and Address.** Enter the company name, address, and U.S. EPA I.D. number of the facility designated to receive the waste listed on the manifest. The address must be the site address, which may differ from the facility's mailing address.

-
- **Item 11 — Department of Transportation (DOT) Description of the Waste, Including the Shipping Name, Hazard Classification, and Identification Number.** Enter (1) the proper DOT shipping name of the substance, (2) the DOT hazard class, and (3) the UN or NA identification number for the substance (see Section 3.8.3.).

Note: If additional space is needed for waste descriptions, enter these additional descriptions in Item 28 on EPA Form 8700-22A (see Figure 3-5).

- **Item 12 — Number and Type of Containers.** Enter the number of containers for each waste and the appropriate abbreviation for the type of container:

DM	=	Metal drums, barrels, kegs
DF	=	Fiberboard or plastic drums, barrels, kegs
DW	=	Wooden drums, barrels, kegs
TP	=	Portable tanks
TT	=	Cargo tanks (tank trucks)
TC	=	Tank cars
DT	=	Dump trucks
CM	=	Metal boxes, cartons, cases
CF	=	Fiberboard or plastic boxes, cartons, cases
CW	=	Wooden boxes, cartons, cases
CY	=	Cylinders
BA	=	Burlap, cloth, paper, or plastic bags

- **Items 13 and 14 — Quantity of Waste Being Transported.** Enter the total quantity and unit of measurement (gallons, pounds, or cubic feet) of waste described on each line. Enter the appropriate abbreviation:

G	=	Gallons (liquids only)
P	=	Pounds
T	=	Tons (2,000 lb)
Y	=	Cubic yards
L	=	Liters (liquids only)
K	=	Kilograms
M	=	Metric tons (1,000 kg)
N	=	Cubic meters

-
-
- 3.8.6**
- **Item 1 — U.S. EPA Hazardous Waste I.D. Number.** You must enter the U.S. EPA Hazardous Waste I.D. number for each waste listed under Item 11.
 - **Item 16 — Generator's Certification.** The authorized representative of the SQG is required to sign the manifest. If a transportation mode other than highway is used, the word "highway" should be lined out and the appropriate mode (rail, water, or air) inserted in the space below. If another mode in addition to the highway mode is used, enter the appropriate additional mode (e.g., rail) in the space below.

Are There Any Exemptions to the Manifesting Requirement?

In some cases, spent materials can be regenerated, recycled, or reclaimed for reuse (e.g., lead acid batteries, solvents). SQGs are not required to prepare a manifest when using the service of a reclaimer provided:

- the waste is being reclaimed under a contract,
- the contract specifies that either the SQG or the reclaimer retain ownership of the material,
- the type of waste and frequency of service are specified,
- the service owns the vehicle used to transport the waste and regenerated material, and
- the SQG keeps a copy of its contract with the reclaiming service for at least 5 years after the contract terminates or expires.

3.8.7 What Should I Do if the Signed Manifest Is Not Returned to Me by the Designated Facility?

If you do not receive a signed copy from the designated waste facility within 35 days, you must determine why by contacting either the transporter or destination facility.

Please print or type (Form designed for use on elite (12-pitch) typewriter)

Form Approved OMB No. 2050-0039 Expires 9-30-88

UNIFORM HAZARDOUS WASTE MANIFEST		1 Generator's US EPA ID No	Manifest Document No	2 Page 1 of	Information in the shaded areas is not required by Federal law	
3 Generator's Name and Mailing Address				A State Manifest Document Number		
4 Generator's Phone ()				B State Generator's ID		
5 Transporter 1 Company Name		6 US EPA ID Number	C State Transporter's ID			
			D Transporter's Phone			
7 Transporter 2 Company Name		8 US EPA ID Number	E State Transporter's ID			
			F Transporter's Phone			
9 Designated Facility Name and Site Address		10 US EPA ID Number	G State Facility's ID			
			H Facility's Phone			
11 US DOT Description (Including Proper Shipping Name, Hazard Class and ID Number)		12 Containers No	Type	13 Total Quantity	14 Unit Weight	15 Waste No
a						
b						
c						
d						
J. Additional Descriptions for Materials Listed Above				K. Handling Codes for Wastes Listed Above		
15 Special Handling Instructions and Additional Information						
16 GENERATOR'S CERTIFICATION I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked, and labeled, and are in all respects in proper condition for transport by highway, according to applicable international and national government regulations. If I am a large quantity generator, I certify that I have a program in place to reduce the volume and toxicity of waste generated to the degree I have determined to be economically practicable and that I have selected the practicable method of treatment, storage, or disposal currently available to me which minimizes the present and future threat to human health and the environment. OR, if I am a small quantity generator, I have made a good faith effort to minimize my waste generation and select the best waste management method that is available to me and that I can afford.						
Printed/Typed Name		Signature		Month Day Year		
17 Transporter 1 Acknowledgement of Receipt of Materials		Signature				
Printed/Typed Name		Month Day Year				
18 Transporter 2 Acknowledgement of Receipt of Materials		Signature				
Printed/Typed Name		Month Day Year				
19 Discrepancy Indication Space						
20 Facility Owner or Operator Certification of receipt of hazardous materials covered by this manifest except as noted in Item 19						
Printed/Typed Name		Signature		Month Day Year		

EPA Form 8700-22 (Rev. 9-86) Previous editions are obsolete

Figure 3-4. U.S. EPA Uniform Hazardous Manifest form.

GENERATOR STANDARDS

5-771
161 1519

Please print or type (Form designed for use on nine (12-pitch) typewriter)

Form Approved OMB No. 2050-0038 Expires 9-30-88

UNIFORM HAZARDOUS WASTE MANIFEST (Continuation Sheet)		21. Generator's US EPA ID No.	Manifest Document No.	22. Page	Information in the shaded areas is not required by Federal law	
23. Generator's Name			L. State Manifest Document Number			
			M. State Generator's ID			
24. Transporter Company Name		25. US EPA ID Number	N. State Transporter's ID			
			O. Transporter's Phone			
26. Transporter Company Name		27. US EPA ID Number	P. State Transporter's ID			
			Q. Transporter's Phone			
28. US DOT Description (Including Proper Shipping Name, Hazard Class, and ID Number)			29. Containers	30. Total	31. Unit	32. Waste No.
			No.	Type	Capacity	
a						
b						
c						
d						
e						
f						
g						
h						
i						
j						
k						
l						
m						
n						
o						
p						
q						
r						
s						
t						
u						
v						
w						
x						
y						
z						
S. Additional Descriptions for Materials Listed Above			T. Handling Codes for Wastes Listed Above			
32. Special Handling Instructions and Additional Information						
33. Transporter Acknowledgement of Receipt of Materials			Date			
Printed/Typed Name			Signature		Month Day Year	
34. Transporter Acknowledgement of Receipt of Materials			Date			
Printed/Typed Name			Signature		Month Day Year	
35. Discrepancy Indication Space						

EPA Form 8700-22A (Rev. 9-88) Previous edition is obsolete

(Appendix, Form 8700-22A)

Figure 3-5. U.S. EPA Uniform Hazardous Manifest form (page 2).

Remember that just because the hazardous waste has been shipped off-site and it is no longer in your possession, your liability has not ended. You are potentially liable under Superfund for any mismanagement of your hazardous waste. The manifest will help you to track the waste during shipment and be certain it arrives at the proper destination.

3.9 Commonly Asked Questions About Recordkeeping and Other Management Requirements

3.9.1 What Are My Recordkeeping and Reporting Requirements?

The Federal regulations set forth specific recordkeeping and reporting requirements associated with managing your hazardous waste.

Recordkeeping

Maintaining records of how you handle the hazardous waste generated from your business is a very important part of achieving compliance. Good recordkeeping is helpful to avoid problems with the regulatory agencies and to minimize future cleanup liabilities.

SQGs who are judged out of compliance may spend a lot of time and money dealing with enforcement actions and paying fines—which may also result in bad publicity. The best way to prevent this from happening is by making an honest effort to maintain compliance with the regulations and to keep records that are sufficient to prove to agency officials that you are operating in compliance.

When agency enforcement personnel conduct inspections, one of the first things they will ask to see is your “hazardous waste file.” This is because documents such as acknowledgment copies of hazardous waste shipping manifests provide strong indications of your efforts to comply.



If you do not have such a file, or if your papers are unorganized, the inspector will immediately receive a bad impression of your operation and be suspicious about how carefully you are handling your responsibilities. It is also very difficult for you to monitor your own compliance without a good record of the on-going operations.

Good recordkeeping cannot be overemphasized. The following minimum recordkeeping is required by most regulations.

- Keep records of any test results, waste analyses, or other determinations made to identify if wastes generated from your facilities are hazardous.
- Prepare a monthly summary of wastes generated which substantiates your generator category. This summary should indicate the final disposition of the wastes, particularly those not manifested (i.e., hazardous wastes discharged to a Publicly Owned Treatment Work (POTW), reclaimed on site, or reclaimed through a contract with an off-site reclaimer).
- Keep on-site waste accumulation records, including the date accumulation began and the quantity accumulated to date.
- Record "in-house" facility inspections, including deficiencies noted and when such deficiencies were resolved.
- Keep records of employee training.
- Keep on file the generator's copy of the manifest and the copies returned from the destination facility.
- Maintain copies of contracts with reclaiming services.

Reporting

Small quantity generators are exempted from all Federal and state reporting requirements except those "Spill and Leak" reporting requirements described in Section 3.7.4.

3.9.2 May I Treat or Dispose of My Wastes at My Facility Rather than Ship Them Off-Site?

You may treat or dispose of your hazardous wastes at your own plant **only** if you are permitted or registered to treat or dispose of hazardous wastes, with a few exceptions.

You are exempt from the permitting requirements if you:

- legitimately use, recycle, or reclaim your hazardous wastes (see Section 3.5) (However, you are still subject to the regulatory notification and reporting requirements);
- neutralize corrosive hazardous wastes in an “elementary neutralization unit” such as a tank, container, or transport vehicle—not a surface impoundment;
- treat hazardous wastes in a “totally enclosed treatment facility”—which is defined as a facility for the treatment of hazardous waste which is directly connected to an industrial production process and which is constructed and operated in a manner which prevents the release of any hazardous constituent into the environment during treatment; and
- treat hazardous wastes in a National Pollution Charge Elimination System (NPDES)-regulated “waste water treatment unit”—some states have special requirements for waste water treatment units treating hazardous wastes, and some residuals generated by these units may be hazardous.

If you already are treating or disposing of your wastes at your facility, then you should contact your state environmental regulatory agency or call the CHMR Hotline at (800) 334-CHMR to determine if additional requirements have been issued recently to be sure you are still permitted, licensed, or registered to manage your hazardous wastes at your facility.

3.9.3 What Should I Do if I Have Determined that My Wastes Are Non-Hazardous?

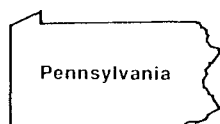
Because you have determined that your wastes are not defined by U.S. EPA as a "Hazardous Waste," does not mean that your waste does not contain some hazardous chemicals or that your wastes do not have the potential to cause harm to human health or the environment if improperly treated, stored, or disposed.

You should still take steps to ensure that you are complying with all applicable Federal and state requirements for disposal of non-hazardous wastes, and you should make all reasonable efforts to ensure that your non-hazardous wastes are handled in a way that prevents uncontrolled release to the environment and the potential future liabilities associated with such release.

3.10 Where to Call for Additional Assistance

For more information and assistance in complying with the RCRA regulations, you can call CHMR's toll-free Hazardous Materials Hotline at (800) 334-CHMR or the regional office of your state environmental regulatory agency. See Chapter 11 of this manual for more information and telephone numbers of these and other helpful organizations.

3.11 RCRA Regulations for SQGs in Pennsylvania



State regulatory requirements must be at least as stringent as Federal requirements (exceptions sometimes occur when a Federal regulation was recently changed and made more stringent and the state regulation has not yet been revised to keep up with the Federal standards). You must comply with the most stringent requirements whether they are Federal or state.

Pennsylvania is currently considering whether to adopt the U.S. EPA regulations for small quantity generators (SQGs). In the meantime, the U.S. EPA regulations are more stringent and should be followed—with the important exception of the requirements described in the following sections.

Table 3-2 provides a brief summary of the regulatory requirements for SQGs in Pennsylvania.

3.11.1 RCRA Regulatory Requirements for Conditionally Exempt SQGs in Pennsylvania

According to the Federal regulations, conditionally exempt SQGs (generators of no more than 100 kg/mo) must send their hazardous waste to a hazardous waste facility, or to a facility approved by the State for industrial or municipal wastes (see Section 3.6.5).

However, facilities in Pennsylvania approved by the Pennsylvania Department of Environmental Resources (PA DER) for industrial or municipal wastes (e.g., sanitary or residual waste landfills) are not approved to receive any hazardous wastes. Therefore conditionally exempt SQGs in Pennsylvania must ship their wastes to a hazardous waste management facility in Pennsylvania (with an EPA I.D. number) or to an out-of-state hazardous, industrial, or municipal waste facility approved to receive hazardous wastes.

Also, most commercial hazardous waste transporters and treatment, storage, or disposal facilities in Pennsylvania will not accept any hazardous wastes without an accompanying manifest. Therefore, as a practical matter, “conditionally exempt, small quantity generators” in Pennsylvania should get a U.S. EPA I.D. number and accompany their hazardous waste shipments with a manifest.

**Table 3-2. RCRA regulatory requirements
for small quantity generators in Pennsylvania**

<i>Requirement</i>	<i>Produce less than 100 kg/mo</i>	<i>Produce 100-1,000 kg/mo</i>
Determine quantity of hazardous waste generated	Required	Required
Obtain EPA I.D. number	*	Required
Observe accumulation time or quantity limits	Required	Required
Observe storage facility criteria	-	Required
Prepare/plan for accidents/emergencies	-	Required
Properly label and package shipments	*	Required
Ship wastes with a manifest	*	Required
Use a licensed transporter	*	Required
Ship to an approved treatment storage or disposal facility	Required	Required
Keep records	Required	Required

* Not required by regulation but in practice necessary for most businesses in Pennsylvania (see Section 3.11.1)

3.11.2 On-Site Storage Time and Quantity Limitations in Pennsylvania

According to both Federal and Pennsylvania regulations, you are allowed to accumulate hazardous wastes on your site subject to certain limitations. The Federal regulations were recently amended, which has made the Federal regulations more stringent in some cases and the state regulations more stringent in others. However, in all cases, comply with the most stringent of the two regulations.

Currently, the following limitations apply to hazardous waste generators in Pennsylvania. If you exceed these time or quantity limits, you will be considered a storage facility and you must obtain a RCRA storage permit and meet all of the RCRA storage requirements.

Generators of 1,000 kg/mo or more

Both the Pennsylvania and Federal requirements are the same for generators of 1,000 kg/mo or more. You must properly dispose of your wastes within 90 days after you begin accumulating the waste in storage. The 90-day clock begins when the first waste goes into the storage container (except at "satellite" accumulation areas—see Section 3.7.1) under both Federal and Pennsylvania regulations. However, the Federal regulations allow you to petition for an extension if circumstances beyond your control force you to store wastes past the 90-day deadline.

Generators of 100-1,000 kg/mo

Pennsylvania requirements	100-1,000 kg/mo generators must remove their wastes within 90 days after they accumulate 1,000 kg. The 90-day clock starts after you reach 1,000 kg.
Federal requirements	You must remove your wastes within 180 days after you begin accumulating wastes. The 180-day clock starts when the first waste goes in the storage container (except at "satellite" accu-

mulation areas—see Section 3.7.1). You must never accumulate more than 6,000 kg.

If you must transport wastes more than 200 miles, the 180-day clock becomes a 270-day clock under Federal regulations. Also under Federal regulations, you are allowed to petition for a 30-day extension if conditions beyond your control force you to hold wastes beyond the allowed limits.

Therefore

Whether the Pennsylvania or Federal regulation is more stringent depends on whether you accumulate 1,000 kg before or after 90 days (180 days if you must ship more than 200 miles) from the time the first waste goes into the storage container.

The Pennsylvania regulation is more stringent if you accumulate 1,000 kg in less than 90 days. For example, suppose it takes you 80 days to accumulate 1,000 kg from the day the first waste goes into storage. Pennsylvania requires you to remove the waste within 80 plus 90, or 170 days, which is less than the Federal allowance of 180 days.

The Federal regulation is more stringent if it takes you more than 90 days to accumulate 1,000 kg. For example, suppose it takes you 100 days to accumulate 1,000 kg from the day the first waste goes into storage. Pennsylvania requires you to get rid of the waste within 100 plus 90, or 190 days, which is more than the Federal allowance of 180 days.

Generators Of No More Than 100 kg/mo

Pennsylvania requirements	Generators of no more than 100 kg/mo are treated the same as 100-1,000 kg/mo generators. You must remove your wastes within 90 days after you accumulate 1,000 kg. The 90-day clock starts when you reach 1,000 kg.
Federal requirements	There are no Federal time limits for storage of wastes as long as you never accumulate 1,000 kg. If you accumulate 1,000 kg, you will then be treated the same as the 100-1,000 kg group except that the 180-day clock starts after you reach 1,000 kg.
Therefore	<p>As long as you never accumulate 1,000 kg, you are not subject to any time clock under either Pennsylvania or Federal regulations. It is, therefore, strongly recommended that generators in this category remove their wastes before they accumulate 1,000 kg.</p> <p>If you accumulate 1,000 kg, the PA DER time clock is more stringent, and you must now remove your wastes within 90 days. However, you will also be subject to all of U.S. EPA's various requirements for the 100-1,000 kg generator category.</p>

3.11.3 Additional Requirements for The PA DER Manifest Form

In addition to those items discussed in Section 3.8.5, facilities using the PA DER Uniform Hazardous Waste Manifest form (see Figure 3-3) must also complete the following sections.

- **Item J — Physical State and Hazard Code.** Enter the physical state of each waste and the hazard code or codes that correspond to the hazardous waste number:

Physical state

S = solid
L = liquid
SL = sludge
G = gas

Hazard code

I = ignitable
C = corrosive
R = reactive
E = EP toxic
H = acute hazardous
T = toxic

- **Item K — Handling Codes.** Handling codes for wastes are not required for Pennsylvania generators but may be required for some interstate shipments. You should use the U.S. EPA Uniform Manifest Form or the receiving state's manifest for interstate shipments, and you can omit Item K unless it is required by the receiving state.

3.11.4 Pennsylvania "Permit by Rule"

In Pennsylvania, the owner or operator of an elementary neutralization unit or a waste water treatment or pretreatment facility may be eligible for a Hazardous Waste Management "Permit by Rule" if all of the following criteria are met:

- The facility is located upon lands owned by the hazardous waste generator and the only waste treated is generated on site.
- It is not a surface impoundment.
- It has an NPDES permit, if required, and complies with the conditions of that permit.

or

It is a pretreatment facility and it discharges into a permitted Publicly Owned Treatment Work (POTW).

-
- It complies with various requirements of hazardous waste treatment, storage, and disposal facilities such as: I.D. number; security; inspection; preparedness, prevention, and contingency procedures; operating record; and design requirements for hazardous waste chemical, biological, or physical treatment units.
 - The owner of such facilities has notified the agency of the on-site hazardous waste treatment activities.

The regulations essentially say that all such facilities which are operated in accordance with the requirements listed above automatically have a hazardous waste management permit from the agency—otherwise known as a “permit by rule”—and a separate application is not required.

PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL RESOURCES
Bureau of Waste Management
P O Box 8550
Harrisburg PA 17105-8550

FOR SHIPMENT OF HAZARDOUS, INFECTIOUS
AND CHEMOTHERAPEUTIC WASTE
Form Approved
OMB No. 2050-0035
Expires 9-30-91

ER-HWM-51 REV 12-88

UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator's US EPA ID No. _____ Manifest Document No. _____ 2. Page 1 of _____

3. Generator's Name and Mailing Address _____ Information in the shaded areas is not required by Federal law but is required by State law

4. Generator's Phone () _____ A. State Manifest Document Number **PAC 1208782**

5. Transporter 1 Company Name _____ 6. US EPA ID Number _____ B. State Gen. ID _____

7. Transporter 2 Company Name _____ 8. US EPA ID Number _____ C. State Trans. ID **PA-AH**

9. Designated Facility Name and Site Address _____ 10. US EPA ID Number _____ D. Transporter's Phone () _____

E. State Trans. ID **PA-AH**

F. Transporter's Phone () _____

G. State Facility's ID _____

H. Facility's Phone () _____

11. US DOT Description (including Proper Shipping Name, Hazard Class, and ID Number)	12. Containers	13. Total Quantity	14. Unit (Lb./Gp.)	15. Waste No.
a	No. Type			
b				
c				
d				

J. Additional Descriptions for Materials Listed Above (include physical state and hazard code)

Lab Pack	Physical State	Lab Pack	Physical State
a		c	
b		d	

K. Handling Codes for Wastes Listed Above

a	c
b	d

15. Special Handling Instructions and Additional Information _____

16. GENERATOR'S CERTIFICATION I hereby declare that the contents of this consignment are fully and accurately described above by the generator, and that the materials are properly classified, labeled, packaged and are in all respects in proper condition for transport by highway according to applicable regulations and national government requirements.

I am a large business generator. I certify that I have a long-term plan to reduce the volume and toxicity of waste generated to the greatest extent practicable and that I have selected the applicable method of treatment, storage, or disposal currently available to me which minimizes the present and future threat to public health and the environment. OR I am a small quantity generator. I have a long-term plan to reduce the volume and toxicity of waste generated to the greatest extent practicable and that I have selected the applicable method of treatment, storage, or disposal currently available to me which minimizes the present and future threat to public health and the environment.

Printed Typed Name _____ Signature _____ MONTH DAY YEAR

17. Transporter 1 Acknowledgement of Receipt of Materials

Printed Typed Name _____ Signature _____ MONTH DAY YEAR

18. Transporter 2 Acknowledgement of Receipt of Materials

Printed Typed Name _____ Signature _____ MONTH DAY YEAR

19. Discrepancy Indication Space _____

20. Facility Owner or Operator: Certification of receipt of hazardous materials covered by this manifest except as noted in item 19

Printed Typed Name _____ Signature _____ MONTH DAY YEAR

EPA Form 8700-22 (Rev. 9-88)

Figure 3-6. Pennsylvania Hazardous Waste Manifest form

4.0 **LAND DISPOSAL, SARA TITLE III, AND UNDERGROUND STORAGE TANKS**

4.1 **Land Disposal Bans**

In 1984, Congress enacted the Hazardous and Solid Waste Amendments (HSWA) to the Resource Conservation and Recovery Act (RCRA) restricting land disposal of hazardous waste unless properly containerized or treated. The act schedules a phased-in "land disposal ban" on hazardous waste pending establishment of specific treatment standards for the identified waste by 1990.

Wastes subject to the land disposal ban fall into three target groups:

1. Hazardous wastes containing solvents and dioxin.
2. RCRA-listed California-List wastes:
 - Liquid forms of hazardous wastes that contain specific metals, free cyanides, or PCBs
 - Liquid acid wastes, equal to or below pH 2
 - Hazardous wastes that contain halogenated organics
3. 450 RCRA-listed hazardous wastes:
 - first-third
 - second-third
 - final-third

These regulations affect all land-based disposal including landfills, surface impoundments, waste piles, injection wells, underground mines or caves, and concrete vaults or bunkers.

4.1.1 **Hazardous Wastes Containing Solvents and Dioxin**

The first phase prohibiting the disposal of specific types of waste was adopted in 1986. It banned the disposal of a select group of wastes containing spent solvents (U.S. EPA Hazardous Waste Numbers F001, F002, F003, F004, and F005) and dioxin (F020, F021, F026, F027, and F028). Refer to Appendix 12.2 for further

information concerning the **F** series of EPA hazardous wastes. In order to dispose of the indicated wastes, U.S. EPA has established certain concentration requirements for disposal and has designated the best demonstrated available technologies (BDATs) to meet the requirements.

Wastes containing solvents must meet the following concentration requirements.

- Waste water containing solvents may contain between 0.05 and 12.7 milligrams per liter depending on the specific solvent.
- Wastes (not waste water) containing solvents may contain between 0.05 and 5.0 milligrams per liter depending on the specific solvent.

If the waste exceeds any of these concentrations, then it must be treated before disposal on land. The BDATs for solvent treatment before disposal are:

- incineration,
- biological treatment,
- steam stripping, or
- activated carbon adsorption.

U.S. EPA has mandated the following requirements for land disposal of wastes containing dioxin.

- Wastes which contain dioxin must contain less than one part per billion of the dioxin.
- The BDAT for dioxin treatment is incineration.

4.1.2 RCRA-Listed California-List Wastes

The second phase prohibiting the disposal of "California-list" wastes was adopted in 1987. It banned the disposal of a select group of wastes containing cyanides, certain metals, halogenated organic compounds, PCBs, and low-pH wastes.

For disposal on land, wastes must meet the following requirements.

- Free cyanide concentrations in liquid hazardous wastes cannot exceed 1,000 mg/l (milligrams per liter).
- Liquid hazardous wastes containing elemental metals or metal compounds cannot exceed the following concentrations:
 - Arsenic and arsenicals, 500 mg/l
 - Cadmium and its compounds, 100 mg/l
 - Chromium VI and its compounds, 500 mg/l
 - Lead and its compounds, 500 mg/l
 - Mercury and its compounds, 20 mg/l
 - Nickel and its compounds, 134 mg/l
 - Selenium and its compounds, 100 mg/l
 - Thallium and its compounds, 130 mg/l
- Liquid waste must have a pH greater than 2.0.
- PCB concentrations in liquid hazardous wastes cannot exceed 50 ppm.
- The concentration of halogenated organic compounds (HOCs) cannot exceed 1,000 mg/kg.

U.S. EPA has determined that incineration is the appropriate treatment standard for the category of wastes classified as HOC- and PCB-contaminated wastes. No required treatment standards for the remaining California-list wastes have been established; however, applicable technologies generally capable of meeting the statutory prohibition levels are discussed in the final rule.

4.1.3 450 RCRA-Listed Hazardous Wastes

The remaining phase of land disposal bans restricts the disposal of all 450 RCRA-listed hazardous wastes (see Appendix 12.2 for RCRA-listed waste streams). The rule is being implemented in thirds, and the ban on the first-third was established in August 1988.

To date, treatment standards have been established for 39 hazardous waste streams; however, treatment standards for 14 other hazardous waste streams covered under the first-third rule remain to be established. Also, 107 **P** list and **U** list wastes (small volume discarded commercial chemical products and spill residues, respectively—see Appendix 12.2) identified in the first-third rule do not have treatment standards established. Treatment is required, however, if the technology is available.

For wastes and waste streams where no treatment standards have been established, landfilling is still a disposal option as long as state-of-the-art landfills are used. Where no treatment standards have been established, a “soft-hammer” clause in the rule automatically requires land disposal bans for all first-third listed wastes by 1990.

The remaining two-thirds of RCRA-listed hazardous wastes are to have treatment standards and final rules established in 1989 (second-third) and 1990 (final-third), with complete implementation of the disposal ban by 1992.

Generators of any amount of hazardous waste are being forced to examine waste management alternatives to land disposal. Now is the time to minimize, reuse, or recycle wastes or to use non-hazardous substitution chemicals in your process. Land disposal bans will only become more restrictive and costly for businesses, so conscientious decisions must be made and implemented to reduce hazardous waste generation.

4.2 SARA Title III

On October 17, 1986, the Superfund Amendments and Reauthorization Act (SARA) was signed into law. Title III of SARA is also known as the Emergency Planning and Community Right-to-Know Act (EPCRA). As the name implies, EPCRA has two major themes: emergency planning and community right-to-know. This section discusses the various aspects of compliance with Title III of SARA, details major sections of SARA, and discusses what facilities are subject to the various requirements. A list of key deadlines is also provided.

4.2.1 Background

Many small businesses may be subject to provisions of SARA Title III based on the types and amounts of chemicals present on-site. This Federal legislation, prompted by the Bhopal incident in 1984, requires (1) industry to provide information concerning hazardous substances used, and (2) local governments and communities to plan for hazardous materials emergencies.

Title III establishes requirements for Federal, state, and local governments, and industry for emergency planning and community right-to-know reporting on hazardous chemicals. The program is designed to help protect communities from potential chemical emergencies.

4.2.2 Emergency Planning and Notification, Community Right-to-Know, and Toxic Chemical Release Reporting

Title III has four major parts: emergency planning, emergency notification, community right-to-know, and toxic chemical release reporting.

Emergency Planning (Sections 301, 302, and 303)

The emergency planning sections are designed to develop government emergency preparedness capabilities through increased coordination and planning on the state and local level.

Section 301 establishes two planning levels within each state—a state emergency response commission (SERC) and local emergency planning districts governed by a local emergency planning committee (LEPC).

Facilities which are subject to emergency planning requirements under Section 302 include those with listed extremely hazardous chemicals on-site in a quantity equal to or greater than the established threshold planning quantity (TPQ). These facilities are to notify the SERC and LEPC that they are subject to the provisions of EPCRA.

Section 303 also requires local emergency planning commissions to submit emergency response plans to the SERC. The plan must include identification of facilities and transportation routes for extremely hazardous substances, emergency response procedures, community and facility coordinators, emergency notification procedures, release detection, emergency equipment available, evacuation plans, training programs, and methods and schedules for exercising emergency response plans.

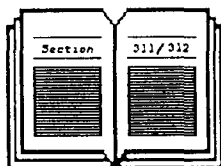
Emergency Notification (Section 304)

Emergency notification is an essential element of EPCRA emergency planning. Facilities that have an unplanned release of any listed extremely hazardous substance or CERCLA Section 103(a) chemical exceeding the reportable quantity must notify the LEPC and SERC immediately.

Written follow-up is also required under this section. Information provided during the emergency notification should be reported, updating it with additional information such as actions taken to respond to and contain the release, known and anticipated health effects, medical advice, etc.

Community Right-to-Know Reporting (Sections 311 and 312)

The Community Right-to-Know provisions of SARA Title III are intended to increase the public's knowledge and access to information regarding the presence of hazardous chemicals in the community and releases of these chemicals into the environment.

**Community
Right-To-Know**

According to Section 311, facilities that must prepare or have available MSDSs under the Occupational Safety and Health Act (OSHA) hazard communication regulations must submit copies of MSDSs or a list of MSDSs to the local emergency planning and state emergency response commissions and the local fire department.

If significant new information about a chemical is discovered, or if new hazardous chemicals become present at a facility in quantities above the established threshold levels, appropriate agencies must be notified.

Section 312 requires submission of emergency and hazardous chemical inventory forms by facilities to the LEPC, SERC, and local fire department. These forms provide information on the types, amounts, and locations of hazardous chemicals at a facility.

Inventory forms for Section 312 reporting are divided into Tier I and Tier II forms. Under Tier I, facilities must provide the following information for each applicable OSHA category of health and physical hazard:

- an estimate of the maximum amount of chemicals in each category present at the facility at any time during the preceding calendar year,
- an estimate of the average daily amount of chemicals in each category, and
- the general location of hazardous chemicals in each category.

Upon request of the SERC, LEPC, or local fire department, the facility must provide Tier II information for each covered substance including:

- the chemical name or common name on the MSDS,
- an estimate of the maximum amount of chemical present at any time during the preceding calendar year,

-
- a brief description of the chemical storage methods,
 - the location of the chemical at the facility, and
 - an indication of whether the owner elects to withhold information from disclosure to the public.

U.S. EPA published a uniform format for the inventory forms. Since many state emergency response commissions have additional requirements or have incorporated Federal contents into their own forms, Tier I and Tier II forms should be obtained from the state agencies.

Toxic Chemical Release Reporting (Section 313)

Section 313 of EPCRA requires facilities to submit Toxic Chemical Release Forms (Form R) for specified chemicals. Owners and operators of certain facilities that process, manufacture, or otherwise use a listed toxic chemical in amounts exceeding threshold quantities must report emissions of such chemicals on an annual basis.

This reporting covers releases from normal business operations. It must also include emergency releases as well as information on off-site shipment of wastes containing listed toxic chemicals. The purpose of this requirement is to inform government officials and the public about releases of toxic chemicals from a facility into the environment.

The forms must be submitted to U.S. EPA and designated state officials on or before July 1, 1988, and annually thereafter on July 1, reflecting releases during each preceding calendar year.

Section 313 applies to owners and operators of facilities that meet all three of the following requirements.

- The facility has ten or more full-time employees.

- The facility is included in Standard Industrial Classification codes 20 through 39.
- The facility manufactures, processes, or uses a listed toxic chemical in the course of a calendar year in excess of specified threshold quantities.

The list of toxic chemicals subject to Section 313 reporting consists of acutely toxic chemicals listed on the Maryland-New Jersey lists. There are over 300 chemicals and categories on these lists.

A complete Form R must be submitted for each toxic chemical manufactured, processed, or otherwise used at each covered facility. These forms must be sent to the U.S. EPA and state-designated agencies. U.S. EPA must establish and maintain a national toxic chemical inventory based on the data submitted. The public must have access to this information.

4.2.3 Other Title III Provisions

Public Availability of Plans, Data Sheets, Forms, and Follow-Up Emergency Notices (Section 324)

Information, such as emergency plans, MSDSs, hazardous chemical lists, inventory forms, toxic chemical release forms, and follow-up emergency notices must be made available to the public under Section 324 of EPCRA.

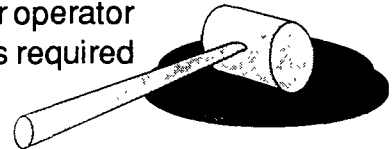
Each local emergency planning commission is required to publish an annual notice in a local newspaper stating that emergency plans, inventory forms, etc., were submitted and are available for review.

Enforcement (Section 325)

There are civil, administrative, and criminal penalties ranging from \$10,000 to \$75,000 per violation or per day for failure to comply.

Citizen Suits (Section 326)

Citizens or state/local governments may sue an owner or operator of a facility for failure to submit various forms and notices required under EPCRA.



4.2.4 SARA Title III—Key Dates to Remember

Deadlines for Industrial Facilities

May 17, 1987	Any facility subject to Section 302 planning requirements must have notified the SERC that it is covered by SARA.
May 22, 1987	A facility must have notified the state commission of emergency releases.
September 17, 1987	A facility must have notified the local emergency planning committee of the name of the designated facility representative.
October 17, 1987	A manufacturing facility should have submitted MSDSs or list of MSDS chemicals on-site in quantities greater than initial thresholds to SERC, LEPC, and the local fire department.
March 1, 1988	A manufacturing facility must submit hazardous chemical inventory forms to the SERC, LEPC, and local fire department. Revisions are due annually.
July 1, 1988	A covered facility must submit toxic chemical release forms to U.S. EPA and designated state officials. Revisions are due annually.
September 24, 1988	A non-manufacturing facility covered under the new OSHA expansion as of June 24, 1988, should have submitted MSDSs or list chemicals present in quantities over the first-year threshold to the SERC, LEPC, and local fire department.

March 1, 1989	A facility subject to the OSHA Hazard Communication Standard should have submitted emergency inventory forms to the SERC, LEPC, and local fire department.
October 17, 1989	A manufacturing facility should have submitted MSDSs or list chemicals exceeding the final threshold quantities to the SERC, LEPC, and local fire department.

Deadlines for Local and State Agencies

April 17, 1987	State governors must have appointed State Emergency Response Commissions (SERCs).
July 17, 1987	SERC must have designated local emergency planning districts
August 17, 1987	SERC must have appointed members of local emergency planning committees (LEPCs)
October 17, 1988	Local emergency planning committees must have completed preparation of an emergency plan (review annually thereafter)

4.2.5 Emergency Planning, Right-to-Know, and Waste Minimization

An important first step in any waste minimization program is to complete an inventory of all hazardous substances in the workplace. Since the EPCRA requires such an inventory, an employer can take steps toward right-to-know compliance—and simultaneously initiate a waste minimization program.

While conducting an inventory, an employer may find hazardous substances which are no longer used, which are used in excessive quantities, or which are replaceable by less hazardous or non-hazardous alternatives.

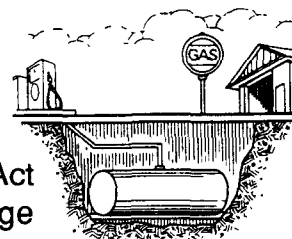
By listing the environmental hazards emitted, discharged, or disposed from your business, you are starting a "waste audit." The waste audit is an important primary step in any waste minimization program. You can, by conducting a waste audit:

- begin to realize exactly where your business is wasting materials;
- recognize specific areas of substance emission or discharge where you can contain, recycle, or reuse some of your waste—saving on raw material costs; and
- realize savings in decreased waste treatment and disposal costs.

The waste reduction audit is a systematic and periodic survey of company operations designed to identify areas of potential waste reduction. More detailed guidance on how to conduct a waste audit is provided in Chapter 6 of this manual.

4.3 Underground Storage Tanks (USTs)

Under Subtitle I of the Resource Conservation and Recovery Act (RCRA), U.S. EPA has issued regulations for underground storage tanks (USTs). The regulations include financial, technical, and reporting requirements for owners and operators of USTs. These regulations took effect on December 23, 1988.



A tank is an underground storage tank if it meets these two criteria.

1. Ten percent or more of the tank volume (including the volume of associated piping) is below ground.
2. The tank is used to manage "regulated substances." These substances include petroleum-based compounds and hazardous chemicals listed by U.S. EPA.

Underground tanks containing hazardous wastes are regulated under the hazardous waste tank regulations (see Section 3.7.5), which are generally stricter than the UST regulations dealing with hazardous substances.

The regulations pertain to both owners and operators of underground storage tanks. If a tank is located on leased property, the U.S. EPA may hold both the landowner and leasee responsible for the tank.

4.3.1 Financial Requirements

The U.S. EPA requires UST tank owners/operators to demonstrate "financial responsibility" for their USTs. They have set minimum monetary requirements for insurance or the ability to make direct payment for tank cleanups.

The amount of coverage required for marketing firms varies between \$1 million and \$2 million depending on the number of tanks you own. If you own between 1 and 100 tanks, you are required to demonstrate ability to pay \$1 million for cleanup costs. Some small non-petroleum marketing firms may only be required to obtain a half million dollars in coverage. Coverage for tanks may be provided by an insurance policy, by state approved or funded methods, or by the owner or operator if they can demonstrate that their net worth is at least ten times the amount of coverage required. Because many firms expressed difficulty in finding insurance, U.S. EPA decided to phase in the financial requirements between January 1989 and October 1990. Firms with 12 or less petroleum USTs are not required to demonstrate financial responsibility until October 26, 1990.

4.3.2 Technical Requirements — New Tanks

Corrosion Protection

New tanks (built after December 1988) are required to have corrosion protection, which can consist of any one of:

- coated and cathodically protected steel,
- fiberglass construction, or
- steel clad with fiberglass construction.

Spill/Overflow Protection

New tanks are required to have spill/overflow protection consisting of catchment basins and either ball float valves, automatic shutoff devices, or overflow alarms.

Leak Detection

New tanks are also required to have a leak detection system in place. This can consist of either monthly monitoring, **or** monthly inventory control along with tank tightness testing every 5 years. Monthly monitoring includes either:

- automatic tank gauging,
- vapor monitoring,
- interstitial monitoring,
- groundwater monitoring, or
- other approved methods.

Monthly inventory control must be accompanied by tank tightness testing every 5 years. It can only be done until the tank is 10 years old, at which time one of the monthly monitoring methods must be instituted.

Piping Requirements

The piping on new tanks must meet certain requirements—it must be made of either coated and cathodically protected steel or fiberglass. It must also be monitored by a leak detection system.

Special Requirements for Hazardous Chemical Tanks

Finally, secondary containment and interstitial monitoring are required for all new USTs containing hazardous chemicals (not petroleum product tanks). Secondary containment may include: either vault, outer tank, or lining the excavation with an appropri-

ate liner. The interstitial monitoring system must be able to detect leaks in the confined space between the tank and the secondary containment.

4.3.3 Technical Requirements—Existing Tanks

The general intent of the regulations covering existing tanks is to force them to comply with the new tank regulations within 10 years or less.

Corrosion Protection

All existing tanks and associated piping must have a corrosion protection system in place by December 1998. The corrosion protection requirements include a choice from one of these five alternatives:

- coated and cathodically protected steel,
- fiberglass tank construction,
- steel tank clad with fiberglass,
- cathodic protection system, or
- interior lining.

Spill/Overfill Protection

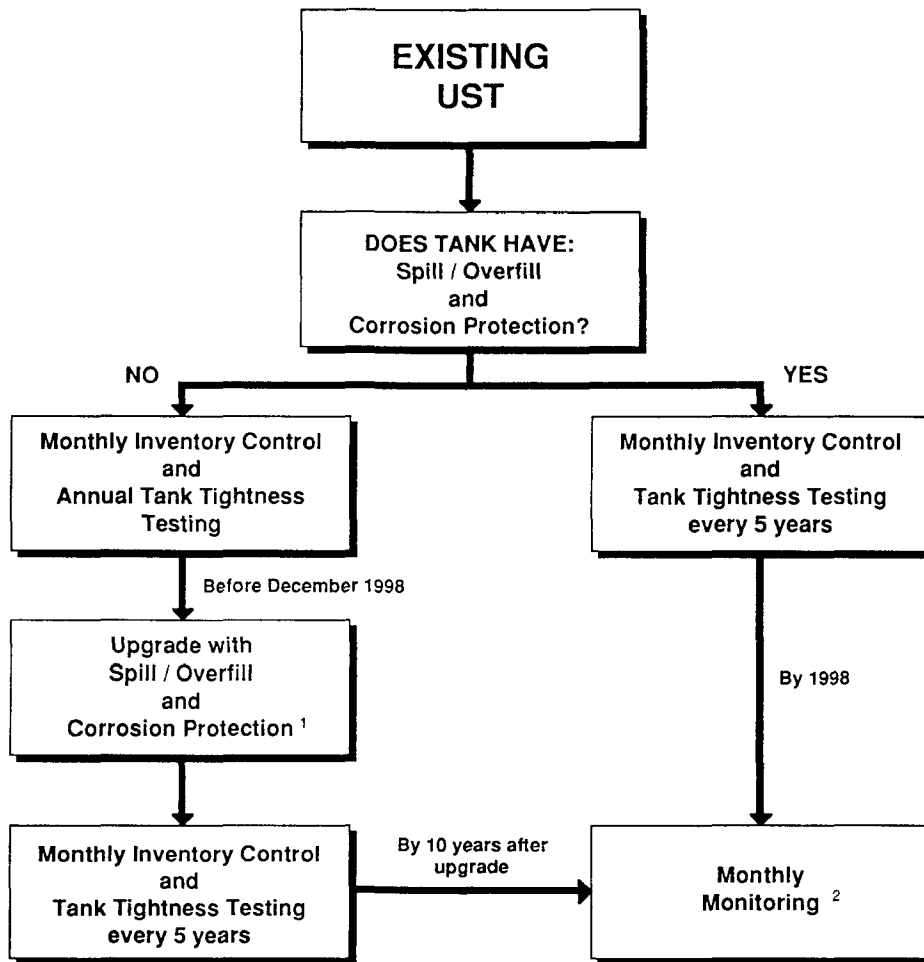
The spill/overfill protection systems required of existing tanks are identical to those required for new tanks. They must be in place by December 1998.

Leak Detection

The leak detection requirements for existing tanks include either:

- monthly monitoring as described for new tanks, or
- monthly inventory control plus tank tightness testing. Tightness testing is required annually or once every 5 years, depending on the tank.

The regulatory requirements are summarized in Figure 4-1.



1 Upgrading tanks includes internal inspection for tanks more than 10 years old, and tightness testing for younger tanks. The corrosion protection system may be installed only if the tank passes the inspection & tests.

2 Tank owners may use monthly monitoring instead of other leak detection systems at any time. Tank "upgrading" requirements will still be in place even if monthly monitoring is used.

Figure 4-1. Leak detection requirements for existing USTs.

Leak detection systems are required on existing tanks between December 1989 and December 1993, depending on the age of the tanks.

<u><i>Date tank installed</i></u>	<u><i>Date leak detection required for tanks and suction piping</i></u>
Before 1965	December 1989
1965-1969	December 1990
1970-1974	December 1991
1975-1979	December 1992
1980-1988	December 1993

For tanks with pressurized piping, leak detection systems **for the piping** are required by December 1990.

Piping Requirements

Piping on existing tanks is required to be cathodically protected by 1998. The piping must also be monitored monthly or tested every 3 years.

Special Requirements for Hazardous Chemical Tanks

Secondary containment and interstitial monitoring is required by 1998 for all existing USTs containing hazardous chemicals (not petroleum products).

4.3.4 Response to Leaks

Signs of a leak from an underground storage tank include warnings from monitoring equipment, sustained losses of inventory, unexplained vapors near the tank or in neighboring basements, discolored soil, or signs of vegetative distress.

If you suspect a spill or leak, notify your state UST office, and then confirm the leak by checking equipment, re-checking inventories, looking for environmental evidence of distress, etc. If the spill or leak is confirmed, then you must:

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- take immediate action to contain and stop the release;
 - report the confirmed leak to your state UST office within 24 hours for a hazardous chemical release of any quantity, or a petroleum leak of over 25 gallons;
 - remove immediate threats such as explosion or fire hazards;
 - determine the extent of contamination and recover any spillage possible;
 - report progress to the state agency within 20 days; and
 - determine the extent of damage to the environment and develop a plan for remediation within 45 days.

There are strict standards for tank and piping repairs, and follow-up testing requirements. You may also be required to perform additional remediation or testing.

4.3.5 Closing USTs

USTs may be closed temporarily or permanently. Tanks not used for 3 to 12 months must be temporarily closed. All lines (except vent lines) to temporarily closed USTs must be capped, corrosion protection systems must be maintained, and leak detection systems must be operated unless the temporarily closed tank is empty. To permanently close a tank, the owner/operator must:

- notify the state or Federal agency 30 days prior to tank closure;
- sample soil, vapor, or groundwater adjacent to tank to determine whether or not the tank leaked (if it did, the owner/operator must take corrective action as described previously); and

- empty and clean the tank (then either remove the UST from the ground or fill it with sand).

These requirements took effect December 1988. For tanks closed prior to that date, inform the agency of the location, the date it was closed, its former contents, type of construction, any remediation required, and closure procedures. Government agencies reserve the right to require testing to ensure that the tank did not leak.

4.3.6 Reporting and Recordkeeping Requirements

Reporting Requirements

When the tank is installed (or immediately if it has not already been done) the owner/operator of a UST must complete a notification form available from the state. Thirty days before the tank is removed, notify the state of the intent to remove it.

If you suspect a leak or spill, notify your regulatory agency immediately and follow the various notification requirements described in Section 4.3.4.

Recordkeeping Requirements

You must keep records of leak detection performance and up-keep—including at least one full year of monitoring results. Keep records of inspections performed by corrosion experts and records of tank repairs or upgrades. Finally, you must keep site testing records for 3 years after the UST is permanently closed.

4.4 Where to Call for Additional Assistance Regarding Land Disposal Bans, SARA Title III, or USTs

For more information and assistance regarding land disposal bans or compliance with SARA Title III and underground storage tank requirements, call the toll-free CHMR Hazardous Materials Hotline at (800) 334-CHMR.

CHMR also has available comprehensive information packets which provide many more details on how to comply with the SARA TITLE III and UST requirements.

5.0 APPROACHES TO WASTE MINIMIZATION

Up to this point, you have been introduced to the importance of waste minimization to the small quantity generator, the advantages of waste minimization, and how complying with various environmental regulatory requirements can be an important first step in minimizing your hazardous waste.

For the next four chapters, you will be shown the actual approaches and techniques of waste minimization, illustrated in a format easily used in the workplace.

5.1 Introduction

Approaches to waste minimization are primarily low-cost, low-risk alternatives to hazardous waste disposal. Most of the approaches do not require a great deal of sophisticated technology and can be relatively inexpensive. In short, waste minimization approaches are:

- technically feasible,
- economically viable, and
- ecologically beneficial.

In general, any waste minimization program should include or consider:

- management initiatives,
- waste audits,
- improved housekeeping,
- materials substitution,
- redesigning equipment,
- recycling and reuse, and
- waste exchange.

The following sections will introduce you to these various approaches to waste minimization. By becoming familiar with these general approaches, you will be better prepared to understand the next three chapters, which describe how to actually implement a waste minimization program.

5.2 Developing Management Initiatives

The commitment to waste minimization must come from the top—the management of a business or organization. Management initiatives are vital to the success of any waste minimization efforts, and like the waste audit, should be considered as a preliminary step in your waste minimization program.

5.2.1 Overview

Two management actions are crucial to a successful waste minimization program:

- **Communication:** Management must make all employees aware of the waste minimization effort.
- **Incentives:** Just as incentives are used to boost employee productivity, management should provide incentives for the development of useful waste minimization ideas.

Although a waste minimization commitment should begin with management, the employees are often able to suggest improvements in the day-to-day operations of the business. To utilize this important resource, many businesses give their employees incentives such as:

- recognition awards for outstanding waste minimization projects, as well as for resource and energy conservation projects; and
- financial awards for innovative approaches to waste minimization.

These incentives can take any form suitable to the company and the employees. Indeed, the incentives offered by a company with approximately 200 employees may differ greatly from a company with 5 employees. Regardless of the form of the incentives, employees should realize part of the benefits of their waste minimization ideas.

The new management initiatives should foster the following elements of waste minimization success:

- increased awareness and attention to hazardous chemicals,
- motivation to change old work patterns,
- knowledge of options for change,
- willingness to innovate and change,
- willingness to provide resources to implement changes, and
- willingness to learn from changes.

Another important management tool in the waste minimization process is employee training. Although training can be presented in many ways, training programs should include:

- occupational and plant safety;
- company regulatory compliance requirements;
- a statement of the company's waste minimization plan (including incentives for waste minimization ideas and an introduction to why waste minimization is important); and
- Material Safety Data Sheets (MSDSs) and other information that comply with the requirements of worker and community right-to-know laws.

5.2.2 Problem-Solving Through Employee Participation

This section outlines a problem-solving process that can be used to gain employee commitment to and active responsibility for the goals of your company. It is a method that can be directly applied to developing a hazardous waste minimization program.

This method:

- applies some of the most effective approaches in business and industry,
- has been used extensively world wide,
- has been shown to increase productivity as well as decrease operational costs,
- utilizes employee participation realizing that their involvement will directly affect the ultimate operation of your company, and
- can be used as an innovative training technique which gains and holds your employees' attention.

This process is known as Problem Solving Through Employee Participation and consists of five steps. They are:

- state purpose or goal,
- identify problems in the work area,
- list ways to solve the problems identified,
- develop an action plan, and
- follow up.

The key to the success of this problem-solving method is the willingness of management to allow employee participation in the process. This is normally done through group meetings. In order to properly prepare for this, a manager or trainer must:

- state the purpose for conducting the meeting,
- clarify in advance what problems must be solved (waste audit information can be used when applying this method to waste minimization),
- plan the meeting so that time is well used and employee time away from work stations is minimized, and



- organize employees into groups of no more than 2 to 15 individuals.

Following is an outline showing the key ingredients for conducting an employee problem-solving meeting.

A. State the purpose of the meeting.

1. Example—"To minimize waste generated in the work area."

B. Briefly outline what will happen in the meeting.

1. Review the order of the meeting.
2. Participant roles.
 - a. Leader (generally manager, supervisor, or trainer):
 - conducts meeting,
 - encourages participation,
 - allows individual choice,
 - gives equal opportunity, and
 - sets example, listens.
 - b. Scribe/Reporter:
 - notes statements as spoken, and
 - does not editorialize until team critiques list.
 - c. Members in attendance take responsibility to participate and to encourage others.
3. Use audio/visual aids if possible.

C. Method

1. Brainstorming (give each group member an opportunity to contribute to solving the problem).

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- a. Proceed around the group until each member is satisfied that the list includes all of their concerns/ideas.
 - b. If a group member has no concerns or ideas, they indicate this by saying "pass."
 2. Critique/review your list (combine items on list, clarify, gain consensus).
 - a. Incorporate statements that are much the same.
 - b. Get agreement on wording.
 3. Develop an action plan.
 - a. State a goal (this could be the same as one stated at the beginning of the meeting).
 - b. Define action to be taken (example: provide individual containers for different waste types).
 - c. Determine a time frame for action to be taken.
 - d. Assign responsibilities (who, what to do, when, where, how often).
 - e. Write down action plan and post or distribute to employees (this can be done by the leader after the meeting).
 4. Close meeting.
 - a. Recognize member contributions.
 - b. Reinforce the purpose of the meeting (e.g., remind employees to be conscientious about minimizing waste in their work areas).
 - c. Review action plan and follow-up procedures.

D. Conduct follow-up to the meeting.

1. This can be done in the work area or in another meeting.
2. Review goals with people responsible for carrying out assignments.
3. Have responsible people give a progress report on their assignments.
 - a. Determine progress made toward achieving goals.
 - b. Define any problems encountered by employees in pursuing goals.
4. Reinforce the positive aspects of performance toward achieving goals.
5. Make any changes or adjustments necessary to further pursue goals.
6. Determine what additional training or instruction is needed to achieve goals.
7. Record additional assignments and changes that have been made to the action plan, and post or distribute to employees.

5.3 Performing a Waste Audit

The waste audit is the most basic of all of the approaches to waste minimization. However, it is important to keep in mind that the waste audit is a preliminary step—it is an essential precursor to the other waste minimization approaches. A waste audit alone will not minimize your waste, but it will get you started.

The waste audit tracks your hazardous waste by monitoring all of the waste which is produced at your place of business to learn where it was generated. You can determine where hazardous materials are used and where raw materials are being wasted. As a result, you may discover that you are purchasing much more of a raw material than your business can use in a given time, or you may discover areas of waste production that you did not recognize before the audit.

The waste audit can be divided into six steps:

1. Identify hazardous substances in waste or emissions.
2. Identify the sources of these substances.
3. Set priorities for various waste reduction actions to be taken.
4. Analyze some technically and economically feasible approaches to waste minimization.
5. Make an economic comparison of waste minimization and waste management options.
6. Evaluate the results.

The waste reduction audit is a systematic and periodic survey of a company's operations and is designed to identify areas of potential waste reduction. More detailed guidance on conducting a waste audit is provided in Chapter 6.

5.4 Improving Housekeeping

Improved housekeeping, or "good operating practice," is the simplest waste minimization practice. Improved housekeeping relies on using common sense and is often the most effective first step toward waste reduction.

Good housekeeping practices involve the procedural or organizational aspects of a manufacturing process and include elements such as:

- inventory control,
- waste stream segregation,
- material handling improvements,
- scheduling improvements,
- spill and leak prevention, and
- preventive maintenance.

Good housekeeping is good operating practice which can be applied industry-wide. A detailed discussion of good operating practices is provided in Section 7.1.

5.4.1 Waste Segregation

One relatively simple housekeeping method is waste segregation. In many cases, segregation of wastes allows for certain wastes to be recycled or reused, as illustrated in the following examples.

- In a business using both chlorinated and non-chlorinated solvents, these waste types should be kept separate. This enables you to identify precisely which wastes can be recycled.
- In a business which plates metal parts and generates plating wastes, such as cyanide and heavy metals, the parts can be pre-screened for defects. In this way, the company plates only those parts fit for sale, uses less plating solution, and generates less waste.
- At a printing company, waste toluene from printing press cleanup can be eliminated by segregating this solvent according to the color and type of ink cleaned from the press. Each segregated batch of toluene can be reused for thinning the same color ink.

5.4.2 Improved Labeling

Improved labeling allows employees to know precisely what a container or pipeline holds, and guards against accidental spills and unnecessary usage—both a waste of materials. All substances used in the workplace should be properly labeled. In addition, all wastes, once segregated, should be labeled as well. This procedure helps to ensure safe handling of wastes, and can point out containers of waste which have the potential for recycle, reuse, or even resale.

5.5 Substituting Materials

Upon completion of a waste audit, you may identify specific materials within your business which are producing hazardous waste. If this is the case, it may be possible to find a substitute material which is less hazardous. Although material substitution is only applicable in certain situations, it can prove to be an efficient hazardous waste minimization approach.

- A painting business uses a hydrocarbon solvent (toluene) for daily cleanup of hydrocarbon-based paint. By switching to water-based paint, water can be substituted for toluene for cleanup.
- Water-soluble cleaning agents can often replace organic solvents or degreasers. One company did this and successfully reduced its 1,1,1-trichloroethane use by 30 percent, resulting in a \$12,000 annual savings.

5.6 Technology Modifications

In many instances, technological modifications or material substitutions are also very effective in minimizing wastes. Some products can be manufactured by two or more distinct processes, and one process may produce less hazardous waste than the other. Modifying equipment within a given process is another way to reduce waste generation.

Technological modifications can be generally categorized as:

- process modifications,
- equipment modifications,
- process automation,
- changes in operation settings,
- water conservation, or
- energy conservation.

5.6.1 Process Modifications

Production processes may be responsible for the production of hazardous waste. Old or inefficient processes could be sources of hazardous waste. By changing to a newer, more efficient process, a company could decrease the amount of waste it generates. In addition, many companies can experience improved production capacity and product quality and realize savings in expenditures for utilities and raw materials.

- In printed circuit board manufacturing, the use of screen printing for image transfer instead of photolithography eliminates the use of developers.
- By replacing a solvent-based painting system with a water-based electrostatic immersion painting system, the Emerson Electric Company has reduced waste solvent and paint solids generation by over 95 percent.

Process modifications often entail subsequent equipment modifications.

5.6.2 Equipment Modifications

Equipment modifications accomplish waste reduction by reducing or eliminating equipment-related inefficiency. An equipment modification leaves the production process intact and unchanged, because it modifies only the equipment which comprises the process.

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- A simple dragout recovery system was installed by the Stanadyne Company on a nickel plating machine. Less than \$1,000 was invested for a dragout recovery tank, which saved the firm \$4,200 worth of nickel per year and reduced nickel sludge generation by 9,500 pounds per year.

5.6.3 Process Automation

Process automation involves the use of automatic devices to assist or replace employees. Automation can include monitoring and subsequently adjusting process parameters by computer or mechanically handling hazardous substances. Waste minimization is accomplished by reducing the probability of employee error (which can lead to spills or off-spec products) and by increasing product yields through the optimum use of raw materials.

5.6.4 Changes in Operation Settings

Often the generation of hazardous waste may not be the fault of the equipment. Instead, the fault may lie in the way the equipment is set to operate. These are often the most easy and inexpensive equipment changes.

- Many spraying processes operating at decreased pressures have less overspray and subsequently less waste.
- In formulating their cyanide copper plating baths, the Stanadyne Company determined that lower chemical concentrations can be used. By running the potassium cyanide concentration at 2.5 ounces per gallon, instead of 3.5 ounces, the cyanide dragout concentration was reduced by 28 percent—without any adverse effect on plating quality.

Most equipment has optimum settings at which it operates most efficiently. By determining the optimum settings for certain parameters (such as optimum temperature and pressure), less waste is generated as a by-product.

5.6.5 Water Conservation

Although not as significant as other approaches, water conservation can have an effect on minimizing hazardous waste generation.

- By reducing the amount of water used for washing some organic chemical products, companies can lower the amount of waste water which must be pretreated before disposal.

5.6.6 Energy Conservation

Energy conservation minimizes the waste associated with the treatment of raw water, cooling water blowdown, and boiler blowdown. In addition, lower energy usage means a reduction in the generation of ash and other wastes associated with combustion. Energy conservation can be accomplished through a series of heat exchangers within the production process.

5.7 Recycling and Reuse

Recycling and reuse of hazardous wastes can be a very economical undertaking. Many companies have discovered that the cost of installing on-site recycling equipment can be quickly recovered and future profits gained by savings in waste management and raw material costs.

- A pesticide manufacturer generated pesticide dust from two major production systems. The firm replaced the single baghouse with two separate vacuum-air-baghouse systems specific to the two production lines for \$9,600. The collected material was recycled to the process where it was generated. The firm has eliminated over \$9,000 in annual disposal costs, and estimates that the recovered material is worth more than \$2,000 per year.
- The Rexham Corporation facility in Greensboro, North Carolina installed a distillation unit to reclaim n-propyl alcohol from their waste solvent for a total installed cost of \$16,000. The distillation unit recovers 85 percent of the solvent

in the waste stream, resulting in a savings of \$15,000 per year in virgin solvent costs—and in a \$22,800 savings in hazardous waste disposal costs.

In addition, there are many off-site recyclers who will take a company's waste, recycle it, and sell the refined product back to the company at a price significantly less than the cost of virgin material. Additionally, that company will not have to incur waste disposal costs.

- The Hamilton Beach Division of Scovill, Inc. operation requires 1,1,1-trichloroethane solvent to degrease metal stampings. Ashland Chemical Company was contracted to recycle the waste by distilling 1,1,1-trichloroethane. Substituting the recycled solvent for the virgin product has reduced Hamilton Beach's overall raw material costs by \$5,320 per year. Scovill also eliminated all of their previous waste disposal costs, estimated to be about \$3,000 per year.

The array of reuse options is too extensive for detailed discussion here. Numerous recovery technologies are presented in Chapters 7, 8, and 9.

5.8 Participating in Waste Exchanges

Waste exchanges are networks of businesses which attempt to find markets for the wastes they generate. Remember that hazardous waste to one business can be a valuable resource to another. The exchange attempts to match the waste from one business with the raw material requirements of another business. Small businesses can also find excellent recycling opportunities through such organizations. Often a "buyer" company is able to purchase, recycle, and subsequently reuse another's waste. In this way, the buyer is able to save on raw material costs, and the hazardous waste generator is able to market a new product as opposed to disposing a hazardous by-product.

For more information on waste exchanges, see Section 11.5.

6.0 HOW TO CONDUCT A WASTE AUDIT

A waste audit can be extremely useful in diagnosing how a facility can reduce or recycle wastes, and it is an essential first step in any waste minimization program. The waste reduction audit is a systematic and periodic survey of a company's operations and is designed to identify areas of potential waste reduction. This section describes how to conduct a waste audit.

6.1 Introduction

Some of the purposes of a waste minimization audit include:

- reducing waste disposal costs,
- reducing production costs,
- reducing or eliminating future liability,
- enhancing environmental awareness of all company personnel,
- complying with hazardous waste regulations,
- demonstrating concern for the environment, and
- demonstrating concern for worker/community health and safety.

Specific waste audit procedures should be tailored to suit your facility or company. However, a number of factors should be addressed by any waste audit, including:

- selecting an audit team,
- identifying waste streams and flow rates,
- identifying waste generation problems,

-
- formulating a range of solutions for each of these problems,
 - initial screening of these potential solutions,
 - discussing options with plant personnel,
 - ranking the most reasonable options, and
 - examining the feasibility of implementing the recommended options.

Waste audits are intended to identify and recommend options for potential areas of waste reduction and are an essential first step. Implementation and evaluation of progress must follow before the benefits of any waste minimization program will be realized.

6.2 Select the Audit Team

The first task is to select an audit team. The specific makeup and number of members will depend on the size, complexity, and resources of a company. In a small business, the audit “team” may be limited to one or two individuals responsible for facility operations. Ideally, the team should include people who are knowledgeable about the following topics:

- facilities, environmental, and process engineering;
- safety and health;
- product assurance/quality assurance;
- purchasing;
- legal;
- finance; and
- other facilities within the company.



Outside consultants should be used to supplement in-house capabilities.

Some of these topics may seem inappropriate to a waste audit team. However, after closer examination, their relevance becomes more obvious. For example, product assurance is needed to help reduce rejects. Financial information is often required to determine the basis upon which to calculate return on investment.

Although a waste minimization commitment should begin with management, operating employees are quite often qualified to suggest improvements in the day-to-day operations of a business. Employee participation on the waste audit team should be considered. Employee involvement in the waste minimization process through incentive programs, training, and problem-solving is discussed in detail in Section 5.2.

A crucial element in the success of a waste audit is the recognition of the audit's value by management. There is greater probability that waste reduction innovations will be incorporated into plant operations if an audit has been initiated by management.

6.3 Pre-Inspection Review

6.3.1 Audit Team Briefing on General Waste Minimization Opportunities

Before the plant visit, the audit team should be briefed on general waste minimization opportunities. These should include minimization practices which generally apply to any waste stream, as well as those which have been identified to reduce particular waste types in similar industries.

The purpose of the briefing is to educate the audit team on waste minimization opportunities they can be trying to identify during the audit. The briefing should include discussions of waste minimization opportunities in:

- administrative control of materials;
- housekeeping, handling (including waste segregation), and storage;
- raw material substitution;
- recycle or reuse of waste streams;
- modification of process, equipment, or operation;
- potential for redesign of process; and
- phase out production.

General information sources of waste-specific, industry-wide, and industry-specific waste minimization practices (such as this manual) can be used for the audit team briefing.

6.3.2 Collect and Review Background Information of the Facility

Any available and useful background information should be collected and reviewed by the audit team after the team has been selected but before the on-site plant visit. Such information may include:

- company policies on waste minimization;
- process flow diagrams and facility layout;
- chemical analysis of waste streams and waste discharges;
- operating manuals;
- purchasing records;
- waste manifests, annual reports, and other RCRA information;
- environmental regulations;
- contracts with waste management firms;
- RCRA permits;
- regulatory violations;
- results of previous audits;
- description of existing waste minimization program; and
- product information, MSDSs.

It may also be appropriate to combine the waste audit process with the process of compiling the information required to comply with the various worker and community right-to-know laws if such information is not yet compiled.

6.3.3 Identify and Characterize All Waste Streams

Once the audit team has met and reviewed all background information, it must assemble a listing of the facility's waste streams. This should be done before the plant visit and then verified or revised during the visit. Waste streams to consider include discharges such as:

- waste water discharges,
- stack emissions,
- fugitive emissions (e.g., tank evaporation losses), and
- solid wastes.

Each waste stream should then be fully characterized. This should first be attempted based on background information, then revised during the plant visit. Some of the points which should be reviewed on each waste stream include determining:

- actual point of generation,
- any handling and/or mixing,
- if the waste is hazardous or non-hazardous,
- other physical and chemical characteristics,
- quantities—including variations, and
- current costs of waste management.

6.3.4 Request Additional Information

The primary purpose of the "pre-inspection review" phase of the waste audit process is to be better prepared for the site visit by becoming familiar with all available background information. At this point in the audit process, it may be possible to identify

“information gaps” such as missing characterization of identified waste streams. To the extent possible, such additional information should be requested and reviewed before the site visit.

6.3.5 Prepare Checklist for Plant Inspection

A checklist should now be prepared which is specific for the plant to be inspected and which will help guide the audit team through the plant visit. To summarize, the checklist should include:

- full characterization of all waste streams and generation points—to be verified;
- all waste minimization practices including housekeeping which the pre-inspection review identified as already in place—to be verified and evaluated;
- proposed waste reduction options identified during the pre-inspection review—to be verified; and
- other general waste minimization opportunities to identify, including:
 - administrative control of materials;
 - housekeeping, handling (including waste segregation), and storage;
 - raw material substitution;
 - recycle or reuse of waste streams;
 - modification of process, equipment, or operation;
 - potentials for redesign of process; and
 - phase-out production.

6.4 Visit the Plant



You are now ready to visit the plant. Throughout the visit, the team *members should use the inspection checklist and ask questions* related to the specific focus of the items discussed previously and look for specific opportunities to enhance waste minimization. Much of the pre-inspection background information should be verified and any additional waste streams identified and characterized. Any new information gaps should be identified and the additional information gathered.

6.5 Identify and List Plant-Specific Waste Minimization Opportunities

Throughout the audit process, each team member should identify and note potential waste minimization practices they believe can be applied to the audited facility.

After the facility visit, the audit team should list all the possible opportunities to enhance waste minimization options. An effective method is the brainstorming process, where each team member presents his or her list of waste minimization options. These lists can be combined to form a master list. The list may include several options for a single waste stream or process. At this time, it is not necessary to consider in detail the technical or economic feasibility of any option. The development of this list should be based on the broad range of waste minimization opportunities discussed in Section 6.3.1 and presented throughout this manual. These include:

- improved housekeeping,
- material substitutions,
- technology modifications,
- recycling and reuse,
- participation in waste exchanges, and
- detoxification.

These basic waste minimization approaches (see Chapter 5) should begin to become part of the thought and evaluation processes of all team members as they look to identify specific waste minimization opportunities.

6.6 Screen and Set Priorities for Waste Minimization Actions

Now that a complete range of potential waste minimization options has been proposed, it is useful to screen these options to determine which should be studied more thoroughly. After some thought and discussion, but without going into much detail, it will become obvious that some options should be deleted from further consideration.

The audit team should now set some initial priorities for waste minimization actions. In setting priorities, the team should consider:

- the existing regulations affecting particular wastes—for example, when the government bans or restricts the disposal of certain wastes (see Section 4.1), your business may have no choice but to minimize that waste;
- the adverse health and environmental effects of the waste; and
- the ease and expense of implementing a waste minimization practice for the waste.

Setting initial priorities does not require detailed cost/ effectiveness analysis. Some waste minimization options are obviously easier and less expensive to implement than others.

Consider the potential disadvantages of any waste minimization actions. Evaluate any new wastes you may generate and consider the possible difficulties you may encounter when attempting to dispose of these new wastes.

The results of the first screening and ranking of waste minimization actions should then be discussed with plant personnel and company management, if appropriate. Final rankings of the most reasonable options should then be developed in light of these discussions and additional evaluation.

6.7 Examine Feasibility of Implementing Recommended Waste Reduction Options

Following the final ranking, it will be necessary to examine the feasibility of implementing the recommended waste reduction options.

6.7.1 Overview

Depending on the particular structure of your waste audit procedures and the makeup of the audit team, this implementation step will probably go beyond what is generally considered to be part of the waste audit. The waste minimization program must now begin to involve management decision making and, in some cases, an engineering or feasibility study.

The feasibility of some of the more simple, low-cost waste minimization practices—such as improved housekeeping and waste segregation—can be easily determined. Such practices are usually readily approved and implemented.

Other recommended waste minimization practices which involve more capital costs, such as technology modifications or equipment for recycling and reuse, will require a more detailed technical and economic analysis to determine feasibility.

6.7.2 Technical Feasibility

Some waste minimization practices involving technical modifications will require a more detailed evaluation of feasibility. Some issues to consider when making this technical assessment include:

- effects on process production capacity,
- effects on product quality,
- physical plant limitations (e.g., space limits),
- specific equipment requirements and options,
- effects on maintenance requirements,
- utility requirements,

-
- creating new by-products,
 - physical and chemical properties of material or wastes, and
 - potential health, environmental, or safety impacts.

Consideration of these and other technical issues will help you select the best and most appropriate option to achieve a specific reduction goal. On the other hand, a technical feasibility evaluation may determine that certain waste minimization goals are not possible at your facility.

6.7.3 Economic Feasibility

When choosing a waste minimization program, a key question is, "How profitable is this alternative with respect to others?" To answer this question, a method for evaluating the economic feasibility of mutually exclusive projects is required. Two common methods used for pollution control or waste minimization projects are:

- payback period (PBP), and
- net present value (NPV).

Regardless of the method chosen, the first step in evaluating a waste reduction project is to estimate the total costs and future savings expected from the proposed project.

Estimating Costs of a Minimization Project

The total costs of a proposed waste minimization project should include both the initial capital outlays, such as:

- land,
- buildings, and
- equipment;

plus ongoing expected annual expenses, such as:

- supplies,
- spare parts,
- utilities, and
- labor.

The ongoing expected annual expenses should be limited to those additional expenses associated with the proposed project. For example, additional labor to operate new equipment should be included. Any additional maintenance in the facility's production process caused by a proposed modification should also be included. On the other hand, any reduction in labor or maintenance on the production line would be a savings as discussed in the following section.

Estimating Savings from a Minimization Project

For estimating future savings from waste reduction projects, consideration should be given to both anticipated profits, if any, and reduction in future costs. These may include:

- reduced waste transportation and disposal costs;
- reduced waste storage and handling costs;
- reduced on-site pre-disposal treatment costs;
- income derived through sale or reuse of waste;
- reduced production costs;
- reduced raw material purchases;
- utility savings, including fuel and water;
- reduced personnel and maintenance costs;
- reduced or avoided state fees and taxes;
- permit cost savings;
- reduced reporting and/or manifesting costs;
- pollution liability insurance savings;
- reduced costs of emergency preparation;

- reduced costs of health and safety protection requirements; and
- avoided fines and cleanup costs.

Admittedly, some future savings will be difficult to quantify, such as avoided future cleanup costs or avoided disposal taxes not currently assessed. Such savings can be omitted or conservative best estimates used which will result in a conservatively low total savings estimate.

Payback Period (PBP) Method

The payback period is defined as the minimum length of time required to recover the modification cost in the form of cash flows to the project, based on total income minus all costs except depreciation.

The formula for quickly estimating the payback period is:

$$\text{PBP} = \frac{\text{capital cost of project}}{\text{avg. annual savings} + \text{avg. annual depreciation}}$$

For example, a business installs a piece of equipment that generates \$50,000 per year in cost savings and depreciation. If the total cost of the equipment was \$100,000, then the payback period is 2 years.

Many companies use the payback periods of competing projects as the sole tool of comparison. **This method is not completely reliable.** The payback period only measures a project's liquidity. A project with a longer payback period can be more profitable in the long run. So while the payback period is an important feature of a project, it is not a measure of feasibility.

Net Present Value (NPV) Method

The most common method for measuring economic feasibility is the discounted cash flow, or net present value method. This method discounts projected cash flows into the present, thus taking into account inflation and the time value of money. If the NPV is

greater than zero, the project is profitable. The NPV of different projects can then be compared, and the one with the highest value is the most profitable.

The net present value of a project can be calculated by adding together:

$$\frac{\text{Savings} - \text{Costs} (t)}{(1 + \text{MARR})^t}$$

for every year (t) of the project's life, where:

Savings - Cost (t) = the total estimated savings (anticipated revenues plus reduced future costs—see Section 6.7.3) from the proposed project minus the total estimated cost (capital outlay for $t=0$ plus operating costs, see Section 6.7.3) of the proposed project for year t.

MARR = the minimum attractive rate of return, defined as the average cost of capital for the firm.

The following simplified example illustrates the use of the net present value method to evaluate project feasibility:

NPV method example: A company buys a solvent recovery system.

- The total capital outlay for the system is \$7,500.
- The total ongoing average annual operating costs will be \$500 per year.
- The system will last for 5 years, then be discarded as scrap.
- The total estimated average annual savings will be \$2,800 per year in avoided waste disposal and reduced raw material costs.
- The company's MARR is 10 percent (or 0.10).

The net present value of the proposed project is then calculated as:

Year	Savings (t)	Costs (t)	Savings minus Costs(t)	$\frac{\text{Savings-Costs}(t)}{(1+\text{MARR})^t}$
0	\$ 0	\$7500	\$(7500)	\$ (7500)
1	2800	500	2300	2090
2	2800	500	2300	1900
3	2800	500	2300	1730
4	2800	500	2300	1570
5	2800	500	2300	1430

Total project NPV = \$1220

Therefore, the total profit from this project, accounting for inflation, would be \$1,220. The initial cost is felt immediately and is not affected by discounting. Each following year the profits must be discounted.

The numbers in the last column are calculated by the formula given at the beginning of this section. For example, in the fourth year, the year's savings minus the year's costs are divided by one plus the MARR raised to the fourth power, or

$$\frac{\text{Savings- Costs (year 4)}}{(1+\text{MARR})^4} = \frac{2300}{(1.1)^4} = 1570$$

The total NPV for years 0 through 5 are added together, resulting in a total project NPV of \$1,220. Any other project's NPV would be calculated in the same way, and the result compared to the \$1,220. A larger NPV would imply greater profitability. Always implicit in this comparison is the "do nothing" alternative. If all NPV's are less than zero, the least negative is the best, but is still not economically profitable. In that situation, if profits were the only consideration, then the best alternative would be to "do nothing."

6.8 Evaluate Progress and Success of Waste Minimization Efforts

To plan future waste minimization efforts, companies must establish a means of documenting and evaluating current and past waste minimization programs. Such an analysis should consider:

- *how waste minimization efforts have affected:*
 - composition of wastes;
 - amount of waste;
 - cost of waste management;
 - production capacity and product quality;
 - production costs including raw materials;
 - utilities and maintenance costs;
 - environmental compliance;
 - health and safety exposure of workers and community;
 - environmental, health, and safety liability; and
- the program's actual costs and savings compared with initial program estimates.

In order to perform such an analysis, the following information should be collected:

- composition, amounts, and handling of all waste streams before and after the initiation of the waste minimization effort;
- waste minimization costs and savings, including unexpected costs, inconveniences, and unforeseen benefits; and

- initial technical and economic analyses to compare with actual performance of the program.

6.9 Conclusions

The waste audit is a critically important first step toward waste minimization. Performing a thorough waste audit will result in the selection of economically feasible waste reduction options. To perform such an audit will require a good working understanding of the waste minimization approaches and practices discussed throughout this manual. However, in order to gain the benefits of waste minimization, the best recommendations of your program must be implemented.

In addition, it is important to charge all costs associated with waste management to the production processes which are affected. Although this step may seem obvious, many companies treat their waste management costs as separate budget items. By charging waste costs directly to the processes which generate them, companies can determine where waste can be reduced in a cost effective manner. Previous decisions might be reconsidered once it is realized that the cost of managing that waste directly influences the cost of production.

Finally, the waste audit process should be ongoing and repeated periodically. Production processes change. The costs of waste management increase every year. New technologies and waste minimization practices are developing rapidly. Repeated waste audits will identify new waste reduction options previously missed or considered too costly. Waste minimization should become an ongoing part of doing business.

7.0 General Waste Minimization Practices

7.0 General Waste Minimization Practices

This chapter reviews some general routines of good operation and some specific waste minimization practices for certain processes commonly used by many industries: metal parts cleaning, process equipment cleaning, and paint application.

7.1 Good Operating Practices

7.1.1 Introduction

A procedural or policy change in a plant or facility can be a good first step in a waste minimization program. The objective of good operating practice is to reduce accidental and material losses while maintaining or increasing productivity. Good practice can range from a change in management approach to modifications in waste handling procedures. Proper procedures and policies on waste minimization must be a part of the overall operating plan.

Good operating practice for waste minimization is defined as a procedure or institutional policy within a company or organization which results in reduction of hazardous waste generation. Good operating practice relates primarily to the human aspect of production (organizational structure, housekeeping improvements, initiatives, operations planning, and control), as opposed to changes in technology or materials.

Some areas which might easily lend themselves to changes in operating practices are:

Material handling improvements. Change material handling procedures to reduce the amount of waste.

Management initiatives. Revise operational supervisory structure (or schedules) or any managerial procedures and incentives in order to reduce waste.

Employee training. Increase employee awareness of operating practices that reduce waste generation.

Scheduling improvements. Develop tighter, more accurate scheduling and plant area communications to reduce waste and coordinate handling.

Spill and leak prevention. Change existing procedures to reduce waste resulting from cleanup of spills or leaks.

Preventive maintenance. Develop maintenance procedures designed to reduce equipment breakdown, inefficiency, or process fluid leakage.

Corrective maintenance. Make corrective efforts, such as resetting control valves or adjusting process temperatures, to increase efficiency and prevent raw material loss through waste streams.

Material/waste tracking or inventory control. Improve the tracking of a material's location, quality, age, and use; and altering purchased lot sizes to result in less waste.

Communication documentation. Develop procedural guidelines or material information which results in less waste.

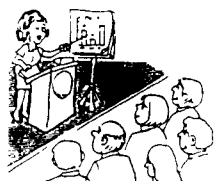
Waste stream segregation. Take measures to isolate waste streams according to (1) toxicity, (2) type of contaminant, and/or (3) physical form, which reduces the amount of waste.

The above elements of good operating procedures are good housekeeping practices that can be implemented in one form or another by most businesses. They can result in tighter management of an operation, more efficiency, and higher productivity.

7.1.2 Good Operating Practices for Waste Minimization

Management Programs

Management initiative programs have arisen as an answer to higher disposal costs and environmental concerns. Several approaches, such as waste audits and safety training courses, have already been discussed in this manual.



A strong management commitment is necessary to make these programs work, and they must be implemented from the top down. Starting with a waste audit and identifying the areas in which improvement is needed.

- The 3M Corporation "Pollution Prevention Pays" Program has eliminated the generation of approximately 103,000 tons of sludge and solid waste annually for the last 11 years. Cumulative savings are estimated at \$248 million.

Programs less complex than 3M's, such as the following basic pollution awareness program, are also effective.

- Borden Chemical Company of Fremont, California, implemented a program which consisted of process reviews by management and training programs for employees. These steps resulted in a 93 percent reduction in the organics entering the company's water treatment system. Often, employee input will be encouraged by creating an incentive program to reward waste minimization ideas which are implemented.

Procedural Measures

Prepare operating manuals. Documentation of each process which generates hazardous waste ensures that all jobs are well defined and uncertainty is reduced. A detailed manual or set of operating instructions can increase safety and efficiency. Such a manual should include:

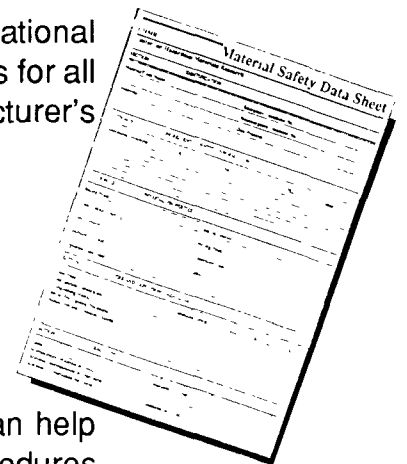
- detailed description of normal operating procedures,
- listing of process operating conditions and controls,
- listing of effluent and emission discharge levels,
- description of the overall process and where individual jobs fit in,

- identification of safety hazards and how to deal with them, and
- an outline of emergency procedures.

Procedural guidelines can be helpful in reducing waste generation during maintenance or emergency shutdowns. Written operating procedures and guidelines also reduce the likelihood of producing unacceptable products which must be discarded.

Keep Material Safety Data Sheets (MSDSs). The Occupational Safety and Health Administration (OSHA) requires MSDSs for all hazardous materials. These sheets contain the manufacturer's information regarding:

- chemical, physical, and toxicological properties of the substance; and
- proper handling and storage procedures.



Although introduced as a safety measure, the MSDSs can help reduce waste generation. For example, following the procedures on the data sheets can reduce the probability of accidental contact between two hazardous materials which may contaminate both. In the event of a spill, these data sheets can be referenced to determine the best method for cleanup. More specifically, some helpful information that can be gained from the MSDS includes:

- boiling point
- flash point
- vapor pressure
- specific gravity

An important piece of information is the boiling point of a substance. You can use the boiling point temperature given on the MSDS to avoid the evaporation of solvents such as paint thinners and degreasers. When a solvent evaporates, its vapors are lost into the air. Losing a solvent through evaporation costs just as much as using the solvent. You can often tell if a solvent is evaporating by the smell of vapors described on the MSDS. These

vapors are just another form of the solvent—but a form that is being wasted into the air. Also, these vapors often pose a fire hazard and expose workers directly to the chemical.

Solvents with low boiling points will evaporate more easily than solvents with high boiling points. Therefore, solvents with low boiling points should be kept:

- in a cool storage area,
- away from open flames,
- away from sunlight or artificial light, and
- with the lid tightly closed.

By employing these simple precautions, you can save money by not wasting your solvent through evaporation.

The flash point temperature is another useful piece of information. The flash point is the temperature at which vapors of a substance will burst into flame, or “flash” when exposed to an open flame. When you know the flash point of a substance, you can provide proper storage facilities and designate places where it is used as **no smoking** areas.

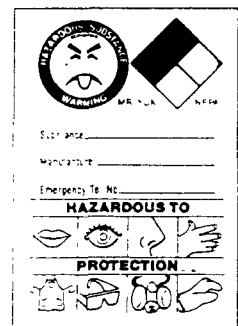
By familiarizing yourself with the flash point, you can provide a safer working environment by lowering the risk of accidental fires. This is not only good safety, but it can also lower insurance costs.

In the case of fires, knowing the specific gravity of a substance can help in choosing the proper fire extinguisher. The specific gravity is the measure of the density of a material relative to water. The specific gravity of water is 1. Thus, if a liquid has a specific gravity less than 1, that substance is “lighter than water.” Therefore, if such a liquid were burning, any water applied to the fire would sink below the flames, allowing the fire to continue. In fact, water can often spread fires this way — as in the case of burning hydrocarbons (e.g., gasoline). An extinguishing agent with a specific gravity less than 1, such as carbon dioxide, would not sink and would consequently smother the flames.

Knowing proper firefighting procedures can save money in insurance costs and materials which would not have been lost had the proper extinguisher been used.

- Consolidated Diesel of Whitakers, North Carolina, uses material safety data sheets to screen all materials entering their plant. Before the material is requisitioned, medical and hazardous materials experts are required to approve it, ensuring that the hazardous characteristics of the substance have been researched and evaluated prior to its use. This reduces hazardous waste generation by preventing the use of some materials which require regulated disposal.

Labeling. Another form of documentation becoming popular is labeling. Labels are clearly marked with information on contents, storage, handling, spill procedures, and first aid for exposure. Bar coded labels can link containers and materials to a computer through all stages of container life. This improves the accuracy of material tracking and inventory accounting. In addition, bar coded labels allow material monitoring during use and prevent lost or outdated materials at the plant site.



Material handling and storage. Proper material handling and storage is an easy and economic procedure for the prevention of waste generation. Losses from improperly handled materials can be minimized without incurring large capital costs. Often a change in procedure or organization is all that is necessary to realize the reduction. The proper storage of hazardous materials includes:

- spacing rows of drums to allow for a visual inspection of each container for corrosion and leaks;
- stacking containers no higher than recommended by the manufacturer and in such a way as to minimize the chance of tipping, tearing, puncturing, or breaking;
- refraining from stacking equipment against containers;
- maintaining distance between different types of chemicals to prevent cross-contamination and reactions;

- providing adequate lighting in all areas where hazardous substances are stored;
- insulating electrical circuitry and checking it frequently for corrosion and potential sparking;
- keeping aisles clear of obstructions;
- maintaining a clear, even surface in areas traversed by personnel and equipment;
- raising drums off the storage area floor to prevent corrosion through concrete "sweating"; and
- curbing or diking around process storage tanks and waste storage areas to contain leakage and prevent contamination.

The use of larger containers for chemical storage should be considered. Alternatives to 55-gallon drums are polyethylene containers enclosed in rigid wire mesh. These can be constructed to hold up to six times the capacity of a 55-gallon drum, are portable, reusable, and can be outfitted for top or bottom discharge, cleaning access, and locking.

Loss Prevention Practices

Loss prevention practices reduce the probability of a product spilling. A long term, slow release spill is often difficult and time consuming to find, and may be very costly in terms of product lost and cleanup costs. Besides the economic concerns, spills are a health and environmental hazard. Studies to implement preventive and corrective maintenance, emergency response, and spill prevention programs should be undertaken and the findings incorporated into the operating procedures for the plant.

The probability of a spill can be decreased by:

- conducting hazard assessment studies during the design and operation phases;
- using properly designed storage tanks and process vessels only for their intended purposes;
- equipping containers with overflow alarms;
- testing the alarms periodically;
- maintaining the physical integrity of the containers over time;
- setting up administrative controls for all loading, unloading, and transfer operations;
- installing sufficient secondary containment facilities;
- having a good valve layout;
- having interlock devices to stop flow to leaking sections;
- disallowing operators to bypass the interlock or to alter the set points;
- isolating equipment or process lines that are not in service;
- documenting the spillages and related dollar values; and
- installing leak detection systems for storage tanks.

The design phase considerations of a maintenance program include larger access doors, wider internal catwalks, accessible components, hopper access doors, and duct cleanout and inspection hatches. Also, keep maintenance costs in mind when ordering new equipment to reduce corrective maintenance costs in the future. Preventive maintenance can save three to four times its cost by reducing equipment breakdown and malfunction.

Waste Stream Segregation

Hazardous waste sent off site for disposal is often a mixture of two different wastes. Segregating materials and wastes can decrease the volume of waste to be handled and disposed. For example, liquid wastes can be isolated from non-hazardous materials, and hazardous waste can be isolated according to the major contaminants. This results in less waste and easier disposal. Also, recyclers and waste exchanges are more receptive to wastes that are not contaminated with other substances. Waste stream segregation is an easy and effective method for minimizing waste.

- ICI America, Inc. separates their hazardous and non-hazardous wastes and chlorinated and nonchlorinated solvents. In conjunction with a policy for returning unused chemicals to the distribution center, these measures saved the company \$37,000 in 1984. They were able to reduce the volume of their hazardous waste from 100 drums in 1981 to 60 drums in 1984.
- Martin Marietta Aluminum of Torrance, California, reduced its cleaning and waste-hauling costs by \$50,000 per year by filtering aluminum particles from soluble oils. The new waste could be disposed of at a municipal, rather than a hazardous waste, disposal site. Additionally, the oil removed by the filter is reused, lowering oil purchasing and transporting costs.
- Daly-Herring Company of Kingston, North Carolina, began segregating their waste stream by altering their dust collection equipment. Waste streams containing different organic chemicals are collected separately and each is recycled to the process from which it originated. The firm has eliminated over \$9,000 in annual disposal costs, and the recovered material is worth an estimated \$2,000 per year.

7.2 Metal Parts Cleaning

Metal parts cleaning is a common concern of many industries. This section details some general routines of good operation and some specific waste minimization practices for metal parts cleaning.

7.2.1 Waste Description

The specific wastes associated with metal parts cleaning, along with their sources, are listed in Section 7.2.3. The waste produced is generally not dependent of the type of method; rather, it depends on the cleaning material used and the type of soil removed.

7.2.2 Good Operating Practices for Waste Minimization

Good operating practices for waste minimization are defined as procedural or institutional policies which result in a reduction of waste, and may include:

- personnel practices,
- procedural measures,
- loss prevention practices, and
- waste stream segregation.

A detailed discussion of good operating practices is provided in Section 7.1.

7.2.3 Specific Waste Minimization Practices

Spent abrasives, solvents, acid and alkaline cleaning solutions, and rinse water are the most common wastes from metal parts cleaning. All but the solvent wastes are extremely diluted with water. The most common waste minimization practices which can be applied to these wastes include:

<u>Waste stream</u>	<u>Minimization practice</u>
Abrasives	Use water-based binders Use liquid spray compositions Control the water level in equipment
Solvent cleaners	See Section 9.1

Acid and alkaline	Remove sludge frequently or cleaners continuously. Install lids on tanks. Implement better operating practices.
Rinse waters	Operate rack system properly. Operate barrel system properly. Operate rinse tanks properly. Install water sprays on rinse tanks. Install fog nozzles on heated tanks. Use chemical rinsing. Use deionized water for rinsing.

Each of these waste minimization practices, (except those for solvent cleaners which are discussed in Section 9.1) are briefly described in the following sections.

Abrasive Wastes

Abrasive wastes can be reduced by using waste minimization practices such as:

Using water-based binders. Water-based or greaseless binders should be used for polishing and buffing. These leave the wheel clean and dry, while oil-based binders often cause it to burn, necessitating an additional cleaning using an alkaline soak. Also, greaseless compositions adhere to the wheel surface better to increase wheel life.

Using liquid spray compositions. Most abrasives are applied to the wheel in bar form, with the bar held against the wheel during application. This often leads to the application of an incorrect amount of abrasive. An automatic liquid spray system ensures that the optimum amount of abrasive is always maintained on the wheel. This reduces or eliminates:

- wheel wear due to compound deficiency,
- compound waste due to over-application, and
- the requirement for subsequent cleaning (spray compounds are usually water-based).

Controlling water level in the equipment. Ensuring that enough water is used during the cleaning process decreases the rate of attrition of the abrasive and decreases replacement frequency. Similarly, if not enough water is used, items exiting the equipment will be dirty.

Alkaline and Acid Cleaning Solutions

Methods for minimizing waste from alkaline and acid cleaners include:

- removing sludge frequently, and
- improving operating practices.
- Waterloo Industries, Inc. of Waterloo, Iowa, installed a separator unit designed to continuously remove sludge and particulate matter from the alkaline bath. Since installation, replacement chemical costs have decreased by 20 percent, the time interval between dumping and total cleanout of the system has increased from 4 to 13 weeks, and maintenance has been reduced—a pump is the only moving part in the cleaning process. This system can also be applied to solvent cleaning operations.

Rinse Water

Conserving water is an effective way to cut operating and capital costs. Reductions can be realized in the amount of water initially needed and in the amount of cleaning solution dragout. A detailed description of rinse water minimization practices is provided in Section 8.3.4.

7.3 Paint Application

Paint application is a common concern of many industries. This section discusses some general routines of good operation, and some specific waste minimization practices for paint application.

7.3.1 Waste Description

The specific wastes associated with paint application technologies are listed in Section 7.3.3. The industry is extremely diverse, so the quantity of each waste produced varies greatly from operation to operation.

7.3.2 Good Operating Practices for Waste Minimization

Good operating practices for waste minimization start with procedural or institutional policies which result in a reduction of waste, and may include:

- personnel practices,
- procedural measures,
- loss prevention practices, and
- waste stream segregation.

Good operating practice applies for every waste stream and is one of the first methods which should be implemented in a waste minimization program. A detailed discussion of good operating practices is provided in Section 7.1.

7.3.3 Specific Waste Minimization Practices

Wastes from parts cleaning, paint application, paint stripping, and equipment cleaning are the most common hazardous wastes from painting operations. The most common waste minimization practices which can be applied to these wastes are:

<i>Waste stream</i>	<i>Minimization practice</i>
Parts cleaning	See Section 7.2, <i>Wastes</i>
Paint application	Use equipment with low overspray. Implement better operating practices.
Paint stripping	Implement proper painting techniques. Implement proper cleaning techniques. Use mechanical paint stripping system. Use non-phenolic/non-acid stripper. Implement better operating practices.
Equipment cleaning wastes	Use equipment with low over-spray. Implement better operating practices.

Refer to Section 7.2 for a discussion of parts cleaning wastes, since methods are specific to the process involved. A discussion of each of the other wastes follows.

Most of the procedures outlined below fall under the category of housekeeping procedures. Proper equipment operation, personnel training, and improved scheduling require minimal capital outlays and no additional equipment, only a company-wide commitment to waste minimization.

Paint Application Wastes

Paint application wastes can be reduced by using waste minimization practices such as:

Use equipment with low overspray. Most paint application wastes are caused by either overspray or the paint not reaching the target. The amount of overspray experienced is a function of the design and operation of the system used. The efficiency of several systems in avoiding overspray is listed below.

<i>System</i>	<i>Efficiency(%)</i>
Conventional air-atomized spray	30-60
Conventional pressure-atomized spray	65-70
Electrostatic air-atomized spray	65-85
Electrostatic centrifugal-atomized spray	85-95
Roller/flow coating machines	90-98
Electrocoating systems	90-99

Implement better operating practices. These play a large role here, since spray systems are often manually operated. Keeping the air pressure low and the spray gun perpendicular to the surface add several degrees of accuracy to the system by avoiding overspray. Proper training of operators and all who work with the system promotes waste minimization.

The likelihood of producing a bad finish is reduced when application equipment is operating properly. Therefore, preventive maintenance is extremely important. All parts should be cleaned, and if necessary, lubricated regularly.

Paint Stripping Wastes

Paint stripping wastes are generated when a bad finish has been produced and the coating must be removed to be reapplied. Many paint stripping wastes are generated due to failure of part of the system. Waste minimization methods are aimed at reducing the number of poor quality products produced. Following are some of these methods.

Inspect parts before painting. This will avoid painting potential rejects. Be sure surfaces are clean, dry, and rust free.

Implement proper paint application techniques. This will avoid unnecessary overspray.

Implement proper cleaning techniques. Efficiency is higher when equipment is cleaned regularly.

Use mechanical (cryogenic) paint stripping methods. Facilities handling items made of soft metals which are inappropriate for sandblasting or glass beadblasting have had great success with plastic bead blasting. High pressure air is used to propel the plastic beads against the paint surface, where they dislodge the paint. The beads and paint are then recovered and separated, with the beads being re-fed into the pressure gun. The dry waste, composed of the paint and any beads broken down due to attrition, is then removed for proper disposal. The U.S. Department of Defense estimates that if all DOD facilities would install this system the cost would be \$13 million and the annual savings would be \$100 million. The waste produced would drop from 7 million gallons of paint stripper waste and 100 million gallons of wash water to 500,000 pounds of dry waste annually.

Use non-phenolic strippers. These were developed in response to the need to reduce toxicity associated with phenol and acid additives.

Locate solvent soak tanks away from paint curing ovens. This will minimize the adverse effect of solvent on a painted surface or item.

Equipment Cleaning Wastes

Equipment cleaning wastes can be reduced by using waste minimization practices such as:

Use equipment with low overspray. By increasing the accuracy of the paint application system, less spray will fall on the machinery.

Implement better operating practices. The amount of equipment cleaning waste generated is directly related to the number of times color or type changes are made. For this reason, scheduling improvements have perhaps the largest effect on the volume of equipment cleaning waste produced. By making large batches of similarly produced items, instead of small batches of custom items, the time between cleanings can be increased. Additionally, since

the need for cleaning is based on the paint application process, all measures described during the discussion of paint application wastes apply here as well.

7.4 Process Equipment Cleaning

Process equipment cleaning is a common concern of many industries. This section details some general routines of good operation and some specific waste minimization practices for process equipment cleaning.

7.4.1 Waste Description

Wastes generated during the periodic cleaning of internal surfaces of process equipment differ widely in composition and quantity depending upon:

- type of deposit being cleaned,
- type of cleaning fluid,
- type of cleaning method,
- size of equipment being cleaned, and
- cleaning frequency.

7.4.2 Specific Waste Minimization Practices

There are two distinct approaches which can be taken to effect a waste minimization program in process equipment cleaning. These are:

- reducing the frequency of the cleanups, and
- reducing the quantity and/or toxicity of wastes.

Here are the most common waste minimization practices.

<i>Approach</i>	<i>Minimization practice</i>
Reduce cleaning frequency	Use proper plant and equipment design. Record cleaning costs as a separate item. Convert batch to continuous process. Maximize dedication of equipment. Avoid unnecessary cleaning. Inhibit fouling deposit formation.
Reduce quantity and/or toxicity of cleanup wastes	Minimize residues. Minimize the amount of cleaning of solution. Carefully choose the cleaning medium and plan cleaning solution reuse.

Reducing Cleanup Frequency

Reducing or eliminating the need for cleanup begins by identifying the causes of undesirable deposit formation, followed by identifying and implementing the following suggested means to prevent or limit it.

Use proper plant and equipment design. The plant should be designed to minimize the equipment surface exposed to the process fluid. Undrainable pockets should be kept to a minimum.

Record the cleaning costs as a separate item. If cleanup costs are not separated from other maintenance costs, proper analysis of these costs and the relative worth of different alternatives cannot be determined.

Convert from batch to continuous process. Continuous processes have many advantages over batch processes. These include:

- lower labor requirements,
- ease of automation and control,
- elimination of the need for manual material transfer operations which tend to have a high probability of a spill, and
- less cleanup waste since continuous processes are cleaned at regular intervals while batch processes must be cleaned before every batch of different materials.

Maximize dedication of process equipment. Producing large quantities of a product at one time through proper scheduling can decrease the cleaning frequency and the down time for a piece of equipment. In many industries, manufacturers produce a year's supply at one time.

Avoid unnecessary cleanup. If a piece of equipment is dedicated, it should not stay on the same cleaning schedule as undedicated equipment.

Inhibit fouling deposit formation. Fouling rates are usually attributed to:

- crystallization,
- sedimentation,
- chemical reactions and polymerization,
- high temperature cooking,
- corrosion, or
- bacterial growth.

Fouling most closely associated with heat transfer will reduce the overall efficiency of equipment while increasing the need for cleaning. Fouling can be most easily inhibited by:

-
- the use of smooth heat transfer surfaces,
 - lower film temperatures or increased turbulence,
 - control of steam composition,
 - careful choice of heat exchanger type,
 - prior removal of deposit precursors,
 - the application of less corrosive and more thermally stable heat transfer fluids, and
 - better design or control of fired heaters.

In closed cooling water systems, the fouling rate can be inhibited through proper water treatment, by using a lower number of concentration cycles in the cooling tower, and by using make-up water with low total solids content.

Reducing the Quantity and Toxicity of Cleanup Waste

When equipment must be cleaned, the cleanup should be performed efficiently with the minimum production of additional hazardous wastes.

Minimize residue. Since the ultimate amount of sludge produced depends on the residue left after the process, minimizing the residue will decrease the amount of waste produced. This can be done by:

- providing adequate batch drainage time,
- using non-stick surfaces,
- using mechanical or manual wall wipers,
- using cylindrical tanks with height-to-diameter ratios close to one (1) to minimize wetted surface,

- rotating agitator after batch dump, and
- maximizing batch size.

Minimize the amount of cleaning solution. Mechanical cleaning should be used over chemical cleaning whenever possible. When chemical cleaning solutions are used, the four parameters to control are time, temperature, concentration, and turbulence. Less cleaning solution is necessary as these parameters are increased. Cleaning solution used can be minimized by the use of:

- high pressure spray nozzles,
- “flow-over” techniques,
- on-stream mechanical cleaning,
- clean-in-place (CIP) system with staged rinses, and
- additives such as defoamers, suspending agents, emulsifiers, and wetting agents.

The elimination of cleaning solutions altogether is possible by cleaning equipment with mechanical devices. One such device is a system which uses steel brushes fitted inside heat exchanger tubes which are propelled by process fluid and reversed periodically by a flow diverter.

Choose cleaning medium and plan cleaning solution reuse. From a waste minimization standpoint, the preferred order to select a cleaning medium is (1) process fluid rather than water, and (2) water rather than chemical solutions. By employing a simple filtration to remove the solids, process-based cleaning solutions can be reused as part of the formulation or process make-up stream. Also, water and water-based cleaners are usually non-toxic or at least less toxic than most chemical solutions.

8.0 **INDUSTRY-SPECIFIC WASTE MINIMIZATION PRACTICES**

This chapter provides detailed information and examples of the waste minimization practices which can be applied to specific industrial categories. It illustrates how companies in 11 major industries can economically minimize their wastes. Each of the following industries is examined individually so that you can refer to the sections which best apply to your business.

Section 8.1	Vehicle Maintenance
Section 8.2	Fabricated Metal Manufacturing and Metal Finishing
Section 8.3	Electroplating
Section 8.4	Printed Circuit Board Manufacturing
Section 8.5	Dry Cleaning and Laundries
Section 8.6	Printing
Section 8.7	Photography
Section 8.8	Construction
Section 8.9	Educational and Vocational Shops
Section 8.10	Analytical and Clinical Laboratories
Section 8.11	Pesticides

The purpose of this chapter is to provide specific waste minimization practices which are normally applied only to manufacturing processes unique to the industry category described. Many specific waste minimization practices can be applied to activities (such as metal parts cleaning) which are common to several industries. Such minimization practices are described in detail in Chapter 7. In addition, Chapter 7 provides information on good operating practices which can also be applied to almost every waste stream and in every industry.

Many industries also produce common waste types, such as solvents, metal bearing sludges, and corrosive wastes. Useful waste minimization practices and recycle/recovery options for such wastes which are common to several industries are fully described in Chapter 9.

8.1 Vehicle Maintenance

8.1.1 Industry Description

The vehicle maintenance industry includes a broad range of businesses. Typically included in this industry are businesses that repair or maintain:

- cars,
- vans,
- trucks,
- heavy equipment, and/or
- farm equipment.

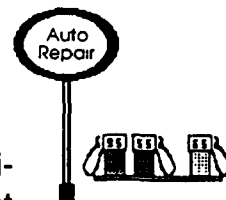
These businesses are generally involved in these maintenance or repair activities:

- removing oil or grease;
- removing rust, dirt, or paint;
- repairing or rebuilding engines;
- refinishing or restoring vehicles;
- painting vehicle bodies; and/or
- replacing lead acid batteries.

8.1.2 Sources of Waste

Almost every aspect of vehicle maintenance operations involves some form of hazardous waste. Some of the most common include:

- rust removers — contain concentrated aqueous solutions;
- carburetor cleaners — contain flammable or combustible liquids;
- used rags — contain flammable or combustible solvents;
- paints — contain flammable or combustible thinners or reducers; and
- auto and truck batteries — contain strong acids or alkalies and lead.



Typical processes which generate hazardous wastes and their associated wastes include:

<i>Process/operation</i>	<i>Waste generated</i>
Oil/grease removal	Ignitable waste, spent solvents, combustible solids, waste acid/alkaline solutions
Engine parts/ equipment cleaning	Ignitable waste, spent solvents, combustible solids, waste acid/alkaline solutions
Rust removal	Waste acids, waste alkalies
Paint preparation	Spent solvents, ignitable wastes, ignitable paint waste, paint wastes with heavy metals
Painting	Ignitable paint wastes, spent solvents, paint wastes with heavy metals, ignitable wastes
Spray booth, spray guns, brush cleaning	Ignitable paint wastes, heavy metal paint wastes, spent solvents
Paint removal	Ignitable paint wastes, heavy metal paint wastes, spent solvents
Used lead acid	Used lead acid batteries, strong acid/alkaline solutions

8.1.3 Good Operating Practices for Waste Minimization

Good operating practices are defined as being procedural or institutional policies which result in a reduction of waste and may include:

- personnel practices,
- procedural measures,
- loss prevention practices, and
- waste stream segregation.

Good operating practice applies for every waste stream and is one of the first methods which should be investigated in a waste minimization program. A detailed discussion of good operating practices is provided in Section 7.1.

8.1.4 Specific Waste Minimization Practices

The four main waste streams from the vehicle maintenance industry include:

- work cleaning wastes,
- solvents,
- paint wastes, and
- oils.

All of the waste minimization practices which can be used by the vehicle maintenance industry are similar to those which can be used in many other industries and include:

<i>Common waste stream</i>	<i>Primary process waste description</i>	<i>Minimization practice</i>
Work cleaning wastes	Spent alkaline cleaning solution, spent acid cleaning solution	See Section 7.2
Paint wastes	Ignitable paint wastes, paint wastes with heavy metals	See Section 7.3
Solvents	Spent solvents from oil/grease removal, paint preparation, and paint removal	See Section 9.1
Oils	Waste oils from oil changes	See Section 9.6

A detailed discussion of the waste minimization practices for each of these waste streams is provided in the other sections of this manual.

Work Cleaning Wastes

Work cleaning wastes from vehicle maintenance shops are similar to the cleaning wastes produced in many other manufacturing processes. A detailed discussion of waste minimization practices for cleaning wastes is provided in Section 7.2, *Metal Parts Cleaning*.

Paint Wastes

Paint wastes generated by vehicle maintenance shops are similar to those generated in other industries. A detailed discussion of waste minimization practices for paint wastes is described in Section 7.3, *Paint Application*.

Spent Solvents

Spent solvents generated in vehicle maintenance shops are similar to those found in other industries. A detailed description of the minimization of spent solvent wastes is found in Section 9.1, *Solvents*.

Oils

There are several oil loss minimization practices and oil recycling technologies that would be useful for minimizing waste oil. A detailed discussion of waste minimization practices for waste oil is provided in Section 9.6, *Oils*.

8.2 Fabricated Metal Manufacturing and Finishing

8.2.1 Industry Process Description

Fabricated metal manufacturers and metal finishers utilize numerous and varied industrial processes during the production of fabricated metal products. Because of the large amount of waste minimization information applicable to these processes, as well as the fact that metal finishing operations are often performed independently from the manufacturing process itself, this chapter will be divided into industry-specific subsections—distinguishing metal manufacturing from metal finishing activities.

Fabricated Metal Manufacturing

Fabricated metal manufacturers include those producing electrical and non-electrical machinery, furniture, transportation equipment, and other metal equipment and supplies for industrial, commercial, and household use.

The processes used to manufacture metal products include, but are not limited to:

- cutting
- machining
- grinding
- die sinking
- painting/enameling
- welding
- buffing/polishing
- cleaning/degreasing

Metal Finishing

The metal finishing industry consists of those firms involved in the physical or chemical modification of metal surfaces to impart particular characteristics to the material, e.g., reducing surface reactivity; increasing corrosion resistance, strength, or conductance; or producing desired textures or colors.

The many different processes utilized by the industry are dictated by the specifications of the product manufacturers and include:

- heat treating
- electroplating
- electroless plating
- chemical conversion coating



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- anodizing
 - galvanizing
 - etching
 - chemical milling/hardening

Surface treatment processes are generally batch operations which include three basic steps: surface preparation/cleaning, surface treatment, and rinsing or postfinishing operations.

8.2.2 Sources of Waste

Wastes generated by both the fabricated metal manufacturing and metal finishing industries fall into eight major categories:

- spent solvents/solvent still bottoms,
- paint wastes with heavy metals,
- strong acid and alkaline wastes,
- other ignitable and reactive wastes,
- plating and stripping solutions,
- waste oils,
- heavy metal waste water sludges, and
- metal dusts, grindings, and cuttings.

Specific information relating wastes to sources (processes) is shown in Tables 8-1 and 8-2.

8.2.3 Good Operating Practices for Waste Minimization

Good operating practices are defined as procedural or institutional policies which result in a reduction of waste and may include:

- personnel practices,
- procedural measures,
- waste stream segregation, and
- loss prevention practices.

Good operating practice applies for every waste stream and is one of the first methods which should be investigated in a waste minimization program. A detailed discussion of good operating practices is provided in Section 7.1.

8.2.4 Waste Minimization Practices—Metal Manufacturing

Table 8-1 outlines the major operations/processes involved in fabricated metal manufacturing, the waste streams which result from these operations, and the waste minimization practices which are most applicable to them.

Waste minimization techniques for most of these waste streams generally fall into one of three categories: process changes, better operating practices, and material/product substitutions. Since these are discussed in detail elsewhere in this manual (primarily in Chapter 7), they will not be repeated here. However, the minimization practices suitable for metal machining and cutting wastes are fairly specific to the manufacturing equipment used in this industry and will be briefly discussed below.

Standardize oil types used on machining equipment. Use of the same type of oil for as many operations as possible (e.g., machining, turning, lathing) will facilitate reuse/recycling activities by eliminating the need for segregation of used oils which are removed from equipment.

Use dedicated lines or improve equipment scheduling to reduce waste oil generated. If different oils are required for work with different metals, the amount of waste oil generated from equipment cleanouts can be decreased by either dedicating particular equipment to use with a specific metal or adjusting the scheduling of equipment use.

Reuse or recycle cutting, cooling, and lubricating oils. There may be certain instances in which these oils can be continually collected and reused until they are completely consumed without ever being treated. For those requiring some filtration or other reclamation technique prior to reuse, segregating the oil types may decrease the amount of treatment necessary and increase the quality of the recycled product.

Table 8-1. Fabricated metal manufacturing wastes.

<i>Process origin</i>	<i>Waste stream</i>	<i>Control methodology</i>
Metal cutting/ machining	Waste oils	<ul style="list-style-type: none"> • Standardize oil types used on machining equipment. • Improve equipment scheduling/establish dedicated lines. • Reuse or recycle cutting, cooling, and lubricating oils. • Substitute lime or borax soap for lubricating oils. • Centrifuge oil/scrap metal mixtures.
	Heavy metal wastes, dust, and sludge	<ul style="list-style-type: none"> • Segregate scrap metal.
	Spent solvents	<ul style="list-style-type: none"> • <i>See Cleaning/Degreasing category below.</i>
Grinding/buffing/ polishing	Spent abrasives	<ul style="list-style-type: none"> • Use water-based or greaseless binders. • Use an automatic liquid spray system for application of abrasive onto wheel. • Ensure sufficient water use during cleaning. • <i>See Section 7.2.2.</i>
Cleaning/ degreasing	Spent alkaline/ acid parts cleaners	<ul style="list-style-type: none"> • Use deionized water to prepare solutions. • Remove sludge frequently/continuously • Install lids on tanks. • Use water sprays/fog nozzles. • Implement better operating practices. • <i>See Section 7.2.2.</i>
	Spent solvent cleaners	<ul style="list-style-type: none"> • Install lids/silhouettes on tanks. • Increase freeboard space on tanks.

Table 8-1. (continued)

<i>Process origin</i>	<i>Waste stream</i>	<i>Control methodology</i>
		<ul style="list-style-type: none"> • Install freeboard chillers on tanks. • Remove sludge from solvent tanks frequently. • Extend solvent life by pre-cleaning parts by wiping, using air blowers, or pre-dipping in cold mineral spirits dip. • Reclaim/recover solvent on- or off-site. • Substitute less hazardous solvent degreasers (e.g., petroleum solvents instead of chlorinated solvents) or alkali washes where possible. • Slow speed of parts removal from vapor zone. • Rotate parts to allow condensed solvent drop-off. • <i>See Section 9.1.</i>
Painting/ Enameling	Spent alkaline/ acid parts cleaners	<ul style="list-style-type: none"> • <i>See above.</i>
	Waste paint	<ul style="list-style-type: none"> • Use equipment with low overspray. • Implement better operating practices. • <i>See Section 7.3.2</i>
	Spent solvents/ strippers	<ul style="list-style-type: none"> • Substitute water based, high solids, or powder coatings for solvent-based ones. • Substitute bead for solvent strippers. • Implement better operating practices. • <i>See Section 7.3.2.</i>
	Solvent vapors	<ul style="list-style-type: none"> • Use solvent recovery or incineration to reduce VOC emissions from cure ovens. • <i>See Section 7.3.2.</i>

Substituting lubricating oils with lime or borax soap. It may be possible to use a hot lime bath or borax soap to replace the use of lubricating oils as drawing agents in certain types of manufacturing operations. This option would not only eliminate the waste oil produced, but would also eliminate the degreasing process which follows.

Centrifuging oil/scrap metal mixtures. If large amounts of oil/scrap metal wastes are generated from the manufacturing process, centrifuge equipment is available to extract most of the oil from the mixture for eventual recycling. Sludge extractors, or "chip wringers," separate the oil through a high speed spinning action, then collect and filter it for reuse. The cost of such units ranges from \$11,000 to \$23,000.

Segregation of scrap metal. Segregation of different metals may increase both the market and price received for scrap metal recovery.

8.2.5 Waste Minimization Practices—Metal Finishing

Some of the waste minimization options that are identified in Table 8-2 apply to the various processes used in the metal finishing industry, and are discussed in more detail elsewhere in this manual. A reference to the appropriate section is provided—either Section 8.3, *Electroplating* or Section 8.4, *Printed Circuit Board Manufacturing*. In fact, these two industries are actually parts of the fabricated metal manufacturing and finishing category.

The remaining waste minimization practices are briefly discussed below. Heat-treating wastes have been accorded their own subsection because there are several waste streams and minimization options which are unique to the heat-treating process and warrant specific mention. For purposes of this discussion, all other metal finishing activities and processes produce wastes which can be grouped into the general categories of spent bath solutions, waste rinse water, filter wastes, spills and leaks, and stripping wastes. There is a subsection provided for each.

Heat-Treating Wastes

Replace cyanide and barium salt baths with alternative treatment methods. Some case-hardening methods that use cyanide or barium can be replaced by other methods like heat treatment. The choice of an appropriate substitute method will depend on the type of steel being treated, the degree of hardness required, and the end use of the manufactured product. Some alternative treatment methods are discussed below.

- The gas phase carbonitriding process can be used with steels containing chromium, molybdenum, or aluminum. This process employs ammonia gas, which is heated to decomposition, producing nascent nitrogen. The nitrogen combines with carbon and diffuses into the metal surface. The ammonia process is not quite as flexible in application as cyaniding, however, and may not be suitable for jobs requiring the simultaneous treatment of small batches with different cycle times. It also requires a higher heating rate than cyaniding.
- Carborizing techniques may also substitute for cyaniding. Atmospheric carbon, or a carbonate/chloride carbon mixture may be used to achieve the desired hardening effect.
- A developmental ion beam processing technique may provide an effective alternative to heat-treating methods of case hardening once it becomes suitable for commercial applications. The method employs a high energy ion beam to implant ions in the surface of the material to be treated.

Use more dilute process solutions. Typical cyaniding bath solutions contain approximately 30 percent sodium cyanide, although some facilities use 45, 75, and 92 percent solutions. For those facilities, limiting cyanide content to the 30 percent range would reduce the toxicity of any spent bath solutions generated.

Recycle oil quench baths by filtration. On-site filtering of metals from quench bath oil would prolong the useful life of the baths and reduce the amount of oil which must be sent for disposal.

Replace solvent washes with alkali washes. Solvents used for oil removal from treated parts could be replaced with alkali washes which can achieve the same effect. This would eliminate the complications involved with the management of spent solvent degreasing solutions.

Extend life of alkali wash by removing oil layer. A skimmer can remove the oil layer from the wash. The material collected is then routed to an oil/water separator, where the oil is collected for eventual reclamation and the water is sent for treatment with other process waste waters.

Spent Bath Solutions

Metal/acid recovery from spent baths. There are several techniques, in various stages of development, which will accomplish the removal of metals or the recovery of acids from spent bath solutions. These methods can reduce the hazardous nature of the waste streams, thereby decreasing the amount of pretreatment required and decreasing the amount of waste treatment residues generated. Various technologies to recover metals and acids are discussed in detail in Section 9.3, *Metal Wastes* and Section 9.4, *Corrosive Wastes*.

Spray/brush items instead of immersing in process solutions. The practical use of both spray and brush methods for applying process solutions depends upon the type of operation and the shape of the object being treated. However, their use wherever possible will result in more efficient use of process solutions and result in a reduction in the amount of waste solution generated.

Use alternative treatment techniques. There are three alternative treatment techniques briefly discussed below which have various applications throughout the metal finishing industry. All of them would result in the elimination of certain process solutions, thereby reducing the amount of waste generated.

- Nickel, aluminum, and other metals have been applied to substrates using vacuum evaporation methods. An electron

Table 8-2. Metal finishing wastes.

<i>Process origin</i>	<i>Waste stream</i>	<i>Control methodology</i>
Heat-treating	Spent cyanide or barium salt solution from salt bath pot cleaning. Quenching oils and bath residues. Spent solvent degreasers. Alkali wash wastes. Quenching waste-water treatment sludges.	<ul style="list-style-type: none"> • Replace cyanide or barium salt baths with alternate treatment methods. • Use more dilute process solutions. • Recycle oil quench baths by filtration. • Replace solvents with alkali washes. • Extend useful life of alkali wash by removing oil. • <i>See Section 8.3.4.</i>
Electroplating/ anodizing/	Cleaning solutions. Spent plating solutions/sludges. Waste rinse waters. Treatment wastes.	<ul style="list-style-type: none"> • <i>See Section 8.3.4 on options for the electroplating industry.</i>
Metal finishing (electroless plating, chemical etching, chemical milling)	Spent bath solutions	<ul style="list-style-type: none"> • Extend bath life (<i>Section 8.3.4</i>). • Recover metal/acid from spent baths. • Spray/brush items instead of immerse. • Use thinner foil for printed circuit boards. (<i>Section 8.4.4</i>) • Use alternative treatment techniques. • Use less toxic process solutions. (<i>Sections 8.3.4 and 8.2.5</i>) • Use more dilute process solutions (<i>Sections 8.3.4</i>) • Use better operating practices.
	Waste rinse water	<ul style="list-style-type: none"> • Reduce dragout of solution from tank (<i>Section 8.3.4</i>) • Employ effective rinsing methods (<i>Section 8.3.4</i>) • Use immiscible rinses.

Table 8.2 (continued)

<i>Process origin</i>	<i>Waste stream</i>	<i>Control methodology</i>
		<ul style="list-style-type: none"> • Use no-rinse coatings. • Reuse and recycle spent rinse water (<i>Sections 8.3.4 and 8.2.5</i>). • Replace hexavalent chromium with trivalent (<i>Section 8.3.4</i>). • Use still rinsing technique (<i>Section 8.3.4</i>). • Reclaim metal from rinse water wastes (<i>Sections 8.3.4 and 9.3</i>). • Change rinse composition. • Minimize process water use. • Use better operating practices.
	Filter wastes	<ul style="list-style-type: none"> • Reclaim metal from solid waste (<i>Sections 8.3.4 and 9.3</i>). • Effectively dewater solids (<i>Section 8.3.4</i>).
	Spills and leaks	<ul style="list-style-type: none"> • Use better operating practices.
	Stripping wastes	<ul style="list-style-type: none"> • Use non-chrome etchants. • Reduce generation of off-spec coating.

beam evaporates metals at low pressures, producing a metal vapor which condenses onto the product to be coated. However, coating costs are high and thickness of the coating applied is difficult to control.

- Ion-plating methods can be substituted for electroplating of chromium and cadmium onto steel. Depositing metals are evaporated by high energy ion bombardment and condense onto the steel surface. Although not common in the U.S., this method is used extensively in Japan.

- Chemical vapor deposition is another alternative method of coating application. Employing the same vaporizing/condensation principle as the two previous methods, this technique would be effective for most coating operations, although its use is currently limited to the semiconductor industry.

Use of less-toxic solutions. One example of this method is the substitution of polysiloxanes for water-soluble metal/cyanide compounds in electroless copper plating. Polysiloxanes have been found to function as effective stress relievers, and result in less hazardous spent bath solutions. An example of these compounds is SF-96, a silicon fluid manufactured by General Electric.

Use of better operating practices. The three methods mentioned below minimize waste bath solutions generated by prolonging or extending the life of the process solutions used.

- Frequent monitoring of bath solution activity and regular replenishment of reagents or stabilizers can increase process solution life. Electroless copper plating baths can be effectively stabilized with methanol or 2-mercaptobenzothiozole.
- Good control of solution temperature can also result in an increase in bath life. This can be achieved by periodic cleaning of cooling/heating coils, or switching to the use of jacketed tanks instead of coils.
- Limiting the amount of time process solutions are in storage prior to use will reduce the possibility that these solutions will degenerate, thereby producing contaminants which shorten bath life.

Waste Rinse Water

Use of immiscible rinses. For rinsing, the use of solvents immiscible in water would facilitate the recovery and reuse of the rinses. This would eliminate the generation of waste rinse waters requiring treatment. However, there are disadvantages to this option, such as the potential for increased air emissions and the need to dispose of solvent residues from on-site reclamation operations.

Use of no-rinse coatings. Chromate conversion coatings requiring no subsequent rinsing have been developed for applications to steel, galvanized steel, and aluminum. The method has been used primarily for coil coating, but its application is not limited to that industry. Disadvantages include the need for very efficient control of the process due to the high speed of the operation, the high cost and difficulties involved in conversion of existing facilities to this type of process, and the lack of FDA approval for the use of no-rinse coatings in food container or equipment applications.

Reuse and recycling of spent rinse water. The following suggestions may substantially reduce the amount of waste process waters sent for pretreatment, and correspondingly reduce the amount of treatment residues generated.

- In the chromate process, the first rinse, which is highest in chromic acid, can be recycled to the chromating tank. The last rinse can be routed through an ion-exchange resin to remove contaminants before reusing the water in the rinsing process. Evaporators can achieve the same results. Concentrate from the evaporator can be recycled to the coating bath, while the vapor can be condensed and returned to the rinsing solutions.
- Techniques to recover metals from rinse water include:
 - evaporation,
 - reverse osmosis,
 - ion exchange,
 - electrolytic metal recovery, and
 - electrodialysis.

Many companies have installed such systems to recover metals from waste rinse water and have found the investment has paid for itself in 1 to 5 years. Section 9.3.2 provides a detailed description of these metal recovery techniques and provides some examples of where they have been successful.

Change rinse composition. If possible, the composition of the rinse solutions should be altered so that they are less hazardous.

For example, the final rinse after a zinc-based phosphating bath is usually a dilute chromic acid solution. The toxicity and environmental controls associated with the presence of chromium in a solution have prompted some companies to develop chrome-free rinses.

Minimize process water use. Reusing waste rinse waters in other operations would reduce the overall amount of waste water generated. For example, fume scrubber water, cooling water, or steam condensate may be used for this purpose if production standards or economics allow.

Better operating practices. The segregation of waste rinse waters may facilitate reuse or recycling of them, and may ease any metal reclamation efforts being employed.

Filter Wastes

There are two main sources of filter wastes generated from metal finishing activities. Solid wastes in the form of metallic salts are deposited onto solution filters, and metallic sludges are generated during waste-water treatment operations such as pH adjustment and clarification. Filter wastes are sometimes drained of water prior to disposal or reclamation. Various metal recovery methods, as well as sludge dewatering techniques, are discussed in Sections 8.3.4 and 9.3.

Spills and Leaks

Better operating practices. Discharges from tank overflows, failure of valve closures, and leaking gaskets and piping can be controlled or eliminated by the installation of splash guards, drip boards, float valves, alarm systems, or liquid level controllers. The institution of certain good housekeeping practices can serve the same purpose. Such measures include the periodic inspection of process equipment and piping, and the periodic relining of tanks. In addition, it is important to emphasize the subject of controlling waste generation when employees undergo training.

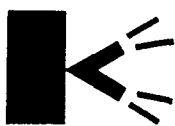
Stripping Wastes

Use of non-chrome etchants. If compatible with the surface treatment being applied, ferric chloride or ammonium persulfate solutions should replace chromic or sulfuric acid etchants to reduce the toxicity of any waste stripping solution generated.

Decrease generation of off-spec coatings that require stripping. This can be accomplished primarily through the application of better operating practices, paying particular attention to process quality control measures, and employee training.

8.3 Electroplating

8.3.1 Industry Process Description



Electroplating is a process in which metal is coated with one or more other metals by electrodeposition. Electrodeposition is achieved by passing an electric current through a solution containing dissolved metal ions and the metal object to be plated. This results in the deposition of the dissolved metal ions onto the surface of the object.

An electroplating process generally calls for moving the object to be coated (workpiece) through a series of baths arranged in a carefully designed sequence. Typically, the sequence consists of cleaning, rinsing, and a number of alternating electroplating and rinsing steps. The workpiece can be carried on racks or in barrels.

8.3.2 Sources of Waste

From a waste minimization standpoint, the ten primary electroplating process wastes can be grouped to reflect only four different process origins:

- work cleaning wastes,
- spent plating solutions/sludges,
- waste rinse water, and
- treatment wastes.

Some or all of the ten waste types may be combined into a single stream before treatment and disposal. A description of the ten primary process wastes organized according to these four common process origins is provided later in this section in Table 8.3.

Contaminated rinse water accounts for a majority of waste produced. Rinse water is used to remove the drag-out from a workpiece. Drag-out refers to the excess cleaning or plating solution that adheres to the workpiece surface and is carried out of the bath along with the workpiece. If the drag-out from one bath is carried into the next bath it is referred to as "drag-in," and is considered a contaminant in the later bath.

Spent cleaning and plating solutions are another waste source. Cleaning solutions may be acidic or basic, and may contain organics, and heavy metals. Some cleaning solutions may also contain cyanide. Spent plating solutions contain high concentrations of metals. These solutions are not regularly discarded but may require purging if impurities build up.

The waste water produced in the electroplating process may contain a variety of heavy metals and cyanide. The metals are removed by adding lime or other precipitation agents. The result is a dilute metal hydroxide sludge, which is thickened and then disposed of in a landfill.

8.3.3 Good Operating Practices for Waste Minimization

Good operating practices are defined as procedural or institutional policies which result in a reduction of waste and may include:

- personnel practices,
- procedural measures,
- loss prevention practices, and
- waste stream segregation.

Good operating practice applies for every waste stream and is one of the first methods which should be investigated in a waste minimization program. A detailed discussion of good operating practices is provided in Section 7.1.

Table 8.3. Electroplating industry waste streams and minimization practices.

<i>Common waste streams</i>	<i>Primary process waste description</i>	<i>Minimization practice</i>
Work cleaning wastes	Spent alkaline cleaning solution; spent acid cleaning solution; degreaser sludges from solvent cleaning; solvent recycle still bottoms.	<ul style="list-style-type: none"> • See Section 7.2.
Spent plating solutions and sludges	Spent plating solutions; filter sludges from electroplating.	<ul style="list-style-type: none"> • Increase plating solution life. • Use non-cyanide plating solutions. • Replace cadmium plating with zinc. • Replace hexavalent chromium with trivalent. • Return spent plating solution to manufacturer.
Waste rinse water	Waste rinse water	<ul style="list-style-type: none"> • Increase solution temperature. • Use less concentrated plating solution. • Withdraw workpiece slowly from solution. • Add wetting agents to plating solution. • Position workpiece properly on rack. • Recover drag-out of plating solutions. • Install multiple rinse tanks. • Install fog nozzles and sprays. • Reuse rinse water elsewhere in plant. • Install still rinsing tanks. • Install automatic flow controls. • Use mechanical/air agitation of bath.

Table 8.3 (continued)

<i>Common waste streams</i>	<i>Primary process waste description</i>	<i>Minimization practice</i>
Treatment wastes	Wastewater treatment sludge; vent scrubber wastes; ion-exchange resin reagents from process water demineralization.	<ul style="list-style-type: none"> • Use efficient precipitating agents. • Use trivalent instead of hexavalent chromium. • Install sludge dewatering systems. • Implement better operating practices. • Install metal recovery systems.

8.3.4 Specific Waste Minimization Practices

The most common waste minimization practices which can be applied to the four main waste streams in the electroplating industry are summarized in Table 8.3. Each of these waste minimization practices for the electroplating industry is briefly described in the following sections.

Work Cleaning Wastes

Work cleaning wastes from electroplating processes are similar to the cleaning wastes produced in many other manufacturing processes. A detailed discussion of waste minimization practices for cleaning wastes is provided in Section 7.2, *Metal Parts Cleaning*.

Spent Plating Solutions and Sludges

Plating solutions are not discarded frequently, but do require periodic replacement. Descriptions of minimization practices available for reduction of spent plating waste follow.

Increase plating solution life. The lifetime of a plating solution is limited by the accumulation of impurities and/or by depletion of constituents due to drag-out. The build-up of impurities can be limited by the following techniques:

- Use purer anodes.
- Reduce drag-in by better rinsing.
- Use deionized or distilled water instead of tap water for make-up.
- Regenerate plating solution through impurity removal by:
 - more efficient filtering of a plating solution; and
 - reducing the carbonate concentration in cyanide baths using a technique developed by the U.S. Army (U.S. Patent 4,365,481), which involves freezing the carbonates out of solution. A metal box containing dry ice and acetone is immersed in the plating bath. Carbonates are precipitated directly onto the outside metal surface of the box which is then removed and the carbonates scraped off the box and discarded as solid waste.
- Properly design and maintain rack. Corrosion and salt deposits on the rack will contaminate plating solutions by chipping and falling into the solution.

Replace cyanide plating solutions with cyanide-free solutions.

A cyanide-zinc solution was replaced with a non-cyanide, non-chelated alkaline zinc solution. Other cyanide-free zinc solutions along with cyanide-free pyrophosphate copper plating solutions have been used. Such replacements often require upgrading of the cleaning techniques used because non-cyanide replacements may require a much more thoroughly cleaned surface to ensure high quality plating. Military contracts often specify the use of cyanide solutions, thereby preventing the use of non-cyanide replacements.

Replace cadmium-based plating solutions with zinc solutions.

The use of cadmium has been replaced with zinc in many applications. Cadmium plating alternatives are discussed later in this section.

Replace hexavalent chromium with trivalent chromium. Trivalent chromium has been used in place of the more toxic hexavalent chromium, but it produces a lower quality surface.

Return spent plating solution to manufacturer. This requires on-site segregation of solutions according to the metal in the solution.

Waste Rinse Water

There are several methods available to reduce the amount and toxicity of waste rinse water. These methods can be grouped into two major techniques:

- **Drag-out minimization.** Reducing drag-out will result in a decrease of the heavy metal content of the ultimate waste (treatment sludge).
- **Rinse water minimization.** Decreasing water consumption will decrease the volume of ordinary calcium and magnesium sludge that results when using hard water. The amount of heavy metal sludge produced remains the same. Therefore decreasing the amount of rinse water without reducing drag-out may result in a smaller, but more highly toxic, volume of treatment sludge.

Drag-Out Minimization

Minimizing the drag-out reduces the amount of rinse water needed. Also, less of the plating solution metals leave the process, which ultimately produces savings in raw materials and treatment/disposal costs. The amount of drag-out depends on the:

- surface tension of the plating solution,
- viscosity of the plating solution,
- physical shape and surface area of the workpiece and rack, and

- speed of workpiece withdrawal and drainage time.

Generally, drag-out minimization techniques include the following practices.

Increase plating solution temperature. Increased temperature lowers both the viscosity and surface tension of the solution. The resulting higher evaporation rate may also inhibit the carbon dioxide absorption rate, slowing down the carbonate formation in cyanide solutions. Disadvantages include:

- formation of carbonate by cyanide breakdown at elevated temperatures,
- higher energy costs,
- higher chance for contamination due to increased make-up requirement, and
- more need for air pollution control due to higher evaporation rate.

Lower the concentration of plating bath constituents. For example, it has been found that acceptable chromium plating can be obtained from baths containing only 25 to 50 grams per liter (g/l) CrO_3 compared to the traditional concentration of 250 g/l. Lowering the concentration will result in:

- lower solution viscosity, and
- reduced rinsing requirement.

Reducing speed of workpiece withdrawal and allowing ample drainage time:

- 30 seconds usually allows most drag-out to drain back to the tank;

- while 10 seconds still permits good drag-out recovery in applications where quick drying is a problem.

Use surfactants. Applied in small amounts, wetting agents can lower a solution surface tension enough to reduce drag-out by up to 50 percent. Only non-ionic wetting agents should be used. The use of surfactants is sometimes limited, because they have an adverse effect on the quality of the plate produced.

Properly position the workpiece on the plating rack. Proper positioning of the workpiece on a rack will facilitate the dripping of the drag-out back into the bath. This is best determined experimentally, although the following guidelines were found effective.

- Orient the surface as close to vertical as possible.
- Situate the longer dimension of the workpiece horizontally.
- Position the workpiece with the lower edge tilted from the horizontal so that the runoff is from a corner rather than an entire edge.

Improve drag-out recovery. A drain board positioned between a plating bath and rinse bath can capture the dripping solution and route it back to the plating bath. Incorporating an empty drip tank between the plating bath and the rinsing bath is another option.

Rinse Water Minimization

Rinse water minimization involves rinsing off the work-piece in the most efficient manner, using the smallest volume of rinse water. Traditionally, a workpiece would be immersed into a single rinsing bath following a plating bath, and then it is moved to the next step in the process. Several methods exist which use less rinse water than the traditional method, while still adequately rinsing the workpiece.

Multiple rinsing tanks. These can reduce rinse water requirements by 66 percent with possible theoretical reductions of over 90 percent reported. In a three-tank, counter-current series system:

- The workpiece enters the first rinse tank, which has the most contaminated rinse water. It is then moved to the second tank, and then to the last, where it contacts fresh rinse water before moving to the next step in the process.
- Fresh rinse water enters only the last (third) rinsing tank. The water then flows into the second tank, then into the first tank from which it is routed to treatment or to the plating tank as a make-up.

Fog nozzles and sprays. Spraying water droplets onto a workpiece is more efficient than immersing a workpiece into a water bath.

- Fog nozzles and sprays are highly effective on simple work pieces, such as sheets.
- Fog nozzles and sprays are not effective on oddly shaped objects, since spray cannot make direct contact with the entire surface.
- Fog nozzles use water and air pressure to produce a fine mist and can be used directly over a heated plating bath to rinse the workpiece which allows for simultaneous rinsing and replenishment of the evaporated losses from the tank.
- Fog nozzles are not used in barrel plating because of the odd shape of the part.

Rinse water reuse. Rinse water picks up contaminants from the workpiece that was rinsed. The same water can be used again in a subsequent plating step if these contaminants do not interfere with the quality of that step. For example, in a nickel plating process, the same rinse water stream was used for the rinses following the alkaline cleaning, acid dip, and nickel plating tanks. Instead of having three different rinse streams, only one stream was used, greatly reducing the overall rinse water requirements.

Still rinsing. The workpiece is immersed in a still (no inflow or outflow) rinse tank following the plating bath. The concentrations of the plating bath constituents build up until they become sufficiently high for the rinse water to be used to replenish the upstream plating bath.

Automatic flow controls. Flow can be automatically controlled at the lowest possible rinse rate to avoid variations associated with water line pressure changes and manual control by the operator.

Rinse bath agitation. Agitating the rinsing bath mechanically or with air increases the rinsing efficiency.

Treatment Wastes

In electroplating, toxic metal sludges result from the conventional treatment processes used to remove metals from waste water. The volume and toxicity of the sludge produced can be lowered by reducing the metal content in the plating and rinse waste waters, or by using different precipitating agents. Following are methods available to accomplish this.

Use of different precipitating agents. Normally, hexavalent chromium is treated with a reducing agent to trivalent chromium, followed by precipitation with lime. In one instance, sodium hydroxide was used in place of lime, which produced 1.98 lb dry solids/lb Cr(VI) compared to 2.24 lb dry solids/lb Cr(VI) produced by lime precipitation.

Use of Cr(III) instead of Cr(VI) for plating. One operation reported a 70 percent reduction in sludge production when trivalent chromium was used for plating instead of hexavalent chromium. This reduction occurred because the necessity to precipitate gypsum was avoided. Gypsum is associated with the excess sulfate ions that are normally added to reduce Cr(VI).

Waste Stream Segregation

- By isolating cyanide-containing waste streams from waste streams containing iron or complexing agents, the forma-

tion of cyanide complexes is avoided, and treatment made much easier.

- Segregating waste water streams containing different metals allows for metals recovery or reuse. For example, by treating nickel plating waste water separately, a nickel sludge is produced which can be reused to produce fresh nickel plating solution.
- In one instance, the scrubber waste from a chromium plating bath was segregated and could then be returned to the bath. This resulted in less waste and increased plating solution life.

Metal recovery techniques. Techniques to recover metals from rinse water before treatment include:

- evaporation,
- reverse osmosis,
- ion exchange,
- electrolytic metal recovery, and
- electrodialysis.

Many companies have installed such systems to recover metals from waste rinse water and have found the investment paid for itself in 1 to 5 years. Section 9.3.2 provides a detailed description of these metal recovery techniques and some examples of where they have been successful.

Use of separate treatments. Use of separate treatments for each solution results in a sludge that bears a single metal. The sludge (metal hydroxide) can then be sold, e.g., to a chemical producer.

Product Substitution

Following are two possible product substitutions.

Cadmium plating alternatives. Products plated with cadmium are highly resistant to corrosion on land and in marine environments. Roughly 40 percent of the total cadmium produced is used

by the U.S. military. It may be possible in some instances to replace cadmium plating with other materials such as:

- zinc plating,
- titanium dioxide plating using vapor deposition, and
- aluminum plating using ion vapor deposition.

None of these coatings have exactly the same properties as cadmium, but some may prove to be satisfactory substitutes nonetheless.

Chromium plating alternatives. Substantial waste is produced during chromium plating; therefore, eliminating any unnecessary use is beneficial. For example, chromium-plated car bumpers can be replaced by nickel-plated bumpers, although customer preference for a shinier finish may play a major role.

8.4 Printed Circuit Board Manufacturing

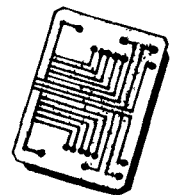
8.4.1 Industry Process Description

Printed circuit board manufacturing involves imprinting metal circuitry onto a board composed of nonconductive material (e.g., glass, epoxy, or plastic) through a series of operations characteristic of the particular production method used. The three principal production methods used in their manufacture are:

- conventional subtractive process,
- fully additive process, and
- semi-additive process.

The subtractive production method is currently the most predominant of the three types. It typically begins with a copper-clad laminate board which is subjected to the following operations.

- **Board preparation:** curing, sanding, drilling, deburring.
- **Electroless copper plating:** scrubbing/cleaning, surface activation etching, electroless plating catalyst application.



- **Printing and masking:**
 - Panel plating: electroplating, etching, resist application.
 - Pattern plating: resist application, printing/developing.
- **Electroplating:** cleaning/rinsing, tin/lead plating, light etch/acid dip, stripping/rinsing, copper electroplating.
- **Etching**

The final stages of the subtractive process involve cleaning and application of selective metallic coatings for solderability and/or corrosion protection.

The additive method differs in that an unclad board is used initially. The only areas of the board to be plated are those containing the circuitry itself; all other areas are coated with plating resist, thus eliminating the need to etch unwanted copper.

8.4.2 Sources of Waste

The waste streams resulting from the five major operations mentioned in the preceding section are listed in Table 8.4.

Airborne particulates generated during board preparations are normally collected and separated using bag-house and cyclone separators. The collected dusts are then removed for disposal at landfills as solid wastes.

Acid vapors are collected and are neutralized prior to sewer discharge or disposal, while organic vapors are collected and condensed, drummed and land disposed, combusted, or reclaimed.

The majority of the liquid waste streams are subject to in-house treatment prior to sewer discharge. Typical treatment systems may consist of pH adjustment and metal precipitation, followed by sludge removal and dewatering.

Spent organic solvents are most often reclaimed, either in-house or at an off-site facility.

8.4.3 Good Operating Practices for Waste Minimization

Good operating practices are defined as procedural or institutional policies which result in a reduction of waste, and may include:

- personnel practices,
- procedural measures,
- loss prevention practices, and
- waste stream segregation.

Good operating practice applies for every waste stream and is one of the first methods which should be investigated in a waste minimization program. A detailed discussion of good operating practices is provided in Section 7.1.

8.4.4 Specific Waste Minimization Practices

Table 8.4 outlines the major operations involved in the manufacture of printed circuit boards, the waste streams which result from these operations, and the waste minimization practices which are most applicable to them.

The waste reduction measures listed in Table 8.4 generally fall into the process change and material/product substitution category. Each measure will be briefly discussed in the following sections.

Cleaning/Surface Preparation

Wastes generated from the cleaning and surface preparation operations of printed circuit board manufacture are similar to those produced from other manufacturing operations involving metal parts cleaning. A detailed discussion of the waste minimization practices applicable to these processes is provided in Section 7.2, *Metal Parts Cleaning*.

Table 8.4. Printed circuit board waste streams and minimization practices.

<i>Process origin</i>	<i>Waste stream</i>	<i>Control methodology</i>
Cleaning/surface preparation	Airborne particulates; acid fumes/organic vapors; spent acid/alkaline solution; spent halogenated solvents; waste rinse water.	<ul style="list-style-type: none"> • See Section 7.2.
Catalyst application/electroless plating	Spent electroless copper bath; spent catalyst solution; spent acid solution; waste rinse water.	<ul style="list-style-type: none"> • Use combined sensitization/activation. • Use lower concentration plating bath. • Use differential electroless plating. • Use weak/biodegradable chelating agents. • Use in-line metal recovery techniques. • Use computerized/automated control.
Pattern printing/masking	Acid fumes/organic vapors; vinyl polymers; spent resist removal solution; spent acid solution; waste rinse water.	<ul style="list-style-type: none"> • Use aqueous processable resists. • Use screen print instead of photolith. • Use Asher dry resist removal method.
Electroplating	Spent plating bath; waste rinse water.	<ul style="list-style-type: none"> • See Section 8.3. • Use pattern instead of panel plating.
Etching	Spent etchant; waste rinse water.	<ul style="list-style-type: none"> • Use dry plasma etching techniques. • Use additive in place of subtractive method. • Use less-toxic etchants. • Use in-line metal recovery techniques. • Use thinner copper foil for cladding.

Catalyst Application and Electroless Plating

Spent process solutions and rinse waters characterize the wastes resulting from these operations. The following methods should result in a decrease in the volume and/or increase in the treatability of wastes generated.

Use a combined sensitization and activation solution to eliminate one extra rinsing step. Although the activity of the catalyst may be reduced by combination of these two steps, the reduction of waste due to elimination of a rinse step should outweigh this disadvantage.

Use a less concentrated plating bath to reduce the degree of subsequent rinsing required. Although no information has been reported on the success of this technique, the approach has been tried by some large companies in the electroplating industry.

Use differential plating instead of the conventional electroless plating process. This technique needs more developmental work before it can be applied commercially. However, the principle involves controlling the concentration of stabilizers in the plating bath, resulting in a rate of copper deposition in the "through holes" three to five times faster than the rate of deposition on the board surface. If the subtractive method of manufacture is used, this technique would decrease the amount of copper which must be etched away later.

Use weak or biodegradable chelating agents. When weak chelating agents, such as hydroxy acids, are used in the electroless plating bath, subsequent metal recovery operations will be more effective due to an increase in the amount of metal which is capable of being removed from solution.

Use in-line techniques for metal recovery. Strategic, in-line placement of metal recovery units, such as ion exchange columns, can serve to remove metals from spent plating baths and waste rinse waters. When the ion exchange resin is regenerated, the metals can be recovered and used to provide plating solutions which can be recycled to the plating baths.

Use computerized/automated control systems. Computerized process-control systems for board handling and process bath monitoring can be used to prevent unexpected decomposition of the plating bath solutions. However, due to high equipment cost and the ongoing need for skilled operations and maintenance personnel, only very large printed circuit board manufacturers find this waste minimization option a practical one. Smaller manufacturers may find that automated board handling systems for the plating operation have a much broader application.

Better operating practices. Although discussed generically in Section 7.1, some waste reduction methods specifically applicable to printed circuit board manufacturing are briefly detailed below.

- Inspect plating racks frequently for loose insulation. This procedure will prevent excess drag-out of process solutions.
- Distribute work load evenly. Dense loading may result in localized instability of the process solution.
- Regularly strip copper from plating tank to prevent continuous deposition of copper and palladium on the tank walls.
- Segregate chelated waste streams to prevent metal precipitation problems during waste treatment.

Pattern Printing/Masking

Liquid waste streams generated from these processes include spent chlorinated solvents, spent resist solutions, and waste rinse waters. The organic solvents are generally gravity separated and collected for disposal or recovery. Source reduction techniques include:

Use a water-processible resist instead of a solvent-processible resist. The use of water-processible resists eliminates the generation of toxic spent solvents by allowing the use of caustics and carbonates as developers and strippers.

Use screen printing instead of photolithography. The use of screen printing would eliminate the need for the developers used in photolithography. Recent improvements to this technique have enabled its use for the manufacture of printed circuit boards requiring resolution down to 0.01 inch, although the majority of manufacturers still use photolithography for circuitry finer than 12 mil lines and spaces.

Use the Asher dry photoresist removal method instead of organic resist stripping solutions. More investigation is needed into the applicability of this process to printed circuit board manufacturing. It is currently utilized by semiconductor manufacturers, but resist layers in this industry are generally much thinner than those utilized in printed circuit board manufacturing.

Electroplating

The waste streams generated in the electroplating process primarily consist of waste rinse waters and spent plating solutions. On-site treatment of these wastes usually consists of metal precipitation by pH adjustment, neutralization, and possibly cyanide destruction, followed by sewer discharge of the treated effluent and transport of the metal sludges off-site for metal recovery or disposal. Source reduction techniques for the various types of electroplating process wastes are detailed in Section 8.3; however, one suggestion specific to the printed circuit board industry is discussed below.

Use pattern instead of panel plating . Switching to this technique will reduce the amount of non-circuit copper which must be etched away, thereby reducing the amount of waste generated from the etching operations. However, customer specifications may not allow this, particularly for products such as computer and microwave printed circuit boards, where the circuitry requires highly uniform copper thickness.

Etching

The etching process generates spent etchants and waste rinse waters. The metals in these can be removed prior to sewer

discharge by adjusting the pH. The source reduction techniques applicable to these waste streams are:

Use dry plasma etching techniques. Etching is achieved either through a chemical method (utilizing reactive gaseous radicals) or a physical method (using nonreactive ion bombardment). A radio frequency source is used to ionize gaseous molecules, thereby creating a plasma. More investigation is necessary regarding the applicability of this technique to removal of the thick (1.4 mil) copper layers used in printed circuit board manufacturing.

Use additive instead of subtractive method. Advantages to the use of the additive method include lower manufacturing costs and a decrease in the amount of waste generated, due to the elimination of the copper etching step. However, there are two factors to be considered if a switch to the additive method is being considered: a water-processible resist may not be substituted for a solvent-processible one; and the heavily complexed copper often found in additive plating solutions may cause difficulties during waste water treatment.

Use less toxic etchant. The use of non-chromium etching solutions would reduce the toxicity of the wastes generated from this process.

Use of in-line techniques for metal recovery. A technique recently developed by Bend Research, Inc. would enable copper to be recovered from etching solutions through the use of liquid membranes.

Use thinner copper foil to clad the laminated board. Starting the manufacturing process with boards covered with a thinner layer of copper will result in a reduction of the amount of copper which must be etched, thereby reducing the amount of wastes generated from the etching process.

8.4.5 Product Substitution Options

Use of surface instead of through-hole insertion mounting in printed circuit board packaging. Although relatively new, this method of attaching packages to printed circuit boards can reduce the size of printed circuit boards required for a given number of packages from 40 to 65 percent, since it allows for closer contact areas of chip leads. This size reduction would result in a corresponding decrease in the amount of wastes generated from the manufacturing process.

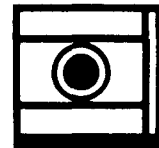
Use of injection molded boards. High-temperature, high-performance thermoplastics can be injected under high pressure into precision molds, and circuitry can then be applied using a semi-additive or fully additive plating process such as fast-rate electrodeposition (a technique developed by Battelle). As previously mentioned in Section 8.4.4, use of the additive method would eliminate the generation of spent toxic etchants.

8.5 Dry Cleaning and Laundries

8.5.1 Industry Description

The dry cleaning and laundry industry typically includes:

- retail dry cleaning stores,
- industrial and linen supply plants with dry cleaning operations,
- leather and fur cleaning plants,
- self-service laundromats with dry cleaning equipment, and
- other establishments with dry cleaning operations.



8.5.2 Sources of Waste

While not all of these facilities will produce hazardous wastes, those using hazardous solvents are subject to regulation under

RCRA. Some of the most common hazardous wastes from the dry cleaning and laundry industry include:

- Wastes from perchloroethylene plants, which include:
 - still residues from solvent distillation,
 - spent filter cartridges, and
 - cooked powder residue.
- Wastes from Valclene plants, which include:
 - still residues from solvent distillation, and
 - spent filter cartridges.
- Wastes from petroleum solvent plants, which include:
 - still residues from solvent distillation.

8.5.3 Good Operating Practices for Waste Minimization

Good operating practices are defined as procedural or institutional policies which result in a reduction of waste and may include:

- personnel practices,
- procedural measures,
- loss prevention practices, and
- waste stream segregation.

Good operating practice applies for every waste stream and is one of the first methods which should be investigated in a waste minimization program. A detailed discussion of good operating practices is provided in Section 7.1.

8.5.4 Specific Waste Minimization Practices

The most serious waste problem in the dry cleaning industry is solvent loss. Waste minimization practices center around controlling solvent emissions and solvent wastes. The most common practices are:

<i>Waste stream</i>	<i>Minimization practice</i>
Solvent emissions	Check for and fix leaks regularly. Reduce solvent vapor loss. Use dry-to-dry machines. Use machines with monitors.
Solvent wastes	See Section 9.1.

Each of these waste minimization practices from the dry cleaning and laundry industry are briefly described in the following section.

Solvent Emissions

Total solvent emissions from dry cleaning facilities can vary greatly with operational and maintenance procedures. A 1980 study by the U.S. Department of Health and Human Services, which examined 20 dry cleaners, concluded that gasket leaks, solvent retention in garments, and poor ventilation were common problems. Also, no correlation was found between plant size and solvent mileage. There are several minimization practices available for reduction of solvent loss.

Check for and fix leaks regularly. The leakage of solvents from worn equipment and hosing can easily go unnoticed unless the operator routinely checks for signs of solvent loss. Liquid leaks can be identified by the presence of a brown residue left on the underside of the leak. The areas which should be checked regularly for liquid leakage are:

- hose connections, couplings, and valve machines;
- door gasket and seating;

- filter head gasket and seating;
- pumps and storage tanks;
- water separators;
- filter sludge recovery;
- cartridge filters;
- distillation unit;
- diverter valves; and
- saturated lint from lint basket.

Reduce solvent vapor loss. Some leaks may be caused by certain operating practices which allow solvent vapor to escape unnecessarily. Unless regular checks are made, the loss of solvent vapor can go undetected for months. Plugging leaks and improving operating practices in the following ways will minimize volatile emissions:

- Periodically replace the seals on the dryer deodorizing and aeration valves.
- Repair holes in the air and exhaust ducts.
- Replace faulty gaskets on machine doors.
- Keep containers of solvent closed while not in use.
- Clean lint screens regularly to avoid clogging fans and condensers. The operation of the solvent recovery system is impeded if the condensers are caked with lint.
- Open button traps and lint baskets only briefly as necessary for cleaning, to avoid residual solvent losses.
- Size the garment load correctly relative to the size of the equipment. Overloading results in incomplete solvent extraction, while underloading increases the amount of solvent loss per garment.

Many companies offer help in gaging solvent performance. PPG Industries offers guidebooks on solvent management through

good operating practices. Dow Chemical, a major producer of perchloroethylene, provides a free computerized solvent analysis service to help dry cleaners assess their solvent performance.

Use dry-to-dry machines. This combines washing and drying functions in a single unit. Using these machines instead of transfer machines requires less contact of the solvent by workers and less loss of solvent into the work environment. Recently, "cold dry" systems have been introduced. This additional feature allows for the use of lower temperatures during the drying process, which minimizes solvent loss and prolongs the life of the machine seals. For example:

- Uni-Rent Ltd. bought a cleaning company in 1977 and immediately upgraded the machines to dry-to-dry models. They use about 300 gallons of perchloroethylene a month, instead of the 700 gallons a month the old machines used. Because the cost of perchloroethylene has more than tripled since 1977, Uni-Rent estimates they have saved approximately \$50,000 per year.

Use machines with monitors. This allows for the correct amount of chemicals and soap to be added automatically, as well as the drying time to be extended until the clothes are fully dried. In this way, the amount of solvent vapor allowed into the plant by removing incompletely dried clothes is minimized. Spent cartridges can be dried out in the machine to recover residual solvent before disposal. American Permac Inc. of Hicksville, New York, is one of the equipment manufacturers which has introduced a line of monitored machines. American Permac boasts a solvent mileage of 30,000 to 50,000 pounds of fabric per drum of solvent with its new line.

Solvent Wastes

Waste solvents can generally be reclaimed by installing on-site distillation units, shipping waste solvent off-site to a solvent reclaimer, or returning waste solvent to the solvent supplier. More detailed information on waste minimization practices for solvents is in Section 9.1.

8.6 Printing

8.6.1 Industry Process Description



There are several commonly employed printing processes currently used by the graphic arts industry, including lithography, gravure, flexography, letterpress, and screen printing. Of these, lithography, gravure, and flexography are the most widely utilized.

While the operational details may vary between these various printing processes, the basic steps involved are the same. These steps include:

- image processing,
- plate or cylinder making,
- printing,
- drying, and
- finishing.

8.6.2 Sources of Waste

Lithography and flexography generally produce the following three main types of waste:

- trash,
- process waste waters and,
- equipment cleaning wastes.

Table 8.5 provides more detail. While gravure printing generates similar waste streams, the waste waters produced are actually more akin to metal processing operations, and the sections of this manual dealing with metal parts cleaning, electroplating, and metal finishing operations (Sections 7.2, 8.3, and 8.2, respectively) should be consulted for further information regarding this waste type.

Trash is by far the largest waste stream produced by the printing industry. Scrap paper generated is either recycled, incinerated, or sent for disposal. Scrap photographic material is often sold for metal recovery. Empty containers are typically discarded, but may be recycled in some cases.

Waste waters may be subject to pretreatment for metal recovery or neutralization prior to sewer discharge, or drummed for off-site disposal if necessary.

Equipment cleaning waste handling depends on the types of inks and solvents used. Cleaning rags are either incinerated or sent for laundering or disposal. Any waste water-based inks are generally discarded with other trash. Solvent-based inks and spent cleaning solvents may be recycled, incinerated, or sent to a hazardous waste treatment or disposal facility.

8.6.3 Good Operating Practices for Waste Minimization

Good operating practices are defined as procedural or institutional policies which result in a reduction of waste, and may include:

- personnel practices,
- procedural measures,
- loss prevention practices, and
- waste stream segregation.

Good operating practice applies for every waste stream and is one of the first methods which should be investigated in a waste minimization program. A detailed discussion of good operating practices is provided in Section 7.1.

8.6.4 Specific Waste Minimization Practices

Table 8.5 outlines the major operations or processes involved in printing, the waste streams which result from these operations, and the waste minimization practices which are most applicable.

The following sections include suggestions on how wastes generated by the printing industry may be reduced in volume or toxicity, either by recycling, source reduction, or product substitution.

Trash

Recycle empty containers. Purchasing ink in bulk containers which are returned to the supplier for refilling will reduce the amount

of trash generated, and cut down on the amount of cleaning time needed to scrape ink residues from the inner walls of the container. If returnable containers are not available from the supplier, it still may be possible to reduce disposal of empties by sending them either to container recyclers or reconditioners.

Recycle spoiled photographic film and paper. Sending used or spoiled film and paper to silver reclaimers is already practiced by much of the printing industry, with the exception of very small operators and those located in areas not serviced by silver recyclers.

Table 8.5. Printing wastes.

<i>Waste stream</i>	<i>Process origin</i>	<i>Composition</i>	<i>Control methodology</i>
Trash	Image processing	Empty containers, used film packages, out-dated material.	<ul style="list-style-type: none"> • Recycle empty containers. • Recycle spoiled photographic film.
	Plate making	Damaged plates, developed film, dated materials.	<ul style="list-style-type: none"> • Use electronic imaging, laser plate making.
	Printing	Test production, bad printings, empty ink containers, used blankets.	<ul style="list-style-type: none"> • Install web break detectors. • Monitor press performance. • User better operating practices.
	Finishing	Damaged products, scrap.	
Wastewater	Image processing	Photographic chemicals, silver.	<ul style="list-style-type: none"> • Use silver-free films. • User water-developed litho plates.
	Plate making	Acids, alkali, solvents, plate coatings, (may contain dyes, photopolymers, binders, resins, pigment, organic acids), developers (may	<ul style="list-style-type: none"> • Electronic imaging/laser print making. • Recover silver and recycle chemicals. • Use counter-current washing sequence. • Use squeegees. • Use better operating practices.

Table 8.5. (continued)

<i>Waste stream</i>	<i>Process origin</i>	<i>Composition</i>	<i>Control Methodology</i>
		contain isoprop- anol, gum arabic, lacquers, caustics) and rinse water.	<ul style="list-style-type: none"> • Remove heavy metals from wastewater.
	Printing	Spent fountain solutions (may contain chromium)	
Equipment cleaning	Printing	Lubricating oils, waste ink, clean-up solvent (halogenated and non-halogenated), rags	<ul style="list-style-type: none"> • Recycle waste ink and solvent. • Use automatic cleaning equipment. • Recover heating value from waste. • Use automatic ink leveler. • Use less toxic solvents. • Use better operating practices.

Electronic imaging and laser platemaking. This technique would allow text and photos to be edited on a video terminal and color separations to be prepared electronically, thereby reducing or eliminating some photographing, editing, re-shooting, and photoprocessing steps (and wastes) involved in the printing process.

Install web break detectors. The Oxy-Dry Corp. manufactures a non-contact electronic system which detects web breaks without smearing or creasing the web, thereby reducing wastes from this source.

Monitor press performance. Waste systems are currently on the market which can monitor press performance. One such system is the Pressdata 190, manufactured by Crosfield in Chicago, Illinois.

Use careful storage practices. Careful attention to storage specifications of photosensitive film and paper may greatly reduce waste produced as a result of improper storage.

Waste Water

Use silver-free films. Silver-free films are currently on the market from several manufacturers. Substitution of silver-free films would eliminate the need to send waste film to a metal reclaimer.

Use water-developed lithographic plates. Switching from chemical processing to water processing of lithographic plates and film may eliminate certain waste waters which currently require pretreatment prior to sewer discharge. The 3M Corporation markets a Hydrolith plate which requires only water to process aluminum offset plates.

Electronic imaging and laser platemaking. Text and photos are read by an electronic scanner, edited with a display monitor, and non-silver plates are made using laser beams. However, this type of system is currently impractical for small print shops due to the great equipment expense involved.

Recover silver and recycle spent chemicals. Keeping individual process baths (developers, fixers, rinses) as uncontaminated as possible facilitates silver recovery, whether it is accomplished by metallic replacement, chemical precipitation, electrolytic recovery, or the like (for more details see below under *Removal of Heavy Metals from Waste Water*). A wide variety of silver recovery equipment is available, no matter what the size of the operation. Technologies such as oxidation, electrolysis, and ion exchange are also available to restore of developers and fixers.

Employ counter-current washing. Process solution contamination and water usage can be reduced by using counter-current washing instead of parallel tank wash systems. In the counter-current system, water from previous rinsings is used in the initial film-washing stage. Fresh water enters only the final rinse tank, instead of each wash tank along the way.

Use squeegees. By using squeegees to wipe off excess liquid in a non-automated processing system, chemical carry-over from one process bath to the next can typically be reduced 50 percent

or more. Minimizing process bath contamination increases the ease with which the bath can be recycled, prolongs bath life, and reduces the amount of replenisher chemicals required.

Substitute iron-EDTA for ferrocyanide bleaches. Although iron-EDTA is a slower acting bleach, it is less toxic and would therefore eliminate costs associated with the treatment, incineration, or disposal of ferrocyanide bleaches.

Use “washless” processing systems. Use of these systems could reduce waste water by 97 percent, although they are expensive to install (approximately \$45,000).

Employ better operating practices. Several suggestions for minimizing waste through improvements in operating practices are briefly described below.

- Frequent monitoring and accurate addition of replenisher chemicals to process baths will reduce chemical waste.
- Pay attention to process chemicals which have short expiration dates (shelf life).
- Reuse rinse water as long as possible.
- Prevent premature expiration of light-sensitive chemicals by keeping them in the dark.
- Prolong the potency of oxidizable process baths by reducing their exposure to air.
- Small-scale photo developers may use glass marbles to bring the liquid levels of their process chemicals to the brim each time the liquid is used. This extends the chemical's life by minimizing the amount of oxygen with which it comes in contact.

Remove heavy metals from waste water. Several methods are available:

- Silver recovery may be enhanced by using two chemical recovery cartridges in series. The second cartridge would also serve to minimize silver breakthrough. Installing a cartridge to polish the effluent of an electrolytic unit would significantly reduce silver levels in sewer discharges .
- The efficiency of an electrolytic recovery unit for silver can be significantly increased by adjusting the concentration of sulfite in the silver-bearing wastes to 10 to 25 grams/liter and the pH to 7.8. *This will also serve to reduce sulfiding.*
- Using a low current for the first plating of silver in an electrolytic unit will minimize silver fin formation ("finning"), a condition which limits the amount of recoverable silver from a particular batch of process waste.
- Keeping concentrations of silver and iron low in the waste streams will increase electrolytic efficiency. This can be accomplished by using a higher-than-normal fixer replenishment rate in film processing.
- Hexavalent chromium can be reduced to the less toxic trivalent form by lowering the pH to approximately 2 using a strong mineral acid, then adding a strong solution of reducing agent such as ferrous sulfate or sodium bisulfite. Heavy metals will then precipitate out upon the addition of caustic soda or lime.

Cleanup Solvents and Waste Ink

Recycle waste ink and cleanup solvent. Ink recovery machines currently on the market in a number of sizes make on-site reclaiming a viable option. It may also be possible to send waste inks back to the manufacturer for conversion to black newspaper ink. Waste solvents can be recovered on-site by simple batch distillation if

sufficient quantities are generated to make this worthwhile. Professional solvent recyclers can also perform this task.

Use automatic cleaning equipment. Equipment of this type can promote a more efficient use of cleaning solvent, although it is very expensive to purchase and maintain.

Use an automatic ink leveler. Ink waste and spoilage around the press can be prevented, and optimum inking conditions in the fountain can be maintained by installing an automatic ink leveler in the fountain.

Substitute less toxic solvents. It may be possible to substitute less toxic solvents, such as hexane, for the highly toxic aromatic solvents, such as toluene and benzene.

Use better operating practices. A variety of suggestions for minimizing wastes by improving operating practices are described below.

- Segregate spent solvent according to color and type of ink contaminant, then reuse the collected wastes to thin future batches of the same ink.
- Avoid drawing too much solvent from the container. Draw only what is necessary to complete the cleaning task.
- Schedule jobs using light-colored inks before those requiring darker ones since this may reduce the amount of equipment cleaning required between color changes. Dedicated presses for various colors of ink may also be feasible in some cases, which would also result in fewer cleanups.
- Save all unused portions of ink for house colors or future production runs.
- Use press wipes as long as possible before discarding, and use dirty ones for the first pass, clean ones for the second pass.

8.7 Photography

8.7.1 Sources of Waste



The primary wastes associated with the photography industry include the spent fix solutions from the film development process. Commercially available recycling equipment exists that makes it possible to reuse spent developer, bleach, bleach-fix, and fix-processing solutions. Equipment is also available to recover the silver present in the wash water after the fix bath.

8.7.2 Good Operating Practices for Waste Minimization

Good operating practices are procedural or institutional policies which result in a reduction of waste and may include:

- personnel practices,
- procedural measures,
- loss prevention practices, and
- waste stream segregation.

Good operating practice applies for every waste stream and is one of the first methods which should be investigated in a waste minimization program. A detailed discussion of good operating practices is provided in Section 7.1.

8.7.3 Specific Waste Minimization Practices

The most common waste minimization practices which can be applied to the three main waste streams in the photography industry are:

<i>Waste stream</i>	<i>Minimization practice</i>
Process bath wastes	Metallic replacement Chemical precipitation Install metal recovery system

Color developer wastes

Metal recovery techniques
Countercurrent washing
Use of squeegees
Reduction of water consumption

Bleach, fix,
bleach-fix wastes

Use of non-complexed bleach-
es, ozone oxidation, electrolysis,
persulfate salts, and/or liquid
bromine.

Each of these waste minimization practices for the photography industry are briefly described in the following sections.

Process Bath Wastes

Three major sources of recoverable silver in the photoprocessing industry include:

- exhausted fixes and bleach-fix,
- film scraps and unexposed paper, and
- waste wash water following fixes and bleach-fixes.

While the recovery of silver from spent fix is very common, the efficiency of silver recovery from spent fix varies greatly. Recovery of silver from the other sources is not as common as recovery from fix.

Metallic replacement. This occurs when a metal such as iron contacts a solution containing dissolved ions of a less active metal such as silver. The dissolved silver reacts with the iron and settles out as a sludge.

Chemical precipitation. This may be done with a variety of different products. Ventron Corporation, for example, manufactures a product marketed as Vensil which may be used for the direct recovery of silver from spent fix.

Metal recovery systems. Technologies to recover metals from rinse water before treatment include:

- evaporation,
- reverse osmosis,
- ion exchange,
- electrolytic metal recovery, and
- electrodialysis.

Many companies have installed such systems to recover metals from waste rinse water and have found the investment has paid for itself in 1 to 5 years. Section 9.3.2 provides a detailed description of these metal recovery techniques and some examples showing where they have been successful.

Color Developer Wastes

Although color developer recycling technologies have been available since the 1950s, not until the last few years—with the rise in organic chemical costs—have they become economically feasible. Following are waste minimization practices for color developer wastes.

Counter-current washing. Water from previous rinsings is used to contact the film at its most contaminated stage. Fresh water enters the process at the final rinse stage, at which point much of the contamination has already been rinsed off the film.

Use squeegees. Wipe excess liquid from the moving photographic material. By reducing chemical carry-over, the lifetime of the process bath is prolonged, reducing the waste water discharge.

Reduce water consumption. Water consumption can be reduced by shutting off water while film processing is halted. Alternatively, a solenoid valve can be installed to automatically reduce water flow when film processing stops. This “housekeeping” technique requires minimum capital outlay, yet the savings can be dramatic. Eastman Kodak cut its consumption rate by 70 percent over 8 years. They estimate their cumulative savings over those 8 years to be \$273,000.

Bleach, Fix, and Bleach-Fix Wastes

Historically, ferricyanide bleach has been used in color processing to convert developed metallic silver and bromine to silver bromide that may be removed by fixer in a subsequent process bath. During this conversion, the ferricyanide is changed to ferrocyanide and leaves the process as overflow.

In the past, ferrocyanide overflow from a processing machine was allowed to pass untreated to the sewer. In recent years, however, the regeneration of ferricyanide bleach has become feasible for both economic and environmental reasons. In all cases, the ferricyanide bleach regeneration process basically involves converting (by oxidation) the non-active ferrocyanide in the overflow to active ferricyanide. The following specific practices can be used to minimize ferricyanide bleach waste.

Use ozone oxidation to regenerate spent ferricyanide bleach.

This process involves the production of ozone gas which functions as the oxidizing agent to regenerate the spent ferricyanide bleach. In this process, the dilute ferricyanide bleach found in rinse waters must first be concentrated using ion-exchange columns before it can be regenerated using ozone. CPAC (Leicester, New York) provides a unit known as the OzPac which uses ozone to regenerate spent bleach. This method can reduce the effluent ferrocyanide concentration by about 90%.

Use electrolysis to regenerate spent ferricyanide bleach or de-silver the fix. An electrical current is applied to the ferrocyanide overflow to convert the non-active ferrocyanide to active ferricyanide. The hydroxide by-product must then be removed and hydrobromic acid added. Some laboratories use an in-line electrolytic system which continuously de-silvers the fix in the tank and extends the life of the fix. Residual silver in the electrically de-silvered fix can be recovered using a metallic replacement cartridge. With some processes, attempts to re-use as little as 50 percent of the de-silvered fix along with new fix have resulted in serious stains on the sensitized product unless proper precautions are taken (such as sulfiting the replenisher solution). CPAC (Leicester, New York) manufactures an electrolytic silver recovery

unit for the closed loop de-silvering of fix which allows a 50 to 90 percent reduction in fix replenishment. The Nash Cell by Eastman Kodak is a small piece of equipment which converts spent bleach to active ferricyanide.

Use persulfate salts to regenerate spent ferricyanide bleach.

This is the most common regeneration practice in use today. Similar to the ozone process, persulfate serves as the oxidizing agent to regenerate ferricyanide from the ferrocyanide overflow. The use of persulfate salts is not as efficient as electrolysis and ozone oxidation. After several regenerations, the bleach becomes saturated with sulfate salts which reduces bleaching efficiency, fouls piping and pumps, and may require elevating the concentration of ferricyanide in an attempt to maintain adequate bleaching.

Use liquid bromine to regenerate spent ferricyanide bleach.

The use of liquid bromine to regenerate ferricyanide is very efficient and provides the bromine ions required for bleaching. In this process, bromine serves as the oxidizing agent to regenerate ferricyanide from the ferrocyanide overflow.

Use iron-complexed bleaches to replace ferricyanide bleaches.

This is not a ferricyanide bleach regeneration process, but rather a recommended material substitution that in some cases may be used to replace ferricyanide bleaches in certain processes altogether. The iron-complexed bleaches are less environmentally harmful and more easily recovered.

8.8 Construction

8.8.1 Industry Process Description



The construction industry generates hazardous waste in these processes:

- plumbing, heating, air conditioning;
- prefabricated wood buildings;
- terazzo, tile, marble, mosaic wall or floor work;
- roofing, sheet metal work;

- painting, decorating;
- mobile home construction;
- other floor work; and
- glass, glazing work.

8.8.2 Sources of Waste

From a waste minimization standpoint, the primary types of construction wastes can be grouped as:

- spent solvents,
- strong acids or alkalies,
- paint wastes with heavy metals,
- ignitable paint wastes, and
- other ignitables.

Some or all of the wastes within a single group may be combined before treatment and disposal. However, wastes of different types should be segregated. A description of the major construction wastes organized according to these five common areas is provided in Table 8.6.

Spent solvents come from many construction processes, including painting, cleaning, air conditioner maintenance, fluxing, and degreasing. Solvents are often used to clean tools and paint spray guns and brushes.

Strong acids and alkalies are another waste source. Acid and alkaline solutions are used in cleaning, degreasing, and plumbing operations.

Paint wastes are common to the construction industry and are generated by painting and other paint-related processes such as paint preparation and paint brush and spray gun cleaning. These wastes can contain a variety of ignitable solvents and/or heavy metals such as lead.

Other ignitable wastes such as epoxy resins and adhesives are also sources of hazardous waste in the construction industry.

8.8.3 Good Operating Practices for Waste Minimization

Good operating practices are defined as procedural or institutional policies which result in a reduction of waste and may include:

- personnel practices,
- procedural measures,
- loss prevention practices, and
- waste stream segregation.

Good operating practice applies for every waste stream and is one of the first methods which should be investigated in a waste minimization program. A detailed discussion of good operating practices is provided in Section 7.1.

8.8.4 Specific Waste Minimization Practices

The most common waste minimization practices applicable to the five main waste streams in the construction industry are summarized in Table 8-6.

Table 8.6. Construction industry waste streams and minimization practices.

<i>Common waste streams</i>	<i>Primary process waste description</i>	<i>Minimization practice</i>
Spent solvents	Spent solvents from parts cleaning; wood cleaning; oil and grease removal; paint removal and preparation.	• See Section 9.1
Strong acid/alkaline wastes	Rust removers; lacquer, paint and varnish removers; cleaners and degreasers.	• See Section 9.4
Paint wastes	Paint wastes containing flammable solvents or heavy metals.	• See Section 7.3

Table 8.6. (continued)

<i>Common waste streams</i>	<i>Primary process waste description</i>	<i>Minimization practice</i>
Other	Epoxy resins, adhesives; paint and ignitables, varnish based paints; cleaners and degreasers.	Exercise care in handling liquids. Substitute water-based removers. Recycle solvents.

Spent Solvents

Spent solvents generated in the construction industry are similar to those found in other industries. A detailed description of the minimization of spent solvent wastes is found in Section 9.1, *Solvents*.

Strong Acids/Alkalies

Strong acid and alkaline wastes generated by the construction industry are similar to those generated in other industries. A detailed discussion of waste minimization practices for acids and alkalies is described in Section 9.4, *Corrosive Wastes*.

Paint Wastes

Paint wastes generated by the construction industry are similar to those generated in other industries. A detailed discussion of waste minimization practices for paint wastes is described in Section 7.3, *Paint Application*.

Other Ignitables

Ignitable wastes other than paint wastes can include epoxy resins, adhesives, gasoline, and paint and varnish thinners. The most common means of minimizing these wastes are:

- **Exercise care in handling liquids.** Hand pumps or dispensers should be used to transfer liquids such as gasoline and kerosene. This reduces the probability of spills as well as the occupational hazards associated with siphoning hoses.

- **Substitute water-based paints.** In many applications, water-based paints can be used instead of solvent-based paints. This reduces the amount of volatile solvents used, and subsequently reduces the amount of solvent wasted.
- **Recycle solvents.** Small-scale solvent distillation units can be purchased to recover solvents from paint wastes (brush and sprayer cleaning) and used cleaning solutions. See Section 9.1 for more details on recycling solvents.



8.9 Educational and Vocational Shops

8.9.1 Industry Process Description

Educational and vocational shops can be divided into four groups, each of which generates hazardous wastes:

- automobile engine and body repair,
- metalworking,
- graphic arts, and
- woodworking.

8.9.2 Sources of Waste

From a waste minimization standpoint, the primary types of educational and vocational shop wastes can be grouped as:

- photographic wastes,
- spent solvents,
- waste ink with solvents,
- waste ink with heavy metals,
- ink sludge with chromium or lead,
- strong acids or alkalies,
- spent plating wastes,
- ignitable paint wastes, and
- paint wastes with heavy metals.

Some or all of the wastes within a single group may be combined before treatment and disposal. However, wastes of different types should be segregated. A description of the major shop wastes organized according to these nine common areas is provided in Table 8.7. A brief discussion of each follows.

- Photographic wastes include the heavy metal solutions used in photographic developing and carbon tetrachloride solutions.
- Spent solvents account for the majority of wastes produced. Solvents are used in virtually all vocational and educational shops—automobile engine and body repair, graphic arts, metalworking, and woodworking. Solvents may be used for cleaning tools, paint spray guns and brushes, and in photographic developing and wood finishing.
- Waste inks can contain either ignitable solvents or heavy metals. Ink sludge usually contains lead or chromium. Each of these wastes is typically generated by graphic arts shops.
- Strong acids and alkalies are another waste source. Acid and alkaline solutions are used in rust removal, metal etching, and are found in lead acid batteries.
- Spent plating solutions from graphic arts shops are another source of waste which may contain high concentrations of heavy metals.
- Paint wastes are common to automobile repair shops as well as graphic arts shops. These wastes can contain a variety of ignitable solvents and/or heavy metals such as lead.

8.9.3 Good Operating Practices for Waste Minimization

Good operating practices are defined as procedural or institutional policies which result in a reduction of waste and may include:

- personnel practices,
- procedural measures,

- loss prevention practices, and
- waste stream segregation.

Good operating practice applies for every waste stream and is one of the first methods which should be investigated in a waste minimization program. A detailed discussion of good operating practices is provided in Section 7.1.

8.9.4 Specific Waste Minimization Practices

The most common waste minimization practices applicable to the nine main waste streams in educational and vocational shops are summarized in Table 8-7.

Table 8.7. Educational and vocational shops waste streams and minimization practices

<i>Common waste streams</i>	<i>Primary process waste description</i>	<i>Minimization practice</i>
Photographic wastes	Waste carbon tetrachloride; spent processing solution containing heavy metals.	See Section 8.7 See Section 9.2
Spent solvents	Spent solvents from parts cleaning; wood cleaning; oil and grease removal; paint removal and preparation.	See Section 9.1
Waste ink	Waste ink with solvents or heavy metals.	See Section 8.6
Ink sludge	Ink sludge with chromium or lead.	See Section 8.6 See Section 9.7
Strong acid/alkaline wastes	Rust removers; lacquer, paint and varnish removers.	See Section 9.4

Table 8.7. (continued)

<i>Common waste streams</i>	<i>Primary process waste description</i>	<i>Minimization practice</i>
Spent plating solutions	Spent plating solutions.	See Section 8.3.4
Paint wastes	Paint wastes containing flammable solvents or heavy metals.	See Section 7.3

Photographic Wastes

Photographic wastes generated in educational and vocational shops are similar to the wastes produced in the photographic industry. Detailed discussions of waste minimization practices for such wastes are in Section 8.7, *Photography*, and Section 9.2, *Halogenated Organic (Non-Solvent) Wastes*.

Spent Solvents

Spent solvents generated in educational and vocational shops are similar to those found in other industries. A detailed description of the minimization of spent solvent wastes is found in Section 9.1, *Solvents*.

Waste Ink

Waste ink generated in educational and vocational shops is similar to the waste ink produced in the printing industry. A detailed discussion of waste minimization practices in the printing industry is found in Section 8.6, *Printing*.

Ink Sludge

Ink sludges generated in educational and vocational shops are similar to those generated in the printing industry. Waste minimization practices in the printing industry are described in Section

8.6, *Printing*. In addition, a discussion of waste minimization for sludges appears in Section 9.7, *Sludges*.

Strong Acids/Alkalies

Strong acid and alkaline wastes generated by educational and vocational shops are similar to those generated in other industries. Waste minimization practices for acids and alkalies are described in Section 9.4, *Corrosive Wastes*.

Spent Plating Solutions

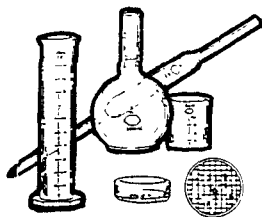
Plating solutions are not discarded frequently, but do require periodic replacement. Minimization practices available for the reduction of spent plating waste are described in detail in Section 8.3.4.

Paint Wastes

Paint wastes generated by educational and vocational shops are similar to those generated in other industries. Waste minimization practices for paint wastes are described in Section 7.3, *Paint Application*.

8.10 Analytical and Clinical Laboratories

8.10.1 Industry Process Description



Analytical and clinical laboratories can operate any number of the following departments, each generating quantities of hazardous waste:

- pathology
- radiology
- nursing units
- equipment repair
- laundry
- embalming
- clinical/research
- histology
- autopsy
- dialysis
- maintenance
- pharmacy
- sterile processing
- laboratories

8.10.2 Sources of Waste

From a waste minimization standpoint, the primary types of analytical and clinical laboratory wastes can be grouped as:

- formaldehyde,
- photographic wastes,
- mercury,
- pesticides, insecticides,
- strong acids or alkalies,
- oxidizers,
- ignitable paint wastes,
- paint wastes with heavy metals,
- spent solvents,
- halogenated solvents,
- poisons, and
- unused chemical reagents.

Some or all of the wastes within a single group may be combined before treatment and disposal. However, waste of different types should be segregated. A description of the major laboratory wastes organized according to these eleven common areas is provided later in this section in Table 8.8.

Spent solvents account for a large portion of the wastes produced. Solvents are used in cleaning laboratory glassware, extractions, and other laboratory procedures. Solvents may also be used for cleaning tools, paint spray guns and brushes, and in photographic developing. Most laboratory sections generate some kind of waste solvent. These wastes can include alcohols and halogenated solvents (e.g., carbon tetrachloride).

Strong acids and alkalies are another waste source. Acid and alkaline solutions are often used as chemical reagents in clinical and research laboratories, or as cleaning agents by maintenance departments.

Photographic wastes include the heavy metal solutions used in photographic developing. These are usually generated by radiology departments.

Waste formaldehyde is generated by those laboratory departments conducting autopsies or involved in embalming.

Paint wastes are common in the maintenance areas of larger laboratories. Paint wastes can contain a variety of heavy metals such as lead or ignitable solvents. Care should be taken to segregate these wastes as much as possible to facilitate efficient waste management.

Waste mercury is generated by accidental thermometer breakage, and in the equipment repair sections dealing with sphygmomanometers.

Waste pesticides and insecticides are often produced when exterminators attempt to provide a pest-free laboratory.

Waste oxidizers are occasionally produced from the use of oxidizers such as silver nitrate. Such chemicals were common laboratory reagents in the past.

Poisons such as phenol and mercuric chloride are often generated by clinical and research labs.

8.10.3 Good Operating Practices for Waste Minimization

Good operating practices are defined as procedural or institutional policies which result in a reduction of waste, and may include:

- personnel practices,
- procedural measures,
- loss prevention practices, and
- waste stream segregation.

Good operating practice applies for every waste stream and is one of the first methods which should be investigated in a waste minimization program. A detailed discussion of good operating practices is provided in Section 7.1.

8.10.4 Specific Waste Minimization Practices

The most common waste minimization practices applicable to the 11 main waste streams in analytical and clinical labs are summarized in Table 8.8. Each of these waste minimization practices is briefly described in the following sections.

Photographic wastes

Photographic wastes generated in analytical and clinical laboratories are similar to the wastes produced in the photographic industry. A detailed discussion of waste minimization practices for such waste is contained in Section 8.7, *Photography*.

Spent Solvents

Spent solvents generated in analytical and clinical laboratories are similar to those found in other industries. A detailed description of the minimization of spent solvent wastes is found in Section 9.1, *Solvents*.

Formaldehyde

Waste formaldehyde generated in analytical and clinical laboratories can be minimized by the following procedures, which are applicable to all laboratory chemicals:

- **Purchase only necessary quantities.** By purchasing only amounts required for proper laboratory operations, laboratories can lessen the probability that chemicals will become too old for testing and analytical purposes—eventually becoming waste.
- **Store efficiently.** Properly stored chemicals have a much lower probability of contamination, thus increasing their chances for use within the laboratory. Proper storage can include:
 - storing chemicals in a well organized, central location;
 - organizing chemicals by their age, using the older chemicals first; and

- maintaining a list of all unused chemicals for possible waste exchange.

Mercury

Waste mercury must be handled with extreme care due to its high level of toxicity. One way of avoiding the generation of waste mercury is to avoid breaking thermometers and the unnecessary repair of laboratory equipment that contains mercury. See Section 7.1, *Good Operating Practices*. In addition, the following can be beneficial in the minimization of waste mercury:

- **Purchase only necessary quantities.** By purchasing only amounts required for proper equipment repair, laboratories can lessen the probability that mercury is wasted—in addition to lessening the probability of excessive exposure.

Strong Acids/Alkalies

Strong acid and alkaline wastes generated by analytical and clinical laboratories are similar to those generated in other industries. A detailed discussion of waste minimization practices for acids and alkalies is described in Section 9.4, *Corrosive Wastes*. In addition, care should be taken in the management of acids and bases used as laboratory reagents as described in this section under *Used Chemical Reagents*.

Pesticides and Insecticides

Pesticide and insecticide wastes generated by analytical and clinical laboratories are similar to those generated in other industries. A detailed discussion of waste minimization practices for pesticide and insecticide wastes is described in Section 8.11, *Pesticides*.

Table 8-8. Analytical and clinical laboratory waste streams and minimization practices.

<i>Common waste streams</i>	<i>Primary process waste description</i>	<i>Minimization practice</i>
Photographic wastes	Spent processing solutions containing heavy metals.	<ul style="list-style-type: none"> • See Section 8.7.
Spent solvents	Spent solvents from glass cleaning; oil, grease, and paint removal.	<ul style="list-style-type: none"> • See Section 9.1
Formaldehyde	Waste formaldehyde from embalming, autopsies.	<ul style="list-style-type: none"> • Purchase only necessary quantities. • Store efficiently.
Mercury	Waste mercury from broken thermometers; waste from instrument repair.	<ul style="list-style-type: none"> • See Section 7.1 • Take care in handling thermometers. • Purchase only necessary quantities.
Strong acid/alkaline wastes	Rust removers; lacquer, paint, varnish removers; laboratory reagents.	<ul style="list-style-type: none"> • See Section 9.4. • See Section 8.10.
Pesticides and insecticides	Waste pesticides and insecticides from maintenance and grounds crews.	<ul style="list-style-type: none"> • See Section 8.11.
Paint wastes	Paint wastes containing flammable solvents or heavy metals.	<ul style="list-style-type: none"> • See Section 7.3.
Oxidizers	Waste oxidizing laboratory reagents such as silver nitrate.	<ul style="list-style-type: none"> • See Section 8.10.
Halogenated organics	Spent halogenated hydrocarbons such as carbon tetrachloride.	<ul style="list-style-type: none"> • See Section 9.2.

Table 8-8. (continued)

<i>Common waste streams</i>	<i>Primary process waste description</i>	<i>Minimization practice</i>
Used chemicals	Waste laboratory reagents.	<ul style="list-style-type: none"> • See Section 7.1. • Purchase only necessary quantities. • Make chemical substitutions. • Store efficiently.
Poisons	Waste such as phenol and mercuric chloride.	<ul style="list-style-type: none"> • Purchase only necessary quantities. • Make chemical substitutions.

Paint Wastes

Paint wastes generated by analytical and clinical laboratories are similar to those generated in other industries. A detailed discussion of waste minimization practices for paint wastes is described in Section 7.3, *Paint Application*.

Oxidizers

Waste oxidizers are generated by analytical and clinical laboratories as waste laboratory reagents such as silver nitrate. A detailed discussion of waste minimization practices for chemical reagents is described in this section under *Used Chemical Reagents*.

Halogenated Organics

Halogenated organic wastes generated by analytical and clinical laboratories are similar to those generated in other industries. A detailed discussion of waste minimization practices for halogenated hydrocarbons is described in Section 9.2, *Halogenated Organic Wastes*.

Used Chemical Reagents

Waste chemical reagents can be minimized by managing chem-

icals more efficiently (see Section 7.1, *Good Operating Practices*). In addition, the following can be beneficial in the minimization of waste chemical reagents:

- **Purchase only necessary quantities.** By purchasing only amounts required for proper laboratory operations, laboratories can lessen the probability that chemicals will become too old for testing and analytical purposes—eventually becoming waste.
- **Make chemical substitutions.** By replacing hazardous laboratory reagents with less hazardous alternatives, the level of hazard in a laboratory's waste can decrease.
- **Store efficiently.** Properly stored chemicals have a much lower probability of contamination, thus increasing their chances for use within the laboratory. Proper storage can include:
 - storing chemicals in a well organized, central location;
 - organizing chemicals by their age, using the older chemicals first; and
 - maintaining a list of all unused chemicals for possible waste exchange.

Poisons

Waste poisons such as phenol and mercuric chloride can be minimized in much the same way as the minimization of other chemical reagents.

- **Purchase only necessary quantities.** By purchasing only amounts required for proper laboratory operations, laboratories can lessen the probability that poisons will become too old or even illegal for testing and analytical purposes—eventually becoming waste.

8.11 Pesticides

8.11.1 Industry Process Description



Pesticide formulators prepare pesticide products from pesticide concentrates, solvents, carriers, and other additives. Pesticide applicators apply the pesticide to the treatment site.

Pesticides are most commonly formulated into wettable powders, dusts, emulsions, granules, and aerosols. Although the processes involved in producing these various formulations are different, there are general operations common to all of them. These common operations include:

- mixing,
- dissolving,
- blending, and
- packaging.

Pesticide applicators purchase the pesticide products, usually dilute them with water or another diluting agent, and apply the pesticide to the treatment site using special application equipment.

8.11.2 Sources of Waste

Waste containing pesticides and other hazardous materials are produced as part of the pesticide formulation and application processes. The waste is principally a result of cleaning equipment between batches, cleanup of spills, and the production of off-specification product. Other pesticide wastes include the empty pesticide containers (e.g., packages or drums) and dust collected in air pollution equipment. These wastes are further described in Table 8-9.

8.11.3 Good Operating Practices For Waste Minimization

Good operating practices are defined as procedural or institutional policies which result in a reduction of waste, and may include:

- personnel practices,
- procedural measures,
- loss prevention practices, and
- waste stream segregation.

Good operating practice applies for every waste stream and is one of the first methods which should be investigated in a waste minimization program. A detailed discussion of good operating practices is provided in Section 7.1.

8.11.4 Specific Waste Minimization Practices

Common waste minimization practices which can be applied in pesticide formulation and application operations are summarized in Table 8-9.

Each of these waste minimization practices are briefly described in the following sections.

Rinse Water or Absorbent

A typical pesticide formulation plant produces different pesticides using the batch process. Between batches, tanks and other equipment must be cleaned to avoid contamination between the various products. Also, applicators apply different pesticides using the same equipment. This necessitates cleaning the equipment between applications in addition to normal cleaning operations. Equipment used in the formulation or application of liquid pesticides are usually cleaned with water, while equipment used in the formulation of "dry" pesticides (e.g., powders and granules) are cleaned using a dry, inert material such as clay. Methods to reduce rinse water or absorbent waste follow.

Store and reuse rinse water or absorbent. Rinse water or absorbent from equipment cleaning can be collected and stored for:

- reuse as make-up water, diluent, or carrier during the next formulation of the same product;

- reuse as rinse water or absorbent in future equipment cleaning. Where more than one rinse is needed to clean the equipment, the first rinse can be performed using old rinse water. That rinse will remove most of the residue, while fresh water can be used for the second rinse.

Use high pressure spray nozzles. Use of high pressure rinsing systems can reduce water consumption and rinse water production by 80-90 percent.

Use dry absorbents for spill clean-up. This greatly reduces the waste volume associated with spill clean-up in comparison to washing down the area with water.

Sweep floor to collect spills for product reformulation. This obvious practice has been successfully used to reduce "dry" pesticide waste volume.

Off-Specification Products

Off-specification pesticide formulations or incorrectly prepared pesticide spray mixtures are produced as a result of poor process control and operation. This waste source can be reduced by using the following methods.

Strict process control or automation. This technique helps ensure that a high quality formulation or mixing process is repeatable and avoids aspects of operator error.

Reformulate off-specification batches. Instead of discarding off-specification batches as waste, they should be reformulated to bring them into product specification.

Packages and Drums

Emptied drums or packages used to store or transport pesticides still contain a pesticide residue. Cleaning the drums to reuse them internally produces pesticide waste. Disposal of drums treats them

Table 8-9. Waste categories of pesticide formulations, and applicators and minimization practices.

<i>Waste category</i>	<i>Source</i>	<i>Minimization practice</i>
Rinse water or absorbent	Equipment cleaning, spills area washdown.	<ul style="list-style-type: none"> • Storage and reuse of rinse water or absorbent. • Use of high pressure spray nozzles. • Use of dry absorbents for spill cleanup. • Floor sweeping to collect spills for product reformulation.
Off-specification products	Poor process control.	<ul style="list-style-type: none"> • Strict process control or automation. • Reformulation of off-specification batches.
Packages and drums	Pesticide residue in drums. Empty packages or drums.	<ul style="list-style-type: none"> • Rinse drums using minimum amount of water and reuse or recondition them. • Use refillable or returnable bulk tote drums bins.
Dust collected in air pollution equipment	Dust generated during handling, grinding, and other formulation operations.	<ul style="list-style-type: none"> • Recycle dust into process where it was generated.

as waste and can be a waste disposal problem. These two recommendations can help you avoid or minimize these problems:

Rinse drums using a minimum amount of water. Triple rinsing with the use of high pressure spray systems can significantly reduce the production of pesticide rinse water.

Use refillable or returnable bulk tote bins. Containers that can be refilled or returned to the supplier eliminates the need for their disposal.

Dust Collected in Air Pollution Equipment

Pesticide dust particles are produced during the grinding and handling operations associated with the formulation of "dry" pesticide formulations.

Recycle collected dust into process where it was generated.

Pesticide dust particles collected in dust collection equipment can be reintroduced into the formulation process, thereby reducing waste production.

Product Substitution

For some pesticide applicators who are also pesticide users (e.g., farmers and greenhouse operators), reducing the use of pesticides can be a means of reducing pesticide waste. Integrated pest management (IPM) is a pest control strategy that does not rely solely on the use of man-made pesticides. Pest control methods included in an IPM program follow.

Biological control. Pests can be controlled by introducing their natural predators into the infested fields. Some natural predators can be purchased from insectaries.

Genetic control. Crop species that are bred to resist certain diseases or pests can be planted.

Cultural control. Pests may be controlled by selecting certain crop rotation schedules, or by timing the planting and harvesting schedule to avoid the pest, and through other agronomic measures.

Chemical control. Use of pesticides is also part of an IPM program in which pesticides are used only when necessary to keep pest populations below levels where they cause economic loss.

9.0 WASTE-SPECIFIC MINIMIZATION PRACTICES

This chapter describes minimization practices for seven specific wastes:

- solvents,
- halogenated organic (non-solvent) wastes,
- metal wastes,
- corrosive wastes,
- cyanide and reactive wastes,
- oils, and
- sludges.

In addition, information is given about off-site recycling and recovery centers

9.1 Solvents

9.1.1 Source of Solvent Wastes

Solvent wastes are generated primarily by industrial operations that include:

- painting and coating shops that use solvents to clean equipment;
- metal-working and machine plating shops that use solvents during degreasing; and
- surface cleaning processes in the electrical, electronics, and printing industries.

9.1.2 Solvent Recycling Technologies

The main solvent recycling and minimization techniques are:

- **Distillation.** Separation techniques that rely on the boiling point differences between the components of a liquid waste.
- **Solids removal.** Elimination of suspended particles to reduce fouling.

- **Emulsion or dispersion breaking.** Separation of solvent or oil droplets in water, or of water droplets in oil.
- **Dissolved and emulsified organics recovery.** Organics separation techniques that concentrate the organics so they can be recovered.

Each of these operations may be performed singly or in sequence. The recyclable product may be the solvent or the isolated contaminants, or both.

9.1.3 On-Site Recycling Equipment

Due to recent developments, small solvent recycling units are now commercially available for businesses generating low volumes of waste solvents. These simple heating and condensing systems remove impurities from the solvent waste streams, returning the solvent or the solvent blend to the process which generated it.

- A B/R Instrument Corporation solvent recovery system was used by a laboratory at Toronto General Hospital. The distillation unit cleaned xylene and chloroform to 100 percent purity and isopropyl alcohol to 99.7 percent. The lab recovered \$180 per week of solvents which would otherwise have required costly off-site disposal.

Some companies have been able to scale down their equipment considerably since the equipment was first marketed.

- The Brighton Corporation introduced its first solvent recovery system over 20 years ago. They now manufacture units with capacities as small as 7.5 gallons of solvent treated per hour.
- There are numerous manufacturers of solvent recovery equipment in a variety of sizes. The smallest of these units reclaims solvents having a boiling point of 160°C or less. The waste solvent is reclaimed in 15-gallon batches,

although clean solvent can be drawn off during operation. Recovery levels range from 80 to 95 percent, depending on the amount and type of contamination. Check one of the equipment buyers' guides or other information source given in Chapter 11 for a list of manufacturers of solvent recovery equipment.

9.1.4 Solvent Loss Minimization Practices

Solvents are used most frequently in:

- the soak tank, and
- the vapor degreaser.

The vapor degreaser, because it produces considerable air pollution, has been studied in much greater detail with respect to pollution control. However, the primary methods for reducing waste are the same for both the degreaser and the soak tank. The two most important goals are to minimize solvent vapor loss and maintain solvent quality. The following methods were considered the most successful in achieving these objectives

Install lids/silhouettes on tanks. All tanks should be covered when not in use. Covers that can be used during the cleaning process (known as "silhouette entries") are available and allow for even greater reduction in vapor loss. All covers should be designed to slide horizontally over the top of the tank, since this disturbs the vapor zone less than hinged covers.

Increase the freeboard space on tanks. An increased freeboard has been proven to decrease emissions. Early degreasers had a freeboard equal to one-half the tank width. When the U.S. EPA in the mid-1970s recommended a 75 percent freeboard, emissions were decreased up to 46 percent. Increasing the freeboard to 100 percent can provide an additional 39 percent reduction when air turbulence is present.

Install freeboard chillers in addition to cooling jackets. A second set of refrigerated coils is installed above the condenser coils. These coils chill the air above the vapor zone and create a second barrier to vapor loss. Reductions in solvent use of up to 60 percent have been realized. However, water contamination of the solvent can occur due to frost buildup on the coils, so special water collection equipment is also necessary.

Implement better operating practices. Several housekeeping measures can significantly affect the amount of solvent waste produced.

- Separators should be cleaned and checked frequently to avoid cross contamination of solvents or water which can lead to acid formation. Also, parts should not enter the degreaser while wet.
- Promptly remove sludge collected at the bottom of the tank. This increases cleaning efficiency because contaminants do not absorb solvent and dissolve into the solution. As solvents are used, their ability to neutralize acids lessens. While the common practice is to add new solvent to the aged solvent, a more efficient method is to analyze the solvent and add specific components. The expense of analysis will be offset by the savings in solvent for tanks of approximately 500 gallons or more.
- Other waste reduction techniques, based on better operating practices, include:
 - standardizing the solvent used to allow for easier recycling,
 - consolidating cold cleaning operations into a centralized vapor degreasing operation,
 - locating cold cleaning tanks away from heat sources,
 - controlling the amount of heat supplied to vapor degreasers,

- avoiding spraying parts above the vapor zone or cooling jacket, and
- avoiding solvent vapor drag-out.

9.2 Halogenated Organic (Non-Solvent) Wastes

9.2.1 Source of Halogenated Organic Wastes

Non-solvent wastes are generated primarily by:

- the pesticide and fertilizer industry, which generates chlorinated pesticide dust and rinse waters;
- miscellaneous repair services, which generate PCB-contaminated fluids (during the maintenance and repair of electrical transformers) and contaminated specialty organic cleaning fluids; and
- the lumber and wood products industry, which generates chlorinated organic wastes from the manufacture of wood preservatives and from application of pentachlorophenol to lumber products.

Halogenated organic wastes include both liquid and solid waste streams.

9.2.2 Non-Solvent Recycling Technologies

These are the main non-solvent recycling and minimization practices:

- **Use of waste as fuel.** Halogenated organic wastes are used as fuel in cement kilns. Energy in the form of heat is recovered, as well as acid gas, which reacts with free alkali in the cement to produce a low-alkali cement.

-
- **Baghouse filters.** Pesticides and pesticide intermediates are usually recycled on site. Baghouse filters are used to collect dust and particulates generated by product drying or blending.

Recycling opportunities are generally more restricted for this class of materials because:

- some of these wastes, especially those containing poly-halogenated aromatics, may be contaminated with dioxins; and
- markets for some of the recycled products, such as carbon tetrachloride, have been declining sharply in recent years.

9.2.3 Halogenated Organic Waste Minimization Practices

Solid waste is generated from the collection of dust in baghouses during material handling, grinding, blending, and standardizing operations. These waste minimization techniques are available:

Use wet instead of dry grinding. Then spray dry the output to reduce the amount of dust emitted.

Increase the use of dust suppression techniques. Atomized water sprays, enclosed weigh-transfer hoppers, or better care during manual handling will all decrease dust emission.

Recycle baghouse fines. Baghouse emptying should be scheduled to encourage recycling.

Better operating practices. As always, closer attention to handling, storing, and spill prevention will increase plant efficiency.

9.3 Metal Wastes

9.3.1 Source of Metal Wastes

Metal wastes are generated primarily by these industrial applications:

- Electroplating, photofinishing, and printing commonly produce process and rinse waters contaminated with silver, nickel, zinc, tin, copper, chromium, lead, or cadmium.
- Equipment cleaning in the steel and metallurgy industries generates aqueous solutions containing toxic metals and oxides.
- Manufacture of leaded paint and gasoline generates sludges containing metals.

9.3.2 Metal Recovery From Waste Rinse Waters

These technologies are available to recover metals from waste rinse water before treatment:

Evaporation. Waste rinse water is evaporated by heating, leaving behind a concentrated solution. The solution is concentrated until its metals content is equal to that of the plating bath. This solution is then reused. This method has been used frequently for chromium recovery from rinse water.

- One plant was able to recover 8,000 pounds of chromium per month—resulting in savings of \$100,000 per year, with a 1-year return on investment.

Evaporation should be combined with multiple countercurrent rinse tanks or spray/fog rinsing. Rinse water should be deionized or softened prior to use in order to prevent calcium and magnesium salt buildup.

Reverse osmosis. At high pressure, dilute waste is applied to a membrane. This allows the water to pass through, but retains the metals and other solutes. Thus, on one side of the membrane, a concentrated metal solution is produced which can be returned to the plating bath. On the other side of the membrane, water is collected and can be reused as rinse water. Reverse osmosis uses less energy than evaporation, but the characteristics of the membranes available limit the type of waste streams that can be treated. Only very dilute streams can be treated, and the solution must be pre-filtered to extend membrane life.

Ion exchange. This involves passing a solution over an ion-exchange resin which exchanges one of its own ions for a metal ion in solution. Once a resin has reached its capacity, it must be regenerated. This is accomplished using an acid or base depending on the resin. Another step may be necessary to remove the metal from the acid or base so the metal can be used.

Electrolytic metal recovery. Metal ions in solution are plated electrochemically onto a cathode surface within the solution. When the cathode becomes fully coated with the metal, it is removed from the solution and placed into a plating bath as an anode, replenishing the bath with the metal. One advantage of this method is that it recovers only the plating metal, not the impurities, from the waste rinse water. This method is most efficient with solutions of metal ions in concentrations greater than 100 mg/l (milligrams per liter), and has been used to recover copper, tin, gold, silver, cadmium, and other metals.

Electrodialysis. An electric current and selective membranes are employed to separate the positive and negative ions from a solution into two streams. While electrodialysis is used mainly to concentrate dilute solutions of salts or metal ions, it has been used to remove nickel, copper, cyanide, chromium, iron, and zinc from waste rinse water.

9.3.3 Metal Waste Recovery Technologies

These are the main metal waste recovery technologies:

Agglomeration. This is a process which gathers small particles into larger particles, where the small particles can still be identified. Because of their metallic contents, mill scale, sludges, and dusts from various industries are agglomerated to be used in blast or induction furnaces. Agglomeration avoids particulate carryover from furnaces.

Particulate and vapor recovery from gases. Metals are usually recovered as fine particles. Cadmium dust generated from cadmium batteries or pigment plants can be recycled. More volatile metals (such as mercury or lead) must be recovered from the vapor phase.

Metal concentration process. There are several methods for concentrating metals from a bulk solid or liquid into a sludge or solution. Unit operations for concentrating metals include hydro-metallurgical processing, solvent extraction, ion exchange, and others. These processes have been developed either to recycle the metals or to treat the bulk stream to render it non-hazardous.

- Vulcan Materials Inc. leaches contaminated brine muds with sulfuric acid to convert the solids to non-hazardous gypsum and recover the mercury.
- Nickel-plating solutions are reacted with soda ash to precipitate nickel carbonate, which then is collected and reacted with sulfuric acid to generate an impure nickel-sulfate solution. Adding small quantities of sodium sulfide will precipitate iron salts as iron sulfide. The solution is next separated from iron sulfide by filtration and evaporated to recover pure nickel sulfate. Spent nickel catalysts, after being dissolved with mineral acid, can be treated the same way.

Metals reduction techniques. Recover metal from rinse water before treatment. Waste must be concentrated before application of a reduction technique.

- In electrolytic recovery, metal ions migrate to the cathode where they are reduced to their elemental form and are plated out. See Section 9.3.2.
- A recently developed process involves addition of sodium borohydrate to neutral or alkaline solutions of metals and the precipitation of metals in their elemental form by reduction. After filtration, the metals can be sold directly to scrap metal dealers.

9.4 Corrosive Wastes

Corrosive wastes are generated by industries that use acidic or alkaline solutions in production or finishing processes.

9.4.1 Source of Corrosive Wastes

Some of the primary industries that generate corrosive wastes include:

- metal-finishing industries, which produce corrosive wastes during electroplating, etching and cleaning operations, among others (spent alkaline cleaning solutions and pickling solutions are the most frequently generated wastes);
- electrical and electronics industry, which generates spent metal-bearing acid solutions from the cleaning of scale from metals during the production of semiconductors, and from etching of metal circuit boards; and
- textile mill industry, which generates spent sodium hydroxide from mercerizing.

9.4.2 Corrosive Waste Recycling Technologies

Corrosive wastes that are recycled include spent acids and alkalis from chemical manufacture and petroleum refining processes—and also the acid from spent pickle liquor. The following technologies are commonly used to recycle corrosive wastes.

Thermal decomposition. This process is used in the recovery of sulfuric acid from spent acid sludges to recover ferric chloride from acidic titanium dioxide waste. Thermal decomposition is also used to recover hydrochloric acid from spent pickling liquor or halogenated organic residues.

Evaporation. Liquid waste is partially evaporated by heating, leaving a concentrated solution. Both atmospheric and vacuum evaporators are used to concentrate corrosive wastes. Evaporation is applicable only to concentrated acids or bases with low amounts of volatile organics.

- Spent acid containing 70 percent sulfuric acid is generated from the production of nitrobenzene by reacting benzene with nitric acid in the presence of sulfuric acid. After removal of organic impurities by stripping, the spent acid is concentrated by evaporation for reuse in the nitration process.

Crystallization. Corrosives are removed from a solution by cooling. The resulting crystals are then separated from the solution by a variety of methods.

Ion exchange. Ion-exchange resins can remove heavy metals and cyanides from acid and base solutions. The purified solutions can then be reused in the manufacturing process.

- A recent ion-exchange process developed by Eco-Tech Ltd. of Canada purifies acid solutions by ion exchange without producing a waste regenerant stream. The process uses a resin that selectively removes acids and rejects metallic contaminants. Metallic salts pass through the resin bed and are collected. The bed is flushed with water to displace the acid for reuse.

9.5 Cyanide and Reactive Wastes

The category of cyanide and reactive wastes includes wastes with cyanide constituents, sulfides, explosives, strong oxidizers and reductants, and wastes that react violently with water.

9.5.1 Source of Cyanide and Reactive Wastes

Cyanide and reactive wastes are generated almost exclusively by the metal finishing and processing industries. The primary applications in which they are generated include:

- cyanide baths used to keep soluble metals in solution so they can be used in either electroplating or stripping solutions; and
- spent process solutions, contaminated rinse waters, and accidental spills.

Other industries which generate reactive wastes include those involved in explosives and propellant manufacture.

9.5.2 Cyanide Waste Recycling Practices

Cyanide waste waters generated from precious metal beneficiation are commonly recycled. Cyanides from other industries are not presently recycled, since the low cost of fresh cyanides makes it economically unfeasible. The waste is destroyed by chemical oxidation before discharge to municipal treatment plants, since the EPA banned land disposal of cyanides several years ago. These practices can be used for recycling cyanide wastes.

Refrigeration/crystallization. This method recovers and recycles cyanide from plating solutions that contain excess amounts of sodium carbonate. This technique was patented by the Department of Defense (DOD). Although it was thought to be promising, widespread use is believed to be limited because of the formalities involved in obtaining permission from the DOD to use the process.

Evaporation. This involves the evaporation of water from waste, leaving a concentrated solution behind.

Ion exchange. A resin is used that selectively absorbs acids and rejects cyanides. The bed is then flushed with water to collect the acid for reuse.

Membrane separation. This includes reverse osmosis and electrodialysis (see Section 9.3.2).

9.5.3 Reactive Waste Recycling Practices

The primary barrier to recycling reactive wastes is a technical one. In specialized applications of alkali metals such as lithium, recycling purified wastes is impractical, since contamination with oxides, dirt, oils, and many other things affects product quality. These are available technologies for recycling reactive wastes:

Ammonium perchlorate separation by filtration and evaporation. Research is under way at DOD facilities to examine the feasibility of recovering reactive wastes. The proposed operation involves concentration of ammonium perchlorate solution to 12 percent, evaporation of the concentrated solution, and then sale of recovered ammonium perchlorate to a contractor.

Separation of propellants constituents by solubilities. Research is also under way at DOD facilities to separate and recover propellants from rocket cases on the basis of differences in solubility. For example, ammonium perchlorate and inorganics are soluble in hot water. RDX (cyclotrimethylene base trinitroamine) is insoluble in water—but soluble in acetone. HMX (cyclotetramethylene tetranitroamine) is insoluble in water and acetone, but soluble in dimethyl sulfoxide (DMSO) and dimethyl formamide (DMF). Recovery of HMX from acetone is possible by evaporation of acetone. Removal of HMX from a DMSO or DMF solution can be achieved by crystallization followed by liquid-solid separation.

Sodium. Waste sodium is recovered from wastes from the Downs Cell Process for sodium manufacture. The technology was discussed earlier (Section 9.3.3, *Metal Reduction Techniques*).

- Ventron, a manufacturer of sodium borohydride, accepts sodium waste for reprocessing by this process to recover sodium. About 600 tons/year of impure sodium waste are returned for reprocessing.

9.6 Oils

9.6.1 Source of Oil Wastes

Oil wastes are generated primarily by:

- oil and grease removal in vehicle maintenance,
- cleanup operations in industries such as the paper industry, and
- equipment repair operations.

9.6.2 Off-Site Collection Centers

There are many used oil collection sites in most states. Although these centers were generally established for the purpose of receiving used oil from households, some may be willing to accept used oil from businesses. For a list of the centers nearest you, please call your state's waste minimization technical assistance program (see Chapter 11), state environmental regulatory agency, or CHMR's toll-free Hazardous Materials Hotline, (800) 334-CHMR.

9.6.3 Oil Recycling Technologies

These are the main oil recycling and minimization practices:

Separation. An oil/water separator uses a series of vertical and horizontal corrugated plates to force oil to the surface of the unit

where it is skimmed off. Oil droplets coalesce and rise to the underside of the plates. Eventually the oil passes through weep holes to the upper surface where it is collected by a skimmer. A computer simulation program allows precise calibration of the plates to maximize recovery from a specific waste stream.

Centrifugation. A centrifuge system decants the oil and removes dirt and metal clippings from the slurry. Centrifuging oil slurries and sludges allows for the sale of the water-free oil to power stations or other industrial plants—or for reuse by the same plant.

Continuous flow electrochemical waste treatment processes. These are custom designed for each application, so they can be scaled down for use by small businesses. Biological oxygen demand (BOD) and suspended solids are reduced. The process, combining electrostatic and electrolytic principles with chemical pH adjustments, reduces sludge production considerably.

Solvent extraction. Dimethylformamide (DMF) solvent extracts PCBs from waste oils. By washing with water in the second stage, solvent is separated and a PCB concentrate is left.

Dechlorination. Sodium compounds are used to dechlorinate PCBs. A nonhalogenated organic compound and a sodium salt are generated.

Each of these technologies has been used with good results.

- The Alfa-Laval centrifuge system, for example, has had varied applications to reclaim oil: from the waste slurry of a car manufacturer to the wash water of an industrial apparel cleaning firm.
- The Iron and Steel Industrial Corporation Works installed a mechanical skimming and chemical processing unit, recovering 40,000 liters of oil a month and saving \$100,000 a year.

9.6.4 Oil Loss Minimization Practices

Good operating practices, which can be implemented with little cost, can have a large effect on the amount of oil waste produced. These housekeeping practices can minimize oil waste:

Prevent spills. Using properly designed storage tanks and documenting the dollar value of any spillage which does occur can lessen the probability of a spill.

Install collection/drip pans. Placing pans under machinery and lubricating operations will allow for the recovery of oils instead of their disposal with absorbents or rags.

Launder oil-soaked rags. During laundering, oil can become biodegradable.

Use rags and absorbents to their limit. Absorbents and rags are often thrown out before their useful life is over. Use them to capacity to reduce the volume of contaminated absorbents.

9.7 Sludges

9.7.1 Source of Sludges

Sludges are generated primarily by industrial applications such as:

- electroplating and other metal manufacturing operations,
- crude oil cleaning in the petroleum refining industry, and
- paint stripping activities.

9.7.2 Sludge Minimization Practices in Storage Tank Cleaning

Sludge buildup can greatly reduce the efficiency of an operation. These waste minimization practices are available for reducing the generation of sludge:

Reduce lead in gasoline. The toxicity of tank sludges will be lower.

Install storage tank agitators. This will prevent the deposit of settling solids and hence reduce the need for cleaning.

Use corrosion resistant material. The use of a liner or construction materials which are more resistant to corrosion will reduce sludge production.

Prevent the oxidation of crude oil. This prohibits the formation of gums and resins. Oxidation can be minimized by providing a nitrogen blanket over the surface or by using floating roofs.

Dry sludge to reduce disposal volume. The Truth Division of Sealed Power, Inc., a manufacturer of door and window hardware, installed a sludge drier. They experienced a 65 percent reduction in the volume of metal hydroxide sludge. They estimate savings of \$18,200 a year in disposal costs.

9.7.3 Sludge Minimization Practices in Utility Production

Sludge that settles in a cooling tower basin is removed whenever the cooling tower is out of operation. Here are some suggestions to reduce sludge volume:

Install air coolers. This reduces the contamination of cooling water with process fluid, as well as the volume of cooling water in circulation.

Prevent leaks in the heat exchanger tube. Cross contamination from the process side of heat transfer equipment is one of the sources of sludge-creating materials. The use of seal welded tube joints, or double tube sheets, will minimize process fluid leakage into the cooling water, and vice versa.

Properly treat cooling tower water. Operators should refrain from overtreatment to avoid excess buildup due to chemical addition.

9.8 Off-Site Recycling and Recovery Centers

For many small businesses, it may be impractical to install certain recycling technologies described in previous sections of this chapter. However, there are numerous commercial facilities nationwide which operate hazardous waste recovery processes. For more information on these facilities or other commercial hazardous waste facilities in neighboring states, call your state's waste minimization regulatory agency, or CHMR's toll-free Hazardous Materials Hotline, (800) 334-CHMR.

10.0 Financing a Waste Reduction Program

Occasionally, small businesses may require assistance accumulating the capital necessary to start a waste minimization program. This chapter reviews financial assistance that is available from private and public sources. Addresses and phone numbers are provided for those interested in obtaining more information on specific forms of funding.

10.1 Types of Assistance

There are several types of assistance available to a company wishing to finance a waste minimization program. These options fall into the two basic categories:

- private funding, and
- government-assisted funding.

While most people are aware of the resources available through private funding, many are not aware of the many government programs to assist business with waste reduction. Also, there have been several cases of communities helping to raise money for a local business if the project is seen to be in the public interest.

10.2 Private Funding of Waste Minimization Programs

The private resources available for funding a waste minimization program are the same as those for any other business improvement. A bank loan is one option. For a public corporation, the issuance of stock is possible. Often banks are willing to grant a loan to a local industry to keep the business competitive and to promote a clean environment. A strong local industry will promote a profitable future for the bank. Also, the public relations benefits and exposure which can be gained by funding environmental programs are good for business. However, experience has shown that banks are reluctant to loan money for pollution control (or waste minimization) projects that do not also increase the efficiency and productivity of the business.

Two examples of innovative private funding for waste minimization programs are presented below. These financing programs arose from the compliance requirements of the 1977 Clean Water Act, which threatened the electroplating industry.

- The U.S. EPA estimated that Minneapolis/St. Paul could lose up to 20 percent of its electroplating industry if those companies were forced to purchase conventional treatment technology in order to meet the new standards. Consequently, nearly all electroplaters faced a simultaneous need to improve waste management.

The Metropolitan Council, the Twin Cities' regional planning organization, appointed a task force composed of members of the trade associations and the regulatory agencies to coordinate industry-wide compliance with the new waste water requirements. The study was funded by industry donations and a grant from the Minnesota Economic Development Section. Upon completion of the study, an industry-dominated corporation was set up to finance and develop the proposed treatment facility. In 1983 a site was purchased; in 1984 ion-exchange technology was tested; and in 1985 applications were made for the required permits and licenses. A pooled industrial bond offering was prepared to finance the \$6.5 million capital investment.

- In New Jersey, The Master's Association of Metal Finishers (MAMF) established a non-profit arm, the Research Foundation, to examine the feasibility of a centralized treatment facility for use by metropolitan New York-New Jersey electroplaters. Ninety members of MAMF each paid \$2,500, and additional assistance was obtained through grants and of other sources, including the the Port Authority of New York and New Jersey, the New York City Office of Economic Development, and the New York Community Trust. A study determined that a conventional treatment system would cost each company approximately \$200,000 to purchase and install at their own plants. On the other hand, it was determined that the centralized system would save the companies at least \$14,000 a year compared to the costs of operating their previous systems.

Each participating shop was to install an ion-exchange recovery system. When the ion-exchange resins are full, they are to be transported to the Central Recovery System (CRS), where the metals will be removed and sold to industries which can use them in the manufacturing process.

10.2.1 Business Development Corporations

One approach to private funding involves the use of business development corporations (BDC). Through a BDC, financing is provided in conjunction with another lending institution. BDCs are private lenders who secure loans for businesses which would not normally be approved for conventional financing. Therefore loans must be evaluated by the BDC and the conventional institution, if one is participating. Under this program, loans must be used to purchase land or buildings, to rehabilitate or construct buildings, and/or to purchase equipment, machinery, furniture, fixtures, and pollution control equipment. Funds may also be used to make leasehold improvements.

For additional information, contact the appropriate member of the National Association of Business Development Corporations given in Section 10.4.1.

10.2.2 Venture Capital

Venture capital financing involves direct investment of capital in a business by a private group. The investment is generally structured to allow the group to convert their equity position into cash or other liquid assets within a few years. There are private sources of venture capital, as well as capital firms licensed by the Small Business Administration (SBA), called the Small Business Investment Companies (SBIC). Your regional SBA office can refer you to the SBIC in your area.

10.3 Government-Assisted Funding of a Waste Minimization Program

Federal and state governments have both addressed the issue of financing waste minimization programs. Each has its own method of determining eligibility and dispensing money. These are examined separately below.

10.3.1 Federal Assistance

To date, there are no specific financial assistance programs geared toward waste minimization on the Federal level. The Federal government makes a distinction between pollution control and waste minimization. Waste minimization efforts are not eligible for the pollution control programs the government runs. This "realized waste" clause specifically requires that the assistance funds be used to construct facilities to treat or store waste. Any equipment or modification that reduces or eliminates the production of waste is not eligible.

In fact, some pollution control facilities have lost some of their incentives under the new tax laws. While they previously enjoyed tax-exempt bond status, the new laws have transferred that status to hazardous waste treatment facilities. RCRA prohibits issuance of tax-free industrial bonds for funding equipment purchases or modifications to bring a business into compliance with RCRA. Also under RCRA, certain on-site waste recycling practices require a "Part B" authorization from the U.S. EPA. Many industry leaders feel this is an extreme disincentive because of the cost to achieve compliance and to gain authorization.

Following is a list of organizations to contact for several of the Federal loan programs which are candidates for waste minimization financing. A brief description of the eligibility requirements is also given.

Small Business Administration (SBA)

Small Business Administration loan candidates for the following two programs must be small businesses unable to obtain private financing at reasonable rates and must be unable to qualify for conventional long-term asset financing. Each program has its own restrictions on the use of funds.

Business Loan Program (7A)
Office of Business Loans
Small Business Administration
1441 L Street, N.W.
Washington, DC 20416
(202) 653-6696

Section 503 Programs
Office of Economic Development
Small Business Administration
1441 L Street, N.W.
Washington, DC 20416
(202) 653-6416

The SBA manages one program specifically to help businesses meet pollution control or hazardous waste disposal regulations. This program, the Pollution Control Financing Program, helps businesses secure loans to cover capital costs incurred while implementing a pollution control project. The address is:

Pollution Control Financing Guarantees
Pollution Control Financing Branch
Small Business Administration
4040 North Fairfax Drive
Arlington, VA 22203
(703) 235-2902

EDA and FHA Loan Programs

Economic Development Administration (EDA) and Farmer's Home Administration (FHA) loans may be used for business and industrial construction; and the purchase and development of land, easements, equipment, facilities, machinery, supplies or materials; and working capital.

U.S. Department of Commerce
Economic Development Administration (EDA)
Room 7839
Washington, DC 20230
(202) 377-2621

FHA-Business and Industry Loan Guarantees
Farmer's Home Administration
Business and Industry Division, Room 5420
South 14th and Independence Avenue, S.W.
Washington, DC 20250
(202) 475-4100

10.3.2 State Assistance

There is a wide variation in the type and number of assistance programs at the state level which can assist businesses in financing waste minimization programs. Three main areas in which a state may assist a business include:

- technical assistance,
- loans, and
- grants.

Each of these will be discussed briefly in the following sections.

Technical Assistance

Technical assistance and information dissemination are indirect forms of financial assistance. This is especially valuable for smaller businesses which lack the resources to research and develop their own programs.

Typically, technical assistance programs are involved in three areas:

- identification and collection of technical information useful to local industries,
- preparation of appropriate informational material, and
- dissemination of information.

A list of state technical assistance programs is provided in Section 11.2.

Loans

In many states offering loan programs, most of the loans available require applicants to meet three eligibility requirements similar to the Federal ones. Applicants must be:

- small- to medium-sized businesses,
- unable to secure a loan through conventional financing sources and not have the capital to finance the program on their own, and
- classified in a standard industrial code classification that has a high potential for waste minimization.

Funding for such programs comes from a number of sources. Some states, while not directly involved in financing programs, can still direct small businesses to existing sources of financing on Federal and local levels. In all cases, state development agencies are an excellent reference. A list of state agency contacts is provided in Section 10.4.2.

Grants

A few states offer grants to offset the installation and capital cost of recycling equipment. The state agency contacts, or the appropriate organization within a state's environmental regulatory agency, should be able to provide information on any such available grants.

For additional information, contact the appropriate member of the National Association of Business Development Corporations given in Section 10.4.1.

10.4 Directories of State Contacts

Two lists published by the U.S. EPA in Washington, D.C. are potentially useful to small business owners: the national directory of the National Association of Business Development Corporations, and the state agency contacts for pollution control financing.

10.4.1 National Directory of the National Association of Business Development Corporations

Following is the national directory of the National Association of Business Development Corporations.

National Directory

National Association of Business Development Corporations

State	Director and Address	Phone Number
Arkansas	George H. Eagen First Arkansas Development Finance Corp. 910 Kane Bldg. Little Rock, AR 72201	501-374-9247
California	Leslie Brewer First California Business & Ind. Dev. Corp. 3901 MacArthur Blvd., Suite 101 Newport Beach, CA 92660 William N. L. Hutchinson, Jr. Provident Calbidco 160 Sansome St., Fifth Floor San Francisco, CA 94104 Sidney Moray Government Funding - Calbidco 9200 Sunset Blvd., Suite 702 Los Angeles, CA 90069 John R. Neiswender Statewide California Bus. & Ind. Dev. Corp. 4600 Campus Dr., Suite 21 Newport Beach, CA 92660	714-851-0855 415-393-0440 213-278-1236 714-545-5333
Florida	Ray C. Barton Industrial Development Corp. of Florida 801 North Magnolia Ave., Suite 218 Orlando, FL 32803	305-841-2640
Georgia	David M. Johnson The Business Dev. Corp. of Georgia, Inc. 558 South Omni International Atlanta, GA 30303	404-577-5715
Iowa	Don J. Albertson Iowa Business Dev. Credit Corp. 901 Insurance Exchange Bldg. Fifth & Grand Ave. Des Moines, IA 50309	515-282-2164
Kansas	George L. Doak Kansas Dev. Credit Corp. First National Bank Tower, Suite 1030 Topeka, KS 66603	913-235-3437
Kentucky	Jesse C. Dixon, Jr. Business Dev. Corp. of Kentucky 382 Starks Bldg. Louisville, KY 40202	502-584-3519
Maryland	W. G. Brooks Thomas Dev. Credit Corp. of Maryland 40 West Chesapeake Ave., Suite 211 P.O. Box 10629, Towson, MD 21204	301-828-4711
Massachusetts	Fred F. Stockwell Massachusetts Bus. Dev. Corp. One Boston Place, Suite 925 Boston, MA 02108	617-723-7515
Missouri	Richard V. Jeffrey First Missouri Dev. Finance Corp. 1411 Southwest Blvd., Suite B P.O. Drawer 1745 Jefferson City, MO 65101	314-635-0138
Montana	Richard L. Bourke Dev. Credit Corp. of Montana P.O. Box 916 Helena, MT 59601	406-442-3850

State	Director and Address	Phone Number
Nebraska	James H. Childe Business Dev. Corp. of Nebraska 1044 Stuart Bldg. Lincoln, NE 68508	402-474-3855
Nevada	David L. Buckman Nevada Financial Dev. Corp. 1 East Liberty St., Suite 602 Reno, NV 89501	702-323-3033
New Hampshire	Albert Hall, III New Hampshire Bus. Dev. Corp. 10 Fort Eddy Rd. Concord, NH 03301	603-224-1432
New York	Marshall R. Lustig New York Bus. Dev. Corp. 41 State St. Albany, NY 12207	518-463-2268
North Dakota	W. C. Smith North Dakota State Dev. Credit Corp. Box 1212 Bismarck, ND 58502	701-223-2288
Pennsylvania	C. Drew Moyer Pennsylvania Dev. Credit Corp. One Commerce Center 2595 Interstate Dr., Suite 103 Harrisburg, PA 17110	717-652-9434
	Paul Mitchell Southeastern Pennsylvania Dev. Fund 3 Penn Center Plaza, Suite 604 Philadelphia, PA 19102	215-568-4677
	Joseph M. Dougherty Western Pennsylvania Dev. Credit Corp. 534 Union Trust Bldg. Pittsburgh, PA 15219	412-288-9206
Rhode Island	Clifton A. Moore Business Dev. Company of Rhode Island Howard Bldg., 10 Dorrance St., Suite 330 Providence, RI 02903	401-351-3036
South Carolina	William V. Harvey Business Dev. Corp. of South Carolina P.O. Box 11606 Columbia, SC 29211	803-799-9825
Washington	V. Gibson Sears Business Dev. Corp. of Eastern Washington 607 Mohawk Bldg. Spokane, WA 99201	509-838-2731
Wyoming	Larry McDonald Wyoming Ind. Dev. Corp. 145 South Durbin, P.O. Box 612 Casper, WY 82602	307-234-5351

10.4.2 State Agency Contacts for Pollution Control Financing

Following is a list of state agency contacts for pollution control financing:

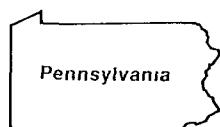
State Agency Contacts for Pollution Control Financing

State	Agency and Address	Phone Number
Alabama	Alabama Development Office, State Capitol, 135 South Union St., Montgomery, AL 36130	205-263-0048
Alaska	Office of Enterprise, Pouch EE, Juneau, AK 99811	907-465-2017 Zenith5-5500
Arizona	Arizona Department of Economic Planning and Development, 1645 West Jefferson St., Phoenix, AZ 85007	602-255-5705
Arkansas	Arkansas Industrial Development Commission 1 State Capitol Mall, Little Rock, AR 72201	501-371-1151
California	Economic and Business Development Department 1030 13th St., Sacramento, CA 95814	916-322-1394
Colorado	Division of Commerce and Development, 500 State Centennial Bldg., Denver, CO 80203	303-866-2205
Connecticut	Connecticut Development Authority 217 Washington St., Hartford, CT 06106	203-522-3730
Delaware	Delaware Department of Community Affairs & Economic Development, 630 State College Rd., Dover, DE 19901	302-736-4201
Florida	Division of Commercial Development Florida Department of Commerce, 107 West Gaines St., Tallahassee, FL 32304	904-487-0466
Georgia	Georgia Department of Community Development 1400 North Omni International, Atlanta, GA 30301	404-881-4325
Hawaii	Department of Planning & Economic Development Financial Management and Assistance Branch P.O. Box 2359, Honolulu, HI 96813	808-548-4617
Idaho	Division of Economic and Community Affairs Room 108, Capitol Bldg., Boise, ID 83720	208-334-3322
Illinois	Illinois Department of Business and Economic Development, 222 South College, Springfield, IL 62706	217-782-7500
Indiana	Indiana Department of Commerce, Business & Financial Service Division, 1 North Capitol, Suite 700, Indianapolis, IN 46204	317-232-8800
Iowa	Iowa Development Commission, Product Development Corporation, 600 East Court Ave., Suite A, Des Moines, IA 50309	515-281-3619
Kansas	Kansas Department of Economic Development 503 Kansas Ave., 6th Fl., Topeka, KS 66603	913-296-3481

State	Agency and Address	Phone Number
Kentucky	Development Finance Authority, 2400 Capitol Plaza Towers, Frankfort, KY 40601	502-564-4270
Louisiana	Louisiana Department of Commerce and Industry P.O. Box 44185, Capitol Station, Baton Rouge, LA 70804	504-342-5361
Maine	State Planning Office, 184 State St., Augusta, ME 04333	207-289-3261
Maryland	Maryland Department of Economic and Community Development, Small Business Assistance, 45 Calvert St., Annapolis, MD 21401	301-269-2624
Massachusetts	Massachusetts Industrial Finance Agency 125 Pearl Street, Boston, MA 02110	617-451-2477
Michigan	Michigan Department of Commerce, Office of Business and Community Development, P.O. Box 30225, Lansing, MI 48909	517-373-0347
Minnesota	Energy and Economic Development American Center Bldg., 150 East Kellogg St., St. Paul, MN 55101	612-297-3976
Mississippi	Certified Development Company of Mississippi P.O. Box 849, Jackson, MS 39205	601-359-3437
Missouri	Missouri Division of Commerce and Economic Development, P.O. Box 118 Jefferson City, MO 65102	314-751-4982
Montana	Department of Commerce, Business Assistance Division, 1424 9th Ave., Helena, MT 59620	406-444-3923
Nebraska	Small Business Revitalization Program 1044 Stewart Bldg., Lincoln, NE 68508	402-474-3855
Nevada	Division of Economic Development Capitol Complex, 600 East Williams Carson City, NV 89710	702-885-4325
New Hampshire	New Hampshire Office of Industrial Dev. P.O. Box 556, Concord, NH 03301	603-271-2591
New Jersey	Dept. of Commerce and Economic Development Division of Economic Development, Office of Small Business Assistance, 1 West State St., CN 823, Trenton, NJ 08625	609-984-4442
New Mexico	Economic Development Department,ataan Memorial Bldg., State Capitol Complex, Santa Fe, NM 87503	505-827-6207
New York	New York State Environmental Facilities Corp. 50 Wolf Rd., Albany, NY 12245 New York State Department of Commerce 1 Commerce Plaza, Albany, NY 12245	518-457-4100 518-474-7533
North Carolina	State of North Carolina, Department of Commerce, Industrial Financing Section, Business Assistance Division, 430 North Salisbury St., Raleigh, NC 27611	919-733-5297
North Dakota	North Dakota Economic Development Commission Liberty Memorial Bldg., State Capitol Grounds, Bismarck, ND 58505	701-224-2810
Ohio	Ohio Air Quality Development Authority and Ohio Water Quality Development Authority, 50 West Broad St., Suite 1901 Columbus, OH 43215	614-224-3383
Oklahoma	Oklahoma Financial Authority 4024 N. Lincoln Blvd., P.O. Box 53424 Oklahoma City, OK 73152	405-521-2182
Oregon	Financial Programs, Economic Development Department, 155 Cottage St., N.E., Salem, OR 97310	503-373-1200
Pennsylvania	Bureau of Economic Assistance, 405 Forum Bldg., Harrisburg, PA 17120	717-787-1909
Puerto Rico	Government of Puerto Rico, Economic Development Administration, Box 2350 San Juan, PR 00936; or Government of Puerto Rico, Economic Development Administration, 1290 Avenue of the Americas, New York, NY 10104	809-758-4747 212-245-1200
Rhode Island	Rhode Island Dept. of Economic Development 7 Jackson Walkway, Providence, RI 02903	401-277-2601

State	Agency and Address	Phone Number
South Carolina	South Carolina State Development Board P.O. Box 927, Columbia, SC 29202	803-758-3046
South Dakota	Dept. of State Development P.O. Box 6000, Pierre, SD 57501	800-843-8000
Tennessee	Department of Economic and Community Development, Andrew Jackson State Office Bldg., 10 Fl., Nashville, TN 37219	615-741-1888
Texas	Texas Economic Development Authority 410 E. Fifth St., Austin, TX 78701	512-472-5059
Utah	Utah Division of Economic Development 6150 State Office Bldg., Salt Lake City, UT 84114	801-533-5325
Vermont	Economic Development Department, Pavilion Office Bldg., Montpelier, VT 05602	802-826-3221
Virginia	Small Business Coordinator, Governor's Office Division of Industrial Development, 1000 Washington Blvd., Richmond, VA 23219	804-786-3791
Washington	Department of Commerce and Economic Development, Washington State Office of Small Business, 101 General Administration Bldg., AX-13, Olympia, WA 98504	206-753-5614
West Virginia	Governor's Office of Economics and Community Development, Bldg. G, Room B-517, Capitol Complex, Charleston, WV 25305	304-348-2234
Wisconsin	State of Wisconsin Small Business Ombudsman Wisconsin Department of Development 123 West Washington Ave., P.O. Box 7970, Madison, WI 53707	608-266-0562
Wyoming	Industrial Development Division, Department of Economic Planning and Development, Barrett Bldg., Cheyenne, WY 82002	307-777-7285

10.5 State Assistance in Pennsylvania



In Pennsylvania, assistance programs for businesses interested in financing waste minimization programs vary widely. Three main areas in which Pennsylvania may assist a business include:

- technical assistance,
- loans, and
- grants.

Each of these will be discussed briefly in the following sections.

10.5.1 Technical Assistance

Technical assistance and information dissemination are indirect forms of financial assistance. This is especially valuable for smaller businesses which lack the resources to research and develop their own programs.

Typically, technical assistance programs are involved in three areas:

- identification and collection of technical information useful to local industries,
- preparation of appropriate informational material, and
- dissemination of information.

The two technical assistance programs available in Pennsylvania are the CHMR (Center for Hazardous Materials Research) program and the PENNTAP (Pennsylvania Technical Assistance Program) program. The CHMR program focuses exclusively on solving hazardous waste problems, while the PENNTAP program is a more general technical assistance program.

Waste minimization information available from the CHMR program includes:

- approaches to reducing production of hazardous or toxic wastes;
- suggestions for substituting less hazardous materials or processes;
- evaluation of waste streams to determine potential for treatment, volume or toxicity reduction, reuse, or recycling; and
- techniques for recycling hazardous effluents and using waste exchanges.

The address and toll-free telephone number for the CHMR program are:

Center for Hazardous Materials Research (CHMR)
University of Pittsburgh Applied Research Center
320 William Pitt Way
Pittsburgh, PA 15238
(412) 826-5320
(800) 334-CHMR (toll-free)

The Pennsylvania Technical Assistance Program (PENNTAP) is a service organization which functions as the middleman in the transfer of technical, scientific, and engineering data and information. PENNTAP works to help firms in Pennsylvania solve technical problems in a way that will enhance the firm's ability to assume a stronger competitive position, thereby improving local and state economic development.

PENNTAP is not a consulting service, nor does it conduct research. It assembles current information and presents it in understandable terms so the user is able to decide on the most practical application.

The address and telephone number for the PENNTAP program are:

Pennsylvania Technical Assistance Program (PENNTAP)
Building #1114
University Park, PA 16802
(814) 865-1914

10.5.2 Loans

As in most states offering loan programs, most of the loans available in Pennsylvania require the business applicant to meet three eligibility requirements similar to the Federal ones:

- small to medium size,
- unable to secure a loan through conventional financing sources and not have the capital to finance the program, and
- classified in a standard industrial code classification that has a high potential for waste minimization.

Funding for such programs comes from a number of sources. The Pennsylvania Bureau of Economic Assistance, for example, has two programs under which a business may be able to gain financial support.

- The Pennsylvania capital loan fund will finance the purchase of any piece of equipment.
- A \$345 million dollar revenue bond/mortgage program will offer financial assistance to hazardous and solid waste disposal programs with the stipulation that at least 25 percent of the funds be spent on solid waste disposal.

Both are contingent upon the fact that the improvement will increase employment in the area. For more information on these programs, contact:

Bureau of Economic Assistance
Room 405
Forum Building
Harrisburg, PA 17120
(717) 787-1909

Additionally, many of the Federal programs have local branches to handle loans. For these local branches, Federal eligibility requirements apply.

Small Business Administration
Philadelphia District Office
Suite 400 East Lobby
1 Bala Cynwyd, PA 19004
(215) 596-5889

Small Business Administration
Pittsburgh District Office
906 Penn Avenue, 5th Floor
Pittsburgh, PA 15222
(412) 644-2780

National Association of Business Development
Corporations
Western PA Development Credit Corp.
534 Union Trust Building
Pittsburgh, PA 15219
(412) 288-9206
Attn: Joseph M. Dougherty

Allegheny County Department of Development
400 Fort Pitt Commons
445 Fort Pitt Boulevard
Pittsburgh, PA 15219
(412) 644-1010
Attn: Joseph Hohman

Pennsylvania Development Credit Corporation
One Commerce Center
2595 Interstate Drive, Suite 103
Harrisburg, PA 17110
(717) 652-9434

Southeastern Pennsylvania Development Fund
3 Penn Center Plaza, Suite 604
Philadelphia, PA 19102
(215) 568-4677

Small Business Administration
Harrisburg District Office
100 Chestnut Street, Suite 309
Harrisburg, PA 17101
(717) 782-3840

The Environmental Quality Board of the Pennsylvania Department of Environmental Resources adopted the Pennsylvania Hazardous Waste Facilities Plan on July 15, 1986. Included in this plan is a recommended program for granting loans, and possibly awards, to businesses that wish to implement waste reduction programs. While this program is still in the planning stages, it represents the first potential future opportunity to secure state funds distributed solely on the basis of minimizing waste.

10.5.3 Grants

Under the Hazardous Sites Cleanup Act, Act 108, which was signed into Law in October 1988, facilities that install and operate recycling equipment before April 15, 1993, are eligible for a grant of up to 25 percent of installation costs. The Act defines "recycling equipment" as "machinery used exclusively to process and reclaim hazardous waste materials into a raw product that is non-hazardous and reusable, thereby reducing the total amount of hazardous material produced at a particular location."

Additional information on this grant can be obtained from:

Pennsylvania Department of Environmental Resources
Office of Recycling and Waste Reduction
P. O. Box 2063, 8th Floor
Harrisburg, PA 17120
(717) 787-1749

11.0 SOURCES FOR INFORMATION ON WASTE MINIMIZATION

This chapter contains information on organizations and sources where small businesses can obtain useful information on hazardous waste minimization. Also provided are important telephone and Hotline numbers, as well as information on waste exchanges and commercial hazardous waste recovery, treatment, and disposal facilities.

11.1 CHMR's Program for SQG Assistance

The Center for Hazardous Materials Research (CHMR) operates a comprehensive nationwide technical assistance program for organizations and businesses handling small quantities of hazardous materials. This program is intended to:

- help SQGs reduce their hazardous waste generation, and
- offer practical information on complying with applicable environmental, health, and safety regulations.

Information is provided on:

- regulatory requirements,
- process modifications,
- substitution of less toxic materials, and
- available new equipment that can reduce hazardous materials problems.

Important elements of CHMR's technical assistance program include:

- **Hazardous Materials Hotline.** This confidential, nationwide, toll-free Hazardous Materials Hotline, (800)334-CHMR, is where callers can receive answers to a range of regulatory and technical questions, as well as information on hazardous waste transporters, and treatment, storage, and disposal facilities.
- **Quarterly Newsletter.** CHMR publishes a quarterly newsletter—*The Minimizer*—containing valuable waste minimization information for small businesses.
- **CHMR Speakers Bureau.** CHMR can provide speakers on several important subjects to address trade associations, businesses, and other organizations.
- **On-Site Consultations.** CHMR performs on-site consultation services for small and medium-sized businesses to provide clients with a general assessment of their hazardous waste management needs and compliance requirements, as well as identification of opportunities for minimizing hazardous waste generation. Services performed are tailored to meet specific needs of the client. Fees for these services are based on the size and scope of the project.



11.2 Other State Technical Assistance Programs

11.2.1 Waste Minimization and Treatment

The state programs which follow offer technical and/or financial assistance in the areas of waste minimization and treatment for other states throughout the nation.

Alabama

Hazardous Material Management and Resource
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) 276-2664

Arkansas

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

California

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

Connecticut

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

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

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

Georgia (continued)

Environmental Protection Division
Georgia Department of Natural Resources
Floyd Towers East, Suite 1154
205 Butler Street
Atlanta, CA 30334
(404) 656-2833

Illinois

Hazardous Waste Research and Information Center
Illinois Department of Energy and Natural Resources
1808 Woodfield Drive
Savoy, IL 61874
(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
(312) 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

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

Center for Industrial Research and Service
205 Engineering Annex
Iowa State University
Ames, IA 50011
(515) 294-3420

Kansas

Bureau of Waste Management
Department of Health and Environment
Forbes Field, Building 730
Topeka, KS 66620
(913) 296-1607

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 200A
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 Safe Waste Management
Department of Environmental Management
100 Cambridge Street, Room 1094
Boston, MA 02202
(617) 727-3260

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

Michigan

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

Minnesota

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

Minnesota (continued)

Minnesota Technical Assistance Program
W-140 Boynton Health Service
University of Minnesota
Minneapolis, MN 55455
(612) 625-9677
(800) 247-0015 (in Minnesota)

Minnesota Waste Management Board
123 Thorson Center
7323 Fifty-Eighth Avenue North
Crystal, MN 55428
(612) 536-0816

Missouri

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

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

Risk Reduction Unit
Office of Science and Research
New Jersey Department of Environmental Protection
401 East State Street
Trenton, NJ 08625

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

North Carolina (continued)

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

Ohio Technology Transfer Organization
Suite 200
65 East State Street
Columbus, OH 43266-0330
(614) 466-4286

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

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

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

Rhode Island

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)

Rhode Island (continued)

Center of 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

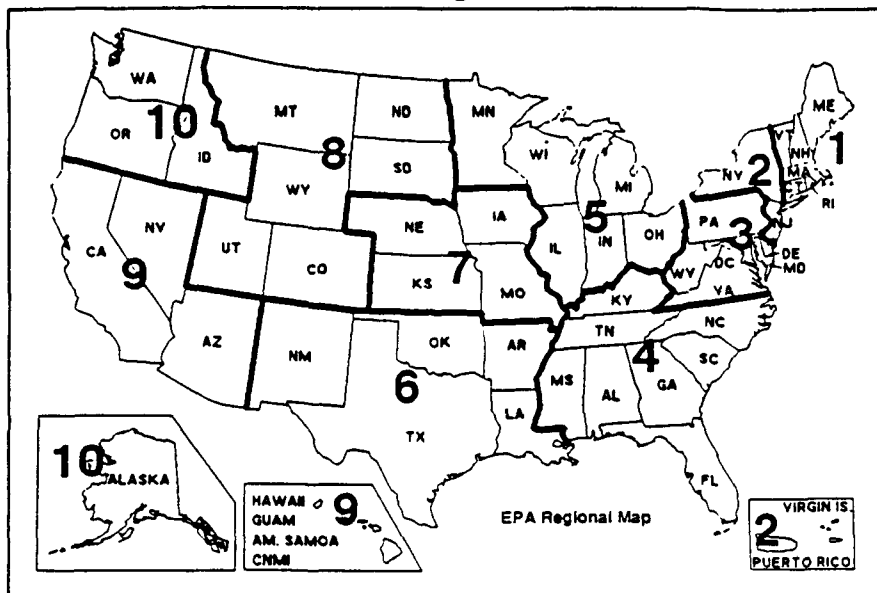
Bureau of Solid Waste Management
Wisconsin Department of Natural Resources
P.O. Box 7921
101 South Webster Street
Madison, WI 53707
(608) 266-2699

Wyoming

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

11.2.2 Underground Storage Tank (UST) Program Offices

State UST Program Offices



<p>AL AL Dept. of Environmental Mgmt. Ground Water Section/Water Division 1751 Congressman W. Dickerson Dr. Montgomery, AL 36130 205-271-7832</p> <p>AK Dept. of Environmental Conservation P.O. Box 0 Juneau, AK 99811-1800 907-465-2653</p> <p>AR AR Dept. of Pollution Control & Ecol. P.O. Box 9583 Little Rock, AR 72219 501-562-7444</p> <p>AZ AZ Dept. of Environmental Quality Environmental Health Services 2005 N. Central Phoenix, AZ 85004 602-257-6984</p> <p>CA State Water Resources Control Board OUST P.O. Box 944212 2014 T Street Sacramento, CA 95814 916-322-3133</p> <p>CO CO Dept. of Health Waste Mgmt. Division Underground Tank Program 4210 East 11th Avenue Denver, CO 80220 303-331-4864</p>	<p>CT Hazardous Materials Mgmt. Unit Dept. of Environmental Protection State Office Building 165 Capitol Avenue Hartford, CT 06106 203-566-4630</p> <p>DC Dept. of Consumer and Regulatory Affairs Environmental Control Division 516 H Street, N.W. Washington, D.C. 20001 202-783-3205</p> <p>DE Division of Air and Waste Mgmt. Dept. of Natural Resources & Environmental Control 89 Kings Highway Dover, DE 19903 302-323-4588</p> <p>FL FL Dept. of Environmental Regulation Solid Waste Section Twin Towers Office Building 2600 Blair Stone Road Tallahassee, FL 32399-2400 904-488-0300</p> <p>GA GA Environmental Protection Division 3420 Norman Berry Drive Hapeville, GA 30334 404-656-7404</p>	<p>HI Dept. of Health Hazardous Waste Program P.O. Box 3378 645 Halekauwila Street Honolulu, HI 96801-9984 808-548-8837</p> <p>IA IA Dept. of Natural Resources Henry A. Wallace Building 900 East Grand Des Moines, IA 50319 515-281-8779</p> <p>ID ID Dept. of Health & Welfare Division of Environmental Quality 450 W. State Street Boise, ID 83720 208-334-5847</p> <p>IL Office of State Fire Marshal 3150 Executive Park Drive Springfield, IL 62703-4599 217-785-5878</p> <p>IN Underground Storage Tank Program IN Dept. of Environmental Mgmt. 105 South Meridian Street Indianapolis, IN 46225 317-243-5055</p> <p>KS KS Dept. of Health & Environment Forbes Field, Building 740 Topeka, KS 66620 913-286-1594</p>
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KY Dept. of Environmental Protection Hazardous Waste Branch Fort Boone Plaza, Building #2 18 Reilly Road Frankfort, KY 40601	NH NH Dept. of Environmental Services Water Supply & Pollution Control Div. Hazen Drive, P.O. Box 95 Concord, NH 03301	UT Bureau of Solid & Hazardous Waste UT Dept. of Environmental Health 288 N. 1460 West Salt Lake City, UT 84116-0700
502-564-6716	603-271-3503	801-538-6170
LA LA Dept. of Environmental Quality P.O. Box 44274 625 North 4th Street Baton Rouge, LA 70804	NJ Dept. of Environmental Protection Div. of Water Resources (CN-029) Trenton, NJ 08625	VA VA Water Control Board 2111 North Hamilton Street P.O. Box 11143 Richmond, VA 23230-1143
504-342-7808	609-984-3156	804-367-6350
MA Dept. of Public Safety P.O. Box 490 Tewksbury, MA 01876	NM UST Section (Rm. N. 2150) NM Environmental Improvement Div. H. W. Bureau 1190 St. Francis Drive Santa Fe, NM 87503	VT Dept. of Environmental Conservation Waste Management Division 103 South Main St. Waterbury, VT 05676
508-851-9813	505-827-2894	802-244-8702
ME Underground Tanks Program Bureau of Oil & Hazardous Material Control Dept. of Environmental Protection Ray Bldg. - Station 17 Augusta, ME 04333	NV Division of Environmental Protection Dept. of Conservation & Natural Res Capitol Complex 201 S. Fall St. Carson City, NV 89710	WA WA Dept. of Ecology, M/S PV-11 Solid & Hazardous Waste Program Olympia, WA 98504-8711
207-289-2651	702-885-5872	206-459-6272
MD MD Dept. of the Environment Hazard & Solid Waste Mgmt. & Admin. OUST and LUST Division 2500 Broening Highway Baltimore, MD 21224	NY Bulk Storage Section, Div. of Water Dept. of Environmental Conservation 50 Wolf Road, Room 326 Albany, NY 12233-0001	WI Dept. of Industry, Labor and Human Relations P.O. Box 7979 Madison, WI 53707
301-631-3442	518-457-4351	608-266-7605
MI Fire Marshall Division MI Dept. of State Police 7150 Hams Drive Lansing, MI 48913	OH State Fire Marshall's Office Dept. of Commerce 8895 E. Main Street Reynoldsburg, OH 43068	WV Division of Waste Management WV Dept. of Natural Resources 1260 Greenbriar Street Charleston, WV 25305
517-322-1935	614-864-5510	304-348-5935
800-MICHUST	800-282-1927	
MN Underground Storage Tank Program MN Pollution Control Agency 520 West Lafayette Road St. Paul, MN 55155	OK OK Corporation Comm Jim Thorpe Building Oklahoma City, OK 73105	WY Water Quality Division Dept. of Environmental Quality Herschler Building, 4th Floor West 122 West 25th Street Cheyenne, WY 82002
612-296-7743	405-521-3107	307-777-7785
MO MO Dept. of Natural Resources P.O. Box 176 Jefferson City, MO 65102	OR OR Dept. of Environmental Quality 811 SW Sixth Ave Portland, OR 97204	AS Environmental Quality Commis Office of the Governor American Samoan Government Pago Pago, American Samoa 96799
314-751-7428	503-229-5769	684-633-2582
MS Dept. of Natural Resources Bureau of Pollution Control UST Section P.O. Box 10385 Jackson, MS 39209	PA PA Dept. of Environmental Resources Bureau of Water Quality Mgmt. Non-point Source & Storage Tank Section 9th Floor Fulton Building Harrisburg, PA 17120	GU GU Environmental Protection Agency P.O. Box 2999 Agana, Guam 96910
601-961-5171	717-787-8184	671-646-8863
MT Solid & Hazardous Waste Bureau Dept. of Health & Environmental Sci. Cogswell Bldg. - Room B-201 Helena, MT 59620	RI Div. of GW and FW Wetlands Dept. of Environmental Management 291 Promenade St. Providence, RI 02903	NMI Division of Environmental Quality P.O. Box 1304 Commonwealth of Northern Mariana Islands Saipan, CM 96950
406-444-2821	401-277-2234	607-234-6984
NC Div. of Environmental Mgmt. Ground-Water Operations Branch Dept. of Natural Resources and Community Development 512 N. Salisbury, P.O. Box 27687 Raleigh, NC 27611	SC Ground-Water Protection Division SC Dept. of Health & Environ. Control 2600 Bull Street Columbia, SC 29201	PR Water Quality Control Area Environmental Quality Board Commonwealth of Puerto Rico Sanjurjo, Puerto Rico
919-733-3221	803-734-5332	809-725-8410
ND Division of Waste Mgmt. ND Dept. of Health 1200 Missouri Avenue Bismarck, ND 58502-5520	SD Office of Water Quality Dept. of Water & Natural Resources Joe Foss Building, rm 217 Pierre, SD 57501-3181	VI Environmental Protection Division Dept. of Planning and National Resources 179 Altona and Weigunst Charlotte Amalie, St. Thomas, Virgin Islands 00802
701-224-3498	605-773-3351	809-774-3320
NE NE State Fire Marshal P.O. Box 94677 Lincoln, NE 68509-4677	TN Division of Ground-Water Protection TN Dept. of Health & Environmental 150 9th Avenue, North Nashville, TN 37219-5404	
402-471-9465	615-741-0690	
	TX UST Program Texas Water Commission P.O. Box 13087, Capital Station Austin, TX 78711	U.S. Environmental Protection Agency Office of Underground Storage Tanks Washington, D.C. 11/88 Biannual Update
	512-463-8180	

11.3 Important Telephone and Hotline Numbers

There are a number of private and public organizations offering technical assistance to businesses and the community via telephone, often through toll-free hotlines. Such services can often provide quick and easy answers to questions related to hazardous materials. Below are telephone numbers for hotlines and information services covering a variety of hazardous materials topics.



CHMR Hazardous Materials Hotline

Center for Hazardous Materials Research	Technical information on hazardous materials and Federal/state regulations	(800) 334-CHMR
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EPA Hotlines

EPA chemical emergency pre- paredness/SARA Title III hotline	For information on proper procedures for handling chemical emergencies	(800) 535-0202
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EPA RCRA/ CERCLA hotline	For help with hazardous waste and/or Federal Superfund-related problems	(800) 424-9346
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EPA small business ombudsman	For help with environ- mental problems specific to small business	(800) 368-5888
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Safe drinking water		(800) 426-4791
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EPA Waste Reduction Programs/Research

Office of Research and Development Waste Minimization Division, Cincinnati, Ohio	Technical information on waste reduction	(513) 569-7529 (Harry Freeman)
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Emergency Response

Bureau of Explosives Association of American Railroads	Assistance for hazardous materials problems involv- ing railroads (operates emergency number 24 hours per day.)	(202) 639-2222
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CHEMTREC Chemical Transporters Emergency Center	To report major chemical spills	(800) 424-9300
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Hazardous Materials Newsletter Informa- tion Line	For response teams (public or industrial) requiring information on tools, materials, emergency planning, etc.	(802) 479-2307
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Federal National Response Center Hazardous Spills Hotline	To report a chemical spill on navigable waterways	(800) 424-8802
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Transportation of Hazardous Materials

Department of Transportation Hotline	To receive assistance on Federal hazardous substance transporta- tion regulations	(202) 366-4488
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Occupational Safety and Health

OSHA Hotline	Information on occupational exposure to hazardous substances	(202) 523-8036
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Pesticides and Toxic Substances Information

National Animal Poison Control Center, University of Illinois (Staffs a North American response team.)	For consultation in the diagnosis and treatment of suspected or actual animal poisonings	(217) 333-3611
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Texas Tech University Pesticide Hotline	Contact to reach the National Pesticide Telecommunication Network, providing health, toxicology, and cleanup information	(800) 858-7378
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TSCA Hotline	For problems related to toxic substances	(202) 554-1404
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Miscellaneous Hazardous Materials Information

Radon technical assistance	For technical information on Radon	(800) 23-RADON (in PA)
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CMA National Chemical Resource Information Center	For technical information on hazardous chemicals	(800) 262-8200
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Chemical Services Information Network	Can put you in touch with manufacturers of chemicals in question	(202) 395-7285
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Asbestos technical information and referral	For information on handling asbestos	(202) 554-1401
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Household Hazardous Materials Information

Consumer Product Safety Commission	For information on safety of consumer goods	(800) 638-2772
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Household Products Disposal Council	Information on disposal of household hazardous waste	(202) 659-5535
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Cancer Causing (Carcinogenic) Substance Information

National Institute of Health, Cancer Information Service	For information on the carcinogenic qualities of certain chemicals	(800) 422-6237
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11.4 Other Useful Resources



Other useful resources such as certain mailing lists, equipment source guides, and directories of facilities are available to help businesses establish and implement their waste minimization programs.

11.4.1 Mailing Lists

Subject-specific mailing lists are available to help businesses keep up to date with changes and information on specific regulatory and waste reduction subjects. Some of these include:

“Information For Small Business”
Small Business Ombudsman
U.S. Environmental Protection Agency
401 M Street, SW (A-149C)
Washington, DC 20460
(800) 368-5888

U.S. Environmental Protection Agency
Office of Underground Storage Tanks
Box 6044
Rockville, MD 20850

Center for Environmental Research Information (CERI)
Technology Transfer
U.S. Environmental Protection Agency
P. O. Box 12505
Cincinnati, OH 45212

11.4.2 Equipment Buyers' Guides

Numerous equipment buyers' guides are available which provide the names of manufacturers and vendors of equipment for waste reduction and/or recycling. Subscriptions to equipment buyers' guides are usually free. Some useful guides and subscriptions include:

Pollution Equipment News
Rimbach Publishing Inc.
8650 Babcock Boulevard
Pittsburgh, PA 15237
(412) 364-5366

Water & Wastes Digest
Scranton Gillette Communications, Inc.
380 Northwest Highway
Des Plaines, IL 60016
(312) 298-6622

Chemical Equipment
Gordon Publications, Inc.
Box 1952,
Dover, NJ 07801
(201) 361-9060

11.4.3 Directories of Commercial Hazardous Waste Recovery, Treatment, and Disposal Facilities

There are several publications which provide comprehensive listings of commercial hazardous waste recovery, treatment, and disposal facilities.

*Hazardous Waste Services Directory—
Transporters, Disposal Sites, Laboratories, Consultants,
and Specialized Services (Recyclers)*

J. J. Keller & Associates, Inc.
145 West Wisconsin Avenue
P. O. Box 368
Neenah, WI 54957
(414) 722-2848
1 (800) 558-5011

Hazardous Wastes Management Reference Directory
Rimbach Publishing Inc.
8650 Babcock Boulevard
Pittsburgh, PA 15237
(412) 364-5366

For more information call CHMR's toll-free Hazardous Materials Hotline, (800) 334-CHMR, or your local state technical assistance program listed in Section 11.2.

11.5 Waste Exchanges

11.5.1 Northeast Industrial Waste Exchange

The Northeast Industrial Waste Exchange (NIWE) is an information clearinghouse. Established in 1981 by the Manufacturers Association of Central New York in cooperation with the Central New York Regional Planning and Development Board, the non-profit exchange is co-sponsored and partially funded by the New York State Environmental Facilities Corporation, the Ohio Environ-

mental Protection Agency, and the U.S. Environmental Protection Agency. NIWE's information is widely circulated but used primarily in the northeastern United States.

Information is distributed in two ways—a Listings Catalog is published quarterly, and a computerized waste materials listings service is available. Each February, May, August, and November, a list of "Materials Available" and "Materials Wanted" is printed and distributed as widely as possible, with current circulation numbering 10,500. A company wishing to have information included in a list may do so for \$25 for three issues. The information is also made available on the computerized listings for the same period of time.

The computerized service is provided free of charge and is available to anyone having access to a microcomputer and modem. The service is designed to allow immediate access to current information.

For more information contact:

Northeast Industrial Waste Exchange
90 Presidential Plaza
Suite 122
Syracuse, NY 13202
(800) 237-2481

11.5.2 Other Waste Exchanges

Alberta Waste Materials Exchange
4th Floor, Terrace Plaza
4445 Calgary Trail South
Edmonton, Alberta
Canada T6H 5R7
(403) 450-5461

California Waste Exchange
Department of Health Services
Toxic Substances Control Division
714 P Street
Sacramento, CA 95814
(916) 324-1807

Canadian Inventory Exchange
900 Blondin
Ste-Adele, Quebec
Canada J0R 1L0
(514) 229-6511

Canadian Waste Materials Exchange
Ontario Research Foundation
Sheridan Park Research Community
Mississauga, Ontario
Canada L5K 1B3
(416) 822-4111

Enkarn Research Corporation
P. O. Box 590
Albany, NY 12202
(518) 436-9684

Georgia Waste Exchange
c/o America Resource Recovery
P. O. Box 7178, Station A
Marietta, GA 30065
(404) 363-3022

Great Lakes Regional Waste Exchange
470 Market Street, SW, Suite 100-A
Grand Rapids, MI 49503
(616) 451-8992

Indiana Waste Exchange
P. O. Box 1220
Indianapolis, IN 46206
(317) 634-2142

Industrial Materials Exchange Service
2200 Churchill Road, IEPA/DLPC-24
Springfield, IL 62706
(217) 782-0450

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

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

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

Northeast Industrial Waste Exchange
90 Presidential Plaza, Suite 122
Syracuse, NY 13202
(315) 422-6572

Ontario Waste Exchange
Ontario Research Foundation
Sheridan Park Research Community
Mississauga, Ontario
Canada L5K 1B3
(416) 822-4111

Resource Recovery of America
P. O. Box 75283
Tampa, FL 33675-0283
(813) 248-9000

Southeast Waste Exchange
Urban Institute
UNCC Station
Charlotte, NC 28223
(704) 547-2307

Southern Waste Information Exchange
P. O. Box 6487
Tallahassee, FL 32313
(904) 644-5516

Tennessee Waste Exchange
Tennessee Manufacturers and Taxpayers Association
226 Capitol Boulevard, Suite 800
Nashville, TN 37219
(615) 256-5141

Wastelink, Division of Tencon Associates
P. O. Box 12
Cincinnati, OH 45174
(513) 248-0012

Western Waste Exchange
ASU Center for Environmental Studies
Krause Hall
Tempe, AZ 85287
(602) 965-1858

Zero Waste Systems
2928 Poplar Street
Oakland, CA 94608
(415) 893-8261

11.6 Waste Reduction/Recovery Equipment

This section provides examples of equipment to help you reduce your waste. **The following is not a comprehensive list of all waste reduction equipment suppliers and should not be viewed as an endorsement by CHMR of the suppliers listed.**

Rather, it is provided to illustrate that many waste reduction opportunities and sources of waste reduction equipment are available.

CHMR in no way endorses any of the goods or services described. CHMR also does not warrant that the information is accurate or complete or that it constitutes a complete description of all the goods and services of this type which are available. CHMR welcomes receipt of information from equipment suppliers for our information clearinghouse.

You are strongly encouraged to consult other sources, such as your trade association, state technical assistance program (Section 11.2), and equipment buyers' guides (section 11.4.2), for a more comprehensive list of waste reduction equipment suppliers.

11.6.1 Chemical Substitutes

An effective method to reduce hazardous waste is to substitute a less hazardous chemical. There is no "magic" chemical which works in all situations. However, CHMR recommends that you contact chemical suppliers for a potential alternate which you can test in your operations. A few examples of alternative sources are listed here.

(Titan Chemicals natural solvent cleaners and degreasers)
Functional Quality Products
4503 Lebanon Church Road
Pittsburgh, PA 15122
(412) 469-2241

(Simple Green non-toxic industrial cleaner and degreaser)
Sunshine Makers, Inc.
16771 Pacific Coast Highway
Sunset Beach, CA 90742
(213) 592-2844
(800) 228-0709

Chesterton Technical Products Divisions
Middlesex Industrial Park
Route 93
Stoneham, MA 02180
(617) 438-7000

DuPont Co.
C&P Department, Chestnut Run-709
Wilmington, DE 19898
(302) 999-3018

Research Chemicals Inc.
P. O. Box 1492
Fort Worth, TX 76101
(817) 451-7565

Total Systems Technology Inc.
65 Terence Drive
Pittsburgh, PA 15236
(412) 653-7690
(800) 245-4828

Other chemical suppliers are also listed in U.S. EPA's publication, *Evaluation of Alternatives to Toxic Organic Paint Strippers*, U.S. EPA WERL, Cincinnati, OH, September 1986, NTIS No. PB86-219177.

11.6.2 Solvent Recovery Equipment

Numerous on-site solvent recovery units are available for purchase, including from these companies:

Recyclene Products, Inc.
405 Eccles Avenue
South San Francisco, CA 94080
(415) 589-9600

HOYT Corporation
Forge Road
Westport, MA 02790
(617) 636-8811

Finish Engineering Company
921 Greengarden Road
Erie, PA 16501
(814) 455-4478

Progressive Recovery, Inc.
1020 North Main Street
Columbia, IL 62236
(618) 281-7196

Pittsburgh Spray Equipment Co.
3601 Library Road
Pittsburgh, PA 15234
(412) 882-4550

Giant Distillation & Recovery Co.
900 N. Westwood Avenue
Toledo, OH 43607
(419) 531-4600

Pope Scientific Inc.
N90 W14337 Commerce Drive
P. O. Box 495
Menomonee Falls, WI 53051
(414) 251-9300

In addition to on-site recovery units, some chemical suppliers will take and recover solvents from your waste, and we encourage you to also consider this option.

11.6.3 Coolant Recovery Equipment

Numerous on-site coolant recovery units (such as the following) are available for purchase.

Sanborn/Donaldson Systems
25 Commercial Drive
Wrentham, MA 02093
(800) 343-3381

Environmental Management Technologies, Inc.
27766 Deya
Mission Viejo, CA 92692
(714) 583-0512

11.6.4 On-Site Hydraulic Oil Recycling

On-site waste hydraulic oil recycling systems can reduce the frequency of changing oil.

Harvard Filtration Systems
R. D. #2, Box 388
Eighty-Four, PA 15330
(412) 225-3650

11.6.5 Metals Recovery Equipment

Numerous on-site metals recovery units such as these are available for purchase.

Hallmark Refining Corp.
1743 Cedardale Road
P. O. Box 1446
Mt. Vernon, WA 98273
(206) 428-5880

Lancy International, Inc.
181 Thorn Hill Road
Warrendale, PA 15086
(412) 772-0044

Ionics, Inc.
Separations Technology Division
65 Grove Street
Watertown, MA 02172
(617) 926-2500

EcoTech Ltd.
925 Brock Road South
Pickering (Toronto), Ontario
Canada L1W2X9
(416) 831-3400

The J. T. MacDermid Group
Wastesaver Corporation
P. O. Box 296
Plymouth, CT 06782
(203) 283-5858

Eastman Kodak Company (Silver Recovery)
Department 412-L
Rochester, NY 14650
(800) 242-2424

CPAC, Inc.
2364 Leicester Road
Leicester, NY 14481
(716) 382-3223

BEWT Recovery Technologies Inc.
1380 Hopkins Street, Unit 11
Whitby, Ontario
Canada L1N2C3
(416) 430-7666

11.7 Other References

Some information provided in this manual was compiled from the following publications on waste minimization. Individuals interested in more detailed information on waste minimization are encouraged to review these references.

U.S. EPA. 1986. *Report to Congress: Minimization of Hazardous Waste*. Volumes I and II. EPA/530-SW-86-033A. Office of Solid Waste, U.S. Environmental Protection Agency. Washington, DC (Available from NTIS: PB87-114336 & PB87-114344)

U.S. EPA. 1986. *Waste Minimization Issues and Options*. Volumes I, II, and III. EPA/530-SW-86-041. Office of Solid Waste, U.S. Environmental Protection Agency. Washington, DC (Available from NTIS: PB87-114351, PB87-114369 and PB87-114377)

Monica E. Campbell and William M. Glenn. *Profit from Pollution Prevention*. Pollution Probe Foundation, 12 Madison Avenue, Toronto, Ontario, Canada M5S 2S1, 1982.

Donald Huisingh, Larry Martin, Helene Hilger, and Neil Seldman. *Proven Profits from Pollution Prevention*. Institute for Local Self-Reliance, 2425 18th Street, NW, Washington, DC 20009, 1985, ISBN 0-912582-47-0.

Rosanne A. Field. *Management Strategies and Technologies for the Minimization of Chemical Wastes from Laboratories*. Duke University Medical Center, Division of Environmental Safety, Durham, NC. September 1986 by the North Carolina Pollution Prevention Pays Program.

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U.S. EPA. 1988. *Waste Minimization Opportunity Assessment Manual*. EPA/625/7-88/003. Alternative Technologies Division, Hazardous Waste Engineering Research Laboratory, U.S. Environmental Protection Agency, Cincinnati, OH 45268.

Hahn, Wilfred J., and P. O. Werschulz. *Evaluation of Alternatives to Toxic Organic Paint Strippers*. U.S. EPA, WERL, Cincinnati, OH. EPA/600/S2-86/063.. September 1986. (Available from NTIS: PB86-219177)

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Lenckus, D. "Increasing Productivity." *Finishing Wood and Wood Products Magazine*. Vol. 87, No. 4, May 1982, pp. 44-66.

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California State Department of Health Services. *Guide to Solvent Waste Reduction Alternatives*. October 1986, pp. 4-25 to 4-49.

Kenson, R. D. "Recovery and Reuse of Solvents from VOC Air Emissions." *Environmental Progress*. August 1985, pp. 161-165

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Loucks, C. M. "Boosting Capacities with Chemicals." *Chemical Engineering Deskbook Issue*. Vol. 80, No. 5, pp. 79-84, 1973.

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Fromm, C. H., and M. S. Callahan. "Waste Reduction Audit Procedure." *Conference Proceedings of the Hazardous Materials Control Research Institute*. Atlanta, 1986, pp. 427- 435.

North Carolina Pollution Prevention Pays Program. *Environmental Auditing*. North Carolina Department of Environmental Health. 1985.

Baumer, R. A. "Making Environmental Audits." *Chemical Engineering*. Vol. 89, No. 22, November 1, 1982, P. 101.

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Sarokin, D. "Reducing Hazardous Wastes at the Source: Case Studies of Organic Chemical Plants in New Jersey." Paper presented at Source Reduction of Hazardous Waste Conference, Rutgers University, August 22, 1985.

Singh, J. B., and R. M. Allen. "Establishing a Preventive Maintenance Program." *Plant Engineering*. February 27, 1986, p. 46.

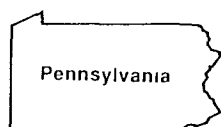
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Parker, N. H. "Corrective Maintenance and Performance Optimization." *Chemical Engineering*. Vol. 91, No. 7, April 16, 1984, p. 93.

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11.8 Pennsylvania Resources



This section contains information on organizations and sources in Pennsylvania where small businesses can obtain useful information on hazardous waste minimization.

11.8.1 CHMR's Program for SQG Assistance in Pennsylvania

The Center for Hazardous Materials Research (CHMR) operates a comprehensive statewide technical assistance program in Pennsylvania for organizations and businesses handling small quantities of hazardous materials. This program is intended to:

- help SQGs reduce their hazardous waste generation, and
- offer practical information on complying with applicable environmental, health, and safety regulations.

Information is provided on:

- regulatory requirements,
- process modifications,
- substitution of less toxic material, and
- available new equipment that can reduce hazardous materials problems.

Hazardous Materials Hotline

Central to the technical assistance program is a confidential, nationwide, toll-free Hazardous Materials Hotline, (800) 334-CHMR, where callers can receive answers to a range of regulatory and technical questions, as well as information on hazardous waste transporters, and treatment, storage, and disposal facilities.

The Hotline staff has developed an extensive information clearinghouse containing texts, periodicals, and papers on such topics as:

- waste minimization techniques,
- radiation,
- laws and regulations,
- risk assessment,
- standards and policy,
- pollution treatment,
- health and toxicology,
- case studies,
- emergency response,
- vendors and suppliers,
- TSD facilities, and
- reference information

Quarterly Newsletter—*The Minimizer*

CHMR publishes a quarterly newsletter—*The Minimizer*—containing valuable waste minimization information for small businesses. Articles have covered:

- a synopsis of waste minimization practices for small businesses,
- right-to-know compliance,
- used oil recycling,
- waste minimization case studies,
- regulatory updates, and
- a calendar of events.

The Minimizer currently reaches 2,600 businesses, trade associations, and individuals interested in waste minimization. To begin receiving *The Minimizer*, contact the Hazardous Materials Hotline at (800) 334-CHMR and you will be placed on the mailing list.

CHMR Speakers Bureau

As part of the statewide hazardous materials technical assistance program, CHMR can provide speakers on important subjects to address trade associations, businesses, and other organizations.

A partial list of topics currently offered by CHMR include:

- small quantity hazardous waste generator regulations,
- hazardous waste minimization,
- community right-to-know and emergency response,
- protecting drinking water,
- pesticide waste management,
- management of underground storage tanks, and
- health and safety training.

For more information and to make arrangements for a CHMR speaker for your trade association, business, or organization, write to CHMR at the above address, or call our Hazardous Materials Hotline at (800) 334-CHMR.

On-Site Consultations

Another aspect of CHMR's technical assistance program is on-site consultation services which are provided to small and medium-sized businesses. CHMR makes one-day visits to businesses to provide clients with a general assessment of their hazardous waste management needs and compliance requirements, as well as identification of opportunities for minimizing hazardous waste generation.

CHMR provides a number of technical on-site consultation services, including:

-
- identification and implementation of waste reduction opportunities;
 - environmental compliance reviews (e.g., OSHA, RCRA, SARA);
 - independent, third-party environmental evaluations;
 - risk assessments;
 - facility permitting guidance;
 - air, land, and water contamination investigations;
 - environmental crisis evaluations;
 - environmental liability investigations; and
 - environmental property assessments.

Services performed are tailored to meet specific needs of the client. Fees for these services are based on the size and scope of the project.

11.8.2 Important Telephone Numbers

U.S. Environmental Protection Agency

U.S. EPA Region 3

Waste Management Branch(215) 597-0980

PA Department of Environmental Resources

Bureau of Solid Waste Management(717) 787-6239

Director's Office(717) 787-9870

Assistant Director's Office(717) 787-9871

Division of Facilities Management(717) 787-7381
or 787-1749

Division of Resource Recovery
and Planning(717) 787-7382
Division of Emergency and
Remedial Response(717) 783-7816
Division of Compliance and Monitoring(717) 787-6239

Regional Offices

Meadville(814) 724-8557
Pittsburgh(412) 645-7100
Williamsport(717) 327-3636
Harrisburg(717) 657-4585
Wilkes-Barre(717) 826-2511
Norristown(215) 270-1900

PA Used Oil Recycling Information Center(717) 783-6004

Recycling Hotline(800) 346-4242

RADON technical assistance in PA(800) 23-RADON

PA Department of Labor and Industry

Right to Know Office(717) 783-2071

PA Department of Transportation

Motor Carrier Safety Division(717) 787-7444

PA State Police

State Fire Marshall
(Captain Joseph Robyak)(717) 783-5529

11.8.3 Names and Addresses of Resource Organizations

Center for Hazardous Materials Research
University of Pittsburgh Applied Research Center
320 William Pitt Way
Pittsburgh, PA 15238
(412) 826-5320
Hazardous Materials Hotline: (800) 334-CHMR

Pennsylvania Environmental Council
225 South 15th Street - Suite 506
Lewis Tower Building
Philadelphia, PA 19102
(215) 735-0966

U.S. EPA, Region III
Waste Management Branch
841 Chestnut Building (3HW30)
Philadelphia, PA 19107
(215) 597-0980

PA Department of Environmental Resources (PA DER)
Bureau of Solid Waste Management
Third and Locust Streets
Fulton Bank Building - 8th Floor
Harrisburg, PA 17120
(717) 787-9870

PA DER Regional Offices

PA DER Meadville Regional Office
1012 Water Street
Meadville, PA 16335
(814) 724-8557

PA DER Pittsburgh Regional Office
4th Floor - Highland Building
121 South Highland Avenue
Pittsburgh, PA 15206
(412) 645-7100

PA DER Williamsport Regional Office
200 Pine Street
Williamsport, PA 17701
(717) 327-3636

PA DER Harrisburg Regional Office
1 Ararat Boulevard
Harrisburg, PA 17110
(717) 657-4585

PA DER Norristown Regional Office
1875 New Hope Street
Norristown, PA 19401
(215) 270-1900

PA Department of Labor and Industry
Right to Know Office
Room 1404
Labor and Industry Building
7th and Forster Streets
Harrisburg, PA 17120
(717) 783-2071

PennDOT
Motor Carrier Safety Division
Room 215
Transportation and Safety Building
Harrisburg, PA 17120
(717) 787-7444

State Fire Marshal
PA State Police Fire Marshall's Bureau
1800 Elmerton Avenue
Harrisburg, PA 17110
(717) 783-5529

12.0 APPENDICES

APPENDIX 12.1

**List of Wastes Specifically Excluded from
the Definition of a RCRA Solid Waste
or a RCRA Hazardous Waste**

The following wastes are excluded from the definition of a RCRA solid waste:

- domestic sewage;
- any mixture of domestic sewage and other wastes treated by POTWs;
- NPDES permitted industrial wastewater discharges (does not exclude industrial wastewaters while they are being collected, stored, or treated before discharge or sludges thereby generated);
- irrigation return flows;
- source, special nuclear or by-product material as defined by the Atomic Energy Act of 1954;
- certain materials subjected to in situ mining techniques;
- certain pulping liquors;
- spent sulfuric acid used to produce virgin sulfuric acid;
- secondary materials that are reclaimed and returned to the original process or processes in which they were generated where they are reused in the production process subject to certain provisions.

The following solid wastes are excluded from the definition of a RCRA hazardous waste:

- household waste;
- certain agricultural solid wastes returned to the soil as fertilizers;
- mining overburden returned to the mine site;
- fly ash waste, bottom ash waste, slag waste, flue gas emission control waste;
- drilling fluids and produced waste;
- some wastes which fail the test for EP toxicity because chromium is present;
- solid waste from the extraction, beneficiation and processing of ores;
- cement kiln dust waste;
- certain solid waste which consists of discarded wood or wood products and which fails the test for EP toxicity.

APPENDIX 12.2**EPA's Lists of Hazardous Wastes**

Note: The following pages are taken from 40 CFR Part 261 as of 8/18/88. Since regulations are often changing, please check with a regulatory agency to see if any changes have been made which may apply to you.

Subpart D—Lists of Hazardous Wastes
[Interim final]

§ 261.30 General.

(a) A solid waste is a hazardous waste if it is listed in this Subpart, unless it has been excluded from this list under §§ 260.20 and 260.22.

(b) The Administrator will indicate his basis for listing the classes or types of wastes listed in this Subpart by employing one or more of the following Hazard Codes:

Ignitable Waste	(I)
Corrosive Waste	(C)
Reactive Waste	(R)
EP Toxic Waste	(E)
Acute Hazardous Waste	(H)
Toxic Waste	(T)

Appendix VII identifies the constituent which caused the Administrator to list the waste as an EP Toxic Waste (E) or Toxic Waste (T) in §§ 261.31 and 261.32.

(c) Each hazardous waste listed in this Subpart is assigned an EPA Hazardous Waste Number which precedes the name of the waste. This number must be used in complying with the notification requirements of Section 3010 of the Act and certain recordkeeping and reporting requirements under Parts 262 through 265, 268 and Part 270 of this Chapter.

[261.30(c) amended by 48 FR 14153, April 1, 1983; 51 FR 40636, November 7, 1986]

(d) The following hazardous wastes listed in §261.31 or §261.32 are subject to the exclusion limits for acutely hazardous wastes established in §261.5: EPA Hazardous Wastes Nos. FO20, FO21, FO22, FO23, FO26, and FO27.

[261.30(d) revised by 45 FR 74890, November 12, 1980; 50 FR 1999, January 14, 1985]

[Sec. 261.30(d)]

§261.31 Hazardous waste from nonspecific sources.

The following solid wastes are listed hazardous wastes from non-specific sources unless they are excluded under

§§260.20 and 260.22 and listed in Appendix XI.

[261.31 introductory text added by 49 FR 37070, September 21, 1984]

Industry and EPA hazardous waste No	Hazardous waste	Hazard code
Generic		
F001	The following spent halogenated solvents used in degreasing: tetrachloroethylene, trichloroethylene, methylene chloride, 1,1,1-trichloroethane, carbon tetrachloride, and chlorinated fluorocarbons, all spent solvent mixtures/blends used in degreasing containing, before use, a total of ten percent or more (by volume) of one or more of the above halogenated solvents or those solvents listed in F002, F004 and F005, and still bottoms from the recovery of these spent solvents and spent solvent mixtures	(T)
F002	The following spent halogenated solvents: tetrachloroethylene, methylene chloride, trichloroethylene, 1, 1, 1-trichloroethane, chlorobenzene, 1, 1, 2-trichloro-1, 2, 2-trifluoroethane, orthodichlorobenzene, trichlorofluoromethane, and 1, 1, 2-trichloroethane, all spent solvent mixtures/blends containing, before use, a total of ten percent or more (by volume) of one or more of the above halogenated solvents or those listed in F001, F004, or F005, and still bottoms from the recovery of these spent solvents and spent solvent mixtures	(T)
F003	The following spent non-halogenated solvents: xylene, acetone, ethyl acetate, ethyl benzene, ethyl ether, methyl isobutyl ketone, n-butyl alcohol, cyclohexanone, and methanol, all spent solvent mixtures/blends containing, before use, only the above spent non-halogenated solvents, and all spent solvent mixtures/blends containing, before use, one or more of the above non-halogenated solvents, and, a total of ten percent or more (by volume) of one or more of those solvents listed in F001, F002, F004, and F005, and still bottoms from the recovery of these spent solvents and spent solvent mixtures	(U)*
F004	The following spent non-halogenated solvents: cresols and cresylic acid, and nitrobenzene, all spent solvent mixtures/blends containing, before use, a total of ten percent or more (by volume) of one or more of the above non-halogenated solvents or those solvents listed in F001, F002, and F005, and still bottoms from the recovery of these spent solvents and spent solvent mixtures	(T)
F005	The following spent non-halogenated solvents: toluene, methyl ethyl ketone, carbon disulfide, isobutanol, pyridine, benzene, 2-ethoxyethanol, and 2-nitropropane, all spent solvent mixtures/blends containing, before use, a total of ten percent or more (by volume) of one or more of the above non-halogenated solvents or those solvents listed in F001, F002, or F004, and still bottoms from the recovery of these spent solvents and spent solvent mixtures	(U, T)
F006	Wastewater treatment sludges from electroplating operations except from the following processes: (1) sulfuric acid anodizing of aluminum, (2) tin plating on carbon steel, (3) zinc plating (segregated basis) on carbon steel, (4) aluminum or zinc-aluminum plating on carbon steel, (5) cleaning/stripping associated with tin, zinc and aluminum plating on carbon steel, and (6) chemical etching and milling of aluminum.	(T)
F019	Wastewater treatment sludges from the chemical conversion coating of aluminum	(U)
F007	Spent Cyanide plating bath solutions from electroplating operations	(R, T)
F008	Plating sludges from the bottom of plating baths from electroplating operations where cyanides are used in the process	(R, T)
F009	Spent stripping and cleaning bath solutions from electroplating operations where cyanides are used in the process	(R, T)
F010	Quenching bath residues from oil baths from metal heat treating operations where cyanides are used in the process	(R, T)
F011	Spent cyanide solutions from salt bath pot cleaning from metal heat treating operations	(R, T)
F012	Quenching wastewater treatment sludges from metal heat treating operations where cyanides are used in the process	(T)
F024	Wastes, including, but not limited to, distillation residues, heavy ends, tars, and reactor cleanout wastes from the production of chlorinated aliphatic hydrocarbons, having carbon content from one to five, utilizing free radical catalyzed processes [This listing does not include light ends, spent filters and filter aids, spent desiccants, wastewater, wastewater treatment sludges, spent catalysts, and wastes listed in §261.32]	(T)
F020	Wastes (except wastewater and spent carbon from hydrogen chloride purification) from the production or manufacturing use (as a reactant, chemical intermediate, or component in a formulating process) of tri- or tetrachlorophenol, or of intermediates used to produce their pesticide derivatives. (This listing does not include wastes from the production of Hexachlorophene from highly purified 2,4,5-trichlorophenol)	(H)
F021	Wastes (except wastewater and spent carbon from hydrogen chloride purification) from the production or manufacturing use (as a reactant, chemical intermediate, or component in a formulating process) of pentachlorophenol, or of intermediates used to produce its derivatives	(H)
F022	Wastes (except wastewater and spent carbon from hydrogen chloride purification) from the manufacturing use (as a reactant, chemical intermediate, or component in a formulating process) of tetra-, penta-, or hexachlorobenzenes under alkaline conditions	(H)
F023	Wastes (except wastewater and spent carbon from hydrogen chloride purification) from the production of materials on equipment previously used for the production or manufacturing use (as a reactant, chemical intermediate, or component in a formulating process) of tri- and tetrachlorophenols. (This listing does not include wastes from equipment used only for the production or use of Hexachlorophene from highly purified 2,4,5-trichlorophenol)	(H)
F026	Wastes (except wastewater and spent carbon from hydrogen chloride purification) from the production of materials on equipment previously used for the manufacturing use (as a reactant, chemical intermediate, or component in a formulating process) of tetra-, penta-, or hexachlorobenzene under alkaline conditions	(H)
F027	Discarded unused formulations containing tri-, tetra-, or pentachlorophenol or discarded unused formulation containing compounds derived from these chlorophenols. (This listing does not include formulations containing Hexachlorophene synthesized from prepurified 2,4,5-trichlorophenol as the sole component)	(H)
F028	Residues resulting from the incineration or thermal treatment of soil contaminated with EPA Hazardous Waste Nos. F020, F021, F022, F023, F026, and F027	(T)

* (U, T) should be used to specify mixture containing ignitable and toxic constituents

[261.31 amended by 45 FR 47833, July 16, 1980, revised by 45 FR 74890, November 12, 1980, 46 FR 4617, January 16, 1981, 46 FR 27476, May 20, 1981, 49 FR 5312, February 10, 1984, 50 FR 661, January 4, 1985, 50 FR 1999, January 14, 1985, 50 FR 53319, December 31, 1985, corrected by 51 FR 2702, January 21, 1986, amended by 51 FR 6541, February 25, 1986]

§261.32 Hazardous waste from specific sources.

The following solid wastes are listed hazardous wastes from specific sources unless they are excluded under

§§260.20 and 260.22 and listed in Appendix IX.

[261.32 introductory text added by 49 FR 37070, September 21, 1984]

Industry and EPA hazardous waste No	Hazardous waste	Hazard code
Wood preservation K001	Bottom sediment sludge from the treatment of wastewaters from wood preserving processes that use creosote and/or pentachlorophenol	(T)
Inorganic pigments, K002	Wastewater treatment sludge from the production of chrome yellow and orange pigments	(T)
K003	Wastewater treatment sludge from the production of molybdate orange pigments	(T)
K004	Wastewater treatment sludge from the production of zinc yellow pigments	(T)
K005	Wastewater treatment sludge from the production of chrome green pigments	(T)
K006	Wastewater treatment sludge from the production of chrome oxide green pigments (anhydrous and hydrated)	(T)
K007	Wastewater treatment sludge from the production of iron blue pigments	(T)
K008	Oven residue from the production of chrome oxide green pigments	(T)
Organic chemicals		
K009	Distillation bottoms from the production of acetaldehyde from ethylene	(T)
K010	Distillation side cuts from the production of acetaldehyde from ethylene	(T)
K011	Bottom stream from the wastewater stripper in the production of acrylonitrile	(R, T)
K013	Bottom stream from the acetonitrile column in the production of acrylonitrile	(R, T)
K014	Bottoms from the acetonitrile purification column in the production of acrylonitrile	(T)
K015	Still bottoms from the distillation of benzyl chloride	(T)
K016	Heavy ends or distillation residues from the production of carbon tetrachloride	(T)
K017	Heavy ends (still bottoms) from the purification column in the production of epichlorohydrin	(T)
K018	Heavy ends from the fractionation column in ethyl chloride production	(T)
K019	Heavy ends from the distillation of ethylene dichloride in ethylene dichloride production	(T)
K020	Heavy ends from the distillation of vinyl chloride in vinyl chloride monomer production	(T)
K021	Aqueous spent antimony catalyst waste from fluoromethanes production	(T)
K022	Distillation bottom tars from the production of phenol/acetone from cumene	(T)
K023	Distillation light ends from the production of phthalic anhydride from naphthalene	(T)
K024	Distillation bottoms from the production of phthalic anhydride from naphthalene	(T)
K093	Distillation light ends from the production of phthalic anhydride from ortho-xylene	(T)
K094	Distillation bottoms from the production of phthalic anhydride from ortho-xylene	(T)
K025	Distillation bottoms from the production of nitrobenzene by the nitration of benzene	(T)
K026	Stripping still tails from the production of metoxy ethyl pyridines	(T)
K027	Centrifuge and distillation residues from toluene diisocyanate production	(R, T)
K028	Spent catalyst from the hydrochlorinator reactor in the production of 1,1,1-trichloroethane	(T)
K029	Waste from the product steam stripper in the production of 1,1,1-trichloroethane	(T)
K095	Distillation bottoms from the production of 1,1,1-trichloroethane	(T)
K096	Heavy ends from the heavy ends column from the production of 1,1,1-trichloroethane	(T)
K030	Column bottoms or heavy ends from the combined production of trichloroethylene and perchloroethylene	(T)
K083	Distillation bottoms from aniline production	(T)
K103	Process residues from aniline extraction from the production of aniline	(T)
K104	Combined wastewater streams generated from nitrobenzene/aniline production	(T)
K085	Distillation or fractionation column bottoms from the production of chlorobenzenes	(T)
K105	Separated aqueous stream from the reactor product washing step in the production of chlorobenzenes	(T)
[K111 through K116 added by 50 FR 42942, October 23, 1985]		
K111	Product washwaters from the production of dinitrotoluene via nitration of toluene	(C, T)
K112	Reaction by-product water from the drying column in the production of toluenediamine via hydrogenation of dinitrotoluene	(T)
K113	Condensed liquid light ends from the purification of toluenediamine in the production of toluenediamine via hydrogenation of dinitrotoluene	(T)
K114	Vicinals from the purification of toluenediamine in the production of toluenediamine via hydrogenation of dinitrotoluene	(T)
K115	Heavy ends from the purification of toluenediamine in the production of toluenediamine via hydrogenation of dinitrotoluene	(T)
K116	Organic condensate from the solvent recovery column in the production of toluene diisocyanate via phosgenation of toluenediamine	(T)
K117	Wastewater from the reactor vent gas scrubber in the production of ethylene dibromide via bromination of ethene	(T)
K118	pent adsorbent solids from purification of ethylene dibromide in the production of ethylene dibromide via bromination of ethene	(T)
K136	Still bottoms from the purification of ethylene dibromide in the production of ethylene dibromide via bromination of ethene	(T)

[K117, 118 and 136 added by 51 FR 5330, February 13, 1986]

Industry and EPA hazardous waste No	Hazardous waste	Hazard code
Inorganic chemicals		
K071	Brine purification muds from the mercury cell process in chlorine production where separately prepurified brine is not used	(T)
K073	Chlorinated hydrocarbon waste from the purification step of the diaphragm cell process using graphite anodes in chlorine production	(T)
K106	Wastewater treatment sludge from the mercury cell process in chlorine production	(T)
Pesticides		
K031	By-product salts generated in the production of MSMA and cacodylic acid	(T)
K032	Wastewater treatment sludge from the production of chlordane	(T)
K033	Wastewater and scrub water from the chlorination of cyclopentadiene in the production of chlordane	(T)
K034	Filter solids from the filtration of hexachlorocyclopentadiene in the production of chlordane	(T)
K097	Vacuum stripper discharge from the chlordane chlorinator in the production of chlordane	(T)
K035	Wastewater treatment sludges generated in the production of creosote	(T)
K036	Still bottoms from toluene reclamation distillation in the production of disulfoton	(T)
K037	Wastewater treatment sludges from the production of disulfoton	(T)
K038	Wastewater from the washing and stripping of phorate production	(T)
K039	Filter cake from the filtration of diethylphosphorodithioic acid in the production of phorate	(T)
K040	Wastewater treatment sludge from the production of phorate	(T)
K041	Wastewater treatment sludge from the production of toxaphene	(T)
K098	Untreated process wastewater from the production of toxaphene	(T)
K042	Heavy ends or distillation residues from the distillation of tetrachlorobenzene in the production of 2,4,5-T	(T)
K043	2,6-Dichlorophenol waste from the production of 2,4-D	(T)
K099	Untreated wastewater from the production of 2,4-D	(T)
[K123 through 126 added by 51 FR 37728, October 24, 1986]		
K123	Process wastewater (including supernates, filtrates, and washwaters) from the production of ethylenebisdithiocarbamic acid and its salt	(T)
K124	Reactor vent scrubber water from the production of ethylenebisdithiocarbamic acid and its salts	(C, T)
K125	Filtration, evaporation, and centrifugation solids from the production of ethylenebisdithiocarbamic acid and its salts	(T)
K126	Baghouse dust and floor sweepings in milling and packaging operations from the production or formulation of ethylenebisdithiocarbamic acid and its salts	(T)
Explosives		
K044	Wastewater treatment sludges from the manufacturing and processing of explosives	(R)
K045	Spent carbon from the treatment of wastewater containing explosives	(R)
K046	Wastewater treatment sludges from the manufacturing formulation and loading of lead-based initiating compounds	(T)
K047	Pink/red water from TNT operations	(R)
Petroleum refining		
K048	Dissolved air flotation (DAF) float from the petroleum refining industry	(T)
K049	Slop oil emission solids from the petroleum refining industry	(T)
K050	Heat exchanger bundle cleaning sludge from the petroleum refining industry	(T)
K051	API separator sludge from the petroleum refining industry	(T)
K052	Tank bottoms (leaded) from the petroleum refining industry	(T)
Iron and steel		
K061	Emission control dust/sludge from the primary production of steel in electric furnaces	(T)
K062	Spent pickle liquor generated by steel finishing operations of facilities within the iron or steel industry (SIC Codes 331 and 332)	(C, T)
Secondary lead		
K069	Emission control dust/sludge from secondary lead smelting	(T)
K100	Waste leaching solution from acid leaching of emission control dust/sludge from secondary lead smelting	(T)
Veterinary pharmaceuticals		
K084	Wastewater treatment sludges generated during the production of veterinary pharmaceuticals from arsenic or organo-arsenic compounds	(T)
K101	Distillation tar residues from the distillation of aniline-based compounds in the production of veterinary pharmaceuticals from arsenic or organo-arsenic compounds	(T)
K102	Residue from the use of activated carbon for decolorization in the production of veterinary pharmaceuticals from arsenic or organo-arsenic compounds	(T)
Ink formulation K086	Solvent washes and sludges, caustic washes and sludges or water washes and sludges from cleaning tubs and equipment used in the formulation of ink from pigments, driers, soaps, and stabilizers containing chromium and lead	(T)
Coking		
K060	Ammonia still lime sludge from coking operations	(T)
K087	Decanter tank tar sludge from coking operations	(T)

[261.32 amended by 45 FR 47833, July 16, 1980; 45 FR 72039, October 30, 1980, revised by 45 FR 74980, November 12, 1980; 46 FR 4617, January 16, 1981; 46 FR 27476, May 20, 1981; 50 FR 42942, October 23, 1985; 51 FR 5330, February 13, 1986; 51 FR 19322, May 28, 1986; corrected by 51 FR 33612, September 22, 1986, amended by 51 FR 37728, October 24, 1986]

§261.33 Discarded commercial chemical products, off-specification species, container residues, and spill residues thereof.

[261.33 revised by 45 FR 78541, November 25, 1980]

The following materials or items are hazardous wastes if and when they are discarded or intended to be discarded as described in § 261.2(a)(2)(i), when they are mixed with waste oil or used oil or other material and applied to the land for dust suppression or road treatment, when they are otherwise applied to the land in lieu of their original intended use or when they are contained in products that are applied to the land in lieu of their original intended use, or when, in lieu of their original intended use, they are produced for use as (or as a component of) a fuel, distributed for use as a fuel, or burned as a fuel.

[261.33 introductory text amended by 49 FR 37070, September 21, 1984; 50 FR 661, January 4, 1985; 50 FR 28742, July 15, 1985; 52 FR 21306, June 5, 1987]

(a) Any commercial chemical product, or manufacturing chemical intermediate having the generic name listed in paragraph (e) or (f) of this section.

(b) Any off-specification commercial chemical product or manufacturing chemical intermediate which, if it met specifications, would have the generic name listed in paragraph (e) or (f) of this section.

(c) Any residue remaining in a container or in an inner liner removed from a container that has held any commercial chemical product or manufacturing chemical intermediate having the generic name listed in paragraph (e) of this section, unless the container

is empty as defined in §261.7(b)(3) of this chapter

[Comment: Unless the residue is being beneficially used or reused, or legitimately recycled or reclaimed, or being accumulated, stored, transported or treated prior to such use, re-use, recycling or reclamation, EPA considers the residue to be intended for discard, and thus, a hazardous waste. An example of legitimate re-use of the residue would be where the residue remains in the container and the container is used to hold the same commercial chemical product or manufacturing chemical intermediate it previously held. An example of the discard of the residue would be where the drum is sent to a drum reconditioner who reconditions the drum but discards the residue.]

[261.33(c) revised by 45 FR 78541, November 25, 1980; 46 FR 27476, May 20, 1981; corrected by 52 FR 26012, July 10, 1987]

(d) Any residue or contaminated soil, water or other debris resulting from the cleanup of a spill into or on any land or water of any commercial chemical product or manufacturing chemical intermediate having the generic name listed in paragraph (e) or (f) of this section, or any residue or contaminated soil, water or other debris resulting from the cleanup of a spill, into or on any land or water, of any off-specification chemical product and manufacturing chemical intermediate which, if it met specifications, would have the generic name listed in paragraph (e) or (f) of this section.

[Comment: The phrase "commercial chemical product or manufacturing chemical intermediate having the generic name listed in . . ." refers to a chemical substance

which is manufactured or formulated for commercial or manufacturing use which consists of the commercially pure grade of the chemical, any technical grades of the chemical that are produced or marketed, and all formulations in which the chemical is the sole active ingredient. It does not refer to a material, such as a manufacturing process waste, that contains any of the substances listed in paragraphs (e) or (f). Where a manufacturing process waste is deemed to be a hazardous waste because it contains a substance listed in paragraphs (e) or (f), such waste will be listed in either §§ 261.31 or 261.32 or will be identified as a hazardous waste by the characteristics set forth in Subpart C of this part.]

[261.33(d) amended by 46 FR 27476, May 20, 1981]

(e) The commercial chemical products, manufacturing chemical intermediates or off-specification commercial chemical products or manufacturing chemical intermediates referred to in paragraphs (a) through (d) of this section, are identified as acute hazardous wastes (H) and are subject to be the small quantity exclusion defined in § 261.5(e).

[Comment: For the convenience of the regulated community the primary hazardous properties of these materials have been indicated by the letters T (Toxicity), and R (Reactivity). Absence of a letter indicates that the compound only is listed for acute toxicity.]

These wastes and their corresponding EPA Hazardous Waste Numbers are:

[261.33(e) amended by 46 FR 27476, May 20, 1981; corrected and revised by 51 FR 28297, August 6, 1986, (e) table corrected by 53 FR 13382, April 22, 1988; amended by 53 FR 43883, October 31, 1988]

Hazardous waste No	Chemical abstracts No	Substance	Hazardous waste No	Chemical abstracts No	Substance
P023	107-20-0	Acetaldehyde, chloro-	P044	60-51-5	Dimethoate
P002	591-08-2	Acetamide, N-(aminothioxomethyl)	P046	122-09-8	alpha, alpha-Dimethylphenethylamine
P057	640-19-7	Acetamide, 2-fluoro-	P047	534-52-1	4,6-Dinitro-o-cresol, & salts
P058	62-74-8	Acetic acid, fluoro-, sodium salt	P048	51-28-5	2,4-Dinitrophenol
P002	591-08-2	1-Acetyl-2-thiourea	P020	88-85-7	Dinoseb
P003	107-02-5	Acrolein	P085	152-16-9	Diphosphoramidate, octamethyl-
P070	116-06-3	Aldicarb	P111	107-49-3	Diphosphonic acid, tetraethyl ester
P004	309-00-2	Aldrin	P039	298-04-4	Disulfoton
P005	107-18-6	Allyl alcohol	P059	541-53-7	Dithioburet
P006	20859-73-8	Aluminum phosphide (R,T)	P050	115-29-7	Endosulfan
P007	2763-96-4	5-(Aminomethyl)-3-isoxazolol	P068	145-73-3	Endothall
P008	504-24-5	4-Aminopyridine	P051	72-20-8	Endrin
P009	131-74-8	Ammonium picrate (R)	P051	72-20-8	Endrin, & metabolites
P119	7803-55-6	Ammonium vanadate	P042	51-43-4	Epinephrine
P099	506-61-6	Argentate(1-), bis(cyano-C)-, potassium	P031	400-19-5	Ethanedinitrile
P010	7718-39-4	Arsenic acid H ₃ AsO ₄	P066	16752-77-5	Ethanimidothioic acid, N-[(methylamino)carbonyloxy]-, methyl ester
P012	1327-53-3	Arsenic oxide As ₂ O ₃	P101	107-12-0	Ethyl cyanide
P011	1303-28-2	Arsenic oxide As ₂ O ₅	P054	151-56-4	Ethyleneimine
P011	1303-28-2	Arsenic pentoxide	P097	52-85-7	Famphur
P012	1327-53-3	Arsenic trioxide	P066	7782-41-4	Fluorine
P078	682-42-2	Arsine, diethyl-	P057	640-19-7	Fluoroacetamide
P036	626-28-6	Arsinous dichloride, phenyl-	P058	62-74-8	Fluoroacetic acid, sodium salt
P054	151-56-4	Azardine	P065	628-86-4	Fulminic acid, mercury(2+) salt (R,T)
P007	75-55-8	Azidine, 2-methyl-	P059	76-44-8	Heptachlor
P013	542-62-1	Barium cyanide	P062	757-58-4	Hexaethyl tetraphosphate
P024	106-47-8	Benzenamine, 4-chloro-	P116	79-19-6	Hydrazinocarbathioamide
P077	100-01-6	Benzenamine, 4-nitro-	P068	60-34-4	Hydrazine, methyl
P028	100-44-7	Benzene, (chloromethyl)-	P063	74-90-9	Hydrocyanic acid
P042	51-43-4	1,2-Benzenediol, 4-[1-hydroxy-2-(methylamino)ethyl]-, (R)-	P063	74-90-8	Hydrogen cyanide
P046	122-09-8	Benzenethanamine, alpha, alpha-dimethyl-	P063	7803-51-2	Hydrogen phosphide
P014	108-98-5	Benzenethiol	P060	465-73-6	Isodrin
P001	81-81-2	2H-1-Benzopyran-2-one, 4-hydroxy 3-(3-oxo-1-phenyl-butyl)-, & salts, when present at concentrations greater than 0.3%	P007	2763-96-4	3(2H)-Isoxazolone, 5-(aminomethyl)-
P028	100-44-7	Benzyl chloride	P092	62-38-4	Mercury (acetato-O)phenyl-
P015	7440-41-7	Beryllium	P065	628-86-4	Mercury fulminate (R,T)
P017	598-31-2	Bromoacetone	P082	62-75-9	Methanamine, N-methyl-N-nitroso-
P018	357-57-3	Bruone	P064	624-83-9	Methane, isocyanato-
P045	39196-18-4	2-Butanone, 3,3-dimethyl-1-(methylthio)-O-[(methylamino)carbonyl] oxime	P016	542-68-1	Methane, oxybis(chloro-
P021	592-01-8	Calcium cyanide	P112	509-14-8	Methane, tetranitro- (R)
P021	592-01-8	Calcium cyanide Ca(CN) ₂	P118	75-70-7	Methanethiol, trichloro-
P022	75-15-0	Carbon disulfide	P050	115-29-7	6,9-Methano-2,4,3-benzodioxathiepin, 6,7,8,9,10,10-hexachloro-1,5,5a,6,9,9a-hexahydro-, 3-oxide
P095	75-44-5	Carbonic dichloride	P059	76-44-8	4,7-Methano-1H-indene, 1,4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-
P023	107-20-0	Chloroacetaldehyde	P066	16752-77-5	Methomyl
P024	106-47-8	p-Chloroaniline	P068	60-34-4	Methyl hydrazine
P026	5344-82-1	1-(o-Chlorophenyl)thiourea	P064	624-83-9	Methyl isocyanate
P027	542-76-7	3-Chloropropionitrile	P069	75-86-5	2-Methylacetonitrile
P029	544-92-3	Copper cyanide	P071	298-00-0	Methyl parathion
P029	544-92-3	Copper cyanide Cu(CN)	P072	86-88-4	alpha-Naphthylthiourea
P030		Cyanides (soluble cyanide salts), not otherwise specified	P073	13463-39-3	Nickel carbonyl
P031	460-19-5	Cyanogen	P073	13463-39-3	Nickel carbonyl Ni(CO) ₄ , (T-4)-
P033	506-77-4	Cyanogen chloride	P074	557-19-7	Nickel cyanide
P033	506-77-4	Cyanogen chloride (CN)Cl	P074	557-19-7	Nickel cyanide Ni(CN) ₂
P034	131-89-5	2-Cyclohexyl-4,6-dinitrophenol	P075	54-11-5	Nicotine, & salts
P016	542-88-1	Dichloromethyl ether	P076	10102-43-9	Nitric oxide
P036	696-28-6	Dichlorophenylarsine	P077	100-01-6	p-Nitroaniline
P037	60-57-1	Dieldrin	P078	10102-44-0	Nitrogen dioxide
P038	692-42-2	Diethylarsine	P076	10102-43-9	Nitrogen oxide NO
P041	311-45-5	Diethyl-p-nitrophenyl phosphate	P078	10102-44-0	Nitrogen oxide NO ₂
P040	297-97-2	O,O-Diethyl O-pyrazinyl phosphorothioate	P081	55-63-0	Nitroglycerine (R)
P043	55-91-4	Diisopropylfluorophosphate (DFP)	P082	62-75-9	N-Nitrosodimethylamine
P004	309-00-2	1,4,5,8-Dimethanonaphthalene, 1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-, (1alpha,4alpha,4beta,5alpha,8alpha,8beta)-	P084	4549-40-0	N-Nitrosomethylvinylamine
P060	465-73-6	1,4,5,8-Dimethanonaphthalene, 1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-, (1alpha,4alpha,4beta,5beta,8beta,8beta)-	P085	152-16-9	Octamethylpyrophosphoramidate
P037	60-57-1	2,7,3,6-Dimethanonaphth[2,3-b]oxirene, 3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-, (1aalpha,2beta,2aalpha,3beta,6beta,6aalpha,7beta,7aalpha)-	P087	20816-12-0	Osmium oxide OsO ₄ , (T-4)-
P051	72-20-8	2,7,3,6-Dimethanonaphth[2,3-b]oxirene, 3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-, (1aalpha,2beta,2aalpha,3beta,6beta,6aalpha,7beta,7aalpha)-, & metabolites	P087	20816-12-0	Osmium tetroxide
			P088	145-73-3	7-Oxabicyclo[2.2.1]heptane-2,3-dicarboxylic acid
			P089	56-38-2	Parathion
			P034	131-89-5	Phenol, 2-cyclohexyl-4,6-dinitro-
			P048	51-28-5	Phenol, 2,4-dinitro-
			P047	534-52-1	Phenol, 2-methyl-4,6-dinitro-, & salts
			P020	88-85-7	Phenol, 2-(1-methylpropyl)-4,6-dinitro-
			P009	131-74-8	Phenol, 2,4,6-trinitro-, ammonium salt (R)
			P092	62-38-4	Phenylmercury acetate
			P093	103-85-5	Phenylthiourea
			P094	298-02-2	Phorate
			P095	75-44-5	Phosgene
			P096	7803-51-2	Phosphine
			P041	311-45-5	Phosphonic acid, diethyl 4-nitrophenyl ester

Hazardous waste No	Chemical Abstracts No	Substance
P039	298-04-4	Phosphorodithioic acid, O,O-diethyl S-[2-(ethylthio)ethyl] ester
P094	298-02-2	Phosphorodithioic acid, O,O-diethyl S-[(ethylthio)methyl] ester
P044	60-51-5	Phosphorodithioic acid, O,O-dimethyl S-[2-(methylamino)-2-oxoethyl] ester
P043	55-91-4	Phosphorofluoridic acid, bis(1-methylethyl) ester
P089	55-38-2	Phosphorothioic acid, O,O-diethyl O-(4-nitrophenyl) ester
P040	297-97-2	Phosphorothioic acid, O,O-diethyl O-pyrazinyl ester
P097	52-85-7	Phosphorothioic acid, O-[4-[(dimethylamino)sulfonyl]phenyl] O,O-dimethyl ester
P071	258-00-0	Phosphorothioic acid, O,O-dimethyl O-(4-nitrophenyl) ester
P110	78-00-2	Plumbane, tetraethyl-
P098	151-50-8	Potassium cyanide
P098	151-50-8	Potassium cyanide K(CN)
P039	506-61-6	Potassium silver cyanide
P070	116-06-3	Propanal, 2-methyl-2-(methylthio)-, O-[(methylamino)carbonyl]oxime
P101	107-12-0	Propanenitrile
P027	542-76-7	Propanenitrile, 3-chloro-
P069	75-86-5	Propanenitrile, 2-hydroxy-2-methyl
P081	55-63-0	1,2,3-Propanetriol, trinitrate (R)
P017	598-31-2	2-Propanone, 1-bromo-
P102	107-19-7	Propargyl alcohol
P003	107-02-8	2-Propenal
P005	107-18-6	2-Propen-1-ol
P067	75-55-8	1,2-Propylenimine
P102	107-19-7	2-Propyn-1-ol
P008	504-24-5	4-Pyridinamine
P075	¹ 54-11-5	Pyridine, 3-(1-methyl-2-pyrrolidinyl)-, (S)-, & salts
P114	12039-52-0	Selenious acid dithallium(1+) salt
P103	630-10-4	Selenourea
P104	506-64-9	Silver cyanide
P104	506-64-9	Silver cyanide Ag(CN)
P105	26628-22-8	Sodium azide
P106	143-33-9	Sodium cyanide
P106	143-33-9	Sodium cyanide Na(CN)
P107	1314-96-1	Strontium sulfide
P107		[Removed by 53 FR 43883, October 31 1988]
P108	¹ 57-24-9	Strychnidin-10-one, & salts
P108	357-57-3	Strychnidin-10-one, 2,3-dimethoxy-
P108	¹ 57-24-9	Strychnine, & salts
P115	7446-18-6	Sulfuric acid, dithallium(1+) salt
P109	3689-24-5	Tetraethylthiopyrophosphate
P110	78-00-2	Tetraethyl lead
P111	107-49-3	Tetraethyl pyrophosphate
P112	509-14-8	Tetranitromethane (R)
P062	757-58-4	Tetraphosphoric acid, hexaethyl ester
P113	1314-32-5	Thallic oxide
P113	1314-32-5	Thallium oxide Tl ₂ O ₃
P114	12039-52-0	Thallium(I) selenite
P115	7446-18-6	Thallium(I) sulfate
P109	3689-24-5	Thiodiphosphoric acid, tetraethyl ester
P045	39196-18-4	Thiofancx
P049	541-53-7	Thioimidodicarbonic diamide [(H ₂ N)C(S)], NH
P014	108-98-5	Thiophenol
P116	79-19-6	Thiosemicarbazide
P026	5344-82-1	Thiourea, (2-chlorophenyl)-
P072	86-68-4	Thiourea, 1-naphthalenyl-
P093	103-85-5	Thiourea, phenyl-
P123	8001-35-2	Toxaphene
P118	75-70-7	Trichloromethanethiol
P119	7803-55-6	Vanadic acid, ammonium salt
P120	1314-62-1	Vanadium oxide V ₂ O ₅
P120	1314-62-1	Vanadium pentoxide
P084	4549-40-0	Vinylamine, N-methyl-N-nitroso-
P001	¹ 81-61-2	Warfium, & salts, when present at concentrations greater than 0.3%
P121	557-21-1	Zinc cyanide
P121	557-21-1	Zinc cyanide Zn(CN) ₂
P122	1314-84-7	Zinc phosphide Zn ₃ P ₂ , when present at concentrations greater than 10% (R,T)

¹ CAS Number given for parent compound only.

(f) The commercial chemical products, manufacturing chemical intermediates, or off-specification commercial chemical products referred to in paragraphs (a) through (d) of this section, are identified as toxic wastes (T), unless otherwise designated and are subject to the small quantity generator exclusion defined in §261.5 (a) and (g)

[261.33(f) introductory paragraph amended by 51 FR 10174, March 24, 1986]

[Comment. For the convenience of the regulated community, the primary hazardous properties of these materials have been indicated by the letters T (Toxicity), R (Reactivity), I (Ignitability) and C (Corrosivity). Absence of a letter indicates that the compound is only listed for toxicity.]

These wastes and their corresponding EPA Hazardous Waste Numbers are:

[261.33(f) amended by 46 FR 27476 May 10, 1984, 50 FR 1999, January 14, 1985, 50 FR 42942, October 23, 1985, corrected and revised by 51 FR 28297, August 6, 1986, (f) table corrected by 53 FR 13382, April 22, 1988; amended by 53 FR 43881, 43883, October 31, 1988]

Hazardous waste No	Chemical abstracts No	Substance	Hazardous waste No	Chemical abstracts No	Substance
U001	75-07-0	Acetaldehyde (I)	U222	636-21-5	Benzenamine, 2-methyl-, hydrochloride
U014	75-87-6	Acetaldehyde trichloro-	U181	99-55-8	Benzenamine, 2-methyl-5-nitro-
U187	62-34-2	Acetamide, N-(4-ethoxyphenyl)-	U019	71-43-2	Benzene (I,T)
U005	53-56-3	Acetamide, N-9H-fluorenyl-	U038	510-15-6	Benzenecetic acid, 4-chloro alpha-(4-chlorophenyl)-alpha-hydroxy-, ethyl ester
U240	94-75-7	Acetic acid, (2,4-dichlorophenoxy)- salts & esters	U030	101-55-3	Benzene, 1-bromo-4-phenoxy-
U112	141-78-6	Acetic acid ethyl ester (I)	U035	305-03-3	Benzenebutanoic acid 4-[bis(2-chloroethyl)amino]-
U144	301-04-2	Acetic acid, lead(2+) salt	U037	108-90-7	Benzene, chloro-
U214	563-68-8	Acetic acid, thallium(1+) salt	U221	25376-45-8	Benzenediamine, ar-methyl-
see F027	93-76-5	Acetic acid (2,4,5-trichlorophenoxy)-	U028	117-81-7	1,2-Benzenedicarboxylic acid, bis(2-ethylhexyl) ester
U002	67-64-1	Acetone (I)	U063	84-74-2	1,2-Benzenedicarboxylic acid, dibutyl ester
U003	75-05-8	Acetonitrile (I,T)	U088	84-66-2	1,2-Benzenedicarboxylic acid, diethyl ester
U004	98-86-2	Acetophenone	U102	131-11-3	1,2-Benzenedicarboxylic acid, dimethyl ester
U005	53-96-3	2-Acetylaminofluorene	U107	117-84-0	1,2-Benzenedicarboxylic acid, dioctyl ester
U006	75-36-5	Acetyl chloride (C,R,T)	U070	95-50-1	Benzene, 1,2-dichloro-
U007	79-06-1	Acrylamide	U071	541-73-1	Benzene, 1,3-dichloro-
U008	79-10-7	Acrylic acid (I)	U072	106-46-7	Benzene, 1,4-dichloro-
U009	107-13-1	Acrylonitrile	U060	72-54-8	Benzene, 1,1'-(2,2-dichloroethylidene)bis[4-chloro-
U011	61-82-5	Amitrole	U017	38-67-3	Benzene, (dichloromethyl)-
U012	62-53-3	Aniline (I,T)	U223	26471-62-5	Benzene, 1,3-disocyanatomethyl-, (R,T)
U136	75-60-5	Arsinic acid, dimethyl-	U239	1330-20-7	Benzene, dimethyl-, (I,T)
U014	492-80-9	Auramine	U201	108-46-3	1,3-Benzenediol
U015	115-02-6	Azaserine	U127	118-74-1	Benzene, hexachloro-
U010	50-07-7	Azirino[2,3'-3,4]pyrrolo[1,2-a]indole-4,7-dione 6	U056	110-82-7	Benzene, hexahydro- (I)
		amino 8-[[[aminocarbonyl]oxy]methyl-1,1a,2,6,8a,8b-hexahydro-8a-methoxy-5-methyl-11aS-(1aalpha,8beta,8aalpha,8balpha)]	U220	108-88-3	Benzene, methyl-
U157	55-49-5	Benz[a]aceanthrylene, 1,2-dihydro-3-methyl-	U105	121-14-2	Benzene, 1-methyl-2,4-dinitro-
U016	225-51-4	Benz[c]acridine	U106	606-20-2	Benzene, 2-methyl-1,3-dinitro-
U017	98-67-3	Benzal chloride	U055	98-82-8	Benzene, (1-methyl)ethyl-, (I)
U192	23950-58-5	Benzamide, 3,5-dichloro-N-(1,1-dimethyl-2-propynyl)-	U169	98-95-3	Benzene, nitro-
U018	56-55-3	Benz[a]anthracene	U183	608-93-5	Benzene, pentachloro-
U094	57-97-6	Benz[a]anthracene, 7,12-dimethyl-	U185	82-68-8	Benzene, pentachloronitro-
U012	62-53-3	Benzenamine (I,T)	U020	98-09-9	Benzenesulfonic acid chloride (C,R)
U014	492-80-8	Benzenamine, 4,4'-carbonyldi[bis(N,N-dimethyl-	U207	95-94-3	Benzenesulfonyl chloride (C,R)
U049	3165-93-3	Benzenamine, 4-chloro-2-methyl-, hydrochloride	U061	50-29-3	Benzene, 1,1'-(2,2,2-trichloroethylidene)bis[4-chloro-
U093	60-11-7	Benzenamine, N,N-dimethyl-4-(phenylazo)-	U247	72-43-5	Benzene, 1,1'-(2,2,2-trichloroethylidene)bis[4-methoxy-
U328	95-53-4	Benzenamine, 2-methyl-	U023	98-07-7	Benzene, (trichloromethyl)-
U353	106-49-0	Benzenamine, 4-methyl-	U234	99-35-4	Benzene, 1,3,5-trinitro-
U158	101-14-4	Benzenamine, 4,4'-methylenebis[2-chloro-			

Hazardous waste No	Chemical abstracts No	Substance
U021	92-87-5	Benzo[d]pyrene
U022	81-07-2	1,2-Benzisothiazol-3(2H)-one, 1,1-dioxide, & salts
U203	94-59-7	1,3-Benzodioxole, 5-(2-propenyl)-
U141	120-58-1	1,3-Benzodioxole, 5-(1-propenyl)-
U090	94-58-6	1,3-Benzodioxole, 5-propyl-
U064	189-55-9	Benzo[rs]pentaphene
U248	81-81-2	2H-1-Benzopyran-2-one, 4-hydroxy-3-(3-oxo-1-phenyl-butyl)-, & salts, when present at concentrations of 0.3% or less
U022	50-32-8	Benzo[a]pyrene
U197	106-51-4	p-Benzoquinone
U023	98-07-7	Benzo[rs]trichloride (C,R,T)
U085	1464-53-5	2,2'-Bioxirane
U021	92-87-5	[1,1'-Biphenyl]-4,4'-diamine
U073	91-94-1	[1,1'-Biphenyl]-4,4'-diamine, 3,3'-dichloro-
U091	119-90-4	[1,1'-Biphenyl]-4,4'-diamine, 3,3'-dimethoxy-
U095	119-93-7	[1,1'-Biphenyl]-4,4'-diamine, 3,3'-dimethyl-
U225	75-25-2	Bromoform
U030	101-55-3	4-Bromophenyl phenyl ether
U128	87-68-3	1,3-Butadiene, 1,1,2,3,4,4-hexachloro-
U172	924-16-3	1-Butanamine, N-butyl-N-nitroso-
U031	71-38-3	1-Butanol (I)
U159	78-93-3	2-Butanone (I,T)
U160	1338-23-4	2-Butanone, peroxide (R,T)
U053	4170-30-3	2-Butenal
U074	764-41-0	2-Butene, 1,4-dichloro- (I,T)
U143	303-34-4	2-Butenoic acid, 2-methyl-, 7-[[2,3-dihydroxy-2-(1-methoxyethyl)-3-methyl-1-oxobutoxy]methyl]-, 2,3,5,7a-tetrahydro-1H-pyrrolizin-1-yl ester, [1S]-[1alpha(Z),7(2S*,3R*),7aalpha(Z)]-
U031	71-36-3	n-Butyl alcohol (I)
U136	75-60-5	Cacodylic acid
U032	13755-19-0	Calcium chromate
U216	51-79-6	Carbamic acid, ethyl ester
U178	615-53-2	Carbamic acid, methylnitroso-, ethyl ester
U097	79-44-7	Carbamic chloride, dimethyl-
U114	111-54-6	Carbamodithioic acid, 1,2-ethanedithylbis-, salts & esters
U152	2303-16-4	Carbamothioic acid, bis(1-methylethyl)-, S-(2,3-dichloro-2-propenyl) ester
U215	6533-73-9	Carbonic acid, dithallium(1+) salt
U033	353-50-4	Carbonic difluoride
U156	79-22-1	Carbonochloridic acid, methyl ester (I,T)
U033	353-50-4	Carbon oxyfluoride (R,T)
U211	56-23-5	Carbon tetrachloride
U034	75-87-6	Chloral
U035	365-03-3	Chlorambucil
U036	57-74-9	Chlorane, alpha & gamma isomers
U026	494-03-1	Chloronaphazin
U037	108-90-7	Chlorobenzene
U038	510-15-6	Chlorobenzilate
U039	59-50-7	p-Chloro-m-cresol
U042	110-75-8	2-Chloroethyl vinyl ether
U044	67-66-3	Chloroform
U046	107-30-2	Chloromethyl methyl ether
U047	91-58-7	beta-Chloronaphthalene
U045	95-57-8	o-Chlorophenol
U049	3165-93-3	4-Chloro-o-toluidine, hydrochloride
U032	13765-19-0	Chromic acid H ₂ CrO ₄ , calcium salt
U050	218-01-9	Chrysene
U051		Creosote
U052	1319-77-3	Cresol (Cresylic acid)
U053	4170-30-3	Crotonaldehyde
U055	98-82-8	Cumene (I)
U246	506-68-3	Cyanogen bromide (CN)Br
U197	106-51-4	2,5-Cyclohexadiene-1,4-dione
U056	110-82-7	Cyclohexane (I)
U129	58-89-9	Cyclohexane, 1,2,3,4,5,6-hexachloro-, (1alpha,2alpha,3beta,4alpha,5alpha,6beta)-
U057	108-94-1	Cyclohexanone (I)
U130	77-47-4	1,3-Cyclopentadiene, 1,2,3,4,5,5-hexachloro-
U058	50-18-0	Cyclophosphamide
U240	94-75-7	2,4-D, salts & esters
U059	20833-81-3	Daunomycin
U060	72-54-8	DDD
U061	50-29-3	DDT
U062	2303-16-4	Diallate
U063	53-70-3	Dibenz[a,h]anthracene
U064	189-55-9	Dibenzo[a,j]pyrene

Hazardous waste No	Chemical abstracts No	Substance
U066	96-12-8	1,2-Dibromo-3-chloropropane
U069	84-74-2	Dibutyl phthalate
U070	95-50-1	o-Dichlorobenzene
U071	541-73-1	m-Dichlorobenzene
U072	106-46-7	p-Dichlorobenzene
U073	91-94-1	3,3'-Dichlorobenzidine
U074	764-41-0	1,4-Dichloro-2-butene (I,T)
U075	75-71-8	Dichlorodifluoromethane
U078	75-35-4	1,1-Dichloroethylene
U079	156-60-5	1,2-Dichloroethylene
U025	111-44-4	Dichloroethyl ether
U027	108-60-1	Dichloroisopropyl ether
U024	111-91-1	Dichloromethoxy ethane
U081	120-83-2	2,4-Dichlorophenol
U082	87-65-0	2,6-Dichlorophenol
U084	542-75-6	1,3-Dichloropropene
U065	1464-53-5	1,2,3,4-Diepoxybutane (I,T)
U108	123-91-1	1,4-Diethylenoxide
U028	117-81-7	Diethylhexyl phthalate
U086	1615-80-1	N,N'-Diethylhydrazine
U087	3288-58-2	O,O-Diethyl S-methyl dithiophosphate
U088	84-66-2	Diethyl phthalate
U089	56-53-1	Diethylstilbesterol
U090	94-58-6	Dihydrosafrole
U091	119-90-4	3,3'-Dimethoxybenzidine
U092	124-40-3	Dimethylamine (I)
U093	60-11-7	p-Dimethylaminoozobenzene
U094	57-97-6	7,12-Dimethylbenz[a]anthracene
U095	119-93-7	3,3'-Dimethylbenzidine
U096	80-15-9	alpha,alpha-Dimethylbenzylhydroperoxide (R)
U097	79-44-7	Dimethylcarbamoyl chloride
U098	57-14-7	1,1-Dimethylhydrazine
U099	540-73-8	1,2-Dimethylhydrazine
U101	105-67-9	2,4-Dimethylphenol
U102	131-11-3	Dimethyl phthalate
U103	77-78-1	Dimethyl sulfate
U105	121-14-2	2,4-Dinitrotoluene
U106	606-20-2	2,6-Dinitrotoluene
U107	117-84-0	Di-n-octyl phthalate
U108	123-91-1	1,4-Dioxane
U109	122-66-7	1,2-Diphenylhydrazine
U110	142-84-7	Dipropylamine (I)
U111	621-64-7	Di-n-propylnitrosamine
U041	105-89-8	Epichlorohydrin
U021	75-07-0	Ethanal (I)
U174	55-18-5	Ethanamine, N-ethyl-N-nitroso-
U155	91-80-5	1,2-Ethanediamine, N,N-dimethyl-N'-2-pyridinyl-N'-(2-thienylmethyl)-
U067	105-93-4	Ethane, 1,2-dibromo-
U076	75-34-3	Ethane, 1,1-dichloro-
U077	107-06-2	Ethane, 1,2-dichloro-
U131	67-72-1	Ethane, hexachloro-
U024	111-91-1	Ethane, 1,1'-[methylenebis(oxy)]bis[2-chloro-
U117	60-29-7	Ethane, 1,1'-oxybis(-I)
U025	111-44-4	Ethane, 1,1'-oxybis[2-chloro-
U184	76-01-7	Ethane, pentachloro-
U208	630-20-6	Ethane, 1,1,1,2-tetrachloro-
U209	79-34-5	Ethane, 1,1,2,2-tetrachloro-
U218	62-55-5	Ethanethioamide
U226	71-55-6	Ethane, 1,1,1-trichloro-
U227	79-00-5	Ethane, 1,1,2-trichloro-
U359	110-80-5	Ethanol, 2-ethoxy-
U173	1116-54-7	Ethanol, 2,2'-(nitrosoimino)bis-
U004	99-66-2	Ethanone, 1-phenyl-
U043	75-01-4	Ethene, chloro-
U042	110-75-8	Ethene, (2-chloroethoxy)-
U078	75-35-4	Ethene, 1,1-dichloro-
U079	156-60-5	Ethene, 1,2-dichloro-, (E)-
U210	127-18-4	Ethene, tetrachloro-
U228	73-01-6	Ethene, trichloro-
U112	141-78-6	Ethyl acetate (I)
U113	140-88-5	Ethyl acrylate (I)
U238	51-79-6	Ethyl carbamate (urethane)
U117	60-29-7	Ethyl ether (I)
U114	111-54-6	Ethylenebisdithiocarbamic acid salts & esters
U067	106-93-4	Ethylene dibromide
U077	107-06-2	Ethylene dichloride
U359	110-80-5	Ethylene glycol monoethyl ether
U115	75-21-8	Ethylene oxide (I,T)

Hazardous waste No	Chemical abstracts No	Substance	Hazardous waste No	Chemical abstracts No	Substance
U116	96-45-7	Ethylenethiourea	U045	74-87-3	Methyl chloride (I,T)
U076	75-34-3	Ethylene dichloride	U156	79-22-1	Methyl chlorocarbonate (I,T)
U118	97-63-2	Ethyl methacrylate	U226	71-55-6	Methyl chloroform
U119	62-50-0	Ethyl methanesulfonate	U157	56-49-5	3-Methylcholanthrene
U120	205-44-0	Fluoranthene	U158	101-14-4	4,4'-Methylenebis(2-chloroaniline)
U122	50-00-0	Formaldehyde	U068	74-95-3	Methylene bromide
U123	64-18-6	Formic acid (C,T)	U080	75-09-2	Methylene chloride
U124	110-00-9	Furan (I)	U159	78-93-3	Methyl ethyl ketone (MEK) (I,T)
U125	98-01-1	2-Furancarboxaldehyde (I)	U160	1338-23-4	Methyl ethyl ketone peroxide (R,T)
U147	108-31-6	2,5-Furandione	U138	74-88-4	Methyl iodide
U213	109-59-9	Furan, tetrahydro-(I)	U161	108-10-1	Methyl isobutyl ketone (I)
U125	98-01-1	Furfural (I)	U162	80-62-6	Methyl methacrylate (I,T)
U124	110-00-9	Furfuran (I)	U161	108-10-1	4-Methyl-2-pentanone (I)
U206	18663-66-4	Glucopyranose, 2-deoxy-2-(3-methyl-3-nitrosoureido)-D-	U164	56-04-2	Methylthiourea
U206	18683-66-4	D-Glucose, 2-deoxy-2-(((methylnitrosocamino)-carbonyl)amino)-	U010	50-07-7	Mitomycin C
U126	765-34-4	Glycidylaldehyde	U059	20830-81-3	5,12-Naphthacenedione, 8-allyl-1,1'-bis(2,3,6-tridecyl)-alpha-L-lyxo-hexopyranosyl-oxo-7,9,10-tetrahydro-6,8,11-trihydroxy-1-methoxy-3S-cis-
U163	70-25-7	Guanidine, N-methyl-N-nitro-N-nitroso-	U167	134-32-7	1-Naphthalenamine
U127	118-74-1	Hexachlorobenzene	U168	91-59-8	2-Naphthalenamine
U128	87-68-3	Hexachlorobutadiene	U026	494-03-1	Naphthalenamine, N,N-bis(2-chloroethyl)-
U130	77-47-4	Hexachlorocyclopentadiene	U165	91-20-3	Naphthalene
U131	67-72-1	Hexachloroethane	U047	91-58-7	Naphthalene, 2-chloro-
U132	70-30-4	Hexachlorophene	U166	130-15-4	1,4-Naphthalenedione
U243	1688-71-7	Hexachloropropene	U236	72-57-1	2,7-Naphthalenedisulfonic acid, 3,3'-(1,3,3'-dimethyl-1,1'-biphenyl)-4,4'-diyl)bis(azo)bis-5-amino-4-hydroxy-, tetrasodium salt
U133	302-01-2	Hydrazine (R,T)	U166	130-15-4	1,4-Naphthoquinone
U066	1615-80-1	Hydrazine, 1,2-diethyl-	U167	134-32-7	alpha-Naphthylamine
U098	57-14-7	Hydrazine, 1,1-dimethyl-	U168	91-59-8	beta-Naphthylamine
U099	540-73-8	Hydrazine, 1,2-dimethyl-	U217	10102-45-1	Nitric acid, thallium(1+) salt
U109	122-66-7	Hydrazine, 1,2-diphenyl-	U169	98-95-3	Nitrobenzene (I,T)
U134	7664-39-3	Hydrofluoric acid (C,T)	U170	100-02-7	p-Nitrophenol
U124	7064-29-3	Hydrogen fluoride (C,T)	U171	79-46-9	2-Nitropropane (I,T)
U125	7782-06-4	Hydrogen sulfide	U172	924-16-3	N-Nitrosodi-n-butylamine
U135	7782-06-4	Hydrogen sulfide H ₂ S	U173	1116-54-7	N-Nitrosodiethanolamine
U096	80-15-9	Hydroperoxide, 1-methyl-1-phenylethyl- (R)	U174	55-18-5	N-Nitrosodiethylamine
U116	96-45-7	2-Imidazolidinethione	U176	759-73-9	N-Nitroso-N-ethylurea
U137	193-35-5	Indeno[1,2,3-cd]pyrene	U177	684-93-5	N-Nitroso-N-methylurea
U139		[Removed by 53 FR 43581, October 31, 1988]	U178	615-53-2	N-Nitroso-N-methylurethane
U190	85-44-9	1,3-Isobenzofurandione	U179	100-75-4	N-Nitrosopipendine
U140	78-83-1	Isobutyl alcohol (I,T)	U180	930-55-2	N-Nitrosopyrrolidine
U141	120-58-1	Isosafrole	U181	99-55-8	5-Nitro-o-toluidine
U142	143-50-0	Kepone	U193	1120-71-4	1,2-Oxathiolane, 2,2-dioxide
U143	303-34-4	Lasiocarpine	U058	50-18-0	2H-1,3,2-Oxazaphosphon-2-amine, N,N-bis(2-chloroethyl)tetrahydro-, 2-oxide
U144	301-01-2	Lead acetate	U115	75-21-8	Oxirane (I,T)
U146	1335-32-6	Lead, bis(acetato-O)tetrahydroxytri-	U126	765-34-4	Oxiranecarboxaldehyde
U145	7446-27-7	Lead phosphate	U041	106-89-8	Oxirane, (chloromethyl)-
U146	1335-32-6	Lead subacetate	U182	123-63-7	Paraldehyde
U129	58-89-9	Lindane	U183	608-93-5	Pentachlorobenzene
U163	70-25-7	MNNG	U184	76-01-7	Pentachloroethane
U147	108-31-6	Maleic anhydride	U185	82-68-8	Pentachloronitrobenzene (PCNB)
U148	123-33-1	Maleic hydrazide	See	87-86-5	Pentachlorophenol
U149	109-77-3	Malononitrile	F027		
U150	148-82-3	Melphalan	U161	108-10-1	Pentanol, 4-methyl-
U151	7439-97-6	Mercury	U186	504-60-9	1,3-Pentadiene (I)
U152	126-98-7	Methacrylonitrile (I, T)	U187	62-44-2	Phenacetin
U092	124-40-3	Methanamine, N-methyl- (I)	U188	108-95-2	Phenol
U029	74-83-9	Methane, bromo-	U048	95-57-8	Phenol, 2-chloro-
U045	74-87-3	Methane, chloro- (I, T)	U039	59-50-7	Phenol, 4-chloro-3-methyl-
U046	107-30-2	Methane, chloromethoxy-	U081	120-83-2	Phenol, 2,4-dichloro-
U068	74-95-3	Methane, dibromo-	U082	87-65-0	Phenol, 2,6-dichloro-
U080	75-09-2	Methane, dichloro-	U089	56-53-1	Phenol, 4,4'-(1,2-diethyl-1,2-ethenediyl)bis-, (E)-
U075	75-71-8	Methane, dichlorodifluoro-	U101	105-67-9	Phenol, 2,4-dimethyl-
U138	74-88-4	Methane, iodo-	U052	1319-77-3	Phenol, methyl-
U119	62-50-0	Methanesulfonic acid, ethyl ester	U132	70-30-4	Phenol, 2,2'-methylenebis[3,4,6-trichloro-
U211	56-23-5	Methane, tetrachloro-	U170	100-02-7	Phenol, 4-nitro-
U153	74-93-1	Methanethiol (I, T)	See	87-86-5	Phenol, pentachloro-
U225	75-25-2	Methane, tribromo-	F027		
U044	67-66-3	Methane, trichloro-	See	58-90-2	Phenol, 2,3,4,6-tetrachloro-
U121	75-69-4	Methane, trichlorofluoro-	F027		
U036	57-74-9	4,7-Methano-1H-indene, 1,2,4,5,6,7,8,8-octachloro-2,3,3a,4,7,7a-hexahydro-	See	95-95-4	Phenol, 2,4,5-trichloro-
U154	67-56-1	Methanol (I)	F027		
U155	91-80-5	Methapyrene	See	88-06-2	Phenol, 2,4,6-trichloro-
U142	143-50-0	1,3,4-Metheno-2H-cyclobuta[cd]pentalen-2-one, 1,1a,3,3a,4,5,5a,5b,6-decachlorooctahydro-	F027		
U247	72-43-5	Methoxychlor	U150	148-82-3	L-Phenylalanine, 4-[bis(2-chloroethyl)amino]-
U154	67-56-1	Methyl alcohol (I)	U145	7446-27-7	Phosphonic acid, lead(2+) salt (2,3)
U029	74-83-9	Methyl bromide	U087	3288-58-2	Phosphorodithioic acid, O,O-diethyl S-methyl ester
U186	504-60-9	1-Methylbutadiene (I)			

Hazardous waste No	Chemical abstracts No	Substance
U189	1314-80-3	Phosphorus sulfide (R)
U190	85-44-9	Phthalic anhydride
U191	109-06-8	2-Picoline
U179	100-75-4	Piperidine, 1-nitroso-
U192	23950-58-5	Pronamide
U194	107-10-8	1-Propanamine (I,T)
U111	621-64-7	1-Propanamine, N-nitroso-N-propyl-
U110	142-84-7	1-Propanamine, N-propyl- (I)
U066	96-12-8	Propane, 1,2-dibromo-3-chloro-
U083	78-87-5	Propane, 1,2-dichloro-
U149	109-77-3	Propanedinitrile
U171	79-46-9	Propane, 2-nitro- (I,T)
U027	108-60-1	Propane, 2,2'-oxybis[2-chloro-
U193	1120-71-4	1,3-Propane sultone
See F027	93-72-1	Propanoic acid, 2-(2,4,5-trichlorophenoxy)-
U235	126-72-7	1-Propanol, 2,3-dibromo-, phosphate (3 1)
U140	78-83-1	1-Propanol, 2-methyl- (I,T)
U002	67-64-1	2-Propanone (I)
U007	79-06-1	2-Propenamide
U084	542-75-6	1-Propene, 1,3-dichloro-
U243	1888-71-7	1-Propene, 1,1,2,3,3,3-hexachloro-
U009	107-13-1	2-Propenenitrile
U152	126-98-7	2-Propenenitrile, 2-methyl- (I,T)
U008	79-10-7	2-Propenoic acid (I)
U113	140-88-5	2-Propenoic acid, ethyl ester (I)
U118	97-63-2	2-Propenoic acid, 2-methyl-, ethyl ester
U162	80-62-6	2-Propenoic acid, 2-methyl-, methyl ester (I,T)
U194	107-10-8	n-Propylamine (I,T)
U083	78-87-5	Propylene dichloride
U148	123-33-1	3,6-Pyridazinedione, 1,2-dihydro-
U196	110-86-1	Pyridine
U191	109-06-8	Pyridine, 2-methyl-
U237	66-75-1	2,4-(1H,3H)-Pyrimidinedione, 5-bis[2-chloroethyl]amino]-
U164	56-04-2	4(1H)-Pyrimidinone, 2,3-dihydro-6-methyl-2-thioxo-
U180	930-55-2	Pyrrolidine, 1-nitroso-
U200	50-55-5	Reserpine
U201	108-46-3	Resorcinol
U202	1 81-07-2	Saccharin, & salts
U203	94-59-7	Safrole
U204	7783-00-8	Selenious acid
U204	7783-00-8	Selenium dioxide
U205	7488-56-4	Selenium sulfide
U205	7488-56-4	Selenium sulfide SeS ₂ (R,T)
U015	115-02-6	L-Serine, diazoacetate (ester)
See F027	93-72-1	Silvex (2,4,5-TP)
U206	18883-66-4	Streptozotocin
U103	77-78-1	Sulfuric acid, dimethyl ester
U189	1314-80-3	Sulfur phosphide (R)

Hazardous waste No	Chemical abstracts No	Substance
See F027	93-76-5	2,4,5-T
U207	95-94-3	1,2,4,5-Tetrachlorobenzene
U208	630-20-6	1,1,1,2-Tetrachloroethane
U209	79-34-5	1,1,2,2-Tetrachloroethane
U210	127-18-4	Tetrachloroethylene
See F027	58-90-2	2,3,4,6-Tetrachlorophenol
U213	109-99-9	Tetrahydrofuran (I)
U214	563-68-8	Thallium(I) acetate
U215	6533-73-9	Thallium(I) carbonate
U216	7791-12-0	Thallium(I) chloride
U216	7791-12-0	Thallium chloride TlCl
U217	10102-45-1	Thallium(I) nitrate
U218	62-55-5	Thioacetamide
U153	74-93-1	Thiomethanol (I,T)
U244	137-26-8	Thioperoxydicarbonyl diamide [(H ₂ N)C(S)] ₂ S ₂ , tetramethyl-
U219	62-56-6	Thiourea
U244	137-26-8	Thiram
U220	108-88-3	Toluene
U221	25376-45-8	Toluenediamine
U223	26471-62-5	Toluene diisocyanate (R,T)
U328	95-53-4	o-Toluidine
U353	106-49-0	p-Toluidine
U222	636-21-5	o-Toluidine hydrochloride
U011	61-82-5	1H-1,2,4-Triazol-3-amine
U227	79-00-5	1,1,2-Trichloroethane
U228	79-01-6	Trichloroethylene
U121	75-69-4	Trichloromonofluoromethane
See F027	95-95-4	2,4,5-Trichlorophenol
See F027	88-06-2	2,4,6-Trichlorophenol
U234	99-35-4	1,3,5-Trinitrobenzene (R,T)
U182	123-63-7	1,3,5-Trioxane, 2,4,6-trimethyl-
U235	126-72-7	Tris(2,3-dibromopropyl) phosphate
U236	72-57-1	Trypan blue
U237	66-75-1	Uracil mustard
U176	759-73-9	Urea, N-ethyl-N-nitroso-
U177	684-93-5	Urea, N-methyl-N-nitroso-
U043	75-01-4	Vinyl chloride
U248	1 81-81-2	Warfarin, & salts, when present at concentrations of 0.3% or less
U239	1330-20-7	Xylene (I)
U200	50-55-5	Yohimban-16-carboxylic acid, 11,17-dimethoxy-18-[(3,4,5-trimethoxybenzoyl)oxy]-, methyl ester, (3beta,16beta,17alpha,18beta,20alpha)-
U249	1314-84-7	Zinc phosphide Zn ₃ P ₂ , when present at concentrations of 10% or less

¹ CAS Number given for parent compound only

(The reporting and recordkeeping requirements contained in this section were ap-

proved by OMB under control number 2050-0047)

[Added by 50 FR 28742, July 15, 1985]

APPENDIX 12.3**Definitions of Ignitability,
Corrosivity, and Reactivity**

Note: The following pages are taken from 40 CFR Part 261 as of 8/18/88. Since regulations are often changing, please check with a regulatory agency to see if any changes have been made which may apply to you.

§ 261.21 Characteristic of ignitability.

(a) A solid waste exhibits the characteristic of ignitability if a representative sample of the waste has any of the following properties:

(1) It is a liquid, other than an aqueous solution containing less than 24 percent alcohol by volume and has flash point less than 60°C (140°F), as determined by a Pensky-Martens Closed Cup Tester, using the test method specified in ASTM Standard D-93-79 or D-93-80 (incorporated by reference, see §260.11), or a Setaflash Closed Cup Tester, using the test method specified in ASTM Standard D-3278-78 (incorporated by reference, see §260.11), or as determined by an equivalent test method approved by the Administrator under procedures set forth in §§260.20 and 260.21.

[261.21(a)(1) amended by 46 FR 35247, July 7, 1981]

(2) It is not a liquid and is capable, under standard temperature and pressure, of causing fire through friction, absorption of moisture or spontaneous chemical changes and, when ignited, burns so vigorously and persistently that it creates a hazard.

(3) It is an ignitable compressed gas as defined in 49 CFR 173.300 and as determined by the test methods described in that regulation or equivalent test methods approved by the Administrator under §§ 260.20 and 260.21.

(4) It is an oxidizer as defined in 49 CFR 173.151.

(b) A solid waste that exhibits the characteristic of ignitability, but is not listed as a hazardous waste in Subpart D, has the EPA Hazardous Waste Number of D001.

§ 261.22 Characteristic of corrosivity.

(a) A solid waste exhibits the characteristic of corrosivity if a representative sample of the waste has either of the following properties:

[261.22(a)(1) and (2) amended by 46 FR 35247, July 7, 1981]

(1) It is aqueous and has a pH less than or equal to 2 or greater than or equal to 12.5, as determined by a pH meter using either an EPA test method or an equivalent test method approved by the Administrator under the procedures set forth in §§ 260.20 and 260.21. The EPA test method for pH is specified as Method 5.2 in "Test Methods for the Evaluation of Solid Waste, Physical/Chemical Methods" (incorporated by reference, see § 260.11).

(2) It is a liquid and corrodes steel (SAE 1020) at a rate greater than 6.35

mm (0.250 inch) per year at a test temperature of 55°C (130°F) as determined by the test method specified in NACE (National Association of Corrosion Engineers) Standard TM-01-69 as standardized in "Test Methods for the Evaluation of Solid Waste, Physical/Chemical Methods" (incorporated by reference, see § 260.11) or an equivalent test method approved by the Administrator under the procedures set forth in §§ 260.20 and 260.21.

(b) A solid waste that exhibits the characteristic of corrosivity, but is not listed as a hazardous waste in Subpart D, has the EPA Hazardous Waste Number of D002.

§ 261.23 Characteristic of reactivity.

(a) A solid waste exhibits the characteristic of reactivity if a representative sample of the waste has any of the following properties:

(1) It is normally unstable and readily undergoes violent change without detonating.

(2) It reacts violently with water.

(3) It forms potentially explosive mixtures with water.

(4) When mixed with water, it generates toxic gases, vapors or fumes in a quantity sufficient to present a danger to human health or the environment.

(5) It is a cyanide or sulfide bearing waste which, when exposed to pH conditions between 2 and 12.5, can generate toxic gases, vapors or fumes in a quantity sufficient to present a danger to human health or the environment.

(6) It is capable of detonation or explosive reaction if it is subjected to a strong initiating source or if heated under confinement.

(7) It is readily capable of detonation or explosive decomposition or reaction at standard temperature and pressure.

(8) It is a forbidden explosive as defined in 49 CFR 173.51, or a Class A explosive as defined in 49 CFR 173.53 or a Class B explosive as defined in 49 CFR 173.88.

(b) A solid waste that exhibits the characteristic of reactivity, but is not listed as a hazardous waste in Subpart D, has the EPA Hazardous Waste Number of D003.

APPENDIX 12.4**Maximum Concentration of Contaminants for
Characteristics of EP Toxicity**

Note: The following pages are taken from 40 CFR Part 261 as of 8/18/88. Since regulations are often changing, please check with a regulatory agency to see if any changes have been made which may apply to you.

Note: Proposed expansion of toxicity characteristic

On June 12, 1986, EPA proposed expanding the toxicity characteristic to include an additional 38 compounds and to add a new testing procedure. The table below lists these **proposed** additions. Note that this table also includes the contaminants already regulated in Section 261.24. If you generate one of these wastes check with EPA or your state agency to see if these regulations have become final.

§ 261.24 Characteristic of EP Toxicity.

(a) A solid waste exhibits the characteristic of EP toxicity if, using the test methods described in Appendix II or equivalent methods approved by the Administrator under the procedures set forth in §§ 260.20 and 260.21, the extract from a representative sample of the waste contains any of the contaminants listed in Table I at a concentration equal to or greater than the respective value given in that Table. Where the waste contains less than 0.5 percent filterable solids, the waste itself, after filtering, is considered to be the extract for the purposes of this section.

(b) A solid waste that exhibits the characteristic of EP toxicity, but is not listed as a hazardous waste in Subpart D, has the EPA Hazardous Waste Number specified in Table I which corresponds to the toxic contaminant causing it to be hazardous.

Table I.—Maximum Concentration of Contaminants for Characteristic of EP Toxicity

EPA hazardous waste number	Contaminant	Maximum concentration (milligrams per liter)
D004	Arsenic	5.0
D005	Barium	100.0
D006	Cadmium	1.0
D007	Chromium	5.0
D008	Lead	5.0
D009	Mercury	0.2
D010	Selenium	1.0
D011	Silver	5.0
D012	Endrin (1,2,3,4,10,10-hexachloro-1,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-endo, endo-5,8-dimethano naphthalene.	0.02
D013	Lindane (1,2,3,4,5,6-hexachlorocyclohexane, gamma isomer	0.4
D014	Methoxychlor (1,1,1-Trichloro-2,2-bis (p-methoxyphenyl)ethane)	10.0
D015	Toxaphene (C ₁₂ H ₁₄ Cl ₆ , Technical chlornated camphene, 67-69 percent chlorine)	0.5
D016	2,4-D, (2,4-Dichlorophenoxyacetic acid)	10.0
D017	2,4,5-TP Silvex (2,4,5-Trichlorophenoxypropionic acid)	1.0

NOTE: Proposed Expansion of Toxicity Characteristic

On June 12, 1986, EPA proposed expanding the toxicity characteristic to include an additional 38 compounds and to add a new testing procedure. The table below lists these PROPOSED additions. Note that this table also includes the contaminants already regulated in Section 261.24. If you generate one of these wastes check with EPA or your state agency to see if these regulations have become final.

Proposed Toxicity Characteristic Contaminants and Regulatory Levels

TABLE 1: PROPOSED TOXICITY CHARACTERISTIC CONTAMINANTS AND REGULATORY LEVELS

HWNO	Contaminants	CASNO	Regulatory level (mg/l)
D018	Acrylonitrile	107-13-1	5.0
D004	Arsenic	7440-38-2	5.0
D005	Barium	7440-39-3	100
D019	Benzene	71-43-2	0.07
D020	Bis(2-chloroethyl) ether.	111-44-4	0.05
D006	Cadmium	7440-43-9	1.0
D021	Carbon disulfide	75-15-0	14.4
D022	Carbon tetrachloride	56-23-5	0.07
D023	Chlordane	57-74-9	0.03
D024	Chlorobenzene	108-90-7	1.4
D025	Chloroform	67-66-3	0.07
D007	Chromium	1333-82-0	5.0
D026	o-Cresol	95-48-7	10.0
D027	m-Cresol	108-39-4	10.0
D028	p-Cresol	106-44-5	10.0
D016	2,4-D	94-75-7	1.4
D029	1,2-Dichlorobenzene	95-50-1	4.3
D030	1,4-Dichlorobenzene	106-46-7	10.8
D031	1,2-Dichloroethane	107-06-2	0.40
D032	1,1-Dichloroethylene	75-35-4	0.1
D033	2,4-Dinitrotoluene	121-14-2	0.13
D012	Endrin	72-20-8	0.003
D034	Heptachlor (and its hydroxide)	76-44-2	0.001
D035	Hexachlorobenzene	118-74-1	0.13
D036	Hexachlorobutadiene	87-68-3	0.72
D037	Hexachloroethane	67-72-1	4.3
D038	Isobutanol	78-83-1	36
D008	Lead	7439-92-1	5.0
D013	Lindane	58-89-9	0.06
D009	Mercury	7439-97-6	0.2
D014	Methoxychlor	72-43-5	1.4
D039	Methylene chloride	75-09-2	8.6
D040	Methyl ethyl ketone	78-93-3	7.2
D041	Nitrobenzene	98-95-3	0.13
D042	Pentachlorophenol	87-86-5	3.6
D043	Phenol	108-95-2	14.4
D044	Pyridine	110-86-1	5.0
D010	Selenium	7782-49-2	1.0
D011	Silver	7440-22-4	5.0
D045	1,1,1,2-Tetrachloroethane	630-20-6	10.0
D046	1,1,2,2-Tetrachloroethane	79-34-5	1.3
D047	Tetrachloroethylene	127-18-4	0.1
D048	2,3,4,6-Tetrachlorophenol	58-90-2	1.5
D049	Toluene	108-88-3	14.4
D015	Toxaphene	8001-35-2	0.07
D050	1,1,1-Trichloroethane	71-55-6	30
D051	1,1,2-Trichloroethane	79-00-5	1.2
D052	Trichloroethylene	79-01-6	0.07
D053	2,4,5-Trichlorophenol	95-95-4	5.8
D054	2,4,6-Trichlorophenol	88-06-2	0.30
D017	2,4,5-TP (Silvex)	93-76-5	0.14
D055	Vinyl chloride	75-01-4	0.05

Source: 51 FR 21652 (June 13, 1986).

APPENDIX 12.5

**EPA Hazardous Waste Numbers for Waste Streams
Commonly Generated by Small
Quantity Generators**

EPA HAZARDOUS WASTE NUMBERS FOR WASTE STREAMS COMMONLY GENERATED BY SMALL QUANTITY GENERATORS

The industries and waste streams described here do not provide a comprehensive list, but rather serve as a guide to potential small quantity generators in determining which of their wastes, if any, are hazardous. Except for the pesticide and wood preserving categories, this Appendix does not include EPA Hazardous Waste Numbers for commercial chemical products that are hazardous when discarded unused. These chemicals and their EPA Hazardous Waste Numbers are listed in Title 40 of the Code of Federal Regulations (40 CFR) in Section 261.33.

Solvents:

Solvents, spent solvents, solvent mixtures, or solvent still bottoms are often hazardous. This includes solvents used in degreasing (identified as F001) and paint brush cleaning and distillation residues from reclamation. The following are some commonly used hazardous solvents (also see ignitable wastes for other hazardous solvents, and 40 CFR 261.31 for most listed hazardous waste solvents):

Benzene	F005
Carbon Disulfide	F005
Carbon Tetrachloride	F001
Chlorobenzene	F002
Cresols	F004
Cresylic Acid	F004
O-Dichlorobenzene	F002
Ethanol	D001
2-Ethoxyethanol	F005
Ethylene Dichloride	D001
Isobutanol	F005
Isopropanol	D001
Kerosene	D001
Methyl Ethyl Ketone	F005
Methylene Chloride	F001
	F002
Naphtha	D001
Nitrobenzene	F004
2-Nitropropane	F005
Petroleum Solvents	D001
(Flashpoint less than 140°F)	
Pyridine	F005
1,1,1-Trichloroethane	F001
	F002
1,1,2-Trichloroethane	F002

Tetrachloroethylene	F001
(Perchloroethylene)	F002
Toluene	F005
Trichloroethylene	F001
	F002
Trichlorofluoromethane	F002
Trichlorotrifluoroethane	
(Valclene)	F002
White Spirits	D001

Acids/Bases:

Acids, bases, or mixtures having a pH less than or equal to 2 or greater than or equal to 12.5, are considered corrosive (for a complete description of corrosive wastes, see 40 CFR 261.22, Characteristic of corrosivity). All corrosive materials and solutions have the EPA Hazardous Waste Number D002. The following are some of the more commonly used corrosives:

Acetic Acid	Nitric Acid
Ammonium Hydroxide	Oleum
Chromic Acid	Perchloric Acid
Hydrobromic Acid	Phosphoric Acid
Hydrochloric Acid	Potassium Hydroxide
Hydrofluoric Acid	Sodium Hydroxide
	Sulfuric Acid

Dry Cleaning Filtration Residues:

Cooked powder residue (perchloroethylene plants only), still residues, and spent cartridge filters containing perchloroethylene or valclene are hazardous and have the EPA Hazardous Waste Number F002.

Still residues containing petroleum solvents with a flashpoint less than 140°F are considered hazardous and have the EPA Hazardous Waste Number D001.

Heavy Metals/Inorganics:

Heavy metals and other inorganic waste materials exhibit the characteristic of EP Toxicity and are considered hazardous if the extract from a representative sample of the waste has any of the specific constituent concentrations as shown in 40

CFR 261.24, Table 1. This may include dusts, solutions, wastewater treatment sludges, paint wastes, waste inks, and other such materials which contain heavy metals/inorganics (note that wastewater treatment sludges from electroplating operations are identified as F006). The following are EP Toxic:

Arsenic	D004
Barium	D005
Cadmium	D006
Chromium	D007
Lead	D008
Mercury	D009
Selenium	D010
Silver	D011

Ignitable Wastes:

Ignitable wastes include any liquids that have a flashpoint less than 140°F, any non-liquids that are capable of causing a fire through friction, absorption of moisture, or spontaneous chemical change, or any ignitable compressed gas as described in 49 CFR 173.300 (for a complete description of ignitable wastes, see 40 CFR 261.21, Characteristic of ignitability). Examples are spent solvents (see also solvents), solvent still bottoms, ignitable paint wastes (paint removers, brush cleaners and stripping agents), epoxy resins and adhesives (epoxies, rubber cements and marine glues), and waste inks containing flammable solvents. Unless otherwise specified, all ignitable wastes have the EPA Hazardous Waste Number of D001.

Some commonly used ignitable compounds are:

Acetone	F003
Benzene	F005
n-Butyl Alcohol	F003
Chlorobenzene	F002 ¹
Cyclohexanone	F003
Ethyl Acetate	F003
Ethylbenzene	F003
Ethyl Ether	F003
Ethylene Dichloride	D001

¹ Chlorobenzene is listed by EPA as a hazardous waste due to its toxicity and has been assigned EPA Hazardous Waste Number F002. It has a flashpoint, however, of less than 140°F and is therefore included here as an ignitable waste.

Methanol	F003
Methyl Isobutyl Ketone	F003
Petroleum Distillates	D001
Xylene	F003

Ink Sludges Containing Chromium and Lead:

This includes solvent washes and sludges, caustic washes and sludges, or water washes and sludges from cleaning tubs and equipment used in the formulation of ink from pigments, driers, soaps, and stabilizers containing chromium and lead. All ink sludges have the EPA Hazardous Waste Number K086.

Lead-Acid Batteries:

Used lead-acid batteries should be reported on the notification form *only* if they are not recycled. Used lead-acid batteries that *are* recycled do not need to be counted in determining the quantity of waste that you generate per month, nor do they require a hazardous waste manifest when shipped off your premises. (Note: Special requirements do apply if you recycle your batteries on your own premises—see 40 CFR Part 266.)

Lead Dross	D008
Spent Acids	D002
Lead-Acid Batteries	D008

Pesticides:

The pesticides listed below are hazardous. Wastes marked with an asterisk (*) have been designated acutely hazardous. For a more complete listing, see 40 CFR 261.32 and 261.33 for specific listed pesticides, and other wastes, wastewaters, sludges, and by-products from pesticide formulations. (Note that while many of these pesticides are no longer in common use, they are included here for those cases where they may be found in storage.)

* Aldicarb	P070
* Aldrin	P004
Amitrole	U011
* Arsenic Pentoxide	P011
* Arsenic Trioxide	P012
Cacodylic Acid	U136
Carbamic Acid, Methylnitroso-, Ethyl Ester	U178
Chlordane	U036

Pesticides (Continued):

*Copper Cyanides	P029
1,2-Dibromo-3-chloropropane	U066
1,2-Dichloropropane	U083
1,3-Dichloropropene	U084
2,4-Dichlorophenoxy Acetic Acid	U240
DDT	U061
*Dieldrin	P037
Dimethylcarbamoyl Chloride	U097
*Dinitrocresol	P047
*Dinoseb	P020
Disodium Monomethane arsenate	D004
*Disulfoton	P039
*Endosulfan	P050
*Endrin	P051
Ethylmercuric Chloride	D009
*Famphur	P097
*Heptachlor	P059
Hexachlorobenzene	U127
Kepone	U142
Lindane	U129
2-Methoxy Mercuric Chloride	D009
Methoxychlor	D014
*Methyl Parathion	P071
Monosodium Methane arsenate	D004
*Nicotine	P075
*Parathion	P089
Pentachloronitrobenzene	U185
Pentachlorophenol	U242
Phenylmercuric Acetate	D009
*Phorate	P094
*Strychnine	P108
2,4,5-Trichlorophenoxy	
Acetic Acid	U232
2-(2,4,5-Trichlorophenoxy)-	
Propionic Acid	U233
*Thallium Sulfate	P115
Thiram	U244
*Toxaphene	P123
Warfarin	U248

Reactives:

Reactive wastes include reactive materials or mixtures which are unstable, react violently with or form explosive mixtures with water, generate toxic gases or vapors when mixed with water (or when exposed to pH conditions between 2 and 12.5 in the case of cyanide or sulfide bearing wastes), or are capable of detonation or explosive reaction when heated or subjected to shock (for a complete description of reactive wastes, see 40

CFR 261.23, Characteristic of reactivity). Unless otherwise specified, all reactive wastes have the EPA Hazardous Waste Number D003. The following materials are commonly considered to be reactive:

Acetyl Chloride	Organic Peroxides
Chromic Acid	Perchlorates
Cyanides	Permanganates
Hypochlorites	Sulfides

Spent Plating and Cyanide Wastes:

Spent plating wastes contain cleaning solutions and plating solutions with caustics, solvents, heavy metals, and cyanides. Cyanide wastes may also be generated from heat treatment operations, pigment production, and manufacturing of anti-caking agents. Plating wastes are generally Hazardous Waste Numbers F006-F009, with F007-F009 containing cyanide. Cyanide heat treating wastes are generally Hazardous Waste Numbers F010-F012. See 40 CFR 261.32 for a more complete description of plating wastes.

Wood Preserving Agents:

The wastewater treatment sludges from wastewater treatment operations are considered hazardous (EPA Hazardous Waste Number K001—bottom sediment sludges from the treatment of wastewater processes that use creosote and pentachlorophenol). In addition, unless otherwise indicated, specific wood preserving compounds are:

Chromated Copper Arsenate	D004
Creosote	U051
Pentachlorophenol	F027

APPENDIX 12.6

Counting Your Hazardous Waste

Do Count

You do count **all** quantities of "Listed" and "Characteristic" hazardous wastes as defined on page 2 that you:

- ▶ Accumulate on-site for any period of time prior to subsequent management.
- ▶ Package and transport off-site.
- ▶ Place directly in a regulated on-site treatment or disposal unit.
- ▶ Generate as still bottoms or sludges and remove from product storage tanks.

Don't Count

You do not have to count wastes that:

- ▶ Are specifically exempted from counting. Examples of these exempted wastes are:
 - spent lead-acid batteries that will be sent off-site for reclamation.
 - used oil that has not been mixed with hazardous waste.
- ▶ May be left in the bottom of containers that have been completely emptied through conventional means, for example, by pouring or pumping. Containers that held an acute hazardous waste must be more thoroughly cleaned.
- ▶ Are left as residue in the bottom of product storage tanks, if the residue is not removed from the product tank.
- ▶ You reclaim continuously on-site without storing the waste prior to reclamation, such as dry cleaning solvents. (You *do* have to count any residue removed from the machine as well as spent cartridge filters.)
- ▶ You manage in an elementary neutralization unit, a totally enclosed treatment unit, or a wastewater treatment unit. An elementary neutralization unit is a regulated tank, container, or transport vehicle (including ships) which is designed to contain and neutralize corrosive wastes.
- ▶ Are discharged directly to a publicly-owned treatment works (POTW) without being stored or accumulated first. This discharge to a POTW must comply with the Clean Water Act. POTWs are public utilities, usually owned by the city, county, or state, that treat industrial and domestic sewage for disposal.
- ▶ You have already counted once during the calendar month, and treated on-site or reclaimed in some manner, and used again.

* SOURCE: U.S. EPA Understanding the Small Quantity Generator Hazardous Waste Rules: A Handbook for Small Business, Sept. 1986

APPENDIX 12.7

**Counting Your Hazardous Waste
in Pennsylvania**

Do Count

You **do** count all quantities of "Listed" and "Characteristic" hazardous wastes as defined on page 2 that you:

- accumulate on-site for any period of time prior to subsequent management.
- package and transport off-site.
- place directly in a regulated on-site treatment or disposal unit.
- generate as still bottoms or sludges and remove from product storage tanks.
- manage in an elementary neutralization unit, a totally enclosed treatment unit, or a wastewater treatment unit. An elementary neutralization unit is a regulated tank, container, or transport vehicle (including ships) which is designed to contain and neutralize corrosive wastes.
- discharge directly to a publicly-owned treatment works (POTW) without being stored or accumulated first. This discharge to a POTW must comply with the Clean Water Act. POTWs are public utilities, usually owned by the city, county, or state, that treat industrial and domestic sewage for disposal.

Don't Count

You **do not** have to count wastes that:

- are specifically exempted from counting. Examples of these exempted wastes are:
 - spent lead-acid batteries that will be sent off-site for reclamation.
 - used oil that has not been mixed with hazardous waste.
 - may be left in the bottom of containers that have been completely emptied through conventional means, for example, by pouring or pumping. Containers that held an acute hazardous waste must be more thoroughly cleaned.
 - are left as residue in the bottom of product storage tanks, if the residue is not removed from the product tank.
 - you reclaim continuously onsite without storing the waste prior to reclamation, such as dry cleaning solvents. (You do have to count any residue removed from the machine as well as spent cartridge filters.)
 - you have already counted once during the calendar month, and treated on-site or reclaimed in some manner, and used again.
-