

Section 5 Water Management and Safety

This section provides guidelines for laboratory waste management. These guidelines are only a summary of basic USEPA requirements and do not relieve the user from complying with the complete regulations contained in the Code of Federal Regulations (CFR). The regulations may change or additional state and local laws may apply; waste generators are responsible for knowing and following all the laws and regulations that apply to their operations.

5.1 Waste minimization

The most effective way to decrease waste management problems and expense is through waste minimization. To do this:

- Use the smallest sample size that will produce accurate results.
- Where possible, choose methods that use reagents that pose fewer hazards.
- Eliminate the need to dispose of out-dated materials by purchasing in smaller quantities.
- Use biodegradable detergents to clean glassware and apparatus unless solvents or acids are specifically required.

5.2 Regulatory overview

The Resource Conservation and Recovery Act (RCRA) controls all solid waste disposal with an emphasis on hazardous waste. Title 40 Code of Federal Regulations (CFR) part 260 contains the federal hazardous waste disposal regulations issued in accordance with the RCRA. The regulations create a system to identify hazardous wastes and track waste generation, transport and ultimate disposal from cradle to grave. Each facility involved in hazardous waste management must be registered with the USEPA, with the exception of conditionally exempt small quantity generators.

Federal regulations recognize three categories of generators with those generating larger amounts of waste being under stricter control.

The categories are:

Conditionally Exempt Small Quantity Generator— less than 100 kg (220 lb) per month

Small Quantity Generator— between 100 kg (220 lb) and 1000 kg (2200 lb) per month

Large Quantity Generator— greater than 1000 kg (2200 lb) per month.

5.3 Hazardous waste

5.3.1 Definition

For regulatory purposes, a *hazardous waste* is a material that is subject to special consideration by the USEPA under 40 CFR 261. State or local authorities may also designate additional materials as hazardous waste in their areas.

Many toxic compounds are not regulated, but improper management or disposal may lead to legal problems under CERCLA (Superfund) or common law tort.

The definition given by 40 CFR 261 defines a hazardous waste as a solid waste that is not excluded from regulation and meets one or more of the following criteria:

- It is a discarded commercial chemical product, off-specification species, container residue or spill residue of materials specifically listed in 40 CFR 261.33 (P- and U-codes);
- It is a waste from a specific source listed in 40 CFR 261.32 (K-code);
- It is a waste from a non-specific source listed in 40 CFR 261.31 (F-code);
- and/or
- It displays any of the following characteristics of hazardous waste:
 - ignitability
 - corrosivity
 - reactivity
 - toxicity

There are exceptions to these regulations; review the regulations to determine applicable exclusions.

5.3.2 Sample codes

Hazardous wastes are managed by specific codes assigned in 40 CFR 261.20–261.33. These codes are provided to help identify hazardous waste. The generator is responsible for making the actual waste code determination.

Selected characteristic waste codes for chemicals which may be generated using methods for water analysis are given in the following table. A complete list of waste codes is found in 40 CFR 261.20 through 40 CFR 261.33.

Table 14 Hazardous waste codes

Characteristic	USEPA code	Chemical abstract services (CAS) No.	Regulatory level (mg/L)
Corrosivity	D002	na	na
Ignitability	D001	na	na
Reactivity	D003	na	na
Arsenic	D004	6440-38-2	5.0
Barium	D005	6440-39-3	100.0
Benzene	D018	71-43-2	0.5
Cadmium	D006	7440-43-9	1.0
Chloroform	D022	67-66-3	6.0
Chromium	D007	7440-47-3	5.0
Lead	D008	7439-92-1	5.0
Mercury	D009	7439-97-6	0.2
Selenium	D010	7782-49-2	1.0
Silver	D011	7440-22-4	5.0

5.3.3 How to determine if waste is hazardous

Federal laws do not require testing of material to decide if it is a hazardous waste. If the product is not specifically listed in the regulations, apply product or generator knowledge to decide if it is hazardous. Often, there is enough information on a Material Safety Data Sheet (MSDS) to decide. Look for characteristics of a hazardous waste:

- Flash point is below 60 °C (140 °F) or it is classified by DOT as an oxidizer (D001).
- The pH of the material is ≤ 2 or ≥ 12.5 (D002).
- The material is unstable, reacts violently with water, may generate toxic gases when mixed with water (D003).
- It is toxic (D004–D043).

Use the chemical composition data to decide if a material is toxic based on the concentration of certain contaminants (Heavy metals and a number of organic compounds). If the waste is a liquid, compare the concentration of contaminants to the concentrations listed in 40 CFR 26. If the waste is a solid, analyze the sample by the Toxicity Characteristic Leachability Procedure (TCLP) and then compare the results to the concentrations in 40 CFR 261.24. Levels above the threshold amounts are considered hazardous.

For more information on using the MSDS, see [Material safety data sheets](#).

Some tests use or produce a number of chemicals that make the end product a hazardous waste; for example, the COD tests and Nessler reagent. Hazardous waste status may also result from substances present in the sample.

5.3.4 Disposal

Hazardous waste must be managed and disposed of according to federal, state and local regulations. The waste generator is responsible for making hazardous waste determinations. Analysts should check with their facility's environmental compliance department for specific instructions.

Most hazardous wastes should be handled by treatment, storage and disposal facilities (TSDF) that have USEPA permits. In some cases, the generator may treat the hazardous waste, but may need a permit from the USEPA and/or state agency. Laboratories are not exempt from these regulations. If the facility is a "Conditionally Exempt Small Quantity Generator," special rules may apply. Check 40 CFR 261 to determine the laws and rules that apply for a given generator.

The most common allowed treatment is elementary neutralization. This applies to wastes that are hazardous only because they are corrosive or are listed only for that reason. Neutralize acidic solutions by adding a base such as sodium hydroxide; neutralize basic solutions by adding an acid such as hydrochloric acid. Slowly add the neutralizing agent while stirring. Monitor the pH. When it is at or near 7, the material is neutralized and may be flushed down the drain. Many generated wastes may be treated in this manner.

Other chemical or physical treatments such as cyanide destruction or evaporation may require a permit. Check with the environmental department or local regulators to determine which rules apply to each facility.

Laboratory chemicals may be mixed and disposed of with other hazardous wastes generated at a facility. They may also be accumulated in accordance with 40 CFR 262.34 satellite accumulation rules. After collection they may be disposed of in a *labpack*. Many environmental and hazardous waste companies offer labpacking services. They will inventory, sort, pack and arrange for proper disposal of hazardous waste. Find companies offering these services in the Yellow Pages under "Waste Disposal — Hazardous" or contact state and local regulators for assistance.

5.4 Management of specific wastes

Recycling programs for some forms of laboratory waste are available through Hach Company. Obtain information on recycling services by calling 1-800-227-4224 or by visiting www.hach.com."

Several documents are also available to assist in managing generated waste. Obtain available documents by calling 1-800-227-4224 or 970-669-3050 and requesting the literature codes given:

Table 15 Waste management literature

Literature code	Title
9323	Mercury Waste Disposal Firms
9324	RCRA Waste Disposal Information
9325	COD Waste Disposal Information
9326	COD Heavy Metal Concentrations

5.4.1 Special considerations for Cyanide-containing materials

Several procedures in this manual use reagents that contain cyanide compounds. These materials are regulated as reactive waste (D003) by the Federal RCRA. Instructions provided with each procedure explain how to collect these materials for proper disposal. It is imperative that these materials be handled safely to prevent the release of hydrogen cyanide gas (an extremely toxic material with the smell of bitter almonds). Most cyanide compounds are stable and can be safely stored for disposal, in highly alkaline solutions (pH >11) such as 2 N sodium hydroxide. Never mix these wastes with other laboratory wastes that may contain lower pH materials such as acids or even water.

If a cyanide-containing compound is spilled, avoid exposure to hydrogen cyanide gas. Take the following steps to destroy the cyanide compounds in an emergency:

1. Use a fume hood, supplied air or self-contained breathing apparatus.
2. While stirring, add the waste to a beaker containing a strong solution of sodium hydroxide and either calcium hypochlorite or sodium hypochlorite (household bleach).
3. Add an excess of hydroxide and hypochlorite. Let the solution stand for 24 hours.
4. Neutralize the solution and flush it down the drain with a large amount of water. If the solution contains other regulated materials such as chloroform or heavy metals, it may still need to be collected for hazardous waste disposal. Never flush untreated hazardous wastes down the drain.

5.5 Resources

Many sources of information on proper waste management are available. The USEPA has a hotline number for questions about the Resource Conservation and Recovery Act (RCRA). The RCRA Hotline number is 1-800-424-9346. Copies of the appropriate regulations are available. Federal hazardous waste regulations are found in 40 CFR 260-99. Obtain this book from the U.S. Government Printing Office or an alternate vendor. Other documents that may be helpful to the hazardous waste manager in the laboratory include:

- Task Force on Laboratory Waste Management. *Laboratory Waste Management, A Guidebook*; American Chemical Society, Department of Government Relations and Science Policy: Washington, DC 1994.
- Task Force on Laboratory Waste Management. *Waste Management Manual for Laboratory Personnel*; American Chemical Society, Department of Government Relations and Science Policy: Washington, DC 1990.

- Task Force on Laboratory Waste Management. *Less is Better*, 2nd ed.; American Chemical Society, Department of Government Relations and Science Policy: Washington, DC 1993.
- Committee on Chemical Safety. *Safety in Academic Chemistry Laboratories*, 5th ed.; American Chemical Society: Washington, DC, 1990.
- Armour, Margaret-Ann. *Hazardous Laboratory Chemicals Disposal Guide*; CRC Press: Boca Raton, FL, 1991.
- *Environmental Health and Safety Manager's Handbook*; Government Institutes, Inc.: Rockville, MD, 1988.
- Lunn, G.; Sansone, E.B. *Destruction of Hazardous Chemicals in the Laboratory*; John Wiley and Sons: New York, 1990.
- National Research Council. *Prudent Practices for Disposal of Chemicals from Laboratories*; National Academy Press: Washington, DC, 1983.
- National Research Council. *Prudent Practices for Handling Hazardous Chemicals in Laboratories*; National Academy Press: Washington, DC, 1981.
- Environmental Protection Agency, Office of Solid Waste and Emergency Response. *The RCRA Orientation Manual*; U.S. Government Printing Office: Washington, DC, 1991.
- Environmental Protection Agency, Office of Solid Waste and Emergency Response. *Understanding the Small Quantity Generator Hazardous Waste Rules: A Handbook for Small Business*; U.S. Government Printing Office: Washington, DC, 1986.

5.6 Safety

Safety is the responsibility of every analyst. Many chemical procedures use potentially hazardous chemicals and equipment; it is important to prevent accidents by practicing good laboratory techniques. The following guidelines apply to water analysis and are not intended to cover every aspect of safety.

5.6.1 Read labels carefully

Read each reagent label carefully. Pay particular attention to the precautions given. Never remove or cover the label on a container while it contains reagent. Do not put a different reagent into a labeled container without changing the label. When preparing a reagent or standard solution, label the container clearly. If a label is hard to read, relabel promptly according to the hazard communication program.

Warning labels also appear on some of the apparatus used with the test procedures. The protective shields with the Digesdahl Digestion Apparatus point out potential hazards. Be sure these shields are in place during use and observe the precautions on the label.

5.6.2 Protective equipment

Use the right protective equipment for the chemicals and procedures. The MSDS contains this information. Protective equipment may include:

- Eye protection, such as safety glasses or goggles, to protect from flying objects or chemical splashes.
- Gloves to protect skin from toxic or corrosive materials, sharp objects, very hot or very cold materials or broken glass. Use tongs or finger cots when transferring hot apparatus.
- Laboratory coats or splash aprons to protect skin and clothing from splashes.
- Footwear to protect feet from spills. Open toed shoes should not be worn in chemistry settings.

- Respirators may be needed if adequate ventilation, such as fume hoods, are not available. Use fume hoods when directed to do so by the procedure or as recommended in the MSDS. For many procedures, adequate ventilation is enough if there is plenty of fresh air and air exhaust to protect against unnecessary exposure to chemicals.

5.6.3 First aid equipment and supplies

Most first aid instructions for chemical splashes in eyes or on skin call for thorough flushing with water. Laboratories should have eyewash and shower stations. For field work, carry a portable eyewash unit. Laboratories should also have appropriate fire extinguishers and fume hoods.

5.6.4 General safety rules

Follow these rules when working with toxic and hazardous chemicals:

- **Never** pipet by mouth. Always use a mechanical pipet or pipet bulb to avoid ingesting chemicals.
- Follow test procedures carefully and observe all precautionary measures. Read the entire procedure before beginning.
- Wipe up all spills promptly. Get proper training and have the right response equipment to clean up spills. See the safety director for more information.
- **Do not** smoke, eat or drink in an area where toxic or irritating chemicals are used.
- Use reagents and equipment only as directed in the test procedure.
- **Do not** use damaged labware and broken equipment.
- Minimize all chemical exposures. **Do not** breathe vapors or let chemicals touch the skin. Wash hands after using chemicals.
- Keep work areas **neat** and **clean**.
- **Do not** block exits or access to emergency equipment.

5.7 Material safety data sheets

Material safety data sheets (MSDS) describe the hazards of chemical products. This section explains the information found on the MSDS and tells how to locate important information for safety and waste disposal. The information provided on the MSDS applies to the product as sold by a specific manufacturer. The properties of any mixtures obtained by using this product will be different.

5.7.1 How to obtain an MSDS

The MSDS is shipped to a customer with the first order of any chemical product. A new MSDS may be sent when the information on the data sheet is updated. Please review all new MSDS for new information. To obtain another copy of an MSDS, call 1-800-227-4224 or download directly from www.hach.com/msdsinfo.htm.

5.7.2 Sections of an MSDS

Each MSDS has ten sections. The sections and the information included are described below.

Header information

The manufacturer order number, MSDS date, change number, company address and telephone number and emergency telephone numbers are listed at the top of the MSDS.

5.7.2.1 Product identification

This section contains:

- Product name
- Chemical Abstract Services (CAS) number
- Chemical name
- Chemical formula, if appropriate
- Chemical family to which the material belongs

5.7.2.2 Ingredients

This section lists each component in the product. It contains the following information for each component:

- **PCT:** Percent by weight of this component
- **CAS NO.:** Chemical Abstract Services (CAS) registry number for this component
- **SARA:** Superfund Amendments and Reauthorization Act, better known as the “Community Right to Know Law”, informs if the component is listed in SARA 313. If the component is listed and the facility uses more than the specified amount, report use to the USEPA every year.
- **TLV:** Threshold Limit Value. The maximum airborne concentration for an 8-hour exposure that is recommended by the American Conference of Governmental Industrial Hygienists (ACGIH).
- **PEL:** Permissible Exposure Limit. The maximum airborne concentration for an 8-hour exposure that is regulated by the Occupational Safety and Health Administration (OSHA).
- **HAZARD:** Physical and health hazards of the component are explained.

5.7.2.3 Physical data

The physical properties of the product are given in this section. They include the physical state, color, odor, solubility, boiling point, melting point, specific gravity, pH, vapor density, evaporation rate, corrosivity, stability and storage precautions.

5.7.2.4 Fire, explosion hazard and reactivity data

This section contains the flash point and flammable limits of the material. It also includes how to fight fires if the material catches on fire. Key terms in this section include:

- **Flash point:** The temperature at which a liquid will give off enough flammable vapor to ignite.
- **Flammability and ignitability** are usually defined by the flash point.
- **Lower Flammable Limit (LFL or LEL):** The lowest concentration that will produce a fire or flash when an ignition source is present.
- **Upper Flammable Limit (UFL or UEL):** The vapor concentration in air above which the concentration is too rich to burn.
- **NFPA Codes:** The National Fire Protection Association (NFPA) has a system to rate the degree of hazards presented by a chemical. These codes are usually placed in a colored diamond. The codes range from 0 for minimal hazard to 4 for extreme hazard. They are grouped into the following hazards: health (blue), flammability (red), reactivity (yellow) and special hazards (white).

5.7.2.5 Health hazard data

This section describes the pathways by which the chemical can enter the body (i.e., ingestion, inhalation, skin contact). It also gives acute (immediate) and chronic (long-term) health effects. If the material causes cancer or genetic damage, it is stated in this section.

5.7.2.6 Precautionary measures

This section contains special precautions for the material. These may include special storage instructions, handling instructions, conditions to avoid and protective equipment required to use this material safely.

5.7.2.7 First aid

First aid instructions for exposures to the chemical are given in this section. Be sure to read this section before inducing vomiting in a victim. Some chemicals are better treated by not inducing vomiting. Seek prompt medical attention for all chemical exposures.

5.7.2.8 Spill and disposal procedures

This section explains safe practices for cleaning up and disposing of spilled material. For more information, see [Hazardous waste](#). **The waste generator is ultimately responsible for meeting the federal, state and local laws that apply to each facility.**

5.7.2.9 Transportation data

Domestic and International shipping information is provided in this section. It gives shipping name, hazard class and ID number of the product.

5.7.2.10 References

This section lists the reference materials used to write the MSDS.

Following the Reference section, the product will be listed as having SARA 313 chemicals or California Proposition 65 List Chemicals, if applicable. Also found here is any special information about the product.

5.7.3 OSHA chemical hygiene plan

The Occupational Safety and Health Administration (OSHA) enforces laws controlling exposure to hazardous chemicals in laboratories. These regulations are in Title 29 CFR 1910.1450. The regulations apply to all employers who use hazardous chemicals and require employers to develop and use a written Chemical Hygiene Plan and to appoint a qualified person as the Chemical Hygiene Officer.