

Review of Chemical Disposal Procedures

Responsible management of the chemical resources of school science labs encompasses best practices for the purchase, storage, use, and disposal of chemicals. It is a shared responsibility of the administration, faculty, and staff. Chemical disposal procedures require compliance with a variety of federal, state, and local laws and regulations, and are therefore a particular challenge for many science departments.

The Resource Conservation and Recovery Act

The Resource Conservation and Recovery Act, or RCRA, is the key law dealing with the identification, management, and disposal of hazardous waste. All institutions are required to have a policy for identifying hazardous waste and complying with the requirements of RCRA, which was enacted in 1976. The overarching goals of the law are to reduce the amount and toxicity of hazardous waste and thus protect human health and the environment. In writing the regulations to ensure that the goals of RCRA are achieved, the Environmental Protection Agency (EPA) also has the mandate to promote methods to minimize the amount of hazardous waste and reduce its environmental impact. These methods include source reduction, reuse and recycling of wastes, and chemical treatment that will eliminate hazardous waste characteristics.

Knowing Your RCRA Status and Requirements

In most cases authority for implementing and enforcing the law has been delegated to individual states that have adopted the RCRA guidelines. Some states may be more restrictive or impose additional conditions than federal guidelines require. Federal EPA recognizes three classes of hazardous waste generators, based on the amount and kinds of hazardous waste generated in one month. The storage and reporting regulations become increasingly more stringent as the amount of hazardous waste increases. Schools that generate less than 100 kg (220 lbs) of hazardous waste per month, and no more than 1 kg of acutely hazardous waste in any month, would fall into the least regulated, “conditionally exempt small quantity generator,” class. (The definitions for these types of waste are summarized below.) The EPA defines hazardous waste as a subset of solid waste, where solid waste is anything that will be discarded or may enter the environment—by burning, for example. (It’s confusing, but the term solid waste thus includes solids, liquids or gases!) Obviously, all schools and other institutions produce solid waste. Regardless of their RCRA status, all schools are required to determine which types of solid waste must be classified as hazardous waste.

Identifying Hazardous Waste

The first step in managing chemical disposal is identifying which discarded chemicals, as well as chemical reaction mixtures or byproducts that will not be reused, must be considered hazardous waste. There are two broad categories of hazardous waste—characteristic wastes and listed wastes. *Characteristic wastes* have one or more of the following properties:

- **Ignitable** wastes include flammable or combustible liquids (flash point $<140^{\circ}\text{F}$) as well as flammable compressed gases and solid oxidizers. Organic solvents such as acetone or toluene, compressed gases such as hydrogen, and solid ammonium nitrate are examples of ignitable wastes.
- **Corrosive** wastes are acidic or basic solutions that have a pH <2 or >12.5 , respectively.
- **Reactive** wastes are substances that react violently with air or water, are capable of detonation, or can generate toxic gases under relatively neutral conditions. Examples include the alkali metals sodium and potassium, diethyl ether and other peroxide-forming organic compounds, and cyanides or sulfides.

- **Toxic** chemical wastes are substances that, if disposed in a landfill, are capable of leaching threshold amounts of specific chemicals into groundwater. There are 40 substances in this category (also known as toxicity characteristic wastes). Although many of the substances on this list are pesticides, the list includes common heavy metals, including lead, barium, and silver.

There are four categories of *listed wastes*. Two categories include chemical byproducts from manufacturing processes and do not generally apply to schools. The other two categories, designated by the codes P and U, identify by name specific discarded commercial chemical products. All academic institutions should be aware of the chemicals on the P- (acutely toxic) and U- (toxic) lists. The P-listed, or *acutely toxic*, wastes are especially important because any school generating more than 1 kg (2.2 pounds or approx. one quart of liquid) of acutely hazardous waste per month will be subject to the most stringent generator requirements for listing, storing, and reporting all their hazardous waste. Most institutions do not use many P-list chemicals. The exceptions, which some schools might use, are sodium cyanide, potassium cyanide, arsenic trioxide, sodium azide, ammonium vanadate, and carbon disulfide. Recall that listed wastes refer to *discarded* or unused commercial chemical products where the chemical is the sole active ingredient. Make sure your school has effective chemical purchasing and inventory controls in place if you use P-listed chemicals in your science labs. This will prevent the school from accumulating excess chemicals that must be discarded.

Treating Chemicals in the Lab

The EPA encourages all waste generators, including academic institutions and laboratories, to minimize the amount of hazardous waste. Treating materials in the lab to reduce or eliminate chemical and physical hazards is one strategy for accomplishing this goal. Chemicals or chemical byproducts that are stored in the lab or remain in the lab after a lab activity is finished are not generally regulated as solid waste. The treatment of hazardous waste without a permit is generally not allowed. To avoid restrictions on treating hazardous waste, **always incorporate treatment or disposal of excess reagents or chemical byproducts from a chemical reaction into the lab procedure itself.** The Flinn Suggested Disposal Methods described on pages 1273–1294 may frequently be used to treat chemicals and eliminate potential hazards. Before undertaking any of these methods it is important to read, review, and understand the general principles and guidelines governing the disposal of laboratory chemicals:

- Check all federal, state, and local guidelines that may apply.
- All procedures should be carried out by skilled and trained personnel who are familiar with the physical and chemical properties of the chemicals and understand the procedure.
- Observe all safety precautions, including the requirements for personal protective equipment.
- Carry out all reactions that may generate gases in the hood.
- Provide secondary containment to protect against spills.
- Consult current Safety Data Sheets for storage, handling, and disposal information.
- Wear chemical splash goggles, chemical-resistant gloves, and a lab coat or chemical-resistant apron.

Examples of generally allowed chemical treatment methods include neutralization of acids and bases (Flinn Suggested Disposal Methods #24a, b and #10, respectively); redox reactions for oxidizing agents and reducing agents (Flinn Suggested Disposal Methods #12a and 12b); and precipitation reactions for metals (Flinn Suggested Disposal Methods #11 and 27h).

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As an example of this strategy, some experiments or demonstrations, such as the iodine clock reaction, may produce small amounts of iodine as a byproduct. Incorporate reduction of the iodine, an oxidizer, at the conclusion of the experiment. (Halogens may be reduced with sodium thiosulfate according to Flinn Suggested Disposal Method #12a.) In reviewing this treatment method, make sure you know the balanced chemical equation so that the appropriate molar excess of reducing agent, as well as any acid or base needed for the reaction, will be used.

Reducing the Amount and Toxicity of Hazardous Waste

Not all potentially hazardous waste must be shipped off-site for treatment or disposal. EPA and many states provide several regulatory exclusions that allow generators to treat hazardous waste without a permit as part of a broader mandate to further waste reduction efforts. In its publication "Little Known but Allowable Ways to Deal with Hazardous Waste," published in 2000, the EPA describes five strategies for minimizing hazardous waste. These include the domestic sewage exclusion, elementary neutralization, recycling, treatment in accumulation containers, and burning in small boilers. Recall that each state sets its own requirements for compliance with RCRA regulations. Requirements cannot be less strict than federal law, but states may impose more limitations than federal law. Thus, 28 states allow treatment in accumulation containers, two prohibit it, and the others impose some conditions or restrictions on treatment methods. (A complete state-by-state listing of all allowable waste reduction strategies can be found in the Appendix to the EPA publication cited above.)

Source reduction, or pollution prevention, is the preferred method for reducing the environmental burden of hazardous wastes. Materials may also be reclaimed by processing them to recover useful products. When source reduction and reuse or recycling are not feasible, waste may be treated to reduce its volume and toxicity. EPA allows drain disposal of even hazardous wastes via the "domestic sewage exclusion" provided that amounts and chemicals are in compliance with all wastewater standards and discharge limits imposed by publicly owned water treatment works. Among the allowed chemical treatments are elementary neutralization of acids and bases, precipitating metals from solution to obtain insoluble salts, and oxidation–reduction reactions. Treatment residues may still require management as a hazardous waste and residues destined for land disposal are subject to land disposal restriction standards. **Never dispose of chemicals in a septic system or storm sewer.** Make sure chemicals will not react with piping systems, and do not specifically rely on dilution to reduce the reactivity of chemicals or render them nonhazardous.

Licensed Hazardous Waste Disposal

Some chemicals will always require licensed hazardous waste disposal. These include toxic heavy metal salts and their solutions, including mercury, lead, cadmium, and chromium; arsenic and its compounds; halogenated organic solvents such as methylene chloride, chloroform, trichloroethylene or perchloroethylene; and various pesticides.

Summary

Most schools and many small colleges will fall into the least regulated "conditionally exempt small quantity generator" class for complying with EPA regulations regarding the storage and disposal of hazardous waste. However, it is important to know your status. It is the responsibility of every school to identify all types of hazardous waste that they generate. Hazardous waste generally falls into two categories, characteristic wastes and listed wastes. An accurate and up-to-date chemical inventory is the most effective means of keeping track of all chemicals and thus preventing the accumulation of unused chemicals that will need to be discarded. This is especially important for discarded chemicals that would be designated as P-list, or acutely toxic, hazardous waste. Of the more than 1200 chemicals that Flinn Scientific sells,

only six chemicals are on the P-list. Laboratory chemicals or chemical byproducts are not generally considered to be waste until they have left the lab. To avoid restrictions on treating hazardous waste, always incorporate treatment of excess chemicals or chemical byproducts from a lab activity into the lab procedure itself. Please consult this *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures, and review all federal, state, and local regulations that may apply, before proceeding. In its effort to reduce the amount and toxicity of hazardous waste, the EPA provides several exclusions for the treatment of hazardous waste without a permit. Not all states, however, allow all of these procedures. Among the generally allowed treatment methods are acid–base neutralization reactions, oxidation–reduction reactions, and precipitating metals to obtain insoluble salts. Some chemicals will always require licensed hazardous waste disposal. Please call or e-mail Flinn Scientific if you have any questions or if we can offer additional assistance.

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The administration, faculty, and staff share responsibility for minimizing the amount of hazardous waste and disposing of those wastes in a way that safeguards human health, protects the environment, and complies with all relevant environmental laws and regulations.

It is suggested that regular safety meetings are conducted. The discussion period will vary depending on the issues that need to be addressed.

It is important to keep a copy of safety training notes and a signed attendance sheet to verify that regular safety training meetings were held. The sign-up sheet is almost as important as the training notes and is usually the first thing that is requested and reviewed by regulatory inspectors. A copy of the sign-up sheet that we suggest using may be found at www.flinnsci.com/forms/signup.aspx.

References

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