

## Discussion and Notes

*Keep a copy of these safety training notes and a signed attendance sheet to verify regular safety training. Regulatory inspectors will usually request proof of safety training.*

## Review of Chemical Disposal Procedures

Responsible management of chemical resources encompasses best practices for the purchase, storage, use, and disposal of chemicals. It is a shared responsibility of the administration, faculty, and staff.

### 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 schools 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 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 are 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, commonly known for the acronym CESQG. (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. (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 by-products 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 °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 include aqueous solutions that have a pH ≤2 or ≥12.5, as well as liquids that will corrode steel.
- ◆ *Reactive* wastes are substances that react violently with air or water, are capable of detonation, or generate toxic gases when mixed with water. Examples include the alkali metals sodium and potassium, diethyl ether and other peroxide-forming organic compounds, and cyanides or sulfides.

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Examples of P-listed wastes include sodium azide and ammonium vanadate. Please consult the EPA Web site for a full description of all listed hazardous wastes. <http://www.epa.gov/osw/hazard/wastetypes/listed.htm>

- ◆ *Toxic* chemical wastes are substances that, if disposed of 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). The category includes common heavy metals, including lead, barium, and silver salts, as well as halogenated solvents such as carbon tetrachloride and chloroform.

There are four categories of *listed wastes*. Two categories include chemical by-products from manufacturing processes and do not generally apply to schools. The other two categories, designated by the codes P and U, specifically identify by name certain discarded commercial chemical products. Schools 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 approximately 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. Recall that listed wastes refer to *discarded* or unused commercial products where the chemical is the sole active ingredient. Make sure that you have effective chemical purchasing and inventory controls in place if you use P-listed chemicals. This will prevent the institution from accumulating excess chemicals that must be discarded.

### Treating Chemicals in the Lab

The EPA encourages all waste generators to minimize the amount of hazardous waste. Treating materials in the lab to reduce or eliminate chemical hazards is one strategy for accomplishing this goal. Chemicals or chemical by-products remaining after a lab activity has been 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 by-products from a chemical reaction into the lab procedure itself.** The Flinn Suggested Disposal Methods described in the *Flinn Scientific Catalog/Reference Manual* 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 procedures.
- ◆ Observe all safety precautions, including the requirements for personal protective equipment.
- ◆ Carry out all reactions that may generate gases in a fume 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 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).

As an example of this strategy, some experiments or demonstrations, such as the iodine clock reaction, may produce small amounts of iodine as a by-product. Incorporate reduction of iodine, an oxidizer, at the conclusion of the activity. (Halogens may be reduced with sodium thiosulfate according to Flinn Suggested Disposal Method #12a.)

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*Treating hazardous waste on-site in ways other than provided for in regulatory exclusions may subject generators to extremely high fines.*

## Reducing the Amount and Toxicity of Hazardous Waste

Not all potentially hazardous waste must be shipped off-site for treatment or disposal. The 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 reduce waste. 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. 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. (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. The 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. 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 aqueous solutions in a septic system or storm sewer. 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, barium, and chromium; arsenic and its compounds; halogenated organic solvents such as methylene chloride, trichloroethylene or perchloroethylene; and various pesticides.

## Summary

Most schools 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 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. To avoid restrictions on treating hazardous waste, always incorporate treatment of excess chemicals or chemical by-products from a lab activity into the lab procedure itself. Please consult your current *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.

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## References

1. "Hazardous Waste Management for School Laboratories and Classrooms," EPA Publication 908-F-06-001, February 2006. Available online (accessed April 2015):  
<http://nepis.epa.gov/Exe/ZyPDF.cgi/P100JR1S.PDF?Dockey=P100JR1S.PDF>
2. "Chemical Management Resource Guide for School Administrators," EPA Publication 747-R-06-002, December 2006. Available online (accessed April 2015):  
[https://www.epa.gov/sites/production/files/2017-01/documents/chemical\\_management\\_resource\\_guide\\_school\\_administrators\\_508.pdf](https://www.epa.gov/sites/production/files/2017-01/documents/chemical_management_resource_guide_school_administrators_508.pdf)
3. "Little Known but Allowable Ways to Deal with Hazardous Waste," EPA Publication 233-B-00-002, May 2000. Available online (accessed April 2015):  
<http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=2000WIQG.txt>
4. ACS Task Force on Laboratory Waste Management; *Laboratory Waste Management: A Guidebook*; American Chemical Society: Washington, DC (2012).
5. Margaret-Ann Armour, *Hazardous Laboratory Chemicals Disposal Guide*, Third Edition; CRC Press, Lewis Publishers: Boca Raton, FL (2003).
6. National Research Council; *Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards*; National Academies Press: Washington, D.C. (2011).

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