Pollution Prevention in Laboratories
The "How To" Guide

What is a hazardous waste?

Knowing what chemicals are regulated as hazardous wastes provides a starting point for waste minimization. Wastes are classified as hazardous if they meet at least one of the following characteristics:

- ignitable- they have a flash point < 140° F or are oxidizers
- corrosive- pH< 2.0 or pH> 12.5
- reactive- to air or water, explosive, or are a cyanide or sulfide
- toxic- they have levels of certain metals, solvents, or pesticides greater than prescribed limits

How to start - setting up a new laboratory

- Think about the potential hazard of every chemical you intend to use.
- Keep a clean house
  - Keep an updated chemical inventory with locations indicated
  - Label and date chemicals
  - Keep the laboratory orderly and clean
- Centralize chemical purchases through one person in your laboratory
  - Check chemical recycling list first
  - Purchase in smallest quantity needed
  - Share with other laboratories
- Manage wastes properly
  - Establish an area for storing chemical waste>
  - Segregate waste streams as much as possible
  - Label wastes properly
- Consider waste generation a factor when planning experiments.

A number of chemicals are also listed as hazardous if they become wastes. There are the P-list of acutely toxic materials and the U-list of toxic materials. Metals of concern for the toxic characteristic are arsenic, barium, cadmium, chromium, lead, mercury, selenium and silver.

How to start - Improving an existing laboratory

- Cleanup house
  - Review all chemicals in stock for: outdated, off-spec, unneeded items
  - Dispose properly
  - Organize shelves for proper chemical storage
  - Label and date all containers
  - Prepare or update chemical inventory (include location)
  - Keep laboratory orderly and clean
- Review laboratory procedures
  - Can less hazardous or nonhazardous reagents be used?
  - Are there safer alternatives to highly toxic, reactive, carcinogenic or mutagenic materials?

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- Review procedures annually to see if quantities of chemicals and/ or chemical waste can be reduced
- New protocols and procedures
- Consider kinds and amounts of waste
- How can they be cut?

- Establish centralized purchasing system
  - One person reviews order for duplication
  - Check chemical recycling list
  - Check other laboratories
  - Order smallest quantity needed
- Evaluate disposal practices
  - Is the waste hazardous?
  - Is more segregation possible?
  - Are wastes labeled properly with names and quantities?

The following is a brief description of chemicals to avoid when planning laboratory experiments for research, analytical or instructional purposes.

Recommendations (in order of priority):

A. Eliminate or reduce the use of reactive chemicals, where possible, for both safety and hazardous waste reasons. If wastes from laboratory work are reactive, deactivate their reactive characteristic as part of the experiment.
B. Eliminate or reduce the use of halogenated solvents, where possible. Many halogenated solvents are carcinogens or suspected carcinogens. If such solvents must be used, investigate redistillation to minimize disposal requirements.
C. Reduce or eliminate the use of arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver where possible. If silver must be used, recover for reclamation.
D. Eliminate or reduce the use of oxidizers, where possible.
E. Eliminate or reduce the use of non-halogenated flammable solvents, where possible. Try to find nonflammable, biodegradable substitutes. If such solvents must be used, investigate redistillation to minimize disposal requirements.
F. Eliminate or reduce the use of highly toxic chemicals, where possible.
G. Neutralize all corrosive solutions as part of the experiment. Waste acid or base may be neutralized to a pH between 6 and 12 and then disposed of down the drain, provided that the solutions do not contain any toxic materials that would classify them as hazardous wastes.

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Use the following substitutions where possible:

Original Material	Substitute	Comments
Acetamide	Stearic acid	In phase change and freezing point depression
Chromic acid cleaning solutions	Detergents	Last resorts: KOH/Ethanol bath, acid bath, or NoChromix
Ethyl Ether	Methyl t-butyl ether	Avoid forming explosive peroxides
Formaldehyde	Ethanol	For storage of biological specimens
Mercury Thermometers	Red liquid thermometers	
Xylene	Limonene based extract	For histology uses

Substitution
Replace hazardous or toxic materials with nonhazardous or less hazardous products.

Reduction
Ways to reduce quantities of hazardous or toxic chemicals:

- Automation/Instrumentation
  - Purchase equipment that enables the use of procedures that produce less waste.
- Reduce scale
  - Scale down experiments producing hazardous waste wherever possible
- Microscaling (in teaching laboratories)
  - Consider use of microscale experiments. Consider demonstrations or video presentations as a substitute for some student experiments that generate chemical wastes.
- Conservation of raw materials
  - When solvent is used for cleaning purposes, use spent solvent for initial cleaning and fresh solvent for final cleaning.
  - Perform work in batches

Recycling
Reusing material (after processing, if needed) in original process or reclamation for use in other processes

- Participate in the chemical recycling program (if don't have one, get it started).
  - Examine your waste/ excess chemicals for other uses in your laboratory, other laboratories or areas.
  - Review list of pre-owned chemicals before purchasing chemicals
  - Inform chemical recycling coordinator of recycled chemicals you can use.
  - Arrange to set up a locker or shelf of excess chemicals in a laboratory, stockroom or hallway in your department.
- Evaluate the possibility of redistillation of waste solvents in your laboratory
- Evaluate other wastes for reclamation in your laboratory. Recover silver, mercury, other heavy metals.

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Treatment

- Rendering the products of a chemical process nonhazardous or reducing the volume of the hazardous material.
- Look into the possibility of including detoxification and/ or waste neutralization steps in laboratory experiments.
- Neutralize wastes that don't contain heavy metals.
- Deactivate highly reactive chemicals in the hood.
- Only treat the material if it renders the waste nonhazardous or reduces its volume.

Incorporate these steps into experimental procedure.

Questions?

Contact the Division of Research Safety, Chemical Safety Section (333-2755 or via e-mail at css@illinois.edu) or visit our web site: http://www.drs.illinois.edu/css/.

Other Chemical Safety Fact Sheets are available from the Chemical Safety Section at our web site: http://www.drs.illinois.edu/css/factsheets/.

References for Treatment Procedures

Armour, M. A ., Hazardous Laboratory Chemicals Disposal Guide, CRC Press, Boco Raton, 1991, 464 pages.

Lunn, George, and Sansone, Eric, Destruction of Hazardous Chemicals in the Laboratory, Wiley- Interscience NY, NY 1990, 271 pages.

National Research Council, Prudent Practices for Disposal of Chemicals from Laboratories, National Academy Press, 2101 Constitution Ave., Washington, DC 20418, 1983, 282 pages.

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