Northwestern University
Office for Research Safety

Hazardous Waste Management Program
http://www.research.northwestern.edu/ors/

Hazardous Waste Disposal Guide

Reporting Inappropriate Disposal of Potentially Hazardous Chemicals

The inappropriate disposal of potentially hazardous chemicals is illegal and can have serious repercussions.

Northwestern University is firmly committed to the safe and proper disposal of all its hazardous wastes. Moreover, the University is committed to promoting waste minimization and pollution prevention in all aspects of its activities.

Under no circumstances should hazardous wastes be discharged into the environment in an effort to “save money,” as a matter of “convenience,” or due to carelessness in planning, preparation, operations or design. Assistance in preventing or resolving such issues is always available from the Office for Research Safety (ORS).

If you suspect or have knowledge of the inappropriate disposal of potentially hazardous materials or deviations from the advice and guidance set forth in this guide, you should immediately report these concerns to the Executive Director ORS.

No employee of Northwestern University shall be discriminated against or be subject to any reprisal for reporting suspected violations of the University’s policies on the disposal of potentially hazardous materials.

ORS will always take waste (regardless of age) if it is given to us in the course of routine operations. We will push back and seek budget relief from the Department if:

1) The lab suddenly closes due to a PI departure and leaves a mess
2) A lab in transition to closure (often retirement) does not divest themselves of waste over time toward the last day-leaving a mess.
3) The lab has been holding on to problematic items (toxic gases, for example) where we have documented that this a liability (yet they have been unresponsive) and then sudden decide to pass this off to us (consuming a disproportionate amount of our budget)

Michael B. Blayney, Ph.D.  Executive Director
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEFINITION OF CHEMICAL WASTE</td>
<td>4</td>
</tr>
<tr>
<td>WASTE MINIMIZATION</td>
<td>5</td>
</tr>
<tr>
<td>SOURCE REDUCTION AND WASTE MINIMIZATION TIPS</td>
<td>5</td>
</tr>
<tr>
<td>HAZARDOUS WASTE MANAGEMENT PLAN</td>
<td>6</td>
</tr>
<tr>
<td>SUBPART K LABORATORY MANAGEMENT PLAN</td>
<td>6</td>
</tr>
<tr>
<td>PART I</td>
<td>6</td>
</tr>
<tr>
<td>PART II</td>
<td>7</td>
</tr>
<tr>
<td>Labeling</td>
<td>7</td>
</tr>
<tr>
<td>Management</td>
<td>7</td>
</tr>
<tr>
<td>Training – Laboratory Workers</td>
<td>8</td>
</tr>
<tr>
<td>Training – On-Site Transfers</td>
<td>8</td>
</tr>
<tr>
<td>Removal of Chemical Waste</td>
<td>8</td>
</tr>
<tr>
<td>Hazardous Waste Determination</td>
<td>9</td>
</tr>
<tr>
<td>Laboratory Clean-Outs</td>
<td>9</td>
</tr>
<tr>
<td>Emergency Prevention</td>
<td>9</td>
</tr>
<tr>
<td>Availability</td>
<td>10</td>
</tr>
<tr>
<td>Review</td>
<td>10</td>
</tr>
<tr>
<td>CHEMICAL WASTE DISPOSAL OVERVIEW</td>
<td>10</td>
</tr>
<tr>
<td>CHEMICAL WASTE COLLECTION AREAS</td>
<td>12</td>
</tr>
<tr>
<td>SATELLITE ACCUMULATION AREA SETUP</td>
<td>12</td>
</tr>
<tr>
<td>CHEMICAL WASTE COLLECTION CONTAINERS:</td>
<td>12</td>
</tr>
<tr>
<td>OPTION A: Original Container</td>
<td>12</td>
</tr>
<tr>
<td>OPTION B: Container other than original container</td>
<td>12</td>
</tr>
<tr>
<td>OPTION C: Chemically contaminated solid waste</td>
<td>13</td>
</tr>
<tr>
<td>OPTION D: Chemically Contaminated Sharps</td>
<td>13</td>
</tr>
<tr>
<td>OPTION E: Solvents</td>
<td>13</td>
</tr>
<tr>
<td>OPTION F: Disposal of empty chemical containers</td>
<td>13</td>
</tr>
<tr>
<td>HOW TO USE THE NSIS HAZARDOUS WASTE MODULE</td>
<td>15</td>
</tr>
<tr>
<td>HOW TO CREATE A CHEMICAL WASTE LABEL LIBRARY</td>
<td>19</td>
</tr>
<tr>
<td>STORAGE OF HAZARDOUS CHEMICALS IN TEACHING AND RESEARCH LABORATORIES</td>
<td>21</td>
</tr>
<tr>
<td>General Principles For Managing Laboratory Chemicals</td>
<td>21</td>
</tr>
</tbody>
</table>
APPENDIX A - LABEL FORMATS ........................................................................ 24

APPENDIX B - DISPOSAL PROCEDURES FOR SPECIFIC WASTE STREAMs ............................................................... 26

Acids and Bases ............................................................................................................. 26
Acrylamide .......................................................................................................................... 26
Aerosol Cans ....................................................................................................................... 26
Aqua regia ............................................................................................................................ 27
Arsenic ........................................................................................................................-------- 28
Asbestos ............................................................................................................................. 28
Barium ............................................................................................................................... 28
Batteries ............................................................................................................................. 28
Bromine solution waste ................................................................................................. 28
Cadmium ............................................................................................................................ 28
Chemical Carcinogens and Mutagens ........................................................................... 29
Chromium ........................................................................................................................ 29
Contaminated Glassware ............................................................................................... 29
Cyanides ............................................................................................................................ 29
Dioxane ............................................................................................................................. 29
Drain Disposal .................................................................................................................. 29
Drugs and Controlled Substances ................................................................................. 30
Ether ................................................................................................................................ 30
Ethidium Bromide (EtBr) & Propidium Iodide ................................................................. 30
Formalin/Formaldehyde/Glutaraldehyde/ Paraformaldehyde ....................................... 31
Formamide ......................................................................................................................... 31
Gas Cylinders .................................................................................................................... 31
Gloves, papers, cardboard .............................................................................................. 32
Laboratory Equipment ..................................................................................................... 32
Lead .................................................................................................................................. 32
Mercury ............................................................................................................................. 33
Naturally Occuring Radioactive Materials (NORM) ...................................................... 33
Nitric Acid ......................................................................................................................... 33
Oils ...................................................................................................................................... 33
| Organic Mercury (Alkyl and Aryl) Compounds | 34 |
| Osmium Tetroxide | 34 |
| Paint | 34 |
| Paint Thinners, Related Chemicals, Contaminated Rags | 34 |
| Perchloric Acid | 35 |
| Peroxide Forming Compounds | 35 |
| Pesticides | 36 |
| Pharmaceuticals | 36 |
| Phenol/Chloroform | 36 |
| Photographic solutions | 37 |
| Piranha etch Solution | 37 |
| Reactives | 38 |
| Selenium | 39 |
| Silver | 39 |
| Small Vials | 39 |
| Sodium Azide | 39 |
| Solvents | 39 |
| Staining Solutions | 40 |
| Scientific Equipment- Surplus, Repair or Disposal | 40 |
| Universal Wastes | 40 |
| Unknowns | 40 |

**APPENDIX C - SANITARY SEWER OR ORDINARY REFUSE DISPOSAL**

**APPENDIX D – DISPOSAL PROCEDURES FOR NON-LABORATORY AREAS**

| AEROSOL CANS | 42 |
| BATTERIES | 42 |
| GAS CYLINDERS | 42 |
| GLYCOL | 42 |
| OILS | 42 |
| PAINT | 42 |
| PAINT THINNERS, RELATED CHEMICALS, CONTAMINATED RAGS | 42 |
| PHOTOGRAPHIC SOLUTIONS | 43 |
| SOLVENTS | 43 |
| SAW DUST | 43 |
DEFINITION OF CHEMICAL WASTE

Any chemical that exhibits hazardous characteristics as defined by federal and Illinois rules and regulations, is unusable or unwanted in any way and poses a potential hazard to individuals, the environment or public health is a chemical waste.

Examples:

- Waste and opened surplus chemicals
- Expired or off-specification chemicals
- Carcinogens and cytotoxic (antineoplastic) agents
- Prescription drugs and controlled substances
- Empty chemical drums and other chemical containers with a capacity of 10 gallons and greater
- Thermometers and other items containing mercury
- Non-returnable gas cylinders and lecture bottles or pressurized chemicals
- Residue of spill clean-up materials-contaminated rags and absorbents
- Non-radioactive lead shielding, lead blocks and lead scrap
- Photographic film processing solutions
- Used oil --- motor, vacuum pump, lubricating
- Pesticides
- Used solvents
- Batteries
- Paint, paint thinners, brush cleaners, linseed oil, thinner contaminated rags
- Heavy metal containing waste or products (arsenic, barium, cadmium, chromium, lead, mercury, selenium and silver)

The definitions and disposal procedures for radioactive waste can be found in the ORS Radiation Safety Handbook. ([http://www.research.northwestern.edu/ors/forms/radiation-safety-handbook.pdf](http://www.research.northwestern.edu/ors/forms/radiation-safety-handbook.pdf))

Naturally-Occurring-Radioactive-Materials (NORM) for example uranium, thorium, samarium compounds must be disposed of through the radioactive waste program.

The definitions and disposal procedures for potentially infectious waste can be found on the ORS website under “Biological/Infectious Waste”
WASTE MINIMIZATION

The Environmental Protection Agency’s (EPA’s) policy for hazardous waste management places the highest priority on waste minimization. The University must annually report to the government on efforts it has made to reduce hazardous wastes.

Waste minimization is any action that:

- Decreases the amount of hazardous waste generated;
- Reduces the inherent toxicity of the waste.

The costs associated with the proper disposal of chemical wastes and the safe storage of chemicals in the research laboratory are inextricably linked. Researchers are encouraged to limit the amount of chemicals purchased. It is easier to order additional chemicals than to dispose of unwanted or unused surplus chemicals. REMEMBER: The disposal cost can exceed ten times the cost of the chemical.

In some cases, there are no acceptable waste disposal options.

Rethink how you purchase, handle and store laboratory chemicals to control the increasing costs of proper chemical waste disposal and the inherent hazards of storing and working with hazardous chemicals.

Waste minimization benefits you, the university and the environment by:

- Significantly lowering costs;
- Reducing potential health hazards;
- Reducing potential long-term liabilities for disposal;
- Promoting environmental ethics; and
- Preventing pollution.

It is the responsibility of every investigator who generates waste to incorporate the principles of waste minimization into experimental design. See the ORS website for specific methods to reduce waste and waste minimization.

SOURCE REDUCTION AND WASTE MINIMIZATION TIPS

- Substitute less hazardous chemicals whenever possible.
- When planning experiments or demonstrations, examine all wastes generated and ask if they could be minimized and how.
- Reduce the scale of processes so that less waste is generated.
- Minimize the volume of waste solutions containing mercury and heavy metals.
• Clearly mark the contents of all chemical containers to prevent the generation of unknowns.
• Actively manage the inventory of all hazardous materials used in your laboratory or work location.
• Ask others in your department if they could use your unwanted chemicals.
• Neutralize, quench or destroy hazardous by-products as the last step in experiments.
• Separate halogenated from non-halogenated solvents. The non-halogenated solvent waste may be shipped for fuel blending.
• Separate aqueous and solvent wastes if possible.

When in doubt, call the Office for Research Safety for assistance.

HAZARDOUS WASTE MANAGEMENT PLAN

Northwestern University manages all hazardous waste in accordance with federal, state, and local regulations. Disposal procedures for specific waste streams generated in non-laboratories are outlined in Appendix D.

For laboratory hazardous waste, Northwestern University elected coverage under Subpart K: Alternative Requirements for Hazardous Waste Determination and Accumulation of Unwanted Material for Laboratories Owned by Eligible Academic Entities.

SUBPART K LABORATORY MANAGEMENT PLAN

Northwestern University is an eligible academic entity as defined in 35 IAC 722.300. Only the laboratory facilities that generate hazardous wastes under the following generator identification numbers are included in the Subpart K election: ILT180011553, ILD982646721, ILO000040436, and ILT180011546. Hazardous wastes generated through Facilities under these identification numbers are not part of the Subpart K election.

The format of this Laboratory Management Plan follows the requirements outlined in the regulation. Additional procedural information in the Hazardous Waste Disposal Guide is referenced herein.

PART I

Northwestern University uses the term “chemical waste” on laboratory containers as an equally effective term in lieu of “unwanted material”. “Chemical waste” generated in the eligible laboratories has the same meaning as the term “unwanted material”, and the material is subject to the same requirements as if it were called “unwanted material”. The

---

1 35 Illinois Administrative Code 722
“chemical waste” terminology is consistent with the existing hazardous waste program of the University.

Laboratory containers are labeled and content records logged to impart information “associated with the container”. Laboratory workers complete and submit a *Hazardous Waste Pickup Request* online via the Northwestern Safety Information System (NSIS) at [https://www.NSIS.northwestern.edu/Login.aspx](https://www.NSIS.northwestern.edu/Login.aspx) when a container is ¾ full or has reached 150 days since the start date of accumulation. Detailed chemical waste procedures are presented in the “Chemical Waste Disposal Overview” section of the *Hazardous Waste Disposal Guide*.

An ORS-authorized representative will remove containers of chemical waste from each eligible laboratory within six (6) months of each container’s accumulation start date.

**PART II**

**LABELING**
Northwestern University uses the term “chemical waste” on laboratory containers as an equally effective term in lieu of “unwanted material”. This equivalent labeling protocol is identified in Part I of the Laboratory Management Plan. In addition, the prescribed labeling protocol is (1) the name of the chemical(s) in the container or (2) the type or class of chemical(s) in the container.

Each container is also labeled with the date on which the chemical waste first began accumulating in the container. Laboratory workers who add the chemical waste to the laboratory containers log the following information, as it relates to each container:

- name or description of chemical contents or composition of the chemical waste (if known, product(s) of chemical reaction)
- whether the chemical waste has been used or is unused
- description of the manner in which the chemical was produced or processed

This information is used in determination of the status of the chemical waste as a solid waste and a hazardous waste.

**MANAGEMENT**
Laboratory containers are maintained in good condition and kept closed at all times, except when adding, removing, or bulking chemical waste. If a container is damaged, it will be replaced, repaired, or overpacked.

Laboratory containers are compatible with their contents; they are made of, or lined with, a composition material that is compatible with the chemical waste so as not to cause a reaction and maintain integrity of the container.

Detailed container protocols are presented in the “Chemical Waste Disposal Overview” and the “Chemical Waste Collection Containers” sections of the *Hazardous Waste Disposal Guide*. 
**TRAINING – LABORATORY WORKERS**
Northwestern University provides training to all individuals working in the laboratories that is commensurate with their duties in order to understand and implement the requirements of Subpart K. Lab workers must complete the Chemical Waste Management Training module in NSIS, which includes information on Subpart K implementation.

**TRAINING – ON-SITE TRANSFERS**
In addition to the training for laboratory workers, Northwestern University provides training to all individuals in the ORS (and applicable hazardous waste management contractors) in order to understand and implement the requirements of Subpart K. An ORS-authorized representative must accompany the transfer of chemical waste and hazardous waste when the chemical waste and hazardous waste is removed from the laboratory. ORS workers must complete the Chemical Waste Management Training module in NSIS, which includes information on Subpart K implementation. Northwestern University considers only ORS-authorized representatives “trained professionals” as defined in Subpart K.

**REMOVAL OF CHEMICAL WASTE**
An ORS-authorized representative will remove containers of chemical waste from each eligible laboratory within six (6) months of each container’s accumulation start date.

Laboratories accumulate no more than 25 gallons of chemical waste (total, per laboratory) prior to removal of the chemical waste. Further, laboratories accumulate no more than one (1) quart of reactive acutely hazardous chemical waste prior to removal from the laboratory. Reactive acutely hazardous chemical wastes are P-listed wastes signified as reactive.

<table>
<thead>
<tr>
<th>P-listed waste</th>
<th>Chemical Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>P006</td>
<td>aluminum phosphide</td>
</tr>
<tr>
<td>P009</td>
<td>ammonium picrate or 2,4,6-trinitrophenol ammonium salt</td>
</tr>
<tr>
<td>P065</td>
<td>fulminic acid mercury (2+) salt or mercury fulminate</td>
</tr>
<tr>
<td>P081</td>
<td>nitroglycerine or 1,2,3-propanetriol trinitrate</td>
</tr>
<tr>
<td>P112,</td>
<td>tetra nitromethane</td>
</tr>
<tr>
<td>P122</td>
<td>zinc phosphide when present at concentration greater than 10 percent</td>
</tr>
</tbody>
</table>

Laboratory workers complete and submit a *Hazardous Waste Pickup Request* online via the Northwestern Safety Information System (NSIS) at
https://www.NSIS.northwestern.edu/Login.aspx when a container is ¾ full or has reached 150 days since the start date of accumulation.

Total chemical waste stored in any one laboratory is checked regularly. If the total volume of chemical waste in a laboratory reaches the storage limit follow this procedure:

- Mark on all contributing containers the date on which the 25-gallon or one-quart applicable volume was exceeded.
- Complete and submit the Hazardous Waste Pickup Request online via the Northwestern Safety Information System (NSIS). Detailed chemical waste procedures are presented in the “Chemical Waste Disposal Overview” section of the Hazardous Waste Disposal Guide.
- Once a request has been submitted, pick up by an ORS-authorized representative will occur within three (3) business days.

HAZARDOUS WASTE DETERMINATION
Lab workers first classify chemical waste within the laboratory. An ORS authorized representative transfers the chemical waste directly from the laboratory to the on-site central accumulation area. Hazardous waste determinations are only made at the on-site central accumulation area and are completed within four (4) calendar days of arrival in this area.

If the chemical waste is characterized as a hazardous waste, an ORS-authorized representative labels the container with the words “hazardous waste”. Prior to treatment or disposal, an ORS-authorized representative also labels the shipping container with all applicable hazardous waste codes. After determination, this characterized hazardous waste is managed in the same fashion as all other hazardous wastes and according to applicable hazardous waste regulation.

LABORATORY CLEAN-OUTS
Northwestern University does not intend to use the incentives for laboratory clean-outs provided in 35 IAC 722.313.

EMERGENCY PREVENTION
Northwestern University is firmly committed to the safe and proper disposal of all its hazardous wastes. Moreover, the University is committed to promoting waste minimization and pollution prevention in all aspects of its activities. The “Reporting Inappropriate Disposal of Potentially Hazardous Chemicals” section of the Hazardous Waste Disposal Guide presents the ORS statement of intent to safely and properly dispose of hazardous waste. The Hazardous Waste Disposal Guide also presents information on waste minimization, source reduction, and storage of hazardous chemicals (prior to use and becoming chemical waste).

Procedures for proper collection, storage, and initiating disposal of chemical waste is provided in the “Chemical Waste Disposal Overview” section of the Hazardous Waste Disposal Guide. The Hazardous Waste Disposal Guide also includes an Emergency Contact List that provides contact information for the University’s emergency
coordinators and internal response contacts; external response contacts for federal, state, and local agencies; and spill response contractors.

Specific disposal information related to individual waste streams is presented in Appendix B of the *Hazardous Waste Disposal Guide*. This appendix organizes procedures for collection/preparation, personal protective equipment, hazards, and regulated concentrations of several potential waste streams at Northwestern University, including chemicals that become more dangerous when past an expiration date or as they degrade.

**AVAILABILITY**
Northwestern University makes this Laboratory Management Plan available to laboratory workers, students, and others who may request it. This plan works in conjunction with the *Hazardous Waste Disposal Guide*.

**REVIEW**
Northwestern University will review and revise this Laboratory Management Plan as needed: when new waste streams are introduced, when the *Hazardous Waste Disposal Guide* is reviewed and revised, or when prompted by disposal circumstances.

**CHEMICAL WASTE DISPOSAL OVERVIEW**

1) **Collect Chemical Waste in sturdy leak-proof containers for disposal through ORS.** (See also *Hazardous Waste Supplies*)
   - Do not use the sinks or surrounding areas for handling, storing, or disposing of hazardous chemicals.
   - Do not dispose of hazardous chemicals via the sink, in the trash with/as Biological Waste or with/as Radioactive Waste.
   - Evaporation is not an acceptable waste disposal method. Only insignificant, residual amounts of liquid associated with labware or containers can be treated in this way.
   - Do not mix radioactive materials with chemical waste.

2) **Label and seal chemical waste containers at all times.**
   - All chemical waste containers must be properly labeled. Complete and attach an ORS Chemical Waste Label (as seen in Appendix A) for any unlabeled waste containers.
   - Always enter a start date.
   - On the waste label, identify lawfully required constituents by chemical name. No abbreviations, trade names, or chemical formulas!
• The label must contain the amount or concentration of constituents.

• Chemical hazardous waste, radioactive waste and biological waste have unique labels. Contact ORS to get the right label.

3) Store waste containers properly.

• Caps must be tight. No open funnels or filling aids may be left in containers.

• During waste collection, process waste containers (i.e., HPLC, photographic solutions) must have a cap with tight fitting hole for the fill tube.

• Never store flammables with oxidizers or acids with caustics.

• Labs must use bins for segregation and secondary containment.

• Flammable wastes are best stored in a fire rated cabinet.

• As a last step of a research project quench potassium or pyrophoric potassium alloys (NaK) in the lab. Let etch and cleaning solutions (i.e., piranha, aqua regia). cool down to room temperature and provide a vented cap.

4) Non-laboratory waste: Request a waste container pick up in 60 days or when container is ¾ full through hazardous-waste@northwestern.edu

Laboratory chemical waste: Request a waste container pickup in 150 days or when container is ¾ full.

• Fill out and submit a Hazardous Waste Pickup Request online via the Northwestern Safety Information System (NSIS) at https://www.NSIS.northwestern.edu/Login.aspx. Once a request has been submitted, pick up will occur within three (3) business days.

Other Reminders

Never abandon chemicals. Contact ORS immediately for proper disposal.

Always wear eye/face protection, lab coat and gloves when working with hazardous chemicals.

Consult Safety Data Sheets (SDS) for more information on hazardous chemicals you may work with at Northwestern University. SDS sheets can be accessed through the ORS Homepage.
CHEMICAL WASTE COLLECTION AREAS

Regulations define any location where small amounts of chemical waste are temporarily stored prior to pick up by ORS as a “Satellite Accumulation Area” or SAA. To be considered a SAA, waste must be stored at or near the point where the waste is generated.

SAAs in laboratories must not contain *greater than 25 gallons of chemical waste*. In non-laboratory areas the limit is 55 gal. Keep waste volumes to a minimum – request routine waste pickups.

SATellite ACCUmulation AREA SETUP

Lab SAAs may be located inside a chemical fume hood or on a laboratory bench top. If neither of these locations can be utilized, the SAA must be set up in an area with minimal traffic.

**NOTE:** Waste handling and SAAs may not be near open sink or floor drains!!

SAAs must be posted with a sign (provided by ORS). See example sign provided in Appendix A.

SAAs must be provided with secondary containment. Use gray plastic bins provided by ORS.

Incompatible wastes must be separated by storing wastes in separate containment bins, or if appropriate, in separate areas within the lab. Contact ORS if you have any questions regarding incompatibility of waste streams, especially waste containing nitric acid and etching solutions.

CHEMICAL WASTE COLLECTION CONTAINERS:

 Appropriately size waste containers! (See also Hazardous Waste Supplies.)

All chemical waste containers must be:

- Properly labeled (See example label in Appendix A.) Package small containers so a fully completed label is securely attached.
- Closed and sealed except when adding contents; and
- Liquids must be stored in secondary containment bins.

OPTION A: ORIGINAL CONTAINER

Submit for disposal in the original labeled container.

OPTION B: CONTAINER OTHER THAN ORIGINAL CONTAINER

Deface existing label or mark “XXX” through the existing label. Attach a completed ORS Chemical Waste Label as shown in Appendix A.
OPTION C: CHEMICALLY CONTAMINATED SOLID WASTE

1. Obtain a five-gallon plastic pail with lid from Fisher. Label the outside of the pail with a completed ORS Chemical Waste Label.

2. Line the pail with a clear plastic bag. The lid must be on the pail except when adding contents to the bag.

3. When bag is ¾ full, close bag with tape or zip tie. Complete and attach an ORS Chemical Waste Label to the bag.

NOTE: Never use black plastic or biohazard bags to collect chemical wastes!

OPTION D: CHEMICALLY CONTAMINATED SHARPS

Chemically contaminated broken glass, pipette tips, needles, blades and sharps must be disposed of in a labeled puncture-proof container.

OPTION E: SOLVENTS

Separately collect mercury or other heavy metals containing solvents. Separate aqueous waste, halogenated and non-halogenated solvents.

1. Solvents must be collected in compatible and right-sized containers.

2. Complete and attach an ORS Chemical Waste Label to the container. Each time you add waste to the container, note this on the waste tag. Use pencil as ink will smudge. Chemical Waste Labels can also be created and printed through NSIS.

3. Fill container no more than ¾ full. DO NOT OVERFILL.

OPTION F: DISPOSAL OF EMPTY CHEMICAL CONTAINERS

1. Thoroughly empty all contents. Only de minimis amounts of the chemical may remain before rinsing. Collect all rinsate as chemical waste.

2. Obliterate, remove or thoroughly deface labels before disposal.

---

3 The mixture rule at 40 CFR 261.3(a)(2)(iv) states that if you mix a solid waste with any listed waste, the entire mixture is listed hazardous waste. Discarded, unused, commercial chemical products arising from what are known as de minimis losses are exempt from the mixture rule when they are discharged through a wastewater treatment system regulated by the Clean Water Act.

De minimis losses include spills from unloading or transfer of materials, leaks from process equipment, leaks from well-maintained pump packings and seals, sample purgings, relief device discharges, safety shower discharges, rinsing and cleaning of personal safety equipment, and rinsate from emptying containers.
3. Place rinsed and dried glass in the glass disposal container, or affix a yellow recycling sticker and place in the hallway.

If the chemical containers has a capacity of >10 gallons, or solids or sludge remain, dispose of as chemical waste see OPTION A.
HOW TO USE THE NSIS HAZARDOUS WASTE MODULE

Log into NSIS. From the NSIS Home page, select Hazardous Waste from the menu bar.

Select the Add new Waste Pickup Request link.

Select the type of hazardous waste you wish to include in your pickup request. You may add other types to this request later in the process. Click Next Screen.
The Chemical Disposal Information page appears. Select the correct Tab for your purpose.

Select the laboratory from your drop-down list.

Type in the more-specific location information.

Enter the number of containers to be picked up, the number to be replaced, and the type of container.

Add any additional description information, and when ready, click Save and Continue.

Your request has not yet been submitted. Delete it or Edit it until it has been submitted. Click the Radioactive waste button and Add New Item.
Complete all the necessary information and then click Save and Continue.

Add a Laboratory Equipment Disposal to your request.

There may be some cleanup/prep-work required before disposal.

Select the location, provide a description (i.e., freezer, oven, incubator, etc.).

Answer all questions pertaining to the state of the equipment, and enter any special precautions pertaining to the safe removal of the equipment.
Certify that you have made every effort to make the equipment safe for removal and disposal, and click Next.

If your waste pickup request is complete, you must now click Proceed to Submission Page.

Here are all of your pending waste pickup requests. Those that do not have the Delete or Submit to ORS buttons available are waiting to be picked up. To submit your request, click the Submit to ORS button, and you are finished.
HOW TO CREATE A CHEMICAL WASTE LABEL LIBRARY

From the Hazardous Waste Pickup Requests page, you can create labels and save them for future use. Click the Chemical Waste Label Library link.

Enter a name for your label that will help you identify this specific label for future use. Enter the chemical information and the hazard class. Click Save and Print or Save and Continue.
Your label will be prepared for printing and saved to your library. Plastic sleeves are available at the Office for Research Safety for the paper labels.

To retrieve a label previously saved to your library, from the Hazardous Waste Pickup Requests page, click Chemical Waste Label Library.

From here, you can search for your label by the name you created. Then click the printer icon to print a new label.
STORAGE OF HAZARDOUS CHEMICALS IN TEACHING AND RESEARCH LABORATORIES

In the laboratory, hazardous chemicals can be divided into four general categories - corrosives, flammables, reactives and toxics. In most cases, it is the immediate or obvious hazard that determines which category a particular chemical is classified. See the Laboratory Safety and Chemical Hygiene Plan for further definitions.

Note: Highly toxic gases and select agents are restricted commodities requiring approval from ORS.

Below are some general principles to follow when handling and storing chemicals:

GENERAL PRINCIPLES FOR MANAGING LABORATORY CHEMICALS

- **Less is better.** Purchase small amounts that you will use up within a year. Whereas the per-unit cost may be greater—significant savings are realized in reduced disposal costs and safer storage.

- Buy pre-made molar and normal solutions, thereby reducing the likelihood of waste.

- Obtain access to a SDS for each chemical, and consult the SDS before using a chemical.

- Read labels. Handling and storage information is on the manufacturer’s label.

- Purchase chemicals in plastic containers to minimize potential breakage. If this is not possible, purchase shatter-resistant plastic coated bottles.

- Manage first-in, first-out! **Indicate the date received and the date opened.** Pay particular attention to expiration dates.

- Dispose of open, partially used or expired chemicals.

- Peroxide-forming compounds require frequent testing or disposal.

- Keep all chemical containers off floors, carts and electrical equipment.

- Physically segregate your chemicals according to compatibility.

- Label the secondary storage containers or areas in which particularly hazardous chemicals may be used. These substances must be kept in a Designated Area.

- Store hazardous chemicals **below** eye level. This simple task greatly reduces the likelihood of something falling from above and breaking.
Cabinets with doors are safer locations than open shelves for hazardous chemicals.

Safely transport any hazardous chemical. Place in secondary containment such as a bottle carrier.

Avoid placing any chemical container in direct sunlight, underneath a sink or near heat sources.

Place volatile or flammable chemicals only in specially designed refrigerators.

DO NOT STORE HAZARDOUS CHEMICALS, FLAMMABLES, AND CRYOGENIC LIQUIDS IN COLD ROOMS.

Be especially careful with reactive chemicals. Obtain and read the SDS for each reactive chemical that you may have or may work near.

Label all containers in the laboratory with the following information (this includes any stock or working solutions):

Name of chemical or stock solution
Date started
Your initials
Hazard warning (i.e., flammable, toxic, corrosive, reactive)

Store chemical by hazard class. Do not store merely by alphabetical order.

Use and manage your chemical fume hood, wisely. Too many chemical containers or equipment block the air slots and compromise the containment performance.

Follow all waste disposal guidelines provided by ORS.

STORAGE OF FLAMMABLE LIQUIDS

Limit the amount of flammable liquids in use to the smallest practical volume. Work with flammable liquids inside a chemical fume hood. Return all flammable liquids to an approved flammable storage cabinet. The doors to flammable storage cabinets must close securely. Self-closing doors are best. Contact ORS for assistance in ordering flammable storage cabinets.

The maximum quantity of flammable and combustible liquids that can be stored openly or within an approved flammable storage cabinet is defined for each campus. See the Laboratory Safety and Chemical Hygiene Plan

The purchase of 5-gallon containers of flammable liquids is strongly discouraged. All transfers of flammable liquids from containers of five gallons or more must be
performed inside a fume hood. These containers also must be stored in a flammable storage cabinet.

- Segregate flammables from oxidizers and oxidizing acids.
- Most refrigerators/freezers purchased by the labs are designed for non-hazardous materials. Refrigerators and freezers suitable for flammable material storage are specially labeled “Explosion safe” of “Explosion proof.”

STORAGE OF GAS CYLINDERS

- In general, only keep cylinders in your lab that are in current use or waiting for immediate use.
- Large toxic gas cylinders must be in an approved gas cylinder cabinet.
- Maximum allowable storage quantities for cylinders is defined in the ORS Compressed or Liquified Gas Cylinders in Laboratories policy. A summary table is available online at http://www.research.northwestern.edu/ors/safety/chemical/hazard-groups/gas-cylinders.html
- All cylinders not attached to a regulator must have a valve protection cap in place.
- For vertical storage, cylinders must be secured (at a minimum) in their upper third by a tight fitting chain or belt secured to the wall or non-movable casework. This applies to all cylinders.
- One cylinder per chain or web belt.
- Horizontal storage of cylinders is only allowed in racks designed for the purpose. Cylinders must be chained to the rack.
- Cylinders must not be kept in corridors, hallways, stairways or cold rooms (or any other area with limited ventilation). Exceptions must be approved by ORS.

HANDLING CRYOGENIC FLUIDS

- Cryogenic liquids, such as liquid nitrogen, must be handled only in containers designed for that purpose.
- Full face protection (face shield) including safety glasses and goggles as well as insulated gloves, lab coat, covered shoes must be worn when handling cryogenic liquids.
- When transferring liquid from one container to another, the receiving container must be cooled gradually.
APPENDIX A - LABEL FORMATS

Adhere the completed label, securely to the container.

Chemical waste container labels can also be created in the NSIS Hazardous Waste module.

Example of a labeled SAA below.
APPENDIX B - DISPOSAL PROCEDURES FOR SPECIFIC WASTE STREAMS

Northwestern University laboratories utilize and generate a wide variety of hazardous substances. Appendix B contains a comprehensive list of some of the more common waste streams generated by the University. Refer to the following list for specific information:

ACIDS AND BASES
1. Collect concentrated acids and bases in original containers whenever possible. This includes nitric, hydrofluoric, sulfuric, glacial acetic, hydrochloric, sodium hydroxide, ammonium hydroxide. Hydrofluoric acid etches glass and must be collected in plastic containers.
2. Dilute acid and base solutions may be disposed of down a lab sink with copious amounts of water provided they are treated as follows:
   - Slowly stir acid in a large amount of an ice-water-to dilute to about 5%.
   - Prepare a base solution of one of the following: sodium carbonate (soda ash), calcium hydroxide (slaked lime), or sodium hydroxide. The base concentration should be 5 to 10% for nitric and perchloric acids. A one-molar solution is about 4% (4 grams per 100 ml).
   - Slowly stir diluted acid into the base solution until the pH is at least 5 but not greater than 10^4.
   - Slowly pour the neutralized solution down the drain with large amounts of water.
3. No solvent or metal contamination is permitted for drain disposal.

NOTE: The use of chromic acid or Chromerge® is strongly discouraged by ORS. If used, these cleaning solutions must be collected through the third rinse. Contact ORS for recommendations on possible alternatives.

ACRYLAMIDE
1. Unused/unwanted acrylamide powder or opened liquid must be disposed of through ORS using Container Option A.
2. For the collection of acrylamide gels that contain ethidium bromide, dispose of in a five-gallon plastic pail (See Container Option C.).

NOTE: Only small amounts of liquid can be placed in these plastic pails. For large amounts of unpolymerized acrylamide liquid see Container Option B.

AEROSOL CANS
If completely empty, aerosol cans may be disposed of as non-hazardous waste. If contents or pressure remains, dispose through ORS.

---

4 The pH of solutions poured down the drain shall be between 5 and 10 to avoid violating local, state, or federal regulations.
AQUA REGIA

Aqua regia is typically a 3:1 mixture of Hydrochloric Acid (HCL) and Nitric Acid (HNO3). It is commonly used to remove metals and trace organic compounds from glassware, as well as noble metals from some substrates.

Aqua regia MUST be prepared in a fume hood.

PPE

Proper PPE must be worn while making or handling aqua regia. This includes a lab coat, safety glasses, and neoprene gloves. Additionally, a face shield and neoprene apron should be worn.

Preparation and Handling

Aqua regia should be made fresh before use; it should never be stored. Aqua regia should only be prepared and handled in clearly labeled glass containers (preferably Pyrex) inside of a fume hood free and clear of all chemicals. When preparing aqua regia, always add the nitric acid to the hydrochloric acid. The concentration of nitric acid must never be over 38%

Aqua regia is an oxidizer, and will oxidize over time; this will form toxic gases, such as nitrogen dioxide and chlorine. Therefore, aqua regia should be disposed of as soon as possible after use. Aqua regia should never be handled outside of a fume hood, and should never be tightly capped.

Disposal

Aqua regia solution should be allowed to cool in an open container, preferable overnight, in a working fume hood. A sign should be placed on the fume hood alerting people to the hazard. Aqua regia should be neutralized before disposal, according to the procedure below. Once the aqua regia is neutralized, it can be submitted for disposal.

1. Place the neutralization container onto a stir plate, in a secondary container that is free of any organic residue, inside of a fume hood. The neutralization container must be glass, and should be large enough that the dilution water and aqua regia is no more than 2/3 of the total volume of the container. The amount of solution water needed is 7.5 times the amount of aqua regia.

2. Weight out the necessary amount of magnesium hydroxide (0.533 grams per mL of aqua regia)

3. Add the total necessary volume of dilution water to the beaker, and begin stirring without over-agitating the water.
4. Add the magnesium hydroxide and a dash of bromothymol blue solution to the beaker. The bromothymol solution is prepared with 0.8 g of bromothymol blue, 100 mL of water, and a drop of NaOH.

5. SLOWLY add the aqua regia to the full volume of water, carefully avoiding overheating. The bromothymol blue indicator will turn yellow if you overshoot neutral pH. If your solution turns yellow, but there is still undissolved magnesium hydroxide, let the solution stir longer to equilibrate. Test the pH using a pH strip, and add more magnesium hydroxide if necessary.

6. Allow solution to cool to room temperature before moving the container, capping the container, or transferring the solution.

(Above adapted from University of Michigan Occupational Safety and Environmental Health Aqua Regia SOP, available at www.oseh.umich.edu/SOP/AquaRegia.doc)

Once the solution has cooled, it may be transferred to another glass container for pickup. This container should have a pressure-venting cap. Label the waste bottle appropriately, and submit a pickup request immediately. Do not try to combine multiple batches of aqua regia solution into one waste container; ORS Hazardous Waste Services will pick up multiple containers.

ARSENIC
Wastes containing more than 5ppm are regulated.

ASBESTOS
Wet asbestos containing lab ware and bag them up for disposal through ORS.

BARIUM
Wastes containing more than 100ppm are regulated.

BATTERIES
There are many types of batteries on campus: lead-acid (automotive), mercury, lithium containing, ordinary household and rechargeable. Dispose of all battery types through ORS. There is no charge for the disposal of batteries.

BROMINE SOLUTION WASTE
Bromine solutions containing more than 1% bromine must be collected in containers no larger than 1 gal.

CADMIUM
Wastes containing more than 1ppm are regulated.

5 Source: 40 CFR §261.24
6 Source: 40 CFR §261.24
7 Source: 40 CFR §261.24
CHEMICAL CARCINOGENS AND MUTAGENS

If original containers are to be discarded, use Container Option A. For associated contaminated disposable labware, use Container Option C or Option D. Triple rinse empty containers and collect all rinsate as chemical waste or present to ORS for cleaning.

CHROMIUM

Wastes containing more than 5ppm are regulated.

CONTAMINATED GLASSWARE

Chemically contaminated glass ware, pipette tips, needles, blades and sharps are collected in a puncture proof container using Option D.

Broken glass ware not contaminated with hazardous chemicals can be put in a cardboard container, sealed and picked up as trash.

CYANIDES

Cyanides, nitrites and sulfides are among the most toxic and rapidly acting substances found in a chemical lab. Symptoms of toxicity occur if these materials are swallowed, inhaled or absorbed through the skin. Keep stored in locked and secure locations. Always use secondary containers to help prevent breaks or spills. Use Container Option A or B for disposal.

DIOXANE

Dioxane (1,4-Dioxane) is a highly flammable liquid and can form potentially explosive peroxides upon long exposure to air. Containers of dioxane must be dated when opened and tested periodically for the presence of peroxides. Dioxane must be collected using Container Option A or E. If old, undated dioxane is found, do not open and contact ORS immediately.

DRAIN DISPOSAL

The range of substances that can be potentially hazardous is enormous. Almost any substance can be a hazardous waste if it is disposed of in large quantities or in high concentrations. Federal and state hazardous waste laws permit laboratories to dispose of small amounts of some chemicals in quantities that do not pose a hazard to human health or the environment. It is the policy of Northwestern University to prohibit the drain disposal of all potentially hazardous chemicals and take a more conservative approach when confronted with a less defined disposal situation.

Suitable for Drain Disposal (See Appendix C)

NOT Suitable for Drain Disposal

---

8 Source: 40 CFR §261.24
1. Inherently toxic, malodorous or lachrymatory chemicals
2. Solutions containing heavy metals
3. Flammable liquids (flash point < 140°F) of any type.
4. Organic solvents—methanol, acetone, hexane, chloroform
5. Paint and paint thinner
6. Poisons, carcinogens, teratogens or embryotoxins
7. Toxic dyes and stains
8. Sodium azide
9. Strong acids and bases (either in pH extremes/concentration)
10. Chromic/sulfuric acid cleaning solutions
11. Photographic fixer
12. Motor oil, gasoline, degreasing solutions, antifreeze or other automotive fluid
13. Pesticides

**DRUGS AND CONTROLLED SUBSTANCES**
See Pharmaceuticals

**ETHER**
Ether is a highly flammable liquid and can form potentially explosive peroxides over time. Containers of ether must be dated when opened and tested periodically for the presence of peroxides. Ether must be collected using Container Option A and E. Ether cans have expiration dates on the label. Dispose before they expire. If old, undated ether is found, do not open and contact ORS immediately.

**ETHIDIUM BROMIDE (EtBr) & PROPIDIUM IODIDE**
Ethidium bromide staining and running buffer solutions must be disposed using Container Option B. For the collection of acrylamide gels that contain ethidium bromide, dispose of in a five-gallon plastic pail (See Container Option C.)

*Never use bleach to treat EtBr wastes. This actually increases toxicity.*

**NOTE:** *SYBR Safe® is sold as a safer alternative to Ethidium Bromide. It is less toxic and the stain and gels can be disposed as regular waste. SYBR Safe can be used in the same manner as solutions of EtBr. Tests indicate that it is just as, if not more sensitive than EtBr. It can also be read in the same manner with a standard UV or visible light trans-illuminator, or laser based scanner. SYBR Safe is provided ready to*
use as a concentrate, it can be cast directly in the gel or used as a post stain. It may also be used to stain RNA in gels. Recommended storage time is six months at room temperature.

FORMalin/FORMalDEHyDE/GLUTARALDEHyDE/PARAFORMalDEHyDE

1. Unwanted or unused formalin or formaldehyde must be disposed through ORS using Container Option A.

2. If you have a large number of specimens preserved in formalin that you wish to dispose of, contact ORS to discuss disposal options.

**NOTE:** The use of so-called "cold sterilants" such as Cidex® or other higher molecular weight aldehydes such as glutaraldehyde is strongly discouraged for both occupational and environmental reasons.

FORMamide

Formamide must be collected using Container Option B. If radioactive, attach an ORS Radioactive Waste Label and dispose of as radioactive waste.

GAS CYLINDERS

Compressed gases are among the most problematic wastes to handle and dispose. Avoid buying gas cylinders if at all possible. Buy only what you need, use all you buy and return cylinders to the gas vendors if empty or not routinely used. Lecture bottles can be a serious disposal problem. If at all possible, return these to the manufacturer or supplier for reuse. If not, dispose of through ORS. Label integrity is essential. Ensure that the label on each cylinder is legible. Keep the valve protection cap on the cylinder when not in use. When the cylinder is in use, keep this valve cap near the cylinder so that it does not get misplaced. Attach an ORS Chemical Waste Label when the cylinder is to be disposed. Return gas cylinders to University Services using the online tool at [http://labservicesorders.com/PickUpsEv.asp](http://labservicesorders.com/PickUpsEv.asp).
NOTE: Never dispose of the contents of a compressed gas cylinder by releasing outdoors or in a fume hood.

GLOVES, PAPERS, CARDBOARD
Gloves, papers, or cardboard that are grossly contaminated or were immersed in hazardous chemicals are disposed of using Container Option C. (See also Hazardous Waste Supplies)

Gloves, papers or cardboard that are not contaminated with hazardous chemicals, radioactive materials or potentially infectious agents are disposed of as trash.

LABORATORY EQUIPMENT
See http://www.research.northwestern.edu/ors/forms/index.html or enter a pick-up request through the NSIS Hazardous Waste Disposal.

LEAD
Wastes containing more than 5ppm are regulated.

---

9 Source: 40 CFR §261.24
MERCURY
Mercury and mercury compounds are especially hazardous. If spilled, elemental mercury in cracks of lab benches or floor tiles may pose an exposure hazard for years. Few hazardous waste facilities accept mercury. Therefore, it is essential that the use of mercury be avoided. Substitute mercury thermometers with non-mercury alternatives or electronic devices to measure temperature and pressure.

All wastes\textsuperscript{10} containing more than 0.2 ppm must be disposed through ORS. For mercury spills, contact ORS.

NATURALLY OCCURING RADIOACTIVE MATERIALS (NORM)
NORM refers to all radioactive elements found in the environment where human activities have increased the potential for exposure compared with unaltered situation.

Chemical compounds containing NORM are mostly purchased as staining agents for electron microscopy. Common compounds contain long-lived radionuclides such as uranium and thorium. Typical commercial forms include uranium oxide, uranium fluoride, uranium nitrate, uranium acetate, thorium oxide, thorium fluoride, thorium nitrate and thorium acetate.

In general, all chemical compounds containing NORM must be collected and disposed of as radioactive waste. Uranium nitrate and thorium nitrate are considered radioactive and oxidizers, and are treated as “mixed waste”.

Important note on “Mixed Waste”: Never mix aqueous uranyl acetate with other staining compounds such as lead citrate or other heavy metals, solvents and other hazardous chemicals.

All liquid and solid radioactive waste must be accumulated in properly labeled containers provided by ORS- Health Physics Services.

NITRIC ACID
Many reported waste container ruptures and explosions in laboratories involve the accidental mixing of nitric acid with reducing agents (e.g., organic compounds). Avoid creating nitric acid waste mixtures with acetone, acetic acid, acetic anhydride, alkali metals, cyanides, aldehydes, powdered metals, organic materials, ammonia, acetonitrile, alcohols, acrylonitrile and organic matter. Nitric acid is a powerful oxidant and reacts violently, sometimes explosively with liberation of toxic nitrogen oxides. Oxidation is invariably accompanied by more or less gas evolution, usually capable of rupturing closed vessels.

OILS
Uncontaminated instrument and machine oils such as centrifuge, diffusion pump and vacuum pump oils must be collected in plastic containers and labeled with an ORS

\textsuperscript{10} Source: 40 CFR §261.24
Chemical Waste Label. Oils found in X-Ray machines and other similar devices may contain PCB’s (polychlorinated biphenyls), especially if the equipment is old. **DO NOT MIX PCB CONTAMINATED OIL WITH OTHER OILS.** Contact ORS if you suspect you have PCB oil.

**NOTE:** *All vacuum pumps must be emptied of oil prior to disposal. If sending them out or to the shop for service, they must be rinsed and purged with clean oil. Collect rinse oil for disposal through ORS.*

**ORGANIC MERCURY (ALKYL AND ARYL) COMPOUNDS**

Organic mercury compounds pose special hazards in the laboratory. Under all circumstances, these compounds must be handled according to the [Laboratory Safety and Chemical Hygiene Plan](https://ors.northwestern.edu/laboratory-safety-and-chemical-hygiene-plan). Alkyl mercury compounds require prior approval from ORS before purchase or use. Contact ORS for assistance in planning, use and disposal before using these compounds.

**OSMIUM TETROXIDE**

Osmium tetroxide solutions must be disposed of using Container Option A or B. The osmium tetroxide can be converted to a less volatile (safer) form by adding corn oil to the solution and shaking. This method takes advantage of the double bonds of the unsaturated oil to form a cyclic osmic ester. The reaction may be slow because corn oil is not readily miscible in water, but it's easy and it works.

Osmium tetroxide contaminated labware must be disposed of by using Container Option C or D.

**PAINT**

Paint can be a significant potential source of pollution in landfills. Dispose of all oil based paints through ORS. Old, unwanted full cans of latex paints must be disposed of through ORS. Opened, nearly empty cans of latex paint can be allowed to air dry until solid then be disposed in the trash as non-hazardous waste. This must be waste generated at Northwestern University. *You may not bring personal wastes from home for disposal through Northwestern University.*

**PAINT THINNERS, RELATED CHEMICALS, CONTAMINATED RAGS**

Chemicals associated with the use of paint thinner, brush cleaners, linseed oil, etc. must be collected for disposal by ORS. Rags and paper towels contaminated with paint thinner or related chemicals are chemical waste. Contact ORS for more information on collection options and disposal.
PERCHLORIC ACID
Perchloric acid reacts violently with many oxidizable substances. The anhydrous (dehydrated) acid presents a serious explosion hazard. It is unstable and can decompose explosively at ordinary temperatures or in contact with many organic compounds. Amounts in labs must be limited to 1 pound or less. Any work with perchloric acid heated above ambient temperature requires ORS approval. Special wash-down hoods may be required. Use Waste Collection Option A or B for disposal.

Many heavy metal perchlorates and organic perchlorate salts are extremely sensitive explosives; the ammonium, alkali metal and alkali earth perchlorates are somewhat less hazardous. Mixtures of perchlorates with many oxidizable substances are explosive. Cold 70% perchloric acid is a strong acid but is not considered to be a strong oxidizing agent; however more concentrated solutions are good oxidizers. Work with >85% perchloric acid requires special precautions and should be carried out only by specially trained personnel and in specially designed fume hoods.

PEROXIDE FORMING COMPOUNDS
Certain chemicals such as isopropyl ether, diethyl ether, dioxane, 2-butanol, tetrahydrofuran can form organic peroxides if they are exposed to air, become more concentrated or age. These compounds may violently explode when combined with certain other compounds (i.e., metals or by heat, shock, friction, light or static discharge).

Never move or open a container if crusty deposits formed on the material or its container, an oily, viscous layer appeared, or there are solids on the bottom. Immediately contact ORS if rusted, damaged, undated or suspicious looking containers of peroxide forming materials are found.

- Clearly and explicitly label chemicals known to form peroxides.
- Always date the container when received and when opened.
- Limit the on-hand stock to a three (3) month supply or less.
- Air dry empty containers under the hood, flush with water, deface the label and put containers in the glass disposal container.
• Store away from heat and light.
• Protect from ignition sources, physical damage, contact with strong reducing agents or oxidizers, or other contamination.
• Ensure air-tight closures on containers, purge head space with nitrogen when possible.
• Keep a minimal working inventory.
• Never store in a freezer. Use explosion-proof or explosion-safe refrigerators, as needed.
• Never store in glass bottles with glass stoppers.
• Never attempt to clean containers that were used to store peroxide forming compounds by scraping or rubbing, especially if an oily deposit or crusty residue is present.
• Test for peroxide concentration before distilling or concentrating.
• Prevention of unwanted peroxides is paramount. Stabilization and disposal can cost up to $3,000 per container.

PESTICIDES
If old pesticides are found, please contact ORS.

PHARMACEUTICALS
The possession of controlled substances is only permitted with a valid DEA license. Keep Drug Enforcement Administration (DEA) regulated drugs under lock and key security until time of pick up. Any drugs provided by the Center for Comparative Medicine (CCM) must be disposed of through CCM - contact h-fletcher@northwestern.edu. Dispose otherwise acquired Schedule 2-5 DEA Controlled Substances through a reverse distributor such as Pharma Logistics. Other drug disposal requests enter in NSIS or send an email to hazardous-waste@northwestern.edu.

PHENOL/CHLOROFORM
1. Collect liquid mixtures using Container Option E. Indicate percentages on the label.

2. Phenol/Chloroform contaminated labware such as pipette tips and Eppendorf tubes with small volumes of liquid must be collected using Container Option D. See also under SMALL VIALS.
It is not acceptable to throw this type of waste into general trash containers, autoclave in biohazard bags, or dispose of as biological waste.

PHOTOGRAPHIC SOLUTIONS
All darkrooms must be registered in NSIS with the Office for Research Safety.

Used Fixer (Black & White, Color, Bleach, Microfilm, X-ray): Fixers pick up unexposed silver during photo processing. Due to this, used fixer solutions are classified as a chemical waste and are prohibited from drain disposal. Used fixer must be collected using Container Option A or B.

Stabilizers and Activators: Some activators and stabilizers pick up unexposed silver during photo processing. Use Container Option A or B.

Indicator Stop Bath or Acetic Acid: If Indicator Stop Bath has changed color, the solution is neutral and can be drain disposed. If Stop Bath does not have an indicator, check the pH. Adjust the pH to between 5-10 before drain disposal. Use Container Option A or B to dispose of used Indicator Stop Bath or acetic acid solutions that do not meet either of these conditions.

Developers - Black & White: In general, these solutions can be drain disposed. Identify the chemical constituents from the product's SDS and call ORS for disposal information.

Developers - Color: Some color developers contain hazardous constituents and others have a pH that prohibits them from being drain disposed. Identify the chemical constituents from the product's SDS and call ORS for disposal information and assistance.

Hypo Clearing Agent: These solutions can be drain disposed.

Mixtures: Certain photo processing operations do not allow for the collection of fixer separate from other photochemicals. These mixtures cannot be discharged to the sewer. All silver bearing solutions MUST be collected using Container Option A or B.

NOTE: All automated film processors must be equipped with silver recovery systems, and approved and registered with ORS.

PIRANHA ETCH SOLUTION
There are two types of piranha etch: acid piranha and base piranha. Standard acid piranha is a 3:1 mixture of concentrated sulfuric acid (H2SO4) and hydrogen peroxide (H2O2).

This reaction is extremely exothermic when the peroxide is added to the acid. A standard base piranha solution is a 3:1 mixture of ammonium hydroxide (NH4OH).
and hydrogen peroxide (H2O2). This reaction must be heated to 60°C before the reaction takes place.

**PPE**

Proper PPE must be worn while making or handling piranha etch. This includes a lab coat, safety glasses, and neoprene gloves. Additionally, a face shield and neoprene apron should be worn.

**Preparation and Handling**

Piranha solution should be made fresh before use; it should never be stored. Piranha should only be prepared and handled in clearly labeled glass containers (preferably Pyrex) inside of a fume hood free and clear of all chemicals (especially organic compounds). When preparing piranha, always add the peroxide to the acid. If the peroxide concentration is greater than 50% in a piranha etch, the solution will most likely explode.

Piranha is used to remove residues, not actual compounds. Failure to properly remove the majority of a compound could result in an explosion, especially with organic materials. If piranha is mixed with sufficient amounts of organic materials, it will generate enormous quantities of heat and gas.

**Disposal**

Hot piranha solution should be allowed to cool in an open container, preferably overnight, in a working fume hood. A sign should be placed on the fume hood alerting people to the hazard. Once the solution is cool, it may be transferred to another glass container for pickup. This container must have a pressure-venting cap, as piranha will continue to off-gas. Label the waste bottle appropriately.

---

**Do not try to combine multiple batches of piranha solution into one waste container; ORS Hazardous Waste Services will pick up multiple containers.**

**REACTIVES**

Chemicals that are considered reactive can react violently with air, water or other substances and also have the potential to explode. These chemicals include picric acid, sodium cyanide and sodium azide.

- Segregate oxidizers from flammable and combustible materials, organic material and reducers;

- Pyrophoric chemicals ignite spontaneously on contact with air. Store breakable glass bottles inside a plastic bottle carrier. Keep these chemicals in a glove box.
• Shock-sensitive and/or explosive materials (benzoyl peroxide) can spontaneously release large amounts of energy when struck, shaken, dropped or agitated. Some chemicals become increasingly shock sensitive with age. Inspect these regularly for degradation and dispose of promptly. Consult the Safety Data Sheet (SDS) before working with reactives.

• Never contaminate reactive chemicals with heavy metals or incompatibles.

SELENIUM
Wastes\textsuperscript{11} containing more than 1 ppm are regulated.

SILVER
Wastes\textsuperscript{12} containing more than 5 ppm are regulated.

SMALL VIALS
Small vials filled with compatible chemicals may be collected in wide mouth quart and gallon jars or 5 gal buckets with lids. Separate containers are required for the collection of mercury containing liquids, reactive, oxidizing and acutely toxic liquids. Label the outside of the collection container with all chemical contents. Choose the container size according to expected waste volumes so the container can be filled and picked up in less than 150 days.

SODIUM AZIDE
Sodium azide is commonly used in low concentrations as a microbicide to preserve samples. Avoid exposure to the pure material. Avoid weighing the solid by adding solvent to the material and diluting to working concentrations. Take care not to contaminate pure sodium azide with metals or foreign materials as this can lead to the formation of explosive metal azides. If used as a microbicide, purchase sodium azide in solution. Azide solutions can also form explosive metal azides in drain pipes. Collect solutions and pure material for disposal through ORS. Best practice is to make azide waste solutions basic > pH 10 before submittal.

SOLVENTS
All solvents must be collected using Container Option E. Aqueous, halogenated and non-halogenated waste streams should be separated if possible. Halogenated solvents include methylene chloride and chloroform. Non-halogenated solvents include methanol, acetone and xylene. List all chemical constituents on the waste label. This includes any metals. The pH also is very important to note on the waste label. No excess solids or debris is allowed. For laboratories using large volumes of certain solvents, it may be possible to distill or purify these solvents for reuse. Please contact ORS for more information on solvent recycling.

\textsuperscript{11} Source: 40 CFR §261.24
\textsuperscript{12} Source: 40 CFR §261.24
STAINING SOLUTIONS
Staining solutions such as Wright's, eosin, iodine and methylene blue stains must be in Container Option A or B. You must list the solvent concentrations on the waste label (i.e., water, glacial acetic acid, methanol).

SCIENTIFIC EQUIPMENT- SURPLUS, REPAIR OR DISPOSAL
Any piece of scientific equipment must be carefully surveyed and decontaminated when it may have been in contact with potentially hazardous biological, chemical or radioactive materials. See additional steps.

UNIVERSAL WASTES
Universal waste is "universally generated." It is defined as a hazardous waste but has low risk relative to other hazardous wastes. Types of universal wastes recognized in Illinois are batteries, fluorescent light bulbs, mercury containing devices, used automotive antifreeze, certain pesticides and color cathode ray tubes. Due to the large volume, Northwestern University collects and recycles batteries, bulbs and cathode ray tubes. A pickup request must be made within 9 months of accumulation.

You may not bring personal wastes from home for disposal through Northwestern University.

UNKNOWNWS
Analysis and disposal of material for which the identity is not known can be expensive, from $300 to $1500 or more per unknown. If unknowns are found, consult with other workers who may have an idea as to the identity of the material. Even a general chemical classification (such as "aromatic sulfur compound") can be very helpful. A phone call to a colleague who has left will pay for itself several times over.

To prevent unknowns, remember to label all your containers regardless of size. Labeling of stock solutions is essential. All labels must include the commonly accepted name (NO CHEMICAL FORMULAS), special warnings, individual responsible and the date made. When scientists plan to leave the University, contact ORS to help you clean out the laboratory so that unknowns can be identified.

Researchers must make every effort to identify the contents and to avoid the generation of these materials. List unknown materials on the Hazardous Waste Pickup Request in NSIS. It is helpful to include the color and physical state of these materials on the form and any other information that may help in identification.

When unknowns are found in the laboratory, exercise caution as these materials may be old and unstable. If you suspect unknowns are reactive, call ORS prior to moving these materials.
APPENDIX C - SANITARY SEWER OR ORDINARY REFUSE DISPOSAL

Only dilute solutions of non-toxic materials shall be disposed of in the sanitary sewer system. This includes most normal biological metabolites and nontoxic cellular constituents (proteins, nucleic acids, carbohydrates, soluble fats, and their precursors and catabolites, common sugars, amino acids, non-toxic common salts (NaCl, MgCl2, etc) and biological buffers with pH between 5-10. (Phosphate buffers, saline, Tris, etc.).

Note that acid or base solutions containing organic or inorganic impurities (e.g. base baths or acidic solutions used to clean glassware) must not be flushed down the drain even if neutralized. These solutions must be collected for chemical waste disposal by ORS.

In general, only the following non-hazardous laboratory chemicals may be placed into the ordinary refuse (garbage) for disposal. Non-hazardous materials in aqueous solution may be poured down the drain with the exception of >2% slurries of sand-, earth-, gypsum-, cement or other insoluble material.

<table>
<thead>
<tr>
<th>Acids, pH&gt;5</th>
<th>Calcium oxide</th>
<th>L-cysteine</th>
<th>Sephadex</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actin</td>
<td>Calcium phosphate</td>
<td>L-glutamic acid</td>
<td>Silica Gel</td>
</tr>
<tr>
<td>Agar</td>
<td>Calcium sulfate</td>
<td>L-histidine</td>
<td>Sodium borate</td>
</tr>
<tr>
<td>Agarose</td>
<td>Citric acid</td>
<td>L-leucine</td>
<td>Sodium bicarbonate</td>
</tr>
<tr>
<td>Alcohol &lt;24%</td>
<td>Collagen</td>
<td>Lactose monohydrate</td>
<td>Sodium carbonate</td>
</tr>
<tr>
<td>Alanine</td>
<td>Dextrin</td>
<td>Lysine hydrochloride</td>
<td>Sodium chloride</td>
</tr>
<tr>
<td>Albumin, bovine</td>
<td>EDTA (acid free)</td>
<td>Maltose</td>
<td>Sodium citrate</td>
</tr>
<tr>
<td>Alumina</td>
<td>EDTA disodium salt</td>
<td>Manganese chloride</td>
<td>Sodium phosphate</td>
</tr>
<tr>
<td>Aluminum oxide</td>
<td>Egg albumin</td>
<td>Manganese sulfate monohydrate</td>
<td>Sodium sulfate</td>
</tr>
<tr>
<td>Ammonium acetate</td>
<td>Ferric citrate</td>
<td>Mannitol</td>
<td>Sorbitol</td>
</tr>
<tr>
<td>Ammonium phosphate dibasic</td>
<td>Ferric oxide</td>
<td>Magnesium borate</td>
<td>Stannic oxide</td>
</tr>
<tr>
<td>Ammonium sulfate</td>
<td>Ferrous sulfate hexahydrate</td>
<td>Magnesium carbonate</td>
<td>Stannous oxide</td>
</tr>
<tr>
<td>Amylase</td>
<td>Fetal bovine serum</td>
<td>Magnesium chloride</td>
<td>Starch</td>
</tr>
<tr>
<td>Amylose</td>
<td>Folic acid</td>
<td>Magnesium oxide</td>
<td>Sugars</td>
</tr>
<tr>
<td>Antifoam E Emulsion</td>
<td>Fructose</td>
<td>Magnesium phosphate</td>
<td>Tetraethylammonium chloride monohydrate</td>
</tr>
<tr>
<td>Asparagine</td>
<td>Gelatin</td>
<td>Magnesium sulfate</td>
<td>Thiamine hydrochloride</td>
</tr>
<tr>
<td>Aspartic acid</td>
<td>Glucose</td>
<td>Niacin</td>
<td>Tin</td>
</tr>
<tr>
<td>Bases, pH &lt;10</td>
<td>Glutamic acid</td>
<td>Pectin</td>
<td>Titanium oxide</td>
</tr>
<tr>
<td>Boric Acid</td>
<td>Glycerol</td>
<td>Potassium borate</td>
<td>Tris base</td>
</tr>
<tr>
<td>Calcium acetate</td>
<td>Glycine</td>
<td>Potassium carbonate</td>
<td>Trypsin</td>
</tr>
<tr>
<td>Calcium borate</td>
<td>Glycogen</td>
<td>Potassium chloride</td>
<td>Yeast extract</td>
</tr>
<tr>
<td>Calcium carbonate</td>
<td>Inositol</td>
<td>Potassium phosphate</td>
<td>Zinc oxide</td>
</tr>
<tr>
<td>Calcium chloride</td>
<td>Iron</td>
<td>Potassium sulfate</td>
<td></td>
</tr>
<tr>
<td>Calcium citrate</td>
<td>Iron oxide</td>
<td>Riboflavin</td>
<td></td>
</tr>
</tbody>
</table>

Materials that do not appear on these lists **MUST** be collected for disposal by ORS.

**NOTE THAT LIQUID NITROGEN OR DRY ICE MUST NEVER BE PLACED IN THE SINKS, AS THEY CAN CRACK THE SINK AND CAUSE DAMAGE TO THE PLUMBING.**
APPENDIX D – DISPOSAL PROCEDURES FOR NON-LABORATORY AREAS

Northwestern University non-laboratory areas utilize and generate a wide variety of hazardous substances. Non-laboratory areas include shops and classrooms serving departments such as Facilities Management, Athletics’ facilities, Wirtz Center, and the Department of Art Practice & Theory. Appendix C contains a comprehensive list of the waste streams generated by the University. For disposal, contact hazardous-waste@northwestern.edu. Refer to the following list for specific information:

AEROSOL CANS
If completely empty, aerosol cans may be disposed of as non-hazardous waste. If contents or pressure remains, dispose in designated hazardous waste containers.

BATTERIES
There are a variety of batteries used: lead-acid (automotive), mercury, lithium containing, ordinary household and rechargeable. Dispose of all battery types through hazardous-waste@northwestern.edu.

GAS CYLINDERS
If at all possible, return compressed gases to the manufacturer or supplier for reuse. Ensure that the label on each cylinder is legible. Keep the valve protection cap on the cylinder when not in use. Attach a Hazardous Waste Label when the cylinder is to be disposed.

GLYCOL
Dispose of all glycol in a designated hazardous waste container.

OILS
Waste oils are to be contained in double-walled containers. If at all possible, return to the supplier for reuse.

PAINT
Dispose of all oil-based paints through Clean Harbors. Old, unwanted full cans of latex paints must be disposed of through hazardous-waste@northwestern.edu. Opened, nearly empty cans of latex paint can be allowed to air dry until solid then be disposed in the trash as non-hazardous waste.

PAINT THINNERS, RELATED CHEMICALS, CONTAMINATED RAGS
Rags and paper towels contaminated with paint thinner must be stored in a flammable-rated container.
PHOTOGRAPHIC SOLUTIONS
Used Fixer (Black & White, Color, Bleach, Microfilm): Dispose in a designated container with a Hazardous Waste Label.

Stabilizers and Activators: Dispose in a designated container with a Hazardous Waste Label.

Developers - Black & White, and Color: Dispose in a designated container with a Hazardous Waste Label.

SOLVENTS
Aqueous, halogenated and non-halogenated waste streams should be separated if possible. Common solvents include acetone and methanol. Solvents must be collected in compatible and right-sized containers. Attach a Hazardous Waste Label to the container. List all chemical constituents and pH on the waste label.

SAW DUST
Saw dust is collected in a designated sealed container. These containers are closed-topped and no other material should be deposited inside these containers.