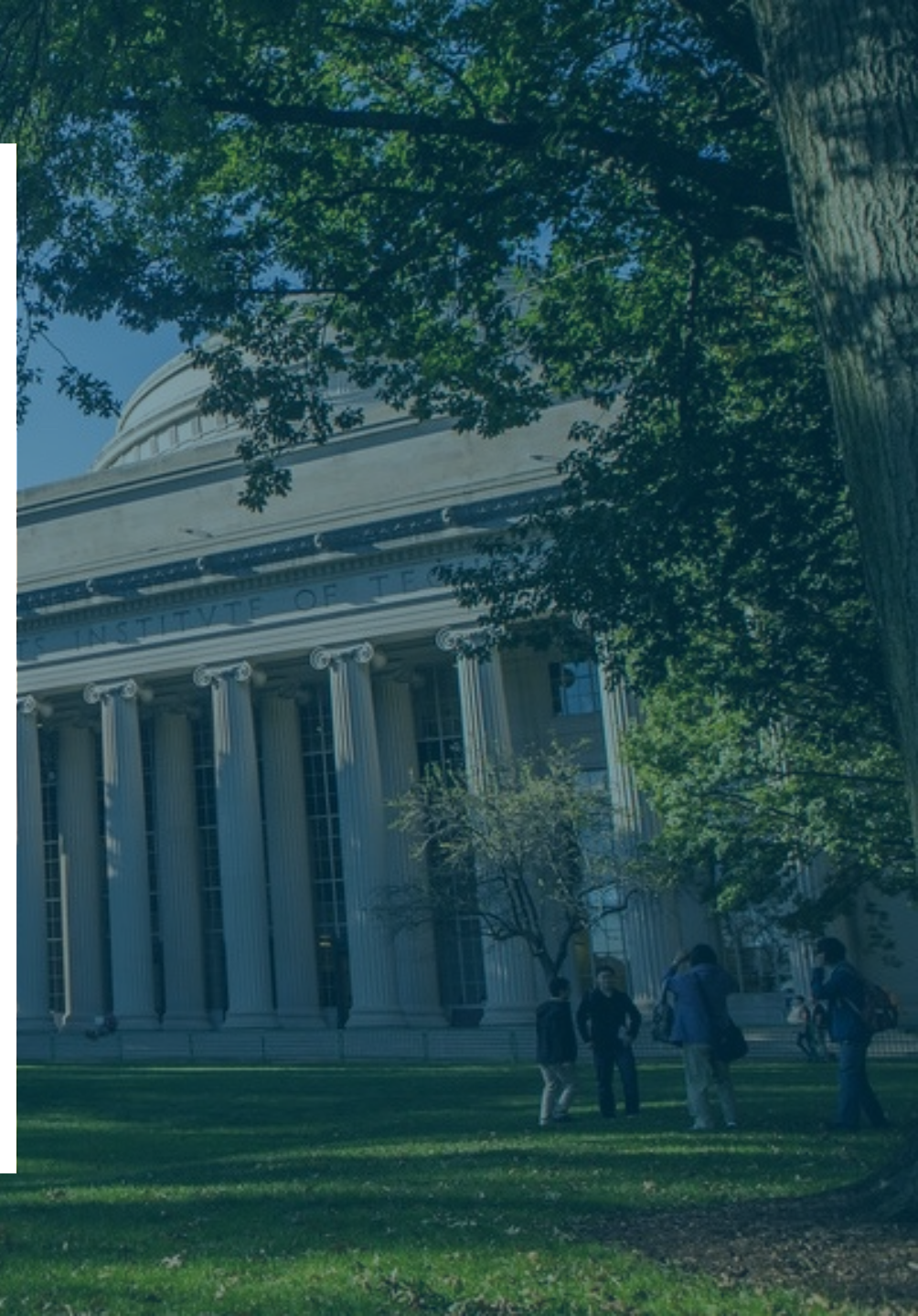




Managing Hazardous Waste

Training Course 501c
Environmental Management Program
MIT EHS Office



Hazardous Waste Regulation: Necessary

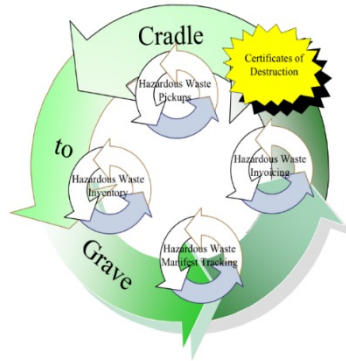


"A school, however, could be built in the center unfilled section (with chemicals underground). We became convinced that it would be a wise move to turn this property over to the schools provided we could not be held responsible for future claims or damages resulting from underground storage of chemicals." Hooker Chemical Co.

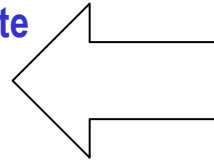
Hazardous Waste Regulation: Costly

\$76,764

Pollution Prevention & Waste Management

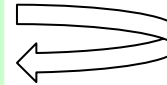


Non-Hazardous Waste
or
Hazardous waste?



- *Order & use alternative chemicals
- * **Maintain an inventory**

*Determine if chemicals used in the process can be recycled and reused

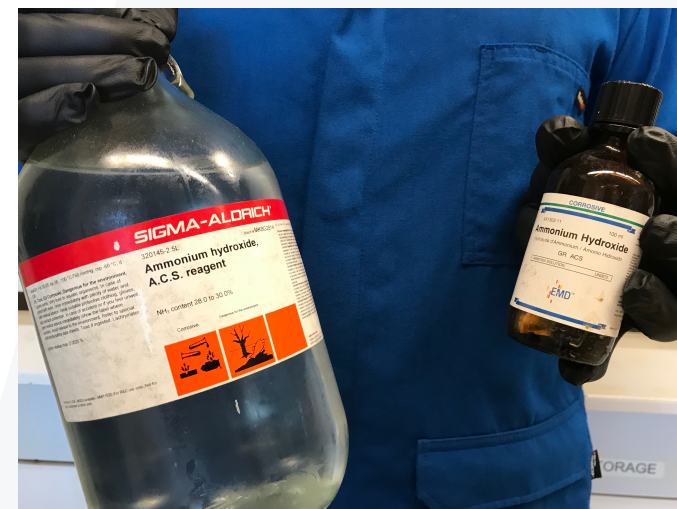


- *Solvents for consolidation must comply with specific requirements
- *Accumulate in lab within SAA
- *Move from lab to MAA
- *Vendor ships to TSDF
- *EHS manages program, TSDFs, due diligence, etc.

Pollution Prevention and Waste Management

The safest and best way to manage hazardous wastes is to generate less of them:

- Share chemicals – especially within lab groups
- Purchase **ONLY** what you need. Buying in bulk does **NOT** save money.
- Substitute less-hazardous or non-hazardous chemicals into processes wherever possible.
- Downsize experiments (volumes, column diameters, etc.) wherever possible.
- Don't mix hazardous chemical wastes with other wastes (because the entire mixture usually becomes hazardous).



What is a 'Hazardous Waste'?

Hazardous Wastes are chemical wastes that, because of their inherent danger or toxicity must be collected for proper disposal.

Chemical wastes can **exhibit a hazardous characteristic**:

- Ignitable
- Reactive
- Corrosive
- Toxic

Or chemicals can be hazardous wastes because they **appear on regulatory lists** of hazardous waste:

- Federal 'F List', 'U' list or 'P' list
- Massachusetts List (oils, PCBs)
- MIT List (Ethidium Bromide, engineered nano-particles)

Ignitable Hazardous Waste

- Liquids with a flashpoint of less than 60°C / 140°F
 - Toluene, Acetonitrile, Alcohols
- Solids that burn spontaneously
- Oxidizers
 - Nitric Acid
 - Hydrogen Peroxide



Corrosive Hazardous Waste

Aqueous solutions with a pH:

- Less than or equal to 2
- Greater than or equal to 12.5
- Note that solid materials which, when mixed with equal volume of water, would create a solution with a pH in this range should also be collected.

Examples include acids such as sulfuric and hydrochloric, and bases such as sodium hydroxide.



Reactive Hazardous Waste

Materials that tend to be **unstable** at normal temperature and pressure.

- Water-reactive materials
- lithium, sodium, potassium metal
- Cyanide & sulfide bearing wastes
- Explosives
 - Peroxide-formers
 - Outdated ethers
- Shock sensitive materials (ex. dry picric acid)



Safe Management of Reactive Metal Waste Streams



NEVER in a black bucket

Lithium, Sodium & Potassium Metal:

- Within the glove box, or controlled environment, containerize the waste materials and **completely submerge them in oil.**
- Remove the waste container from the glove box
- Label it with a red tag
- Spell out the chemical constituents
- Indicate “ignitable and reactive” as the associated hazards
- Date the container
- Place it in the MAA or place a waste collection pick up request online for removal

Peroxide Forming Chemicals

- Peroxide test strips available from JT Baker (4416-01) through VWR
- Examine bottle carefully for possible crystals or particles in bottle or around the cap
- Lab should test containers before use if expiration dates have been reached or containers are no longer wanted & if waste stream is >25% concentration of a peroxide forming chemical; *do not worry about IPA*
- If \leq 20 ppm, place red tag on container, indicate peroxide levels, and request disposal or bring to MAA
- **If > 20 ppm, contact EHS**
- If at any time a researcher does NOT feel comfortable testing the container they should not attempt this and should contact EHS for assistance.

Toxic Hazardous Waste

Concern is for effects to ecosystems & human toxicity:

- Federal Toxics List (40 total)
- Includes materials that should be collected, but don't exhibit other characteristics, including:
 - Metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver)
 - Halogenated chemicals
 - Pesticides, etc.



Listed Hazardous Wastes

- Federal 'F list': most relevant are the halogenated and non-halogenated solvents in F1-F5.
- Federal 'U list': for unused materials
- Federal 'P List': of acutely hazardous substances (must 3xrinse or collect even empty containers).
- Massachusetts Lists waste oil (unless from animal or vegetable) and PCBs.
- MIT collects ethidium bromide and engineered nanoparticles as hazardous wastes.




Sink Disposal Limits

SINK DISPOSAL

The following materials are the only allowable discharges to laboratory sinks:

- Inorganic solutions with pH between 5.5 and 12
- Soaps / detergents
- Mercury-free Elach/Hexadyne™/Clorox OFA™/Quatrol/Quatrol II solutions
- Aqueous, soluble and dispersible radioactive isotopes into designated sinks or pipe openings within established limits (detailed lists posted at the designated sinks)
- Infectious / Biological materials that have been properly treated as described in each laboratory's registration protocols
- Non-contaminated growth media
- Purified biological materials such as amino acids and proteins in aqueous or buffer solutions
- Sugars and sugar alcohols (polyols) such as glycerol, xylitol and sorbitol
- Buffer solutions
- Spent photo developer (not fixer)
- Inorganic salts for which both the cations and anions are listed in the following table:



Cations	Anions
Aluminum, Al ³⁺	Borate, BO ₃ ³⁻ , B ₄ O ₇ ²⁻
Ammonium, NH ₄ ⁺	Bromide, Br ⁻
Calcium, Ca ²⁺	Carbonate, CO ₃ ²⁻
Cesium, Cs ⁺	Chloride, Cl ⁻
Iron, Fe ⁺	Bicarbonate, HCO ₃ ⁻
Lithium, Li ⁺	Bisulfite, HSO ₃ ⁻ , Bisulfate, HSO ₄ ⁻
Magnesium, Mg ²⁺	Fluoride, F ⁻
Manganese, Mn ²⁺ , Mn ³⁺ , Mn ⁴⁺ , Mn ⁷⁺	Hydroxide, OH ⁻
Potassium, K ⁺	Iodide, I ⁻
Sodium, Na ⁺	Nitrate, NO ₃ ⁻ , Nitrite, NO ₂ ⁻
Strontium, Sr ²⁺	Oxide, O ²⁻
Tin, Sn ²⁺	Phosphate, PO ₄ ³⁻
Titanium, Ti ³⁺ , Ti ⁴⁺	Sulfate, SO ₄ ²⁻ , Sulfide, SO ₃ ²⁻
Zirconium, Zr ²⁺	Thiosulfate, S ₂ O ₃ ²⁻

All other materials must be collected and managed as hazardous waste.

Please call MIT's EH&S Office (2-EHSS) for assistance in evaluating your waste disposal needs.

MWRA Requirements prohibit:

- Strong acids and bases
 - acids: pH <5.5
 - bases: pH >12
- Copper, nickel, zinc
- Volatile Organic compounds (i.e., common laboratory solvents)

Determining if a Chemical Waste is Hazardous



In order to determine if a chemical waste is hazardous, you need to understand which chemicals and materials it is comprised of and then determine if a hazardous characteristic is exhibited or if any component is listed.

We can use laboratory tests (pH, 'HPLC' toxicity for example) or generator knowledge to make this determination.

Waste Determination - SDS

- A **GOOD** (Sigma, Fisher are good sources) SDS sheet can often tell you about hazardous characteristics:
 - Physical and Chemical Properties
 - Shipping Descriptions
 - Pictograms
- Note that SDS sheets are typically not good sources of disposal information (too general/vague)

SECTION 9: Physical and chemical properties

9.1 Information on basic physical and chemical properties

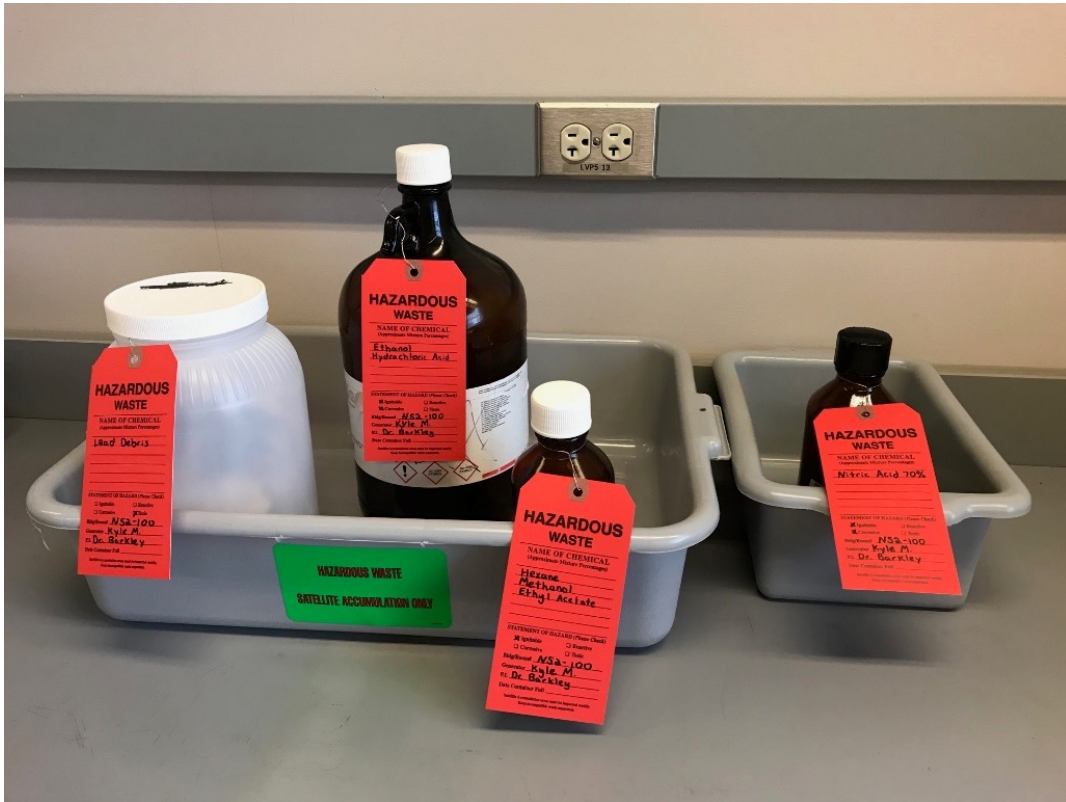
a) Appearance	Form: liquid Colour: colourless
b) Odour	stinging
c) Odour Threshold	No data available
d) pH	2.5 at 50 g/l at 20 °C (68 °F)
e) Melting point/freezing point	Melting point: 16.64 °C (61.95 °F)
f) Initial boiling point and boiling range	117.9 °C 244.2 °F at 1,013.25 hPa
g) Flash point	39 °C (102 °F) - closed cup
h) Evaporation rate	No data available
i) Flammability (solid, gas)	Not applicable
j) Upper/lower flammability or explosive limits	Upper explosion limit: 19.9 %(V) Lower explosion limit: 4 %(V)
k) Vapour pressure	20.79 hPa at 25 °C (77 °F)
l) Vapour density	2.07
m) Relative density	1.04 g/cm ³ at 25 °C (77 °F)
n) Water solubility	602.9 g/l at 25 °C (77 °F) at 1,013 hPa - completely soluble
o) Partition coefficient:	log Pow: -0.17 at 25 °C (77 °F) - Bioaccumulation is not

Waste Determination – Other Sources of Information

- Hazardous waste lists available from EHS.
- Campus EHS can help any time you are unsure. Sometimes testing is necessary.
- Remember that most chemical wastes should be collected as hazardous: over-classifying is not a problem, but under-classifying is.

NAME	CAS Sort Value	CAS/313 Category Codes	Section 302 (EHS) TPQ	Section 304 EHS RQ	CERCLA RQ	Section 313 CODE	RCRA CODE	CAA 112(r) TQ
Abamectin	71751412	71751-41-2				313		
Acenaphthene	83329	83-32-9			100			
Acenaphthylene	208968	208-96-8			5,000			
Acephate	30560191	30560-19-1				313		
Acetaldehyde	75070	75-07-0			1,000	313	U001	10,000
Acetaldehyde, trichloro-	75876	75-87-6			5,000		U034	
Acetamide	60355	60-35-5			100	313		
Acetic acid	64197	64-19-7			5,000			
Acetic acid, (2,4-dichlorophenoxy)-	94757	94-75-7			100	X	U240	
Acetic acid ethenyl ester	108054	108-05-4	1,000	5,000	5,000	X		15,000
Acetic anhydride	108247	108-24-7			5,000			
Acetone	67641	67-64-1			5,000		U002	
Acetone cyanohydrin	75865	75-86-5	1,000	10	10	X	P069	
Acetone thiosemicarbazide	1752303	1752-30-3	1,000/10,000	1,000				
Acetonitrile	75058	75-05-8			5,000	313	U003	
Acetophenone	98862	98-86-2			5,000	313	U004	
2-Acetylaminofluorene	53963	53-96-3			1	313	U005	
Acetyl bromide	506967	506-96-7			5,000			
Acetyl chloride	75365	75-36-5			5,000		U006	
Acetylene	74862	74-86-2						10,000
Acetylphosphoramidothioic acid O,S-dimethyl ester	30560191	30560-19-1				X		
1-Acetyl-2-thiourea	591082	591-08-2			1,000		P002	
Acifluorfen, sodium salt	62476599	62476-59-9				313		
Acrolein	107028	107-02-8	500	1	1	313	P003	5,000
Acrylamide	79061	79-06-1	1,000/10,000	5,000	5,000	313	U007	

Satellite Accumulation Areas



- Identified with a sticker or sign – take green sticker off bin if re-purposed
- Only 1 container per waste stream per SAA
- All containers tightly closed
- All containers correctly labeled
- All containers inside secondary containers (not solids in black buckets w/ liners)
- Incompatible materials stored in separate secondary containers
- Only hazardous waste bottles stored inside secondary containers (no useful chemicals, squeeze bottles, debris, etc.)
- **Inspected weekly with all errors corrected – Level 1**

Chemical Incompatibility Chart

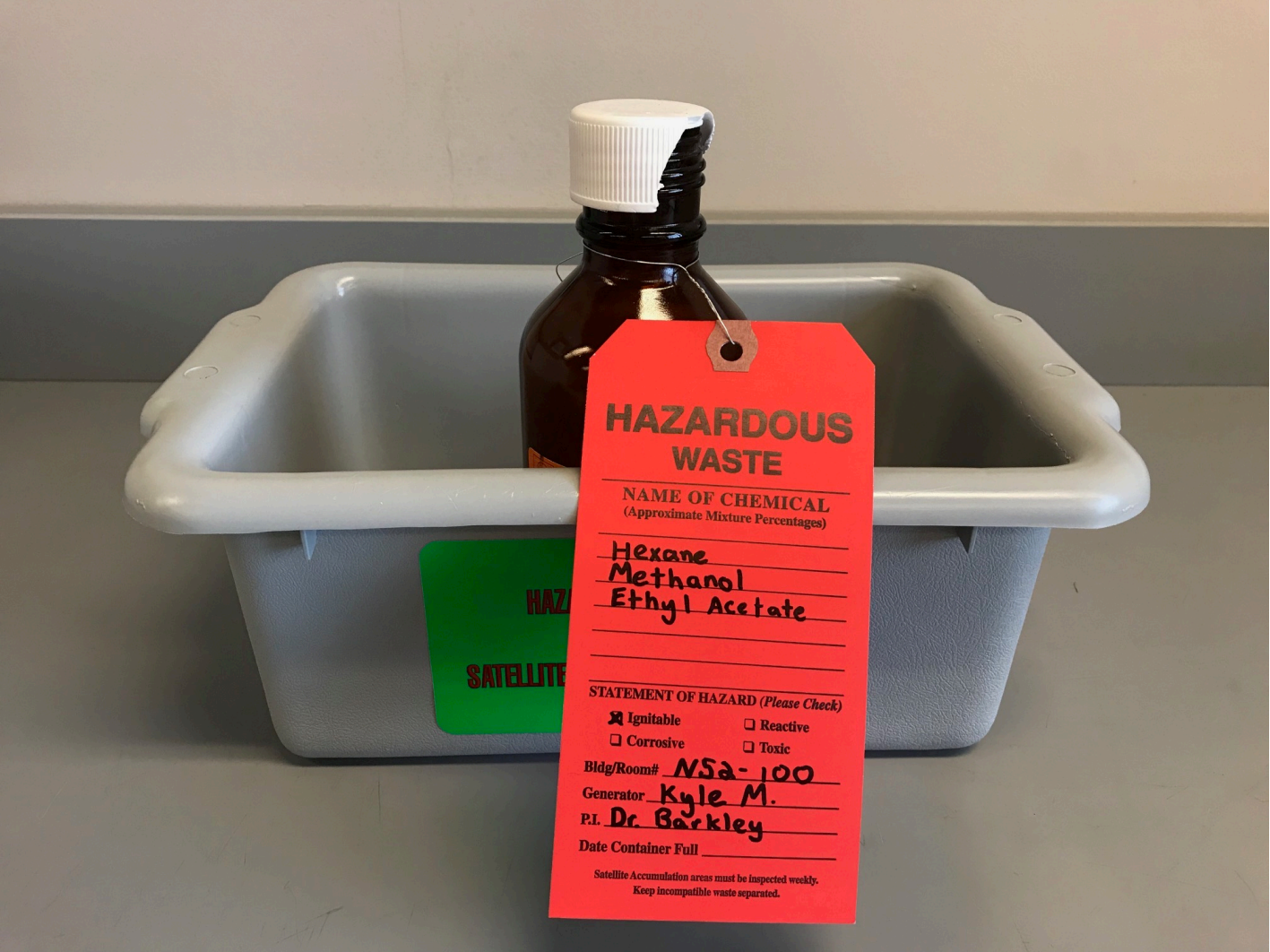
Hazardous Waste Storage Incompatibility Chart		
If material contains:	Do not store/mix with:	Other Dangerous Combinations:
Acids	<ul style="list-style-type: none"> - Caustics - Reactive Metals - Alcohol - Water - Aldehydes - Halogenated, Nitrated or Unsaturated Hydrocarbons - Reactive Organic Compounds and Solvents - Spent Cyanide and Sulfide Solutions - Oxidizers 	<p>• Acids + Oil/Grease = Fire</p> <p>• Acids + Caustics = Heat</p> <p>• Caustics + Epoxies = Extreme Heat</p> <p>• Chlorine Gas + Acetylene = Explosion</p> <p>• Flammable liquids + Hydrogen Peroxide = Fire/Explosion</p> <p>• Aluminum Powder + Ammonium nitrate = Explosion</p> <p>• Sodium cyanide + Sulfuric acid = Lethal gas</p> <p>• Ammonia + bleach (sodium hypochlorite) = Lethal gas</p> <p>General Practices – Segregate these materials from each other:</p> <ul style="list-style-type: none"> • Reactives from Ignitables • Acids from Caustics • Corrosives from Ignitables • Oxidizers from Everything • Corrosives from Water • Reactive organics from reactive inorganics
Caustic	<ul style="list-style-type: none"> - Acid - Reactive Metals - Alcohol - Water - Aldehydes - Halogenated, Nitrated, or Unsaturated Hydrocarbons - Reactive Organic Compounds and Solvents 	
Reactive Metals	<ul style="list-style-type: none"> - Caustics - Acids - Alcohol - Aldehydes - Halogenated, Nitrated, or Unsaturated Hydrocarbons - Reactive Organic Compounds and Solvents - Oxidizers 	
Spent Cyanide and Sulfide Solutions		Acids
Oxidizers		Organic Acids Concentrated Mineral Acids Reactive Metals Reactive Organic Compounds and Solvents Ignitable Wastes (Flammable/Combustible)

HPLC Waste

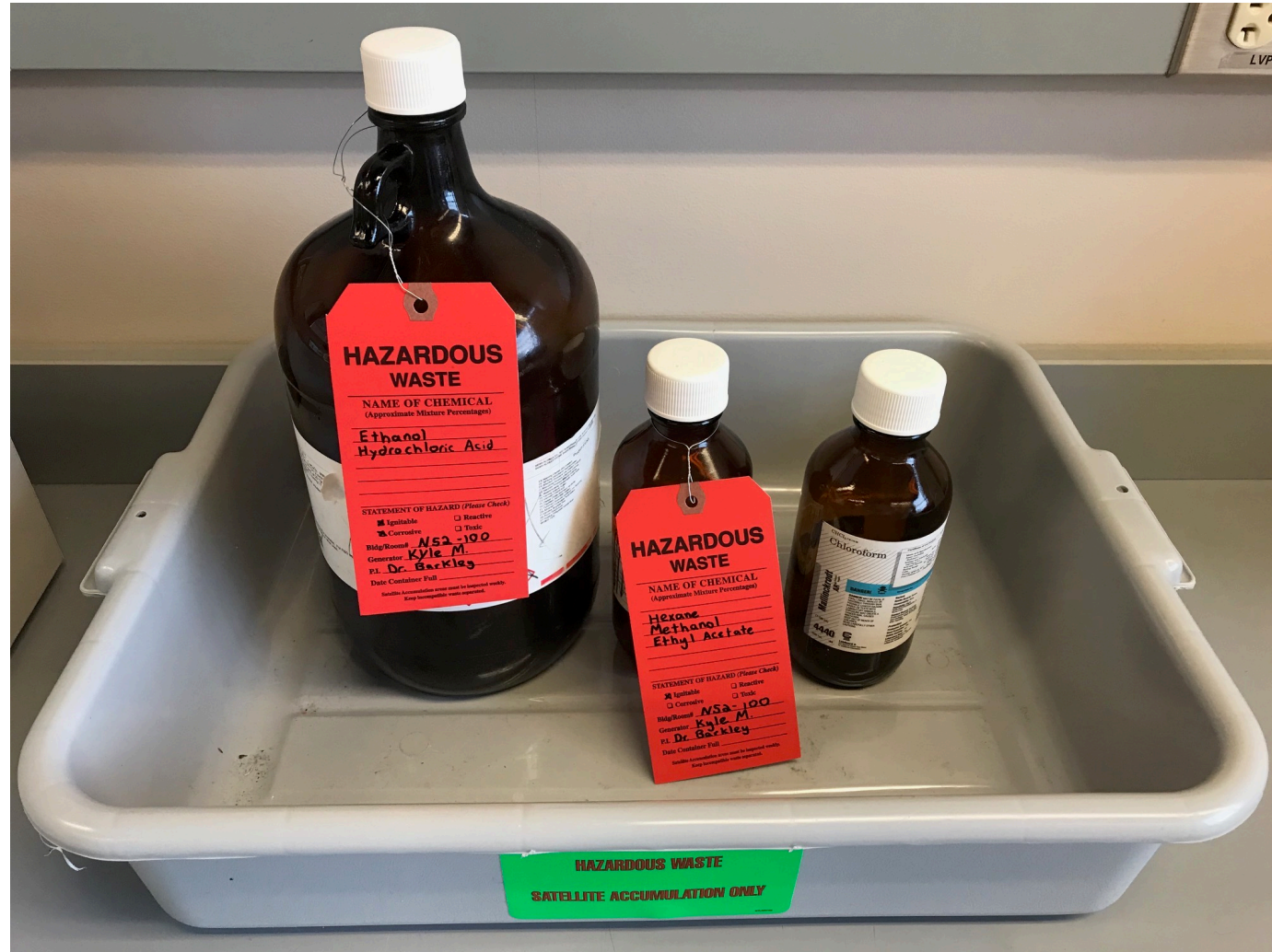


- Label container with red tag
- Clearly identify constituents on red tag
- Secondary containment with Green SAA sticker
- Quick Connect in use to provide closed container
- Monitor levels
- Clean up overflow material
- Request for pickup at unit, don't bring to MAA

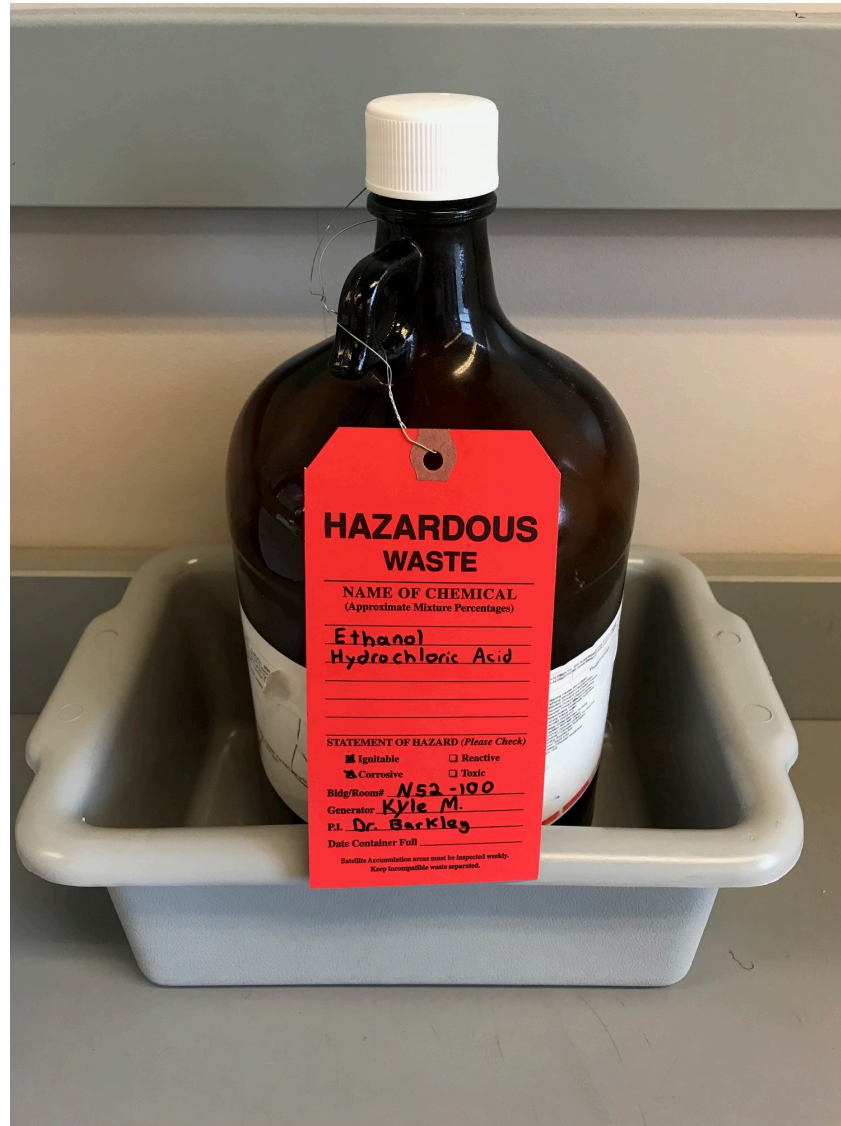
What's Wrong with this Picture?



What's Wrong with This Picture?



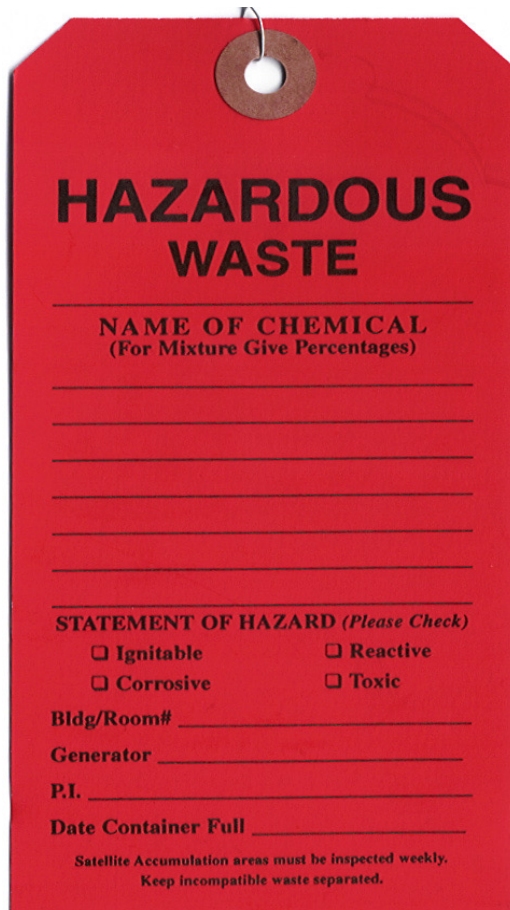
What's Wrong with this Picture?



What's Wrong with this Picture?



Proper Labeling



**HAZARDOUS
WASTE**

NAME OF CHEMICAL
(For Mixture Give Percentages)

STATEMENT OF HAZARD *(Please Check)*

Ignitable Reactive
 Corrosive Toxic

Bldg/Room# _____
Generator _____
P.I. _____
Date Container Full _____

Satellite Accumulation areas must be inspected weekly.
Keep incompatible waste separated.

- The words ‘Hazardous Waste’
- The name(s) of the chemical(s) in the container:
 - Spelled out in full, English words
 - Never abbreviations
 - Never formulas
 - Never trade names
 - Do not omit chemicals – especially if they effect the characteristics of the waste stream
- A Statement of Hazard(s): check the box(es) that apply
- The date FULL:
 - Must be moved from SAA to MAA within 3 days

What's Wrong with this Label?

HAZARDOUS WASTE

NAME OF CHEMICAL
(Approximate Mixture Percentages)

Ethanol

Methanol

IPA

STATEMENT OF HAZARD *(Please Check)*

Ignitable Reactive
 Corrosive Toxic

Bldg/Room# 1-111

Generator J. Jones

P.I. S. Smith

Date Container Full _____

Satellite Accumulation areas must be inspected weekly.
Keep incompatible waste separated.

What's Wrong with this Label?

HAZARDOUS WASTE

NAME OF CHEMICAL
(Approximate Mixture Percentages)

Acetone
Ethyl Acetate
Hexanes
Xylene

STATEMENT OF HAZARD (Please Check)

Ignitable Reactive
 Corrosive Toxic

Bldg/Room# 1-111

Generator J. Jones

P.I. S. Smith

Date Container Full _____

Satellite Accumulation areas must be inspected weekly.
Keep incompatible waste separated.

What's Wrong with this Label?

HAZARDOUS WASTE

NAME OF CHEMICAL
(Approximate Mixture Percentages)

Organic
Solvents

STATEMENT OF HAZARD (Please Check)

Ignitable Reactive
 Corrosive Toxic

Bldg/Room# 1-111

Generator J. Jones

P.I. S. Smith

Date Container Full _____

Satellite Accumulation areas must be inspected weekly.
Keep incompatible waste separated.

Main Accumulation Areas



- Researchers bring waste to these locations in carriers or chemical cart
- Documented inspection and waste removal done weekly by EHS
- **Labels MUST be dated (w/year)**
- More than one stream of same waste allowed in these locations
- Rooms / Cabinets clearly marked
- Full or partially filled containers okay
- No unknowns or cylinders
- DO NOT STACK containers
- Use secondary containment bins

Chemical Sharps

HAZARDOUS WASTE

NAME OF CHEMICAL
(For Mixture Give Percentages)

SHARPS:
Benzene

STATEMENT OF HAZARD (Please Check)

Ignitable Reactive
 Corrosive Toxic

Bldg/Room# _____
NAME: _____
Date Container Full _____

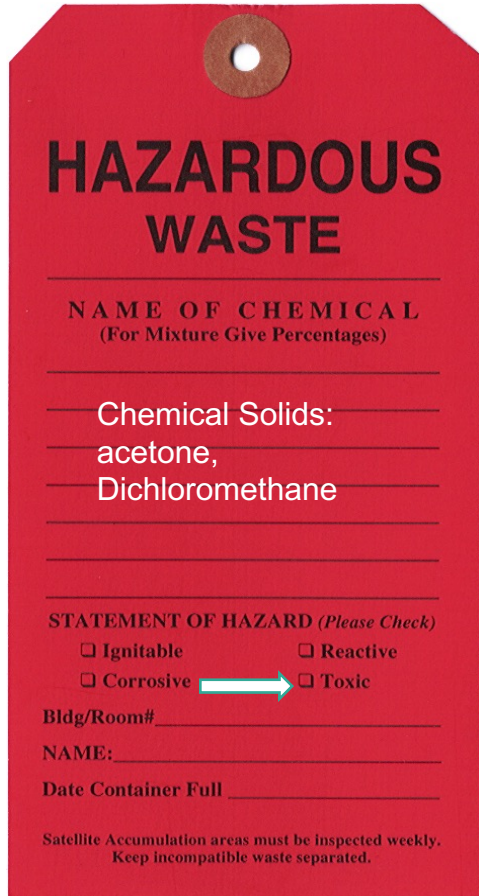
Satellite Accumulation areas must be inspected weekly.
Keep incompatible waste separated.

- Sharps (syringes, blades, etc. which will puncture skin) which are not empty or which are contaminated with particularly-hazardous chemicals, acutely-toxic chemicals, heavy metals, odiferous/noxious chemicals, etc.
- Collected in proper container with compatible materials. No syringes or blades in mayo jars or black buckets.
- Labeled with Red Tag: SHARPS, listed constituents and TOXIC for the hazard
- Container closed and stored within or near a labeled Satellite Accumulation Area (SAA)
- Examples to keep separate from other chemical sharps:
 - **Pyrophoric** chemicals (lithium, magnesium, potassium, etc)
 - **Heavy metals** (mercury, chromium, lead, arsenic, etc.)



Contaminated Solids

- Any disposable item which is used to clean up a chemical spill. Examples could include wipes, paper towels, and gloves.
- Any disposable item (i.e. you will throw it away instead of cleaning and re-using) which has known, visible, or odiferous contamination with a chemical.
- Of particular concern are solids contaminated with acutely hazardous wastes (p list), particularly-hazardous chemicals, heavy metals, and odiferous/smelly chemicals.
 - ✓ Collected in proper container with compatible materials
 - ✓ Labeled with Red Tag: listed with associated constituents and associated hazard(s) indicated
 - ✓ Container closed and stored within or near a labeled Satellite Accumulation Area (SAA)
- Examples to keep separate from general solids:
 - **Pyrophoric** chemicals (lithium, magnesium, potassium, etc.)
 - **Heavy metals** (mercury, chromium, lead, arsenic, etc.)



HAZARDOUS WASTE

NAME OF CHEMICAL
(For Mixture Give Percentages)

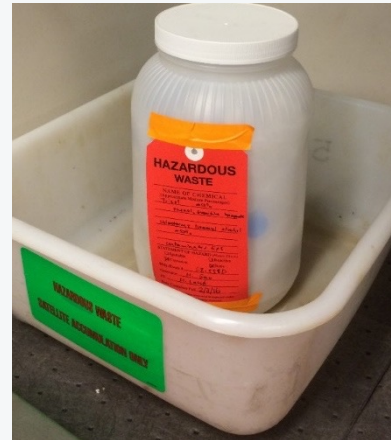
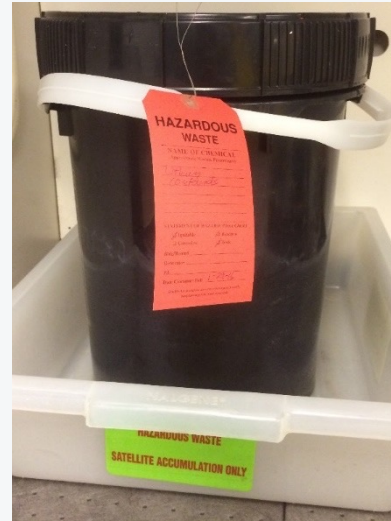
Chemical Solids:
acetone,
Dichloromethane

STATEMENT OF HAZARD (Please Check)

Ignitable Reactive
 Corrosive Toxic

Bldg/Room# _____
NAME: _____
Date Container Full _____

Satellite Accumulation areas must be inspected weekly.
Keep incompatible waste separated.



Clean Glass Container



Empty, 3xRinsed
chemical bottles



Clean vials, tubes, slides

**Remember – clean glass only, no odors,
no needles, no chemical debris**

Disposal Process:

1. Use sturdy cardboard box to collect.
2. Tape bottom of box before use.
3. Once filled, close the inner liner, if you have one.
4. Replace the lid (or close the box) and tape it closed.
5. Indicate, **CLEAN BROKEN GLASS** for **RECYCLING** on the outer box.
6. Move the box to a location within the lab that is close to the trash.

- Custodial Services will remove the box during their evening rounds.



Example of boxes to use



Vented Caps

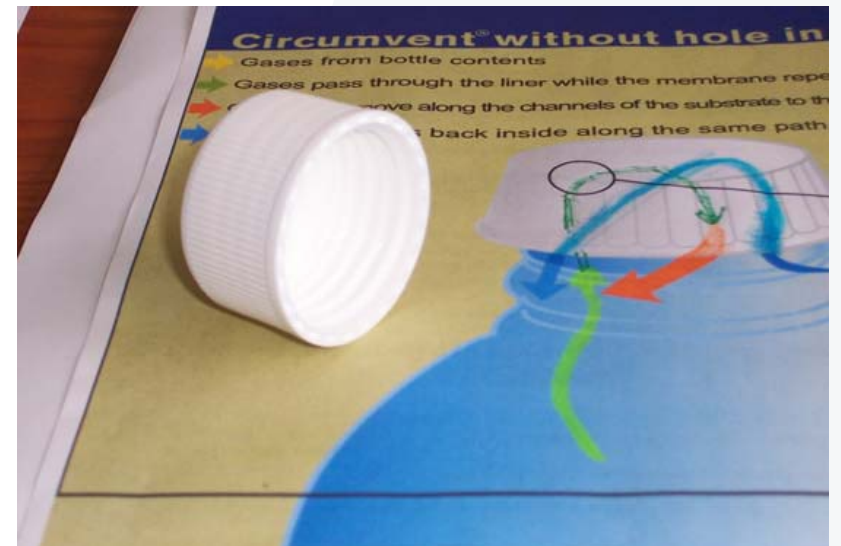
Provided free for use any time there is the potential for waste containers to off-gas/build pressure. For Example:

Piranha Solution

- acid 3:1 mixture of concentrated sulfuric acid with hydrogen peroxide
- base 3:1 mixture of ammonium hydroxide w/ hydrogen peroxide

Aqua Regia Solution

- 3:1 mixture of hydrochloric acid with nitric acid



Universal Wastes



Must be Recycled:

- Rechargeable Batteries
- Fluorescent & UV Light Bulbs
- Mercury Containing Devices & Equipment
- Computer Monitors (e-Waste)

Battery bins exist across campus (map of locations vis Atlas)

Facilities R&M for bulbs & e-Waste (Atlas)

EHS for mercury containing devices



Tape terminals



Tape terminals

Waste Equipment

EQUIPMENT DECONTAMINATION RECORD

Principal Investigator _____
Name Phone Date

This piece of equipment was used with the following:

No Hazardous Materials Biologicals

Chemicals PCBs surveyed by IHP _____
Initials Date

Radiation Surveyed by RPP _____
Initials Date

Other Hazardous (specify) _____

Decontaminated with _____

By (Name) _____ Date _____

Equipment OK for removal or reuse: ___ Yes ___ No

REMOVE THIS LABEL BEFORE REUSING EQUIPMENT

BTL 007 REV. 11/07

- May contain:
 - oils or hazardous liquids
 - mercury
 - lead
- Drain liquids & clean (decon) prior to donation or disposal
- Place EHS sticker on equipment
- Request removal via Atlas to MIT Recycling

Chemical Waste Pickup Request

The screenshot shows a web browser window with the URL `mit.quickbase.com/db/bms438qt87a=nwr`. The page title is "MIT" and it includes a "Sign in" link. The navigation bar contains icons for Home, Radioactive Waste Pick..., Chemical Waste Collec..., Fume Hood Survey Re..., Laser Status, Signs & Stickers, and LAF. The main heading is "Chemical Waste Collection Form > Add Chemical Waste".

Contact Information

- Name *
- Building *
- Room Number (Of Waste Location) *
- Telephone *
- Email * A copy of this record will be sent to this email.

Chemical Waste Information

- Quantity Size Replacements
- Quantity Size Replacements

Supplies

- Do You Need Any Supplies?
- When Is The Best Time To Come To The Lab?:
- Comments/Special Instructions:

Buttons: Save & close, Cancel

Remember:
3 day time limit

Spills

In the event of a spill:

- Notify other personnel of the accident, and instruct them to evacuate the area if necessary.
- Tend to any injured/contaminated personnel, and request help if necessary.
- Take steps to confine and limit the spill if it can be done safely:
 - Put nearby fume hoods in 'emergency exhaust' if possible.
 - Use your spill kit: place absorbent pads and socks around the spill to stop its spread, especially to stop spilled materials from entering drains or escaping the lab. Spill kits are available via EHS.
- Make decisions about 'major' vs 'minor' and notifications in a safe space, away from the site of the spill.

Spills

It is a Minor Spill if...

- Responsible party is present
- Known material
- Not highly toxic
- Small quantity
- No fire hazard
- No potential to reach the environment
- Not in a common area or other area accessible to the general public
- Advanced PPE is not needed

Call EHS if during
business hours:

617-452-3477

Call MIT Operations
Center if off-hours:

617-253-4948

It is a Major Spill if...

- Any of the 'minor' spill criteria are not met, or
- You are uncertain whether minor or major

Active Emergency
Response by calling:

x100 (Campus Phone)
617-253-1212

Questions?

Contact EHS at
617-452-3477 or environment@mit.edu