U.S. National Science Foundation

EARTH

Safety: Chemical Compatibility, and Waste

Dr. Thomas J Poskin

9/17/2025

Sign In Here!

KU THE UNIVERSITY OF KANSAS

UNIVERSITY OF HAWAI'I

LEHIGH UNIVERSITY

UNIVERSITY OF MARYLAND

UNIVERSITY OF NOTRE DAME

UNIVERSITY OF SOUTH DAKOTA

Introduciton

- Purpose: Show how strong safety practices are key to research success and how knowing about chemical compatibility is key at all stages of research

Real-World Relevance:

➔ Safety isn't just a checklist — it protects *you*, *your team*, and *your project.*

EARTH

Practical issues in Labs

"Up to 25% of chemical lab incidents involve improper use of fume hoods"

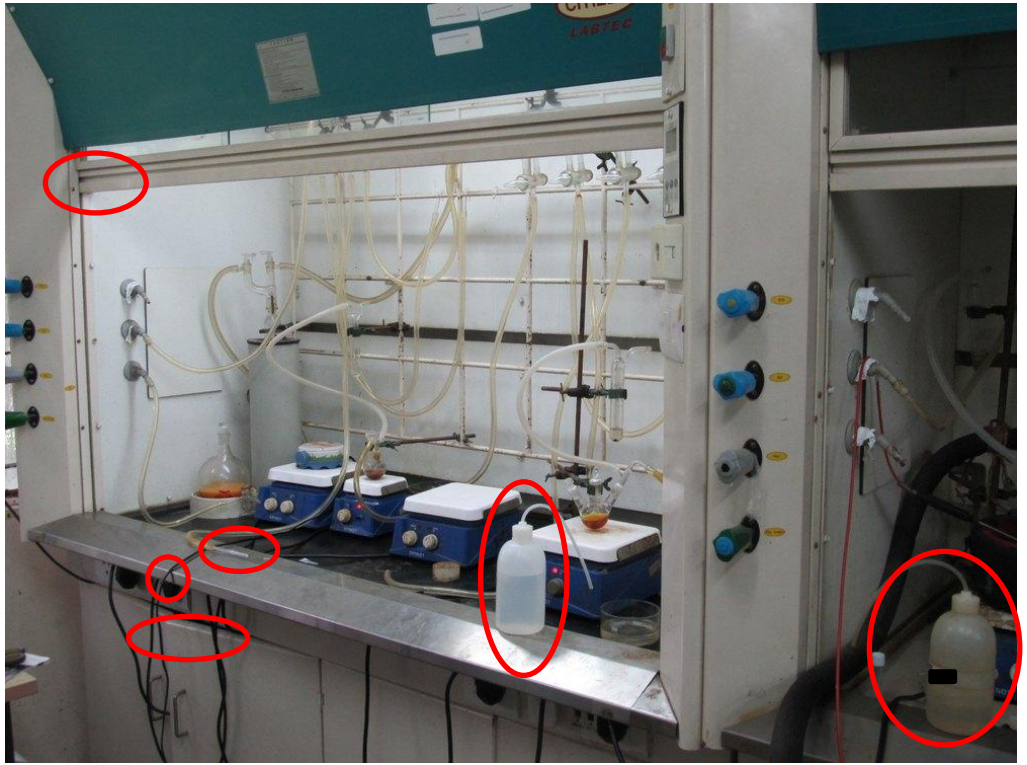
Real-World unsafe fume hood:

Can you find the issues with this hood

American Chemical Society (ACS) Safety Program, as reported in various institutional EHS reviews.

Practical issues in Labs

Real-World unsafe fume hood:
The 6 issues with this hood



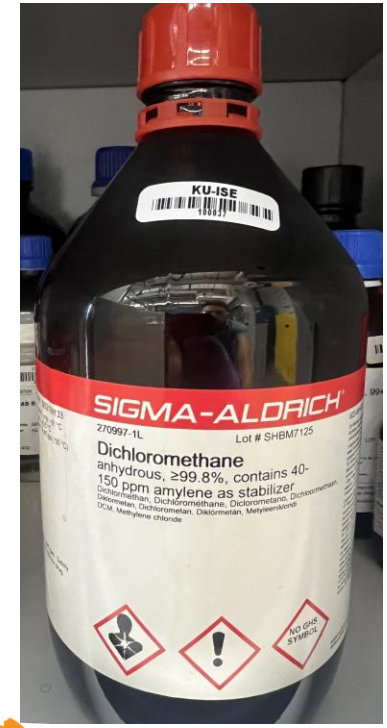
Why Safety is Essential

- Labs have *chemical* and *physical* hazards.
- Small mistakes → Big consequences (injury, lost research, lab shutdowns).
- Example: Leaving lab doors unlocked = huge security/safety risk.
- Example: Chemicals stored incorrectly

Strong safety = Better science!

Lab Upkeep and Respect: a quick reminder

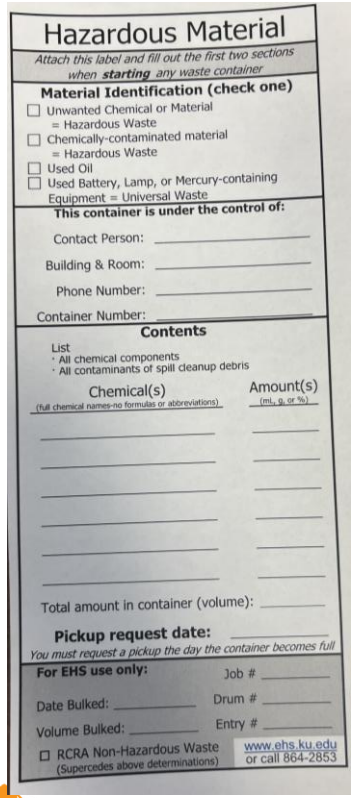
- Clean workspace = safe workspace



- Label everything clearly (samples, reagents, waste)
  - Samples are labeled to your lab notebooks along with the date.
  - TJP123 1-1-25
  - Reagents are labeled on the bottles if you make your own smaller sample, be sure to include chemical name, CAS number, and date you made the reagent.
  - New chemicals added to the online system with barcode: during this stage is when to find out where to store the chemical!

EARTH

Lab Upkeep and Respect: a quick reminder



Hazardous Material

*Attach this label and fill out the first two sections when **starting** any waste container*

Material Identification (check one)

- ☐ Unwanted Chemical or Material = Hazardous Waste
- ☐ Chemically-contaminated material = Hazardous Waste
- ☐ Used Oil
- ☐ Used Battery, Lamp, or Mercury-containing Equipment = Universal Waste

This container is under the control of:

Contact Person: _____

Building & Room: _____

Phone Number: _____

Container Number: _____

Contents

List
- All chemical components
- All contaminants of spill cleanup debris

Chemical(s) (full chemical names-no formulas or abbreviations)	Amount(s) (ml, g, or %)

Total amount in container (volume): _____

Pickup request date: _____

You must request a pickup the day the container becomes full

For EHS use only:

Job # _____

Date Bulked: _____ Drum # _____

Volume Bulked: _____ Entry # _____

☐ RCRA Non-Hazardous Waste (Supercedes above determinations)

www.ehs.ku.edu or call 864-2853

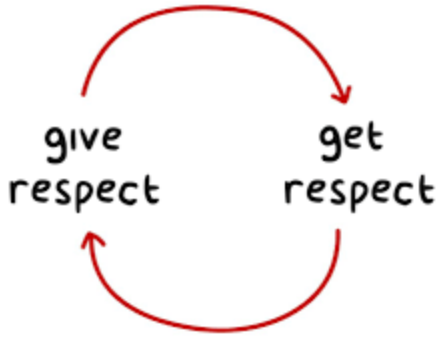
- Clean workspace = safe workspace

- Label everything clearly (samples, reagents, waste)
  - Samples are labeled to your lab notebooks along with the date.
  - TJP123 1-1-25
  - Reagents are labeled on the bottles if you make your own smaller sample of it be sure to include chemical name, CAS number, and date you made the reagent.

  - Waste should be labeled with the Hazardous Materials forms found on EHS KU

EARTH

Lab Upkeep and Respect:



- Clean workspace = safe workspace

- Label everything clearly (samples, reagents, waste)
  - Samples are labeled to your lab notebooks along with the date.
  - TJP123 1-1-25
  - Reagents are labeled on the bottles if you make your own smaller sample of it be sure to include chemical name, CAS number, and date you made the reagent.
  - Waste should be labeled with the Hazardous Materials forms found on EHS KU
  - Finally Respect the shared spaces, instruments and people

EARTH

Lab Upkeep and Respect: a quick reminder

- **SOPs are key:** A recipe for your experiment — follow them precisely and carefully
- "Over 90% of chemical lab injuries could be prevented through proper use of PPE, engineering controls, and adherence to SOPs"

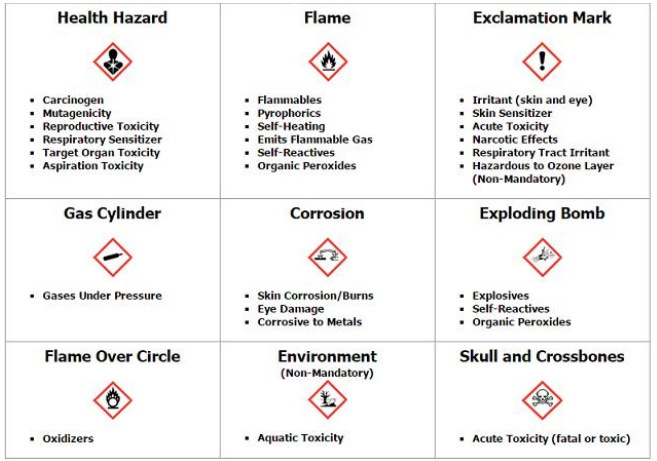
Hazards Analysis and Method Selection Guidelines

Level or Review & Checklists Required*	Minimal	Low	Moderate	High
Materials and Products				
HMIS- Flammability (Volume <1L)	☒ 0-1	☐ 2-4		
HMIS- Flammability (Volume ≥1L)	☐ 0	☐ 1-2	☐ 3-4	
HMIS- Flammability (Volume ≥1L) under pressure or above flashpoint	☐ 0		☐ 1	☐ 2-4
HMIS- Reactivity	☐ 1	☐ 2	☒ 3-4	
HMIS- Health	☐ 0	☒ 1-2	☐ 3	☐ 4
Capable of Generating of Strong Odors	☒ No		☐ Yes	
Biological Materials	☒ No	☐ Yes		
HIGH OR LOW TEMPERATURES – SURFACE	☐ > -30°C (-20°F) or <60°C (140°F)		☒ < -30°C (-20°F) or >60°C (140°F)	
HIGH OR LOW TEMPERATURES – INTERNAL TEMPERATURE OR EXOTHERMIC REACTION	☐ <60°C (140°F)		☒ >60°C (140°F) or reaction boiling	
EQUIPMENT UNDER PRESSURE/VACUUM	☐ Atmospheric Pressure	☐ Vacuum and 0-40 PSIG pressure for shielded glassware; rated vessels	☒ Unshielded glassware; non-rated vessels; >40 PSIG	
GASES- flammable, toxic, corrosive			☒ Yes	
GASES		☒ In Cylinder closet/hood	☐ Outside cylinder closet	
ELECTRICAL- Voltage	☐ < 110V	☒ 110-120V	☐ 208-220 V Protected	☐ >220V Protected
MECHANICAL MOTION			☐ Yes	
VENTILATION REQUIRED-fume hood		☒ Yes		
COMPUTER AND AUTOMATED CONTROL SYSTEMS	☒ No		☐ Yes	
WORKING ALONE			☒ Yes	
UNATTENDED EXPERIMENTS- with proper interlock/safety system			☐ Yes, minimal hazard	☒ Yes > minimal hazard
LABORATORY ERGONOMICS		☐ Repetitive motion >4 hours/day or awkward height/posture		
NOISE LEVEL/NOISE CONTROL	☒ <85 dBA		☐ ≥85 dBA	
IONIZING RADIATION – SEALED RADIOACTIVE SOURCES	☒ No		☐ Yes	
IONIZING RADIATION – UNSEALED RADIOACTIVE MATERIALS	☒ No		☐ Yes	
IONIZING RADIATION – X-RAY	☒ No	☐ <20 kv	☐ ≥20 kv	
NON-IONIZING RADIATION – INFRARED, MICROWAVE, RADIO, ULTRAVIOLET	☒ No	☐ <TLV	☐ ≥TLV	
NON-IONIZING RADIATION – LASERS	☒ No	☐ Class I - IIIA	☐ Class IIIB - IV	
NOVELTY- New Technology		☒ First time running experiment		☐ Unknown reactions
LEVEL OF REVIEW: Complete EHS Hazard Review Document if Moderate or High Risk	☐ Minimal	☐ Low	☐ Moderate	☒ High

*__Minimal:__ Student with Student; __Low:__ Student with Advisor; __Moderate:__ Student with Advisor + Technical Expert(s); __High:__ Student with Advisor + Technical Expert(s) + Safety Resource with hazard experience.

Lab Upkeep and Respect: a quick reminder

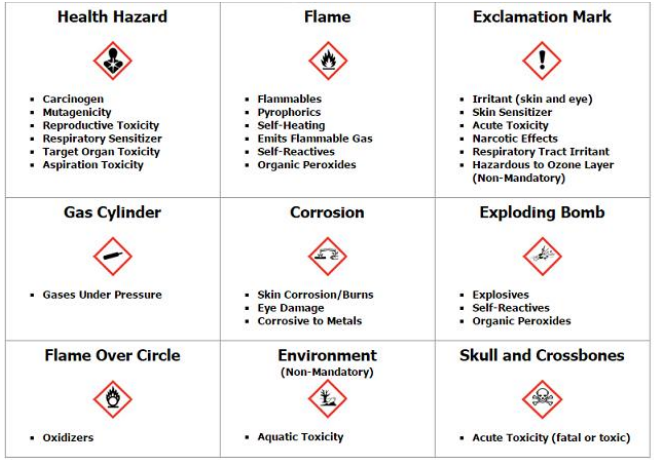
- PPE – Always safety specs, long trousers, closed toed shoes
- “Improper glove use contributes to over 30% of lab-acquired chemical exposure cases”[1]
- Only 62% of chemical engineering students consistently wear full PPE during lab experiments.[2]
- NO PPE outside of labs – gloves, coats etc



1) Journal of Chemical Health & Safety (2012), “Chemical Exposure Incidents in Laboratories: Causes and Prevention
2) AIChE Education Division Survey (2019)

Lab Upkeep and Respect: a quick reminder

- PPE – Always safety specs, long trousers, closed toed shoes
- Know emergency equipment locations:
  - Safety showers, eyewashes, fire extinguishers (site-specific locations).
- Understand your chemicals (read SDS) BEFORE beginning research!
- Get trained before using specialized equipment.



Chemical Handling and Transport

- Use secondary containment
- Avoid transporting open containers!
- Never rush with hazardous materials
- Emphasize planning ahead

EARTH

Storage of Chemicals: compatability

General key points

- Acids and bases Need to be in different cupboards!
- Organic materials and inorganic materials should be stored separately
- All compounds should be stored in ventilated areas (like we do in our labs)

Chemical Compatability

- Store chemicals under the correct and safe environment!

- Real world example
- Yuniva: Chlorotrimethylsilane SDS
- Where would you open this bottle?

Acute toxicity (Inhalation)	:	Category 3
Acute toxicity (Dermal)	:	Category 4
Skin corrosion	:	Category 1A
Serious eye damage	:	Category 1

Other hazards

Reacts violently with water.

GHS label elements

Hazard pictograms :

Signal Word	:	Danger
Hazard Statements	:	H225 Highly flammable liquid and vapor. H301 + H331 Toxic if swallowed or if inhaled. H312 Harmful in contact with skin. H314 Causes severe skin burns and eye damage.

EARTH

Chemical Compatability

- Store chemicals under the correct and safe environment!
- Yuniva: Chlorotrimethylsilane: needs sure/seal to be stored under ‘air’
- Bottle open to environment = store in glovebox

Acute toxicity (Inhalation)	:	Category 3
Acute toxicity (Dermal)	:	Category 4
Skin corrosion	:	Category 1A
Serious eye damage	:	Category 1

Other hazards
Reacts violently with water.

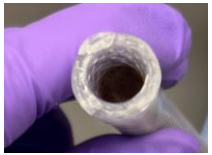
GHS label elements

Hazard pictograms :

Signal Word	:	Danger
Hazard Statements	:	H225 Highly flammable liquid and vapor. H301 + H331 Toxic if swallowed or if inhaled. H312 Harmful in contact with skin. H314 Causes severe skin burns and eye damage.

EARTH

Chemical Compatability



- **Equipment**

  Always verify tubing compatibility with the chemicals in use.

  Compatibility charts are **guidelines**, not guarantees.

  Long-term exposure can degrade “compatible” materials.

  Real-world example: acid-resistant tubing failure on Schlenk line.

  PTFE (Tygon) tubing offers better resistance, but still degrades over time.

  Regular inspection and replacement are essential.

1: excellent; 2: good; 3: fair; 4: not recommended

Name	Tygon LFL	Tygon ST R-3603	PharMed	Tygon HC F-4040-A	Tygon MH 2075	Tygon SI Silicone Platinum	Silicone Peroxide	Norprene A-60-G	Flurane F-5500-A (Viton)
Stannous Chloride, 45% in w	1	1	1	1	1	1	1	1	1
Stearic Acid, 5% in alc	4	4	3	2	3	2	2	3	1
Styrene Monomer	4	4	4	4	4	4	4	4	3
Sulfur Chloride	4	4	4	4	1	4	4	4	1
Sulfur Dioxide, Dry Gas	1	1	1	2	1	1	1	1	1
Sulfur Dioxide, Wet Gas	1	1	1	2	1	1	1	1	1
Sulfur Trioxide, Wet	2	2	2	4	2	2	2	2	2
Sulfuric Acid, 10% in w	1	1	1	1	1	1	1	1	1
Sulfuric Acid, 30% in w	1	1	1	2	1	2	2	1	1
Sulfuric Acid, 95-98% in w	4	4	4	4	1	4	4	4	1

EARTH

Waste Streams and Chemical Compatibility

Waste Streams and Chemical Compatibility

General Waste Handling Principles

Label everything clearly (contents, hazards, dates) following EHS guidelines

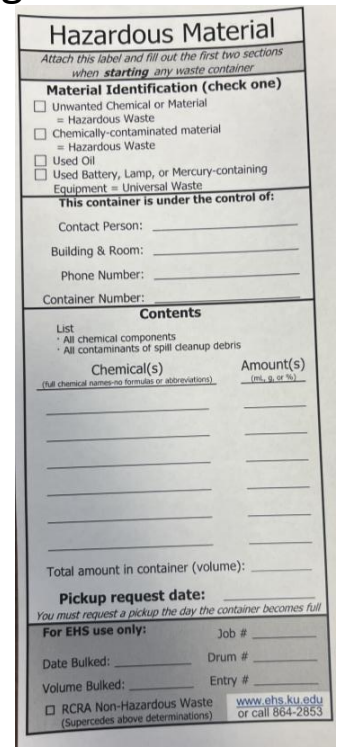
Segregate waste by type

solid, aqueous, organic, halogenated organic, special waste

Keep containers closed when not in use

NEVER mix incompatible chemicals

eg: nitric acid (oxidizer) with acetone (organic solvent)



Hazardous Material

*Attach this label and fill out the first two sections when **starting** any waste container*

Material Identification (check one)

- ☐ Unwanted Chemical or Material = Hazardous Waste
- ☐ Chemically-contaminated material = Hazardous Waste
- ☐ Used Oil
- ☐ Used Battery, Lamp, or Mercury-containing Equipment = Universal Waste

This container is under the control of:

Contact Person: _____

Building & Room: _____

Phone Number: _____

Container Number: _____

Contents

List
- All chemical components
- All contaminants of spill cleanup debris

Chemical(s) (full chemical names-no formulas or abbreviations)	Amount(s) (mL, g, or %)

Total amount in container (volume): _____

Pickup request date: _____

You must request a pickup the day the container becomes full

For EHS use only:

Job # _____

Date Bulked: _____ Drum # _____

Volume Bulked: _____ Entry # _____

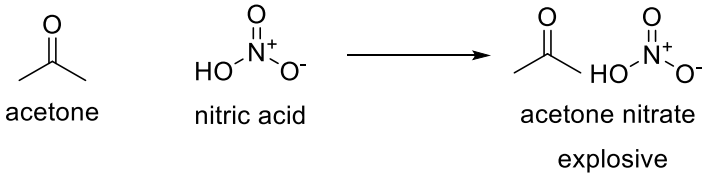
☐ RCRA Non-Hazardous Waste (Supercedes above determinations)

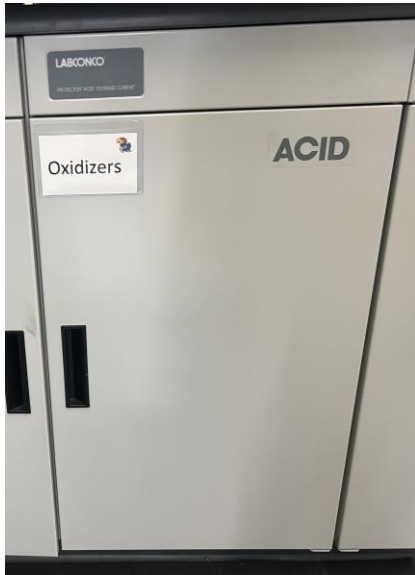
www.ehs.ku.edu or call 864-2853

Waste Streams and Chemical Compatibility

General Waste Handling Principles

- Label everything clearly (contents, hazards, dates) following EHS guidelines
- Segregate waste by type
  - solid, aqueous, organic, halogenated organic, special waste
- Keep containers closed when not in use
- NEVER mix incompatible chemicals
  - eg: nitric acid (oxidizer) with acetone (organic solvent)

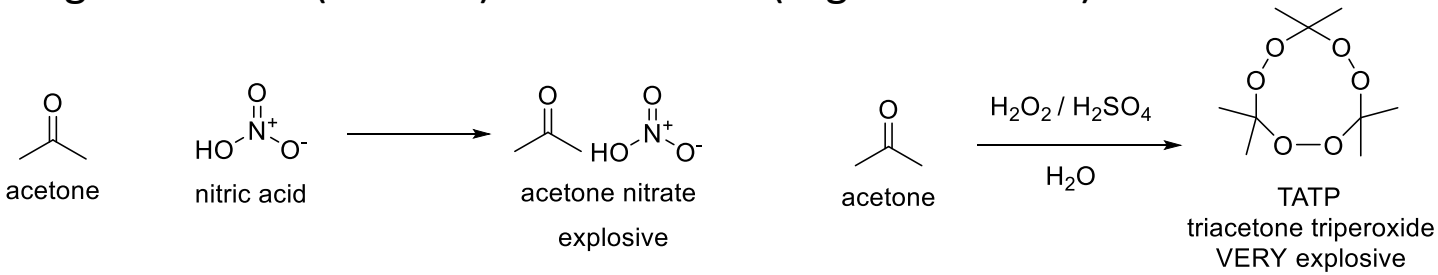




Waste Streams and Chemical Compatibility

General Waste Handling Principles

- Label everything clearly (contents, hazards, dates) following EHS guidelines
- Segregate waste by type
  - solid, aqueous, organic, halogenated organic, special waste
- Keep containers closed when not in use
- NEVER mix incompatible chemicals
  - eg: nitric acid (oxidizer) with acetone (organic solvent)



Waste Streams and Chemical Compatibility

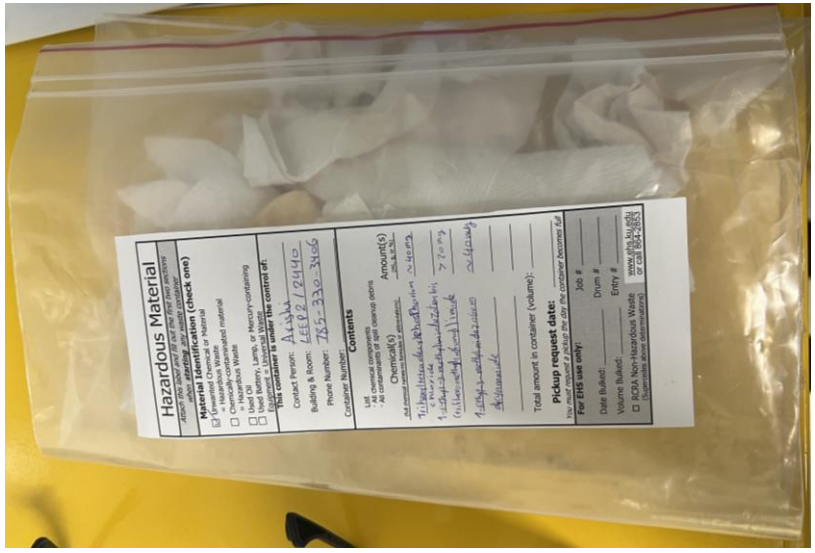
Solid Chemical Waste

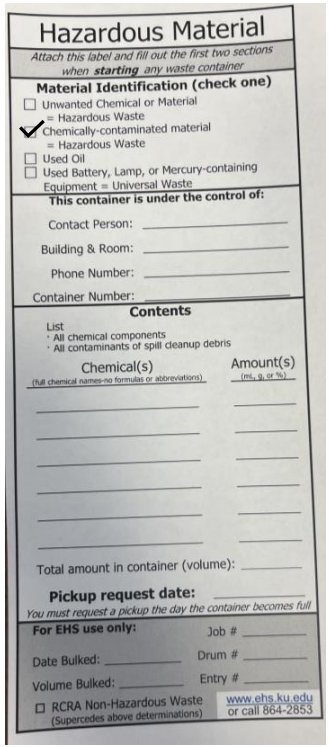
e.g.: contaminated gloves, paper towels, solid reagents

Do NOT throw in general trash bins

Collect into designated solid waste containers and label well

Avoid free liquids in solid waste





Hazardous Material

*Attach this label and fill out the first two sections when **starting** any waste container*

Material Identification (check one)

- ☐ Unwanted Chemical or Material = Hazardous Waste
- ☑ Chemically-contaminated material = Hazardous Waste
- ☐ Used Oil
- ☐ Used Battery, Lamp, or Mercury-containing Equipment = Universal Waste

This container is under the control of:

Contact Person: _____

Building & Room: _____

Phone Number: _____

Container Number: _____

Contents

List
- All chemical components
- All contaminants of spill cleanup debris

Chemical(s) (full chemical names-no formulas or abbreviations)	Amount(s) (mL, g, or %)

Total amount in container (volume): _____

Pickup request date: _____

You must request a pickup the day the container becomes full

For EHS use only:

Job # _____

Date Bulked: _____ Drum # _____

Volume Bulked: _____ Entry # _____

☐ RCRA Non-Hazardous Waste (Supercedes above determinations)

www.ehs.ku.edu or call 864-2853

Waste Streams and Chemical Compatibility

Aqueous Chemical Waste

Water-base solutions without organics or heavy metals

Neutralize acids/bases if possible (I do my best with my superacids)

Collect in labeled containers with EHS tag

Check pH before disposal making it as neutral as possible

EARTH

Waste Streams and Chemical Compatibility

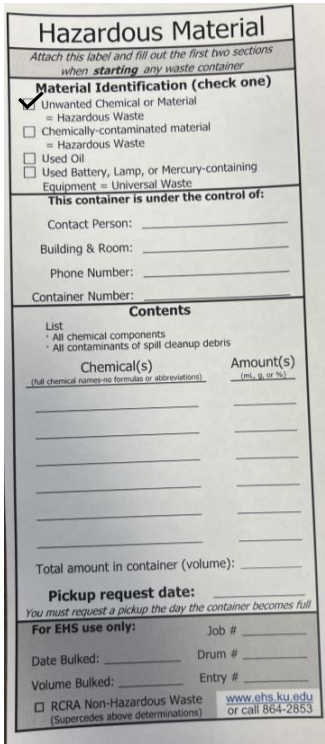
Organic Solvent Waste

e.g. acetone, ethanol, hexane, octane, methanol

Collect in compatible containers (use empty solvent containers as waste containers when possible)

Keep halogenated and non-halogenated separate

Store in flammable cabinets or within fume hoods


Hazardous Material

*Attach this label and fill out the first two sections when **starting** any waste container*

Material Identification (check one)

- ☑ Unwanted Chemical or Material = Hazardous Waste
- ☐ Chemically-contaminated material = Hazardous Waste
- ☐ Used Oil
- ☐ Used Battery, Lamp, or Mercury-containing Equipment = Universal Waste

This container is under the control of:

Contact Person: _____

Building & Room: _____

Phone Number: _____

Container Number: _____

Contents

List
- All chemical components
- All contaminants of spill cleanup debris

Chemical(s) (full chemical names-no formulas or abbreviations)	Amount(s) (mL, g, or %)

Total amount in container (volume): _____

Pickup request date: _____

You must request a pickup the day the container becomes full

For EHS use only:

Job # _____

Date Bulked: _____ Drum # _____

Volume Bulked: _____ Entry # _____

☐ RCRA Non-Hazardous Waste (Supercedes above determinations)

www.ehs.ku.edu or call 864-2853

EARTH

Waste Streams and Chemical Compatibility

Halogenated Organic Waste

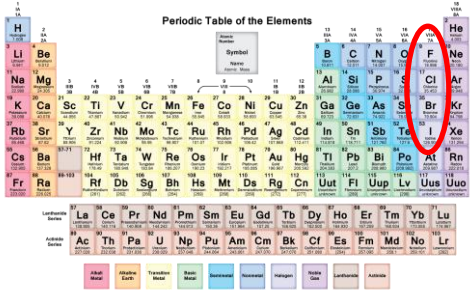
e.g. chloroform, dichloromethane, PFAS

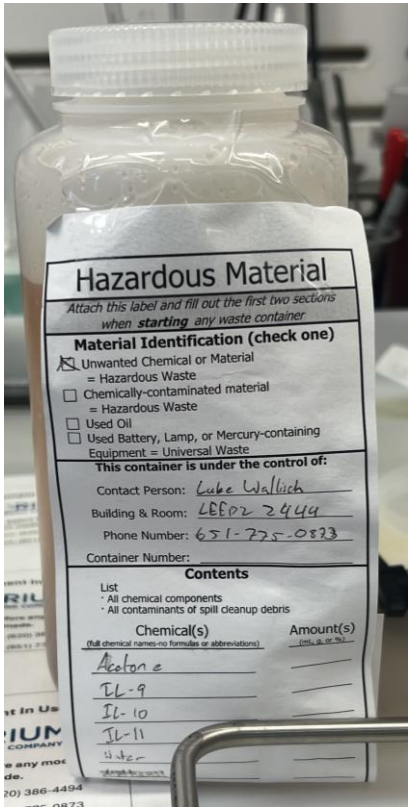
F, Cl, Br, I = halogens. IF the molecule has one of these then it is halogenated

Toxic and environmentally persistent

segregate as best as possible from non-halogenated organics

waste is delt with via incineration by license vendor

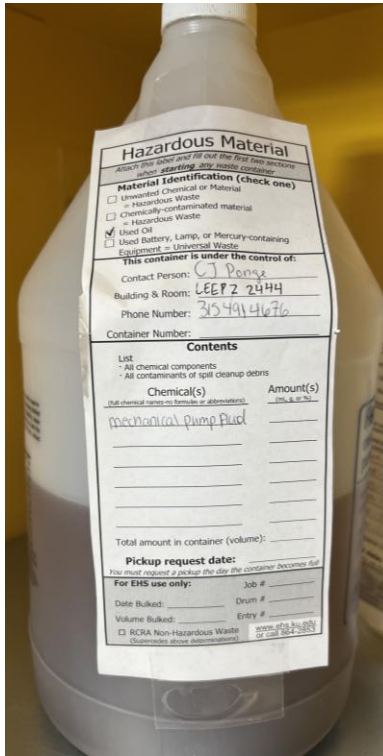




Waste Streams and Chemical Compatibility

Special Waste Categories

- Heavy metal solutions (e.g. chromium, mercury, palladium, platinum)
- Peroxide-forming chemicals
- Air- or moisture-sensitive residues
- Oil pump liquid
- Sharps
- Broken glass



Responding to Incidents: Hazards

- Mistakes happen – your response matters
- Steps:
  - Stay calm.
  - Inform your mentor/supervisor.
  - Follow emergency protocols.
  - Never cover up an incident!
- Incidents = Opportunities for lab improvement.

EARTH

Real-World Case Studies

- Chiller Leak:
  ➔ Minor spill → Proper cleanup with spill kit → Safe disposal.
- Chemical Splash:
  ➔ Missing PPE → Minor injury + lab shutdown.

EARTH

Real-World Case Studies

When & Where: May 2019, University of Utah undergraduate lab

- **What Happened:** Student carried a beaker of sodium hydroxide; a small splash landed in his eye
- **Immediate Response:**
  - Lab was shut down
  - Spill cleaned up
  - Eyewash station inspected
  - Formal incident investigation launched
- **Outcome:**
  - Minor chemical burn only
  - Lab-wide PPE refresher and renewed emphasis on eye protection

EARTH

https://www.sltrib.com/news/education/2019/05/14/student-burned-his-eye.com

Real-World Case Studies

- **Scenario:** Student used a base bath (alcohol + strong base) on an open bench, added hot organic residues
- **What Went Wrong:** Heated vapors ignited, starting a fire
- **Immediate Response:** Fire blanket proved insufficient → student evacuated safely
- **Damage:** No injuries, but lab flooded with extinguishing water → full refurbishment required

EARTH

Real-World Case Studies

Root Causes

•Working unsupervised during off-hours
•Base bath placed on bench instead of in a fume hood
•Lack of strict “no weekend” or “unsupervised” protocols

Key Safety Lessons

1.No Unsupervised Experiments

1. Enforce strict access rules for nights/weekends

1.Contain Hazards in Fume Hoods

1. Base baths and heated organics **always** under proper ventilation

2.Follow SOPs Rigorously

1. Detailed written procedures for high-risk operations

3.Enhanced Training & Enforcement

1. Regular safety refreshers and audits, especially for off-hour work

Takeaway: Proper supervision, containment, and protocol adherence prevent small mistakes from becoming lab-wide disasters

EARTH

https://news.st-andrews.ac.uk/archive/anatomy-of-a-fire/

Safety is a Team Effort

- Safety = Teamwork: Watch out for each other.
- Leadership = Responsibility: Speak up even when it’s uncomfortable.
- Learning = Asking Questions: Always ask if unsure!
- Ultimately being safe is YOUR responsibility! Do NOT do any work you feel is dangerous, ask any supervisors for assistance when needed

EARTH

Questions?

Sign In Here!

- Your voice matters in building a safer laboratory!

- Please ask any questions you may have

EARTH

References

1) *American Chemical Society (ACS) Safety Program*, as reported in various institutional EHS reviews.

2) Occupational Safety and Health Administration (OSHA) Laboratory Standard (29 CFR 1910.1450) – Interpretive Guidance

3) Journal of Chemical Health & Safety (2012), “Chemical Exposure Incidents in Laboratories: Causes and Prevention

4) AIChE Education Division Survey (2019)

5) https://www.sltrib.com/news/education/2019/05/14/student-burned-his-eye.com

6) https://news.st-andrews.ac.uk/archive/anatomy-of-a-fire/

EARTH