Research Lab Safety: Hazard Evaluation and Heuristics

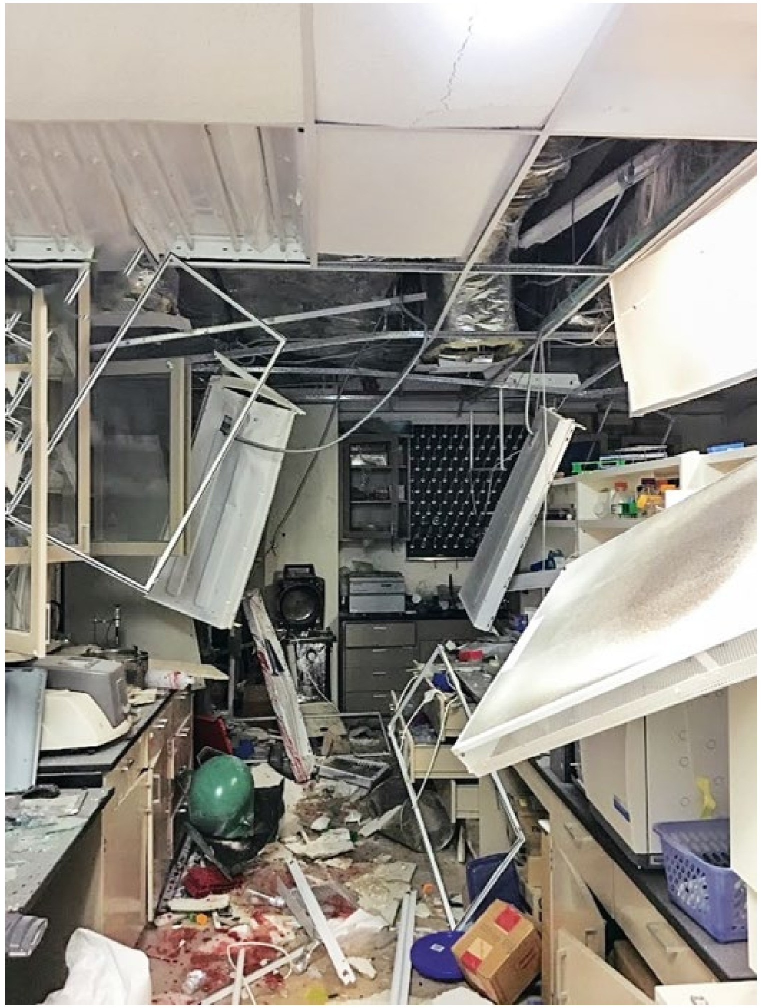
ENVIRONMENTAL HEALTH & SAFETY

Overview

1. Why we care about lab safety
2. Brief review of Hazard Communication and Hazard Controls
3. How to evaluate a hazard
4. Preparing SOPs that reflect hazards
5. How it can break down
6. What to do if something goes wrong

Lab Accidents in University Research Labs

- 1997 Dartmouth – Professor experimenting with methyl mercury absorbs compound through glove and dies of mercury poisoning
- 2008 UCLA – Post-Bac researcher died of injuries sustained while working with a pyrophoric liquid in laboratory
- 2010 Texas Tech – Graduate student lost 3 fingers, had permanent eye damage, and sustained burns when compound he was working with exploded
- 2016 U of Hawaii – Postdoc lost arm and sustained burns when a compressed hydrogen oxygen mixture was ignited by a static spark



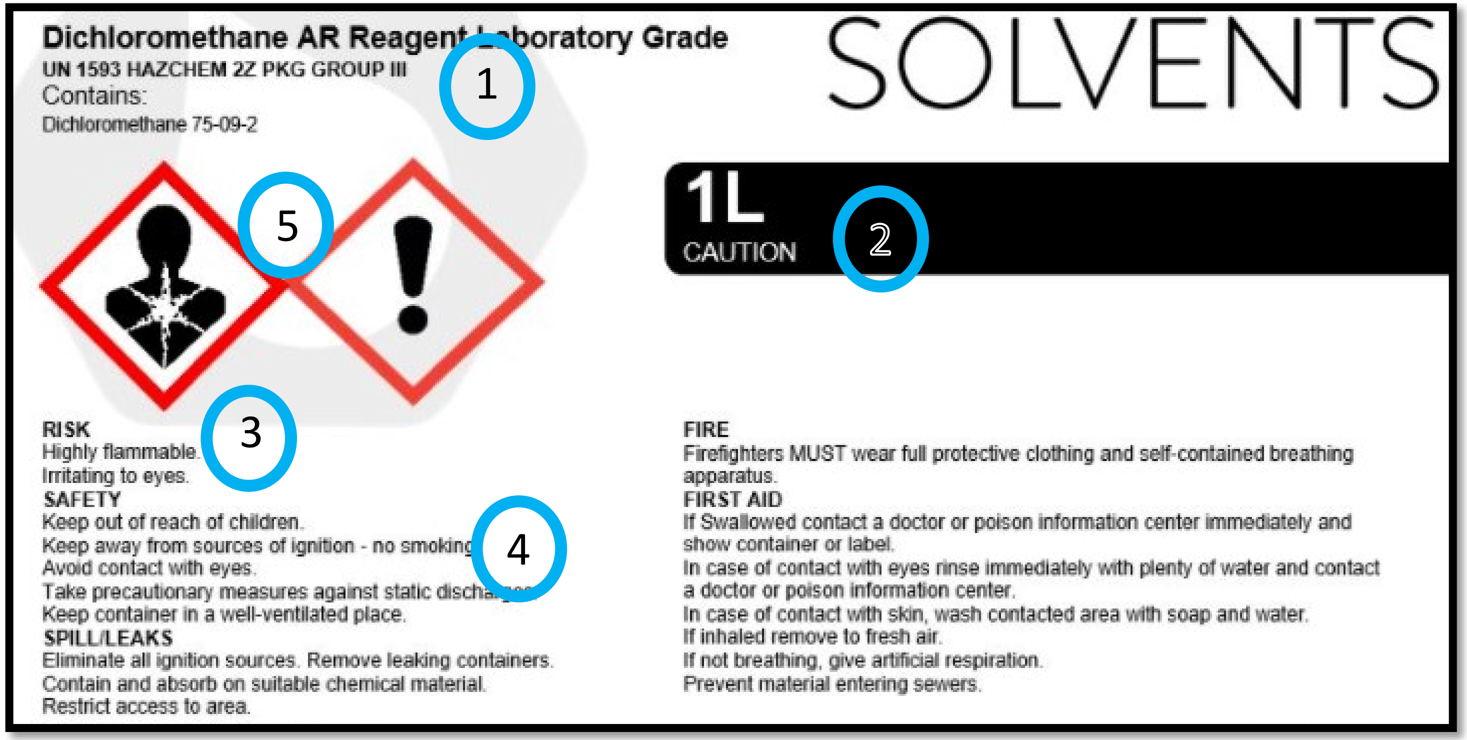
What do these accidents have in common?

- There was **no formal hazard evaluation**, i.e. written documentation, such as SOPs or JHAs.
- There was **insufficient training** or knowledge about the hazards.
- Previous near-misses were neither recorded nor learned from.
- In 3 out of 4 incidents, the *physical* hazards of the chemicals were not identified.

How to Identify Hazards of Chemicals – Read the Label

OHSA's Hazard Communication Standard requires manufacturers of hazardous chemicals to label their product with information that communicates the hazards:

1. Product identifier (name of chemical)
2. Signal word (such as "danger/warning/precaution")
3. Hazard statement(s)
4. Precautionary statement(s)
5. Pictogram(s)



Chemical Hazard Symbols/Pictograms

1. Explosive
2. Flammable
3. Oxidizer
4. Compressed Gas
5. Corrosive
6. Toxic
7. Irritant/Sensitizer or Acute toxicity or narcotic effect
8. Health Hazard
9. Dangerous for Environment

How to Identify Hazards of Chemicals – Read the SDS

Section 2 of all SDSs contains more detailed information on the hazards of a chemical.

***NOTE* The GHS categories are as such:**

Category 1 = Severe Hazard

Category 2 = Serious Hazard

Category 3 = Moderate Hazard

Category 4 = Slight Hazard

Category 5 = Minimal Hazard

SECTION 2: Hazards identification

2.1 Classification of the substance or mixture

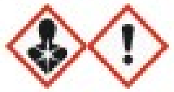
GHS Classification in accordance with 29 CFR 1910 (OSHA HCS)

Skin irritation (Category 2), H315
Eye irritation (Category 2A), H319
Carcinogenicity (Category 2), H351
Specific target organ toxicity - single exposure (Category 3), Central nervous system, H336

For the full text of the H-Statements mentioned in this Section, see Section 16.

2.2 GHS Label elements, including precautionary statements

Pictogram



Signal word Warning

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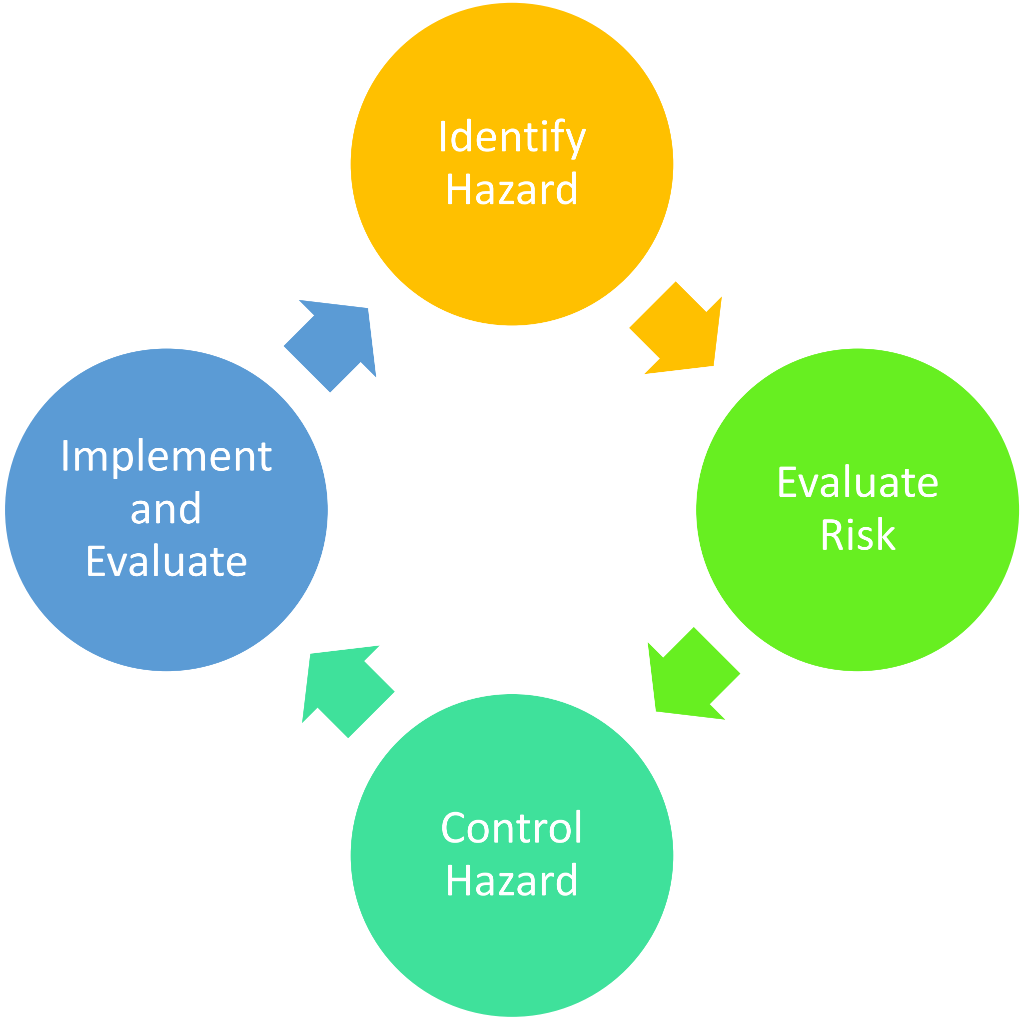
The life science business of Merck KGaA, Darmstadt, Germany operates as MilliporeSigma in the US and Canada

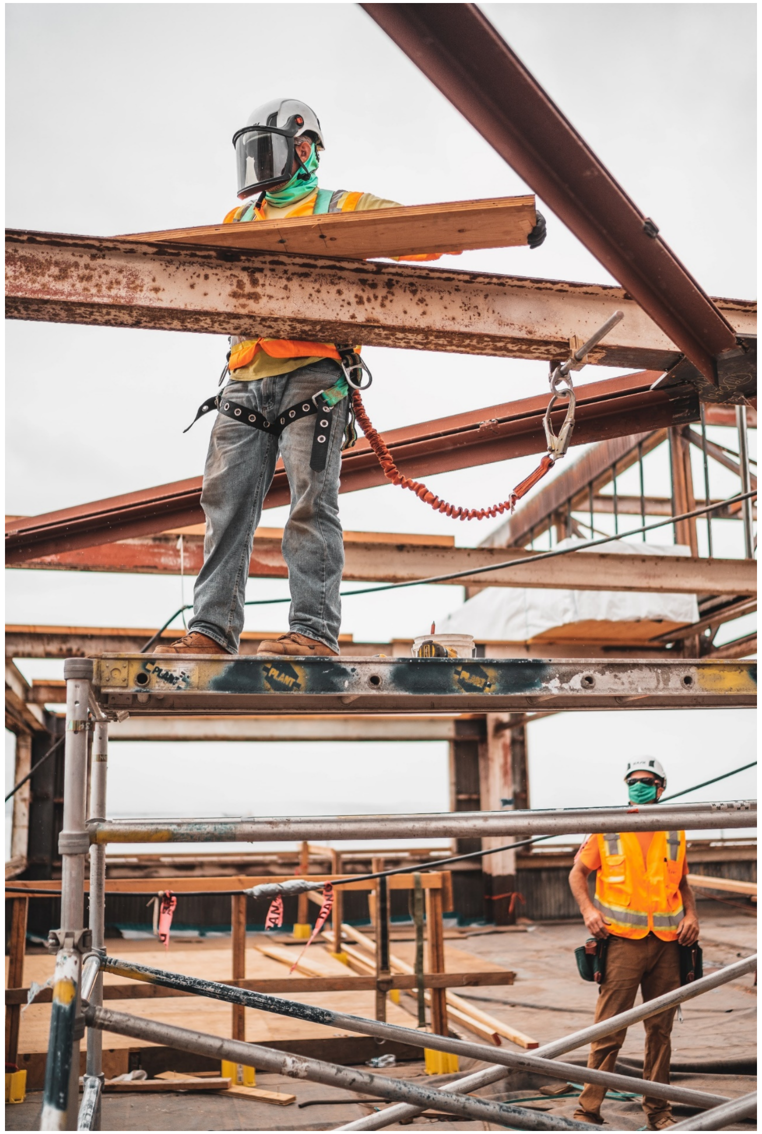
MilliporeSigma

Hazard Control Overview



How do you evaluate risk?

- Risk
  - Likelihood
  - Consequence
  - Unknowns



Example

You are a biologist working above the tree line during monsoon season. What is your risk?

What steps can you take to mitigate this risk/control this hazard?

Controlling Hazards

Hazards: Lightening & Flooding

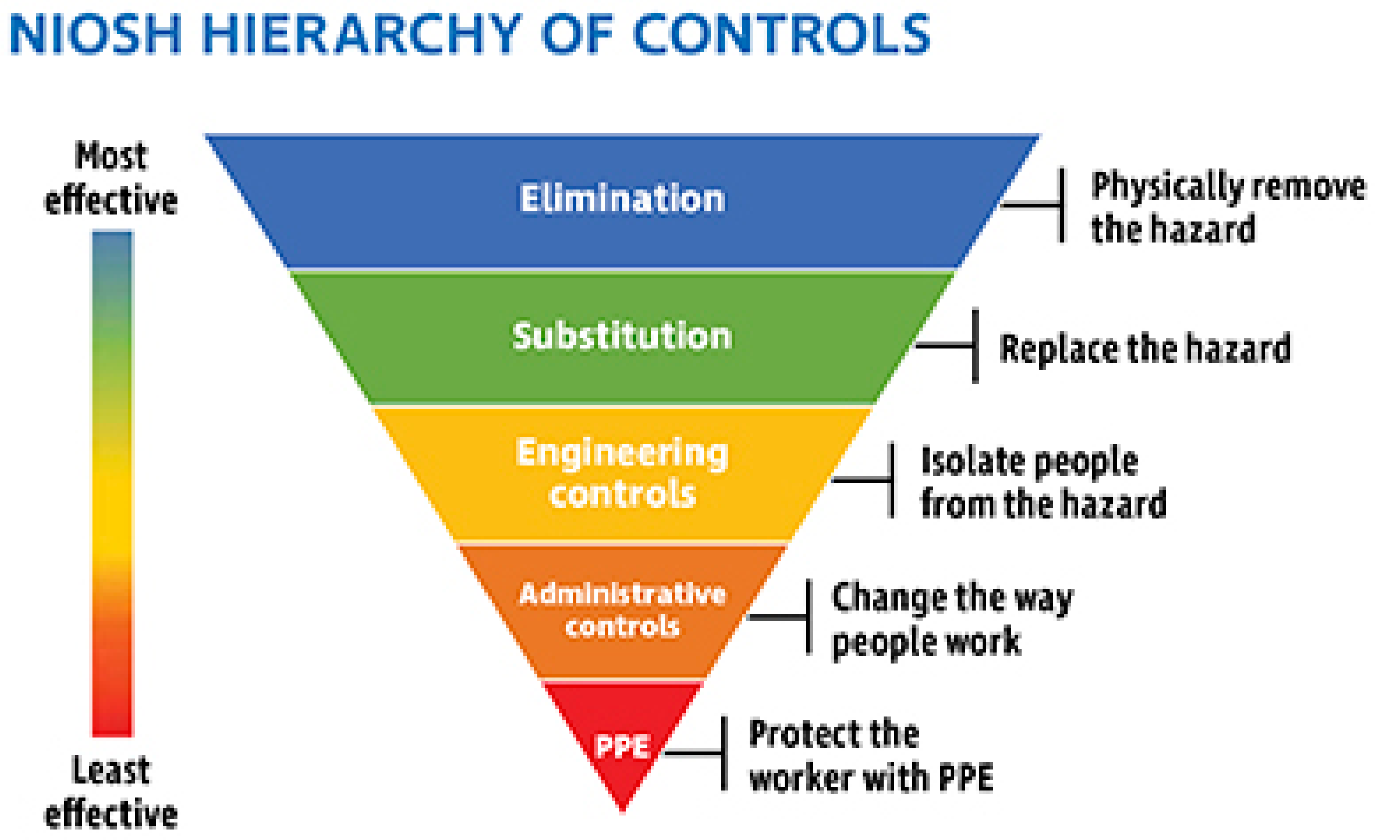
Can we eliminate them? No

Is there a suitable substitute? Not applicable

Can we isolate ourself from the hazards? Yes, we can move to a location where the risk of lightening and flooding are lower

Can we change the way this research is conducted? Yes, we can alter our work schedule so that we aren't working during monsoon season.

Will PPE protect us from the hazards? No



Hazard Control Example

You are using HPLC to measure different sterols extracted from corals. The HPLC protocol calls for the use of dichloromethane as an eluent.

What are the hazards?

What are the risks?

Hazards:

- Central nervous system toxin
- May cause organ damage through prolonged exposure

Risks:

- If you conduct the HPLC process regularly, your risk of exposure will rise.

Hazard Control Example

Elimination –

Substitution –

Engineering Controls –

Administrative Controls –

PPE –

Hazard Control Example

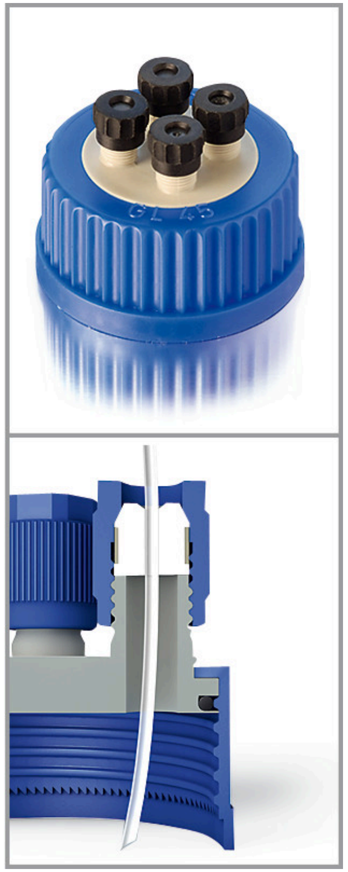
Elimination – Probably not possible. A solvent required for elution off-column.

Substitution – Some substitute solvents that are less toxic are available. Worth investigating.

Engineering Controls – Open only in a fume hood. Use lid with small tubing to keep bottle sealed.

Administrative Controls – Written standard operating procedures and spill clean-up protocols in place.

PPE – Gloves, goggles, lab coat.



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Hazard Control *Essential* -- SOPs

- **A Standard Operating Procedure (SOP) is a set of written instructions that document a routine or repetitive activity followed by an organization.**
- **SOPs should be prepared by individuals with expert knowledge of the process or activity (the PI, lab manager or supervisor).**
- **SOPs should be written in a concise, step-by-step, easy to read format.**
- **A good SOP will include a Job Hazard Analysis (JHA).**

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Standard Operating Procedures (SOP) for Using Benzene

Benzene Use SOP	
1. Process (if applicable)	Injections of benzene standards for gas chromatograph calibrations and sample analyses. **Note:** *All use of benzene is strictly regulated by OSHA (29 CFR 1910.1028).*
2. Chemical(s)	Benzene, at known and unknown concentrations.
3. Engineering & Administrative Controls	Benzene-containing solutions should be dispensed and used only in a properly operating fume hood. Syringe purging should also be done in the fume hood.
4. Personal Protective Equipment (PPE)	Chemical splash goggles, butyl or natural rubber gloves, and a lab coat or apron is required.
5. Special Handling Procedures & Storage Requirements	Mixing and dispensing done in fume hood with all sources of ignition turned off (hot plates, burners, etc.). Benzene stored in metal safety cans or glass bottles (4 liter maximum). Transported in spill-proof carriers. Benzene is stored in a flammables cabinet, separate from acids, bases, and oxidizers. The flammables cabinet is located _______________.
6. Spill & Accident Procedures	For small benzene spills (<1L): Turn on and open fume hood. Close lab door. Remove/turn off all sources of ignition in the spill area. Locate spill kit. Use absorbent pads from spill kit to absorb spill. For benzene spills >1L or beyond lab staff capabilities: evacuate lab and call UNM PD (277-2241) and SRS (277-2753). For benzene contact with eyes: immediately flush eyes in eyewash station for at least 15 minutes. For benzene contact with skin: immediately wash skin with soap and water and remove any contaminated apparel. After clean-up, room air must be monitored by SRS prior to re-occupancy.
7. Waste Disposal	For spills: double-bag used absorbent pads, label as "Hazardous Waste,

SOPs + JHAs = Ideal

A JHA is an exercise in detective work in which the goal is to determine:

1. **What can go wrong?**
2. **What are the consequences?**
3. **How could it arise?**
4. **Contributing factors?**
5. **Likelihood hazard will occur?**

Once identified, hazards can be eliminated or mitigated with engineering and administrative controls.

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Enter information electronically in shaded areas, name Word document file, and save to device.
Or print document to enter information manually.

Job Hazard Analysis

Name of Lab:	**Department:** Click to enter text.
Activity or Process: Click to enter text.	**Building/Room:** Click to enter text.
Job Title: Click to enter text.	**Supervisor:** Click to enter text.
Prepared By: Click to enter text.	**Date:** Click to enter a date.

This document is the certification of hazard assessment for PPE for the workplace.

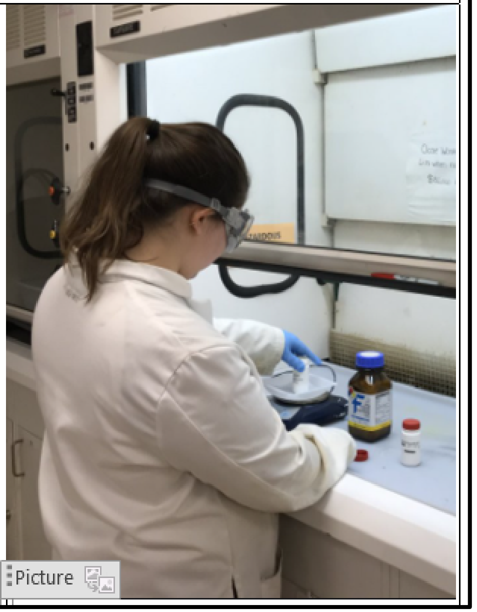
TASKS/STEPS	HAZARDS - CONSEQUENCES	CONTROLS (SAFEGUARDS)	PHOTO
1 Click to add first task/step.	• Click to add a hazard and consequence. • Click to add a hazard and consequence. • Click to add a hazard and consequence.	• Click to add a control. • Click to add a control. • Click to add a control. • Click to add a control. • Click to add a control. • Click to add a control. • Click to add a control.	
2 Click to add second task/step.	• Click to add a hazard and consequence. • Click to add a hazard and consequence. • Click to add a hazard and consequence.	• Click to add a control. • Click to add a control. • Click to add a control. • Click to add a control. • Click to add a control. • Click to add a control.	

JHA Example

Job Hazard Analysis

Name of Lab: Martinez Lab	**Department:** Chemical Engineering
Activity or Process: High Pressure Liquid Chromatography (HPLC)	**Building/Room:** Centennial Engineering/Room 1234
Job Title: Principal Investigator	**Supervisor:** Dr. Martinez
Prepared By: Dr. Martinez	**Date:** 10/23/2020

This document is the certification of hazard assessment for PPE for the workplace.

TASKS/STEPS	HAZARDS - CONSEQUENCES	CONTROLS (SAFEGUARDS)	PHOTO
1 Open container of dichloromethane	• Corrosive – causes skin and eye irritation • Toxic – may cause organ damage • Carcinogenic – may cause cancer	• Engineering Control – open only inside a fume hood • Administrative Control – abide by SOP • PPE – gloves, goggles, lab coat required • Click to add a control. • Click to add a control. • Click to add a control. • Click to add a control.	

Picture

SOPs + JHAs +Heuristics = Not Ideal

Heuristics is a problem-solving technique that employs a practical (vs. scientific) method that is not guaranteed to be optimal, perfect or rational but is sufficient for reaching a "good enough" conclusion.

Examples of heuristic techniques include:

- **Trial and error**
- **Rule of thumb**
- **Educated guess**
- **Familiarity heuristic**
- **Affect heuristic**

Heuristics can also be thought of as "mental shortcuts". They are useful in certain situations but not usually in the laboratory.

Heuristics in the Laboratory

Examples of heuristics in the lab include:

- **Familiarity heuristic: You are rushing to finish setting up the HPLC process. You have set it up dozens of times with no problems. You skip putting on goggles because you've never ever splashed DCM in your eyes. You pour the DCM into a beaker and a couple of drops splash into your face and eyes.**
- **Affect heuristic: After splashing DCM in your face and eyes, you use the eyewash station to rinse your eyes. They stop burning after 2 minutes and you make a gut decision to stop rinsing at that moment instead of continuing to rinse for the recommended 15 minutes. Within a few hours, your eyes are red and swollen and you end up having to go to EOHS for medical treatment.**

How to Overcome Heuristics in the Lab

- **Use and abide by the SOPs and JHAs.**
- **Budget plenty of time to finish a task or process – do not rush.**
- **Do not make assumptions.**
- **Do not "go with your gut" when making decisions.**
- **Think critically about the hazards of your work.**

What to do when things go wrong

1. **Prepare for the worst**

   - **Have an idea of what the worst case scenario is for the hazardous processes, activities and/or materials you work with**

   - **Use the internet to research incidents and accidents that have occurred in laboratories that perform similar processes**

What to do when things go wrong

2. **Create an Emergency Plan that includes:**

   - **Who to call (PI, UNM Police, 911)**
   - **Location of emergency equipment (spill kits, first aid kits, fire extinguisher, safety shower, eyewash)**
   - **Where to go for medical treatment**

What to do when things go wrong

3. **Report near-misses**

   - **An unreported near-miss is a missed opportunity to learn from a mistake**
   - **Being able to scrutinize a near-miss can ensure that future incidents are avoided**

References

- American Council on Science and Health – *Two Drops of Death, Dimethylmercury*, June 2016
- UCLA, Report to the Chancellor on UCLA Lab Safety, Tert-butyllithium Fire and Fatality, December 2008
- UC Center for Laboratory Safety, Report to the UH on the Hydrogen/Oxygen Explosion, June 2016
- OSHA Hazard Communication Standard, 29 CFR 1910.1200

Questions?

Environmental Health & Safety – 505-277-2753 or
www.ehs.unm.edu