Laboratory Safety for CNAM & JQI

Miriam Sharp, Ph.D.
Safety in Academic Laboratories

The primary motivation for incorporating safety is improved health and safety for researchers.

Incorporation of safety includes research benefits:
- Improved research quality
- Optimize use of resources
- Teaching and learning outcomes

Being able to apply safety in your work is an important career development skill:
- Employers expect knowledge and competence in industry safety standards
- Becoming a PI requires managing not only your own safety and safety of others
Safety Structure at UMD

- Researchers and Students
- Principal Investigators
- Department
- University
  - ESSR
    - Research Safety
    - Fire Marshal
    - Environmental Affairs
    - Risk Management
    - Occupational Safety and Health
  - Other Institutional Bodies
    - Vice President of Research
    - Compliance Committees
- External Bodies
  - Regulatory Bodies (e.g., MOSH, EPA)
  - Funding Agencies (e.g., NIH)
Laboratory Requirements

- Required Documentation
  - Training
    - Laboratory Specific Training
  - Chemical Hygiene Plan
  - Standard Operating Procedures
- Maintain updated BioRAFT information
- Appropriate chemical storage and waste management
- Appropriate use of safe procedures and controls
- Address safety inspection findings in a timely manner
- Reach out to ESSR when research methods or laboratory facility changes may have external compliance issues
Researchers have a responsibility to follow all safety instructions designated by the principal investigator and/or field leader.

Researchers have a responsibility to communicate safety concerns, hazards, or incidents to PI.

Researchers have a responsibility to follow federal, state, and local laws while performing research activities.

Researchers have the right to not engage in an activity that they do not believe is safe.
PI Responsibilities

- PI’s at the University of Maryland are ultimately responsible for the safety of their personnel in their laboratory and in the field
  - Managing the safety of others
    - Providing appropriate training and safety equipment
    - Ensuring procedures and protocols have had thorough risk assessment
    - Making safety decisions and developing rules for lab/field personnel
    - Maintain a safe work environment
    - Enforcing the rules and holding personnel accountable
  - Follow external compliance requirements
Changing Landscape of Liability

- **2008 UCLA Lab Fatality**
  - Criminal Charges for PI brought by LA County District Attorney

- **2016 University of Hawaii-Major Lab Injury**
  - OSHA Fine $69,300 (proposed $115,000)
  - Civil suit named PI and Program Director currently under litigation
    - Eight separate counts, including gross negligence and failure to warn
Safety Culture

- National Academy of Sciences, ACS, APLU Safety Culture Surveys and Guidance
  - According to ACS survey:
    - 86% thought their laboratory is a safe work environment
      - 46% have had an injury
      - 40% saw a colleague injured
      - 70% have had a near miss
How Does Safety Fit Into Research?

- Safety should be incorporated at every stage of experimental development:
  - Before you begin
    - Hazard Recognition
    - Assess Risk
    - Mitigate Risk
  - During
    - Performing work using appropriate controls and procedures
  - After
    - Managing waste and clean-up
    - Learning from incidents
Hazard Recognition Tools

- **General**
  - PI
  - Internet searches
  - Textbooks and Articles
  - Other Lab Personnel or Faculty
  - ESSR

- **Chemical Hazards**
  - Safety Data Sheets
  - Chemical Label

- **Process Hazards**
  - Equipment manuals
  - Manufacturer recommendations (call them)

- **Laboratory Environment**
  - Other lab members

- **Chemical Reactivity**
  - Writing out chemical reactions
  - *Bretherick's Handbook of Reactive Chemical Hazards* (online e-book)

*Bretherick's Handbook of Reactive Chemical Hazards*
Melting basalt in a crucible at 1300°C to create synthetically quenched glass

Changed crucible composition
- Changed from Al₂O₃ crucible to MgO to reduce Al contamination in samples
- Reaction between molten basalt and crucible led to it eating through the crucible, destroying the insulation and lava pooling at the bottom of the furnace
It is extremely important not to make assumptions that any researcher, including you, will instinctively know how to behave to avoid hazards or respond in emergency situations via “common sense”

- Researchers from diverse backgrounds have different “common senses” and perceptions of hazards
- Common sense is not universally applicable
- Being able to recognize and respond appropriately to hazards may vary with experience
Risk Perception

- Risk is the probability of a negative outcome when an incident involving a given hazard occurs.
- It is important to realize that people usually think about risk subjectively and that this kind of thinking can distort the perception of risk. Generally, people:
  - Have a tendency to emphasize uncommon risks but become complacent with common risks.
  - React quickly to immediate or quickly developing threats but under-react to long term or slowly developing threats.
  - Underestimate the risks they are willing to take in the heat of the moment.
  - Have difficulty assessing risks in unfamiliar situations or locations.
Why Researchers Take Risks

- Lack of knowledge/experience
  - Reluctance to ask questions
  - Improper/Inadequate training

- Convenience
  - Poor Time Management

- Complacency

- Lack of appropriate resources
Principal Investigators are responsible for performing a risk assessment for hazardous lab activities

- Define experiment and emergency response procedures
- Establish controls

As graduate students become independent researchers, the PI will transfer more responsibility in performing the bulk of risk assessments

- Become the expert
Assessing Risk

• Perform hazard identification and risk assessment prior to new experimental procedures and new chemical usage
  ▶ Anticipate what could go wrong
    • “What if?”
  ▶ When planning for emergencies, consider:
    • The experiment (spill, explosion, unexpected reaction, fire)
    • The building (fire, loss of utilities, unexpected building closure)
    • The campus (unexpected campus closure)
Assessing Risk

- Levels of risk are determined by looking at severity and probability
  - What’s the worst that could happen? and What’s the probability of that outcome if an incident occurs?

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<tr>
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<th>1 Minor Injury</th>
<th>2 Serious Injury</th>
<th>3 Major Injury</th>
<th>4 Fatal Injury</th>
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Imagine you are creating an etchant with Hydrofluoric Acid and you need to assess the risk of a chemical splash.

What if you knock over the bottle you are using to dilute the acid and concentrated HF splashes out?

- Severity: What is the worst case scenario?
  - HF is extremely hazardous, depending on the volume major or fatal
- Probability: What's the likelihood of injury?
  - Likely

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Reducing the risk of an activity requires the addition of control measures:

- **Elimination**
  - Not always feasible

- **Substitution**
  - Replacing chemicals or equipment

- **Engineering Controls**

- **Administrative Controls**

- **PPE**
Choosing Your Controls

- Start with the strongest control (elimination) and work your way down the hierarchy of controls.

- Controls may have pros and cons:
  - You may have to purchase some materials or alter the lab environment to achieve appropriate control.
    - If your lab is not able to support the work in a safe manner, you must find another location or restructure the work so that it fits the restrictions of your laboratory.

- Your controls may address different hazards:
  - Working with chemicals in a fume hood addresses respiratory exposure hazards, but gloves and safety goggles are also required to address a splash hazard.
Let’s return to the HF example. How can we reduce the risk?

 Elimination/Substitution
  • Maybe you can use another acid for the etching that is less toxic
  • Use a commercial etchant, which removes dilution step

 Engineering
  • Use in fume hood not open bench

 Administrative
  • Training/Procedures: SOP and Emergency Response
    – Use smallest volumes possible
    – Calcium Gluconate

 PPE
  • Gloves
  • Lab Coat
  • Chemical Apron
  • Face shield

The severity and probability have decreased due to the control measures

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When to Reassess Risk

- If you change the process, reassess the risk
  - Change chemicals
  - Change equipment
  - Scaling up
  - After an incident/near miss (apply lessons learned)

- If something is not going to plan during your experiment, you should stop and reassess
  - Not enough materials to complete the procedure
  - Essential step was inadvertently skipped
  - Experiment or equipment is behaving in a way that is unexpected or unusual
  - Safety controls have been compromised (e.g., hood shut down for maintenance)
Spark from pressure gauge caused University of Hawaii explosion, fire department says

Postdoc Thea Ekins-Coward, who lost an arm in the incident, was using a gauge not specified for work with flammable gases

By Jyllian Kemsley
Chemical Accident Lessons Learned
• Student spent afternoon cleaning up the laboratory
• Student made assumption about unlabeled chemical based on a secondary storage container
• Disposed of material in concentrated nitric acid it reacted violently in his hands and he suffered burns to his eyes and face
  ➢ Quick reaction by lab group saved their vision

July 2017
Lesson Learned #1: Labeling

- Chemical in an unlabeled centrifuge tube sitting in Pyrex beaker indicating use for Piranha
  - Likely left by previous student who had graduated years prior
- Generation of unknown materials can be avoided by good labeling practices
  - Disposal costs $125 per container due to testing required for waste processing
- Unknown materials should never be combined into existing waste streams
Labeling and Storage

- All chemical containers, of any size, must be labeled with the chemical contents
  - Including water, media, and non-hazardous materials
  - Includes squeeze bottles, centrifuge tubes, and flasks

- All chemical containers that are used for long term storage must have a fixed lid
  - Parafilm or foil lids are not adequate
Samples

- All samples must be:
  - Clearly labeled with chemical composition (not sample names)
  - Appropriately contained and stored
  - Disposed to appropriate waste stream when finished
  - If they must be kept long term when someone leaves, a written transfer should take place where another person takes responsibility for the safe storage of these materials
Lesson Learned #2: Procedures and Training

- MOSH wanted to see SOPs and training records
  - Including laboratory specific training records
- Laboratory had conducted training, but did not document laboratory specific training
- Laboratory had to write SOPs for lab clean-ups and PPE use and retrain entire lab group
Lesson Learned #3: PPE

- Was not wearing lab coat or splash goggles, was only wearing nitrile gloves
  - Did not perceive a risk, as the task wasn’t an experiment and thought materials were known
- MOSH requested a face shield, apron, and chemical resistant gloves be purchased and available
  - Additional precautions meant for work with larger volumes and for use during existing SOP tasks
Personal Protective Equipment

- Appropriate Lab Attire
  - Closed toe shoes
  - Long Pants
- Lab Coat
- Gloves
- Safety glasses or splash goggles
  - Laser Safety Glasses
- Working with Large Volumes
  - Face shield
  - Chemical Resistant Apron
Appropriate Use of PPE

- Only useful if it is worn
- Do not use reuse single use PPE
- Prescription glasses are not good enough
- Only wear PPE that fits appropriately
- Ensure PPE is appropriate and maintained
- Do not leave the lab with PPE on
PPE Must Be Compatible!!!

Fuming nitric acid vs. nitrile glove
Incidents and Emergencies
Incidents vs. Emergencies

- An emergency is any event that is beyond your ability to control and requires immediate action
  - Medical emergencies
  - Fire
- The distinction between emergencies and incidents depends on the scale, location and ability to respond
  - Chemical spills
  - Exposures
  - Minor injuries
Incidents and Emergencies

- How to report emergencies
  - Call 911 from UMD landlines
  - Call 301-405-3333 from a cell phone (Program this number into your cell phone!)
  - Use emergency phones
    - Blue light phones outside
    - Yellow phones in some buildings such as Chemistry
Give as much information as possible when reporting an emergency:

- Name
- Phone number
- Exact location
- Type of emergency
- If injury or illness:
  - Victims approximate age, sex and condition (responsiveness, breathing, bleeding, etc.)
  - What happened to the victim
  - What is being done to help the victim
Medical Incidents and Emergencies

- What to do if medical attention is needed
  - Serious injury or illness, call for ambulance
  - In case of minor injury
    - Health Center between 8 AM – 6 PM
    - Call Health Center Urgent Care line at 301-314-8162 before going to Health Center
    - Urgent Care or Emergency Room
Chemical Exposure: Eyes

- Chemical in Eye
  - Rinse eye at eyewash for 15 minutes holding eyes open
  - Call Health Center/Emergency Services for advice
Chemical Exposure: Skin
Chemical Spills

- When can lab personnel clean up a chemical spill?
  - Chemical(s) involved in the spill are known
  - Small quantity, low hazard
  - Spill kit contents are compatible with the spill
  - Spill kit contents is sufficient for the spill
  - You have been trained to clean up spills
  - You have the appropriate PPE to clean up the spill
Chemical Spills: Incident

• If you clean up a spill in the lab:
  ➢ Use spill kit and wear PPE
  ➢ Dispose of clean-up materials as hazardous waste
  ➢ Notify PI

• If you need assistance:
  ➢ Contact ESSR (main number or spill assistance 301-314-2000)
Chemical Spill: Emergency

- Evacuate the lab
- Assist anyone that is injured, if it is safe to do so
- Close door as you leave
- Report emergency
- Notify PI
- Do not re-enter lab until ESSR says it is safe to do so
Lab Fire

- Evacuate lab
- Close sash if the fire is in fume hood only if safe to do so
- Close door as you leave
- Evacuate building immediately
- Activate alarm as you leave if it is not already sounding
- Call 911 or 301-405-3333
- Do not re-enter until told it is safe to do so (by ESSR)
- **Fires are always emergencies!!!**
  - Even if you extinguish a fire, you must call emergency services
- Notify PI and lab manager of all incidents
- Complete UMD Incident Reporting Form found on ESSR website www.essr.umd.edu
- If you are injured at another institution, you still need to report to ESSR
Paid University employees are covered by Workers’ Compensation, which is used in place of personal medical insurance for workplace injuries.

If you are hurt on the job, you and your supervisor will need to notify ESSR and fill out a Report of Injury form. This needs to be completed within 24 hours of the injury.
Requirements for use of Radiation Producing Devices – X-ray and Laser Devices
Radiation Producing Devices

- **Regulation** – COMAR 26.12.01.01 Part B, D, H, I
- **Registration** – with MDE Rx-1 and payment
- **Certification** – by inspector and Rx-1,2,&4
- **Application** – to possess and use on campus
- **Authorization** – interim approval and RSC final action
Radiation Producing Devices

• Lasers
  • Regulation – OSHA wide but none specific in Maryland
  • Standards – ANSI Z136.1
  • Registration – with ESSR Registry Form in house
  • Certification – Inspection to the ANSI standard Z136.1
  • Application – to possess and use on campus
  • Authorization – interim approval and RSC final action
Laser Changes and Updates

- Signage
- Laser Safety Eyewear
  - ANSI Z136.1 + EN207
  - OD and Impact Safety Together
  - Do your homework when selecting eyewear
  - Take advantage of speaking with the technical reps from the Laser Safety Eyewear companies
Radiation Producing Devices

Training through ESSR – Radiation Safety

- Laser/X-ray Safety Training
- Classroom Training
- Room 2306 Building 090
- Sign up on Bio-Raft
- Times vary
- At least twice per month
- Some special Sessions
Radiation Producing Devices

• Questions ????

• Answers ???😊