

Introduction

Welcome to Working Safely with Pyrophoric Chemicals at UAB (CS305) Course Material. This course is required for anyone working with pyrophoric chemicals at UAB. This training applies to all clinical and research laboratories and advises the campus community on using, storing, and disposing of pyrophoric and water-reactive chemicals in a manner minimizing risks to personnel, facilities, and the environment.

Objectives

At the conclusion, participants should be able to do the following for pyrophoric chemicals:

1. Recognize the associated level of danger.
2. Identify the correct Personal Protective Equipment (PPE) to wear.
3. Apply the proper Engineering and Administrative Controls.
4. Implement the proper storage requirements.
5. Formulate and employ an Emergency Response Plan if a spill, accident, or injury occurs.

Overview

Standard Operating Procedures (SOPs)

Any area, lab, or department using pyrophoric, and water-reactive materials must have an up-to-date written Standard Operating Procedure (SOP). Contact UAB's Department of Environmental Health and Safety (EHS) at (205) 934-2487 if you need assistance.

Description

Pyrophoric chemicals can be liquid, solid, or gas having the potential to spontaneously ignite in air at temperatures of 54°C or below. They may exhibit other properties (e.g., being corrosive, water-reactive, and peroxide forming). Improper handling of these materials can cause fire or explosions, which may cause serious injuries, death, and significant damage to facilities.

Types

Below are some examples of some common pyrophoric and water-reactive chemicals. There is a more comprehensive list [here](#).

- **Liquids:** Alkylaluminum Reagents, Boranes, Metal alkyls and Aryls (RLi, RNa, R3Al, R2Zn)
- **Solids:** Alkali Metals (Lithium, Sodium, Potassium, Sodium Potassium Alloy – NaK), Potassium Sulfide (K2S), Aluminum Phosphide (AlP)
- **Gases:** Nonmetal Hydrides (Arsine, Boranes, Germane, Phosphine, Silane), B2H6 and other Boranes, PH3, AsH3

Hazards and Safety

The main danger associated with pyrophoric and water-reactive chemicals is fire upon contact with air or moisture. The high level of reactivity associated with these chemicals requires handling with extra care.

- Working in pairs is a requirement.
- Consulting the Safety Data Sheet (SDS) before working with any pyrophoric chemical.
- Never placing open containers of pyrophoric liquids inside the fume hoods.
 - Dispensing of pyrophoric liquids inside the fume hood must be done from a sure-seal type bottle using a syringe or cannula.
 - Open dispensing can be done inside a glove box or a similar inert atmosphere.
- Dispensing or handling pyrophoric solids that are not stabilized using mineral spirits or solvents inside a glove box.
- Handling or dispensing water-reactive solids that are not protected or stabilized by mineral spirits or other solvents only inside of an inert atmosphere glove box.
- Backfilling all sure-seal type containers with a dry inert gas after withdrawing reagent from the bottle.

Working Safely with Pyrophoric Chemicals at UAB (CS305) Course Material

- Keeping needles, spatulas, wipes, or any other items coming in contact with byproducts or water in an inert atmosphere or neutralized following manufactures instructions before exposing to water or air.

Controls

Engineering

Glove Boxes and Fume Hoods

Glove boxes are strongly recommended for the safe use of pyrophoric materials, especially for transfers. If glove boxes are not available, perform the experiments in a fully functioning

fume hood. Do not store any other chemicals or materials that are considered flammable or combustible in the fume hood.

Gas Cabinets

Gas cabinets are required for the storage of pyrophoric gases. Gas cabinets must be located in areas with continuous mechanical or natural ventilation. Outside of each cabinet, there should be a remote manual shut off device available in case of an emergency. Pyrophoric gas flow, purge, and exhaust systems should have redundant controls that prevent pyrophoric gas from igniting or exploding.

Special continuously ventilated gas cabinets that store pyrophoric gases must have:

- Provide remote manual shutdown to pyrophoric gas flow outside each gas cabinet.
- Pyrophoric gas flow, purge, and exhaust systems should have controls that prevent pyrophoric gas from igniting or exploding. These controls include excess flow valves, flow orifices, mass flow controller sizing, process bypass line control, and automatic gas shutdown.
- Provide emergency back-up power for all electrical controls, alarms, and safeguards associated with the storage and process systems.
- Purge all system components and equipment with inert gas.



All work with pyrophoric chemicals must be completed in a Glove Box or Fume Hood with the sash as low as possible.

Working Safely with Pyrophoric Chemicals at UAB (CS305) Course Material

Administrative

- Conduct a hazard analysis and review the emergency response protocol with the employees, including the location and use of emergency equipment like fire extinguishers, eyewash, and a safety shower. This hazard analysis is the responsibility of the PI or the Supervisor and included in the procedure specific Standard Operating Procedure (SOP).
- Reduce the quantities purchased and stored to a minimum (no more than a month's supply).
- Purchase pyrophoric materials dissolved in solvents if possible.
- Carry out experiments in smallest scale possible.
- Keep a small bucket of sand within arm's length.
- Work with pyrophoric and water-reactive materials shall be handled only by experienced individuals in the safe handling of these chemicals. It is the responsibility of the PI or Supervisor to provide and document the employee's required lab and procedural specific training before starting the experiment.
- Work with pyrophoric materials outside the regular working hours (8am-5pm) is forbidden by UAB EHS (including weekends and holidays).



Never work alone!
Working alone with pyrophoric materials is not allowed. At least two people must be present at all times.

Labeling

Label containers carrying pyrophoric and water-reactive materials with the correct chemical name in English, including appropriate hazard warnings.

Storage

- Follow the manufacturer's instructions and those in the SDS for the storage of pyrophoric chemicals. Store pyrophoric chemicals in an explosion-proof refrigerator.
- Keep pyrophoric gases in approved gas cabinets.
- Use and store minimal amounts of pyrophoric chemicals in the area.
- Keep pyrophoric liquids in airtight containers away from combustible materials (paper, flammables,

Working Safely with Pyrophoric Chemicals at UAB (CS305) Course Material

etc.) water, oxidizer, heat sources, vibration sources, and air.

- Check regularly to make sure sufficient quantities of protective solvents like oil, kerosene, or inert gas remains in the container of pyrophoric or water-reactive solids while being stored.
- Store Organolithium compounds inside a flammable storage refrigerator with the metal can act as secondary containment
 - Always put the cap back to protect the septa.
 - EHS strongly recommends that you discard any unused amount after one month of opening.
- Do not store with flammable materials or in a flammable liquids storage cabinet.
- Never store with corrosive materials that could damage the containers.
- Never return the unused amount to the original container.

Specialized Training

- If you are responsible for handling, using, or transporting compressed gas cylinders, you are required to complete [Managing Compressed Gas Cylinders \(OHS200\)](#).
- If you are responsible for generating, handling, packing, or electronically signing a manifest requesting hazardous waste for pick up or disposal, you are required to complete [Hazardous Waste Handling & Packing \(CS055\)](#).
- If the work or research you are conducting requires a Biosafety Cabinet (BSC), Fume Hood, or Clean Air Station, you are required to complete [Biosafety Cabinets & Fume Hoods \(BIO304\)](#).

PPE

- Minimum PPE: Safety goggles, fire-resistant lab coat, cotton clothing (no synthetic material – this includes clothes under lab coat) and, closed-toe shoes. Wear a chemical apron and fire-resistant gloves as an extra layer of protection.
- Eye Protection: Safety goggles or face shields approved by the American National Standards Institute (ANSI).
- Hand Protection: Nomex gloves are made of excellent fire retardant materials. For this reason, Nomex is the recommended type of glove for pyrophoric operations. If the reactive material were to ignite and spill onto the hand, nitrile gloves would also ignite and contribute to serious injury.

Working Safely with Pyrophoric Chemicals at UAB (CS305) Course Material

- Lab Coat: The required lab coat should be made from 100% cotton (no synthetic material is allowed) if no transfer is involved. If the experiments require the transfer of pyrophoric material, the lab coat must be of flame-resistant material. All clothing under the lab must be of 100% cotton, including the socks.

Ordering

Order pyrophoric chemicals in the smallest bottle possible. If the open bottle is not used completely, discard it after one year. Ensure that the integrity of that container is maintained if the pyrophoric or water-reactive reagents are received in a specially designed shipping, storage, or dispensing container (such as the Aldrich Sure/Seal packaging system).

Transferring

Before starting the transfer:

- Make sure you are wearing all the required PPE
- Check access to emergency equipment:
 - Eyewash and safety shower required to be within 10-second access.
 - An appropriate fire extinguisher within 10 seconds of access.
 - A small sand bucket within arm's length for small fires.
- Check to make sure engineering controls are working correctly. The preferred engineering control is a glove box. If it is not accessible, use a chemical fume hood. Make sure the hood is working at its preferred efficiency.
- Glass syringes with Teflon-tipped (gas-tight) are the best for pyrophoric transfers. Disposable plastic syringes have a good seal on the plunger and work well too.
- Needles must be long enough to withdraw the material without tilting the bottle.
- Never use syringes for more than 20 ml at one time.



Experiments requiring more than 50 ml of pyrophoric liquids require a Principal Investigator's (PI) written approval. These transfers must be carried out using the cannula (double ended needle) system.

Working Safely with Pyrophoric Chemicals at UAB (CS305) Course Material

- If you need to transfer quantities above 20 ml, cannulas (double-ended needles) are the best choice.
- Never reuse syringes. Plunger might stick in the barrel as the tiny residual material in barrel forms a solid when exposed to air. This solid residue could cause the syringe to stick during the transfer.
- Limit the amount used in one experiment to 50ml.

Cleaning

A small amount of residual pyrophoric material will always remain in the syringe. You should be:

- Making sure the syringe is quenched before washing or disposing of materials.
- Rinsing the syringe and the needle with a non-reacting solvent such as Hexane by drawing solvent into the syringe
- Repeating the process three times.
- Rinsing the syringe again with alcohol two more times.
- Cleaning both the syringe and needle with water.
- Discarding wash solvents as hazardous waste.



Re-using syringes is not allowed!

Emergency Preparation

Safety Equipment

- Those who work with pyrophoric chemicals must have training on the use and location of the emergency equipment, including fire extinguishers, safety shower, and eyewashes. The appropriate fire extinguisher must be within 10 seconds of travel time.
 - Class A, B, C (dry chemical) will be appropriate for pyrophoric liquids and supporting flammable solvents.

Working Safely with Pyrophoric Chemicals at UAB (CS305) Course Material

- Class D (are recommended for certain materials) like reactive metals.
- Do not use extinguishers containing or developing water, carbon dioxide, or halons. They are not suitable for fighting fire caused by organolithium compounds as they react violently.
- A sand bucket should be available within arm's length while working with pyrophoric in case of small fires.
- Eyewash and safety showers must be within the required 10 seconds of travel time.

Spills

Large

- Use extreme caution due to the potential for spontaneous ignition. Do not attempt to clean up the spill yourself.
- Activate the fire alarm and evacuate the building immediately!
- Call:
 - 911 from a campus phone
 - (205) 934-3535 from a cell phone
 - (205) 934-2487 (EHS)
- Tell the person who answers the phone details of the accident:
 - the location – street address and building name
 - types of hazardous materials involved
 - your name
 - phone number where you can be reached

Small

Perform the following procedures only if you feel confident enough to do them safely and correctly. If not, call 911 or other emergency numbers immediately.

- Use extreme caution due to potential for spontaneous ignition.

Working Safely with Pyrophoric Chemicals at UAB (CS305) Course Material

- If a person is exposed or is on fire, rinse with copious amounts of water under the emergency safety shower.
- Dial 911 from a campus landline in the event of a flash fire.
- If nobody is injured and nothing has ignited:
 - Access an appropriate fire extinguisher and place it near the spill area.
 - Call a coworker for assistance/backup.
 - Carefully remove any flammable materials that are near the spill area.
 - Completely cover the spill with dry sand.
 - Carefully quench by slowly adding isopropanol.
 - Call EHS for assistance.

Conclusion

This concludes the Working Safely with Pyrophoric Chemicals at UAB (CS305) Course Material. You should now take the assessment. 90% or higher is considered passing. You have two chances to complete the assessment successfully. Failing both attempts means that you fail the course and must start over.

Want to Learn More?

EHS has many training courses available to all UAB active employees and students. This includes topics such as in-depth radiation training, biosafety, bloodborne pathogens, chemical safety, Controlled Substances, building life safety, hazardous and medical waste, universal waste, PPE, Hazard Communication, etc.

We have a [decision tree](#) to assist you in choosing the right course to match the knowledge/skills you may need at work every day as well. If you have any questions or comments, contact EHS at (205) 934-2487.