# General Use Standard Operating Procedure (SOP)

# Pyrophoric Chemicals

**Flammable

Globally Harmonized System pictogram Indicating a chemical is a flammable hazard.**

*Globally Harmonized System Hazard Class: Pyrophoric liquids; pyrophoric solids; pyrophoric gas*

*Examples: (commonly found in labs)*

| **Liquids/Solutions** | **Solids** | **Gases** |
| --- | --- | --- |
| Alkylated metals   * Butyllithium, Triethylboron, Trimethylaluminum, Diethyl zinc   Alkylated metal alkoxides or halides   * Dimethylaluminum chloride, diethylethoxyaluminium, Grignard Reagents (Methylmagnesium Chloride, Allylmagnesium Bromide)   Metal Carbonyls   * Nickel Carbonyl | Alkali Metals   * Lithium, Sodium, Potassium, Cesium and Rubidium   Metal Alloys   * Sodium Potassium Alloy   Metal Hydrides  Sodium Hydride, Potassium Hydride  Finely Divided Metals   * Aluminum, Lithium, Zinc, Magnesium, Sodium, Potassium   Used Hydrogenation Catalysts   * Raney Nickel * Palladium on Carbon   Finely Divided Iron Sulfides  Potassium Sulfide  Aluminum phosphide  Low Valent Metal Salts   * Titanium Dichloride   Nonmetals   * White phosphorous | Nonmetal hydrides   * Silane, Diborane, Arsine, Phosphine |

**Note**: This SOP is intended to provide general guidance on how to safely work with pyrophoric chemicals and only addresses safety issues specific to pyrophoric chemicals. Other hazard classes may also apply. Review Safety Data Sheets (SDS) and refer to other general use SOPs relevant to the chemical you are working with. Contact the Principal Investigator/ Laboratory Supervisor or the WSU Chemical Hygiene Officer for questions concerning the applicability of any item listed in this SOP (OEHS: 313-577-1200).

**If the chemical of interest is a particularly hazardous substance or a high risk chemical a lab specific SOP is required.**

## **Hazard Description**

Pyrophoric chemicals are liquids, solids, or gasses which are liable to ignite spontaneously, without the influence of heat. These chemicals ignite, after coming into contact with; air at or below 54.4 °C (130°F), moisture in the air, oxygen, or water. The most significant hazard of pyrophoric chemicals is the high flammability. In addition, pyrophoric materials can be toxic, corrosive, water reactive, and/or form peroxides.

## Control of Hazards – General

* Conduct a hazard assessment to identify proper use and handling techniques, fire safety, storage, and waste disposal issues specific to the chemical being used.
* Before purchasing pyrophoric materials, consult with OEHS at (313) 577-1200 to select a compatible fire extinguisher. The extinguisher must be on hand before any work with the pyrophoric material takes place (and preferably before the material is ordered).
* Do not use reactive chemicals if less-hazardous alternatives are possible.
* Purchase, dispense, and use the smallest quantity of reactive chemicals possible.
* Purchase the lowest concentration of reactive chemicals that will meet your research needs.
* Containers carrying pyrophoric materials must be clearly labeled with the correct chemical name and hazard warning.
* Never return used pyrophoric chemicals to the original container.
* A container with pyrophoric material (even with residual amounts) must NEVER be opened to the atmosphere.
* Set up a designated area for work with pyrophoric materials – a chemical fume hood and/or a (dry) glove box (with inert atmosphere, if needed) located within 10 seconds of an eyewash/drench hose, safety shower, and an appropriate fire extinguisher.
* Incompatible materials (e.g. flammable materials, water, etc.) should be removed from the designated work areas and ensure those are clutter free.
* All glassware and equipment used for pyrophorics should be free of moisture.
* Purge all air from the apparatus/equipment with the proper inert gas before introducing pyrophoric materials. Always refer to SDS to select the appropriate inert gas.
* Use the recommended inert gas for purging air and material transfer. Nitrogen is not suitable for all materials, consult the SDS.
* For apparatus, secure fittings air-tight with a light coat of vacuum grease.
* When performing pressurized reactions involved pyrophorics, used pressure rated glassware and fittings.
* Secure the pyrophoric reagent bottle to a stand to prevent accidental spills
* When transferring pyrophoric liquids:
* Use containers with transfer septa (i.e. Aldrich Sure/Seal septa) for liquid reagents.
* Visually check the chemical container and septa for degradation before use.
* Use a long needle and a syringe that is twice the volume of the liquid to be transferred.
* Ensure syringes used are gas-tight, completely dry and purged with appropriate inert gas.
* Secure the syringe so if the plunger blows out, the contents will not splash anyone.
* Use a recommended cannula method when transferring large volumes (>20 mL). Avoid using a syringe.
* Before working with these compounds, read the SDS and other reference material carefully for safe handling of pyrophoric materials. Good web resources include:
* UCSD training videos: How to Handle Pyrophoric Reagents
  + [Working with pyrophoric reagents Eps 1: getting ready](https://www.youtube.com/watch?v=3_cBVfYVAC8&feature=youtu.be)
  + [Transferring Pyrophoric Liquids Eps 2](https://www.youtube.com/watch?v=WUHrzcEunNY&feature=youtu.be)
  + [Working with Reactive Metals Eps 3](https://www.youtube.com/watch?v=ozmddj0fIpk&feature=youtu.be)
* Sigma Aldrich Technical Bulletins
  + [AL-164 (Handling Pyrophoric Reagents)](https://www.sigmaaldrich.com/content/dam/sigma-aldrich/docs/Aldrich/Bulletin/al_techbull_al164.pdf)
  + [AL-134 (Handling Air-Sensitive Reagents)](https://www.sigmaaldrich.com/content/dam/sigma-aldrich/docs/Aldrich/Bulletin/al_techbull_al134.pdf)
  + Other Aldrich Technical Bulletins describe specific laboratory equipment designed for use with air- and moisture-sensitive reagents.
* [Safe Handling of Organolithium Compounds in the Laboratory](https://www.sciencedirect.com/science/article/pii/S1074909802002952), Schwindeman, Woltermann, and Lethford, Chemical Health and Safety, Vol. 9, Issue 3, May-June 2002, pages 6-11
* Prudent Practices in the Laboratory (National Academies Press) Sections 4.D and 6.G and Laboratory Chemical Safety Summaries for

Butyllithiums

Sodium (reactive metal)

Lithium aluminum hydride

* A container of powdered lime or sand should be kept within arm’s reach (for covering spills).
* Before conducting the actual procedure, always perform a dry run (without the pyrophoric material) to identify and resolve possible safety hazards.
* NEVER work alone with pyrophorics. Work within sight and/or hearing of at least one other person who is familiar with the hazards and written procedures.

## Engineering/Ventilation Controls

* Liquid pyrophorics should be stored in sealed containers with PTFE-lined septa. This will prevent exposure of pyrophoric materials to air and moisture and allow safely transfer pyrophoric material via syringe or cannula specially when an inert atmosphere is not available (e.g. in a chemical fume hood)
* Solid pyrophorics must be handled only in an inert atmosphere glove box or glove bag.
* When using chemical fume hoods ensure the sash is lowered as far as possible. This will assist with containment in event of a violent reaction and provide a safety barrier.
* Mineral oil bubblers must be used when releasing pressure from reagent or reaction vessels to prevent overpressure and back air flow.
* Use a blast shield if available.

## Personal Protective Equipment

In addition to proper street clothing (long pants or equivalent that cover legs and ankles, close-toed non-perforated shoes that completely cover the feet), wear the following Personal Protective Equipment (PPE) when performing lab operations/tasks:

* Safety glasses (If splash potential exists, use goggles + face shield instead)
* Lab coat.
  + Hazard assessment of procedures may indicate the need for a flame resistant lab coat, such as Nomex.
* Appropriate chemical‐resistant gloves.
  + Refer to Section 8 “Exposure controls/personal protection” of SDS or a glove selection guide (e.g. [Ansell Chemical Protection Guide](https://www.ansellguardianpartner.com/chemical/home#hp)) to identify appropriate glove type.
  + Additional fire resistant gloves may be necessary depending on the task.

Additional PPE for potentially explosive substances or by-products:

* Heavyweight gloves (such as anti-static PVC gauntlets)
* Avoid wearing synthetic clothing while working with pyrophorics.

## Special Handling Procedures and Storage Requirements

* Store and use pyrophoric chemicals under an inert atmosphere or under kerosene as appropriate.
* Store in secondary containers, away from flammables and oxidizers. (You may be able to reuse the secondary container provided by the manufacturer.)
* Avoid areas with heat, flames, and water sources.
* Some of these materials may need to be kept below threshold temperatures.
* For pyrophoric materials stored in solvents, do not allow the solvents to dry out. Check periodically to ensure there is a visible amount of solvent is in the container all the time

## Decontamination Procedures

Review the chemical Safety Data Sheet for guidance on cleaning specific materials.

## Waste Disposal

Waste pyrophorics should be properly sealed to prevent exposure to air and moisture and disposed of IMMEDIATELY through OEHS Hazardous Waste Management. Pyrophorics must NOT be allowed to accumulate.

Do not dispose of waste by dumping down a drain or discarding in regular trash containers, unless authorized in writing by OEHS. Submit requests to OEHS for waste containers, labels, and waste collection. Also, refer to the OEHS Hazardous Waste Management web page and WSU Chemical Hygiene Plan for more information.

# **Spill procedures**

For spills of any size of pyrophoric material **DO NOT** attempt to clean up the spill. If safe to do so, **only contain the small** **spills**. Powdered lime can be used to contain/cover the spills and slow the reaction with air/humidity. Lime is hydroscopic; keep storage containers closed to prevent absorption of atmospheric moisture.

* 1. Evacuate the spill area
  2. Call WSU Police (313 577 2222) immediately.
  3. Post someone or mark-off the hazardous area with tape and warning signs to keep other people from entering.
  4. Remain in the vicinity until emergency personnel arrive and provide them with information on the chemicals involved.

For additional information regarding spill response procedures, refer to the [OEHS chemical spill response guidelines](http://research.wayne.edu/oehs/chemical/spills), [WSU Chemical Hygiene Plan](http://research.wayne.edu/oehs/pdf/chemical-hygiene-plan.pdf) and [American Chemical Society (ACS) guide for chemical spill response](https://www.acs.org/content/acs/en/about/governance/committees/chemicalsafety/publications/guide-for-chemical-spill-response.html).

# **Emergency Procedures**

**\*\*If medical attention required, call WSU police (313-577-2222) immediately\*\***

* **Fire Extinguishers** – Refer to section 5 of the SDS for chemical specific firefighting measures. Please note that use of ABC and CO2 extinguishers can cause some pyrophorics to react more vigorously.
* **Eyewash/Safety Showers** – Depending on the chemical hazard type, an ANSI approved eyewash station and safety shower may be required, easily accessed, and available within 10 seconds travel time for emergency use. Instruct personnel on the locations of eyewashes and safety showers, and how to activate them, prior to an emergency. Refer to [MIOSHA Fact Sheet: Eyewashes and Safety Showers](https://www.michigan.gov/documents/lara/lara_miosha_cet0199_628109_7.doc) to determine if an eyewash/safety shower is required for your specific chemical.

Please note: Additional hazards present in the laboratory may require that an eyewash or safety shower be present. This emergency equipment is required for treating exposures to workplace hazards such as chemical splashes, biological agents, welding sparks, metal shavings, or fine particulates like dust, dirt and sand.

1. **Health Threatening Emergencies**
   1. **Fire, explosion, health threatening hazardous material spill or release, compressed gas leak, or valve failure.**
      1. Call WSU Police (313) 577-2222.
      2. Alert people in the vicinity and activate the local alarm systems.
      3. Evacuate the area and go to your Emergency Assembly Point.
      4. Remain nearby to advise emergency responders.
      5. Once personal safety is established, call OEHS at (313) 577-1200.

Note: For compressed gas leaks, shut off gas supply only if this can be done safely, without risk to personnel.

* 1. **Injuries and Exposures:** 
     1. Remove the injured/exposed individual from the area, unless it is unsafe to do so because of the medical condition of the victim or the potential hazard to rescuers.
     2. Call WSU Police (313) 577-2222.
     3. Administer first aid as appropriate.
        1. Eye contact: Promptly flush eyes with copious amounts of water for a prolonged period (at least 15 minutes). Seek medical attention.
        2. Ingestion: Seek medical attention IMMEDIATELY. See first aid section of chemical Safety Data Sheet.
        3. Skin contact: Remove any contaminated clothing. IMMEDIATELY flush contamination from skin using the nearest emergency shower for a minimum of 15 minutes. Seek medical attention.
        4. Inhalation: Get to a source of fresh air. Seek medical attention.
     4. Call OEHS (313) 577-1200, to report the exposure and complete [Report of Injury](https://risk.wayne.edu/files/rofi.pdf) form.
     5. Bring to the hospital copies of the Safety Data Sheets for all chemicals to which the victim was exposed.

1. **Non-Health Threatening Emergencies**
   1. **Injuries and Exposures**

For injuries and exposures that are not considered serious or a medical emergency, visit:

Henry Ford Occupational Health – Harbortown

3300 East Jefferson, Suite 100

Detroit MI 48207

(313) 656-1618

Monday – Friday 8:00 AM to 6:30 PM

If Henry Ford Occupational Health Center is closed or for serious injuries, visit:

Henry Ford Hospital – Emergency Room

2799 W. Grand Blvd.

Detroit MI 48202

(313) 916-8742

OR

Detroit Receiving Hospital - Emergency Room

4201 St. Antoine St, Detroit, MI 48201

Phone: (313) 745-3000

# **Minimum Training Requirements**

1. **General Training:**

* Online through the [Collaborative Institutional Training Initiative (CITI)](https://about.citiprogram.org/en/homepage/).
  + Laboratory Safety Training (general lab & chemical safety issues) and Hazard Communication
* [Fire Safety](https://risk.wayne.edu/fire-safety).

1. **Laboratory Specific Safety Training:**

* [Laboratory-Specific Safety Training](https://research.wayne.edu/oehs/docs/lab-safety-training-checklist.doc) checklist
* Review of SDS for chemicals involved in process/experiment.
* Review of this SOP.
* Review [WSU Hazardous Waste Management](https://research.wayne.edu/oehs/hazardous/chemical-waste) guidelines.
* Other: \_\_\_\_\_\_\_\_\_

# **Laboratory Personnel Review**

Prior to initiating work, lab personnel using these types of chemicals must complete the table below confirming that they have read and understood the above SOP and the associated hazards.

| **Name** | **Signature** | **Date** |
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