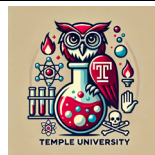


CHEMICAL SAFETY GUIDE

PYROPHORIC CHEMICALS



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A laboratory -specific SOP is required for *particularly hazardous substance (PHS)* and/or any operation involving a High-Risk chemical. PI approval of a lab specific SOP is required for all PHS and/or high-risk chemicals

1. DESCRIPTION:

Pyrophoric materials ignite spontaneously on exposure to, air, moisture in the air, oxygen, or water. Pyrophoric materials can be a solid, liquid, or gas.

Some examples of pyrophoric chemicals include Grignard reagents (e.g. RMgX), metal alkyls and aryls (e.g. tert-butyllithium, n-butyllithium, phenyl lithium), metal carbonyls (e.g. lithium carbonyl, nickel tetracarbonyl), finely divided metal powders (e.g. cobalt, iron, zinc, zirconium, lithium), and non-metal alkyls (e.g. R₃B, R₃P, R₃As).

Safety Data Sheets (SDS) use numbered hazard statements to communicate hazards, although the number may not always be present. The presence of the following hazard information indicates the chemical is a flammable chemical.

GHS Pictogram	TU Hazard Category	GHS Category	GHS H-Code	Signal Word
	High-Risk Chemical	Pyrophoric Liquids & Solids (Cat.1)	H250	Danger

All pyrophoric chemicals are considered a High-Risk chemical.

Contact EHRS via ehrschem@temple.edu for questions on the safe management of Pyrophoric chemicals.

2. POTENTIAL HAZARDS:

The most significant hazard presented by pyrophoric materials is the obvious risk of fire. Pyrophoric chemicals ignite spontaneously on contact with atmospheric oxygen, moisture in the air, or both. Therefore, pyrophoric chemicals should only be handled under an inert atmosphere. Failure to follow proper handling procedures can result in fire or explosion, leading to serious injuries or death, and significant damage to facilities.

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Many pyrophoric are sold/used as solutions in flammable solvents, which may exacerbate any dangerous reactions that can occur with misuse of these reagents. In addition, pyrophoric chemicals tend to exhibit additional hazards such as target organ toxicity, reproductive toxicity, corrosivity, water reactivity, and peroxide formation.

Check the Safety Data Sheet (SDS) to determine the specific hazard of the substance, including route of exposure and other hazard classifications, such as flammable, corrosive, etc. Follow other hazard specific guidelines as appropriate.

3. REQUIRED TRAININGS & INFORMATION:

Before beginning work with pyrophoric chemicals, all laboratory personnel must have completed the following:

- TU Required Trainings (available at [TU-EHSA](#))
 - Initial Safety Training for Researchers
 - Regulated Chemical Waste Management for Laboratories-Annual
- Review the Temple University [Chemical Hygiene Program \(CHP\)](#)
- Review any required Laboratory-specific Standard Operating Procedures (SOPs)
- Review any relevant Safety Data Sheets (SDS) available from the manufacturer or from [TU-EHSA-Search for Safety Data Sheets](#)
- Review the online section on Laboratory Emergencies
- Complete any laboratory-specific training necessary to perform the procedures.
- Place signature on the [Laboratory-Specific Training Checklist](#) to indicate review.

4. HAZARD CONTROLS

Purchasing:

- When possible, look for alternative procedures or reagents that will eliminate the need for the pyrophoric chemicals, or substitute it for a less hazardous chemical.

Engineering Controls:

- All manipulation of liquid or solid pyrophoric materials must be conducted inside an inert glove box or properly functioning fume hood with the sash level at the lowest height possible to perform the required operations.
- Before starting work, clear the fume hood or glove box of any unnecessary equipment or chemicals.
- Solids must be transferred under an inert atmosphere in a glove box.

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- The purchase of pyrophoric gases must undergo a review by EHRS staff for use.
- Pyrophoric gases must be stored in gas cabinets with mechanical ventilation. Gas cabinets storing pyrophoric gases are required to have the appropriate remote sensors and fire suppression equipment. Gas flow, purge, and exhaust systems should have redundant controls to prevent pyrophoric gas from igniting or exploding. All pyrophoric gases must have Restricted Flow Orifices (RFO) installed on the cylinder. Emergency back-up power should be provided for all electrical controls, alarms, and safeguards associated with the pyrophoric gas storage and process systems.

Administrative Controls-General:

- Never work alone with pyrophoric chemicals. Inform all other personnel in the laboratory before working with these chemicals.
- Conduct a 'dry run' with low hazard materials.
- Laboratory personnel must be trained and demonstrate a proficiency in handling pyrophoric materials prior to work.
- Consult with your PI before scaling up procedures involving pyrophoric chemicals.
- Consult with the University Fire Marshal for assistance on determining the appropriate type of fire extinguisher for your pyrophoric chemical.
- If pyrophoric chemicals are to be used in research animals, ensure that they are listed on the laboratory's IACUC protocol.

Administrative Controls-Chemicals Categorized as a Particularly Hazardous Substance (PHS) or a "High-Risk" Chemical:

These chemicals require the following to reduce the risk of exposure to laboratory personnel:

- Development of a laboratory-specific Standard Operating procedure (SOP)
- Establishments of a designated area. A designated area may be the entire laboratory, an area of a laboratory, or a device such as a laboratory hood.
- Use of a containment device such as chemical fume hoods or glove boxes.
- Procedures on the safe removal of contaminated waste.
- Decontamination procedures.
- Restrictions on working alone with pyrophoric chemicals.
- Required PI approval before starting use.
- Special laboratory specific signs or labels indicating warnings or work practices to be followed.
 - A "High Hazard Substance Sign" must be posted in the designated area. Signs are available via EHRS.

Designated area locations, applicable work practices, and information regarding the general

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handling must be included in the laboratory-specific SOP and be communicated to laboratory personnel through laboratory specific training provided by the PI prior to beginning work.

5. PERSONAL PROTECTIVE EQUIPMENT (PPE)

Follow the PPE recommendations listed in this guideline, Safety Data Sheets (SDS) and/or any required laboratory-specific SOPs for specific PPE recommendations. This should include at a minimum:

Skin and Body Protection:

Long pants (or equivalent) completely covering legs, closed toed shoes, and a flame resistant Nomex® lab coat when working with pyrophoric chemicals. Never wear synthetic clothing when working with pyrophoric chemicals. Additional protective clothing should be worn if the possibility of skin contact is likely or working with large quantities.

Hand Protection:

Gloves must be worn when handling pyrophoric chemicals. Fire-resistant gloves must be worn when handling pyrophoric liquids. Nomex flight gloves are highly recommended for general use because they allow more dexterity. Other fire-resistant gloves may be used, such as Kevlar or leather welding gloves. Heavy fire-resistant gloves are required when large quantities are used. Nitrile gloves should be worn as inner gloves, when possible. Note that nitrile gloves are combustible.

Consult the SDS, glove manufacturers compatibility charts and/or the laboratory specific SOP to determine which glove type is recommended.

Eye Protection:

Eye protection in the form of ANSI Z87.1-compliant safety glasses with side shields must be always worn when handling pyrophoric chemicals. Safety goggles and/or face protection must be worn when there is the potential for a splash hazard or working with large quantities.

A face shield is required any time there is a risk of explosion, large splash hazard or a highly exothermic reaction. All manipulations of pyrophoric chemicals which pose this risk should occur in an inert glove box or a fume hood with the sash in the lowest feasible position. Portable shields, which provide protection to all laboratory occupants, are acceptable.

Additional Hygiene Measures:

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If hazardous chemicals come into contact with gloves, immediately dispose of the affected gloves as hazardous waste. If hazardous chemicals come into contact with reusable PPE (lab coat, etc.) immediately remove the affected PPE, then dispose of it or submit it for laundering.

Additional PPE may be required depending on the specific operations involving your experimental procedures.

6. STORAGE, HANDLING & TRANSPORTATION

Always follow the manufacturer's recommendations for storage and handling.

Storage:

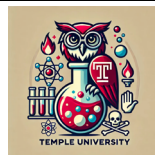
- All pyrophoric chemicals must be clearly labeled with the correct chemical name and hazard warning. Handwritten labels are acceptable; chemical formulas and structural formulas are not acceptable.
- Pyrophoric reagents can only be handled and stored in fully-sprinklered buildings.
- Pyrophoric reagents must be handled and stored under an inert atmosphere in a manner to avoid exposure to atmospheric oxygen and moisture.
- Pyrophoric chemicals must be stored away from incompatible materials including combustible materials, oxidizing acids, oxidizers, and aqueous solutions.
- Store pyrophoric chemicals in a flammable storage cabinet, refrigerator/freezer rated for flammable storage, glovebox, or a desiccator. Consult the SDS for the most appropriate storage location and ensure proper segregation.
- If pyrophoric reagents are received in a specially designed shipping, storage, or dispensing container, ensure that the integrity of that container is maintained.
- Ensure that sufficient protective solvent, oil, kerosene, or inert gas remains in the container while the material is stored.
- Pyrophoric liquid reagents are typically shipped in bottles provided with gas impermeable septa such that transfers can be made via needles under a chemically inert atmosphere (e.g., the "Sure/Seal" packaging system used by Aldrich). NEVER remove the protective septum from such a bottle in an air atmosphere without good reason and unless you are sure that the contents are neither pyrophoric nor toxic.
- Specialized glass bottles equipped with glass or Teflon stopcocks are superior for the storage of pyrophoric liquids and can be purchased from most laboratory suppliers (e.g., Aldrich Cat. No. Z10 733-6).

Handling:

- A designated area must be established in the lab for working with pyrophoric materials.

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- NEVER work alone. At least one other person must be informed and present in the same room while work with pyrophoric chemicals is being conducted.
- When possible, run reactions with pyrophoric reagents in an inert atmosphere glovebox.
- Pyrophoric solids must be transferred under an inert atmosphere in a glovebox. Pyrophoric liquids may be transferred within a glovebox or using proper syringe, cannula, or Schleck techniques. Cannulation should be used when transferring any amounts greater than 20 mL. (http://www.sigmaaldrich.com/content/dam/sigma-aldrich/docs/Aldrich/Bulletin/al_techbull_al134.pdf)
- Pyrophoric gases should be handled in compliance with applicable Fire Code.
- Ensure that the work area is adequately prepared prior to the experiment (e.g. remove all combustible materials [including paper towels and Kimwipes], remove all excess or nonessential chemicals and equipment from the area).
- A container of powdered lime, dry sand, and/or liquid nitrogen should be kept within arm's length when working with pyrophoric materials (these can be used to smother a small spill).
- NEVER return excess chemical to the original container (small amounts of impurities introduced into the container may cause a fire or explosion).
- Solvent bottles and waste bottles must be removed from the fume hood prior to work beginning.

Transportation:

- Transport pyrophoric chemicals in secondary containment, preferably a polyethylene or other non-reactive acid/solvent bottle carrier.

7. WASTE DISPOSAL PROCEDURES

All spent, unused, expired and materials contaminated with pyrophoric chemicals must be disposed of as a *regulated chemical waste* through EHRS.

Accumulation Limits:

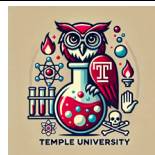
A maximum of 1-gallon liquid waste and 0.5 lbs. of solid waste may be accumulated in a laboratory (Satellite Accumulation Area (SAA)).

Specific Instructions:

1. Do not dispose of chemical waste by dumping down a sink or discarding in regular trash.
2. NEVER leave a container or waste bottle with residue or pyrophoric chemicals open to the atmosphere. These materials should always be contained to prevent fires.
3. Quenching of pyrophoric chemicals should only be performed if necessary for the

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experiment/procedure being performed, as EHRS will accept containers of pyrophoric chemicals for disposal.

- a. Used pyrophoric materials should be quenched under an inert atmosphere with adequate cooling. Do not return pyrophoric materials to their original container.
 - b. Never quench pyrophoric materials with water.
 - c. Refer to a published quenching procedure.
 - d. If a published quenching procedure is not available, the following procedure can be used to quench the majority of pyrophoric and water reactive materials:
slowly add isopropanol under an inert atmosphere while cooling and stirring.
4. Empty containers should be rinsed out 3 times with an inert solvent, after which the container should be left open to the atmosphere for at least one day before disposal. Rinses must be quenched and disposed of as hazardous waste.

Removal:

1. Ensure that a properly completed "Hazardous Waste" tag is affixed to the container. Tag must include the following:
 - a. Generator information is accurate.
 - b. Applicable Waste Stream is checked:
 - c. Applicable Hazards are identified: **Ignitable, Corrosive, Toxic or Reactive (as applicable)**
2. All chemical constituents and amounts (%) are included on the tag.
3. Submit a Chemical Waste Pickup Request Form prior to exceeding the accumulation limits.
4. EHRS will typically process a completed and accurate waste request within 3 days.

Contact EHRS via ehrschem@temple.edu for tags, collection containers and for any questions regarding proper waste disposal. Refer to Chemical Waste Management Program (CWMP) for more information.

8. EMERGENCIES

In the event of an emergency – Call Temple University Public Safety (TUPS) at (215) 214-1234 & EHRS at (215) 707-2520.

Health-Threatening Emergencies

1. Contact TUPS at 1-1234 from a campus landline phone or 215-203-1234 from a cell phone.
2. Go to the Temple University Hospital or nearest emergency room. Bring a copy of the SDS for the chemical.

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Temple University Hospital Emergency Department
Broad & Ontario Streets
Philadelphia, PA 19140

3. Notify your PI and Temple University-Human Resources-Absence Management
4. Notify EHRS at 215-707-2520 or ehrs@temple.edu as soon as possible, but within 8 hours of the incident.

Non-Health-Threatening Emergencies

1. Notify your PI and Temple University-Human Resources-Absence Management.
2. If necessary, go to Temple University Employee Health Services. Bring a copy of the SDS for the chemical.

Temple University Employee Services on Main Campus
1700 N. Broad Street, 4th floor
Philadelphia, PA 19122
Tel:215-204-2679

Additional Instructions:

Skin Contacts

Rinse body thoroughly using a safety shower for at least 15 minutes. If feasible, remove any contaminated or potentially contaminated clothing and/or jewelry.

Eye Contact

Rinse eyes thoroughly using an eyewash station for at least 15 minutes, occasionally lifting up the upper and lower eyelids to allow rinsing of the area beneath the eyelids. Remove contact lenses if possible.

Ingestion of chemical

Do not induce vomiting unless directed otherwise by the SDS or Poison Control (800-222-1222), Rinse mouth with water.

Inhalation of chemical

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Move into fresh air.

Needle stick/puncture exposure.

Wash the affected area with soap and water for 15 minutes. Contact Poison Control 800-222-1222

Fires:

If a small fire occurs, you are trained in the use of fire extinguishers, and you feel safe doing so, use a fire extinguisher to put out the fire. If a single extinguisher cannot put out the fire, activate a fire alarm and evacuate the area. Wait for emergency responders to arrive so that you can provide information about the fire.

Refer to Laboratory Emergencies for additional information.

9. SPILL RESPONSE

1. Notify your PI and all individuals in the general vicinity that a spill has occurred.
2. Evacuate the spill area. Avoid breathing vapors, dusts, or aerosols from the spill.
3. If safe to do so, help contaminated or injured persons evacuate.
4. If possible, confine the spill to a small area using a spill kit or absorbent material.
 - a. If pyrophoric chemicals spill within a glovebox, quench the materials, absorb the spill with non-combustible materials, and dispose of the materials as a regulated chemical waste.
 - b. Powdered lime or dry sand can be used to cover and contain a small spill outside of a glovebox.
5. Keep others from entering the contaminated area (e.g., use caution tape, barriers, etc.)

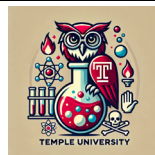
Minor Spill

If the amount and type of chemical spilled presents no potential for a hazardous chemical exposure and if you are trained to do so, wear appropriate PPE, and clean up the spill. Double bag any contaminated cleaning materials and manage as a regulated chemical waste. Contact EHRS at 2-2520 to report the spill if you are not trained and/or there is a risk of chemical exposure.

Major Spill

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Defined as any hazardous chemical spill that:

- would result in chemical exposure during cleanup,
- due to its size and/or hazards, requires capabilities beyond your training, or
- results in a release into the environment (e.g., a spill goes down a drain).

Call TUPS at 215-204-1234 from a cell phone or 1-1234 from a campus phone for assistance.

Refer to Laboratory Emergencies for additional information.

10. REFERENCES

1. Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards. National Research Council, Updated Version-2011
2. 29 CFR 1910.1250-Occupational Exposure to hazardous chemicals in laboratories.
3. Pyrophoric safety video: <https://www.youtube.com/watch?v=21iC4YEgOAs>
4. Aldrich Technical Information Bulletin AL-164:
https://www.sigmaaldrich.com/content/dam/sigma-aldrich/docs/Aldrich/Bulletin/al_techbull_al164.pdf
5. Aldrich Technical Information Bulletin AL-195:
https://www.sigmaaldrich.com/content/dam/sigma-aldrich/docs/Aldrich/Bulletin/al_techbull_al195.pdf

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