Pyrophoric Materials

Standard Operating Procedure

Revision Date: 06/20/22

Laboratory Director (LD) Approval is Required Prior to Performing this Procedure

Proper care must be exercised when handling pyrophoric materials to avoid the possibility of grievous personal injury and/or damage to property. This SOP is intended to inform on safe working practices to follow whenever pyrophoric materials are utilized in the research laboratory; however, it is not a substitute for hands-on training by an experienced co-worker. The SOP should be read and understood prior to the commencement of relevant work and used to complement supervised practical familiarization with the various techniques described. Personnel unfamiliar with safe handling procedures for pyrophoric chemicals MUST NOT attempt experiments using such reagents until properly trained and confident in their ability to perform the appropriate protocols. Consult the Aldrich technical bulletin on handling air-sensitive reagents [[AL-134](http://www.sigmaaldrich.com/content/dam/sigma-aldrich/docs/Aldrich/Bulletin/al_techbull_al134.pdf)], and its companion piece specific to pyrophoric reagents [[AL-164](http://www.sigmaaldrich.com/content/dam/sigma-aldrich/docs/Aldrich/Bulletin/al_techbull_al164.pdf)] for procedural information.

# Description [Provide additional information as it pertains to your research protocol]

Pyrophoric materials ignite spontaneously on exposure to; air at 130°F (54°C) or below, moisture in the air, oxygen, or water. Pyrophoric materials can be a solid, liquid, or gas. The most significant hazard presented by pyrophoric materials is the obvious risk of fire.

## Process [Write the steps for using the chemical in your research protocol]

# Potential Hazards [Provide additional information as it pertains to your research protocol]

To avoid accidental ignition, a protective anhydrous inert atmosphere of either nitrogen or argon gas must be maintained over the surface of the liquid at all times. Pyrophoric liquids are often sold in flammable solvents such as ether, THF or a hydrocarbon. Pyrophoric solids are often stored under oil or kerosene. Even a momentary exposure to air may result in spontaneous combustion and the possibility of a fire spreading throughout the laboratory. The use of appropriate engineering controls and personal protective equipment, together with good laboratory housekeeping, will help to minimize the severity and impact of an accidental fire.

A majority of pyrophoric liquids are chemically aggressive and very corrosive reagents; accordingly, all exposure via the skin or by inhalation should be avoided. The Safety Data Sheet (SDS) will serve to identify other possible health risks that may be attendant with the use of a particular reagent.

Given the significant hazards presented by pyrophoric liquids, any researcher performing an experiment with this class of reagent ***MUST NOT WORK ALONE***.

# Engineering Controls [Provide additional information as it pertains to your research protocol]

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.

The purchase of pyrophoric gases must go through [EHS restricted gas approval](https://ehs.umich.edu/research-clinical/chemical/compressed-gas/) and undergo a review by EHS staff for use. Pyrophoric gases must be stored in gas cabinets with mechanical ventilation and may require air monitoring or special containment.

# Work Practice Controls [Provide additional information as it pertains to your research protocol]

A designated area shall be established in the lab for working with pyrophoric materials. Solvent bottles and waste bottles must be removed from the fume hood prior to work beginning. Clamp bottles and flask securely before work begins. Luer lock syringes are required for syringe transfers of pyrophoric liquids to prevent needle separation. Syringes must be at least twice the volume of the amount of material to be dispensed. Avoid using syringes for quantities greater than 10 mL. Syringes should only be used once, as repeated use can cause solid residue build-up in the syringe that will block the syringe. Use of cannula transfer techniques is recommended for procedures using more than 50 mL of pyrophoric chemicals. In general, less pyrophoric materials should always be substituted for more pyrophoric materials when possible.

For solid pyrophoric chemicals consult the SDS for appropriate handling conditions (i.e. under oil) as well as procedures and reactions to avoid. Always use tweezers or forceps for transfer of pyrophoric solids between containers, when necessary. Remember to wrap containers and glass equipment with tape to protect seals and prevent shattering. All pyrophoric chemicals must be labeled with the date received and date opened.

All lab personnel using pyrophoric materials must receive training from a qualified, experienced supervisor prior to working with pyrophoric materials. This training must include but is not limited to: procedure-specific training to review hazards of the procedure, knowledge of emergency equipment and procedures, review of standard operating procedure, review of techniques used in the procedure, and review of applicable safety data sheets.

Whenever working with pyrophoric material, all work must be done with a partner that has experience working with pyrophoric materials for the entire procedure. In addition, a full, detailed experimental procedure must be written and approved by the PI. This procedure must include reagents, handling, and quenching procedures. Class D fire extinguishers are required for research that uses reactive metals.

# Personal Protective Equipment [Provide additional information as it pertains to your research protocol]

## Eye Protection

Chemical Splash goggles or safety glasses that meet the ANSI Z.87.1 2010 standard must be worn whenever handling pyrophoric chemicals. Ordinary prescription glasses will NOT provide adequate protection unless they also meet this standard. When there is the potential for splashes, goggles must be worn, and when appropriate, a face shield added.

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.

## Skin Protection

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. The SDS for specific chemicals to be used should be consulted for direction on which glove type is recommended.

A fire-resistant, fully-buttoned, knee-length laboratory coat must be worn to protect the body. Synthetic materials tend to melt rather than char so natural fiber clothing should be worn when possible. In addition, fully enclosed shoes which cover the entire foot (with no holes in the top) must be worn.

# Transportation and Storage [Provide additional information as it pertains to your research protocol]

Containers carrying pyrophoric materials must be clearly labeled with the complete chemical name and hazard warning. Glass bottles of pyrophoric reagents should not be handled or stored unprotected. The reagent bottle should be kept within a secondary containment vessel (the metal can that the reagent bottle ships in is convenient for this purpose) and stored appropriately with other materials of the same hazard class. Note that pyrophoric materials may not be stored near any flammable or combustible materials. They should also be stored away from oxidizers, pronating chemicals, or water, if water reactive.

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.

Many pyrophoric liquids benefit from being stored in a refrigerator below 10 °C (SDS and supplier information will indicate if this is essential); however, the material should usually be allowed to warm to ambient temperature shortly before being dispensed. The refrigerator must be designed for the storage of flammable liquids, and must also be designated for the storage of pyrophoric liquids. The SDS must also be consulted for any special storage considerations regarding specific accidental reactions to avoid.

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).

# Waste Disposal [Provide additional information as it pertains to your research protocol]

Because most spent, unused, and expired chemicals/materials are considered hazardous wastes, they must be properly disposed of. **Do not dispose of chemical wastes by dumping them down a sink, flushing in a toilet or discarding in regular trash containers, unless authorized by Environment, Health & Safety (EHS) Hazardous Materials Management (HMM)**. Contact EHS-HMM at (734) 763-4568 for waste containers, labels, manifests, waste collection and for any questions regarding proper waste disposal. Also, refer to the EHS [Hazardous Waste](http://ehs.umich.edu/haz-waste/) Web page for more information.

Even in small quantity or at low molarity, pyrophoric reagents present a fire hazard and a container with any residual material within it **must never** be opened directly to the atmosphere. Both small amounts of pyrophoric materials that are quenched and larger amounts that are not quenched should be disposed of as hazardous waste by EHS-Hazardous Materials Management (HMM). All materials that are contaminated with pyrophoric chemicals must also be disposed of as hazardous waste by HMM. Contact EHS-HMM at (734) 763-4568 to notify them of any wastes contaminated by pyrophoric chemicals. The contaminated waste should not be left overnight in the open laboratory but must be properly contained to prevent fires.

# Training of Personnel

All personnel shall read and fully adhere to this SOP when handling pyrophoric materials.

# Certification

I have read and understand the above SOP. I have received approval from my Lab Director to perform this procedure. I agree to contact my Lab Director if I plan to modify this procedure.

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### Major Revisions (Tracking purposes only -- Do not print as part of SOP)

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| Date | Revision |
| 09-20-18 | EHS name and logo were added, updated the formatting, and revised the content under Exposure/Unintended Content (EN). |
| 02-25-19 | Updated links, certification and formatting (DML). |
| 06-20-22 | Reviewed and updated (WBD) |