

Standard Operating Procedure (SOP)

This Standard Operating Procedure (SOP) describes basic chemical safety information for water reactive chemicals. Prior to conducting work with water reactive chemicals personnel must obtain approval from their Principal Investigator (PI) and/or Supervisor and attend the appropriate laboratory safety training. The PI must complete the Lab-Specific Use Procedures section and provide their personnel with a copy of this SOP and a copy of the SDS from the manufacturer.

Water Reactive Chemicals

Date SOP was written:	
Date SOP was approved by PI/lab supervisor:	
Principal Investigator:	
Principal Investigator Signature:	

Type of SOP: Process Hazardous Chemical Hazardous Class

Purpose

The purpose of this standard operating procedure is to acquaint you with the proper and safe handling, use, storage, and disposal of water reactive chemicals.

Properties & Hazards

General Hazards:

Chemicals in this band react with water to release gases that are either flammable or present a health hazard. All chemicals in this band are considered highly hazardous. Some examples of water reactive chemicals include: grignard reagents (e.g. RMgX), alkali metals (e.g. Li, Na, K); alkali metal amides (e.g. KN[SiMe₃]₂); alkali metal hydrides (e.g. lithium aluminum hydride); metal alkyls (e.g. lithium, aluminum alkyls); chlorosilanes (e.g. HSiCl₃); halides of nonmetals (e.g. BCl₃, BF₃, PCl₃, PCl₅, SiCl₄, S₂Cl₂); inorganic acid halides (e.g. POCl₃, SOCl₂, SO₂Cl₂); anhydrous metal halides (e.g. AlCl₃, AlBr₃, TiCl₄, ZrCl₄, SnCl₄); organic acid halides (e.g. propionyl bromide) and anhydrides of low molecular weight (e.g. O[OCMe₃]).

The GHS and Cal/OSHA definition of this band is described in the table below:

GHS Pictogram	UCI Hazard Level	GHS Category	GHS H-Code	Cal/OSHA Definitions
	Highly Hazardous	Substances and Mixtures Which, In Contact with Water, Emit Flammable Gases (Cat.1, 2, 3)	H260, H261	Water Reactive

This band generally includes all chemicals with an NFPA special notation (white) of "~~W~~".

The production of flammable gases and heat can lead to spontaneous ignition or explosion. Some gases that are commonly produced by water reactive chemicals include: H₂, CH₄, H₂S, NH₃, PH₃, HCN, HF, HCl, HI, SO₂, and SO₃.

Water reactive materials may have pyrophoric properties and may spontaneously ignite in air. Water reactive materials may also present additional hazardous including corrosivity and/or toxicity.

Personal Protective Equipment (PPE)

Skin and Body Protection:

A flame resistant Nomex® lab coat, long pants (or equivalent) completely covering legs, and closed toed shoes must be worn.

Hand Protection:

Nitrile or neoprene gloves are typically adequate for minor splashes. Thicker gloves should be used for longer operations, larger quantities, or direct contact. Consult the SDS, and/or the lab specific use section to determine whether the material or process requires alternative hand protection.

If there is a high risk of fire, fire-resistant hand protection should be worn including a chemical resistant outer glove (neoprene) over an approved fire-resistant (Nomex®) inner glove/liner.

Eye Protection:

ANSI Z87.1-compliant safety glasses or safety goggles if a splash hazard is present.

Administrative Controls

- Never work alone with water reactive chemicals. Inform personnel in the laboratory before working with these chemicals.
- Review the Safety Data Sheets (SDSs) for all chemicals used in the experiment. Online SDSs can be accessed at <https://ehs.uci.edu/sds/index.php>.
- Prior to working with water reactive chemicals, identify and learn the risks associated with the gases which may be formed upon exposure to water.
- The reaction rate of solid material (heat and gas generation) depends on the material's surface area, smaller particle size increase the hazards associated with these materials. Design experiments with this in mind.

Engineering Controls

Gloveboxes:

Gloveboxes provide an inert and dry atmosphere making them the recommended engineering control to use when working with water reactive chemicals.

Fume Hoods:

An inert atmosphere (nitrogen or argon) manifold Schlenk line is a good alternative when working with water reactive chemicals, if a glovebox is not available or cannot be used. Proper manipulation of Schlenk manifolds will avoid exposure of water reactive chemicals to water.

Special Storage and Handling Requirements

Storage:

- Never allow water reactive materials to come into contact with water (this includes water vapor in the atmosphere).
- Keep containers tightly closed in a cool, dry, and well-ventilated place that is free of moisture/humidity. If possible, store water reactive chemicals in a desiccator or glovebox.
- Over time, pressure may increase causing containers to burst, improper storage increases the probability of this happening.
- Store and handle under an inert gas (e.g. nitrogen, argon).

- Protect storage locations from sunlight, store away from heat sources, and in a flame proof area.
- Do not leave the container on the bench top or near a source of water (e.g. lab sink, emergency eyewash, and emergency safety shower) even momentarily.
- Store in secondary containment away from acids, oxidizers, and other incompatible materials.
- Label the containers and storage locations identifying the materials as “Water Reactive”, ~~W~~.
- Ensure that sufficient protective solvent, oil, kerosene, or inert gas remains in the container while the material is stored.

Handling:

- Avoid inhalation and contact with skin, eyes, and clothing. Avoid heat, flames, sparks, and other sources of ignition. Avoid shock or friction. Protect containers from physical damage.
- Unless it is known, assume the material is pyrophoric (water reactive materials often react with water in the atmosphere).
- Handle water reactive materials under an inert atmosphere (e.g. glovebox, Schlenk line).
- A container of powdered lime, dry sand, or liquid nitrogen should be kept within arm’s length when working with water reactive materials (these can be used to smother a small spill).
- Design your experiment to use the least amount of material possible.
- Use fresh, dry solvent. Avoid the formation of dusts and aerosols.
- Keep water reactive materials away from sources of ignition (e.g. open flames, heat) and avoid the build-up of electrostatic charge.

Spill, Accident, and First Aid Procedures

Spills:

If water reactive chemicals spill within a glovebox, quench the materials, absorb the spill with non-combustible materials, and dispose of the materials as hazardous solid waste. Powdered lime, soda ash (sodium carbonate), or dry sand can be used to cover and contain a small spill outside of a glovebox. Notify your supervisor and EHS at x4-6200 immediately.

Skin or Eye Contact:

Remove contaminated clothing or contact lenses and flush the affected area with water for at least 15 minutes. Obtain medical attention immediately.

Inhalation:

Move to fresh air. Obtain medical attention immediately.

Ingestion:

Obtain medical attention immediately. (The poison control center, (800) 222-1222, is available 24 hours every day).

Fire:

Pull the fire alarm and evacuate the area. NEVER use a water or a carbon dioxide fire extinguisher, these can enhance combustion. A Class D fire extinguisher is recommended for combustible solid metal fires (e.g. sodium), and a standard dry powder (ABC) fire extinguisher is recommended for other materials.

Waste Disposal Procedure

Quenching:

- Used water reactive materials should be quenched under an inert atmosphere with adequate cooling. Never use water to quench water reactive materials.
 - Refer to the SDS or a published quenching procedure to design a quenching scheme for residual materials. If a published quenching procedure is not available, this procedure is useful to quench the majority of pyrophoric and water reactive materials: slowly add isopropanol under an inert atmosphere while cooling and stirring.

Disposal:

- Hazardous waste must be transferred to EHS for disposal within 6 months of being generated.
- Hazardous Waste Disposal
 - [Text a pick up](mailto:hwp@uci.edu) to hwp@uci.edu, EHS will pick up your waste within 1-3 days
 - Or visit www.ehs.uci.edu/programs/enviro/

Additional Information

For additional information about handling water reactive materials, refer to:;

- UCI Chemical Hygiene Plan: https://www.ehs.uci.edu/programs/_pdf/lab-res/chemical-hygiene-plan.pdf
- Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards (section 4.D.2.1 "Water Reactives" The National Academies Press: Washington, DC, 2011. (<https://nap.nationalacademies.org/catalog/12654/prudent-practices-in-the-laboratory-handling-and-management-of-chemical>)).

APPENDIX A: **Lab-Specific Use Procedures**

The following procedures describe how the subject chemicals are used in this laboratory beyond the practices described above.

Please see the General Information for ***Hazardous Materials Standard Operating Procedure*** for specific instructions on writing lab-specific use produces.

This section must describe lab-specific procedures to address the safe use of all highly hazardous chemicals from this band in use in the laboratory. These procedures may be organized around specific chemicals, specific tasks or the band as a whole.

