UC Irvine
Environmental Health & Safety

Water-Reactive Chemicals

REFERENCE GUIDE

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Water-reactive chemicals react with water to release gases that are either flammable or present a health hazard. Some may also exhibit pyrophoric properties. All are considered highly hazardous. Water-reactive chemicals should never be exposed to the atmosphere since water in the air can react with them. Care must be taken to ensure these materials are stored and handled properly in inert environments to avoid contact with moisture. Failure to follow proper handling procedures can result in chemical exposure, fire, or explosion, leading to serious injuries or death and significant damage to facilities. All labs using water-reactive materials must have a Standard Operating Procedure (SOP) approved by the Principal Investigator (PI) that includes lab-specific procedures, reviewed and signed by all lab personnel.

Examples of water-reactive chemicals include Grignard reagents, alkali metals, alkali metal amides, alkali metal hydrides, metal alkyls, chlorosilanes, halides of nonmetals, inorganic acid halides, anhydrous metal halides, organic acid halides, and anhydrides of low molecular weight. Some gases that are commonly produced by water-reactive chemicals include: Hydrogen (H_2), Methane (CH_4), Hydrogen Sulfide (H_2S), Ammonia (NH_3), Phosphine (PH_3), Hydrogen Cyanide (HCN), Hydrogen Fluoride (HF), Hydrogen Chloride (HCl), Hydrogen Iodide (HI), Sulfur Dioxide (SO_2), and Sulfur Trioxide (SO_3).

Always review the Safety Data Sheet (SDS) and product information of the chemicals you are working with. Water-reactive chemicals are identified on SDSs with the Globally Harmonized System (GHS) codes H260 and H261 for “substances and mixtures, which in contact with water, emit flammable gases.” The H260 code indicates that these materials may have pyrophoric properties and can emit “flammable gases which may ignite spontaneously.”

Additionally, water-reactive chemicals are generally indicated by the NFPA with a special notation in the white quadrant of the fire diamond, denoted with ₩ to indicate ‘no water’.

Definitions

Water-Reactive Material: A material that explodes; violently reacts; produces flammable, toxic or other hazardous gases; or evolves enough heat to cause autoignition or ignition of combustibles upon exposure to water or moisture.

Cannula: A piece of stainless steel or plastic tubing used to transfer liquids or gases from one vessel to another without exposure to air.

Schlenk Line: Laboratory equipment used to transfer and manipulate air and water-sensitive materials without the use of an inert atmosphere glove box. It consists of a dual manifold in which the vacuum manifold is connected to a vacuum pump and the inert gas manifold is connected to a source of purified and dry inert gas (typically nitrogen or argon).

Glove Box: Sealed enclosure designed to create and maintain an inert environment free from air and moisture.

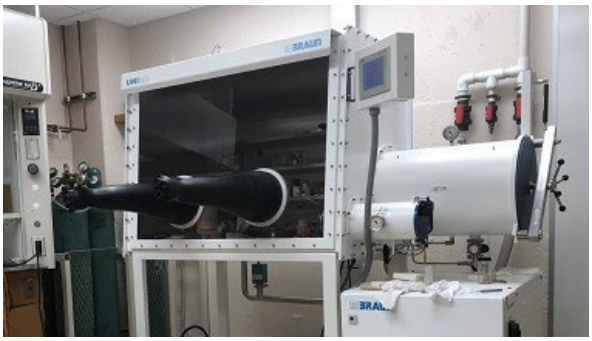
Storage Requirements

- Must be handled and stored under an inert atmosphere at all times.
- Containers must be tightly closed and kept in a cool, dry, well-ventilated area free from moisture. Ideally, store water-reactive materials in an approved hazardous materials storage cabinet, glove box, or desiccator. Note that storage in glove boxes and desiccators does not allow for an increase in the maximum amount that can be stored in the lab.
- Keep segregated from all other chemical classes and incompatibilities, including oxidizers and flammables.
- Ensure sufficient protective solvent, oil, kerosene, or inert gas remains in the container while the material is stored.
- Protect storage areas from sunlight and heat and do not store water-reactive materials near sinks or other water sources.
- It is best practice to store glass containers of water-reactive material with protection, such as within a metal container or other suitable secondary containment. Avoid stacking glass bottles of water-reactive material on top of each other. Hairline cracks in glass bottles or inadvertant dropping can lead to fire, toxic gas release, and/or potentially serious injury.
- Use an appropriate secondary container, preferably one that can be sealed, and a cart with at least 2” lip to transport water-reactive material. Reference the Moving and Transporting Hazardous Materials Reference Guide for more information.

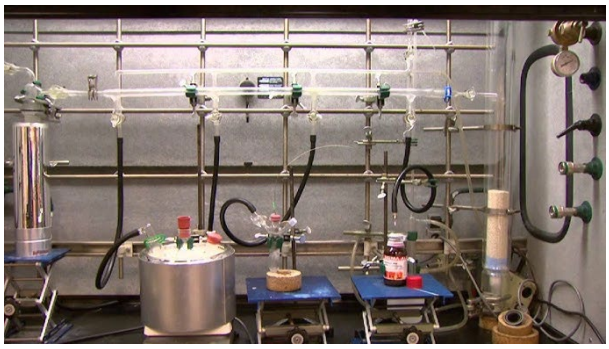
Handling

- Unless it is known, assume the water-reactive material is also pyrophoric.
- **NEVER WORK ALONE.** At least one other person must be informed and present in the same room while work with water-reactive chemicals is being conducted.
- Water-reactive material must be transferred within a glove box or by using a proper syringe (locking tip), cannula, or Schlenk line when working in a fume hood. Syringes should not be used when transferring more than 20 ml of water-reactive liquid.
- Never return excess material to the original container.
- Always have a container of powdered lime, dry sand, and/or liquid nitrogen within arm’s reach to smother a small spill. Always have a Class ABC fire extinguisher on hand, and Class D if combustible metals are involved. Never use a water or CO_2 fire extinguisher to put out fire involving water-reactive material.

Glove Box



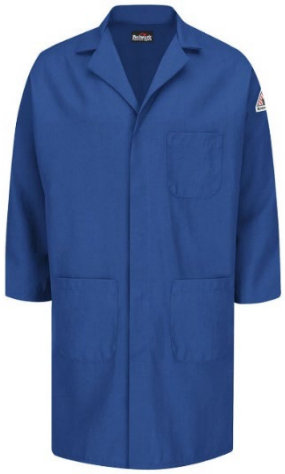
Schlenk Line



Cannula

Personal Protective Equipment

- A flame resistant Nomex® lab coat, long pants completely covering legs, and closed toe shoes. *Never wear synthetic clothing when working with water-reactive material.*
- If handling outside of a glovebox, fire-resistant hand protection is required; chemical resistant outer glove (neoprene) over approved fire-resistant (Nomex®) inner glove/liner.



- ANSI Z87.1-compliant safety glasses, or safety goggles if splash hazard is present. A face shield over safety glasses is recommended if an explosion or high fire hazard is present.

Waste Disposal

- Used water-reactive material should never be returned to the original container and must instead be quenched under an inert atmosphere with adequate cooling.
    - Follow a published quenching procedure from a reputable source for the material you are working with (ie. a UC Standard Operating Procedure, National Lab procedures, other peer-reviewed publications).
    - Do not quench with water.
    - The following procedure can be used to quench most water-reactive materials:
        - Add extra water-reactive material to a non-reacting solvent compatible with the material, ensuring no exposure to air or moisture during the transfer process.
        - Ensure that water-reactive residues are rinsed from inside glassware with non-reacting solvent compatible with the residue.
        - Slowly add isopropanol under an inert atmosphere while cooling and stirring.
- Ensure waste containers with water-reactive residue are not left open to the atmosphere.
- All quenched water-reactive material, solvent, and residue rinses must be disposed of as hazardous waste. Keep water-reactive waste separate from all other waste streams and ensure all contents are compatible.
- Hazardous waste must be transferred to Environmental Health & Safety (EHS) for disposal within 6 months of being generated.

Maximum Allowable Quantity (MAQ)

- There are limits to the amount of water-reactive material that can be stored within buildings, which must be adhered to at all times. These limits are determined by the 2025 California Fire Code and are based on the building's construction attributes and ease of access for first responders. The amount of material that can be stored in a given area decreases drastically on higher floors.
- Storage capacity can increase with the use of approved storage solutions and if work is done in a fully sprinklered building, depending on building occupancy type.
- Ensure that your lab is equipped to handle water-reactive material before purchasing and storing within your space. If you are unsure, contact EHS.
- For more information on MAQs, visit the EHS Website MAQ Page and/or review the UC Irvine MAQ Reference Guide

References

- UC Irvine Chemical Hygiene Plan
- 2025 California Fire Code
- National Academies Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards (2011)
- Moving and Transporting Hazardous Materials Reference Guide
- EHS Website MAQ Page
- UC Irvine MAQ Reference Guide

Contact EHS at (949) 824-6200 or safety@uci.edu for more information and questions regarding this guide.