

CHEMICAL SAFETY GUIDE

PEROXIDE FORMING 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:

Peroxide forming chemicals (PFC) are chemicals that react with atmospheric oxygen to form peroxides (chemicals containing an O-O bond) over time and can become sensitive to heat, shock, and/or friction. Accumulation of peroxide formers in the laboratory has resulted in numerous explosions. Peroxide formation is an autoxidation reaction that can be initiated by light, heat, concentration, contamination, and/or loss of an inhibitor.

Peroxide-forming chemicals are divided into three categories (Class A, B, and C) outlined in the table below. The tables below list some common peroxide forming chemicals and testing frequencies. **The tables are non-exhaustive - review each material's SDS to determine if a chemical can form peroxides, and to check for other hazards.**

	Class A	Class B	Class C
Definition	Chemicals form explosive levels of peroxides without concentration. These are the most hazardous and can form explosive peroxide levels even if not opened.	Chemicals form explosive levels of peroxides upon concentration through distillation, evaporation, or exposure to air after opening	Chemicals may auto polymerize as the result of peroxide formation
Testing for Peroxides Frequency	Test or discard after 3 months of receiving	Test or discard after 6 months.	Test or discard after 12 months
Common Examples	Isopropyl ether Divinyl acetylene Potassium metal Potassium amide Sodium amide Vinylidene chloride	Benzyl Alcohol Dicyclopentadiene Diethyl ether Tetrahydrofuran 1,4-Dioxane Vinyl Ethers Sec. Alcohols	Acrylic acid Acrylonitrile Butadiene Chloroprene Methyl methacrylate Styrene Vinyl acetate

All peroxide forming chemicals are considered a High-Risk chemical. There are no specific

CHEMICAL SAFETY GUIDE

PEROXIDE FORMING CHEMICALS



hazard classifications for peroxide forming chemicals defined by OSHA or GHS.

Contact EHRS via ehrschem@temple.edu for questions on the safe management of Peroxide Forming Chemicals.

2. POTENTIAL HAZARDS:

Peroxide formation in common laboratory chemicals is caused by an autoxidation reaction. The reaction can be initiated by light, heat, introduction of a contaminant, oxygen, or the loss of an inhibitor. Some chemicals have inhibitors such as BHT (butylated hydroxytoluene), hydroquinone, and diphenylamine to slow peroxide formation. Most organic peroxide crystals are sensitive to heat, shock, or friction, and their accumulation in laboratory reagents has resulted in numerous explosions. In addition, some chemicals will autopolymerize as a result of peroxide accumulation. Autopolymerization can result in a rapid temperature rise, leading to over pressurization and catastrophic container failure. For these reasons, it is important to identify and control chemicals that form potentially explosive peroxides.

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 Peroxide Forming 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 [EHRS Management System-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:

- Whenever possible, avoid purchasing a volume of any peroxide forming chemical that

CHEMICAL SAFETY GUIDE

PEROXIDE FORMING CHEMICALS



cannot be used before the required test/disposal date.

- Purchase peroxide formers with inhibitors added by the manufacturer when possible.
- When possible, look for alternative procedures or reagents that will eliminate the need for the PFC, or substitute it for a less hazardous chemical.
- Purchase peroxide test strips/kits.

Engineering Controls:

- All manipulations of peroxide forming chemicals must be conducted in containment devices (e.g., chemical fume hoods, gloveboxes, or similar devices). Keep the sash as low as possible when working in a chemical fume hood,
- If a fume hood or other containment device is not feasible contact EHRS to review the adequacy of the ventilation and alternative ventilation measures.
- Safety shielding and barricades are required any time there is a risk of explosion, splash hazard or a highly exothermic or vigorous chemical reaction. All manipulations of peroxide forming chemicals that pose this risk should occur in a fume hood with the sash in the lowest feasible position.

Administrative Controls-General:

- Never work alone. At least one other person familiar with the hazards of the PFC chemical must be present in the laboratory.
- Work with these chemicals must be performed in an area that is within 10 seconds (~ 55 feet) of a functioning safety shower and emergency eyewash.
- Due to the strict limitations on prolonged storage of peroxide formers, do not order large containers, only order the amount of peroxide formers you need for planned or foreseeable experiments.
- Always keep a testing record for peroxide forming chemicals including the date received, date opened, and date last tested. Each bottle should be labeled with this information.
- Follow the shelf life & peroxide testing guidelines listed in Evaluating Peroxide Formers and Common Peroxide Forming Chemicals section below in this document.
- Inform your colleagues about the PFC and where it will be used.
- Use the smallest necessary amount of the PFC.
- Consult with PI before scaling up procedures involving PHF chemicals.
- If PHFs are to be used in research animals, ensure that they are listed on the laboratory's IACUC.

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:

CHEMICAL SAFETY GUIDE

PEROXIDE FORMING CHEMICALS



- 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 PHF 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 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 traditional lab coat. Wear a flame resistant Nomex® lab coat when working with large quantities of PFCs. Additional protective clothing should be worn if the possibility of skin contact is likely or working with large quantities.

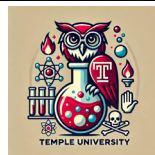
Hand Protection:

Gloves must be worn when handling PFCs. Disposable nitrile gloves provide adequate protection against accidental contact with small quantities of most laboratory chemicals. However, the handling of some chemicals will require specific chemical resistant gloves. Many chemicals, including acetone and methylene chloride, easily penetrate common laboratory gloves.

If direct or prolonged contact is anticipated, consult the SDS, glove manufacturers compatibility charts and/or the laboratory specific SOP to determine whether the material or process requires

CHEMICAL SAFETY GUIDE

PEROXIDE FORMING CHEMICALS



alternative hand protection. Additional protective clothing should be worn if the possibility of skin contact is likely.

Eye Protection:

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

Additional Hygiene Measures:

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 peroxide forming 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.
- Store in airtight containers in a dark, dry, and cool but not freezing area.
- Do not permit sources of heat, friction, grinding, or impact near storage areas.
- Date upon receiving and opening all incoming peroxide forming chemicals and dispose of or test immediately upon reaching their expiration date. Contact EHRS at ehrschem@temple.edu for labels.
- Some peroxide-formers should be stored under nitrogen (or other inert gas) – consult the chemical's SDS for more information.
- Store all flammable PFCs in approved flammables cabinets and keep separate from any incompatible chemicals.
- Flammable PFCs that require refrigeration must only be stored in laboratory-safe flammable material refrigerators or freezers.
- Peroxide forming chemicals should be stored in their original manufacturer's container.
- Minimize the quantity of peroxide forming chemicals stored in the lab.

CHEMICAL SAFETY GUIDE

PEROXIDE FORMING CHEMICALS



Handling:

- **Mark the container with the date it was received, and the date opened. If tested for peroxides, note the date it was tested.**
- Periodically test containers with peroxide strips. Refer to section below of Evaluating Peroxide Forming Chemicals for more information.

NOTE: some peroxide formers (including alkali metals and their amides) should not be tested with standard peroxide strips because they are both water and oxygen-reactive.

- Test for peroxides before any distillation or purification of peroxide forming chemicals. Use extreme caution when concentrating or purifying peroxide forming chemicals as explosions can occur. Refer to section below on Evaluating Peroxide Forming Chemicals.
- Do not use metal spatulas to handle peroxides because contamination by metals can lead to explosive decomposition. Magnetic stirring bars can unintentionally introduce iron, which can initiate an explosive reaction of peroxides. Ceramic, Teflon, or wooden spatulas and stirring blades may be used if it is known the material is not shock-sensitive.
- Never allow peroxide formers to evaporate to dryness, such as during distillation, always leave a minimum of 20% liquid.
- Peroxide crystals formed in a chemical container are particularly likely to accumulate within the threads of the screw cap and may explode when subject to heat, light, friction, or mechanical shock (e.g., unscrewing the cap). Never open, move, or disturb a bottle that is suspected to have peroxides.
- Never open, disturb, or move a container suspected of having peroxides, notify EHRS immediately for evaluation or disposal.

Transportation:

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

7. EVALUATING PEROXIDE FORMERS

Initial Screening:

1. Notify your PI.
2. Verify identity of chemical.
3. Check the date last opened (or, if unopened, date received) is known and is within the recommended safe storage period per guidance below.

CHEMICAL SAFETY GUIDE

PEROXIDE FORMING CHEMICALS



4. Make sure that evaporation of the chemical is known or estimated to be less than 10%.
5. Make sure container shows **no** discoloration, liquid stratification, or crystallization around cap or in solution.

CAUTION: Never try to force open a rusted or stuck cap on a container of a peroxide-forming chemical. Do not open a dented container.

If any point above cannot be verified, the container should be considered unsafe and should not be disturbed. Promptly call EHRS at 215- 707-2520 for assistance with safe disposal.

Peroxide Testing:

Container passing initial screening may be evaluated for peroxide content. There are several methods that are commonly used to detect for peroxides in the laboratory. The most convenient method is the use of peroxide test strips that are manufactured by several companies. These strips are simple to use and can be obtained from a chemical supplier. Test methods for aqueous solutions and organic solvents vary by manufacturer so it is important to follow the instructions supplied with the strips purchased for use in the lab. A color change on the strip indicates the presence of peroxides. The color chart provided for comparison to determine the concentration of peroxides present should be considered a guideline only. In the event the strip does change color, the safest action is to contact EHRS to have the chemical picked up for disposal. Should the lab desire to keep the chemical, additional specific tests for peroxides are available and will need to be utilized.

For ease of tracking, testing should be conducted on a specific schedule (determined by the lab). Labs should maintain a record of testing with other safety-related information.

Assessing Peroxide Levels	
<25 ppm	Considered safe for routine use
25-100 ppm	Not recommended for distilling or otherwise concentrating
>100 ppm	Avoid handling, contact EHRS at 215-707-2502 or ehrschem@temple.edu for additional information.

8. WASTE DISPOSAL PROCEDURES

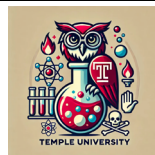
All spent, unused, expired and materials contaminated with PFCs must be disposed of as a *regulated chemical waste* through EHRS.

Accumulation Limits:

Any unopened container of a peroxide forming chemical must be submitted as a regulated

CHEMICAL SAFETY GUIDE

PEROXIDE FORMING CHEMICALS



chemical waste within 18 months of receipt or by the expiration date noted on the containers, whichever comes first.

Specific Instructions:

1. Do not dispose of chemical waste by dumping down a sink or discarding in regular trash.
2. Contact EHRS immediately to arrange for pick-up and disposal if:
 - No receipt date is found on the container and the age of the chemical is unknown.
 - Crystals are found around the lid of the container. Do not attempt to open the container.
 - The container tests positive for peroxides

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: **Other: Peroxide Forming Chemical**
 - c. Applicable Hazards are identified: **Ignitable, Corrosive, Toxic or Reactive (as applicable)**
 - d. All chemical constituents and amounts (%) are included on the tag.
2. Submit a Chemical Waste Pickup Request Form prior to exceeding the accumulation limits.
3. 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.

9. 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 1-12234 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.

Temple University Hospital Emergency Department

CHEMICAL SAFETY GUIDE

PEROXIDE FORMING CHEMICALS



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

Move into fresh air.

Needle stick/puncture exposure.

CHEMICAL SAFETY GUIDE

PEROXIDE FORMING CHEMICALS



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.

10. SPILL RESPONSE

1. Notify your PI and all individuals in the general vicinity that a spill has occurred.
2. Isolate the area and keep other personnel from
3. Evacuate the spill area. Avoid breathing vapors, dusts, or aerosols from the spill.
4. If safe to do so, help contaminated or injured persons evacuate.
5. If possible, confine the spill to a small area using a spill kit or absorbent material.
6. 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

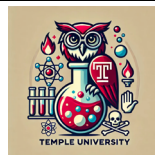
Defined as any hazardous chemical spill that:

- 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.

CHEMICAL SAFETY GUIDE

PEROXIDE FORMING CHEMICALS



Refer to Laboratory Emergencies for additional information.

11. REFERENCES

1. Peroxides and peroxide-forming compounds. D.E Clark. Chemical Health and Safety, 8:12-22
2. Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards. National Research Council, Updated Version-2011
3. 29 CFR 1910.1250-Occupational exposure to hazardous chemicals in laboratories.
4. Temple University-Chemical Hygiene Plan