Standard Operating Procedures

Peroxide Forming Chemicals (PFC) – Class 2

Diethyl Ether

Print a copy and insert into your laboratory SOP binder.

<table>
<thead>
<tr>
<th>Department:</th>
<th>Chemistry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date SOP was written:</td>
<td>June 20, 2013</td>
</tr>
<tr>
<td>Date SOP was approved by PI/lab supervisor:</td>
<td></td>
</tr>
<tr>
<td>Principal Investigator:</td>
<td>Name: Richmond Sarpong</td>
</tr>
<tr>
<td></td>
<td>Signature: __________________________</td>
</tr>
<tr>
<td>Internal Lab Safety Coordinator or Lab Manager:</td>
<td>Name: Rebecca Murphy</td>
</tr>
<tr>
<td>Lab Phone:</td>
<td>510-643-2485</td>
</tr>
<tr>
<td>Office Phone:</td>
<td>510-642-6312</td>
</tr>
<tr>
<td>Emergency Contact:</td>
<td>Name: Richmond Sarpong</td>
</tr>
<tr>
<td>Phone Number:</td>
<td>626-644-2407</td>
</tr>
<tr>
<td>Location(s) covered by this SOP:</td>
<td>Latimer Hall: 834, 836, 837, 838, 839, 842, 847, 849, 907</td>
</tr>
</tbody>
</table>

1 - Purpose

This SOP covers the precautions and safe handling procedures for the use of Diethyl Ether in the Sarpong group, which include the following uses:

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diethyl Ether</td>
<td>1. Used in the lab as a solvent in reactions and extractions.</td>
</tr>
<tr>
<td></td>
<td>2. Used in the lab as a solvent in column chromatography.</td>
</tr>
</tbody>
</table>

2 - Physical & Chemical Properties/Definition of Chemical Group

CAS#: 60-29-7
Molecular Formula: C₄H₁₀O
Form: liquid
Color: colorless
Melting point/freezing point: -116 °C (-177 °F)
Boiling point: 34.6 °C (94.3 °F)
Vapor pressure: 563 hPa (422 mmHg) at 20 °C (68 °F)
Density: 0.706 g/mL at 25 °C (77 °F)
Flash point: -40 °C (-40 °F) - closed cup
Lower explosion limit: 1.8 % (V)
Upper explosion limit: 48 % (V)
Odor: no data available
Odor Threshold: no data available

3 - Potential Hazards/Toxicity

GHS Classification
- Flammable liquids (Category 1)
- Acute toxicity, Oral (Category 4)
- Acute toxicity, Inhalation (Category 5)
- Skin irritation (Category 3)
- Eye irritation (Category 2A)
- Specific target organ toxicity - single exposure (Category 3)

GHS Label elements, including precautionary statements

Pictogram

Signal word Danger

Hazard statement(s)
- H224 Extremely flammable liquid and vapor.
- H302 Harmful if swallowed.
- H316 Causes mild skin irritation.
- H319 Causes serious eye irritation.
- H333 May be harmful if inhaled.
- H336 May cause drowsiness or dizziness.

Precautionary statement(s)
- P210 Keep away from heat/sparks/open flames/hot surfaces. - No smoking.
- P261 Avoid breathing dust/ fume/ gas/ mist/ vapors/ spray.
- P305 + P351 + P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

Other hazards
- May form explosive peroxides. Repeated exposure may cause skin dryness or cracking.

Cal/OSHA Permissible Exposure Limits (PEL): 400 ppm (1200 mg/m³) – 8 hour TWA; 500 ppm STEL (1500 mg/m³)

4 - Engineering Controls

Use the engineering controls listed below unless other lab-specific information is included in the Protocol/Procedure section.

- A laboratory type fume hood with the sash position closed as much as possible;
- A glove box for pyrophorics and water reactive chemicals. Glove boxes may also be required for other chemicals, such as regulated carcinogens and particularly hazardous substances;
- Supplemental protective equipment like a blast shield, where appropriate, to protect from explosions when using peroxide formers, pyrophorics, water reactives, and potentially explosive chemicals.
5 - Personal Protective Equipment

For additional information on PPE requirements, go to:
http://cehss.berkeley.edu/section5#Personnel_Protective_Equipment_Required_in_College_Laboratories

Use the PPE listed below unless other lab-specific information is included in the Protocol/Procedure section.

Eye and Face Protection

ANSI-approved safety glasses with side shields or chemical splash goggles must be worn at all times when handling chemicals in the lab.

Skin and Body Protection

1. Gloves are required when handling hazardous chemicals.
   a. Specific glove type recommendations are provided in the Protocol/Procedure section.
   b. Inspect gloves prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Wash and dry hands after handling chemicals, before breaks, and at the end of the workday.
   c. For additional information on glove selection, go to:

2. Lab coats are required when handling hazardous chemicals in the lab.
   a. Nomex 3A flame-resistant lab coats are required when working with pyrophorics (H250) and explosives (H200, H201, H202, H203)
   b. Flame resistant lab coats (Nomex or other material) should be worn when working with materials such as Category 1 or 2 flammable liquids (H224 and H225).

3. Cotton-based, non-synthetic clothing (including long pants; no skin exposed below the waist) should be worn.

4. Closed-toe and closed-heel shoes are required in the lab.

Respiratory Protection

Respiratory protection is normally not required for UC Berkeley laboratory activities. Any lab personnel considering the use of a respirator must contact EH&S for a workplace assessment. Respirator users will be provided with specific instructions if a respirator is deemed necessary by EH&S.

6 - First Aid Procedures and Medical Emergencies

Notify supervisor and EH&S immediately. Follow up with a call to 510-642-9090 to report the incident.

Life Threatening Emergency, After Hours, Weekends and Holidays – Call 911 or go to the nearest emergency room. Note: All serious injuries must be reported to EH&S within 8 hours. Follow up with a call to 510-642-9090 to report the incident.

Assess the extent of danger. If you cannot assess the conditions of the environment well enough to be sure of your own safety, do not enter the area. If possible, help contaminated or injured persons. Obtain medical attention for the individual as soon as possible by calling 911. Provide a copy of the appropriate SDS to the emergency responders or physician, as needed.

If inhaled

Move into fresh air. Go to the Occupational Health Facility (Tang Health Center) and after hours, go to the nearest emergency room. If person is not breathing, call 911 and give artificial respiration. If unconscious, call 911.
In case of skin contact
Immediately flush with flowing water for no less than 15 minutes; remove any jewelry or clothing as necessary to facilitate clearing of any residual materials. Wash off with soap and plenty of water for 15 minutes. If skin contact requires medical assistance, go to the Occupational Health Facility (Tang Health Center) and after hours, go to the nearest emergency room. If this is a large or serious injury, call 911.

In case of eye contact
Rinse thoroughly with plenty of water using an eyewash station for at least 15 minutes, occasionally lifting the upper and lower eyelids. Remove contact lenses if possible. Call 911.

If swallowed
Call 911. Do not induce vomiting unless directed otherwise by the SDS. Never give anything by mouth to an unconscious person. Rinse mouth with water. Go to the Occupational Health Facility (Tang Health Center) and after hours, go to the nearest emergency room.

Needle stick/puncture exposure
Wash the affected area with antiseptic soap and warm water for 15 minutes. For mucous membrane exposure such as eyes, mouth and/or nose, flush the affected area for 15 minutes using an eyewash station. Go to the Occupational Health Facility (Tang Health Center) and after hours, go to the nearest emergency room.

All needle stick/puncture exposures must be reported to EH&S within 8 hours. Follow up with a call to 510-642-9090 to report the incident.

7 - Special Handling and Storage Requirements
Lab-specific information on handling and storage may be included in the Protocol/Procedure section.

Working alone - Certain extremely hazardous operations should not be performed if the PI or Lab Safety Contact(s) are not present. Never work alone with extremely hazardous materials/operations. See the Protocol/Procedure section below for specific prohibitions (if any) on working alone.

Precautions for safe handling
- Avoid contact with skin and eyes. Avoid formation of vapors, dusts, mists and aerosols.
- Use appropriate exhaust ventilation.
- Use appropriate personal protective equipment.
- Remove incompatible chemicals from immediate work area.
- Keep flammable, pyrophoric, potentially explosive and water reactive chemicals away from sources of ignition
- Use care when preparing chemical solutions.

Conditions for safe storage
- Keep quantities to a minimum.
- Keep containers tightly closed and in a cool, dry and well-ventilated location.
- Keep in proper storage cabinets and shelving. Use lowest shelf possible.
- Assure chemicals are properly labeled.
- Segregate incompatible chemicals.
- Store carcinogens in a designated area.
- Provide secondary containment for chemicals in accordance with the cCEHS "Chemical Hygiene Plan": http://ccehss.berkeley.edu/section5#Chemical_Handling_Storage_and_Transportation
8 - Chemical Spill

**Spill** – Assess the extent of danger; if necessary request help by calling 911 and 510-642-9090. If you cannot assess the conditions of the environment well enough to be sure of your own safety, do not enter the area. If possible help contaminated or injured persons. Evacuate the spill area. Avoid breathing vapors from spill. If possible, confine the spill to a small area using a spill kit or absorbent material. Keep others from entering contaminated area (e.g., use caution tape, barriers, etc.).

**Minor Spill** – In the event of a minor spill, if there is no potential for hazardous chemical exposure, report the spill to 510-642-9090 and proceed to clean it, if you are trained. Use appropriate personal protective equipment and clean-up material for chemical spilled. Double bag spill waste in clear plastic bags, label and take to the next chemical waste pick-up location.

Call 510-642-9090 to report the spill to ccEHSS and for assistance.

**Major Spill** – Any hazardous chemical spill that involves chemical exposure, any chemical spill that due to size and/or hazard requires capabilities beyond your training, or any chemical spill that gives the perception (because of odor, for example) that there has been a hazardous release

Call 911 and 510-642-9090 to report the spill to ccEHSS and for assistance.

9 - Cleaning and Decontamination

Lab-specific information on decontamination may be included in the Protocol/Procedure section.

- Wearing proper PPE, laboratory work surfaces should be cleaned at the end of each work day.
- Dispose of contaminated materials in accordance with hazardous waste disposal guidelines referenced below.
- Decontaminate all equipment before removing from a designated area.

10 - Hazardous Waste Disposal

**Label Waste**

Label all containers with the label provided at: [http://ehs.berkeley.edu/hm/279-new-hazardous-waste-program-hwp.html](http://ehs.berkeley.edu/hm/279-new-hazardous-waste-program-hwp.html).

See the EH&S Fact Sheet, “Hazardous Waste Management” for general instructions on procedures for disposing of hazardous waste.

**Dispose of Waste**

- Dispose of regularly generated chemical waste within 6 months.
- Call EH&S with questions.

11 - Safety Data Sheet (SDS) Location

SDS can be accessed online at [http://ucmsds.com](http://ucmsds.com)
## 12 - Protocol/Procedure – Diethyl Ether

<table>
<thead>
<tr>
<th>Preparation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keep away from sources of ignition - No smoking. Take measures to prevent the buildup of electrostatic charge.</td>
</tr>
<tr>
<td>Never open a dented or otherwise compromised container of diethyl ether. Alert lab safety coordinator and EH&amp;S immediately.</td>
</tr>
<tr>
<td>Never open/use/move a diethyl ether container that is suspected to contain peroxides or is in contact with crystals indicative of peroxide formation. Do not touch the crystals. Alert lab safety manager and EH&amp;S immediately.</td>
</tr>
<tr>
<td>NEVER distill potential peroxide-forming chemicals to dryness. Always leave a minimum of 20% still bottoms. When possible, add a non-volatile organic compound (such as mineral oil) to dilute any peroxides remaining after distillation.</td>
</tr>
<tr>
<td>Know the location of the nearest fire extinguisher, eyewash, and safety shower before beginning work.</td>
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<table>
<thead>
<tr>
<th>Chemical Storage and Disposal</th>
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<tbody>
<tr>
<td><strong>Storage</strong></td>
</tr>
<tr>
<td>Store containers in an approved area, such as a ventilated flammable storage cabinet.</td>
</tr>
<tr>
<td>Segregate from any incompatible materials, such as oxidizing agents and strong acids.</td>
</tr>
<tr>
<td>Keep containers in a cool, well-ventilated area.</td>
</tr>
<tr>
<td>Avoid all possible sources of ignition (spark or flame). Protect from flames, static electricity and sources of heat.</td>
</tr>
<tr>
<td>Prolonged exposure to air and light may form unstable explosive peroxides unless inhibited against peroxide formation.</td>
</tr>
<tr>
<td>Store and transport containers in secondary containment (for example polyethylene bottle carrier).</td>
</tr>
<tr>
<td>Keep storage containers closed (air tight) when not in use.</td>
</tr>
<tr>
<td>Purchase Diethyl Ether with inhibitors added (for peroxide-forming) when possible.</td>
</tr>
<tr>
<td>Due to its peroxide-forming hazard, Diethyl Ether containers must be dated upon receipt and at the time they are opened (mark the date on the bottle). If tested, note the date it was tested on the bottle. Unopened containers of Diethyl Ether have a maximum shelf life of 18 months. Opened containers of Diethyl Ether have a maximum shelf life of 12 months. Test open Diethyl Ether containers with peroxide test strips every 3 months. Dispose of unused amounts after that period of time has passed (or if peroxides are found to be present by testing).</td>
</tr>
<tr>
<td>Degassed Diethyl Ether may be stored in resealable Schlenk flasks under an atmosphere of argon or nitrogen, or stored in closed containers in a glove box with a nitrogen or argon atmosphere.</td>
</tr>
<tr>
<td><strong>Disposal</strong></td>
</tr>
<tr>
<td>Diethyl Ether waste is considered hazardous. Collect all liquid waste in labeled 1 gallon plastic containers.</td>
</tr>
<tr>
<td>Store hazardous waste in closed containers, in secondary containment and in a designated location.</td>
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</tbody>
</table>
### Lab-specific Information

All work using diethyl ether should be carried out inside a fume hood with proper ventilation and if possible the container holding the solvent should be capped to prevent excessive evaporation of solvent.

Given its low boiling point (35 °C) diethyl ether is typically not used at temperatures above 50 °C, but can be used at temperatures down to –100 °C.

<table>
<thead>
<tr>
<th>Procedure/Use</th>
<th>Scale</th>
<th>Engineering Controls/Equipment</th>
<th>PPE (eye, face, gloves, clothing)</th>
<th>Procedure Steps and Precautions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Diethyl ether is used in the lab as a solvent in reactions and extractions.</td>
<td>Up to 500 ml diethyl ether per reaction or extraction</td>
<td>All work using diethyl ether must be performed in a ventilated fume hood. Eliminate ignition sources such as open flames, hot surfaces, steam baths, static electricity, and operation of mechanical and electrical equipment that is not intrinsically safe. Ensure proper grounding and avoid creating static electricity. Be sure to ground metal containers when transferring flammable liquids. Use a blast shield if diethyl ether may be distilled to dryness or evaporated to</td>
<td><strong>Eye protection:</strong> Wear ANSI Approved tight-fitting safety goggles or safety glasses with side shields. <strong>Face protection:</strong> Wear a face shield when handling containers of diethyl ether that are not behind a lab hood sash or blast shield. <strong>Gloves:</strong> Wear fluorinated rubber or nitrile gloves for incidental contact. Extended contact with diethyl ether should generally be avoided. <strong>Clothing:</strong> Wear flame resistant lab coat; cotton based clothing/attire; full length pants or equivalent; and close-toed, close-heeled shoes.</td>
<td>Do not allow to evaporate to near dryness unless absence of peroxides has been shown. If diethyl ether is concentrated on the rotary evaporator, use two dry ice traps to collect the solvent vapors. Distillation/evaporation of diethyl ether efficiently removes all stabilizers. Collected fractions (rotavap) must be treated as unstabilized diethyl ether and must be disposed of soon after generation. Pressure can be built up if diethyl ether is used in reactions. Adequate ventilation (pressure bubbler on Schlenk manifold, or an equilibrating balloon) has to be used to prevent dangerous over pressurization.</td>
</tr>
<tr>
<td>Notes</td>
<td>Any deviation from this SOP requires approval from PI.</td>
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</table>

Dryness. Only when absolutely necessary to transfer larger quantities of diethyl ether, use an appropriately-designed, engineered system that is tested and properly used.

Pressure is built up if diethyl ether is used in extractions. Adequate ventilation (open the valve frequently during the extraction) has to be used to prevent dangerous over pressurization.

If heated, the reaction apparatus has to be fitted with an adequately sized condenser and an adequate flow of cooling water has to be provided to prevent evaporation. Cooling hoses have to be secured with metal hose clamps to the condenser and the outlet.

If distillation or evaporation of diethyl ether to dryness is possible, a second worker should be present outside the potential explosion zone.
<table>
<thead>
<tr>
<th>Procedure/Use</th>
<th>Scale</th>
<th>Engineering Controls/Equipment</th>
<th>PPE (eye, face, gloves, clothing)</th>
<th>Procedure Steps and Precautions</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Diethyl ether is used in the lab as a solvent in column chromatography.</td>
<td>Up to 1 liter</td>
<td>All work using diethyl ether must be performed in a ventilated fume hood.</td>
<td><strong>Eye protection</strong>: Wear tight-fitting safety goggles or safety glasses with side shields.</td>
<td>Eluent may contain no stabilizers. Use a blast shield if eluent may be evaporated to dryness.</td>
</tr>
<tr>
<td></td>
<td>total eluent</td>
<td>Eliminate ignition sources such as open flames, hot surfaces, steam baths, static electricity, and operation of mechanical and electrical equipment that is not intrinsically safe.</td>
<td><strong>Face protection</strong>: Wear a face shield when handling containers of diethyl ether that are not behind a lab hood sash or blast shield.</td>
<td>Do not allow to evaporate to near dryness unless absence of peroxides has been shown.</td>
</tr>
<tr>
<td></td>
<td>volume of diethyl ether</td>
<td>Ensure proper grounding and avoid creating static electricity. Be sure to ground metal containers when transferring flammable liquids.</td>
<td><strong>Gloves</strong>: Diethyl ether penetrates most common lab gloves rapidly. Extended contact with diethyl ether is not allowed. To protect against incidental contact, wear Supported Polyvinyl Alcohol gloves (e.g. Ansell PVA) or double nitrile or butyl gloves (8 mil). Change outer glove as soon as contaminated. To protect against incidental contact, wear Laminate Film gloves (e.g. Ansell Barrier) or double nitrile or butyl gloves (8 mil). Change outer glove as soon as contaminated. <strong>Note</strong>: diethyl ether penetrates 4 mil nitrile gloves in 2 minutes.</td>
<td>If diethyl ether is concentrated on the rotary evaporator use two dry ice traps to collect the solvent vapors. Distillation/evaporation of diethyl ether efficiently removes all stabilizers. Collected fractions (rotavap) must be treated as unstabilized diethyl ether and must be disposed of soon after generation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Use a blast shield if diethyl ether may be distilled to dryness or evaporated to dryness.</td>
<td><strong>Clothing</strong>: Wear fire/flame resistant lab coat (100% cotton based); cotton based clothing/attire; full length pants</td>
<td></td>
</tr>
<tr>
<td>Notes</td>
<td>Any deviation from this SOP requires approval from PI.</td>
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<tr>
<td>Initials of individuals using this procedure</td>
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</table>
Sarpon Group Notes for Diethyl Ether

Diethyl ether is a Peroxide Forming Chemical (PFC). It forms explosive mixtures with air. Ether peroxides are contact explosives when dry. Diethyl ether is also extremely flammable. The auto-ignition temperature of diethyl ether is 160°C (320°F) and can therefore it can be ignited by a hot surface without a flame or spark. If not stored and handled properly, this can pose a serious threat to the health and safety of laboratory personnel, emergency responders and chemical waste handlers.

Diethyl ether is a common laboratory solvent used in liquid-liquid extractions. It is particularly important as a solvent in the production of cellulose plastics such as cellulose acetate.

Potential Hazards/Toxicity
Prolonged storage of diethyl ether could lead to the formation of explosive peroxides. It has also been shown to have mutagen effects. Causes skin, eye, and respiratory tract irritation. Inhalation of vapors may cause narcosis, nausea, loss of consciousness, dizziness and drowsiness. Exposure may cause digestive tract irritation and central nervous effects through ingestion. Symptoms include headache, excitement, fatigue, nausea, vomiting, stupor, and coma.

Peroxide forming chemicals are usually flammable, and all may form explosive peroxides.
A wide variety of organic compounds spontaneously form peroxides by a free radical reaction of the hydrocarbon with molecular oxygen. Under normal storage conditions, formed peroxides can accumulate in the chemical container and may explode when subjected to heat, light, friction or mechanical shock. Peroxides tend to explode violently and are capable of causing serious injury or death to researchers in the laboratory. For this reason, it is imperative that all researchers learn to recognize and safely handle peroxide forming compounds. Peroxide forming chemicals may also have other hazardous properties including toxicity. Safe use requires assessing all potential hazards.

Work with peroxide-forming chemicals must be conducted in a fume hood unless other controls are designated in the Protocol/Procedure section. Sash height must be kept low to avoid escaping fumes and provide explosion barrier. Otherwise, use supplemental explosion protective equipment like a blast shield.

Minimizing the hazards of peroxidizable compounds

Researchers who handle peroxidizable compounds must learn to handle these materials safely. Safe handling practices and procedures involve making effective purchasing decisions, implementing a storage control program, periodic testing for peroxides, and proper disposal of hazardous containers. These elements are described below and are also presented in summary format in Table 2.

General Precautions

Minimize the quantity of peroxides or peroxide forming chemicals in the lab.
Label each container with the Date Received, Date Opened and Date Last Tested.

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Segregate these compounds from incompatible materials. Store away from ignition sources. Protect from flames, static electricity, and sources of heat.

Test chemicals for peroxide before any distillation or purification of peroxide forming chemicals.

NEVER distill potential peroxide-forming chemicals to dryness. Always leave a minimum of 20% still bottoms. When possible, add a non-volatile organic compound (such as mineral oil) to dilute any peroxides remaining after distillation.

Use extreme caution before concentrating or purifying peroxide forming chemicals as most explosions occur during these processes.

Wear proper personal protective equipment, including safety eyewear and face shields, when working with peroxide forming chemicals.

Minimize peroxide formation in ethers by storing in tightly sealed containers in a cool place in the absence of light.

If solids or crystals are observed in either the liquid or around the cap of peroxide forming chemicals, do not open or move the container but contact EH&S for disposal.

**Visual Inspection**: Visually inspect all peroxide-forming chemicals before any operation. Containers that exhibit any unusual visual characteristics, such as the examples listed below, should be assumed to contain dangerous levels of peroxides and should not be disturbed. Notify EH&S, who will assist in the further evaluation. If there is any doubt about the safety of handling a chemical container, notify EH&S immediately.

For liquid chemicals, look for crystallization (around the cap or in the liquid), visible discoloration, or liquid stratification. Diethyl ether is commonly sold in steel containers which prevents visual inspection of the liquid. Therefore, diethyl ether containers whose age and use history are unknown should be assumed to contain dangerous levels of peroxides and should not be disturbed.

For solid chemicals (potassium metal, potassium amide, and sodium amide), look for discoloration and/or formation of a surface crust (for example, potassium metal forms a yellow or orange superoxide at the surface). Evaluation of alkali metals and their amides is based on visual criteria only. These substances react strongly with water and oxygen, and the standard operating procedures for pyrophoric compounds should be followed for these chemicals.

Materials not passing visual inspection are considered to be high risk and will have to be disposed of by special means (limit handling and movement; notify EH&S). Only chemicals that pass visual inspection should be tested.

**Testing for Peroxides**

**Note**: Never try to force open a rusted or stuck cap on a container of a peroxide-forming chemical.

There is a great deal of uncertainty regarding the concentration at which peroxides pose a hazard to researchers. Various sources suggest that the minimum hazardous concentration of peroxides in organic solution is in the range 0.005 - 1.0% (50-10000 PPM). In most safety literature, a conservative concentration of 100 PPM peroxides is used as a control point.

By the end of the expiration date (as indicated in Table 2) for a particular peroxide forming chemical, the person using the chemical should either dispose of it or test it...
for peroxide content. Any container found to have a peroxide concentration greater than or equal to 100 PPM should be disposed of (call EHS&S for assistance). Materials which are older than the suggested shelf life but have been tested and have no detectable peroxides or peroxide concentrations less than 100 PPM may be retained but should be tested at frequent intervals (see Table 2). **All chemicals which are to be distilled must be tested prior to distillation regardless of age.** Important note: Researchers should never test containers of unknown age or origin. Older containers are far more likely to have concentrated peroxides or peroxide crystallization in the cap threads and therefore can present a serious hazard when opened for testing. Please read section below on managing older containers.

There are several methods that are commonly used to detect for peroxides in the laboratory. Perhaps the most convenient method is the use of peroxide test strips which are manufactured by Aldrich and several other suppliers. These strips are simple to use and can be obtained from EHS&S. For volatile organic chemicals, the test strip is immersed in the chemical for 1 second; then the tester breathes slowly on the strip for 15-30 seconds or until the color stabilizes. The color is then compared with a colorimetric scale provided on the bottle. Strips that offer a 1-100 PPM peroxide range are useful for determining if the material is below the control point of 100 PPM. Other testing methods are available. Contact EHS&S for more information.

**Purchasing**

Ideally, purchases of peroxidizable chemicals should be restricted to ensure that these chemicals are used up completely before they can become peroxidized. This requires careful experiment planning on behalf of researchers. Researchers should purchase no more material than is needed to complete an experiment within the chemical’s safe shelf life.

**Storage and Shelf Life**

Peroxides tend to form in materials as a function of age. Therefore, it is imperative that researchers are keenly aware of the age of their peroxidizable chemicals. Researchers must date each container of peroxidizable chemical upon arrival in the laboratory. Containers must be dated again when opened for the first time. Additional dates of testing should be added in certain cases (see below). Special labels as depicted below make dating of the containers convenient. These labels are available free of charge from EHS&S.

Table 2 lists the safe shelf life of the different classes of peroxidizable compounds. Suggested time limits are given for retention or testing of these compounds. However, it must be noted that these shelf life durations are minimum criteria; many other references recommend more frequent testing for peroxides.

Peroxide forming chemicals should be stored in their original manufacturer’s container whenever possible. This is very important in the case of diethyl ether...
because the iron in the steel containers that this material is shipped in acts as a peroxide inhibitor. In general, peroxidizable chemicals should be stored in sealed, air-impermeable containers and should be kept away from light (light can initiate peroxide formation). Dark amber glass with a tight fitting cap is appropriate

Safe storage period for peroxidizable chemicals

Peroxidizable Chemical Classification

<table>
<thead>
<tr>
<th>Dispose or Test After</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unopened chemicals from the manufacturer</td>
<td>18 months</td>
</tr>
<tr>
<td>Opened containers diethyl ethers</td>
<td>12 months</td>
</tr>
</tbody>
</table>

Notes

1 Never open or test containers of unknown origin or age or that have visible evidence of peroxides!
2 Do not store under inert atmosphere

Management and disposal of old containers

Older containers of peroxidizable chemicals, or containers of unknown age or history, must be handled very carefully and should never be opened by researchers. Any peroxidizable chemical with visible discoloration, crystallization or liquid stratification should be treated as potentially explosive. Older steel containers that have visible rust may also be extremely dangerous. If any of these conditions are observed on a peroxidizable chemical or if the origin and age of the container are unknown, do not attempt to move or open the container. Please call EHS&S for assistance. We will arrange to have the container(s) inspected and if necessary will arrange for disposal.
13 - Documentation of Training (signature of all users is required)

✓ Prior to conducting any work with diethyl ether, designated personnel must provide training to his/her laboratory personnel specific to the hazards involved in working with this substance, work area decontamination, and emergency procedures.

✓ The Principal Investigator must provide his/her laboratory personnel with a copy of this SOP and a copy of the SDS provided by the manufacturer.

I have read and understand the content of this SOP:

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