**Standard Operating Procedure**

**PEROXIDE FORMING CHEMICALS   
(e.g. TETRAHYDROFURAN, ETHYL ETHER)**

***This is an SOP template and is not complete until:*** *1) lab specific information is entered into the box below 2) lab specific protocol/procedure is added to the protocol/procedure section and   
3) SOP has been signed and dated by the PI and relevant lab personnel.*

*To find information on what acutely toxic materials are in your inventory, login to SciShield, go to ChemTracker tab, totals link at the top, under the “chemical hazards” drop down, click on the box for “71 Peroxide Forming Material” and click submit.*

Print a copy and keep with your   
*Chemical Hygiene Plan* and/or *Lab Safety Resources Binder*

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| --- | --- |
| **Department:** | Click here to enter text. |
| **Date SOP was approved by PI/lab supervisor:** | Click here to enter a date. |
| **Principal Investigator:** | Click here to enter text. |
| **Lab Safety Coordinator/Lab Manager:** | Click here to enter text. |
| **Lab Phone:** | Click here to enter text. |
| **Office Phone:** | Click here to enter text. |
| **Emergency Contact:** | Click here to enter text. |
| *(Name and Phone Number)* |
| **Location(s) covered by this SOP:** | Click here to enter text. |
| *(Building/Room Number)* |

**Type of SOP:** ☐ Process ☐Hazardous Chemical ☐Equipment

1. **Purpose**

[NOTE: This SOP is a general SOP for peroxide forming chemicals such as ethyl ether and tetrahydrofuran. The SOP should be edited specifically for each peroxide forming chemical you store and use in your lab]

1. **Information about Peroxide Forming Materials:**

Chemicals that are susceptible to peroxide formation are ones that typically react with air, moisture, or impurities and produce a change in their chemical composition in normal storage. Certain organic solvents are susceptible to peroxide formation and can become extremely sensitive to thermal or mechanical shock and may explode violently. Peroxides are formed through a spontaneous reaction with oxygen. Simply opening the container can initiate peroxide formation, while light and heat can act to accelerate the process. Unless these materials are properly handled they can pose a serious safety hazard to users and become a difficult disposal problem for the Environmental Health and Safety Office.

Manufacturers may add an inhibitor to peroxide forming chemicals to counter peroxide formation. For many peroxide-forming solvents, butylated hydroxyl toluene (BHT) is commonly added. BHT scavenges oxygen in the solvent and prevents it from reacting with the solvent to form peroxides. Over time, BHT or other inhibitors in the solvent can become exhausted allowing peroxides to form. Distilling the solvent can completely remove the BHT or inhibitors and make the solvent immediately susceptible to peroxide formation.

1. **Classes of Peroxide Forming Chemicals: [you can delete the information below that is not applicable to your chemicals]**

***Class A:*** Chemicals that form explosive levels of peroxide without concentration. These are the most hazardous and can form explosive peroxide levels even if not opened.

Examples: Divinyl Acetylene, Divinyl Ether, Isopropyl Ether, Sodium or Potassium Amide, Vinylidene Chloride (1,1-dichloroethylene).

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| **Chemical Name** | **Storage Location** |
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***Class B:*** Chemicals that form explosive levels of peroxides when concentrated through distillation, evaporation or exposure to air after opening.

Examples: Acetal, Butadiene, Cellosolve, Cumene (isopropyl benzene), Cyclohexene, Cyclopentene, Decalin, Diacetylene (gas), Dicyclopentadiene, Diethyl ether (ether), Dioxane, Ethylene glycol dimethyl ether (glyme), Ethylene glycol ether acetates, Furan, Methyl Isobutyl Ketone, Methyl Acetylene (gas), Methyl Cyclopentane, Tetrahydrofuran (THF), Tetralin (tetrahydronaphthalene), Vinyl ethers.

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| **Chemical Name** | **Storage Location** |
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***Class C:*** Chemicals which are a hazard due to peroxide initiation of polymerization.

Examples: Acrylonitrile, Chlorobutadiene, Chloroprene, Chlorotrifluoroethylene (gas), Methyl Methacrylate, Styrene, Tetrafluoroethylene (gas), Vinyl Acetate, Vinyl Acetylene (gas), Vinyl Chloride (gas), Vinyl Pyridine**~~.~~**

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| **Chemical Name** | **Storage Location** |
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***Class D:*** Materials that do not fit within Group A or B or C but require special handling.

Examples: tert-Butyl methyl ether,Diallyl ether,

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| **Chemical Name** | **Storage Location** |
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1. **Procedure/Scope: [only keep the information below applicable to your process or write a new one if not listed below]**

*For drying solvents:*

* Check peroxide-forming solvents for the presence of peroxides prior to drying.
* Commercially available Grubb’s-type drying systems (solvent-purification columns) are the safest method to use.
* If distillation is used to dry peroxide-forming solvents, add sodium metal to the distillation pot to reduce peroxide formation and add benzophenone as an indicator for the presence of sodium metal. The resultant blue color confirms that sodium is still present. Add more sodium metal to the pot when the blue color disappears. (See the Water-Sensitive Chemicals SOP and your lab’s Hazard Control Plans for more information about the safe handling of sodium metal)
* Both Grubb’s-Type Solvent Drying Systems and drying stills may remove the inhibitors (BHA & BHT), therefore the dried, uninhibited solvent must never be stored in the lab. Use immediately after dispensing from the still or drying column.

*Safe Distillation of Peroxide Forming Chemicals*

* Eliminate the peroxides with a chemical reducing agent or pass the solvent through activated alumina. Adding mineral oil to the distillation pot has the combined effect of “cushioning” any bumping, maintaining dilution of peroxide concentration, and serving as a vicious reaction moderator in case the peroxides begin to decompose.
* Carefully monitor the distillation process to ensure that it does not dry out completely, and then overheat.
* Distillation can concentrate peroxides, especially if taken to a dry state.
* Peroxides will be present mainly in the still bottoms.
* Small pieces of sodium metal can be added to the distillation vessel to reduce peroxides.
* Use benzophenone as an indicator for the presence of sodium metal (benzophenone in the presence of sodium metal forms a radical with a deep-blue color). When the blue color disappears, add more sodium metal to the vessel.
* Check the connections and the tubing before each use to ensure tubing is not dry and brittle which could potentially allow oxygen into the closed system.

1. **Physical & Chemical Properties/Definition of Chemical Group (Only applies to hazardous chemicals)**

CAS#: [Insert CAS Number]

Class: [Toxic, Corrosive, Caustic, Radioactive, Poison Inhalation Hazard, Oxidizer, Flammable, Explosive, Cryogenic Liquid, Pyrophoric Liquid, etc.]

1. **Safety Data Sheet (SDS) Location**

Online SDS can be accessed at (<http://oregonstate.edu/ehs/sds>). A hard copy can be found at Oak Creek Building with Environmental Health & Safety.

1. **Personal Protective Equipment (PPE) (Describe the correct PPE for working with the chemical or needed during the process)**

Laboratory personnel must always wear a lab coat when working in a lab. Closed-toed shoes are also required at all times.

**Hand Protection**: Nitrile disposable gloves. Change gloves frequently and when contaminated, punctured, or torn. Wash hands immediately after removing gloves.

**Eye Protection:** Use chemical safety goggles and/or a full face shield where splashing may occur.

**Skin and Body Protection:** A laboratory coat should be worn when working with this chemical. Impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact**.**

1. **Equipment and Supplies**

[List any equipment or supplies need for the procedure above.]

1. **Engineering Controls**

All work with**peroxide-forming**chemicals in open or closed systems must be done in a designated area of a laboratory inside of a properly functioning chemical fume hood.

The fume hood is designed to capture chemical vapor and the hood sash acts as a shield in case of chemical splash.  The sash must be kept closed as much as feasible.

Vacuum Protection: Mechanical vacuum pumps must be protected using cold traps and, where appropriate, must include a filter to prevent particulate release.  The pump exhaust must be vented into an approved exhaust duct or chemical fume hood.

1. **First Aid Procedures**

If an accident happens the following documents must be completed:

* Online OSU HR Advocate Public Incident Reporting Form within 24 hours of the incident
* If the employee’s incident resulted in the need for medical treatment, have the employee complete the worker section of the SAIF 801 Form and fax to risk management at 541-737-4855 within 24 hours.

**If inhaled**

[Describe the response plan in the event that someone inhaled a hazardous substance]

Example:   
*Move to fresh air. If the person is not breathing, give artificial respiration. Avoid mouth to mouth contact. Call 911 from a phone. Call EHS at 541-737-2273 after emergency services have been contacted to report the incident.*

**In case of skin contact**

[Describe the response plan in the event that someone’s skin comes in contact with a hazardous substance]

Example:

*Immediately (within seconds) flush affected area for at least 15 minutes. Remove all contaminated clothing. Call 911 immediately. Call EH&S at 541-737-2273.*

**In case of eye contact**

Use eye wash to flush eyes for 15 minutes. Call 911. Follow safety instruction for further assistance: <http://ehs.oregonstate.edu/sites/ehs.oregonstate.edu/files/pdf/si/eyewash_and_safety_shower_si.pdf>

**If ingested**

Do not induce vomiting. Contact 911 and/or poison control center if swallowed: 1(800)222-1222

1. **Special Storage & Handling Requirements**

**Handling**:

[You can delete the sections that are not applicable to your chemicals]

Class A: Chemicals that form explosive levels of peroxides without concentration, even when unopened. Considerations for Class A chemicals:

* Discard within 3 months of receipt (even if unopened) Example: Isopropyl ether, Tetrahydrofuran without inhibitor

Class B: Chemicals that are a peroxide hazard when concentrated through evaporation or distillation. Considerations for Class B chemicals:

* Discard by the expiration date or within two years of receipt (even if unopened)
* Test for peroxide formation:
* If intending to distill or evaporate
* Every 6 months after opening
* If the chemical is unopened but has been in storage for more than a year. Example: Diethyl Ether, Tetrahydrofuran with inhibitor, vinyl ethers, and secondary alcohols

Class C: Chemicals that may autopolymerize without an inhibitor. Considerations for Class C chemicals:

* Discard by the expiration date or within 2 years of receipt (even if unopened)
* Test for peroxide formation every 6 months after opening
* Class C chemicals without inhibitors MUST be stored under inert gas
* Class C chemicals with inhibitors CANNOT be stored under inert gas as the inhibitors REQUIRE oxygen Example: Acrylic Acid, Methyl methacrylate

Class D: Additional chemicals that may form peroxides. Considerations for Class D Chemicals:

* Discard by the expiration date or within 2 years of receipt unless the chemical quality is confirmed.

**General for all:**

* Minimize the quantity of peroxides or peroxide forming chemicals in the lab.
* Know the properties and hazards of all chemicals you are using through adequate research and study, including reading the label and MSDS.
* Store all peroxide forming chemicals in tightly closed, air-impermeable, light-resistant containers, away from heat, light, direct sunlight, static electricity, sources of ignition, oxidizers and oxidizing agents.
* Make sure caps are replaced promptly after use. Store in the original manufacturer’s container whenever possible. Protect containers from shock, friction, and do not shake.
* Test chemicals according to the schedule above.
* Test chemicals for peroxides before any distillation or purification of peroxide forming chemicals. Use extreme caution before concentrating or purifying peroxide forming chemicals as most explosions occur during these processes.
* Immediately rinse empty containers that once held peroxide-forming solvents. Do not allow residues to evaporate. Do not attempt to open or rinse a container of unknown age and history; report these containers to EH&S immediately!
* If solids or crystals are observed or visibly present on or in the container or lid, or if the chemical shows discoloration, string-like formation, or liquid stratification, DO NOT OPEN OR MOVE THE CONTAINER. Contact EH&S immediately.
* Do not handle peroxide-forming chemicals when working alone.

**Labeling:**

* Label each container with the Date Received, Date Opened, and Date Last Tested and test result. Do not cover or otherwise deface the original manufacturer’s label. See Appendix A for some premade Avery label stickers for peroxide dating.

**Storage:**

[Example: do not store flammables next to oxidizers, store in a cool dry location, store in secondary container, etc.]

**Transporting:**

[Example: transport with secondary container, always follow OSU labeling requirements, etc..]

1. **Testing**

Testing for peroxides is done for most organic solvents. Testing should NOT be applied to materials that may be contaminated with inorganic peroxides, such as metallic potassium. NEVER test containers of unknown age or history; report these to EH&S immediately.

There may be times when it is advisable to test for the presence of peroxides, such as when using an inhibitor-free product or prior to drying a potential peroxide-forming solvent.  When testing for peroxides, use the following instructions

*Peroxide Test Strips:* Peroxide detection strips are commercially available from most laboratory equipment supply vendors. Follow the manufacturer’s instructions for storing and using the product. Observe any product expiration dates to ensure adequate detection. Note that these strips must be air dried until the solvent evaporates and then exposed to moisture for proper operation.

While there are no safe peroxide levels contact EHRS if solvent test shows peroxides >100ppm.

1. **Chemical Spill**

**OSU Chemical Spill Safety Instruction**: <http://ehs.oregonstate.edu/sites/ehs.oregonstate.edu/files/pdf/si/spill_response-chemicals_si.019.pdf>

**General Guidelines**

**For spills less than 1 gallon in size, low hazard chemicals:**

Preparation: Ensure employees have adequate Personal Protective Equipment and spill control materials before attempting to clean up a spill

1. Assess the magnitude of the spill and the associated hazards (broken glass, toxic fumes, risk of fire, etc.).

2. If the hazards can be safely mitigated with available personal protective equipment (PPE), do so. This includes informing co-workers of the spill, removing ignition sources, and moving equipment that may be damaged by the spilled chemicals. (Note: If the spill is more than 1 gallon of liquid or 1 pound of solid, contact Public Safety at 541-737-7000 and ask them to notify EH&S.)

3. Once all hazards have been assessed, put on appropriate PPE (respiratory protection, goggles, body protection, gloves, impervious shoes/boots, etc.).

4. Apply the Pig Pads to the spill and give the pads time to absorb the chemical.

5. Use gloves and cardboard to move the used Pig Pads to a garbage bag.

6. Seal the garbage bag with a zip tie and label the bag with a Hazardous Waste Label.

7. Place the garbage bag in secondary containment (a cardboard box or plastic tote/bin) labeled “Hazardous Waste.” Place the box in a location in the laboratory where EH&S personnel will easily find it.

8. Request a Hazardous Waste Pickup (<http://oregonstate.edu/ehs/waste>).

9. Replenish your spill kit’s contents immediately.

**For spills greater than 1 gallon in size, high hazard chemicals:**

1. In general, if a chemical spill is greater than 1 gallon in volume or is a particularly hazardous material (strong acid or base, carcinogen, highly reactive chemical, etc.), call Public Safety (541-737-7000), and tell them to contact the on-call EH&S personnel to respond to the spill.

2. Provide the following information:

o Your name and contact phone number

o Location of the spill (Building and room number)

o Approximate volume of spilled liquid

o Name of chemical

3. Do not attempt to clean up large and/or hazardous chemical spills.

4. Notify all other workers who could be affected by the spill and vacate the laboratory/floor/building, particularly if the chemical produces hazardous fumes or poses other potential health hazards.

5. Wait at the building entrance for EH&S personnel.

6. Serve as a point of contact and provide information about the spill, as requested by EH&S personnel.

1. **Other Emergencies**

**Medical Emergency Dial 911**

**Life Threatening Emergency, After Hours, Weekends and Holidays** – Dial **911** (This will connect you to Good Samaritan Hospital Corvallis where they will be able to treat the victim).

**Non-Life Threatening Emergency** – [Instructions on how to handle a non-life threating chemical exposure, process injury, or procedural injury.]

1. **Decontamination/Waste Disposal Procedure**

*General hazardous waste disposal guidelines:*

**Label Waste**

* Affix an EH&S hazardous waste label on all waste containers (<http://ehs.oregonstate.edu/sites/ehs.oregonstate.edu/files/pdf/hwlabelfull.pdf>) as soon as the first drop of waste is added to the container.

**Store Waste**

* Store hazardous waste in closed containers, in secondary containment and in a designated location. (<http://ehs.oregonstate.edu/sites/ehs.oregonstate.edu/files/pdf/si/waste_hazardous_disposal_si.pdf)>.
* Double-bag dry waste using transparent bags
* Waste must be under the control of the person generating & disposing of it

**Dispose of Waste**

* Dispose of regularly generated chemical waste within 90 days
* Put in a waste request at: <http://ehs.oregonstate.edu/waste>

1. **References**

PennEHRS: <https://ehrs.upenn.edu/health-safety/lab-safety/chemical-hygiene-plan/standard-operating-procedures/sop-peroxide-formers>

OSU EH&S SI: Peroxide Forming Materials: <https://ehs.oregonstate.edu/sites/ehs.oregonstate.edu/files/pdf/si/peroxideformingmaterials_si.pdf>

1. **Training Requirements**

In addition to general lab safety training online, employees must read over this SOP prior to use of a peroxide-forming chemicals. All hands on training should be documented separately and is required when handling and working with peroxide-formers.

**Documentation of Training** (signature of all users is required)

* Prior to conducting any work with [chemical/process/equipment name] 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 this SOP and a copy of the SDS (can be available online) available to all laboratory personnel.
* The Principal Investigator must ensure that his/her laboratory personnel have attended appropriate laboratory safety training or refresher training.

**Principal Investigator SOP Approval**

By signing and dating here the designee certifies that the Standard Operating Procedure (SOP) for *Insert SOP Name* is accurate and effectively provides standard operating procedures for laboratory personnel.

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Signature Printed Name/Title Date

I have read and understand the content of this SOP:

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| **Name** | **Signature** | **Date** |
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| **Instructions for label use:**   1. Place on a new bottle and list “date received” 2. List “date opened” when the bottle is first opened 3. List “discard by” date (within 3 months of receipt for Class A and 2 years for Class B and C) 4. Test for peroxides every 6 months after opening for Class B and C. Initiate Class D test after 2 yrs of receipt 5. Dispose if > 100 ppm, contact UHS if >400 ppm |  | **DANGER! PEROXIDE FORMER Circle Class: A B C D**  Rec’d: Open: Discard by:  List peroxide concentration and date tested  https://www.osha.gov/dsg/hazcom/pictograms/image3.jpg \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  **Dispose if >100 ppm, contact EH&S if >400 ppm** |  | **DANGER! PEROXIDE FORMER Circle Class: A B C D**  Rec’d: Open: Discard by:  List peroxide concentration and date tested  https://www.osha.gov/dsg/hazcom/pictograms/image3.jpg \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  **Dispose if >100 ppm, contact EH&S if >400 ppm** |
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