

UNIVERSITY OF VICTORIA
Occupational Health, Safety and Environment

Chemical Safety – Special Hazards

Safe Work Procedure (SWP – 007)
Peroxide Forming Compounds

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REVISION HISTORY

	<i>Revision Date</i>	<i>Author</i>	<i>Position</i>
1.	18 May 2022	Paraskevi Lagaditis	OHSE consultant
2.	22 May 2024	Paraskevi Lagaditis	OHSE consultant

DOCUMENT APPROVAL

Approved by: Laboratory Safety Committee

Jody Spence

Chair, Laboratory Safety Committee

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Date Approved

**This revision replaces all previous versions of this document. If a copy is printed, it is the users' responsibility to verify the copy is the most current version of the document.*



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PURPOSE

To provide guidance and instruction of the safe use and handling in laboratories of commonly used peroxide forming compounds (PFCs). In addition to this general Safe Work Procedure (SWP), each lab must develop a lab-specific work procedure unique to the experiments and activities being performed for PFCs not included in this SWP. The Lab SWP must be reviewed by OHSE (see Procedures, #7)

SCOPE

The SWP applies towards the handling, testing and disposal of PFCs that are commonly found and used in laboratories.

TRAINING

The following training is required to be completed prior working with peroxide forming compounds:

- [WHMIS](#)
- [Lab Safety for Lab Workers](#)
- Lab SWP with documented signoff by the individual and their supervisor.

Refresher training in the General and Lab SWP must be provided when:

- There has been an extended timeframe of inactivity, or
- There has been an incident or injury, or
- 2 years has elapsed since the original training.

REGULATION AND POLICY

The University of Victoria will follow WorkSafeBC Occupational Health and Safety Regulation Part 30.23, and the University of Victoria Occupational Health, Safety & Environment Department.

RESPONSIBILITY

It is the responsibility of personnel undertaking activities with special hazards to complete all required training and adhere to these safe work procedures, including any additional lab or job-specific procedures.

It is the PI's or supervisor's responsibility to ensure that individuals working with special hazards have been trained prior to commencing work and have demonstrated competency in safely performing all duties associated with the special hazard in accordance with these procedures.

Only individuals with skill and experience in handling extremely hazardous materials should perform handling and disposal.

DEFINITIONS

PFC – Peroxide forming compound or peroxide forming chemical

MATERIALS

- Always wear personal protective equipment (nitrile gloves, safety glasses and laboratory coat) when handling PFCs.
- If potential for explosion exists, use a blast shield (e.g. storing a bottle of diethyl ether found containing peroxide solids until proper disposal).

HAZARD

PFCs are reagents or solvents that over time under the presence of atmospheric oxygen are oxidized and produce organic peroxides. The most common peroxide forming solvents found in labs are diethyl ether and tetrahydrofuran (THF); even other ubiquitous solvents, such as secondary alcohols (e.g. isopropanol) can form peroxides when best practices are not followed. A number of PFCs contain an inhibitor (such as butylated hydroxytoluene, BHT) which scavenges free radical intermediates in the peroxide forming reaction with oxygen. However, continuous exposure to oxygen or exposure to light can deplete inhibitor concentration which allows for peroxide forming reactions to proceed. Peroxides can violently explode by either thermal or mechanical shock when solutions are concentrated or when peroxide solids form. The risk of peroxide formation or concentration can be reduced by following storage and handling practices. Eliminate or substitute for a less hazardous material whenever possible.

COMMON COMPOUNDS/CHEMICALS THAT REQUIRE REGULAR PEROXIDE TESTING:

Class A: Compounds that form explosive levels of peroxides without concentration after exposure to air <u>Test for peroxide formation before using; discard after 3 months.</u>			
Divinyl ether	Isopropyl ether	Potassium metal*	Tetrafluoroethylene
Divinyl acetylene	Potassium amide*	Sodium amide*	Vinylidene chloride
*Solid PFCs cannot be readily tested for the presence of peroxides; discard solid PFCs after 3 months after being exposed to air			
Class B: Peroxide hazards on concentration; <u>Test for peroxide formation or discard after 1 year.</u>			
Acetal	Decahydronaphthalene	2-Hexanol	4-Penten-1-ol
Acetaldehyde	Diacetylene	4-Heptanol	1-Phenylethanol
Benzyl alcohol	Dicyclopentadiene	Isopropylbenzene (Cumene)	2-Phenylethanol
2-Butanol	Diethylene glycol dimethyl ether (diglyme)	Methyl acetylene	Tetrahydrofuran
Chlorofluoroethylene	Diethyl ether	3-Methyl-1-butanol	Tetrahydronaphthalene
Cyclohexene	Dioxanes	Methyl-isobutyl ketone	Vinyl ethers
2-Cyclohexen-1-ol	Ethylene glycol ether acetates	4-Methyl-2-pentanol	Other secondary alcohols
Cyclopentene	Furan	2-Pentanol	
Class C: Compounds that may auto-polymerize as result of internal peroxide formation. <u>Test for peroxide formation or discard liquids after 6 months, discard gases after 1 year</u>			
Acrylic acid	Chlorobutadiene	Methyl methacrylate	Vinyl acetylene (gas)
Acrylonitrile	Chloroprene	Styrene	Vinyl chloride (gas)
Butadiene	Chlorotrifluoroethylene (gas)	Vinyl acetate	Vinyl pyridine

PROCEDURE

1. Handling

- a. Label PFCs bottles with:
 - i. Date received
 - ii. Date opened
 - iii. Date last tested.
- b. Visually inspect bottles before use for evidence of peroxide formation.
 - i. Liquids
 - Solids or crystals are observed in the liquid.
 - Solids or crystals are observed around the bottle cap.
 - Visible discoloration.
 - Liquid stratification.
 - Cloudiness appearance.
 - ii. Solids
 - Discoloration of the solid.
 - Formation of a surface crust.
 - iii. If peroxides are detected do not move or disturb the container
- c. Testing:
 - i. Use quantitative peroxide test strips (e.g. MQuant for Peroxide)
 - ii. Always test for peroxide concentration:
 - Class A: every time before use
 - Class B: before distillation
 - iii. Periodically test for peroxide concentration of Class B PFCs once a year after the bottle has been opened.
 - iv. Never test peroxide concentration of PFCs with unknown age or origin. Request disposal through hazardous waste.
 - v. When peroxide concentration greater than 100 ppm is determined via testing, close the bottle to reduce additional exposure to oxygen and handle bottle gently for hazardous waste disposal.
- d. Use and order the least amount of PFC as possible.
- e. Always handle Class A PFCs under inert atmosphere.
- f. Purification via distillation:
 - i. Do not distill PFCs until dryness.
 - ii. Add either
 - A non-volatile organic compound (such as mineral oil), if possible, to dilute any peroxides remaining after distillation.
 - A suitable peroxide inhibitor before distillation.
 - iii. Use distillate right away or distill under inert atmosphere if distillate will be stored for long duration.

2. Storage

- a. Store in tightly sealed containers (preferably in the original supplier container).
- b. Use a WHMIS labelled amber glass bottle or vial if decanting a PFC for long term storage.
- c. Store away from light and heat.
- d. Store Class A or distilled PFCs under inert atmosphere.

3. Spills

- a. Follow OHSE's [general spill response](#) instructions.
- b. Do not attempt to clean up any spill if not trained. Seek assistance or call Campus Security (250-721-7599)
- c. Specific steps for large spills or a spill of any size known/suspected containing peroxide:
 - i. Secure the area and warn others.
 - ii. Immediately evacuate the area.
 - iii. Post "do not enter" signs on the doors of the lab.
 - iv. Contact Campus Security at 250-721-7599.
- d. Complete a [Department Incident & Investigation Report](#) to document and review the spill incident.

4. Decontamination

- a. Wear proper PPE, laboratory work surfaces must be cleaned at the conclusion of each procedure and at the end of each work day.
- b. Refer to SDS of specific PFC for proper decontamination protocol.

5. First Aid and Emergencies

- a. Call 911 to summon an ambulance if there is a medical emergency.
- b. Call Campus Security at 250-721-7599 for first aid.
- c. If material has contacted the eyes, use emergency eyewash and flush for at least 15-20 minutes.
- d. For skin contact, flush affected area with running water for at least 15-20 minutes.

6. Waste Disposal

- a. PFCs that are regularly tested can be disposed as per standard hazardous waste protocols.
- b. PFCs must be disposed in the same bottle as found (do not decant):
 - i. By the end of the manufacturer expiration date.
 - ii. After the length of time indicated above after the PFC bottle has been opened in air.
 - iii. When peroxides are visually detected.
 - iv. Peroxide concentration is 100 ppm or greater after testing.
- c. PFCs without received or opened dates must be disposed in the same bottle as found.
- d. Affix on PFC bottles for hazardous waste
 - 1) A filled out PFC tag with peroxide concentration tested at the time of pick up (see Appendix 1)
 - 2) A green hazardous waste sticker
- e. If PFC bottles are old, questionable or contain crystals/evidence of peroxides, DO NOT TEST and email OHSE at ohs@uvic.ca
- f. Submit an online request for hazardous waste pick-up.

7. Lab SWP

In addition to this general SWP, each lab that is using a known PFC requires a Lab SWP that includes specific procedures for:

- a. List and categorize the PFCs found in the lab
- b. Frequency and schedule of testing PFCs
- c. Storage details.
- d. Spill containment and response.
- e. Emergency first aid response.

REFERENCES

1. WorkSafeBC *OHS Regulations Part 30.23 Peroxide-forming compounds*. Retrieved from <https://www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation/ohs-regulation/part-30-laboratories>
2. WorkSafeBC *Laboratory health and safety handbook*. 2008
3. Clark, D.E. *Peroxide and peroxide forming compounds*. Chemical Health & Safety, September 2001
4. Berkeley EH&S *Peroxide forming chemicals (PFCs) Chemical class standard operating procedure* 2016.

APPENDIX 1

Peroxide forming compound tag for hazardous waste

Peroxide Forming Compound (PFC) Hazwaste Tag
Supplier: _____
Chemical name (no abbreviations): _____ Lot # (if known): _____
Has container been opened? (Y/N) _____. If yes, date: _____
Are there any additives (e.g. mixed with different solvent, molecular sieves, contaminants etc)?:
Any evidence of crystallization, cloudiness, wispy or ice-like structures? (Y/N) _____
If yes, describe: <i>(Note: if crystals are evident - DO NOT TEST FOR PEROXIDES, contact ohs@uvic.ca)</i>
Peroxide levels detected: _____ ppm or mg/L at time of submission Test performed by: (Name & PI/group) _____ Date test performed (DD-MM-YY): _____

**Attach filled out form with waste bottle using a green hazardous waste sticker. Do not cover WHMIS label*

**Please review the [UVic PFC Safe Work Procedure](#) for a list of applicable chemicals on the OHSE website*