

# Management, Storage and Testing of Peroxide-Forming Chemicals (PFCs)

## REFERENCE GUIDE

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Peroxide-forming chemicals (PFCs) are a class of compounds that can form shock-sensitive explosive peroxide crystals. The proper management, storage and testing of these chemicals is essential to minimize the risk of fire or explosions.

### Background:

PFCs are prone to forming peroxides in the presence of oxygen in an auto-oxidation reaction. The O-O-bond in peroxides is often unstable and tends to spontaneously decompose, which can be violent in nature. This decomposition can be initiated by friction, heat, or mechanical shock. To avoid any spontaneous decomposition, certain safety precautions need to be followed, as outlined in this document. Not all compounds that could possibly form peroxides display a warning on the Safety Data Sheet (SDS) or are labeled as such in chemical inventories within [UC Chemicals](#).

### Steps for Purchasing, Receipt, Testing, and Disposal of PFCs:

- When placing an order for PFCs, take PROACTIVE management steps:
  - Check your current chemical inventory for any existing quantities of PFCs and especially for the PFC you want to order. Order the smallest quantity or amount of a peroxide-forming chemical that is needed in the near future.<sup>1</sup>
  - Determine which class of PFC you want to order and manage the lifespan of the container based on Table 1 and Table 2 below, to determine when to test and when to dispose the container. **This should be determined no later than receiving the peroxide forming chemical in order to ensure proper procedures and timelines are followed.**
- When receiving PFCs, label container with the receipt date or use the label as noted below. Labels are available at [Self-Service Empty Container Locations](#) across Campus. Downloadable [labels](#) are also available online. Some manufacturer's bottles will have a designated label for this purpose already.

Example of acceptable Peroxide-Forming Chemical label:

Peroxide Forming Chemical	
Date Received: _____	Date Opened: _____
Date Tested: _____	Result: _____
_____	_____
_____	_____
_____	_____

- When opening the PFC, label the container with date opened.

Tip: In addition to directly labeling the container, use UC Chemicals to add in the receipt and opened container date to assist you in the management of PFCs in your lab.

### Storage of PFCs:

- Store in original, airtight bottle, away from light and heat sources. Peroxide formation may accelerate once container is opened.
- Segregate from incompatible materials. For information on chemical incompatibility, consult a safety data sheet (SDS).
- Visually inspect for crystal formation (glass bottles: use a flashlight through back or side to light bottle)<sup>1</sup>, cloudiness, discoloration, precipitate, deformed/bulging container, cracked lids, or an oily viscous layer. Do not open if these conditions are observed. Notify EHS immediately by calling (949) 824-6200.

### Testing of PFCs:

- Test for peroxides using a test strip *ONLY* if it is safe to do so. [Quantofix](#) brand test strips ([CTL Scientific Supply Corp QUANTOFIX PEROXIDE, Quantity: Each of 1 | Fisher Scientific](#)) from Fisher Scientific are preferred. Peroxide-forming chemicals should be checked for the presence of peroxides prior to distillation, evaporation, or any other high hazard application.
- Post the date tested and the concentration of peroxide detected on the label that is affixed to the container or directly on the container.

Testing procedures for organic solvents/liquids:

- Quantofix brand test strips from Fisher Scientific are preferred. **QUANTOFIX 25** test strips (0 – 25 detection level) are available from Physical Sciences (PS) Stores.
- Dip test strip into the solution for 1 second, wave the test strip to have the solvent evaporate, add a drop of water, and wait 5 seconds (according to manufacturer).
- Compare the color of the test strip with the colors on the bottle. A change in color after 1 minute does not represent a positive result.
- Any liquid showing a peroxide level of 2 ppm or higher should be discarded as hazardous waste immediately. If the peroxide level is 10 ppm or higher, contact EHS at (949) 824-6200 immediately.
- **Caution: Peroxide test strips have a 1-year shelf life.** Keep container closed.

#### Disposal of PFCs:

Dispose of chemical after the stated time period has passed as listed in Table 2 below.

- Dispose of chemical if the peroxide level is above 2 ppm.
- Dispose of unopened PFCs after the manufacturer's expiration date.
- "Text a pick-up" to schedule a hazardous waste pick-up if it has been determined that the chemical must be disposed of.
- Reference the tables below for additional information.

#### Methods to determine potential peroxide forming chemicals

We recommend the following methods to determine potential PFCs:

A – Check the following list of chemicals contained in Table 1 below. The chemicals listed in this table are common examples of peroxide formers. Information on when to discard or test containers of these chemicals is contained in Table 2. If a suspected compound is not found in Table 1, check the list of PFCs published by Kelly<sup>2</sup>, or search for the chemical in UC Chemicals.

B – If a suspected compound is not found in the resources listed above, compare the structure of the suspected compound with the oxidizable moieties in organic compounds in Kelly's<sup>2</sup> publication. If the suspected compound shows the same oxidizable moiety, treat it as a Class D PFC and test/dispose according to Table 2.

**Table 1. Common Examples of Peroxide-Forming Chemicals**

<b>Class A</b> – Forms explosive levels of peroxides without the process of concentrating through evaporation. Can form explosive peroxide levels even if container is not opened		
Divinyl Acetylene	Potassium Amide	Sodium Amide
Isopropyl Ether	Potassium Metal	Vinylidene Chloride
Divinyl Ether	Butadiene (liquid monomer)	Tetrafluoroethylene (liquid monomer)
<b>Class B</b> – Forms explosive levels of peroxides upon concentration through distillation, evaporation, or exposure to air after opening container		
Acetal	3-Methyl-1-Butanol	Methyl Cyclopentane
Acetaldehyde	Dicyclopentadiene	Methyl-isobutyl Ketone
Benzyl Alcohol	Diglyme	4-Methyl-2-Pentanol
2-Butanol	Diethyl ether	2-Pentanol
Chlorofluoroethylene	1,4-Dioxanes	4-Penten-1-ol
Cumene	Ethylene Glycol Ether Acetates	1-Phenylethanol
Cyclohexene	Furan	Tetrahydrofuran (with inhibitor)
2-Cyclohexen-1-ol	4-Heptanol	Tetrahydronaphthalene
Cyclopentene	2-Hexanol	Vinyl Ethers
Decahydronaphthalene	Methyl Acetylene	Secondary Alcohols
<b>Class C</b> – May auto-polymerize as the result of peroxide formation		
Acrylic Acid	Chlorobutadiene	Styrene
Acrylonitrile	Chloroprene	Vinyl Acetate
Butadiene (gas)	Methyl Methacrylate	Vinyl Pyridine
<b>Class D</b> – May form peroxides but cannot be categorized in the other classes		
Acrolein	Benzyl Ether	Dimethoxymethane
Allyl Ether	tert-Butyl Methyl Ether	1-Pentene
n-Amyl Ether	n-Butyl Vinyl Ether	Methyl Chloromethyl Ether

**Table 2. Disposal and testing of peroxide-forming chemicals of different classifications**

Classification	Conditions for Peroxide Formation	Discard/Testing Timeline
Class A	Form explosive levels of peroxides without concentration. These are the most hazardous and can form explosive peroxides even if not opened.	Test for peroxide formation or discard after 3 months of receipt. Test prior to performing high-hazard processes.
Class B	Form explosive levels of peroxides upon concentration through distillation, evaporation, or exposure to air after opening.	Test for peroxide formation or discard after 12 months of receipt. Test prior to performing high-hazard processes.
Class C	Peroxide formation occurs due to self-polymerization. Storage in the liquid state drastically increases the potential formation of peroxides.	Test for peroxide formation or discard after 12 months of receipt. Test prior to performing high-hazard processes. <b>Not stabilized/uninhibited Class C PFCs should be used in small quantities within 24 hours. Never test or store uninhibited Class C PFCs.</b>
Class D	May form explosive peroxides.	Test for peroxide formation or discard after 12 months of receipt. Test prior to performing high-hazard processes.

**Figure 1. Examples of chemical containers showing signs of crystal formation**



For more information, please review the [UCI Peroxide-Forming Chemicals SOP](#) and [Chemical Hygiene Plan](#).

**References**

1. Clark, D. E. (2001) *Chem. Health Saf.* 8,5, 12-22.
2. Kelly, R. J. (1996) *Chemical Health and Safety* 3(5), 28-36.