

5 STEPS TO MANAGING PEROXIDE-FORMING CHEMICALS



Keep your
chemicals from
blowing up in
your face
(literally)

About the Experts



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Introduction

A student at University of California, Berkeley was injured in a peroxide-forming chemical explosion in November of 2006. Glass fragments shot into her face and torso. She needed stitches above her eyes as well as other hospital treatments.



Peroxide formation in laboratory chemicals by auto-oxidation can result in unexpected lab explosions, resulting in injuries and even fatalities.



This guide will teach you to protect your laboratory workers from accidents like this in 5 steps. Let's get started!



5 STEPS

1 What Are Peroxide Formers?

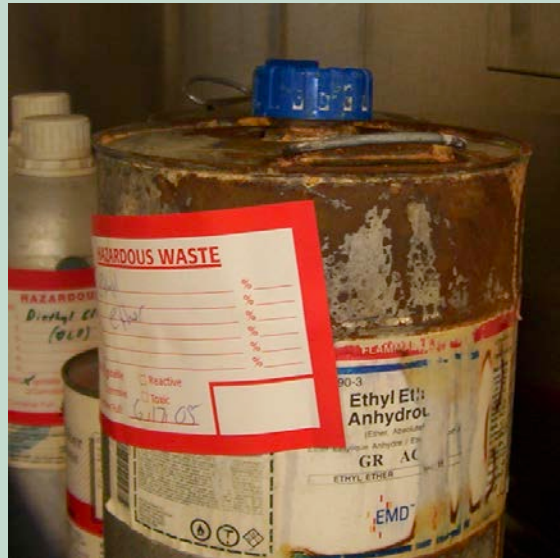
2 Protocol: The Dos & the Don'ts

3 Train in Playing it Safe

4 Know When to Discard

5 Plan for the Long Haul

1 What Are Peroxide Formers?



What are they?

In short, peroxide formers are chemicals that if left after opening for a certain amount of time or if treated in a certain way, can form potentially explosive peroxide by-products. The list of peroxide forming chemicals is long and broken up into four classes (A through D). Class A peroxide formers are the most likely to form peroxide crystals and should be disposed of after three months. Class D chemicals are the least likely and should be disposed of after 12 months. Stay tuned for more details on these classes in following chapters.

1 What Are Peroxide Formers?

What are they? (Continued)

It's important to audit your chemical supply thoroughly before determining whether or not you're using peroxide forming chemicals.

How do they form?

Chemicals can form dangerous peroxide by-products in a number of ways. The **most dangerous** chemicals are those that become potentially explosive **when stored for a certain amount of time – usually after 3-months of opening**. Isopropyl ether and vinylidene chloride are examples of such chemicals.



1 What Are Peroxide Formers?

How do they form? (Continued)

Peroxides can form when bottles containing these chemicals are exposed to light, heat, oxygen, moisture, or impurities. When they have formed, unscrewing a cap can contribute to a peroxide explosion.

Small things like air exposure can contribute to crystals forming and explosion upon opening. The explosion this could cause could break a bottle into pieces in a millisecond and send shards flying with enough force to fatally injure a researcher.



1 What Are Peroxide Formers?

How do they form? (Continued)

Other chemicals can become explosive **if they become concentrated through processes such as distillation or evaporation** during laboratory research. Some of these chemicals are diethyl ether, tetrahydrofuran, 1, 4 dioxane, isopropyl ether, cyclohexene, glycol ethers, decalin, and 2-propanol.

[Here](#) is a list of common peroxide forming chemicals. This list is not complete. To determine if you have any peroxide chemicals in your workspace [contact one of our specialists for a consultation.](#)



1 What Are Peroxide Formers?

How do I know if they're dangerous?

So, if you've determined you have peroxide forming chemicals, how do you know when peroxides have formed in your solvents?

Although testing is the best way to determine this, there are telltale signs – **visible crystals that look like snowflakes, precipitate, discoloration of solids, and/or an oily viscous layer.** If any of these warning signs are present, researchers should cease moving forward in any usage of this solvent and enlist the help of EH&S.

Even if there aren't any telltale signs of peroxide, all people handling formers should have explicit requirements for safe handling. In the next section you'll learn what these requirements should be.

5 STEPS

1 What Are Peroxide Formers?

2 Protocol: The Dos & the Don'ts

3 Train in Playing it Safe

4 Disposal Determinations

5 Plan for the Long Haul

2 Protocol: The Dos & the Don'ts

Your EH&S department should develop a list of management protocols for researchers. While protocol should be tailored to your specific environment, we did most of the heavy lifting and made a list of Dos and Don'ts that should be included in all protocols.

Do's

1. Avoid less stable chemicals if the procedure can do without them.
2. If a peroxide-forming solvent is necessary to use, estimate in advance – as accurately as possible – the amount needed for a certain procedure. This will help you avoid the costly disposal of leftovers.
3. Use any old bottles (with date of receipt under 1 year) before ordering or using new ones.
4. Purchase chemicals with inhibitors such as butylated hydroxytoluene

2 Protocol: The Dos & the Don'ts

Do's (Continued)

5. Store peroxide-forming solvents in opaque containers under inert atmospheric gases.
6. Keep away from heat and light.
7. Close containers tightly and keep caps free from dirt, dust, powders, and other liquids.
8. Open bottles with these chemicals carefully behind a safety shield in a fume cupboard.
9. Test for peroxide formation before conducting distillation or evaporation with pre-used solvents. Use test strips, interferences, and potassium iodide. >80 ppm peroxides should be disposed of! If lower, keep retesting every 3 months. Chemical distributors will provide inhibitor formulations and storage times for products.
10. If bottles display and peroxide warning signs (like visible crystals or precipitation) contact EH&S professionals to dispose of the chemical immediately.

2 Protocol: The Dos & the Don'ts

Don'ts

1. Do not perform distillation or evaporation prior to testing.
2. Do not distill peroxide-forming solvents at all unless this process is very well controlled.
3. Do not return unused chemical to the container. Dispose of it appropriately.
4. Do not touch a bottle that contains a peroxide-forming solvent if you see snowflake-like crystals, any precipitate, discolored solids, or a viscous layer. Contact EH&S.
5. Do not expose peroxide-forming solvents to heat, light, air, moisture, or impurities.
6. Do not use a bottle of peroxide-forming solvent without first reading the date on the label.

2 Protocol: The Dos & the Don'ts

For a good example of a protocol sheet, [look here](#). We suggest typing up instructions in addition to this list above and hanging it up throughout the facility to educate employees and ensure compliance.



5 STEPS

1 What Are Peroxide Formers?

2 Protocol: The Dos & the Don'ts

3 Train in Playing it Safe

4 Know When to Discard

5 Plan for the Long Haul

3 Train in Playing it Safe

There are several simple steps you can take to ensure your researchers are fully educated on proper peroxide former protocol. To make this easier on you, we've created a checklist.

Employee Education Checklist

- Require formalized training for new researchers.
- Supply handbooks and additional lab safety and chemical management reading to all researchers.
- Continue to mandate regular refreshers for undergraduate and graduate researchers after their first year.
- Review your inventory and **make a list of materials that can potentially form peroxides**. Make this list and the characteristics/hazard levels of each chemical public to your researchers. You can find an example [here](#), from a higher education institute with over 7,000 students. Note that this list is a part of a safety topic update sent out from EH&S.

3 Train in Playing it Safe

Employee Education Checklist (Continued)

- Implement chemical safety by getting word out to researchers in a way that catches their attention. Include a list of chemicals & hazards in prominent parts of the lab, warning labels on bottles that contain peroxide-forming solvents, and handling tips in standard of procedure (SOP) documentation, trainings, email updates, etc.
- Require researchers to read Safety Data Sheets (SDSs) prior to working with any new chemical.



5 STEPS

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2 Protocol: The Dos & the Don'ts

3 Train in Playing it Safe

4 Know When to Discard

5 Plan for the Long Haul

4 Know When to Discard

Removing expired peroxide-forming solvents should be a process managed by EH&S and participated in, to an extent, by researchers. While researchers should track dates of receipt and last-opened on bottles in the lab and test for peroxides, it is up to EH&S to develop and implement the label system, as well as to monitor that researchers are fulfilling this label system, and to perform regular inventory inspections.

Below is an example of a label. The University of Illinois uses this for peroxide-forming chemicals.

Peroxide-Forming Chemical
Date Received: _____
Date Opened: _____

4 Know When to Discard

(continued)

In order to determine disposal requirements, divide your chemical inventory into the four different classes of peroxide-forming chemicals:

Grouping	Chemical Characteristics	Disposal Best Practices
Class A	Present a peroxide hazard without concentration	Dispose of within 3 months of opening
Class B	Present a peroxide hazard with concentration	Dispose of within 12 month of opening
Class C	<u>Autopolymerize</u> as a result of accumulation	Dispose of within 12 months of opening
Class D	Normally stable but do have the potential to form peroxides	Dispose of within 12 month of opening

By labeling tracking and reporting all chemicals you can ensure safety and compliance for your organizations and it's employees.

4 Know When to Discard

(Continued)

While researchers should be aware of these disposal requirements and notify EH&S of disposal needs, **it is EH&S's responsibility to ensure that these standards are being followed.**

Disposing of chemicals *prior* to peroxide formation saves your research institution thousands of dollars. Costs depend on the amount of material, but typically are between \$2,000 and \$6,000. Waiting to dispose of a chemical until peroxides form may also require your institution to pay a fine to your local fire or police departments. Not only are disposal costs high for chemicals peroxides, but the **NFPA has strict guidelines for storage limits of these materials.** Your fire department could charge anywhere from \$100 to \$1000 or shut down your lab and building if expired peroxides are found. If negligence is found, OSHA could also charge tens of thousands of dollars.

4 Know When to Discard

What can you do today?

Perform an inventory check to benchmark the current standing of chemicals within your labs. If you have bottles with unknown constituents in your lab, or if the date of origin/last-open of a bottle containing peroxide-forming chemicals is found within your building, cease research immediately and ask the researcher who owns the bottle for further details. If the constituents of a bottle with peroxide indicators remain unknown, or the dates for peroxide-forming chemicals cannot be determined, bring in an outside company with high-haz experience to deal with this situation.



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4 Keys to Long-term Success

1. **Regular inspections** – the University of California performs safety inspections of lab space every two weeks, verifying that all containers are labeled and properly sealed. You should also have someone in EH&S monitor and replenish bottle labels and test materials so that researchers have no excuse when it comes to following protocol.
2. **Continual training** – who tracks training in your EH&S department? Are researchers being notified and held accountable when they need to refresh their training?
3. **Applicability** – Share with researchers instances of mismanagement. In order to make peroxide hazards real to your researchers, send out incident reports at your institution, and distribute news articles that show the unfortunate after-effects of improper handling.
4. **Accountability** – Do researchers know the consequences of not sticking to EH&S rules? How are they held accountable if they do not properly label, manage, and dispose of peroxide-forming chemicals?

CONCLUSION

The dangers of peroxides are real, but they should not prevent staff in your labs from performing what they are there for – research. EH&S departments should use this guide to develop a plan for the management of peroxide-forming chemicals, to improve a current plan, or to educate researchers. Increased awareness in labs triggers compliant behaviors and minimizes risk and cost.

Special thanks to New England Quality Manager, Ted Dubiel whose writing was an invaluable resource in the creation of this guide.

ABOUT

Triumvirate Environmental is an environmental services provider to life sciences, biotechnology, and pharmaceutical companies throughout the US. We pride ourselves on providing innovative, customer-intimate environmental services that keep your organization safe, compliant, and focused on its mission.

To learn more about peroxides management , or any of our life science services, please call:

888-TEI-WOWS

Complete Peroxide Former Management

We will:

- Do a complete chemical audit of your entire inventory
- Label all peroxide forming compounds with a “peroxide former” tag
- Label everything with received and expiration dates
- Train employees on peroxide formers & encourage additional labeling to better determine peroxide potential
- Perform regular sweeps of storage area.
- Proactively move and material due to expire.
- Remove any dangerous peroxide formers safely and compliantly

Call for a
Consultation