GENERAL SUMMARY

Peroxide-forming chemicals (PFC’s) contain an oxygen-oxygen single bond and can form shock-sensitive explosive crystals when exposed to certain conditions or left for extended times. Evidence of peroxide formation can include crystalline solids in the liquid itself or around the cap. These crystals may explode when subjected to heat, light, friction or mechanical shock (e.g. unscrewing the cap). It is particularly dangerous to allow these materials to evaporate. Peroxide forming chemicals include solids, liquids, and gases and may also be flammable or reactive, so always consult the Safety Data Sheet of the chemical you plan to use. Peroxides form after exposure to air at a rate which is dependent on the specific chemical, the amount of air exposure, and whether the chemical contains an inhibitor. There are three classes (A-C) of potentially peroxide-forming chemicals defined below, along with their storage limitations.

PLANNING CONSIDERATIONS

- Use a less hazardous chemical, if possible.
- Purchase the quantities of peroxide-forming chemicals that you expect to use within expiration and disposal timeframes.
- Purchase peroxide-forming chemicals containing a peroxide formation inhibitor (e.g., tetrahydrofuran or diethyl ether inhibited with butylated hydroxytoluene (BHT)).
- Verify all work areas have appropriate engineering controls in place.

LABELING REQUIREMENTS

Chemical containers must be labeled with:

- Full chemical name and all hazards.
- Date received and opened. Date Tested, if applicable; labels are available through EHS & EM.
- Labels should be legible and in good condition.
- Regularly check chemical stock to verify chemicals are labeled properly.
ENGINEERING CONTROLS

**Single pass ventilation**, where 100% of the air is pulled from outside and directly exhausted back out, should be provided to areas where peroxide-forming chemicals are handled or stored.

**Chemical Fume hoods** are required when working with peroxide-forming chemicals. If a chemical fume hood is not available, glove boxes or other appropriate containment devices may be used.

Check that your fume hood is in working order by:
- Verifying the **certification** date is in the past year.
- Check the flow monitor is between **80 and 120 FPM**.
- Test the hood alarm to ensure correct function.
- Contact EHS&EM if hood is not functioning properly.

Work safely in a fume hood by:
- Working with the **sash as low as practicable**, never above 16.”
- **Working 6” into the depth** of the cabinet, not on the edge.
- Keeping **bulky equipment outside the hood** if possible.

**Emergency showers, eye washes, and/or eyewash/drench hose units** must be available. **A weekly operational check** of the eyewash stations is required and the path to all emergency equipment should be **free of any obstructions**.

ADMINISTRATIVE CONTROLS

- Design procedures to:
  - **Minimize contact and exposure time**
  - **Minimize open container work**
  - Designate and label work areas with **limited access**
  - Complete all relevant **training**
  - Know the location of all **emergency equipment**
  - **Never leave experiments unattended**
  - Do not allow materials to evaporate to near dryness
  - Perform **liquid transfers** slowly using a **funnel** to minimize splash, splatter, and spills; for **small volumes** utilize luer-lock, integrated-needle syringes or mechanical pipettes
  - Ensure all **containers/materials are compatible** for proposed use. **Do not use metal spatulas or magnetic stirring bars** with peroxide forming chemicals
  - Use a spreadsheet, list, or inventory management tool to keep **track of PFC’s and relevant dates**

Always Use **Good Lab Safety Practices**!
- No Food or drink
- Wash Hands
- Clean after yourself
- Label fridges and ice machines “Lab Use only”
- Utilize appropriate PPE
- Never reuse disposable gloves
- Don’t work alone
PERSONAL PROTECTIVE EQUIPMENT

Remove all PPE before leaving the lab; don’t touch common items (e.g., doorknobs) with gloves on.

### Hands
- Gloves are always required.
- Always check glove compatibility with the specific chemical in use.
- If working with a chemical with high dermal toxicity, double-glove.
- Change gloves when contaminated or damaged.

### Eye & Face
- Safety glasses required.
- Safety goggles and/or a face shield must be worn when testing peroxide levels, transferring large volumes, and in other situations where a splash or aerosols are likely (e.g., transfer of liquids outside of a fume hood).

### Skin
- Lab coat, fastened with sleeves extending to the wrists is required.
- Long pants and close-toed shoes are required.
- Use a rubber apron when handling large volumes or there is a high splash risk.

### STORAGE REQUIREMENTS
- Store in light-resistant containers.
- Store in the original manufacturer’s container whenever possible. This is very important in the case of diethyl ether because the iron in the steel containers that the material is shipped in acts as a peroxide inhibitor.
- Keep containers tightly closed.
- Store in shatter-resistant containers in secondary containment.
- Store in a well-ventilated area away from light, heat sources and combustible materials.
- Do not store potentially hazardous material under sinks or above eye level.
- Regularly check containers for cracks/warping, testing dates, and expiration dates.
- Do not store with incompatible chemicals: Keep away from all organic reagents and solvents; Separate acids and bases; inorganic acids and organic acids. Access our compatibility flyer here.
PEROXIDE TESTING

Stabilized peroxide formers should be periodically tested for the presence of peroxides. For chemicals that have been determined to be safe to open, measure the peroxide concentration using commercial peroxide test strips (e.g., Quantofix Peroxide Test Strips (CTL Scientific Supply) and (MilliporeSigma)). Laboratory personnel are responsible for performing peroxide testing of chemicals present in their labs or storage areas. While there is uncertainty regarding the concentration at which peroxides pose a hazard, solutions with a peroxide concentration below 25 mg/L are considered safe for general use while those with a concentration between 25 and 100 mg/L should not be distilled or concentrated; Solutions with a concentration over 100 mg/L should be discarded as hazardous waste.

Peroxide formers should be tested for peroxide content or disposed as hazardous waste based on the suggested shelf life for its peroxide forming classification (see table below). Materials lacking a manufacturer’s expiry date and are older than the suggested shelf life with no detectable peroxides may be retained but should be re-tested every three months. All chemicals that will be distilled must be tested prior to distillation regardless of age.

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.

WASTE DISPOSAL

- Do not dispose of peroxide-formers in sinks or sewer drains. Refer to App State’s Drain Disposal Guidance if you are unsure on whether a chemical can be discarded into the drain or must be collected for disposal.
- Store hazardous waste in chemically compatible containers (light resistant) within the designated waste area.
- Dispose of expired peroxide formers, rusted containers, and any peroxide former with visible discoloration, crystallization, or liquid stratification promptly.
Ensure **structural integrity** of containers until pick up.

- Keep containers **capped tightly** and use **secondary containment**.
- **Separate** waste by hazard class and compatibility.
- **Label** with an Appalachian State hazardous waste label prior to pick up.
- Waste should be neutralized before pickup, if possible.

**CONTACT EHS & EM AT (828) 262-4008 FOR CHEMICAL WASTE COLLECTION OR REGULATORY GUIDANCE.**

**EMERGENCY INFORMATION:**

**FIRE:**
Evacuate the building immediately, pulling the fire alarm on the way out. Meet at your building’s assembly point and contact emergency personnel (University Police- 828-262-8000 or 911). Follow instructions and advise emergency personnel of the situation. When able, contact the primary and secondary emergency contacts listed in the Lab Safety Plan.

**SPILLS:**
Do not clean the spill unless trained. Evacuate the area if the spill is fuming or irritating to the respiratory tract or eyes/skin. Contact emergency personnel (University Police- 828-262-8000 or 911). Follow instructions and provide information such as location, chemical name & hazards, amount released, etc. When able, contact the primary and secondary emergency contacts listed in the Lab Safety Plan.

**EXPOSURE:**
Consult the Lab-Specific procedures to identify and follow any exposure procedures for the specific chemical in question. If no specific procedures are listed, for spills on the body, in the eye, or in an open wound, find and activate the nearest emergency shower or eyewash station. Immediately discard any contaminated clothing. Stand in the emergency shower stream or use the eyewash/drench hose to stream water over the affected areas for at least 15 full minutes. Contact emergency personnel (University Police- 828-262-8000 or 911) using the Safety Data Sheet of the chemical to communicate the hazards with medical professionals. When able, contact the primary and secondary emergency contacts listed in the Lab Safety Plan.

**EMERGENCY CONTACT INFORMATION**

Appalachian Police Department................................................................. (828) 262-8000
Environmental Health, Safety, and Emergency Management .................... (828) 262-4008
Watauga Medical Center ............................................................................. (828) 262-4100
Poison Control Center .............................................................................. (800) 222-1222
### Peroxide Forming Chemical Classifications

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>Storage &amp; Use</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetaldehyde</td>
<td>Store in a dark location and test for peroxide formation every 6 months after opening and before use. Test liquids for peroxide formation before use, and discard when peroxides are detected.</td>
<td>Severe peroxide hazard after prolonged storage, especially after exposure to air. Most of these solvents are sufficiently volatile that multiple openings of a single container can result in a dangerous and dangerous peroxide concentration. The peroxide formation can initiate explosive auto-polymerization. The peroxide forming potential is higher for liquids than for gases in this group. In this group, peroxide formation may initiate without concentration. All listed chemicals have been responsible for fatalities.</td>
</tr>
<tr>
<td>Ethylene Glycol</td>
<td>Store in a dark location and test for peroxide formation every 12 months after opening or dispose of the chemical as hazardous waste. Additionally, always test before distillation or evaporation. If peroxides are detected, discard the chemical</td>
<td>Severe peroxide hazard after prolonged storage, especially after exposure to air. Most of these solvents are sufficiently volatile that multiple openings of a single container can result in a dangerous and dangerous peroxide concentration. The peroxide formation can initiate explosive auto-polymerization. The peroxide forming potential is higher for liquids than for gases in this group. In this group, peroxide formation may initiate without concentration. All listed chemicals have been responsible for fatalities.</td>
</tr>
<tr>
<td>Isopropanol</td>
<td>Store in a dark location and test for peroxide formation every 6 months after opening and before use. Test liquids for peroxide formation before use, and discard when peroxides are detected.</td>
<td>Severe peroxide hazard after prolonged storage, especially after exposure to air. Most of these solvents are sufficiently volatile that multiple openings of a single container can result in a dangerous and dangerous peroxide concentration. The peroxide formation can initiate explosive auto-polymerization. The peroxide forming potential is higher for liquids than for gases in this group. In this group, peroxide formation may initiate without concentration. All listed chemicals have been responsible for fatalities.</td>
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</tbody>
</table>

*When stored as a liquid monomer*

**When stored as a gas or liquid**