

2. A material that will moderately increase the burn rate.
3. A material that will cause a severe increase in burn rate.
4. A material that has the potential to lead to an explosive oxidation with combined with other materials.

Class 1: Generally, it is the anionic component of a salt that causes the oxidation. Examples in class 1 are metal salts of chromates and dichromates, chlorates and perchlorates, nitrates, peroxides, and perborates. Perchloric acid (below 70% conc.) and hydrogen peroxide (8-27% conc.) are prominent examples of non-salts in this class.

Class 2: Salts in class two are those of hypochlorite, permanganate, and peroxide. Non-salts in this class are chromium trioxide, hydrogen peroxide (27-52%), halane, and nitric acid (>70%).

Class 3: Common class 3 oxidizers are ammonium dichromate, potassium chlorate, hydrogen peroxide (55-91%), calcium hypochlorite, sodium chlorate, perchloric acid (60-72%), sodium chlorite (>40%), and potassium bromate.

Class 4: Materials in class 4 include ammonium perchlorate, ammonium permanganate, guanidine nitrate, hydrogen peroxide (>92%), perchloric acid (>72%), and potassium superoxide.

2. HAZARDOUS CHEMICAL(S)/CLASS OF HAZARDOUS CHEMICAL(S)

For each process, list or attach the hazardous chemical(s) and the expected by-product(s) produced. List the chemical(s) or class of chemical(s). Please list signs and symptoms of exposure.

Common groups of strong oxidizing agents:

Class 1: Metal salts of chromates and dichromates, chlorates and perchlorates, nitrates, peroxides, and perborates. Non-salts such as Perchloric acid (below 70% conc.) and hydrogen peroxide (8-27% conc.).

Class 2: Salts of hypochlorite, permanganate, and peroxide. Non-salts such as chromium trioxide, hydrogen peroxide (27-52%), halane, and nitric acid (>70%).

Class 3: Ammonium dichromate, potassium chlorate, hydrogen peroxide (55-91%), calcium hypochlorite, sodium chlorate, perchloric acid (60-72%), sodium chlorite (>40%), and potassium bromate.

Class 4: Ammonium perchlorate, ammonium permanganate, guanidine nitrate, hydrogen peroxide (>92%), perchloric acid (>72%), and potassium superoxide.

3. PERSONAL PROTECTIVE EQUIPMENT (PPE)

Discuss the personal protective equipment and hygiene practices used with each process, class of chemicals or individual chemical. Personal protective equipment includes gloves, laboratory coats/coveralls or aprons, safety spectacles, goggles or face-shields, and air-purifying respirators. Include the type of gloves needed for each phase of the process. If laboratory coats, eye protection, or respirators are required indicate when and why. If you think that your process may require respirator use, contact EH&S for assistance.

At a minimum, the following PPE must be worn at all times:

Eye Protection

1. Safety glasses with side shields or splash goggles that meet the ANSI Z.87.1 1989 standard. When there is the potential for splashes, goggles must be worn.
2. Ordinary prescription glasses will NOT provide adequate protection unless they also meet this standard and have compliant side shields.
3. Face shields must only be used over either safety spectacles or goggles (for face protection).

Skin Protection

1. Flame-resistant lab coat. Fully extend sleeves to the wrists. Buttoned at all times.
2. Non-synthetic clothing should be worn.
3. Gloves.

When handling hazardous chemicals or contacting potentially contaminated surfaces, protective gloves are to be worn. For proper selection of glove material, review chemical Safety Data Sheet and glove selection guidance on the Environment, Health and Safety web page.

Wear gloves to prevent skin exposure. In a glove box, use the glove box gloves and sleeves. If this chemical is handled in a closed system in a certified fume hood, use appropriate chemical resistant gloves.

NOTE: Consult with your preferred glove manufacturer to ensure that the gloves you plan on using are compatible with the specific material.

Refer to glove selection chart from the links below:

<http://www.allsafetyproducts.biz/page/74172>

<http://www.showabestglove.com/site/default.aspx>

<http://www.mapaglove.com/>

Never re-use disposable gloves, such as nitrile. If there is a risk of explosion, Kevlar gloves must be worn.

4. Closed-toed, closed-heel shoes.
5. Covered legs.

Additional PPE may be required if procedures or processes present additional risk. It is the responsibility of the PI to ensure that any additional PPE requirements are identified and communicated to research staff. Contact EH&S for consultation.

Hygiene Measures

Avoid contact with skin, eyes and clothing. Wash hands before breaks and immediately after handling the product.

4. ENGINEERING/VENTILATION CONTROLS

Describe engineering controls designed to reduce employee exposures to hazardous chemicals, such as fume hoods, snorkels, aerosol suppression devices, or safety features on equipment.

The following is a general plan for all strong oxidizers:

Always use strong oxidizers in a certified chemical fume hood to minimize the potential for the spread of a fire if one should occur. Have a fire extinguisher at hand (not just hanging on the wall in a distant part of the laboratory) when working with Class 2-4 materials. It is recommended to avoid the use of Class 4 oxidizers. If no alternative can be found, then operations MUST be carried out in a fume hood with the addition of a blast shield. No part of the body (for example, hands) should ever be directly exposed to these materials when they are mixed with other chemicals.

Perchloric acid has a notorious history of causing unanticipated explosions. Perchloric acid can form explosive salts almost anywhere, including in the exhaust ducts of fume hoods and even laboratory benches where other materials have been spilled in the past. Many perchlorate salts are shock sensitive and can lay dormant for very long periods.

For these reasons, it is imperative that perchloric acid only be used in a perchloric acid designated fume hood that is not used for any other function. Spills should be immediately and thoroughly cleaned up. This fume hood shall be prominently marked as for use ONLY with perchloric acid and no other materials. EH&S should be contacted for proper signage and approvals. Keep in mind that only a new fume hood can be designated for perchloric acid use.

5. SPECIAL HANDLING PROCEDURES AND STORAGE REQUIREMENTS

Describe storage requirements for hazardous chemicals in your laboratory. Include restricted access plans, ventilation systems used, and special containment devices, etc. Describe safe methods of transporting chemicals, such as double containment and using a University vehicle to transport chemicals.

The following administrative controls must be followed:

1. Never work alone. At least one other person must be present in the same laboratory when any work involving strong oxidizers is carried out.
2. Eliminate or substitute a less hazardous material when possible.
3. Design your experiment to use the least amount of material possible to achieve the desired result.
4. Verify your experimental set-up and procedure prior to use.
5. Inform colleagues that this material will be used and where. Label the work area with a sign saying "Strong Oxidizing Agent Use Area."
6. Only use if the area is properly equipped with a certified eye wash/safety shower within ten seconds of travel.
7. Ensure that all use details are recorded in a log book which notes the date, user, amount used, and current quantity on hand.
8. Consult with the campus Chemical Hygiene Officer if work involves large quantities.

It is better to do multiple transfers of small volumes than attempt to handle larger quantities. Finely divided solids must be transferred under an inert atmosphere in a glove box. Liquids may be safely transferred without a glove box by employing certain syringe techniques and equipment. Before transferring, make sure that the material is at room temperature.

It is essential that all strong corrosives be stored separately from all chemicals with which they may react. Ensure secondary containment and segregation of incompatible chemicals per guidance within the UC Davis Chemical Hygiene Plan. Also, follow any substance-specific storage guidance provided in Safety Data Sheet (SDS) documentation.

6. SPILL AND INCIDENT PROCEDURES

Indicate how spills or incidents should be handled and by whom (See SafetyNet #13).

If there is an unusual or unexpected occurrence when using this material(s), the occurrence must be documented and discussed with the Principal Investigator or Lab Supervisor and others who might be using the material(s). Unusual or unexpected occurrences might include a fire, explosion, sudden rise or drop in temperature, increased rate of gas evolution, color change, phase change, or separation into layers.

Spills should be immediately and thoroughly cleaned up. Proceed only if you will not injure yourself or others and it is not an emergency and not likely to become an emergency. Work areas should be demarked with an indicator that strong oxidizing materials are in use or exposed. Keep a chemical spill kit easily accessible. In the case of strong oxidizing agents, consider the likelihood of fire. If you are unsure about how to clean up a spill, contact EH&S for help.

Chemical Spill: Dial 9-1-1 and EH&S at (530) 752-1493 for assistance.

Once spilled, all liquid or solid pyrophoric chemicals will instantly ignite.

Chemical Spill on Body or Clothes: Remove clothing and rinse body thoroughly in emergency shower for at least 15 minutes. Seek medical attention. Notify supervisor and EH&S at (530) 752-1493 immediately.

Chemical Splash into Eyes: Immediately rinse eyeball and inner surface of eyelid with water from the emergency eyewash station for 15 minutes by forcibly holding the eye open. Seek medical attention. Notify supervisor and EH&S at (530) 752-1493 immediately.

Medical Emergency: Dial 9-1-1 and EH&S (530) 752-1493

Life-Threatening Emergency, After Hours, Weekends and Holidays: Dial 9-1-1. Note: All serious injuries must be reported to EH&S at (530) 752-1493 within 8 hours.

Non-Life Threatening Emergency: Go to the Occupational Health Services, (530) 752-6051 in the Cowell Building. Hours: Monday-Friday, 8:00 a.m. to 5:00 p.m. At all other times report to the Sutter Davis Emergency Room at (530) 757-5111. Note: All serious injuries must be reported to EH&S at (530) 752-1493 within 8 hours.

For larger spills, evacuate the lab, close the door and call 9-1-1.

In a spill situation, always remember to:

1. Use extreme caution due to potential ignition of flammable solvents or other materials.
2. Evacuate the spill area. Post someone or mark-off the hazardous area with tape and warning signs to keep other people from entering the area.
3. Contact EH&S if you have any concerns about how to manage a spill no matter how large or small.
4. Review the EH&S Emergency Guide before beginning work.
5. Keep the appropriate fire extinguisher nearby.
6. Keep a chemical spill kit easily accessible.

7. WASTE DISPOSAL

Describe waste disposal procedures for these chemicals.

All waste must be disposed through the EH&S Hazardous Waste Program.

Label all waste with the chemical contents and the appropriate hazard warning.

General hazardous waste disposal guidelines:

Affix a completed hazardous waste label on all waste containers as soon as the first drop of waste is added to the container, <http://safetyervices.ucdavis.edu/ps/hmhwm>

Store hazardous waste in closed containers, in secondary containment and in a designated location.

Double-bag dry waste using transparent bags.

Waste must be under the control of the person generating and disposing of it.

Dispose of regularly generated chemical waste according to the UC Davis waste disposal policy and procedures. <http://safetyervices.ucdavis.edu/ps/hmhwm/iwm/cw/accumulationTime>

Request a waste pick-up on-line: <http://safetyapps.ucdavis.edu/EHS/wasterequest/index.cfm>

8. PRIOR APPROVAL/REVIEW REQUIRED

Discuss the circumstances under which a particular laboratory operation, procedure, or activity will require prior approval from the PI or laboratory supervisor. Describe the circumstances under which this SOP will have to be reviewed by PI/lab supervisor – scale up, temperature/pressure change that might cause the reaction to proceed more quickly, change in reactants that might result in increased hazards, etc.

All work with strong oxidizers requires the following prior to beginning work:

1. Must be pre-approved by the Principal Investigator prior to use and all training must be well documented.
2. Must be familiar with the UC Davis Chemical Hygiene Plan.
3. Must have documented Chemical and Laboratory Safety training, and specific training on the techniques and processes to be used.
4. Must read the relevant Safety Data Sheet (formerly referenced as Material Safety Data Sheets).
5. EH&S must be consulted in advance if any work involves the heating of perchloric acid.
6. Must demonstrate competence to perform work.
7. Must read Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards (section 3.D.2.3 - 3.D.3.3 Incompatible Chemicals - Other Oxidizers) - http://www.nap.edu/openbook.php?record_id=4911&page=51
8. When there are any changes to procedures, personnel, equipment, or when an incident or near-miss occurs, a review of this SOP and re-approval is required.

9. DECONTAMINATION

Discuss decontamination procedures for equipment and glassware. Include controlled areas (e.g., glove boxes, restricted access hoods, perchloric/hot acid fume hoods, or designated portions of the laboratory) in your discussion.

Carefully inspect work areas to make sure no materials remain. Clean contaminated work areas with wipers moistened with dry, non-polar solvent (hexane). Be sure all ignition sources are secured before beginning cleaning up with flammable liquids.

10. DESIGNATED AREA

Indicate the designated area for your laboratory. A designated area must be considered for work with "particularly hazardous substances" or chemical carcinogens. The entire laboratory, fume hood, or a portion of the laboratory may be considered as a designated area.

11. SAFETY DATA SHEETS AND OTHER RESOURCES

ChemWatch is the safety data sheet application provided by University of California, Office of the President. If other sites or SDS resources are used, please describe. Include applicable SafetyNet(s) or journal citation(s), specific to this process.

Online SDS can be accessed at: <http://safetyservices.ucdavis.edu/ps/cls/msds>

12. DETAILED PROTOCOL

Insert or attach a copy of your specific laboratory procedures for the process, hazardous chemical, or hazard class.

All lab workers who will be using this material(s) must review this SOP and sign the associated training sheet. Lab workers must have specific training on the proper handling of this material(s) and understand the hazards.

Lab workers using this material(s) must demonstrate competence to the Principal Investigator or designee by being able to 1) identify the hazards and list any particularly hazardous handling techniques (use of a Schlenk line, rotary evaporation, cannula transfer, extremes of pressure or

temperature, etc.), 2) list the foreseeable emergency situations, 3) describe the proper response to the emergency situations, and 4) know the control measures to minimize the risks.

When working in the lab, a laboratory worker must:

1. Not work alone (if you are alone in the laboratory, leave),
2. Be cognizant of all of the SDS and safety information presented in this document,
3. Find/follow a literature experimental procedure describing the use of this reagent covered by this SOP in a related chemical transformation ... if a pertinent literature protocol cannot be found, the researcher **MUST** discuss the planned experiment with the PI (or designee) prior to using this reagent,
4. Not deviate from the literature experimental protocol mentioned in (3) in either temperature or pressure without **PRIOR APPROVAL** from the PI (or designee),
5. Follow all related SOPs in the laboratory SOP bank (PPE, syringe techniques, waste disposal, etc. as appropriately modified by any specific information in the SDS information presented in this document),
6. Employ (< quantity) of this reagent in any given reaction (larger quantities **REQUIRE** the approval of PI or designee), and
7. Discuss **ALL** issues or concerns regarding this reagent with the PI prior to its use.