Strong Oxidizing Agents (SOAs)

H270 H271 H272

Areas with blue text indicate that information must be provided or modified by researcher prior to the SOP approval.

This SOP is not a substitute for hands-on training.

Print a copy and insert into your laboratory SOP binder.

Department:	Chemistry
Date SOP was written:	Monday, October 24, 2016
Date SOP was approved by PI/lab supervisor:	
Principal Investigator:	Name: R. Sarpong Signature: _____
Internal Lab Safety Coordinator or Lab Manager:	Name: Melissa Hardy/Justin Jurczyk Lab Phone: 406-696-1225/412-728-1952 Office Phone:
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Location(s) covered by this SOP:	Latimer Hall 831,832,834,836,837,838,839,842,844,847,849

1. Purpose

This SOP covers the precautions and safe handling procedures for the use of Strong Oxidizing Agents (SOAs).

For a list of SOAs covered by this SOP and their use(s), see the "List of Chemicals". Procedures described in Section 12 apply to all materials covered in this SOP.

If you have questions concerning the applicability of any recommendation or requirement listed in this procedure, contact the Principal Investigator/Laboratory Supervisor or the campus Chemical Hygiene Officer at ucbcho@berkeley.edu.

2. Physical & Chemical Properties/Definition of Chemical Group

Oxidizing chemicals are materials that promote/support combustion or spontaneously evolve oxygen at room temperature or with slight heating. The rate of O_2 evolution increases rapidly as the temperature

increases, often leading to a fire or explosion. This class of chemicals includes peroxides, chlorates, perchlorates, nitrates, and permanganates. Strong oxidizers are capable of forming explosive mixtures when mixed with combustible, organic or easily oxidized materials.

3. Potential Hazards/Toxicity

Strong oxidizing agents can present fire and explosive hazards. This hazard is highest when there is a possibility of an oxidizing agent coming in contact with a reducing agent, a fuel, or some other combustible.
The NFPA defines four categories of strong oxidizers, divided by the severity of risk when mixed with other compounds:

- Class 1. An oxidizer that does not moderately increase the burn rate of another material.
- Class 2. An oxidizer that will moderately increase the burn rate.
- Class 3. An oxidizer that will cause a severe increase in burn rate.
- Class 4. An oxidizer that has the potential to lead to an explosive oxidation when combined with other materials.

The Globally Harmonized System of Classification and Labeling of Chemicals (GHS) designates acutely toxic chemicals by one or more of the following H codes:

H270 May cause or intensify fire; oxidizer

H271 May cause fire or explosion; strong oxidizer

H272 May intensify fire; oxidizer

Strong oxidizing agents may also have other hazardous properties in addition their oxidizing properties. Safe use requires assessing all potential hazards.
It is the Principal Investigator's responsibility to ensure activity-specific laboratory procedures and/or processes are taken into account when using this Chemical Class SOP.
Please, review the SDS of any chemical before use (see Section 11 – SDS Location).

4. Engineering Controls

Use the engineering controls listed below unless other lab-specific information is included in Section 12 - Protocol/Procedure.

- Work with SOAs – the work must be conducted in a fume hood unless other controls are designated in the lab-specific Protocol/Procedure section. Sash height must be kept as low as possible to avoid escaping fumes and provide a physical barrier.
- Laboratories and rooms where SOAs are used must have general room ventilation that is negative pressure with respect to the corridors and external environment. The laboratory/room door must be kept closed at all times.

5. Personal Protective Equipment

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

Eye and Face Protection

A. ANSI Z87.1-compliant safety glasses with side shields, or chemical splash goggles.
   - Ordinary prescription glasses will NOT provide adequate protection unless they also meet ANSI standard and have compliant side shields.

B. If the potential for explosion/splashing exists, and adequate coverage is not provided by the hood sash, a face shield must be worn.

Skin and Body Protection

A. Gloves are required when handling hazardous chemicals.
   - Refer to specific chemical SDS for information on glove selection.
   - For additional information on glove selection, go to: http://ehs.berkeley.edu/hs/63-laboratory-safety/94-glove-selection-and-usage.html

B. Lab coats are required when handling hazardous chemicals in the lab. Select the type of lab coat according to the hazards at the specific workplace.

C. Long pants, closed-toe/closed-heel shoes, covered legs, and ankles.

Respiratory Protection

Respiratory protection is normally not required for UC Berkeley laboratory activities. Any lab personnel considering the use of a respirator (e.g. N-95 respirator, dust mask) must contact EH&S for a workplace assessment.

6. First Aid Procedures and Medical Emergencies

In the event of an injury, notify your supervisor immediately and EH&S within 8 hours.

Go to the Occupational Health Facility (Tang Health Center, on campus); if after hours, go to the nearest emergency room (Alta Bates, 2450 Ashby Ave in Berkeley); or

Call 911 (from a cell phone: 510-642-3333) if:

- ***it is a life threatening emergency; or***
- ***you are not confident in your ability to fully assess the conditions of the environment and/or the condition of the contaminated/injured person, or you cannot be assured of your own safety; or***
- ***the contaminated/injured person is not breathing or is unconscious.***

Please remember to provide a copy of the appropriate manufacturer SDS (if available) to the emergency responders or physician. At a minimum, be ready to provide the identity/name of any hazardous materials involved.

In case of skin contact

If skin contact occurs, and/or skin or clothing are on fire, immediately drench in the safety shower with copious amounts of water for no less than 15 minutes to remove any remaining contaminants. If possible to do so without further injury, remove any remaining jewelry or clothing.

In case of eye contact

Rinse thoroughly with plenty of water using an eyewash station for at least 15 minutes, occasionally lifting the upper and lower eyelids. Remove contact lenses if possible.

If swallowed

Do NOT induce vomiting unless directed otherwise by the SDS. Never give anything by mouth to an unconscious person. Rinse mouth with water.

If inhaled

Move into fresh air.

Needle stick/puncture exposure

Wash the affected area with antiseptic soap and warm water for 15 minutes.

7. Special Handling, Storage and Disposal Requirements

Lab-specific information on handling and storage may be included in the Protocol/Procedure section.

Precautions for safe handling

- Remove flammables and reducing agents from immediate work area.
- Strong oxidizer gases (e.g., chlorine, oxygen) can react strongly with metals. Use only compatible cylinder fittings, regulators and piping. If other chemicals have recently been used with a regulator, extensively flush the regulator with an inert gas before use.
- When using **perchlorate salts**, if the possibility of the release of perchloric acid fumes exists, the process must be done in a hood designed for perchloric acid release (see PEC SOP).
- Eliminate or substitute for a less hazardous material when possible.
- Design your experiment to use the least amount of material possible to achieve the desired result.
- Do not exceed the scale of procedures specified in Protocol/Procedure section without approval of the PI.
- Verify your experimental set-up and procedure prior to use.
- Know the location of the nearest eyewash, safety shower and fire extinguisher before beginning work.
- Upon leaving the work area, remove any personal protective equipment worn and wash hands.
- At the end of each project, thoroughly decontaminate the work area according to the material being handled.

Conditions for safe storage

- Oxidizers must be stored separately from flammables and reducing agents, and with consideration to other hazardous properties of the particular oxidizer.
- Gas Cylinders: Cylinders must be stored upright, with valve protection cap in place, and firmly secured to prevent falling or being knocked over. Cylinder temperatures not to exceed 52 °C (125 °F).

Disposal

- Waste materials generated must be treated as a hazardous waste.
- The empty container must be rinsed three times with a COMPATIBLE solvent; leave it open in the back of the hood overnight. Solvent rinses and water rinse must be disposed of as hazardous waste.
- As an alternative, unrinsed empty containers can be disposed of through EH&S as hazardous waste. The unrinsed empty containers must be capped.
- Do not mix with incompatible waste streams.
- Decontamination of containers in order to use them for other purposes is not permitted.

8. Chemical Spill

Spill – Assess the extent of danger; if necessary request help by calling **911** (from a cell phone: **510-642-3333**) for emergency assistance or 510-642-3073 for non-life threatening situations. If you cannot assess the conditions of the environment well enough to be sure of your own safety, do not enter the area. If

possible help contaminated or injured persons. Evacuate the spill area. Avoid breathing vapors from spill. If possible, confine the spill to a small area using a spill kit or absorbent material. Keep others from entering contaminated area.

- **Minor Spill –** In the event of a minor spill, if there is no potential for hazardous chemical exposure, report the spill to 510-642-3073 and proceed to clean it, if you are trained. Use appropriate personal protective equipment and clean-up material for chemical spilled. Double bag spill waste in clear plastic bags, label and request pick-up.
- **Major Spill –** Any hazardous chemical spill that involves chemical exposure, any chemical spill that due to size and/or hazard requires capabilities beyond your training, or any chemical spill that gives the perception (because of odor, for example) that there has been a hazardous release. Call **911** or 510-642-3073 for assistance.

9. Cleaning and Decontamination

Lab-specific information on decontamination may be included in Section 12 - Protocol/Procedure.

- Wearing proper PPE, laboratory work surfaces must be cleaned at the conclusion of each procedure and at the end of each work day.
- Decontaminate all equipment before removing from a designated area.

10. Hazardous Waste Disposal

Label Waste

- Label all waste containers. See the EH&S Fact Sheet, “Hazardous Waste Management” for general instructions on procedures for disposing of hazardous waste.

Dispose of Waste

- Dispose of regularly generated chemical waste within 6 months.
- Contact EH&S at 642-3076 if you need assistance.

11. Safety Data Sheet (SDS) Location

SDS can be accessed online at http://ucsds.com

-Take Ownership of Your Safety-

Before starting any work, ask yourself:

1- What will I be doing?
2- Do I know what the hazards are?
3- Do I have everything I need to do the job safely?
4- Am I doing the job safely?
5- What can we do better?

12. Protocol/Procedure – Strong Oxidizing Agents

Section 12 must be customized to your specific needs. Delete any procedure that does not apply to your laboratory.

Procedure/ Use	Scale	Engineering Controls/Equipment	PPE (eye, face, gloves, clothes)	Procedure Steps and Precautions
1. Use SOA in oxidations or as a reagent in chemical reactions.	Up to 10 grams or 100 mL as supplied in the reagent bottle. Remember to obtain PI approval if higher scale is necessary.	All reactions using these materials must be performed in a properly operating fume hood with the sash as low as possible. Or in an inert atmosphere glovebox.	**Eye protection**: Wear ANSI Approved tight-fitting safety goggles or safety glasses with side shields. **Face Protection**: Face shields are to be used when there is no protection from the hood sash. **Hand Protection:** Confirm compatibility of glove material with chemical being used. General guidance (unless otherwise specified in the specific SDS): Nitrile gloves must be used to prevent incidental contact. For spill handling or for potential contact with larger quantities, use double nitrile or heavier gauge nitrile or neoprene gloves. Gloves must be inspected prior to use. Wash and dry hands after use. **Clothing**: Wear lab coat; full length pants or equivalent; and close-toed, close-heeled shoes.	Use the smallest amount necessary to complete the experiment. If following a literature procedure, do not modify it without approval from PI. Consult PI on process before beginning. Eliminate any incompatible materials from potential spill area. Carefully weigh materials. Use of enclosed balance or tared method with secondary containment is recommended for solid oxidizers. Avoid spill near the balance or creating any dust. Avoid heating or flames when handling the compound. Keep containers closed when not in use. Clean up any powder that may have spilled and discard everything according to the chemical disposal procedure. Authorized person using a strong oxidizing agent is responsible for the safe collection and disposal of waste. Never dispose into container with incompatible materials. Never dispose into sink drain. ***Special Remarks on Explosion Hazards:*** Strong Oxidizing Agents react EXPLOSIVELY with reducing agents and oxidizable solvents. Do not use oxidizable solvents Temperature control over the reactions is required to minimize potential explosions.

				Care must be taken to minimize violent reactions with reducing agents especially under acidic conditions. Gaseous oxygen and benzoic acid can be emitted upon reaction between peroxide and some metals or by simply heating thus adequate ventilation (pressure bubbler on a Schlenk manifold, or an equilibrating balloon) has to be used to prevent dangerous over pressurization.
Notes	**Any deviation from this SOP requires approval from PI.**			

13. Documentation of Training (signature of all users is required)

- Prior to conducting any work with SOAs, designated personnel must provide training to his/her laboratory personnel specific to the hazards involved in working with this substance, work area decontamination, and emergency procedures.
- The Principal Investigator must provide his/her laboratory personnel with a copy of this SOP and a copy of the SDS provided by the manufacturer.

I have read and understand the content of this SOP:

Name	Signature	Identifier	Date

Appendix – List of Strong Oxidizing Agents (non-exhaustive list)

The National Fire Protection Association (NFPA) Code 430 (1995) "Code for the Storage of Liquid and Solid Oxidizers" provides many examples of typical oxidizing materials listed according to the NFPA classification system. Some of these examples include:

Chemical Name	Formula	CAS#	Class
Ammonium perchlorate	NH_4ClO_4	7790-98-9	4
Ammonium permanganate	NH_4MnO_4	13446-10-1	4
Barium peroxide	BaO_2	1304-29-6	1
Calcium chlorate	$CaClO_3$	10043-53-4	2
Calcium hypochlorite	$Ca(OCl)_2$	7778-54-3	2 (50% or less by weight)
Chromic acid	$H_2Cr_2O_7$	7738-94-5	2
Hydrogen peroxide	H_2O_2	7722-84-1	>27.5-52% Class 2, >52-91% Class 3
Magnesium peroxide	MgO_2	1335-26-8	1
Nitric Acid	HNO_3		<40% Class 1, >40-86% Class 2, >86% Class 3
Perchloric acid	$HClO_4$	7601-90-3	>50-60% Class 2, >60-72% Class 3, >72% Class 4
Potassium bromate	$KBrO_3$	7758-01-2	3
Potassium chlorate	$KClO_3$	3811-04-9	3
Potassium peroxide	K_2O_2	17014-71-0	2
Sodium chlorate	$NaClO_3$	7775-09-9	3
Sodium chlorite	NaOCl	7758-19-2	>40% Class 3
Sodium perchlorate	$NaClO_4$	7601-89-0	2
Sodium peroxide	Na_2O_2	1313-60-6	2

List of Chemicals

Chemical(s)	Chemical(s)	Chemical(s)
1,3-dibromo-5,5-dimethylhydantoin	1,3-diiodo-5,5-dimethylhydantoin	ammonium nitrate
barium manganate	bismuth nitrate pentahydrate	calcium hypochlorite
ceric ammonium nitrate	chromium trioxide	copper chromite
copper(ii) perchlorate hexahydrate	cupric nitrate trihydrate	dess-martin periodinane
diammonium peroxodisulphate	dibromoisocyanuric acid	diiodine pentaoxide
disilver oxide	guanidinium nitrate	hydrogen peroxide, 35% solution, technical
iodic acid	lithium nitrate	lithium perchlorate
magnesium perchlorate	nickel dioxide	nitric acid
oxygen	perchloric acid	periodic acid
phosphomolybdic acid hydrate	platinum dioxide	potassium bromate
potassium chlorate	potassium dichromate	potassium iodate
potassium nitrate	potassium periodate	potassium permanganate
potassium superoxide	pyridinium chlorochromate	pyridinium dichromate
silver nitrite	silver perchlorate	silver perchlorate monohydrate
sodium bis(2-hydroxy-2-methylbutyrato)oxochromate(v)	sodium bromate	sodium chlorate
sodium chlorite	sodium dichromate dihydrate	sodium iodate
sodium nitrate	sodium nitrite	sodium nitrite-15n
sodium perborate monohydrate	sodium perborate tetrahydrate	sodium percarbonate
sodium perchlorate	sodium periodate	sodium persulfate
tetrabutylammonium periodate	tetranitromethane	tetrapropylammonium perruthenate
thallium(iii) nitrate trihydrate	trichlorocyanuric acid	urea hydrogen peroxide