Potentially Explosive Compounds (PECs)

Examples: sodium azide, trimethylsilyl azide, ammonium nitrate, nitromethane, sodium perchlorate, 2,2'-Azobis(isobutyronitrile) (AIBN), Dinitrobenzene, *tert*-butyl peroxide
For more PECs, see Appendix

Note: Potentially Explosive Chemicals are materials that **may** oxidize, decompose, polymerize, become contaminated, dry out or destabilize and subsequently become explosive when subjected to heat, light, friction or mechanical shock.

It is paramount that researchers be aware of the hazards associated with PECs.

!! If you plan to ISOLATE PECs – refer to chemical specific SOP !!

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: 510-642-6312
Emergency Contact:	Name: Melissa Hardy/Justin Jurczyk Lab Phone: 406-696-1225/412-728-1952
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 Potentially Explosive Compounds (PECs).

For a list of PECs 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. Potentially Explosive Compounds Information

A potentially explosive compound (PEC) may be defined as any chemical compound or mechanical mixture that, when subjected to heat, impact, friction, detonation, or other suitable initiation, undergoes rapid chemical change, evolving large volumes of highly heated vapors and gases that exert pressure on the surrounding medium, possibly leading to a catastrophic failure of the vessel.

Before using the potentially explosive compound determine what is the initiating mechanism or trigger that could lead to an explosion; this could be friction, pressure, impact, light, or heat. This knowledge will be a key in determining how to handle the chemical. Refer to the SDS of your compound to determine potential triggers to avoid.

Note: Most explosions occur while purifying or distilling mixtures. If you are planning on isolating or purifying PECs, please refer to the Isolating PECs SOP.

3. Potential Hazards/Toxicity

The danger of PECs arises from lacerations due to shrapnel (metal, glass, ceramic, etc.) and burns due to fires that might accompany or follow the explosion.

PECs may also present additional hazards such as corrosivity, toxicity, pyrophoricity, or water reactivity. 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).

An explosion might also lead to exposure to other hazardous chemicals. See the appropriate SOPs and SDSs for any other chemicals used in tandem with PECs to determine if there is the potential of exposure to toxic chemicals.

4. Engineering Controls

Lab-specific information on engineering controls may be included in the Protocol/Procedure section.

The following is the set of engineering controls required when handling PECs:

- Work in a properly functioning chemical fume hood when handling PECs. Work with the sash as low as possible.
- When the fume hood sash does not provide adequate protection, use a portable blast shield, inside the hood.
- When working outside of a fume hood, a portable blast shield must be used.
- Laboratories and rooms where PECs 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. Flame-resistant lab coat (Nomex IIIA, NFPA 2112) must be worn.

B. 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

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 Section 12-Protocol/Procedure.

Precautions for Safe Handling:

- Review with the PI and/or experienced peers the lab procedures that could act as an explosion initiator, or trigger, for the particular potentially explosive.
- Keep away from sources of ignition – Open flames (e.g., Bunsen burner). In particular, take measures to prevent the build-up of heat or electrostatic charge.
- When manipulating PECs use equipment that will not generate static electricity, sparks or area of friction. (e.g. **use a Teflon-coated spatula or soft-rubber policeman instead of a regular metal spatula.**) **DO NOT use a metal spatula.**
- It is good practice to inform colleagues that a PEC will be used and where.
- 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

- Store in a location, separated from oxidizing, reducing, and other incompatible materials.
- Store PECs away from heat sources, this includes direct sunlight.

Disposal

- Any unused or unwanted PECs must be destroyed by following the specific destruction procedure(s) included in the Protocol/Procedure section. If you have large quantities of unreacted PECs contact EH&S for guidance on disposal options.
- 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. Spill and Accident Procedure

Note: Whenever conditions alter toward the negative, stop the work and assess the extent of danger.

Spill –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 (e.g., use caution tape, barriers, etc.).

- **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 642-3073 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 for Potentially Explosive Compounds

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, clothing)	Procedure Steps and Precautions
1. Use of PECs as a reagent.	Up to 10g 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. When working inside the hood without the sash protection, a portable blast shield is required. A portable blast shield is required when working with potentially explosive compounds outside of the hood.	**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 Nomex IIIA (NFPA 2112) lab coat; full length pants or equivalent; and close-toed and 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. Use dilute solutions to dissipate heat and reduce risk of fire or explosion. Add solutions slowly, monitoring heat generation. Do not handle dry synthetic PEC's – use as a dilute solution when possible. Do not scrape compounds with a spatula or other hard devices.
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 PECs, designated personnel must provide training to his/her laboratory personnel specific to the hazards involved in working with the specific chemical(s) used, 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 Potentially Explosive Chemicals (non-exhaustive list)

Potentially Explosive Compound Classes:		
Acetylene	Ba/Pb/Hg azide	Trinitrocresol
Acyl Hypohalites	Li/K/Na azide	Trinitronaphthalene
Organic azides	Benzoyl peroxide	Trinitrophenol (picric acid0
Metal azides	Bromopropyne	Trinitroresorcinol
Azo	Butanone peroxide	Trinitrotoluene
Diazo	Cumene peroxide	Urea nitrate
Diazosulphide	Diazodinitrophenol	
Diazonium salts	Dinitrophenol	
Fulminate	Dinitrophenylhydrazine	
Halogen Amine	Dinitroresorcinol	
Nitrate	Dipicryl amine	
Nitro	Dipicryl sulphide	
Aromatic or Aliphatic Nitramine	Dodecanoyl peroxide	
Nitrite	Ethylene oxide	
Nitroso	Laurie peroxide	
Ozonides	MEK peroxide	
Peracids	Hg/Ag fulminate	
Peroxide	Nitrocellulose	
Hydroperoxide	Nitrogen trifluoride	
Metal peroxide	Nitrogen triiodide	
Explosive salts:	Nitroglycerine	
Bromate salts	Nitroguanidine	
Chlorate salts	Nitromethane	
Chlorite salts	Nitrourea	
Perchlorate salts	Picramide	
Picrate salts	Picric acid (trinitrophenol)	
Picramate salts	Picryl chloride	
Hypohalite salts	Picrylsulphonic acid	
Iodate salts	Propargyl bromide (neat)	
Potentially Explosive Chemicals:	Sodium dinitrophenate	
Acetyl Peroxide	Succinic peroxide	
Acetylene	Tetranitroaniline	
Ammonium nitrate	Trinitroaniline	
Ammonium perchlorate	Trinitroanisole	
Ammonium picrate	Trinitrobenzene	
Trinitrobenzenesulphonic acid	Trinitrobenzoic acid	

List of Chemicals

Chemical(s)	Chemical(s)	Chemical(s)
?-cumene hydroperoxide	1-hydroxybenzotriazole	2,2'-azobis(2-methylpropionitrile)
2,4-dinitrophenylhydrazine	2-nitropropane	3-chloroperbenzoic acid
3h-1,2,3-triazolo[4,5-b]pyridin-3-ol	4,4'-azobis(4-cyanovaleric acid)	4-methylbenzenesulfonhydrazide
4-nitrosophenol	5-(ethylthio)-1h-tetrazole	ammonium nitrate
benzenesulfonyl hydrazide	benzoyl peroxide	diethyl azodicarboxylate
dilauroyl peroxide	nitromethane	peracetic acid
propargyl bromide	p-tolylsulfonylmethylnitrosamide	tert-butyl hydroperoxide
tert-butyl hydroperoxide (5.0-6.0M in decane)	tert-butyl peroxybenzoate	