Standard Operating Procedure

POTENTIALLY EXPLOSIVE AND EXPLOSIVE COMPOUNDS*

This standard operating procedure (SOP) is intended to provide general guidance on how to safely work with compounds which are explosive or potentially explosive. This SOP is generic in nature and only addresses safety issues specific to these materials. In some instances, several general use SOPs may be applicable for a specific chemical.

An explosive is 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 gases that exert pressure on the surrounding medium. The term applies to materials that either detonate or deflagrate. Heat, light, mechanical shock and certain catalysts initiate explosive reactions.

Examples of potentially explosive and explosive compounds include:

Potentially Explosive Compounds (PEC)

Acetyl peroxide	Acetylene	Ammonium nitrate
Ammonium perchlorate	Ammonium picrate	Barium azide
Benzoyl peroxide	Bromopropyne	Butanone peroxide
Cumene peroxide	Diazodinitrophenol	Dinitrophenol
Dinitrophenylhydrazine	Dinitroresorcinol	Dipicryl amine
Dipicryl sulphide	Dodecanoyl peroxide	Ethylene oxide
Heavy metal azides	Lauric peroxide	Lead azide
Lithium azide	Methyl ethyl ketone peroxide	Mercury azide
Mercury fulminate	Nitrocellulose	Nitrogen trifluoride
Nitrogen triiodide	Nitroglycerine	Nitroguanidine
Nitromethane	Nitrourea	Organic azides
Picramide	Picric acid	Picryl chloride
Picryl sulphonic acid	Potassium azide	Propargyl bromide (neat)
Silver fulminate	Sodium azide	Sodium dinitrophenate
Succinic peroxide	Tetranitroaniline	Trinitroaniline
Trinitroanisole	Trinitrobenzene	Trinitrobenzenesulphonic acid
Trinitrobenzoic acid	Trinitrocresol	Trinitronaphthalene
Trinitrophenol	Trinitroresorcinol	Trinitrotoluene
Urea nitrate		

Potentially Explosive Compound Classes

Acetylene (-C=C-)	Acyl hypohalites (RCO-OX)	Azide Organic (R-N3)
Azide Metal (M-N3)	Azo (-N=N-)	Diazo (=N=N)
Diazosulphide (-N=N-S-N=N-)	Diazonium salts (R-N2+)	Fulminate (-CNO)
Halogen Amine (=N-X)	Nitrate (-ONO2)	Nitro (-NO2)
Aromatic or Aliphatic Nitramine (=N-NO2) (-NH-NO2)	Nitrite (-ONO)	Nitroso (-NO)
Ozonides	Peracids (-CO-O-O-H)	Peroxide (-O-O-)
Hydroperoxide (-O-O-H)	Metal peroxide (M-O-O-M)	

Explosive Salts

Bromate salts (BrO3-)	Chlorate salts (ClO3-)	Chlorite salts (Cl02-)
Perchlorate salts (Cl04-)	Picrate salts (2,4,6-trinitrophenoxide)	Picramate salts (2-amino-4,6-dinitrophenoxide)
Hypohalite salts (XO-)	Iodate salts (IO3-)	

Potential Hazards/Toxicity

*Note: Some of the information in this SOP was adopted from ***Prudent Practices in the Laboratory, Handling and Management of Chemical Hazards, Updated Edition,*** National Research Council.

The most obvious hazard of potentially explosive and explosive compounds stems from the physical injuries that may occur from flying debris (metal, glass, ceramic, etc.) and burns due to fires that might accompany or follow the explosion.

Some of these compounds may also cause acute and chronic health effects.

Users must familiarize themselves with the specific hazards and toxicity of the compounds they are working with, which can be found on the chemical's Safety Data Sheet (SDS). SDSs are available through the Safety Data Sheet link on Yale's EHS webpage (ehs.yale.edu).

Personal Protective Equipment (PPE)

The University's Personal Protective Equipment Policy can be found on the EHS website (ehs.yale.edu)

Eye Protection

Goggles and faceshield must be worn whenever handling these compounds.

Hand Protection

Gloves must be worn when handling PECs and explosive compounds. Exam style nitrile gloves (minimum 4mil thickness) are generally adequate for handling these compounds in laboratory settings when working with the solids or when skin contact is unlikely with solutions. However, if skin contact with the solution is likely or larger amounts are being used, then a utility grade glove should be worn over the exam style nitrile. In many cases, a utility grade nitrile or neoprene glove is appropriate, but verify by referring to the chemical's SDS, a glove manufacturer's selection guide or by contacting EHS.

Skin and Body Protection

Long pants or clothing that covers the body to the ankles and closed-toe solid top shoes must be worn when handling PECs and explosive compounds. Lab coats must be worn. If the compound also poses a health hazards through dermal absorption, additional protective clothing (i.e., apron, oversleeves) may be appropriate where chemical contact with the skin is likely.

Engineering Controls

Fume Hood

Fume hoods, or other locally exhausted ventilation, must be used whenever handling PECs and explosive compounds.

Portable Blast Shield

While a blast shield is recommended whenever working with potentially explosive compounds, it is required under the following conditions:

- When a reaction is attempted for the first time (small quantities of reactants should be used to minimize hazards);
- When a familiar reaction is carried out on a larger than usual scale (i.e., 5-10 times more material); or
- When operations are carried out under non-ambient conditions.

Storage/Handling

- Store in designated cabinets and not on benches or shelves. PECs which are flammable should be stored in cabinets or refrigerators which are rated for flammable storage.
- Label incoming containers with the date of receipt. Do not use reactive materials past their expiration date.
- Exercise due care when handling peroxide formers. Visually inspect bottle cap and threads of container (without handling) for presence of organic peroxide crystals.
- The scale of work is critical. It should be done at the smallest scale possible (e.g., mmole) and scaled up only with the authorization of the Principal Investigator.

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- For those chemicals that deflagrate, eliminate sources of confinement if possible.
- Only those chemicals involved in the operation should be in the vicinity of the work being done.
- Identify and eliminate sources of static discharge since this can be an initiating force for some explosives. Low humidity environments also increase the potential for static.
- Conduct transfers and other operations with compatible tools and equipment. For example, some explosives can form more sensitive compounds when exposed to metal and especially heavy metals. For those chemicals, non-metal tools and equipment should be used.
- Keep the work area, tools and equipment clean. Do not allow explosives to build up. Use non-static wipes or brushes or use appropriate wet methods to clean handling areas. Do not scrape explosives from surfaces.
- Do not attempt to crush or grind an explosive or apply other pressure to it unless it is explicitly known that the explosive is not sensitive to it.

Waste Disposal

Collect PECs and explosive compounds as hazardous waste. Where possible dilute explosive wastes in a safe solvent, since many explosives are more stable when dilute. Keep explosive wastes separate from other wastes.

Emergency Procedures

Fire Extinguishers
Both ABC dry powder and carbon dioxide extinguishers are appropriate for most fires involving PECs and explosive compounds.

Eyewash/Safety Showers
An ANSI approved eyewash station that can provide quick drenching or flushing of the eyes must be immediately available within 10 seconds travel time for emergency use. An ANSI approved safety drench shower must also be available within 10 seconds travel time from where these compounds are used. Ensure the locations of the eyewashes and safety showers, and how to activate them, are known prior to an emergency.

First Aid Procedures

If inhaled
Remove to fresh air. Follow up with Acute Care or Employee Health as appropriate (203-432-0123).

In case of skin contact
Go to the nearest emergency shower if contaminated. Yell for assistance and rinse for 15 minutes, removing all articles of clothing to ensure contaminate is completely removed. Follow up at Acute Care/Employee Health as appropriate (203-432-0123).

In case of eye contact
Go to the nearest emergency eyewash. Yell for assistance and rinse for 15 minutes. Follow up at Acute Care/Employee Health (203-432-0123).

Explosion

If an explosion occurs, determine if any injuries have occurred. If immediate medical attention is necessary, call 911. After assisting injured persons, secure the area and call EHS for emergency assistance (203-785-3555).

Spills

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Small Spill
If a small occurs, lab personnel should be able to safely clean it up by following standard spill clean up procedures:

- Alert people in immediate area of spill
- Increase ventilation in area of spill (open fume hood sashes)
- Wear personal protective equipment, including utility grade gloves
- Confine/adsorb spill with spill clean up pads or absorbent
- Collect residue, place in container, label container, and dispose of as hazardous waste
- Clean spill area with soap and water

Larger Spill/Any spill outside a fume hood

- Call EHS for emergency assistance (203-785-3555)
- Evacuate the spill area
- Post someone or mark-off the hazardous area with tape and warning signs to keep other people from entering
- Stay nearby until emergency personnel arrive and provide them with information on the chemicals involved

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