

## **CAES Standard Operating Procedure**

# **CAES Guidelines for Safe Chemical Storage**



**Center for Advanced  
Energy Studies**



<b>CAES GUIDELINES FOR SAFE CHEMICAL STORAGE</b>	CAES-016 Revision: 0 Effective Date: 07/01/09
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## 1. PURPOSE

Safe chemical handling requires routine inspections of chemical storage areas and maintenance of stringent inventory control. The inherent hazards of chemicals can be reduced by minimizing the quantity of chemicals on hand. However, when chemicals must be used, proper storage and handling can reduce or eliminate associated risks. All chemical storage areas and cabinets should be inspected at least annually and any unwanted or expired chemicals should be removed.

Typical storage considerations may include temperature, ignition control, ventilation, segregation and identification. Proper segregation is necessary to prevent incompatible materials from inadvertently coming into contact. A physical barrier and/or distance is effective for proper segregation.

Proper storage information can usually be obtained from the Material Safety Data Sheet (MSDS), label, or other chemical reference material. As required by 29 CFR 1910.1200, an MSDS must be on hand for every hazardous chemical in the workplace. MSDSs must be provided by the manufacturer or distributor of chemicals purchased. The Internet can also be used to find MSDSs.

## 2. KEYS FOR SAFE CHEMICAL STORAGE

- 2.1 Ensure all containers of hazardous/non-hazardous chemicals are properly labeled with the identity (chemical name) of the hazardous/non-hazardous chemical(s) and appropriate hazard warnings.
- 2.2 Segregate all incompatible chemicals for proper storage of chemicals by hazard class. In other words, store like chemicals together and away from other groups of chemicals that might cause reactions if mixed.
- 2.3 Flammable materials should be stored in an approved, dedicated flammable materials storage cabinet or storage room if the volume exceeds ten gallons.
  - 2.3.1 Keep cabinet doors closed.
- 2.4 Chemicals should be stored no higher than eye level and never on the top shelf of a storage unit.

**NOTE:** *Do not overcrowd shelves. Each shelf should have an anti-roll lip.*

- 2.5 Avoid storing chemicals on the floor (even temporarily) or extending into traffic aisles.
- 2.6 Liquids should be stored in unbreakable or double-contained packaging, or the storage cabinet should have the capacity to hold the contents if the container breaks.

**NOTE:** *Nitric acid may be stored in a dedicated acid cabinet but only if it is kept isolated from all other acids.*

2.7 Store acids in a dedicated acid cabinet.

2.8 Store highly toxic or controlled materials in a locked, dedicated poison cabinet.

**NOTE:** *Chemical fume hoods shall not be used for storage as containers block proper air flow in the hood and reduce available work space.*

2.9 Volatile or highly odorous chemicals shall be stored in a ventilated cabinet.

2.10 All chemicals should be labeled and dated upon receipt in the lab and on opening. This is especially important for peroxide-forming chemicals such as ethers, dioxane, isopropanol, and tetrahydrofuran.

2.10.1 Solutions should be labeled and dated when prepared.

2.11 Look for unusual conditions in chemical storage areas, such as:

- Improper storage of chemicals
- Leaking or deteriorating containers
- Spilled chemicals
- Temperature extremes (too hot or cold in storage area)
- Lack of or low lighting levels
- Blocked exits or aisles
- Doors blocked open, lack of security
- Trash accumulation
- Open lights or matches
- Fire equipment blocked, broken or missing
- Lack of information or warning signs (“Flammable liquids,” “Acids,” “Corrosives,” “Poisons,” etc.).

2.12 First aid supplies, emergency phone numbers, eyewash and emergency shower equipment, fire extinguishers, spill cleanup supplies and personal protective equipment should be readily available and personnel trained in their use.

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- 2.13 Keep all stored chemicals, especially flammable liquids, away from heat and direct sunlight.

### 3. EXAMPLES OF INCOMPATIBLE CHEMICALS

**NOTE 1:** *The following list is not a complete listing of incompatible materials. It contains some of the more common incompatible materials. Always research materials you work with in order to work safely in the lab.*

**NOTE 2:** *Chemicals listed in Column A should not be stored with or used near items in Column B.*

Table 1. Examples of incompatible chemicals.

Column A	Column B
Acetic acid	Chromic acid, nitric acid, hydroxyl compounds, ethylene glycol, perchloric acid, peroxides, permanganates
Acetic anhydride	Hydroxyl-containing compounds such as ethylene glycol, perchloric acid
Acetone	Concentrated nitric and sulfuric acid mixtures, hydrogen peroxide
Acetylene	Chlorine, bromine, copper, fluorine, silver, mercury
Alkali and alkaline earth metals such as powdered magnesium, sodium, potassium	Water, carbon tetrachloride or other chlorinated hydrocarbons, carbon dioxide, halogens
Ammonia (anhydrous)	Mercury, halogens, calcium hypochlorite, hydrofluoric acid
Ammonium nitrate	Acids, metal powders, flammable liquids, chlorates, nitrites, sulfur, finely divided organic or combustible materials
Aniline	Nitric acid, hydrogen peroxide
Arsenical materials	Any reducing agent
Azides	Acids, heavy metals and their salts, oxidizing agents
Calcium oxide	Water
Carbon, activated	All oxidizing agents, calcium hypochlorite
Carbon tetrachloride	Sodium
Chlorates	Ammonium salts, acids, metal powders, sulfur, finely divided organic or combustible material
Chlorine dioxide	Ammonia, methane, phosphine, hydrogen sulfide
Chromic acid and chromium trioxide	Acetic acid, alcohol, camphor, glycerol, naphthalene, flammable liquids in general
Copper	Acetylene, hydrogen peroxide
Cumene hydroperoxide	Acids (organic or inorganic)
Cyanides	Acids

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Table 1. (continued).

Column A	Column B
Flammable liquids	Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens, other oxidizing agents
Fluorine	All other chemicals
Hydrides	Water
Hydrocarbons (e.g., butane, propane, benzene)	Fluorine, chlorine, bromine, chromic acid, peroxides
Hydrocyanic acid	Nitric acid, alkalis
Hydrofluoric acid (anhydrous)	Ammonia (aqueous or anhydrous)
Hydrogen peroxide	Copper, chromium, iron, most metals or their salts, any flammable liquid (i.e., alcohols, acetone), combustible materials, aniline, nitromethane
Hydrogen sulfide	Fuming nitric acid, oxidizing gases
Hypochlorites	Acids, activated carbon
Iodine	Acetylene, ammonia (aqueous or anhydrous), hydrogen
Mercury	Acetylene, fulminic acid, ammonia
Metal hydrides	Acids, water
Nitrates	Acids
Nitric acid (concentrated)	Acetic acid, acetone, alcohol, aniline, chromic acid, hydrocyanic acid, hydrogen sulfide, flammable liquids, flammable gases, copper, brass, any heavy metals
Nitrites	Acids
Nitroparaffins	Inorganic bases, amines
Oxalic acid	Mercury and silver and their salts
Oxygen	Oils, grease, hydrogen; flammable liquids, solids, or gases
Perchloric acid	Acetic anhydride, alcohol, bismuth, paper, wood, grease, oils
Permanganates	Concentrated sulfuric acid, glycerol, ethylene glycol, benzaldehyde
Peroxides, organic	Acids (organic or mineral), avoid friction, store cold
Phosphorus, white	Air, oxygen, alkalis, reducing agents
Potassium	Carbon tetrachloride, carbon dioxide, water
Potassium chlorate	Sulfuric and other acids, ammonium salts, metal powders, sulfur, finely divided organics, combustibles
Potassium perchlorate (see also chlorates)	Sulfuric and other acids
Potassium permanganate	Glycerol, ethylene glycol, benzaldehyde, sulfuric acid
Silver and silver salts	Acetylene, oxalic acid, tartaric acid, ammonium compounds, fulminic acid
Sodium	Carbon tetrachloride, carbon dioxide, other chlorinated hydrocarbons, water

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Table 1. (continued).

Column A	Column B
Sodium nitrate	Ammonium nitrate and other ammonium salts
Sodium peroxide	Ethyl or methyl alcohol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide glycerin, ethylene glycol, ethyl acetate, methyl acetate, furfural
Sulfides	Acids
Sulfuric acid	Chlorates, perchlorates, permanganates

Adapted from *Prudent Practices in the Laboratory: Handling and Disposal of Chemicals*, National Research Council, 1995, with additions from OHS.

#### 4. BASIC CHEMICAL SEGREGATION

Table 2. Basic chemical segregation.

Hazard Class of Chemical	Recommended Storage Method	Examples	Incompatibilities
Compressed gases - Flammable	Store in a cool, dry area, away from oxidizing gases. Securely strap or chain cylinders to a wall or bench.	Methane Hydrogen Acetylene Propane	Oxidizing and toxic compressed gases, oxidizing solids.
Compressed gases - Oxidizing	Store in a cool, dry area, away from flammable gases and liquids. Securely strap or chain cylinders to a wall or bench.	Oxygen Chlorine Bromine	Flammable gases
Compressed gases - Poisonous	Store in a cool, dry area, away from flammable gases and liquids. Securely strap or chain cylinders to a wall or bench.	Carbon monoxide  Hydrogen sulfide Nitrogen dioxide	Flammable and/or oxidizing gases.
Corrosives - Acids	Store separately in acid storage cabinet. Segregate oxidizing acids (i.e., Chromic, nitric, sulfuric, and perchloric acids) from organic acids	Acetic acid Phenol  Sulfuric acid Chromerge Nitric acid Perchloric acid Chromic acid Hydrochloric acid	Flammable liquids, flammable solids, bases, oxidizers
Corrosives - Bases	Store in separate corrosive storage cabinet. Store solutions of inorganic hydroxides in labeled polyethylene containers.	Ammonium hydroxide  Sodium hydroxide Calcium hydroxide	Flammable liquids, oxidizers, poisons, and acids

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Table 2. (continued).

Hazard Class of Chemical	Recommended Storage Method	Examples	Incompatibilities
Flammable Liquids	Store in flammable storage cabinet and away from sources of ignition. Store highly volatile flammable liquids in an explosion-proof refrigerator.	Acetone Benzene  Diethyl ether Methanol Ethanol Toluene Glacial acetic acid	Acids, bases, oxidizers, and poisons
Flammable Solids	Store in a separate dry, cool area away from oxidizers, corrosives, flammable liquids	Phosphorus, yellow Calcium carbide Picric acid Benzoyl peroxide	Acids, bases, oxidizers, and poisons
General Chemicals - Non-reactive	Store on general laboratory benches or shelving preferably behind glass doors and below eye level.	Agar  Sodium chloride Sodium bicarbonate Most non-reactive salts	See specific MSDS.
Oxidizers	Store in a spill tray inside a chemical storage cabinet. Separate from flammable and combustible materials.	Ammonium persulfate  Ferric chloride Iodine Sodium hypochlorite Benzoyl peroxide Potassium permanganate Potassium dichromate The following are generally considered oxidizing substances: Peroxides, perchlorates, chlorates, nitrates, bromates, superoxides.	Separate from reducing agents, flammables, and combustibles.

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Table 2. (continued).

Hazard Class of Chemical	Recommended Storage Method	Examples	Incompatibilities
Poisons/Toxic Compounds	Store separately in vented, cool, dry area, in unbreakable chemically-resistant secondary containers and in accordance with the hazardous nature of the chemical.	Aniline Carbon tetrachloride Chloroform Cyanides Heavy metals compounds, i.e., cadmium, mercury, osmium Oxalic acid Phenol Formic acid	Flammable liquids, acids, bases, and oxidizers.  See specific MSDS.
Water-Reactive Chemicals	Store in dry, cool location, protect from water fire sprinkler.	Sodium metal  Potassium metal Lithium metal Lithium aluminum hydride	Separate from all aqueous solutions and oxidizers.
Carcinogens	Label all containers as "Cancer Suspect Agents". Store according to the hazardous nature of the chemical, using appropriate security when necessary.	Benzidine  Beta-naphthylamine Benzene Methylene chloride Beta-propiolactone	See specific MSDS.
Teratogens	Label all containers as "Suspect Reproductive Hazard". Store according to the hazardous nature of the chemical, using appropriate security when necessary.	Lead and mercury compounds  Benzene Aniline	See specific MSDS.
Peroxide-Forming Chemicals	Store in air-tight containers in a dark, cool, dry area. See Table 3 for recommended storage time limits.	Diethyl ether  Acetaldehyde Acrylonitrile	See specific MSDS.
Strong Reducing Agents	Store in cool, dry, well-ventilated location. Water reactive. Segregate from all other chemicals.	Acetyl chloride Thionyl chloride Maleic anhydride Ferrous sulfide	See specific MSDS.

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**NOTE:** Under proper conditions, the chemicals in Table 3 will form explosive peroxides which can be detonated by shock or heat.

Table 3. Suggested storage time limits for common peroxidizable compounds.

<b><u>MOST DANGEROUS:</u></b> Discard after <u>3 months</u> .	
Peroxide formation hazard during storage.	
Diisopropyl ether	Potassium metal
Divinyl acetylene	Sodium amide
Isopropyl ether	Vinylidene chloride

<b><u>DANGEROUS:</u></b> Discard after <u>one year</u> .		
Peroxide formation hazard during storage and on concentration (i.e., distillation) of compound.		
Acetal	Dicyclopentadiene	Methyl cyclopentane
Acetaldehyde	Diethyl ether	Methyl isobutyl ketone
Cumene	1,4-Dioxane	Tetrahydrofuran
Cyclohexene	Ethylene glycol dimethyl ether	Tetrahydronaphthalene
Diacetylene	Methyl acetylene	Vinyl ethers

<b><u>DANGEROUS:</u></b> Discard after <u>one year</u> .		
Peroxide formation causes initiation of hazardous polymerization.		
Acrylic acid	Chloroprene	Tetrafluoroethylene
Acrylonitrile	Chlorotrifluoroethylene	Vinyl acetate
1,3-Butadiene	Methyl methacrylate	Vinyl acetylene
2-Butanol	2-Propanol	Vinyl chloride
	Styrene	Vinyl pyridine

## 5. OTHER SAFETY TIPS

- 5.1 Do not purchase these compounds in quantities greater than can be used in the specified storage time period.
- 5.2 Label containers with receiving, opening and disposal dates.
- 5.3 Ethers should be stored in the dark and under nitrogen if possible.
- 5.4 Always check for the presence of peroxides before distilling any peroxide-former.
- 5.5 Consult safety references (i.e., [MSDSs](#)) before working with peroxidizable compounds.
- 5.6 If old containers of peroxide-forming chemicals are found, do not move them. Contact the Idaho State University Technical Safety Office for safe disposal.