

VA Baltimore Research Service - Chemical Storage Guidelines

Prepared by Grazyna Zaidel, Chemical Hygiene Officer, October 2007

Reviewed by Angela Wood VISN 5 Industrial Hygienist and Dave Pullen VISN 5 Safety and Fire Protection Engineer

Safe chemical handling requires routine inspections of chemical storage areas and maintenance of rigorous inventory control. The inherent hazards of chemicals can be reduced by minimizing the quantity of chemicals on hand. Proper storage and handling can reduce or eliminate associated risks. All chemical storage areas and cabinets should be inspected semi-annually and any unwanted or expired chemicals should be removed.

For guidance on chemicals purchase and storage limitations please get familiar with entire Chemical Storage Guidance and our Picric Acid, Perchloric Acid, and Ethyl Ether Policies.

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 are effective for proper segregation.

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

Maximum allowable quantities of flammable and combustible liquids can be obtained by referencing NFPA 99, Standard for Health Care Occupancies and NFPA 45, Standard on Fire Protection for Laboratories Using Chemicals.

Considerations for proper storage:

- All chemical containers must be labeled in English as to their contents and with appropriate hazard warnings. Label has to match corresponding MSDS. Chemical formulas are not permitted as the sole means of identification.
- All chemicals should be labeled with investigator name and dated upon receipt in the lab and on opening. It will be strictly enforced for potentially reactive chemicals that form unstable compounds over time and require special handling. Solutions should be labeled and dated when prepared.
- Label all chemical waste containers with Chemical Name, "WASTE", and date in which accumulation of that waste began. All waste should have secondary containment.
- Segregate all chemicals for proper storage by hazard class. Always check MSDS before storing chemicals for incompatibilities. Find a designated storage place for each compound. Do not store chemicals alphabetically except within a grouping of compatible chemicals.
- Flammable materials in an excess of 1 gallon/100 sq ft of laboratory space shall be stored in an approved, dedicated flammable materials storage cabinet. Keep flammable cabinet doors closed.
- Chemicals should be stored no higher than eye level and never on the top shelf of a storage unit. Do not overcrowd shelves.
- Avoid storing chemicals on the floor (even temporarily) or extending into traffic aisles.
- Do not store any chemicals except bleach and compatible cleaning agents under the sink.
- Store liquids in unbreakable packaging. If this is not plausible provide secondary containment for all hazardous liquid chemicals.
- Store acids in a dedicated acid cabinet. Nitric acid may be stored there also but only if it is kept isolated from all other acids. Oxidizing acids should be separated from other acids by a secondary containment.
- Store highly toxic or controlled materials in a closed, dedicated cabinet.

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- Volatile or highly odorous chemical shall be stored in a ventilated cabinet or closed outer container to avoid releasing contaminants into the laboratory air.
- Chemical fume hoods shall not be used for storage as chemical containers block proper air flow in the hood, reduce available work space, may provide fuel if there is a fire or sources for chemical reaction of incompatible chemicals.
- 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", "Poisons", etc.)
- 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. These shall be checked daily by the user.
- Chemicals stored in any common use room must be sealed and labeled with the name of the person who stored the material, room number and date when received in addition to all other required hazard warnings.
- Only compressed gas cylinders that are in use and secured in place shall be kept in the laboratory. All others, including empties, shall be sent to the compressed gas cylinder storage area for the facility.
- Keep all stored chemicals, especially flammable liquids, away from heat and direct sunlight.
- Many chemicals pose hazards that correspond to more than one storage group. These chemicals should be stored with precautions for all hazard class that apply.

Table 1. Examples of Incompatible Chemicals

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.

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

Column A - Chemical	Column B - Incompatibilities
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

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Column A - Chemical	Column B - Incompatibilities
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
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

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Column A - Chemical	Column B - Incompatibilities
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
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
Tellurides	Reducing Agents

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

Table 2. Basic Chemical Segregation

DOT Hazard Class	Recommended Storage Method	Examples	Incompatibilities
Class 1 Explosive/Shock Sensitive Definition: Thermodynamically unstable material Hazard: Explosion caused by shock or chemical reaction	Follow manufacturer's recommendations. Discard before expiration date. Store minimum quantities.	Picric acid, 2,4-dinitro-phenol, organic azides	See specific MSDS

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DOT Hazard Class	Recommended Storage Method	Examples	Incompatibilities
<p>Class 2: Gases Definition: Purified gas in a pressurized tank Hazard: Tank rupture, fire, toxic atmosphere, oxygen displacement</p>			
<p>Flammable Gas Definition: Gas with a flash point less than 140° F. Hazard: Ignites easily, burns rapidly</p>	Store in a cool, dry area, at least 20 feet away from oxidizing gases. Securely strap or chain cylinders to wall. A maximum of 3 full-size flammable cylinders may be stored in one lab.	Methane Hydrogen Acetylene Propane	Oxidizing and toxic compressed gases, oxidizing solids.
<p>Oxidizing Gas</p>	Store in a cool, dry area, away from ignition sources and oxidizers. Store away from grease or oil. Securely strap or chain cylinders to wall to prevent falling.	Oxygen Chlorine Bromine	Flammable gases
<p>Poisonous Gas</p>	Store in a cool, dry, well ventilated area, away from flammable gases and liquids. Securely strap or chain cylinders to wall.	Carbon monoxide Hydrogen sulfide Nitrogen dioxide	Flammable and/or oxidizing gases.
<p>Corrosive Gas</p>	Store in a cool, dry area, away from flammable and oxidizing gases and liquids. Securely strap or chain cylinders to wall. Check regularly for corrosion.	Hydrogen fluoride Ammonia Dimethylamine Monomethylamine	Flammable and/or oxidizing gases.
<p>Class 3 Flammable Liquid Flammable Definition: Liquid with a flash point (FP) less than 100°F. Combustible Definition 200 °F>FP>100 °F Hazard: Ignites easily, burns rapidly.</p>	<p>Primary Storage Concern: To protect from ignition</p> <p>Store in flammable storage cabinet and away from sources of ignition.</p> <p>Store highly volatile flammable liquids in an explosion-proof refrigerator.</p> <p>Store flammable that require refrigeration in a flammable safe refrigerator</p>	<p>Flammable Acetaldehyde Acetone Acetonitrile Benzene Chlorobenzene Dimethylsulfide Ethyl ether Ethyl alcohol Ethylene oxide Ethyl acetate Pentane Propane Pyridine Tetrahydrofuran Toluene Xylene Combustible Acetic acid Benzaldehyde Formic acid</p>	<p>Corrosives, oxidizers, and poisons</p> <p>If possible store combustible liquids in separate flammable cabinet.</p> <p>The total volume of class I, II, and IIIA flammable or combustible liquids OUTSIDE of a flammable storage cabinet may not exceed 1 Gallon/100 sq ft of laboratory space.</p> <p>The TOTAL volume of class I, II and IIIA flammable or combustible liquids may not exceed 2 Gallons/100 sq ft of lab space.</p>

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DOT Hazard Class	Recommended Storage Method	Examples	Incompatibilities
<p>Class 4 Flammable Solid</p> <p>Definition: Solid that burns readily Hazard: Ignites easily, burns rapidly.</p>	<p>Store in a separate, dry, cool area away from ignition sources, oxidizers, corrosives, flammable liquids</p>	<p>Benzoyl peroxide Calcium carbide Paraformaldehyde Phosphorus yellow Picric acid</p>	<p>Acids, bases, oxidizers, corrosives, and poisons</p>
<p>Class 5.1 Oxidizer</p> <p>Definition: Agents that react with reducible material to initiate or promote combustion Hazard: Fire or explosion</p> <p><u>The following are generally considered oxidizing substances:</u> Peroxides, Perchlorates, Chlorates, Nitrates Bromates, Superoxides.</p>	<p>Store in a spill tray inside a chemical storage cabinet.</p> <p>Separate from reducing agents, flammable and combustible materials.</p>	<p>Ammonium persulfate Benzoyl peroxide Bromine Ferric chloride Hydrogen peroxide Iodine Nitric acid Sodium hypochlorite Potassium permanganate Potassium dichromate</p>	<p>Reducing agents, flammables and combustibles, organics. Store chlorine separately from acids.</p>
<p>Class 5.2. Organic Peroxide</p> <p>Definition: Any organic compound that forms unstable peroxides when exposed to air Hazard: Explosion resulting from formation of concentrated peroxide crystals</p>	<p>Store in air-tight containers in a dark, cool, dry, designated area.</p> <p>Inspect regularly to track their age.</p> <p>See Table 3 for recommended storage time limits.</p>	<p>See Table 3 below</p>	<p>See specific MSDS.</p>
<p>Class 6 Poisons/Toxic -Volatile Evaporation rate >1</p> <p>Definition: Chemicals that cause damage to target organs (liver, lungs, reproductive system etc.) if inhaled, ingested, or absorbed through skin Hazard: Acute or toxic effects that may be local, systemic, or both</p>	<p><u>Primary storage concern:</u> To prevent inhalation exposure</p> <p>Store separately in unbreakable chemically-resistant secondary containers (enclosed cabinets may serve as a secondary containment) and in accordance with the hazardous nature of the chemical. Use appropriate security.</p>	<p>Carbon tetrachloride Chloroform Dimethylformamide Dimethyl Sulfate Formamide Formaldehyde Halothane Mercaptoethanol Methylene chloride Phenol</p>	<p>Flammable liquids, corrosives, and oxidizers.</p> <p>See specific MSDS</p>

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<p>Class 6 Poisons/Toxic <u>Non-volatile liquids and solids</u> Includes poisons, toxics and known and suspected carcinogens, mutagens, teratogens</p>	<p>Store separately in a dedicated cabinet according to the hazardous nature of the chemical, using appropriate security.</p>	<p>Acrylamide Aniline Benzene Benzidine b-naphthylamine Beta-propiolactone Cyanides Diethylpyrocarbon Ethidium Bromide Formic acid Heavy metals, i.e., cadmium, mercury, osmium, lead, mercury Methylene chloride Oxalic acid Triethalonamine</p>	<p>Flammable liquids, acids, bases, and oxidizers. See specific MSDS.</p>
<p>Class 8 Corrosive</p>			
<p>Organic and Mineral Acids Definition: Compound with pH of 1-7 Hazard: Tissue damage, violent reaction with strong bases</p>	<p><u>Primary Storage Concern:</u> Preventing contact and reaction with bases, oxidizing acids, other substances and corrosive action on surfaces. Store separately in acid storage cabinet.</p>	<p>Organic Butyric Formic Glacial acetic Isobutyric Mercaptopriopronic Priopronic Phenol Trifluoroacetic Mineral Hydrochloric acid Boric acid</p>	<p>Flammable liquids, flammable solids, bases and oxidizers Separate organic acids from mineral acids Acetic acid as combustible liquid shall be stored in the dedicated flammable cabinet</p>
<p>Oxidizing Acids</p>	<p><u>Primary Storage Concern:</u> Preventing contact and reaction with each other, reaction with all other substances and corrosive action on surfaces.</p>	<p>Sulfuric acid Nitric acid Perchloric acid Chromic acid Phosphoric acid</p>	<p>Separate from each other and all other chemicals Oxidizing acids must be double contained or segregated in their own compartment in a safety cabinet separately from other acids.</p>
<p>Caustics Definition: Compound with pH 7-14 Hazard: Tissue damage, violent reaction with strong acids</p>	<p><u>Primary Storage Concern:</u> Preventing contact and reaction with acids and other substances. Store in separate corrosive storage cabinet or separate from other chemicals by secondary containment.</p>	<p>Ammonium hydroxide Sodium hydroxide Calcium hydroxide</p>	<p>Acids, flammable liquids, oxidizers and poisons.</p>

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DOT Hazard Class	Recommended Storage Method	Examples	Incompatibilities
Class 9 Miscellaneous			
Strong Reducing Agents Definition: Readily combines with oxygen or loses electron to the reaction Hazard: Violent reaction with oxidizer producing heat	Store in cool, dry, well-ventilated location. Segregate from all other chemicals.	Acetyl chloride Thionyl chloride Maleic anhydride Ferrous sulfide	Separate from oxidizers. See specific MSDS.
Water-Reactive Definition: Reacts violently with water producing heat or toxic gases Hazard: Explosion, fire or toxic gases	Store in dry, cool location, protect from water, fire sprinkler, sinks and drains.	Sodium metal Potassium metal Lithium metal Lithium aluminum hydride Acid anhydrides Metal anhydrides	Aqueous solutions and oxidizers.
Pyrophoric Definition: Ignites spontaneously in air Hazard: Fire	Store under inert atmosphere per manufacturers instructions.	Phosphorus Lithium	See specific MSDS
Carcinogen Definition: Chemicals that cause cancer in humans or animal models Hazard: Carcinogenesis	Store in a secure sealed container below eye level. Use in only designated areas with approved controls	Formaldehyde Benzene	See MSDS
Cryogen: Definition: Liquefied or solidified gases at low temperatures. Hazard: Tissue damage (frost bite), oxygen displacement, tank rupture	Store in approved containers in well ventilated areas. (Do not store dry ice in cold rooms)	Liquid nitrogen Dry ice	
Sensitizer Definition: Substances that can cause an allergic reaction of the skin or respiratory system Hazard: Allergic reaction	Store in secure container taking into account other hazards associated with the substance	Glutaraldehyde Isocyanets	See MSDS
Controlled substances Definition: Substances specifically controlled by federal law. Hazard: Theft	Store in a secure, locked location. Maintain a current inventory.	Narcotics	See MSDS
General Chemicals - Non-reactive	Store on general laboratory benches or shelving preferably behind glass doors and below eye level.	Agar Buffers Sodium chloride Sodium bicarbonate Non-reactive salts	See MSDS.

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Table 3. Suggested Storage Time Limits for Common Peroxidizable Compounds

Under proper conditions, these chemicals will form explosive peroxides which can be detonated by shock or heat.

<u>MOST DANGEROUS:</u> Discard after <u>3 months</u> . Peroxide formation hazard during storage.		
Diisopropyl ether Divinyl acetylene Isopropyl ether	Potassium metal Sodium amide Vinylidene chloride	
<u>DANGEROUS:</u> Discard after <u>one year</u> . Peroxide formation hazard during storage and on concentration (i.e., distillation) of compound.		
Acetal Acetaldehyde Cumene Cyclohexene Diacetylene	Dicyclopentadiene Diethyl ether 1,4-Dioxane Ethylene glycol diethyl ether Methyl acetylene	Methyl cyclopentane Methyl isobutyl ketone Tetrahydrofuran Tetrahydronaphthalene Vinyl ethers
<u>DANGEROUS:</u> Discard after <u>one year</u> . Peroxide formation causes initiation of hazardous polymerization.		
Acrylic acid Acrylonitrile 1,3-Butadiene 2-Butanol	Chloroprene Chlorotrifluoroethylene Methyl methacrylate 2-Propanol Styrene	Tetrafluoroethylene Vinyl acetate Vinyl acetylene Vinyl chloride Vinyl pyridine

Safety Hints:

- Do not purchase these compounds in quantities greater than can be used in the specified storage time period.
- Label containers with receiving, opening and disposal dates.
- Ethers should be stored in the dark and under nitrogen if possible.
- Always check for the presence of peroxides before distilling any peroxide-former.
- Consult safety references (i.e., MSDSs) before working with peroxidizable compounds.
- If old containers of peroxide-forming chemicals are found, do not move them. Contact the VAMC Industrial Hygienist for assistance in disposing of the container.