University of Colorado at Denver and Health Sciences Center

Environmental Health and Safety Department

# Guidance Note: Unpacking Chemicals and Chemical Storage Guidelines

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*This information is for your use and as a way of providing consistent information. There is no response required.*

## Unpacking Chemicals and Chemical Storage Guidelines

The researchers will be responsible for unpacking the chemical reagents from the shipping containers and rigid plastic coolers at the Anschutz Medical Center laboratories. The shipping containers, rigid plastic coolers, and vermiculite will be reused again by the Lab Packing Contractors so it will be important to insure that all the chemical reagent containers have been removed from the container.

The proper segregation and storage of chemical reagents is important in the laboratory because the accidental mixing (leaking or broken containers) of incompatible chemicals may cause fires, explosions, or the production of toxic gases. The chemical storage guidelines provided in this document will help insure that incompatible chemical reagents will not have the chance to react while they are being stored in the laboratory.

Researchers should follow these guidelines when unpacking chemical reagents from the shipping containers at the Anschutz Medical Campus laboratories:

1. Have flammable rated storage cabinets properly set up so that flammable solvents may be unpacked directly from the shipping container into the flammable cabinet.

2. Pre-plan where the chemical reagents will be stored inside the laboratory.

3. Try and avoid pouring the vermiculite out of the shipping containers, as this will create vermiculite dust which is considered an irritant. Consider wearing a dust mask while unpacking the reagent bottles.

4. Notify EH&S immediately (303 724-0345) whenever you discover a broken or leaking chemical reagent container inside the shipping container. Replace the cover on the shipping container to control the release of toxic vapors.

5. It is critical that the researchers thoroughly check each empty shipping container for chemical containers hidden inside the vermiculite. Both the shipping containers and vermiculite will be reused again by the Lab Packing Contractors.

## GENERAL CHEMICAL STORAGE GUIDELINES

1. Typically, chemicals reagents are segregated into separate chemical storage cabinets by the following hazard classes in order to avoid unwanted chemical reactions:

**a. Flammable solvents and combustible organic solvents**
**b. Acids**
**c. Bases or caustics**
**d. Oxidizers**
**e. Solid chemical reagents**
**f. Aqueous liquid reagents (non-flammable)**

2. Avoid storing chemicals of different hazard classes together in the same storage cabinet or work space. If separate storage cabinets are unavailable, use plastic pails or tubs as a means of secondary containment to segregate incompatible chemicals from one another.

3. Store solid chemicals together on laboratory shelves or inside storage cabinets. Oxidizers (nitrates, nitrites, permanganates, etc.) are usually segregated from all other chemicals and are collected together in a plastic tub.

4. Do not place any chemical reagents into storage until they are plainly and permanently labeled with the full chemical name. Chemical waste containers must also be labeled with the proper UCDHSC Chemical Waste label.

5. Do not store chemical reagents or chemical waste containers inside the chemical fume hood. Chemical fume hoods are active work areas that need to remain clean. Chemical fume hoods that are storing excessive containers or equipment may significantly reduce the airflow inside the hood or they may create unwanted eddy currents that release contaminants back into the room.

6. Do not store old or outdated chemicals. Dispose of all unneeded chemicals promptly through EH&S by filling out a UCDHSC "Chemical Waste Disposal Form". For disposing of large stocks of unwanted chemical reagents call the UCDHSC Hazardous Materials Group (303 315-5661 at the 9th avenue campus or 303 724-0127 at the Anschutz Medical Campus) to schedule an appointment to have the chemicals removed.

7. Do not store chemical reagent containers holding liquids above eye level or on the floor. If you must store containers of liquids on the floor, use a plastic secondary containment to control spills in case the container is accidentally broken.

8. Secure large compressed gas cylinders to the wall (or a sturdy support) with a strap, unless it is secured with a stand. Small lecture bottles of toxic compressed gases should be stored underneath the chemical fume hood.

## FLAMMABLE LIQUID STORAGE GUIDELINES

Flammable liquids need to be stored inside approved fire rated cabinets in order to control fires. Because of the lack of fire separations inherent in the open laboratory building design, each Anschutz Medical Campus laboratory module will be limited to storing a maximum of two gallons of flammable solvents (including flammable chemical waste) outside of an approved flammable storage cabinet. In addition, the total amount of flammable liquids permitted on an entire floor of an open laboratory building is limited to 450 gallons.

Typically, 3-4 laboratory modules may be sharing a single chemical fume hood, therefore flammable storage space under the hood may be limited. Researchers should plan on moving existing flammable storage cabinets and purchasing additional flammable storage cabinets as needed.

The following terminology is used to describe flammable solvents:

Flash Point is the temperature at which a liquid or volatile solid gives off enough vapors to form an ignitable mixture with air.

Flammable Liquids are organic solvents which have a flash point of less than 140°Fahrenheit. The lower the flash point of an organic solvent, the greater the potential fire hazard. Most alcohols have flash points below room temperature, therefore spills must be handled with caution because a fire may occur if a source of ignition is present (spark or flame). Since ethyl ether has a flash point of minus 49 degrees Fahrenheit, even when this solvent is stored inside a freezer there would be enough vapors present from a leaking container to cause a fire should a source of ignition be present.

Combustible Liquids are organic solvents which have a flash point of greater than 140°Fahrenheit and less than 200°Fahrenheit. The lower the flash point of a combustible liquid the greater the potential fire hazard. 37% formaldehyde is a combustible liquid. Many organic acids (acetic acid) also meet the classification of a combustible liquid.

Peroxidizable Solvents have chemical structures that are prone to react with atmospheric oxygen or light to form unstable peroxide-products during storage. A limited number of organic solvents (ethyl ether, isopropyl ether, dioxane, furan, tetrahydrofuran, etc.) form unstable peroxides upon storage. If shock sensitive peroxide crystals are disturbed or heated (distillation), an explosion may occur. Mark the outside of the container with both the date of acquisition and date opened for all containers holding peroxidizable solvents. Purchase peroxide forming solvents in small quantities (enough for immediate use only) and dispose of them in an appropriate time period (one year or by expiration date).

Flammable and Combustible Liquid Storage Store flammable and combustible liquids together and away from all oxidizers or oxidizing acids (nitric acid, chromic acid, perchloric acid). Additional approved storage cabinets must be purchased by the laboratory. In addition, the total amount of flammable liquids permitted on an entire floor of an open laboratory building is limited to 450 gallons.

Non-flammable solvents (chloroform, methylene chloride, etc.) may be stored with flammable liquids if you have adequate storage space.

Refrigerators and Walk-in Coolers **cannot** be used for the storage of flammable liquids. Refrigerators and freezers should be considered a potential source of ignition, which may cause a leaking solvent container to ignite. Also, if the refrigeration system of a walk-in cooler looses its cooling system, the heat accumulated from a light left on inside for several days may raise the inside temperature to several hundred degrees.

## COMMON FLAMMABLE SOLVENTS (not all inclusive)

Alcohols - methanol, ethanol, propanol, butanol, amyl alcohol, hexanol

Aldehydes and Ketones - acetaldehyde, acetone, methyl ethyl ketone, MIBK

Alkanes (hydrocarbons) - butane, hexane, heptane, octane, nonane, ligroin, naphtha, petroleum naphtha, petroleum ether, petroleum distillates, pentane, gasoline

Aromatics - benzene, bromobenzene, cumene, pyridine, toluene, xylene

Ethers - ether, ethyl ether, methyl ether, isopropyl ether, ethylene glycol monomethyl ether, cellosolve

Highly Toxic - acrolein, carbon disulfide, ethyleneimine, ethylene oxide

Miscellaneous - acetic acid, acetyl chloride, acetonitrile, cyclohexane, dichloroethane, dioxane, ethyl acetate, ethylenediamine, furan, methyl methacrylate, propylene oxide, tetrahydrofuran, triethyl amine, (outdated scintillation cocktail)

## COMMON COMBUSTIBLE LIQUIDS (not all inclusive)

Organic acids - acetic acid, formic acid, propionic acid, butyric acid

Miscellaneous - acetic anhydride, dimethylformamide, diesel fuel oil, ethylenediamine, 37% formaldehyde, isoamyl alcohol, kerosene, mercaptoethanol, mineral spirits, phenol, pseudocumene

## UCDHSC REQUIREMENTS FOR COLD-STORAGE OF FLAMMABLE LIQUIDS

Flammable liquids cannot be stored in lab *refrigerators, unless:

a. The refrigerator is specifically designated as a flammable materials storage refrigerator which complies with National Fire Protection Association (NFPA) 45, and is Underwriter's Laboratory (UL) listed, or
b. The refrigerator is specially designed as being an explosion-proof refrigerator and complies with OSHA 29 CFR 1910.307 and is UL listed for Class 1, Groups C and D hazardous locations.
c. Explosion proof refrigerators require EH&S inspection and approval.

Flammable liquids cannot be stored or used in *cold rooms, unless:

a. The cold room's electrical and refrigeration equipment is specially designed as being explosion-proof. The unit must comply with OSHA 29 CFR 1910.307 or UL for Class 1, Groups C and D hazardous locations, and
b. The room must be mechanically ventilated, providing 100% outside air, at an exhaust rate of at least 6 changes per hour at the point of use.
c. These rooms require design approval from EH&S prior to installation or construction.

***EXCEPTION:** A limited risk is associated with the small-quantity cold-storage of **ethyl, methyl, and isopropyl alcohols.** EH&S will accept refrigerator or cold-room storage of these materials, provided:

1. The quantity in a container does not exceed 500 ml, and
2. The liquid is stored in a tightly sealed container with 25% of the bottle empty (for vapor expansion), and
3. There is sealed secondary containment, using a non-breakable container.
4. Only two containers are allowed per cold-storage area.

Transfer of liquid to other containers must take place in a well ventilated area, away from the cold storage unit. **This exception DOES NOT APPLY to ethers or other flammable liquids, unless pre-approved by EH&S.** The consideration of other exceptions will be handled on a case-by-case basis, dependent on use, quantity, and safeguards.

Secondary containment using sealed, hard-sided plastic containers, such as those found at most grocery stores, is acceptable.

For further clarification, please contact the Fire and Life Safety Specialist at 303 724-0293, or EH&S at 303 724-0345.

## ACID STORAGE GUIDELINES

Storage of Acids Acids must be segregated from bases in order to prevent unwanted neutralization reactions and corrosive vapors from forming. Oxidizing acids (e.g. nitric, chromic, perchloric) should not be stored together with flammable liquids. Perchloric acid becomes explosively unstable in concentration of higher than 70 percent, so do not store them next to strong dehydrating agents such as concentrated sulfuric acid or phosphorus pentoxide. Hydrochloric acid is somewhat volatile and it should be stored inside a vented cabinet whenever possible to reduce corrosion. If you must store acids and bases together due to limited storage space, place all of the containers of one hazard class into plastic trays for secondary containment. Do not store acid containers next to metal natural gas lines.

1. Segregate oxidizing acids (nitric, perchloric, chromic acid, chromerge) from organic acids (acetic, formic, etc.) to prevent fires. Many organic acids are also classified as combustible liquids so they should be stored inside fire rated storage cabinets.

2. Acids must be segregated from bases to prevent the generation of heat and toxic gases.

3. Do not store acids near any cyanide or sulfide containing chemicals in order to prevent the generation of highly toxic hydrogen cyanide or hydrogen sulfide gas.

4. Do not store concentrated acids next to household bleach, as mixing will generate highly toxic chlorine gas.

5. Do not store concentrated acids next to window cleaner or ammonium hydroxide, as mixing will generate highly toxic chlorinated amine gas.

Mineral Acids - hydrobromic, hydrochloric, hydrofluoric, hydroidic, nitric, perchloric, phosphoric, sulfuric

Organic Acids - formic, acetic, propionic, butyric, valeric, hexanonic, oxalic, trichloroacetic, citric acid
(Many organic acids are also classified as combustible liquids so they should be stored in fire rated cabinets.)

Water-reactive acids - chlorosulfonic acid, fuming sulfuric acid, acetic anhydride

Oxidizing Acids - nitric acid, perchloric acid, chromic acid, chromerge

HCl, HBr, HI hazard - Concentrated HCl, HBr and HI should be handled with care prior to opening a new container to prevent gas and liquid from spraying out of the container. All of these aqueous acids are prepared by dissolving the acidic gases into water. Containers of concentrated acids packaged at sea level may be under pressure when opened in Denver (5,280 feet above sea level).

## BASES AND CAUSTIC STORAGE GUIDELINES

Storage of Bases Bases must be segregated from acids in order to prevent unwanted neutralization reactions and corrosive vapors from forming.

Common bases include ammonia, calcium oxide, potassium hydroxide, sodium hydroxide, sodium carbonate, sodium phosphate (tribasic), amines and ammonia derivatives

Ammonium hydroxide hazard Concentrated ammonium hydroxide (30%) containers should be cooled prior to opening to prevent ammonia gas and liquid from spraying out of the container. Ammonia is a gas, and its solubility in solution is temperature dependent. At elevated temperatures, a container of concentrated ammonium hydroxide may be under pressure.

## OXIDIZER STORAGE GUIDELINES

Storage of Oxidizers Store oxidizers together in a cool area away from paper and all other chemicals. Oxidizers should be placed together in a plastic tray which is clearly marked with an oxidizer label. Note that some oxidizers are not compatible with one another.

**COMMON OXIDIZERS (not all inclusive)**

Nitrates - ammonium, barium, cadmium, calcium, chromium, copper, ferric, lead, magnesium, mercury, nickel, potassium, propyl, sodium, uranyl, zinc

Nitrites - ammonium, barium, calcium, potassium, sodium

Bromates - ammonium, barium, calcium, potassium, sodium, zinc

Chlorates - ammonium, barium, calcium, potassium, sodium, zinc

Chlorites - calcium, sodium

Dichromates - ammonium, ferric, potassium, sodium

Iodates - ammonium, ferric, potassium, sodium

Perborates - sodium, zinc

Perchlorates - ammonium, barium, calcium, cesium, lead, magnesium, potassium, sodium

Peroxides (dioxides) - barium, calcium, hydrogen peroxide, lead, lithium, manganese, magnesium, potassium, sodium, zinc

Permanganates - ammonium, potassium, sodium

Organic Oxidizers - amyl nitrate, benzoyl peroxide, butyl perbenzoate, cumene hydroperoxide, peroxyacetic acid

Oxidizing Acids - nitric acid, perchloric acid, chromic acid, chromerge

Miscellaneous oxidizers - household bleach, bromine, fluorine, chromic acid, chlorine trifluoride, chromium trioxide, mercuric oxide, osmium tetroxide, periodic acid, nochromix

## SOLID CHEMICAL STORAGE GUIDELINES

Some solid chemicals may react when mixed with water or corrosives to generate either flammable or toxic gases. It is important not to store aqueous liquids or corrosives with water-reactive chemical reagents, to help prevent the generation of hazardous gases.

**Water-Reactive Flammable Compounds**. Some chemicals generate flammable gases (hydrogen) on contact with water, therefore they should be segregated from corrosives and aqueous liquids to prevent fires and/or explosions.

**WATER-REACTIVE FLAMMABLE SOLIDS (not all inclusive)**

Alkali Metals - lithium, sodium, potassium, rubidium, cesium

Borohydrides - aluminum, calcium, lithium, potassium, sodium

Carbides - calcium, lithium (generate acetylene gas)

Hydrides - aluminum, calcium, lithium, potassium, sodium, zirconium

Methoxides or methylates **-** sodium or potassium salts of methanol

Ethoxides or ethylates - sodium or potassium salts of ethanol

**Water-Reactive Toxic Solids**. Water soluble cyanides, sulfides and phosphides generate extremely toxic gases on contact with water or corrosives.

**WATER-REACTIVE TOXIC SOLIDS (not all inclusive)**

Cyanide compounds (water soluble) - Calcium, mercuric, ferric, potassium, sodium, silver, zinc
**Keep away from acids as they generate highly toxic hydrogen cyanide gas.**

Sulfide compounds (water soluble) - ammonium, calcium, magnesium, potassium, sodium
**Keep away from acids as they generate highly toxic hydrogen sulfide gas.**

Phosphide compounds - aluminum, calcium, sodium, stannic
**Keep away from water or acids as they generate highly toxic phosphine gas.**

Miscellaneous Water-Reactives - aluminum chloride (anhydrous), lithium silicon, sodium amide, sodium dithionite, sodium hydrosulfite, dimethyldichlorosilane, thionyl chloride