University of Colorado Health Sciences Center

Health and Safety Division

Guidance Note: Unpacking Chemicals & 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 & Chemical Storage Guidelines

The researchers will be responsible for unpacking the chemical reagents from the shipping containers at the Fitzsimons laboratories. The shipping containers 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. Chemical reagents should also be segregated by hazard class and stored in the laboratory according to the guidelines provided in this document.

Researchers are also responsible for unpacking the rigid plastic coolers that contain refrigerated non-hazardous supplies. Unpack the contents of the cooler directly into the refrigerator inside the laboratory. The coolers will be reused again by the moving contractors so it is important to insure that all the contents including frozen cooling packs have been removed. Researchers are responsible for cleaning up any spills or leaking contents inside the coolers.

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. Incompatible chemicals should never be stored next to one another in order to minimize the possibility of accidental mixing. The chemical storage guidelines provided in this document will help insure that incompatible chemical reagents will not have a chance to react while they are being stored in the laboratory.

Researchers will follow these guidelines when unpacking chemical reagents from the shipping containers at the Fitzsimons 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 (corrosives in acid cabinets, solid chemicals in storage cabinets, chemical stock solutions on laboratory bench top, etc.).

3. Wear clean plastic gloves whenever handling RNAse free chemical reagents in order to prevent genetic material from contaminating the container.

4. Do not inhale vermiculite dust from the shipping container because it is an irritant. Minimize the amount of vermiculite dust that is created when unpacking the liquid chemical reagent bottles from the

shipping container. Do not pour the vermiculite out of the shipping container. Consider wearing a dust mask while unpacking the liquid chemical reagent bottles.

5. Carefully remove each liquid chemical bottle from shipping container in a manner which minimizes the formation of vermiculite dust. Remove the plastic bag covering the liquid container and discard it into the household trash.

6. Notify Health & Safety immediately (x40345) 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.

7. Use a long screw driver or stick to check the vermiculite absorbent sitting inside each "empty" shipping container for lost or buried chemical containers. 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. Chemical reagents will be properly segregated by hazard class in order to reduce the possibility of dangerous chemical reactions from leaking or broken containers (e.g. acids mixed with soluble cyanide salts generate toxic hydrogen cyanide gas).

Typically, chemicals reagents are segregated into separate chemical storage cabinets by the following hazard classes:

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

2. Do not store chemicals of different hazard classes together in the same storage cabinet or work space. Whenever separate storage cabinets are unavailable use secondary containment (plastic pails or tubs) to segregate incompatible chemicals from one another.

3. Store solid chemicals together on laboratory shelves or inside storage cabinets. It is a good practice to segregate liquids from solid chemical reagents in order to prevent water reactive chemicals from contacting leaks or spills. 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. Grease pencil markings and abbreviations are not acceptable. Chemical waste containers must also be labeled with the proper UCHSC 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 flow rate of 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 the Health and Safety Division by filling out a UCHSC "chemical waste request for disposal form." For disposing of large stocks of unwanted chemical reagents call the UCHSC hazardous waste manager (x40127) to schedule an appointment to have the chemicals removed.

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

8. Do not use bottles or containers of chemical reagents to form the support structure for the shelf above them (removing the last bottles will cause the shelf to collapse). Check the shelf to assure that it is supported by metal supports on the cabinet wall.

9. Large compressed gas cylinders must be secured 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 Fitzsimons 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 (when source of ignition present). It should be noted that when a flammable liquid burns it is **not** the liquid, which ignites, but rather the volatile gas-air mixture.

Flammable Liquids are organic solvents which have a flash point of less than 100°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 (light switch or freezer compressor).

Combustible Liquids are organic solvents which have a flash point of greater than 100°Fahrenheit and less than 200°Fahrenheit. The lower the flash point of a combustible liquid the greater the potential fire hazard. 37% formaldehyde also 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 (explosive) during storage. A limited number of organic solvents (ethyl ether, isopropyl ether, dioxane, furan, tetrahydrofuran, etc.) for 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). Each "open" laboratory module at Fitzsimons is limited to storing a maximum of two gallons of flammable solvents (including flammable wastes) outside of an approved flammable storage cabinet. 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 flammable liquids. See the Health & Safety Policy for Cold 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)

Alcohol**s** - methanol, ethanol, propanol, butanol, amyl alcohol, hexanol

Aldehydes & 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, etc.

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

UCHSC 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 Health and Safety Division 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 of the Health and Safety Division, prior to installation or construction.

***EXCEPTION:** A limited risk is associated with the small-quantity cold-storage of **ethyl, methyl, and isopropyl alcohols.** The Health and Safety Division 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 Health and Safety.** 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 the Health and Safety Division at (303) 724-0345.

University of Colorado Health Sciences Center

Health and Safety Division

ACID STORAGE GUIDELINES

The following terminology is used to describe acids:

Acids have the ability to donate a hydrogen ion (H+) or to accept an electron pair. Acids turn litmus paper red. The pH range of acidic aqueous solutions is from 0 to 6.9 . The stronger an acid, the lower the pH. Acids have the ability to neutralize bases. When acids come in contact with metals they may generate flammable hydrogen gas. Proper eye protection and personal protective clothing must be worn at all times when handling strong acids.

Storage of Acids. Acids must be segregated from bases in order to prevent unwanted neutralization reactions and corrosive vapors being generated. Oxidizing acids (e.g. nitric, chromic, perchloric) must 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 with 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 (5,250 feet above sea level).

BASES & CAUSTIC STORAGE GUIDELINES

The following terminology is used to describe bases or caustics:

Bases or Caustics in many cases produce the hydroxyl ion (OH-) which give bases their caustic character. Bases have the ability accept protons (donate electrons) and neutralize acids. Bases turn litmus paper blue**.** The pH range of bases is 7.1 to 14. The stronger a base, the higher the pH. Caustic chemicals are very slippery and they are excellent conductors of electricity. Concentrated bases are corrosive, and they can cause extreme damage to the eyes or tissue because they penetrate tissue much deeper than acids. Proper eye protection and personal protective clothing must be worn at all times when handling strong bases.

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

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

The following terminology is used to describe oxidizers:

Oxidizers in general are any compound that spontaneously evolves oxygen at room temperature or under slight heating. Oxidizers are also defined as a substance that easily gains electrons in redox reactions. The term includes such chemicals containing peroxides, chlorates, perchlorates, nitrates, nitrites and permanganates. Oxidizers may react vigorously at room temperature with carbon containing substances (organic solvents) to produce fires or explosions.

Storage. 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, etc.

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 reagent 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 phospides 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