Chemical/Flammable Storage Management Program

Inventory and Inspection

Each laboratory is to maintain an inventory of the chemicals stored in the laboratory as part of the Laboratory Safety Manual. Designate a storage place for each chemical, and return it to that place after each use. Inspect chemical storage areas at least annually for outdated or unneeded items, illegible labels and leaking containers.


Examples of chemicals in poor condition, that you should NOT keep stored in your lab:

- Degraded containers
- Illegible/removed labels
- Leaking lids

Proper Sealing of Chemical Containers

To prevent leakage, odors, or reaction with air, tightly seal all containers of highly toxic, highly volatile, malodorous, carcinogenic or reactive chemicals. Make sure that caps and other closures are tight on all hazardous chemicals. A limited exception is freshly-generated mixtures such as acids and organics that may generate gas pressure sufficient to burst a tightly sealed bottle. Use commercially available vent calthe lids. Until all reactions are completed, the contents of the bottle are not waste, but are instead the last step of the chemical procedure.

The best seal is the screw cap with a conical polyethylene or Teflon insert. Seal the caps with tape or parafilm as a further precaution. Additional protection can include wrapping the container in an absorbent paper, sealing it inside a plastic bag, and storing the bag inside a metal can with a friction fitting lid.


Smaller Container Sizes – Less is Better

The real cost of a chemical includes its initial purchase price plus the ultimate disposal costs. Keep the quantity of accumulated chemicals in the laboratory at a minimum to reduce the risk of exposures, fires, and waste disposal problems. Smaller package sizes provide the following advantages:

- Reduced storage hazards
- Reduced storage space
- Safety in handling smaller quantities
- Reduced losses due to out-of-date chemicals
- Minimized cost of disposal of "leftovers"

Frequently, it costs many times more than the original purchase price to dispose of leftover chemicals. Chemical storerooms on campus keep supplies of the most frequently used solvents and chemicals to lessen the need for laboratory stockpiles.

Storage Symbols

Most chemical manufacturers include chemical storage symbols on their labels. Many manufacturers use symbols that include a hazard ranking system, such as the National Fire Protection Association (NFPA 704) diamond symbol or the Hazardous Materials Identification System (HMIS) colored rectangle. Picture glyphs are another common label element. Below are examples of the NFPA and HMIS hazard ranking systems (Figure 4.3), and glyph systems from the European Union (Figure 4.4) and Canada (Figure 4.5) which are commonly seen on U.S. chemical labels and safety data sheets.

Recognizing the need for a universal method to identify potentially hazardous substances, the United Nations has created a worldwide Globally Harmonized System (GHS) for label elements and safety data

sheets. Because of the numerous languages used by the worldwide research community, the GHS relies heavily on picture glyphs to convey the basic information. Below are GHS glyphs that will begin appearing on chemical labels and SDSs..

United Nations GHS label elements (left to right): Flammable, Harmful, Oxidizing, Toxic to the Environment, Corrosive, Compressed Gas, Explosive, Human Health Hazard, Highly Toxic.

Chemical Storage

Optimally, incompatible chemicals such as acids and alkalis should be stored completely separate from one another to prevent mixing in the event of an accidental spill or release of the materials. Limited storage space within the laboratories, however, sometimes prevents such prudent practice of chemical segregation and storage. If space is limited, you can store incompatible chemicals in the same storage cabinet if you segregate the chemicals according to their hazard class and you store them in tubs, trays, or buckets while in the cabinet. These secondary containers reduce the chance that incompatible chemicals will inadvertently contact each other.

Laboratory Hoods: Do not store chemicals in laboratory hoods because the containers may impede airflow and thereby reduce the effectiveness of the hood.

Refrigerated Storage: Store flammable solvents that require storage at reduced temperature in refrigerators or freezers designed for storage of flammable liquids. "Safety" refrigerators for flammable liquid storage and "explosion proof" refrigerators are both acceptable. Because refrigerators and freezers have no interior space venting, all chemicals should have tightly sealed caps. Apply signage to the doors of chemical refrigerators stating: NO FOOD, BEVERAGE, OR ICE FOR HUMAN CONSUMPTION."

Cold rooms in the Jenkins Science Center and Pharmacy Complex have closed air circulation systems that re-circulate escaped vapors within the chamber. The refrigeration coils in cold

rooms are aluminum and subject to damage from corrosive atmospheres. The electrical systems normally have vapor proof lights and duplex outlets, but added-on extension cords and plug strips compromise these safety features. Cold rooms are not acceptable for storage of flammables, dry ice, highly toxic liquid chemicals, or compressed gases. If you must refrigerate these chemicals, store them in an approved refrigerator or freezer, rather than a cold room.

Flammable and Combustible Liquid Storage: Fire protection regulations limit the storage of flammable and combustible liquids to 10 gallons (37.9 liters) in open storage, 25 gallons (94.7 liters) in "safety cans", and 60 gallons* (227.3 liters) in "flammable liquid storage cabinets" per laboratory room. These limits are for the total quantities on hand, including chemicals in storage, chemicals in use, and wastes. *Note that only 30 gallons (113.6 liters) of Class I liquids are permitted per room. Class I liquids have a flash points less than 100 °F (37.8 °C), and are traditionally known as "flammable" liquids. Most liquids labeled as flammable are Class I liquids. Combustible liquids are Class II or III liquids, and have flashpoints above 100 °F (37.8 °C). Regulations permit up to 60 gallons (227.3 liters) of combustible plus flammable liquids per room, provided no more than 30 gallons are Class I. Also, the International Fire Code (adopted by the State of North Carolina) places limits on the amounts of flammable and combustible liquids stored in new or renovated buildings as the number of floors above grade increases. For some laboratories located on higher floors in new or renovated buildings, the flammable liquid storage limit per room might be less than 30 gallons. Contact Sheryl Bradford at 252-335-3270 or Rickey Freeman at 252-335-3877 if you have questions about the flammable storage limits for your lab spaces.

Cabinets: You can use cabinets under hoods and laboratory benches for storage of chemicals. In some cases, laboratory furniture manufacturers design cabinets specifically for storage of flammable and/or corrosive materials. However, do not store laboratory chemicals near or under sinks where there may be exposure to water. Storage of cleaning supplies under sinks is acceptable. Cabinets for chemical carcinogens or highly toxic chemicals should have a lock. Desiccator jars and cabinets are useful for storage of air and water reactive, toxic, and malodorous chemicals. In case of especially malodorous compounds such as mercaptans, replace the desiccator material with a vapor adsorber (e.g. charcoal) to control odors. Chemical storage on bench tops is undesirable, and is vulnerable to accidental breakage by laboratory, housekeeping, and emergency response personnel. Do not store liquids on shelves that are above eye-level. When storing chemicals on open shelves, consider several factors such as compatibility grouping (see below), the container material (plastic or metal versus breakable glass), physical state of the chemical (it's riskier to store liquids on open shelves compared to solids), the relative toxicity of the chemical, and the height and depth of the shelving.

<u>Compatibility Groups</u>

Store chemicals in the laboratory according to their compatibility groups.

Group A – Acids, Inorganics

Store large bottles of acid in special acid cabinets, under lab benches, or on low shelves. Place acids in plastic trays for secondary containment in case of breakage. Segregate inorganic and oxidizing acids from organic compounds including organic acids (e.g., acetic acid) and other combustible materials. Segregate nitric acid (>40%) from organic chemicals, including organic acids. Store acids separate from bases and other reducing agents. Inorganic salts, except those of heavy metals, may be stored in this

group. Glacial acetic acid should be stored with flammable and combustible materials since it is combustible.

Group B – Bases

Segregate bases from acids and oxidizers on shelves near the floor. The preferred storage container for inorganic hydroxides is polyethylene instead of glass. Place containers in trays for secondary containment in the event of leakage or breaks.

Group C – Organic chemicals

Segregate organic compounds from inorganics. Organics and inorganics with NFPA 704 or HMIS reactive hazard rating of two (2) or less may be stored together. Chemicals with a reactive hazard rating of three (3) or four (4) are to be stored separately.

Group D – Flammable and Combustible Organic Liquids

Flammable and combustible liquid storage per room is limited to 10 gallons (37.9 liters) in open storage and use, 25 gallons (94.7 liters) in safety cans, and 60 gallons (227.3 liters) in flammable storage cabinets. Remember that only 30 gallons (113.6 liters) of Class I liquids are permitted per room, and International Fire Code restrictions might limit this even further if your lab is located on an upper floor in a new or renovated building. Store flammable and combustible materials away from sources of ignition such as heat, sparks, or open flames, and segregated from oxidizers.

Group E – Inorganic Oxidizers and Salts

Store inorganic oxidizers in a cool, dry place away from combustible materials such as zinc, alkaline metals, formic acid, and other reducing agents. Inorganic salts may also be stored in this group. Store ammonium nitrate separately.

Group F – Organic Peroxides and Explosives

Peroxides contain a double-oxygen bond (R1-O-O-R2) in their molecular structure. They are shock and heat sensitive (e.g. benzoyl peroxide), and readily decompose in storage. Store shock and heat-sensitive chemicals in a dedicated cabinet.

Common explosive compounds include 2,4,6-trinitrotoluene (TNT), nitroglycerin, and several metal fulminates and azides. 2,4,6-trinitrophenol, also known as picric acid, is normally sold as a saturated solution containing at least 40% water, and classified as a flammable solid. If allowed to dry to less than 10% water, picric acid becomes a DOT Class 1.1 explosive. Nitroglycerin in research is usually sold as a tincture mixed with alcohol, but if the alcohol evaporates, the result is explosive nitroglycerin.

Group G – Reactives

Water Reactives

Store water reactives in a cool dry place protected from water sources. Alkali metals (lithium, sodium, potassium, rubidium, and cesium) should be stored under mineral oil, or in waterproof enclosures such as glove boxes.

Pyrophorics (Air Reactives)

Store pyrophorics in a cool, dry place, and provide for an air tight seal. Store white or yellow phosphorous under water in glass stoppered bottles inside a metal can for added protection.

Group H – Cyanides and Sulfides

Cyanides and sulfides react with acids to release highly toxic gases. They must be isolated from acids and other oxidizers.

Group I – Carcinogens, Highly Toxic Chemicals, and Reproductive Toxins

A dedicated lockable storage cabinet in a "designated area" for carcinogens and highly toxic chemicals is the preferred storage method. Stock quantities of reproductive toxins are to be stored in designated storage areas. Use unbreakable, chemically resistant secondary containers. Post the storage cabinet with a sign stating "CANCER SUSPECT AGENT", "HIGHLY TOXIC CHEMICALS", or "REPRODUCTIVE TOXINS". Maintain a separate inventory of all highly acute toxics, carcinogens, and reproductive toxins.

Compatibility Group	Group Name	Chemical Class
Group A	Inorganic Acids, Inorganic Salts	inorganic acids (except nitric), sulfur, arsenic, halides, sulfates, sulfites, thiosulfates, halogens, phosphorus, phosphates
Group B	Inorganic Bases	hydroxides, oxides, silicates, carbonates
Group C	Organics	alcohols, glycols, amines, amides, hydrocarbons, esters, aldehydes, phenol cresols, organic sulfides, organic acids
Group D	Flammables, Combustibles	ethers, aliphatic solvents, aromatic solvents
Group E	Inorganic Oxidizers	borates, chromates, manganates, permanganates, chlorates, perchlorates, chlorites, hypochlorites, hydrogen peroxides, amides, nitrates, nitrites, azides
Group F	Organic Peroxides and Explosives	peroxides, azides, hydroperoxides
Group G	Reactives	air and water reactives, metals and hydrides
Group H	Cyanides, Sulfides	cyanides, cyanates, sulfides, carbides, nitrides
Group I	Highly Toxics, Carcinogens, Reproductive Toxins	highly toxic compounds, carcinogens, mutagens, teratogens