Chemical Segregation and Storage

National Institutes of Health (NIH) • Office of Research Services (ORS) • Division of Safety (DS)

Most chemical storage related emergencies happening in the laboratories can be avoided by following proper storage practices. When chemicals sit on the shelf for an extended period, vapors can migrate, chemicals can get exposed to light/air/other contaminants, containers can disintegrate and incompatibles sitting together can react to form unstable/dangerous products.

Proper storage of chemicals depends on three fundamental concepts:

1. Having an inventory of all the chemicals present in the lab
2. Identifying the hazards associated with each chemical and
3. Understanding the chemical compatibility principle to learn what chemicals can be stored together

Having a Chemical Inventory of all the Chemicals Present in the Lab

An up-to-date chemical inventory is the first step towards chemical hazard identification and the implementation of proper storage practices. Inventory will provide an exact list of all the chemicals present in the lab to group them into hazard classes (corrosives, flammables, oxidizers, etc.). Once they are grouped together, the lab can start planning how and where they should be stored.

If your lab doesn't have a chemical inventory, LabArchives, the electronic notebook used by many at NIH, has an inventory module included. Follow the DS guidance document to learn how to use it.

Identifying Hazards Associated with Each Chemical

OSHA compliant chemical labels with Pictograms and the Safety Data Sheets (SDS) are the best sources of information to understand the hazards associated with the chemicals and storage requirements. There are 9 OSHA approved pictograms (Image 1), and all hazardous chemicals will have at least one pictogram on the label. Chemicals with multiple hazards will have multiple pictograms to indicate each hazard (Image 2). In addition to pictograms, chemical labels also include a hazard statement(s), precautionary statement(s), and **signal word** ("Danger" indicates more severe hazard and "Warning" indicates less severe) to help users to take necessary precautions for safe handling, storage and disposal.

Each SDS has 16 sections and can provide detailed information on incompatibility (Section 7), exposure control/PPE (Section 8), and storage requirements (Section 7), etc. Refer to the Chemical Segregation and Storage Table and the NIH CHP for additional information.

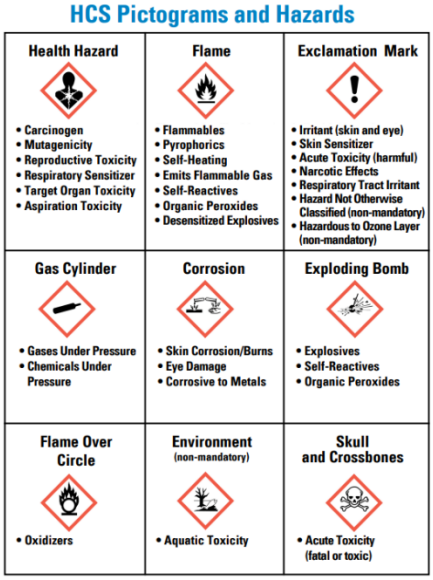

Image 1

Labels on chemical containers procured before 2015 may not have pictograms. Relabel all old containers in the lab by following NIH CHP Section V. The SDS for each chemical need to be consulted to confirm associated hazards.

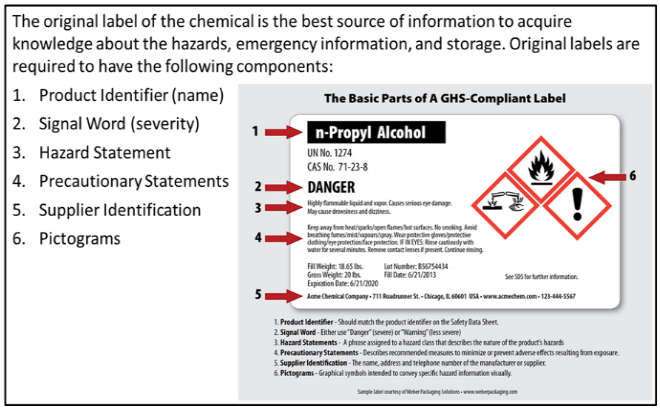

Image 2

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Understanding the Chemical Compatibility Principle

Once you have correctly identified all the chemicals and associated hazards, the next step is to find out what locations are appropriate and which hazard classes can be stored together. Chemical storage areas and practices must meet the following requirements:

- Storage areas must be labeled based on hazards of the chemicals stored there.
- Aisles, hallways, doorways, exits, and entryways must be kept clear.
- Storage areas must be appropriately ventilated, and should be maintained at a consistent, cool temperature.
- Location must be away from ignition sources such as open flames, heat sources, or direct sunlight.
- Emergency equipment such as fire extinguishers, spill kit, eyewash/safety shower must be available and kept in good working order.
- Keep containers closed and address spills and drips immediately.
- Containers must be stored in an upright position with secondary containment.
- Storage areas should have appropriate contact information included. For shared storage areas, contact information for each lab must be included.
- Use shelving with anti-roll lips to prevent bottles rolling/sliding off. Storage of chemicals on the floor, inside fume hoods, cold rooms, under the sink or on benchtops should not occur.

Chemical Hazard Classes

Flammables (including flammable liquids and solids) are substances that can ignite and burn readily (e.g., ethanol, diethyl ether, 2-propanol etc.). Always keep flammables stored inside an approved flammable cabinet and away from oxidizers, corrosives, heat or ignition sources (e.g., radiators, electric power panels, etc.). The maximum allowed quantity of flammable and combustible liquids stored in a laboratory at NIH is 50 gallons (Class I, II and III combined). No more than 10 gallons (38 L) of Class IA flammable liquids (diethyl ether, pentane etc.) can be stored in a laboratory. Limit flammables and combustibles outside of flammable cabinets to what is actively in use. No more than 10 gallons (38L) of flammable liquids are allowed outside of flammable cabinets.

When using flammable cabinets, never exceed the capacity of the flammable storage cabinet and never store more than 60 gallons (227 L) of flammables inside a single flammable storage cabinet. Refer to NIH Division of Technical Resources Bulletin and DS fact sheet on purchase, installation and use of flammable cabinets.

Refer to the NIH CHP Appendix D for information on types of containers and sizes that are allowed to be used in the laboratories for the storage of flammable liquids.

Refrigerators/freezers used for flammable storage must be explosion proof or designed specifically for flammable storage. Standard refrigerators are not intrinsically safe, and storage of flammables can cause buildup of flammable vapors to cause fires/explosions when the refrigerator's compressor or light turns on.

Pyrophoric and water reactive chemicals must be managed by following special guidelines developed by DS. The guidance can be found here.

Oxidizers are chemicals that promote or initiate combustion of other materials by releasing oxygen or other gases (hydrogen peroxide, nitric acid, halogens, ammonium perchlorate etc.). Store them in cool, dry, and well-ventilated areas, away from incompatible materials like organic materials, metals, flammables, and reducing agents. Avoid using metal spatula/objects when stirring or removing oxidizers/organic peroxides from chemical containers. Plastic or ceramic should be used instead. Avoid friction, grinding, and impact with solid oxidizers and organic peroxides. Use plastic/polyethylene lined bottles and caps instead of glass stoppers and screw cap lids for storage.

Peroxide formers are a group of chemicals that can, under certain conditions, form explosive peroxides. These can be detonated by shock, friction, or heat (e.g., THF, diethyl ether, isopropyl alcohol etc.). Refer to DS fact sheet on peroxide formers for guidance on storage and handling.

Poisons/Toxic chemicals are substances that can cause harm to living organisms. Segregate these chemicals from flammables, corrosives and oxidizers. Some of the toxic chemicals can be acutely toxic(fatal/cause serious harm with single exposure) and OSHA classifies those acute toxins as Particularly Hazardous Substances (PHS). Laboratories working with PHS must develop Standard Operating Procedures (SOPs) by using DS provided SOP templates.

Toxin

Carcinogen/ reproductive toxins

Corrosives are extremely reactive chemicals that can damage or destroy living tissue or other materials. Common incompatible chemicals include flammables, oxidizers and toxins. Corrosives can be classified as either acids or bases, depending on the pH of the chemical.

- Acids: Corrosive substances with a low pH (below 7). Acids can be further classified as inorganic acids (hydrochloric acid, sulfuric acid etc.) and organic acids (acetic acid, formic acid etc.).
- Bases: Corrosive substances with a higher pH (above 7). Just like acids, there are inorganic (sodium hydroxide, ammonia, etc.) and organic bases (triethylamine, imidazole etc.).

Organic and inorganic acids and organic and inorganic bases must be segregated from one another. Store corrosives inside vented corrosive cabinets. Refer to DS fact sheet for additional information.

Chemicals with multiple hazards (multiple pictograms on the label) Some chemicals have multiple pictograms on their labels, as they can have more than one type of hazard (Image 2). For chemicals with multiple hazards the segregation is based on a hazard priority ranking by prioritizing the most severe hazard. The most severe hazards are generally pyrophoric/water-reactive followed by flammables, oxidizers, toxins and corrosives. For example, if a chemical is both flammable and corrosive, it should be stored in a cabinet designed for flammables with secondary containment on separate shelves (e.g., acetic acid).

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Storage of Incompatibles Together

If your lab works with small quantities of chemicals and space does not allow for separate Hazard Groups, some of these hazard groups can be stored together with secondary containment by following DS fact sheet on compatible storage. Your Lab Safety Specialist can assist you to conduct a risk assessment before finalizing the storage plan. Secondary containment will provide a physical barrier to prevent the accidental mixing of incompatible chemicals in the event of a leak or spill. Secondary containment must be made of compatible materials and at a minimum, should be able to hold 10% of the total volume of all primary containers or 110% of the volume of the largest container.

One example of incompatible storage commonly found in laboratories is acids and bases stored together in the same corrosive cabinet. If acids and bases are stored together in the same cabinet, they must be stored on separate shelves with secondary containment by following DS fact sheet on corrosive cabinets. Extra care must be taken to provide stable, uncrowded, and carefully monitored storage conditions.

Safety Tips for Avoiding Chemical Related Incidents in the Lab

Hazardous chemicals that are stored in an inappropriate state, condition or place can cause fires, explosions and violent reactions. Regular inspections of the storage area by the laboratory staff can reduce the chances of fires/explosions and unwanted reactions.

Storage Area Inspection should cover the following items:

- **Container Integrity:** inspect for cracks, leaks and other damage including the label. Appearance of rust, caps that are cracked, build up around the cap/container, etc. are signs of degradation of the container.
- **Condition of the chemical:** Assess the physical state of the chemical by visual inspection for signs of degradation, contamination and decomposition. Formation of crystals/turbidity, clumping, stratification and discoloration are indication of degradation or contamination. If you observe any of the above on chemical containers, do not touch, move, open, or try to clean the container. Clear the area and restrict access. Control ignition sources and vibrations. Call 301-496-5685 or contact your Local Lab Safety Specialist and ECC immediately.
- **Improper storage**: Storing chemicals improperly, such as leaving containers open or improperly sealed can increase the risk of explosions/fires and releases of hazardous vapor/gasses.

Refer to DS fact sheet for safety tips and useful information to prevent fires and emergencies. For additional resources visit NIH Chemical Safety webpage.