Laboratory Guide Book

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Campus Covered: All
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Chemical Hygiene Plan

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Forward

The University of Connecticut has numerous laboratories at its main campus, as well as at its branch campuses. It employs people within these laboratories, and therefore the University is required to prepare a Chemical Hygiene Plan to be in compliance with "The OSHA Laboratory Standard". Because Connecticut has its own OSHA-approved occupational safety and health plan ('State Plan State'), the State has adopted its own laboratory standard, which is as stringent as the Federal standard.

The Laboratory Standard was published as an amendment to 29 CFR 1910.1450, Subpart Z, and its title is 'Occupational Exposure to Hazardous Chemicals in Laboratories'. The effective date of the Standard was May 1, 1990, and the required written chemical hygiene plan was to be developed and implemented by January 31, 1991.

The Laboratory Standard supersedes all of Subpart Z of 29 CFR 1910, which includes the Hazard Communication Standard. However, some of the provisions of these standards are retained in the Laboratory Standard. These include the requirement for maintaining exposure limits below the Permissible Exposure Limits (PEL), information and training requirements, the use of Material Safety Data Sheets (MSDS), labeling, and medical surveillance programs.

I. Introduction

This document serves as the Chemical Hygiene Plan for the University's laboratories, and was developed to meet the guidelines of 29 CFR 1910.1450, "Occupational Exposure to Hazardous Chemicals in Laboratories", a standard issued by the Occupational Safety and Health Administration (OSHA). This Chemical Hygiene Plan (CHP) will be accessible to all employees of the University who are involved in any way with a laboratory activity, as well as to employee representatives, and State OSHA inspectors. In addition the publication, "Minimum Guidelines for Laboratory Health and Safety" (see Appendix D), will be copied and distributed to all laboratory employees. Department-Specific Safety Manuals may also be appended to this document.

The Chemical Hygiene Plan places primary emphasis on engineering and administrative controls necessary to protect workers from overexposure to hazardous substances in laboratories. The University of Connecticut Chemical Hygiene Plan is comprised of the following elements:
3. Control Equipment Inspections and Review.
4. Employee Information and Training.
5. Special or Non-Routine Procedures.
6. Medical Surveillance Program/Environmental Monitoring.
7. Designated Chemical Hygiene Officer.
8. Safe Handling of Particularly Hazardous Substances.

II. Summary

The University of Connecticut will follow the National Research Council's general principles of Chemical Hygiene in Laboratories. They are as follows:

1. Minimize all chemical exposures.
2. Avoid underestimation of risk.
3. Provide adequate ventilation.
4. Institute a formal safety program.
5. Observe the Permissible Exposure Limits (PELs, U.S. Dept. of Labor, OSHA) and the Threshold Limit Values (TLVs, American Conference of Governmental Industrial Hygienists).

III. Scope and Definitions

Procedures used do not simulate a production process, whose function is to produce commercial quantities of materials; and where protective laboratory practices and equipment are available and commonly used.

OSHA defines a hazardous chemical as a substance for which there is statistically significant evidence, based on at least one scientific study, showing that acute or chronic harm may result from exposure to that chemical.

The University of Connecticut clearly meets the criteria established under OSHA 1910.1450, and is therefore subject to the requirements of the Laboratory Standard.

IV. University of Connecticut Responsibilities

The University is obligated to ensure chemical health and safety at all levels, including:
1. **President of the University** -- ultimately responsible for chemical safety on the campuses, and who, with the University administration, must provide the support for implementation and maintenance of a chemical hygiene program.

2. **Deans/Departments Heads** -- responsible for incorporating chemical safety committees within their respective departments/units, and for chemical hygiene in general within their departments.

3. **University Laboratory Safety” Committee** -- responsible for reviewing, recommending, and developing policies and procedures toward achieving safe work practices involving chemicals.

4. **Departmental Safety Committees/Building Safety Committees** -- responsible for assisting the University Chemical Hygiene Officer in implementing this plan. These committees may develop additional policies with the intent to promote prudent work practices which are specific for their departments, or specific to research within their department or building.

5. **Principle Investigator (PI)** -- responsible for chemical hygiene in the laboratory/laboratories assigned to them. They must have up-to-date knowledge of the chemical inventory in their laboratory, as well as provide Material Safety Data Sheets (MSDS) to their students and staff upon request. This includes knowing the hazards and how to control exposures through the proper selection of laboratory techniques and engineering controls. The PI should inform all employees working in the laboratory of the hazards associated with the chemicals present, encourage safe analytical techniques, and detail procedures for dealing with accidental spills. The PI should communicate with the parties mentioned above for assistance in monitoring engineering controls (ventilation), lab air quality, chemical waste disposal, chemical inventory maintenance, acquiring permission to obtain extremely hazardous substances, and understanding the legal requirements associated with all aspects of chemical usage in the laboratory.

6. **Laboratory Workers** -- as employees of the University, are obligated to understand the chemical hygiene plan, and to report any unsafe practices or conditions to any of the aforementioned parties. They should develop good laboratory habits in conducting any research involving the use of chemicals, and know the proper means of disposal of waste chemicals. With the PI, the laboratory worker is responsible for dating incoming chemicals, properly storing them, labeling containers holding chemicals or intermediates of reactions, and
informing visitors to the laboratory of the potential hazards within, and the associated rules. This information can be displayed using signs and symbols.

7. **Chemical Hygiene Officers (CHO)** – at the University, the CHO acts as the representative of the President* of the University. Assigned to this CHO is the duty to prepare, implement, and maintain the written Chemical Hygiene Plan. Other CHO’s may be designated by departmental/unit safety committees, Deans and/or Department Heads, and may be a second title for someone such as a Laboratory Director or a PI. Their duties will be to oversee that the Chemical Hygiene Plan is being followed, either as a separate entity, or in conjunction with a departmental safety manual.

**V. Standard Operating Procedures**

**A. General Rules**

1. Avoid working alone in a laboratory, especially if the experiment involves a potentially dangerous operation. In situations where a worker knows he/she will be working alone, a periodic cross check should be maintained, either by phone calls or interlaboratory personal checks.

2. Wear appropriate eye protection in the laboratory at all times. This applies to visitors also.

3. When working with flammable chemicals, be certain that there are no sources of ignition nearby to cause a fire or explosion in the event of a vapor release or liquid spill.

   *For the chemicals they are working with, all employees should know and constantly be aware of:*

4. The chemical hazards as determined from the MSDS and other appropriate references (see UCONN Hazard Communication Policy).

5. The location and proper use of emergency equipment.

6. Appropriate safeguards for using a chemical, including personal protective equipment.
7. How and where to properly store the chemical when it is not in use.

8. Proper personal hygiene practices.

9. The proper methods of transporting chemicals within the facility.

10. Appropriate procedures for emergencies, including evacuation routes, spill cleanup procedures and proper waste disposal.

B. Personal Hygiene
   1. Wash promptly whenever a chemical has come in contact with the skin.
   2. Avoid inhalation of chemicals; do not "sniff" to test chemicals.
   3. Do not use mouth suction to pipet anything; use suction bulbs.
   4. Wash hands well with soap and water before leaving the laboratory; do not wash with solvents.
   5. Do not drink, eat, smoke, or apply cosmetics in the laboratory.
   6. Do not bring food, beverages, tobacco, or cosmetic products into chemical storage or use areas.

C. Protective Clothing and Equipment
   1. Eye protection should meet the requirements of the American National Standards Institute (ANSI) Z87.1. Also wear a face shield, large enough to protect the chin, neck, and ears, as well as the face, in situations where large quantities of chemicals may cause splashing, or where reactions may splash.
   2. When working with corrosive liquids, wear gloves made of a material known to be resistant to permeation by the corrosive chemical. Chemical resistance guidelines can be provided by EH&S.
   3. Laboratory coats or ankle-length rubberized aprons over normal clothing will offer protection against spills. Shorts should not be permitted.
   4. When working with allergenic, sensitizing, or toxic chemicals, wear gloves made of a material known to be, or tested and found to be, resistant to permeation by the chemicals and tested for the absence of pin holes. Contact EH&S for chemical resistance guidelines.
   5. Always wear low-heeled shoes with fully covering uppers; shoes with open toes are not recommended.
6. Whenever exposure by inhalation is likely to exceed the threshold limits described in an MSDS, use a fume hood; if this is not possible, a proper respirator must be worn. Consult with your supervisor before doing any such work, or contact EH&S.

7. Carefully inspect all protective equipment before using. Do not use defective protective equipment.

D. Housekeeping/Laboratory Inspection

1. Access to emergency equipment, showers, eyewashes, and exits should never be blocked by anything, not even a temporarily parked chemical cart.

2. All chemical containers must be labeled with the identity of the contents and any known hazards those contents present to users.

3. Keep all work areas, especially laboratory benches, clear of clutter.

4. Keep all aisles, hallways, and stairs clear of all chemicals.

5. All chemicals should be placed in their assigned storage areas at the end of each workday.

6. At the end of each workday, the contents of all unlabeled containers should be labeled.

7. Waste should be properly labeled and kept in the proper containers. Call EH&S for removal.

8. Promptly clean up all spills; properly dispose of the spilled chemical and cleanup materials.

   EH&S will be conducting routine laboratory inspections on a regular basis, or on request by a department.

E. Prior Approval

Insofar as possible, employees should obtain prior approval to proceed with a laboratory task from their supervisor whenever:

1. An unfamiliar laboratory procedure or test is to be carried out.

2. It is likely that the toxic limit concentration could be exceeded or that other harm is likely.

3. There is a change in a procedure or test, even if it is very similar to prior practices.
   "Change in a procedure or test" means:
   a. A substantial increase or decrease in the amount of one or more chemicals used.
   b. A substitution or deletion of any of the chemicals in a procedure.
   c. Any change in other condition under which the procedure is to conducted.
4. There is a failure of any of the equipment used in the process, especially of safeguards such as fume hoods or clamped apparatus.
5. There are unexpected results.
6. Members of the laboratory staff have become ill, suspect that they or others have been overexposed, or otherwise suspect a failure of any safeguards.

In the event of spills of toxic substances or accidents involving any hazardous chemical, call the UCONN Fire Department at 911 first, and EH&S next.

F. Chemical-Specific Safety Procedures

Procedures for Toxic Chemicals

The MSDSs for many of the chemicals used in the laboratory will state recommended limits or OSHA-mandated limits, or both as guidelines for exposure. Typically limits are Threshold Limit Values (TLV), Permissible Exposure Limits (PEL), and action levels. When such limits are stated, they will be used to assist the chemical hygiene officer in determining the safety precautions, control measures and safety apparel that apply when working with toxic chemicals. The following are meant as guidelines only. When an overexposure is suspected, call EH&S for possible air monitoring.

1. When a TLV or PEL value is less than 100 milligrams per cubic meter of air, the chemical should be used in an operating fume hood, glove box, vacuum line, or similar device.
2. If a TLV, PEL, or comparable value is not available for that substance, the animal or human median inhalation lethal concentration information, LC$_{50}$ should be reviewed if available. If that value is less than 2000 mg/m$^3$ (when administered continuously for one hour or less), then the chemical should be used in an operating fume hood, glove box, vacuum line, or similar device, which is equipped with appropriate traps and/or scrubbers.
3. Whenever laboratory handling of toxic substances with vapor pressures likely to exceed air concentrations limits, laboratory work with such liquids and solids should be conducted in a fume hood, glove box, vacuum line, or similar device.

Recommended values from the American Chemical Society.
See the MSDS for LC$_{50}$ information.
Procedures for Flammable Chemicals

In general, the flammability of a chemical is determined by its flashpoint, the lowest temperature at which an ignition source can cause the chemical to ignite momentarily under controlled conditions.

4. Chemicals with a flash point below 200 °F (93.3 °C) will be considered "fire-hazard chemicals".
5. OSHA standards and the National Fire Protection Association (NFPA) guidelines on when a chemical is considered flammable apply to the use of flammable chemicals in the laboratory.


6. Fire-hazard chemicals should be stored in a flammable solvent storage area or in storage cabinets designed for flammable materials.
7. Fire-hazard chemicals should be used only in vented hoods and away from sources of ignition.

Procedures for Reactive Chemicals

A reactive chemical is one that:

8. Is described as such in the MSDS,
9. Is ranked by the NFPA as 3 or 4 for reactivity,
10. Is identified by the DOT as:
    a. An oxidizer,
    b. An organic peroxide, or
    c. An explosive, Class A, B, or C,
11. Fits the EPA definition of reactive in 40 CFR 261.23,
12. Fits the OSHA definition of unstable in 29 CFR 1910.1450, or
13. Is known or found to be reactive with other substances.

Procedure: Handle reactive chemicals with all proper safety precautions, including segregation...
in storage.

**Procedures for Corrosive Chemicals and Contact-Hazard Chemicals**

Corrosivity, allergenic, and sensitizer information is sometimes given in manufacturers' MSDSs and on labels. Also, guidelines on which chemicals are corrosive can be found in other OSHA standards and in regulations promulgated by DOT in 49 CFR and the EPA in 40 CFR.

A corrosive chemical is one that

14. Fits the OSHA definition of corrosive in Appendix A of 29 CFR 1910.1200,
15. Fits the EPA definition of corrosive in 40 CFR 261.22 (has a pH greater than 12.5 or less than 2.0), or
16. Is known or found to be corrosive to living tissue.

A contact-hazard chemical is an allergen or sensitizer that:

17. Is so identified or described in the MSDS or on the label, or
18. Is so identified or described in the medical or industrial hygiene literature

*Procedure:* Handle corrosive chemicals with all proper safety precautions, including wearing safety goggles and/or face shield, gloves tested and known to be resistant to permeation or penetration, and a laboratory apron or laboratory coat.

**Control Measures and Equipment**

Chemical safety is achieved by continual awareness of chemical hazards and by keeping the chemical under control by using precautions, including engineering safeguards such as hoods. Laboratory personnel should be familiar with the precautions to be taken, including the use of engineering and other safeguards. Laboratory supervisors should be alert to detect the malfunction of engineering and other safeguards. All engineering safeguards and controls should be properly maintained, inspected on a regular basis, and never overloaded beyond their design limits. Contact EH&S for evaluations, and Facilities Operations for maintenance/repair.
Ventilation

19. Laboratory ventilation should be sufficient such that no one is overexposed to chemical vapors. Work involving toxic chemicals that have low air concentration limits, or that have high vapor pressures, should always be done in a fume hood.

20. Fume hoods should provide 100 linear feet per minute of air flow across the face of the hood. EH&S will evaluate hoods on request, and on a continuing scheduled basis.

21. Laboratory employees should understand the following:
   a. A fume hood is a safety backup for condensers, traps, or other devices that collect vapors and fumes.
   b. The apparatus inside the hood should be placed on the floor of the hood at least six inches away from the front edge.
   c. Fume hood windows should be lowered at all times, except when necessary to raise them to adjust the apparatus that is inside the hood.
   d. The hood fan should be kept "on" whenever a chemical is inside the hood, whether or not any work is being done in the hood.
   e. Personnel should be aware of the steps to be taken in the event of a power failure or other hood failure.
   f. Hoods should not be used as storage areas for chemicals, apparatus, or other materials.

Flammable-Liquid Storage

22. If metal safety cans are used for fire-hazard chemicals, they should be used only as recommended by the manufacturer, including the following safety practices:
   a. Never disable the spring-loaded closure.
   b. Always keep the flame-arrestor screen in place; replace it if is punctured or damaged.

23. Cabinets designed for the storage of flammable materials should be properly used and maintained. Read and follow the manufacturer's information and also follow these safety practices:
   a. Store only compatible materials inside a cabinet.
   b. Do not store paper or cardboard or other combustible packaging material in a flammable-liquid storage cabinet.
c. The manufacturer establishes quantity limits for various sizes of flammable-liquid storage cabinets; do not overload a cabinet.

Eyewash Fountains and Safety Showers

24. It is desirable to have plumbed eyewashes and safety showers. These must be located so they can be reached from any point in the laboratory, within 10 seconds, or located within 100 feet.
25. Check the functioning of eyewash fountains and safety showers and measure the water flow. EH&S has a shower test kit available for departmental use. Call to arrange for a loan.
26. Be sure that access to eyewash fountains and safety showers are not restricted or blocked by the temporary storage of objects or in any other way, and that the shower pull rod/chain is accessible.

Respirators

27. Employees should wear respirators whenever it is possible that engineering controls are lacking, or when employees might be exposed to vapor or particulate concentrations greater than the PEL, action level, TLV, or similar limit, whichever is the lowest, due to work practices.
28. The requirements of 29 CFR 1910.134 should be followed, including in particular:
   a. Written standard operating procedures governing the selection and use of respirators.
   b. All employees who are likely to need to use respirators must be trained in their proper use, inspection, and maintenance, and must receive a medical clearance physical examination prior to using a respirator.

Vapor Detection/Environmental Monitoring

Do not use odor as a means of determining if inhalation exposure limits are, or are not, being exceeded. Whenever there is reason to suspect that a toxic chemical inhalation limit might be exceeded, whether or not a suspicious odor is noticed, notify the PI or EH&S. EH&S will provide industrial hygiene consultation, as well as air monitoring and sample analysis, either upon request or as a result of its own assessment of air quality during a laboratory inspection.
Procedures for Carcinogens, Reproductive Toxins, Substances That Have a High Degree of Acute Toxicity.

Follow the procedures described in this section when performing laboratory work with any select carcinogen, reproductive toxin, substance that has a high degree of acute toxicity, or a chemical whose toxic properties are unknown.

29. The following definitions will apply:
   a. Carcinogen: any substance defined as such in 29 CFR 1910.1450 and any other substance described as such in the applicable MSDS.
   b. Reproductive toxin: any substance described as such in the applicable MSDS.
   c. Substance with a high degree of acute toxicity: Any substance for which the LD$_{50}$ data described in the applicable MSDS cause the substance to be classified as a “highly toxic chemical” as defined in ANSI Z129.1.
   d. Chemical whose toxic properties are unknown: A chemical for which there is no known statistically significant study conducted in accordance with established scientific principles that establishes its toxicity.
   e. For the purposes of this Chemical Hygiene Plan, chemicals identified in categories 'a', 'b', 'c', and 'd' will be considered hazardous.
   f. Designated area: A hood, glove box, portion of a laboratory, or an entire laboratory room designated as the only area where work with quantities of the above chemicals in excess of the specified limit shall be conducted.

30. Designated areas shall be posted and their boundaries clearly marked. Only those persons trained to work with these hazardous chemicals will work in the designated area. All such persons should:
   a. Use the smallest amount of a chemical that is consistent with the requirements of the work to be done.
   b. Use High-Efficiency Particulate Air (HEPA) filters or high-efficiency scrubber systems to protect vacuum lines and pumps.
   c. Store chemicals or remove them from storage.
   d. Decontaminate a designated area when work is completed.
   e. Prepare wastes from work with these chemicals for waste disposal in accordance with specific disposal procedures consistent with the Resource Conservation and Recovery Act (RCRA) and as designated by EH&S.
31. If possible, store all hazardous chemicals in locked and enclosed spaces with a slight negative pressure compared to the rest of the building.

32. Because the decontamination of jewelry may be difficult or impossible, do not wear jewelry when working in designated areas.

33. Wear long-sleeved disposable clothing and gloves known to resist permeation by the chemicals to be used when working in designated areas.

VI. Records and Recordkeeping

This section reviews the value of documenting an employer's compliance with the Laboratory Standard, which is required by 29 CFR 1910.20.

A. The Laboratory Standard requires that records of air concentration monitoring results, exposure assessments, medical consultations and examinations be maintained for at least 30 years and that they be accessible to employees or their representatives. Air monitoring records are on file at EH&S. Call EH&S for the location of the medical records on file.

B. It is desirable to develop a system that retains documents related to the distribution and maintenance of materials safety data sheets, the safety training of employees, and significant employee suggestions for many years, perhaps for the lifetime of the institution. For example, although not required by any regulation at this time, some employers use "MSDS sign-off" records; for each hazardous chemical used or handled, employees certify by dated signature that they have read the MSDS and understand the content.

C. Specific records may be required in the event of lost work time resulting from an exposure or accident on the job. Use OSHA Form 200 to record lost workdays that occur. Contact your local OSHA office for details (CT OSHA office (860) 566-4550).

D. In addition to required records, it is often desirable to keep records developed internally that document employee exposure complaints and suspected exposures, regardless of the outcome of an exposure assessment. Other incidents also might be documented for future reference. Examples include:

   1. Major safety suggestions from employees. To improve laboratory safety, keep these records. A suggestion that is unusable today might be useful tomorrow. Even when a suggestion is clearly non workable, it should be taken seriously, examined, and recorded.

   2. Near-miss reports. Employees who participate in or witness events that could have caused harm, but fortunately did not, should prepare reports of the incidents. These reports are used to develop changes in procedures that will prevent a future more serious occurrence.
3. Repair and Maintenance records for control systems. These are useful to suggest corrective actions and indicate that equipment was, or was not, well maintained and kept in working condition.

VII. Chemical Inventory Procedure

A. Chemical Procurement

When placing an order for any chemical, information on proper handling, storage, and disposal should be obtained also from the supplier. This can be in the form of the MSDS. Be sure to request that the MSDS be sent to your department, or to you specifically. This information shall be made readily accessible to all potential handlers and users. It is the responsibility of the PI of the laboratory in which the chemical is to be used to ensure that these conditions are met, including any training. It is the policy of the University that procurement of chemicals be done on a minimum quantity basis; large quantity discounts should not be an incentive in purchasing chemicals that are not used extensively. No containers should be accepted without adequate identifying labels. It is a good idea to review chemical stock rooms and inventory the chemicals -- minimize quantities by eliminating duplicates and seldom used chemicals.

B. Chemical Stockrooms/Storage

The Department of EH&S suggests following the general storage patterns shown in figures 1 and 2. In addition, other storage suggestions are as follows:

1. Avoid chemical storage (even temporary) on the floor.
2. Avoid storage of chemicals on top shelves.
3. Avoid storage of chemicals above eye level.
4. Make sure shelf assemblies are firmly secured to walls. Avoid island shelf assemblies.
5. Ideally, shelving assemblies would be of wood construction.
6. Avoid metal adjustable shelf supports and clips.
7. Store acids in a dedicated acid cabinet. Store nitric acid in that same cabinet only if isolated from the other acids. Store both inorganic and some organic acids in the acid cabinet.
8. Store flammables in a dedicated flammables cabinet.
9. Store severe poisons in a dedicated poisons cabinet.
Fig 1. Suggested Shelf Storage Pattern – Inorganic

SULFUR, PHOSPHOROUS, ARSENIC, PHOSPHOROUS PENTOXIDE
HALIDES, SULFATES, SULFITES, THIOSULFATES, PHOSPHATES, HALOGENS, ACETATES
AMIDES, NITRATES, (not AMMONIUM NITRATE), NITRITES, AZIDES
(Store Ammonium Nitrate away from all other substances—ISOLATE IT!)
METALS and HYDRIDES
(Store away from any water and store flammable solids in a flammables cabinet)
HYDROXIDES, OXIDES, SILICATES, CARBONATES, CARBON

ARSENATES, CYANIDES, CYANATES
(Store away from any water)
SULFIDES, SELENIDES, PHOSPHIDES, CARBIDES, NITRIDES
BORATES, CHROMATES, MANGANATES, PERMANGANATES
CHLORATES, PERCHLORATES, CHLORITES, PERCHLORIC ACID, PEROXI DES, HYPOCHLORITES, HYDROGEN PEROXIDE
MISCELLANEOUS

Avoid Using Floor

Store Nitric Acid away from other acids unless your acid cabinet provides a separate compartment for Nitric Acid.

ACIDS, except NITRIC
(Acids are best stored in dedicated cabinets)

Fig 2. Suggested Sheld Storage Pattern -- Organic

ALCOHOLS, GLYCOLS, AMINES, AMIDES, IMINES, IMIDES
(Store flammables in a dedicated cabinet)
HYDROCARBONS, ESTHERS, ALDEHYDES
(Store flammables in a dedicated cabinet)
ETHERS, KETONES, HALOGENATED HYDROCARBONS,
ETHYLENE OXIDE
(Store flammables in a dedicated cabinet)
EPOXY COMPOUNDS, ISOCYANATES
SULFIDES, POLYSULFIDES, ETC.

PHENOLS, CRESOLS
PEROXIDES, AZIDES, HYDROPEROXIDES
ACIDS, ANHYDRIDES, PERACIDS
(Store certain organic acids in an acid cabinet)
MISCELLANEOUS

ALCOHOLS, GLYCOLS, HYDROCARBONS, ESTHERS,
ETHERS, KETONES, ETC.
STORE FLAMMABLES IN A DEDICATED CABINET

Store Severe Poisons in a Poisons Cabinet

C. Specific Chemical Incompatibilities and Instabilities

In general chemicals with the following functional groups are prone to instability:

- O-O (peroxide) - N₃ (azide)
- NO₂ (nitro) - N=O (nitroso)
- N=N (azo) - ONO₂ (nitrate ester)
- N= (imino) - N-NO₂ (nitro amine)

These reagents should be dated, handled according to prescribed storage conditions, and disposed of after use:

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Chemicals Incompatible with*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetic Acid</td>
<td>Nitric acid, peroxides, permanganates, ethylene glycol, hydroxyl</td>
</tr>
<tr>
<td>Compound/Class</td>
<td>Reactive Substances</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>-------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Acetone</td>
<td>Concentrated sulfuric and nitric acid</td>
</tr>
<tr>
<td>Acetylene</td>
<td>Bromine, chlorine, fluorine, copper, silver, mercury and their compounds</td>
</tr>
<tr>
<td>Alkali Metals</td>
<td>Carbon tetrachloride, carbon dioxide, water, halogens</td>
</tr>
<tr>
<td>Alkaline Metals (powdered aluminum or magnesium)</td>
<td>Carbon tetrachloride, or other chlorinated hydrocarbons, halogens, carbon dioxide</td>
</tr>
<tr>
<td>Ammonia, Anhydrous</td>
<td>Mercury, hydrogen fluoride, calcium hypochlorite, chlorine, bromine</td>
</tr>
<tr>
<td>Ammonium Nitrate</td>
<td>Acids, flammable liquids, metal powders, sulfur, chlorates, any finely divided organic or combustible substance</td>
</tr>
<tr>
<td>Aniline</td>
<td>Nitric acid and hydrogen peroxide</td>
</tr>
<tr>
<td>Bromine, Chlorine</td>
<td>Ammonia, petroleum gases, hydrogen, sodium, benzene, finely divided metals</td>
</tr>
<tr>
<td>Carbon, activated</td>
<td>Calcium hypochlorite and all oxidizing agents</td>
</tr>
<tr>
<td>Chlorates</td>
<td>Ammonium salts, acids, metal powders, sulfur, and finely divided organic or combustible substances</td>
</tr>
<tr>
<td>Chlorine dioxide</td>
<td>Ammonia, methane, phosphine, hydrogen sulphide</td>
</tr>
<tr>
<td>Chromic acid</td>
<td>Glacial acetic acid, camphor, glycerin, naphthalene, turpentine, lower molecular weight alcohols, and many flammable liquids</td>
</tr>
<tr>
<td>Copper</td>
<td>Acetylene and hydrogen peroxide</td>
</tr>
<tr>
<td>Cyanides</td>
<td>Acids and alkalines</td>
</tr>
<tr>
<td>Flammable liquids</td>
<td>Ammonium nitrate, chromic acid, hydrogen peroxide, sodium peroxide, nitric acid and the halogens</td>
</tr>
<tr>
<td>Hydrocarbons (propane, benzene, gasoline)</td>
<td>Fluorine, chlorine, bromine, sodium peroxide and chromic acid</td>
</tr>
<tr>
<td>Hydrofluoric Acid</td>
<td>Ammonia(aqueous or anhydrous)</td>
</tr>
<tr>
<td>Hydrogen Peroxide</td>
<td>Most metals and their salts, alcohols, organic substances, any flammable substances</td>
</tr>
<tr>
<td>Hydrogen Sulfide</td>
<td>Oxidizing gases, fuming nitric acid</td>
</tr>
<tr>
<td>Iodine</td>
<td>Acetylene, ammonia, hydrogen</td>
</tr>
<tr>
<td>Mercury</td>
<td>Acetylene, ammonia</td>
</tr>
<tr>
<td>Nitric Acid</td>
<td>Acetic acid, hydrogen sulfide, flammable (concentrated) liquids and gases, chromic acid, aniline</td>
</tr>
<tr>
<td>Substance</td>
<td>Reactants</td>
</tr>
<tr>
<td>------------------------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Oxygen</td>
<td>Oils, grease, hydrogen, flammable liquids, solids and gases</td>
</tr>
<tr>
<td>Oxalic acid</td>
<td>Silver, mercury</td>
</tr>
<tr>
<td>Perchloric Acid</td>
<td>Acetic anhydride, bismuth and its alloys, alcohols, paper, wood, and other organic materials</td>
</tr>
<tr>
<td>Phosphorus Pentoxide</td>
<td>Water</td>
</tr>
<tr>
<td>Potassium Chlorate</td>
<td>Sulfuric and other acids, any organic material</td>
</tr>
<tr>
<td>Potassium Permanganate</td>
<td>Sulfuric acid, glycerine, ethylene glycol</td>
</tr>
<tr>
<td>Silver</td>
<td>Acetylene, ammonia compounds, oxalic acid, tartaric acid</td>
</tr>
<tr>
<td>Sodium Peroxide</td>
<td>Ethyl or methyl alcohol, glacial acetic acid, carbon disulfide, glycerine, ethylene glycol, ethyl acetate</td>
</tr>
<tr>
<td>Sulfuric Acid</td>
<td>Potassium chlorate, potassium perchlorate, potassium permanganate</td>
</tr>
</tbody>
</table>

* Taken from 'School Science Laboratories -- A Guide" to Some Hazardous Substances' with Technical support from the U.S. Product Safety Commission and the National Institute for Occupational Safety and Health (NIOSH).

D. **Peroxidizable Compounds**

Peroxidizable compounds tend to absorb and react with oxygen from the air to form unstable peroxides. Table 1. lists specific chemicals in this category. Pay attention to the following details regarding these compounds:

1. Date all peroxidizable compounds **when received and when opened**.

2. Eliminate compounds in Group A three months after opening, and Group B compounds one year after opening.

3. Inspect all containers of undetermined age prior to opening, **and** if it appears old or in bad condition, do not attempt to open.

4. Order less than six months supply of these chemicals."

5. Store these materials separately from oxidizers and mineral acids.
Table 1 -- Peroxidizable compounds

<table>
<thead>
<tr>
<th>Group A</th>
<th>Group B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isopropyl ether</td>
<td>Diethyl ether</td>
</tr>
<tr>
<td>Divinyl acetylene</td>
<td>Shock/heat-sensitive compounds</td>
</tr>
<tr>
<td>Vinylidene chloride</td>
<td>Ammonium perchlorate</td>
</tr>
<tr>
<td>Potassium metal</td>
<td>Dicyclopentadiene</td>
</tr>
<tr>
<td>Sodium metal</td>
<td>Dibenzoyl peroxide</td>
</tr>
<tr>
<td></td>
<td>Tetrahydrofuran</td>
</tr>
<tr>
<td></td>
<td>Ammonium permanganate</td>
</tr>
<tr>
<td></td>
<td>Diacetylene</td>
</tr>
<tr>
<td></td>
<td>Anhydrous perchloric acid</td>
</tr>
<tr>
<td></td>
<td>Dioxane</td>
</tr>
<tr>
<td></td>
<td>Dinitrobenzene (ortho)</td>
</tr>
<tr>
<td></td>
<td>Methyl acetylene</td>
</tr>
<tr>
<td>Decahydronaphthalene (Decalin)</td>
<td>Ethyl methyl ketone peroxide</td>
</tr>
<tr>
<td>Tetrahydronaphthalene (Tetralin)</td>
<td>Butyl perbenzoate</td>
</tr>
<tr>
<td>Ethylene glycol dimethyl ether</td>
<td>Ethyl nitrate</td>
</tr>
<tr>
<td>Vinyl ethers</td>
<td>Butyl peroxyacetate, tert</td>
</tr>
<tr>
<td>Acetamethyl methacrylate</td>
<td>Hydroxylamine</td>
</tr>
<tr>
<td>Chlorotrifluoroethylene</td>
<td>Peroxyacetic acid</td>
</tr>
<tr>
<td>Styrene</td>
<td>1-Chloro-2,4-dinitrobenzene</td>
</tr>
<tr>
<td>Vinyl acetylene</td>
<td>Picric acid</td>
</tr>
<tr>
<td>Acrylic acid</td>
<td>Cumene hydroperoxide</td>
</tr>
<tr>
<td>Vinyl acetate</td>
<td>Trinitrobenzene</td>
</tr>
<tr>
<td>Acrylonitrile</td>
<td>Diacetyl peroxide</td>
</tr>
<tr>
<td>Vinyl chloride</td>
<td>Trinitrotoluene</td>
</tr>
</tbody>
</table>

E. Laboratory storage of chemicals

When individual laboratories require their own chemical storage area, amounts permitted should be as small as practical. The PI should inspect and review such storage areas periodically to remove any old and never-used chemicals. Exposure to heat and direct sunlight should be avoided.
VIII. Information and Training

University of Connecticut laboratory employees may encounter various types of hazards, including chemical, biological, radioactive, and fire within their working environment. Individuals properly trained in handling hazardous chemicals are better equipped to minimize the risk of exposure to themselves and their peers. The ultimate responsibility for ensuring a safe working environment rests with the employees. They should assume an active role in maintaining a safe workplace by attending safety seminars (both internal as well as those provided by EH&S), and reporting any unsafe conditions or non-compliance observations with standard operating procedures to their supervisor or EH&S.

Each department, through their own Chemical Hygiene Officer, Department Head, or PI, must provide laboratory employees with information and training at the time of an employee’s initial assignment to a work area where hazardous chemicals are present, and prior to assignments involving exposure to chemicals not previously encountered.

Employees must be informed of:

A. The location and availability of this Chemical Hygiene Plan.
B. The location and availability of any other safety manuals distributed by the particular department, as well as other reference material on the hazards, safe handling, storage, and disposal of hazardous chemicals found in the laboratory including, but not limited to MSDSs received from chemical suppliers. EH&S has MSDSs on a CD-ROM system to assist in this area.
C. The permissible exposure limits for OSHA-regulated substances (also available through EH&S), and signs and symptoms associated with exposures to hazardous chemicals used in the laboratory.
D. Methods, observations, and monitoring that may be used to detect the presence of a hazardous chemical.
E. The measures they can take to protect themselves from these hazards, including specific procedures such as appropriate work practices, emergency procedures, and personal protective equipment to be used. EH&S is available to consult with department heads, PI's, and laboratory employees.

IX. Medical Consultation/Examination

All University laboratory employees who work with hazardous chemicals will be provided the opportunity to receive medical attention and follow-up examinations by, or under the supervision of, a licensed physician. This medical consultation will be provided at no cost to the employee and will be provided to the employee under the following circumstances:
1. Whenever an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been overexposed in the lab.

2. Where monitoring reveals an exposure level routinely above the action level or Permissible Exposure Limit for an OSHA-regulated substance.

3. Whenever an event such as a spill, leak, or explosion takes place in the workplace and results in the likelihood of an overexposure.

4. At the request of the Chemical Hygiene Officer.

**Procedures to follow if the above circumstances occur:**


2. Non-emergency: To assess what action should be taken, contact the person who directly supervises the laboratory where the situation occurred.

3. Follow-up with call to EH&S.

**Appendix A 29 CFR 1910.1450**

OSHA Laboratory Standard

**Appendix B**

ANSI Standard Z87.1 ‘Eye and Face Protection’

Call EH&S at 486-3613 or more information.

**Appendix C**

Carcinogen List

National Toxicology Program Carcinogens

Call EH&S for information on the International Agency for Research on Cancer (IARC) carcinogens.

**Appendix D**

ENVIRONMENTAL HEALTH AND SAFETY
THE UNIVERSITY OF CONNECTICUT
MINIMUM GUIDELINES FOR LABORATORY SAFETY

A. **Safety Practices**

1. Pipetting is done only with mechanical pipetting devices. Mouth pipetting is prohibited.
2. Laboratory doors should be kept closed to minimize the spread of chemical vapors, disease organisms, or fugitive emissions (smoke) in case of an accident.

3. To help comply with state and federal "Laboratory Standard" regulations, a person should be assigned by the department to act as a Chemical Hygiene officer for the completion of necessary activities. These activities include the following:
   a. An inventory of all hazardous chemicals being used and/or stored in each laboratory or facility, with approximate quantities on hand, should be kept on file in the department.
   b. A file of Material Safety Data Sheets (MSDS) for each hazardous chemical in the department should be assembled. The file is available at all times for employees to review.
   c. The University Chemical Hygiene Plan must be available to all employees.
   d. Labels indicating the name of the material and warning of the health and/or physical hazards are attached to all containers of hazardous materials.
   e. Appropriate warning signs are posted in proper locations, including the emergency information notice posted at the entrance of each lab.
   f. Informational meetings are conducted with all employees; those working with hazardous chemicals are given at least basic and simple training which addresses the specific chemicals used, the associated hazards and the use of safety equipment in each work place. Specific hazardous chemical training is conducted for new employees and for all employees any time a new hazardous chemical is introduced into the workplace.
   g. Written records are kept of the training outline and format and a list of employees receiving the training is on file in the department.
   h. The above items are updated as new employees are hired, new chemicals are purchased, laboratory methods are changed, etc.

4. All hazardous processes are performed in an appropriate fume hood or biological safety cabinet.
   a. Fume hoods and biological safety cabinets are used only for procedures and not for routine storage.
   b. Airflow is free from obstruction at all times.
   c. A trained individual is in attendance during any hazardous process and working alone is forbidden.

5. Work surfaces are decontaminated as needed and when a work process is completed. All spills are cleaned up immediately.
6. All contaminated materials are decontaminated before washing, reuse, or disposal. If infectious agents or organisms containing recombinant DNA molecules are present in the laboratory, an autoclave is available in the same building.

7. Containers for hazardous waste are available and clearly marked.

8. A clearly marked and puncture resistant container is used for broken glass, and other glass sharp waste. A separate, puncture resistant, tamper proof and leak proof container is used for syringes and metal sharps. All syringes and metal sharps are collected by the department of Environmental Health and Safety.

9. The creation of aerosols is avoided. This necessitates the use of appropriately designed centrifuges, blenders, and sonicators.

10. Eye and/or face protection is worn at all times where there are corrosives, hot liquids, or other eye irritants, or where there is a possibility of flying materials.

11. Closed toe footwear must be worn at all times in the laboratory.

12. Laboratory coats or protective aprons should be worn at all times in the laboratory.

13. Laboratory coats are not worn into food areas or outside of the building where the laboratory is located. If infectious organisms are involved, protective clothing is not worn outside of the laboratory.

14. Other protective clothing (such as gloves and rubber aprons) and equipment (such as explosion shield) are used where appropriate. Gloves are worn when handling experimental animals, corrosive chemicals, and when skin contact with infectious agents or organisms containing recombinant DNA molecules could occur.

15. Only persons who have received formal training in the nature of the hazards and have the consent of the laboratory supervisor are allowed to enter the laboratory. Such training is available through EH&S.

16. The only animals allowed in the laboratory are those that are essential to the work being done.

17. When levels of work of different hazard are carried out in the same laboratory, that work which involves biohazardous potential is carried out in a different, carefully demarcated area.

18. All accidents and hazardous spills are reported in writing to the laboratory supervisor, and to the Dept. of EH&S.

19. Medical evaluation, treatment, and surveillance are available for each laboratory employee as appropriate under the University's Chemical Hygiene Program.

20. An appropriate departmental laboratory safety manual is available to each laboratory supervisor. All personnel are advised of the hazards and are required to know and
follow recommended practices and procedures specific to that department. This manual should be part of the written Chemical Hygiene Plan.

B. General Health Practices
   1. Eating and drinking are prohibited.
   2. Smoking or the applying of cosmetics is prohibited.
   3. The storage of personal effects, food, and beverages is prohibited.
   4. Sink hoses are located above the sink rim and do not create a potential cross-connection between contaminated water and the water supply.
   5. Hands are washed after working with hazardous material and before working with uncontaminated material or leaving the laboratory.
   6. All areas are designed for easy cleaning and are kept clean and uncluttered. Storage space is sufficient. Spaces between equipment are accessible for cleaning.
   7. Bench tops and work surfaces are smooth and easily cleanable, impervious to water, and resistant to chemicals and moderate heat.

C. Physical Safety
   1. All exit doors are appropriately marked and unobstructed.
   2. Aisles are unobstructed.
   3. There are no tripping hazards.
   4. All equipment is in good repair.
   5. Eye wash and safety shower access is unobstructed.
   6. Circuit breaker panels must be accessible.
   7. Heavy objects are stored below a level of five feet from the floor unless secured.
   8. All shelving and cabinets are secured to prevent tipping.

D. Safety Equipment
   1. Fire extinguishers are of the appropriate type, easily accessible and appropriate in number. Contact the Fire Department to procure one, or to have it inspected, if last date on tag is greater than one year ago.
   2. Spill kits should be available in case of hazardous liquid spills. An appropriate first-aid kit is available.
   3. Non-breakable, leakproof, and closed containers are used for transporting hazardous materials outside of the laboratory.
   4. All belts, pulleys, fans, and other moving parts are guarded.
   5. Catch trays are used where appropriate.
   6. Vacuum equipment is trapped or filtered.
   7. If hypodermic needles are used, they are of the locking or integral type. They should be disposed of in approved sharps containers, not in regular trash.
E. Chemical Storage
   1. All gas cylinders are secured, away from heat sources, and capped if not in use.
   2. Incompatible chemicals are stored separately. All chemicals are stored by hazard categories rather than alphabetically. See the Chemical Hygiene Plan.
   3. Flammable liquids exceeding more than one gallon are kept in safety cans.
   4. Flammable liquids exceeding a total of 10 gallons are prohibited in the laboratory.
   5. Peroxide-forming chemicals are dated when received and when in the laboratory.
   6. Peroxide-forming chemicals should be disposed of within one year of purchase and within six months of opening.
   7. All containers are securely closed when not in use.
   8. All containers are correctly labeled.
   9. Chemical storage areas are adequately ventilated.
   10. Flammable liquid storage areas are free of ignition sources.
   11. All refrigeration equipment is labeled to indicate the suitability or unsuitability for the storage of flammable liquids.
   12. Flammable storage cabinets do not need to be vented.

F. Electrical Safety
   1. Electrical equipment is correctly grounded.
   2. An over-temperature shut-off device is provided for unattended heating equipment.
   3. Electrical cords are in a safe condition and of sufficient capacity.
   4. Multiple plug-ins and extension cords are to be avoided, and not to be used in place of permanent wiring. Extension cords are not to be in areas of traffic.

G. Building and Equipment Repair Safety Items

   Call Facilities Management/Work Order Control (Ext. 3113) for repair and maintenance of certain safety items.

   1. Circuit breaker panels are correctly labeled.
   2. Electrical outlets are correctly wired and grounded and are in good repair.
   3. Ground fault interruption is provided at electrical outlets where needed.
   4. Approved eyewash stations are installed where corrosives, hot liquids, or other eye irritating materials are stored or used.
   5. Approved safety showers are installed within 100 feet of each area where corrosives or flammable liquids are stored or used.
   6. Walls, floors, and ceilings are in good repair.
7. Sufficient fresh air is provided and building air movement is from areas of lesser hazard to areas of greater hazard.
8. Plumbing backflow prevention devices are provided where needed.
9. Chemical fume hoods, biological safety cabinets, and autoclaves are operational and certified.