Villanova University

Chemistry Department

Chemical Hygiene Plan

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Table of Contents

I. Introduction

A. Purpose

The purpose of the Chemical Hygiene Plan is to provide guidelines for the use of chemicals in the laboratory setting. Exposures to chemicals in laboratories tend to be of intermittent nature rather than regular exposure to a few chemicals. The Occupational Safety and Health Administration (OSHA) has addressed this situation by issuing a generic laboratory standard, 29 CFR 1910.1450 The primary goal of this standard is to encourage the implementation of work procedures and practices which will reduce "significant risk of harm". This involves an in-depth look at what is occurring in the lab and what exposures may result. This risk assessment is then used to formulate a systematic approach for controlling chemical exposures in the form of a Chemical Hygiene Plan (CHP). In addition, the lab standard requires employee training, provisions for medical consultation and examination, personal protective equipment, and recordkeeping.

The risk assessment involves examining the way in which chemicals in each department are used and evaluating the potential for exposure. By utilizing chemical inventories from each department, it is possible to earmark certain substances due to toxicity, volatility, or other characteristics for further investigation while eliminating others from the process.

The examination of chemicals and the way they are used identifies where exposures must be controlled. Administrative controls or altered operating procedures can be used to reduce exposures to hazardous substances. A less hazardous chemical can be substituted for a more hazardous one (i.e. use of toluene, xylene and other solvents instead of benzene). Another option is the institution or upgrade of engineering controls. The use of protective equipment such as gloves and respirators is a fourth means of limiting exposures. OSHA requires that these methods of exposure control be compiled into the CHP.

B. Scope and Application

This standard applies where "laboratory use" of hazardous chemicals occurs. Laboratory use of hazardous chemicals means handling or use of such chemicals in which all of the following conditions are met:

- The handling or use of chemicals occurs on a "laboratory scale", that is, the work involves containers which can easily and safely be manipulated by one person.
- Multiple chemical procedures or chemical substances are used.
- Protective laboratory practices and equipment are available and in common use to minimize the potential for employee exposures to hazardous chemicals.

This plan covers all personnel who are working with, or who may come in contact with, hazardous substances at Villanova University. More specifically, employees who use chemicals in teaching and research or work in an area where chemicals may be used and non-employee personnel including graduate and undergraduate students, postdoctoral associates, visiting scientists, and visitors are all covered by the Laboratory Standard.

Maintenance and custodial personnel are also subject to this standard if a significant amount of their working time is spent within a laboratory environment.

The CHP is not intended to be a static collection of standard operating procedures or practices. It should be evaluated and updated at least annually. The required components include standard operating procedures, criteria for determining and implementing control measures, a plan to ensure adequate performance of fume hoods and other protective equipment and provisions for employee information and training. OSHA also requires laboratories to identify circumstances in which a particular activity may need prior approval of the department head or his/her designee and to make special provisions for work with particularly hazardous substances. Finally, if there is reason to believe that exposure levels for a substance routinely exceed the action level or, in the absence of an action level, the permissible exposure limit (PEL), exposure monitoring and medical consultation and examination must be provided.

Chemical hygiene is important in the academic setting. When researchers, instructors and other university employees show familiarity with and an interest in providing a safe work environment, they set an example for students and show them that safety is a real concern.

C. Responsibilities

Responsibility for chemical hygiene rests at all levels including the following:

1. Chief Executive Officer

The President of Villanova University has the ultimate responsibility for chemical hygiene throughout the laboratories and with the assistance of other program administrators will provide continued support for chemical hygiene.

2. Office of Environmental Health and Safety

- The Director or person designated by the Director shall be the Chemical Hygiene Officer (CHO) for the University.
- Consults with and advises users on safe practices for handling chemicals.
- Monitors the procurement, use and disposal of chemicals
- Develops written procedures for safe laboratory practices.
- Knows current legal requirements concerning regulated substances.

3. University Laboratory Safety Committee

- Reviews the University Chemical Hygiene Plan annually.
- Members include departmental Chemical Hygiene Officers, Environmental Health & Safety department personnel, and other departmental representatives.

4. Deans and Department Chairperson

- Responsible for establishing and maintaining compliance with the CHP.
- Department Chairpersons designate CHO for all applicable departments to oversee and implement the CHP.

5. Chemical Hygiene Officer

The CHO is designated by the department chairperson and is qualified by training or experience to provide technical guidance in the development and implementation of the provisions of the CHP. Training can include formal safety training, a degree in a safety-related field, and/or attendance at professional courses. Experience can include participation on a safety committee or through other safety-related responsibilities in the workplace.

- Reviews and updates the CHP annually.
- Acts as liaison between the department and the Office of Environmental Health & Safety (EHS).
- Responsible for safety recordkeeping including safety equipment checks (eyewashes, fire extinguishers), documentation of laboratory incidents and safety training for staff chemists, graduate students, and undergraduate students who will perform research in any laboratory.

6. Principal Investigator (PI) /Faculty Member

It is the primary responsibility of the Principal Investigator (PI) /Faculty member to implement the CHP and ensure compliance with the OSHA Laboratory Standard.

- Requires all personnel to conduct work in accordance with the Chemistry Department's CHP.
- Defines designated areas for work with particularly hazardous substances and ensures that an inventory of these substances is properly maintained.
- Defines hazardous operations and procedures, designating safe practices and specifying protective equipment.
- Writes, reviews and approves standard operating procedures (SOPs) for work involving hazardous operations, procedures and substances and coordinates with the CHO to have SOPs added to the CHP.
- Ensures that all laboratory personnel (Post-Docs, Graduate & Undergraduate researchers) receive instructions and training in safe work practices, use of personal protective equipment, and procedures for dealing with accidents involving toxic substances.
- Directs all personnel to obtain protective equipment necessary for the safe performance of their assigned task.
- Monitors the performance of personnel with regard to required safety practices and techniques.

- Formulates procedures for dealing with accidents that may result in the unexpected exposure of personnel or the environment to toxic substances.
- Reinforces that all staff and students must report all laboratory incidents (spills, injuries, exposures to hazardous chemicals or materials, anything that constitutes a danger of environmental release, etc.) to the Chemical Hygiene Officer or other departmental Safety Officer to be documented using the Mendel Science Center Incident Report form.
- Institutes procedures which will minimize the repetition of accidents.
- Takes action to correct work practices and conditions that may result in the release of toxic chemicals.
- Instructs laboratory personnel to dispose properly of unwanted and/or hazardous chemicals and materials and to contact the Chemical Hygiene Officer or other departmental Safety Officer for assistance with proper disposal if needed.
- Makes copies of the approved CHP available to all laboratory personnel and non-laboratory personnel as necessary.
- Arranges for non-laboratory personnel (visiting Faculty, Scientists, researchers and students) to be informed of potential hazards which they may be exposed to in the laboratory, and provide proper instruction to minimize the risk of harmful exposure to hazardous substances.
- Ensures that an updated inventory list of particularly hazardous chemicals (i.e. peroxide formers and explosive types, short-lived chemicals, etc) is maintained. Such chemicals should be labeled with date received and a decision date for disposal.

7. Lab Safety Officer

- PI's may appoint a graduate student or Post-Doc as the Lab Safety Officer for his/her research laboratory. In lieu of having an appointed Lab Safety Officer, the PI will be the Lab Safety Officer for his/her own laboratory. Lab Safety Officers are responsible for evaluating and making recommendations on safety issues which concern the department. Safety Officers also participate in periodic safety inspections of department laboratories in conjunction with the Office of Environmental Health and Safety.
- Lab Safety Officers advise and assist in training laboratory personnel, disseminating safety information, conducting inspections of their group's laboratories, and inspecting and ensuring the maintenance of group safety equipment such as fire extinguishers, safety showers, and eyewash facilities.

8. Laboratory Personnel (Graduate and Undergraduate student researchers)

- Understands that laboratory safety is a vital component of working in any research laboratory.
- Develops and maintains good personal chemical hygiene habits.
- Plans and conducts each operation or procedure in accordance with safety guidelines outlined in the Chemical Hygiene Plan.

- Reports any unsafe laboratory conditions which may directly or indirectly threaten the safety of yourself or those working around you in the laboratory to the laboratory PI.
- Reports all incidents (accidents), no matter the severity, to their PI and the CHO or a departmental Safety Officer. Incidents can include but are not limited to: spills of hazardous chemicals or materials (Toxic, Ignitable, Corrosive or Reactive); injuries to self or others (chemical burn, allergic reactions [hives, rashes, etc. which may or may not be related to a chemical exposure], cuts & lacerations [from glassware or metal cans, etc.]); exposure to toxic chemicals or materials; fires; explosions (from over-pressurized containers or actual detonations of shock-sensitive materials, etc.); dizziness or fainting; etc.
- Wears appropriate Personal Protective Equipment (PPE) at all times [see Section II C].
- Receives appropriate Safety Training from the CHO and participates in Safety events & programs offered by the Chemistry Department.

9. Non-Laboratory Personnel (visitors, visiting Faculty, Scientists, Researchers)

- Adheres to all safety guidelines as outlined in the Chemistry Department's Chemical Hygiene Plan

II. Standard Operating Procedures

A. General Rules

1. ***DO NOT WORK ALONE*** in the laboratory unless you have received the appropriate approval from your PI or chairperson of your department.

    a. No student in an instructional laboratory may perform work unless a supervisor authorized by the Department is in attendance. **See Appendix J, Instructional Laboratory Student Safety Contract for further information.**

    b. Students may only pursue experiments defined for their course unless the instructor has been informed and has given written permission to the student carrying out the work.

    c. In cases in which hazardous chemicals may be used, students who have been appropriately trained may perform tasks alone in the laboratory during normal working hours with approval of their faculty advisor.

    d. In cases in which hazardous chemicals may be used, students who have been appropriately trained may work alone in the laboratory outside of normal working hours with approval of their faculty advisor as long as they comply with section (e) below.

    e. Students working alone outside of normal working hours must notify a friend, a faculty member or Public Safety as to when they will arrive and leave the laboratory.

    f. Emergency numbers will be posted by the front door in all laboratories in which hazardous chemicals preferably near the telephone.

2. Appropriate eye protection should be worn at all times.
   [see specific guidelines later in this section: **(E)(2) Eye Protection**]

3. Eye protection is required for any visitors whose eyes may be exposed to chemical or physical hazards.

4. When working with flammable chemicals, be certain that there are no sources of ignition near enough to cause a fire or explosion in the event of a vapor release or liquid spill. The minimum distance for such a source is 10 feet. Using flammable chemicals inside the fume hood will mitigate (but not completely eliminate) the risk of fire or explosion.

5. Use a tip-resistant shield for protection whenever an explosion or implosion might occur.

6. Review Sections II and III of this plan for Standard Operating Procedures and Other Special Precautions.

7. When working with chemicals, all faculty, students, and employees have the responsibility to know and be constantly aware of:

    a. The chemical's hazards, as determined from a Safety Data Sheet (SDS) for that chemical and other appropriate references.

    b. Appropriate safeguards for using that chemical, including proper PPE (personal protective equipment). [**See sections C and E**]
    c. The location and proper use of emergency equipment.

    d. Proper laboratory safety practices as outlined in this CHP.

    e. Appropriate procedures for emergencies, including evacuation routes, spill cleanup procedures, and proper waste disposal. [**See sections G and J**]

    f. Proper procedures to follow for chemical storage. [**See section I**]

B. Personal Hygiene

1. Wash promptly whenever a chemical has contacted the skin.
   [Report chemical exposure to the CHO or departmental Safety Officer and your PI.]

2. Avoid inhalation of chemicals.

3. Do not use mouth suction to pipette anything; use pipetting devices.

4. Wash 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, beverage, tobacco, or cosmetic products into chemical storage or use areas.

C. Proper Attire

1. Loose or fluffy clothing is more likely to catch fire and/or cause other accidents than close fitting clothing. (e.g. big fuzzy sweaters in the winter while working in the lab).

2. Avoid wearing synthetic material (polyester, etc.) clothing while working in the laboratory. Many chemicals and solvents will harm synthetic materials, and subsequently may harm you.

3. Some synthetic materials or fluffy/fuzzy clothing may cause a build-up of static charge which can serve as an ignition source for flammable solvents or chemicals,

resulting in a flash fire or explosion…good reasons to avoid both while working in the laboratory.

4. There should be no exposed skin below the waist. Slacks, trousers or preferably jeans are recommended. **Shorts, Capris and yoga tights** should never be worn in the laboratory because they offer little or no protection to exposed skin. If a chemical (such as a concentrated acid) comes into contact with yoga tights, it is immediately in contact with the skin underneath and will result in a chemical burn or possibly toxic effects if absorbed through the skin.

5. The upper arms, shoulders and upper torso must be completely covered.

6. Jewelry and watches should not be worn in the laboratory (chemicals can become trapped between these items and your skin causing chemical burns or toxic effects if absorbed through the skin).

7. Long hair must be tied back, out of the way.

8. Wear the proper Personal Protective Equipment (PPE) while working in the laboratory. [**See section E**]

9. Footwear should be low-heeled and cover the foot. **Bare feet, sandals, and open-toed shoes are not permitted in the laboratory.** Feet should be protected from chemicals and broken glass and socks should be worn.

D. Housekeeping

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 at least the identity (no formulas, full name of chemicals) of the contents, known hazards (flammable, etc.), dated and initialed.

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

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

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

6. Promptly clean up all spills if possible or contact the CHO or departmental Safety Officer for assistance. Properly dispose of the spilled chemicals and cleanup materials. **For large spills, the Chemical Hygiene Officer or departmental Safety Officer must be notified (Cian Watts, 9-6348; Eydiejo Kurchan, 9-7481; Janean Tiggett, 9-7394).** [**See section II. (G) and Section III.(G) Other Special Precautions**]

7. Chemical waste should be properly labeled and kept in proper containers. [**See section J for more information**] No chemicals should be disposed of in regular trash. Contaminated clothing or shoes should be thoroughly decontaminated or incinerated.

8. All working surfaces and floors should be cleaned regularly.

9. No chemicals are to be stored in aisles or stairwells, on desks or laboratory benches, on floors or in hallways, or to be left overnight on shelves over the workbenches.

10. All needles, syringes, and other sharps are to be collected and disposed of in an approved biohazard sharps container.

11. Empty chemical containers should be disposed of properly. All Barcoded chemical containers must be placed inside of the Green Trashcan located in each lab for such purpose. Containers should not be reused without recording the barcode numbers and speaking with the Chemistry Storeroom Manager (Steven Berlin, Mendel 214A, 9-4877).

12. **Review Chemical Waste Plan, Section II. J and Chemical Storage, Section II. I**.

13. Electrical extension cords or surge protectors should not be daisy-chained from an electrical outlet to equipment.

E. Personal Protective Equipment (PPE)

1. Protective clothing

a. Protective clothing worn in the laboratory should offer protection from splashes and spills, should be easily removable in case of accident, and preferably be fire resistant.

b. Non-flammable, non-porous aprons offer minimal protection as the least expensive option.

c. Laboratory jackets or coats should preferably have snap fasteners rather than buttons so they can be more easily removed. These coats are to be fastened closed while working and they should be removed prior to exiting the laboratory.

2. Eye Protection

a. Eye protection worn when working with the chemicals should meet the requirements of the American National Standards Institute (ANSI) Z87.1 and be approved by the Department CHO. Always consult the chemical's MSDS for specific personal protective equipment to be used.

b. At a minimum, safety glasses with side shields are required in all laboratories covered under the CHP. Operations that require improved protection against impact, liquid splash, and other eye hazards will require safety goggles and/or face shields. Always check your MSDS for appropriate eye protection for the chemical you are working with.

c. Contact lens policy – Wearing contact lenses in the lab is acceptable. **However, appropriate safety goggles must be worn.** Some soft lenses do absorb organic vapors and corrosive vapors like hydrogen chloride or ammonia. If you wear contact lenses in the lab and notice any discomfort while working with volatile solvents, or corrosive liquids or gases, leave the lab and remove the lenses.

2. **Gloves**

At the present time, there are no gloves which provide an effective barrier against all of the hazardous chemicals used in laboratories. The selection of the appropriate glove material is critical. Use of an inappropriate glove may actually increase the risk of hazardous skin contact or absorption. For specific recommendations regarding the type of glove to be used, consult the **Chemical Resistance Chart (Appendix A)**, the SDS of the chemical, your supervisor or the Chemical Hygiene Officer.

3. **Dust Masks/Respirators**

a. When working with toxic powders or fine powders, all procedures should be carried out in a hood if possible. Disposable dust and mist respirators are available in the chemistry storeroom. Contact EHS for assistance in selection of appropriate respirators.

b. You MUST have a medical examination, be fit-tested by EHS, and trained in the use of a respirator, including a dust mask. OSHA classifies a dust mask as a respirator.(29 CFR 1910.134)

4. Whenever exposure by inhalation is likely to exceed the threshold limits described in an SDS, use a fume hood. Consult with your supervisor before doing any such work.

5. Carefully inspect all protective equipment before using it. Do NOT use defective protective equipment.

F. Prior Approval

Students and employees must obtain specific approval from the Laboratory Supervisor or her/his designate whenever:

1. A new laboratory procedure or test is to be carried out.

2. Toxic limit concentrations could be exceeded or other harm is possible.
3. There is failure of any of the equipment used in the process, especially of safeguards such as fume hoods or clamped apparatus.
4. Members of the laboratory staff become ill, suspect that they or others have been exposed to a hazard, or otherwise suspect a failure of any safeguards.

G. Spills

To prepare for a chemical spill the appropriate safety equipment must be available and a plan in place. Areas where there is a potential for a chemical spill or explosive reaction that may cause injuries, illnesses, property damage or a significant contamination of the environment must be identified. **Spills of toxic substances or incidents involving any hazardous or flammable chemical are considered major spills should be resolved immediately.** There are several large square yellow trash cans labeled "Spill Response Equipment" strategically located around the Chemistry Department. They contain the necessary sorbents (kitty litter, diatomaceous earth, vermiculite, etc.) and tools to remediate a spill. Their locations are: Mendel 208, Mendel 302 and Mendel 388.

1. **Major spills** should not be handled by laboratory personnel unless they are trained in spill clean-up. Personnel trained in spill clean-up should be able to evaluate situations and take necessary responsive actions. They should be trained in how to efficiently contain and dispose of the various chemicals present in the laboratory as well as the use and maintenance of respirators.

   The following steps should be followed in the event of ***a moderately toxic to highly toxic or flammable material spill*** in the laboratory:

   a. Notify all personnel in the immediate area of the spill and evacuate if necessary.

   b. Remove ignition sources.
      a. Turn off hotplates, stirring motors, flame sources.
      b. Shut down equipment, but **NEVER** unplug equipment (which might cause a spark).
      c. If unable to shut off sources of ignition, notify emergency responders.

   c. Confine the spill area by closing doors or exhausting air to the outside. Do not re-enter the area unless you are wearing appropriate protective equipment.

   d. **Contact the Chemical Hygiene Officer Cian Watts (Mendel 201A, or 207) by Calling ext. 9-6348, or contact another departmental Safety Officer (Janean Tiggett at 9-7394; Eydiejo Kurchan at 9-7481, or the Office of Environmental Health & Safety at 9-8989 or 9-7838) for assistance in clean-up.**

   e. Verify the identity of the spilled material and determine the scope of the hazard via the material's SDS.

f. Clean-up ONLY IF you have been properly trained, have the appropriate personal protective equipment, and the proper material to absorb and clean up the chemical spill, and no one has been injured, the spill is contained, and the spill is not life threatening or a fire or explosion hazard. Otherwise, call for off-site assistance and evacuate the entire building and other areas if warranted.

2. **Minor spills** are those which:
   - are contained within the area or inside the fume hood.
   - Have a low level of toxicity.
   - Do not generate toxic vapors.
   - Have no threat of fire or explosion.
   - Have no threat of discharge to drain/sewer.
   - Do not exceed short-term exposure limits.
   - Have no threat to the community.

   If it has been determined the spill is of minor nature and one has the proper training, personal protective equipment, and the proper material to absorb and clean up the chemical spill, follow these procedures:

   a. Wear appropriate PPE (Personal Protective Equipment).

      1) Always wear protective gloves and eye protection
      2) If there is a chance of body contact, wear an labcoat or disposable coveralls.
      3) If the spill is on the floor, wear rubber or plastic boots (NOT leather).

   b. Remove ignition sources.

      1) Turn off hot plates, stirring motors, flame sources.
      2) Shut down all equipment.
      3) If unable to shut off sources of ignition, notify emergency responders.

   c. Confine or contain the spill.

      1) Cover with an absorbent mixture.
      2) Clean up minor spills with paper towels or sponge if they won't react.
      3) Sweep solid materials into a dust pan, place in sealed container.
      4) If acid/base, first add neutralizing agents; sodium bicarbonate for acids, sodium bisulfate for bases.
      5) Small amounts of inorganic acids/bases: use neutralizing agent and absorbent material.
      6) Small amounts of other materials: absorb with non-reactive material (e.g. vermiculite, sand, towels, Floor-Dri).
      7) Large amounts of inorganic acids/bases: neutralize and call for help.
      8) Large amounts of other materials: make a judgment call; depending on the amount, toxicity or what the substance can run into or react with, you may handle it yourself or call for help.

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d. Remove absorbent material with a broom and dust pan.

   1) Place in plastic bag or other appropriate container.
   2) Dispose of the material through the Chemistry Department Safety Officer.

e. Wet mop the spill area.

3. **Mercury Spills:** Minor mercury spills, such as broken mercury thermometers, can be handled by the department.

   a. Secure the area with the broken thermometer.

   b. Notify the Department Chemical Hygiene Officer or other departmental Safety Officer who will evaluate the spill.

   c. If the spill is deemed small enough to handle in-house, the mercury vacuum located in the Mendel 204 will be used to clean up the spill.

   d. If the spill is deemed too large to handle in-house, notify Public Safety at ext 9-4444 who will call emergency services and the Environmental Health & Safety Department at ext 9-7838.

H. Chemical Inventory

1. In general, all chemicals received at Villanova University's Chemistry Department must be barcoded when received and entered into the department chemical inventory (ChemTracker). Chemical inventories should be updated at least biannually.

2. The Chemistry Department has a more detailed tracking of chemicals due to the hazardous nature of the chemicals used in the department. All Chemistry Department personnel should be familiar with the document, Chemical Inventory Plan, found in **Appendix C**.

3. Faculty Departure

   a. Before leaving the employ of Villanova University, faculty members are responsible for the clean-up of their laboratories, both teaching and research. An inventory of chemicals should be circulated to others who may be able to use the materials. If another department member can use the material, it should be taken to his or her laboratory. If the material cannot be used, it should be disposed of in an appropriate manner. In either case the chemical inventory should be changed to reflect the relocation.

   b. Notify the CHO and EHS of the cleanout.

c. If no other laboratory accepts the surplus chemicals, the CHO will declare that the surplus chemical is waste and store it according to EPA requirements.

I. Chemical Storage

Proper chemical storage is the key to maximize employee and student safety within the laboratory. Read the label of the chemical and its MSDS to determine the appropriate storage areas. In general, chemicals are segregated by compatibility and hazard classification. It is the responsibility of faculty, research students, and storeroom personnel to ensure adequate and proper chemical storage exists in the laboratory. Faculty should perform semi-annual inspections of the laboratory to verify adequacy of chemical storage. The Chemistry Department Safety Officer will conduct monthly inspections of Chemistry Department storage facilities. All other departments covered under the CHP will perform semi-annual inspections.

1. **General rules for chemical storage are listed below. Consult Appendix D Classes of Incompatible Chemicals**

   a. Every chemical in the laboratory should have a definite storage place and should be returned to that location after each use.

   b. Date of receipt must be on the label of the container.

   c. Do not store excessive amounts of chemicals in the laboratory. Purchase the minimum amount of chemical required and dispose of unneeded chemicals in a timely fashion.

   d. Store reagents on shelves or in cabinets. Store large bottles of chemicals on the lowest shelves of any chemical storage area.

   e. Storage shelves should have a ¼- ½" lip on the forward edge of the shelf. Do not allow bottles to extend over the edge of the shelf.

   f. Except for synthetic work in progress (*), no chemicals should be stored in any fume hood, unless that hood is used only for storage. The front shield of all storage fume hoods must be secured all the way down.

   g. *Containers with left over reagents used in the synthesis do not qualify as work in progress – these must be put away.

   h. No chemicals (either reagents or waste chemicals) should be stored on the floor. Floor storage presents a major safety hazard because bottles can break if knocked over or struck together.

   i. Only a day's supply of chemicals should be "stored" on the bench top, and all of these chemicals should be returned to their storage locations at the end of the day.

   j. Inspect storage areas periodically for damaged containers such as cracked bottles or caps or rusted can. Replace loose or deteriorating labels.

k. Whenever possible, all incompatible chemicals should be segregated – stored in the same room but with a physical barrier. At the very least, all incompatible chemicals must be separated – stored in the same room but separated by as much space as practical.

l. Incompatible chemicals should never be stored adjacent to one another on the same shelf, or on vertically adjacent shelves.

m. Wherever possible, compatible materials should be stored according to container size to minimize accidental breakage of small bottles. If this is not possible, large bottles should be kept to the back.

n. Chemicals requiring refrigeration should be properly labeled and sealed to prevent escape of any vapors. The refrigerator should bear a label similar to "No food or drink storage permitted" or "For chemical storage only". Flammables requiring refrigeration should be stored in explosion-safe refrigerators only.

o. Chemicals should be stored by compatibility first. Solvents, acids, bases, reactives, oxidizers, and toxins will be stored separately – that is, physical separation of containers and isolation of potential spills and releases with the goal of preventing chemical reactions. Once separated into hazard classes, chemicals may be stored alphabetically.

p. Small bottles or vials of chemicals may be stored in drawers in ventilated cabinets. Drawers or cabinets used for chemical storage must be labeled with the approximate contents.

2. **Guidelines for Storage of Specific Classes of Chemicals**

a. Store **acids** separate from bases. Store ammonium hydroxide in a separate cabinet, preferably ventilated.

b. Store **oxidizers**, including oxidizing acids such as nitric acid and perchloric acids separate from oxidizable compounds such as acetic acid. Perchloric acid MUST be stored where it cannot contact organic material.

c. Store **highly toxic chemicals** in unbreakable secondary containers labeled with a description of the contents. Cyanides and sulfides MUST be kept safe from any contact with acids. Store cyanides in a closed cabinet, not in a location visible to passerby. Dispose of cyanides for which you have no current use.

d. Store **pyrophoric** materials separate from flammable materials, in a dry inert atmosphere such as a nitrogen-filled desiccators or a glove box.

e. **Organic peroxides** should be kept in the laboratory no longer than 12 months. They should be properly labeled with the date of receipt, opening date, and the date recommended for disposal. Peroxide formers should be stored in air-tight containers in a cool, dry, dark place. **See Appendix E, Examples of Peroxide Forming Compounds** and recommended storage time.

f. **Solvents** are classified by the National Fire Protection Association (NFPA) by flash point and boiling point. Flash point is defined as the minimum temperature at which a liquid gives off vapor in sufficient concentration to form an ignitable mixture with air near the surface of the liquid.

1) **Flammable liquids – Class I**

Class IA – flash point below 73 °F (22.8 °C) and boiling point below 100 °F.
Class IB – flashpoint below 73 °F (22.8 °C) and boiling point at or above 100 °F
Class IC – flash point at or above 73 °F (22.8 °C) and boiling point below 100 °F

2) **Combustible liquids – Class II, III**

Class II – flash point at or above 100 °F and below 140 °F (60 °C)
Class IIIA – flash point at or above 140 °F and below 200 °F (93 °C)
Class IIIB – flash point at or above 200 °F (93 °C)

Proper storage of flammables and combustible liquids depends upon the Class distinction**.** See section III. B. Special Precautions for specific storage requirements for flammables and combustible liquids as determined by NFPA codes.

J. Chemical Waste Plan

1. This plan covers hazardous chemical waste and does not include infectious, biological, or radioactive waste or sharps. These are covered in the Blood-borne Pathogens Program or the Radiation Safety Manual.

2. In general, chemicals will not be disposed of in the regular trash. Evaporation or dilution is not an acceptable means of disposal for toxic and/or ignitable wastes. Once an EPA hazardous waste, always an EPA hazardous waste. Unwanted chemicals or reaction by-products will be kept in closed containers until a university-wide chemical disposal is conducted (approximately twice per year). Chemical mixtures submitted for disposal will be labeled with as complete information as possible regarding the chemical identity and composition including

   - the name(s) of the chemicals
   - approximate amount of each chemical
   - room number
   - hazards
   - date the first drop of waste added

   Use appropriate containers for the type of waste collected. Corks or stoppers are **not** appropriate closure devices - tight-fitting screw type lids are appropriate closure devices.

3. **Instructional Laboratory Waste**

   a. Waste from the Chemistry Department Instructional labs is labeled, dated and collected under the control of the Chemistry Department Chemical Hygiene Officer. Appropriate containers for all wastes are provided to avoid drain disposal.

   b. Segregation of incompatible materials is carried out in compliance with accepted guidelines as set forth in "Prudent Practices in the Laboratory - Handling and Disposal of Chemicals" by National Academy Press.

   c. Volume reduction through chemical treatment is implemented as part of the experiment. This is accomplished through neutralization, precipitation of metals, and conversion to less hazardous forms. Consolidation of solvents for vendor recycling is also performed.

4. **Research Laboratory Waste**

   Chemical waste from the research labs is divided into two groups – waste organic solvents and waste and surplus chemicals.

   a. Waste Organic Solvents

      i. Segregate into halogenated and non-halogenated.
      ii. List the ingredients and approximate amounts, the date and room number on the University Hazardous Waste label which is affixed to a 4L bottle.
      iii. Periodic collection of these solvents for bulking in the basement Hazmat room will be implemented to alleviate storage in the research labs.
      iv. Sulfur containing compounds, amines or other odoriferous materials as well as reactives are to be segregated from these solvents. When in doubt, segregate it.

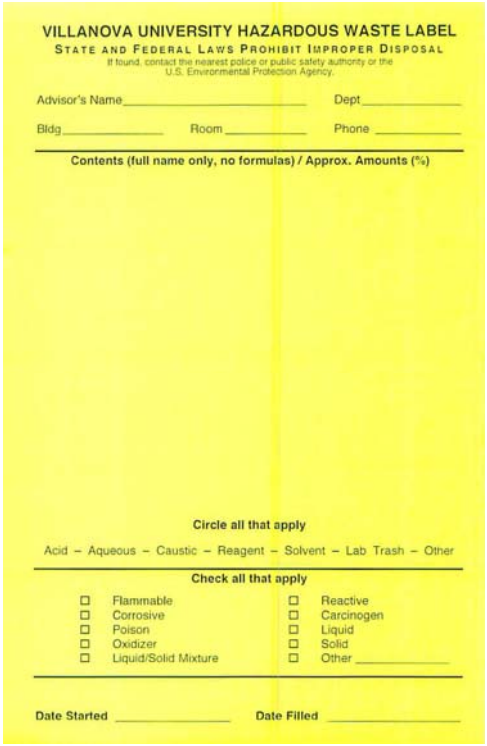
   b. Waste and Surplus Chemicals

      i. Label with the ingredients, approximate amounts, and primary hazard
      ii. Store in the research lab until a waste shipment is implemented.
      iii. For research products, the general chemical class or list of starting materials is sufficient if more accurate identification is not possible.
      iv. Follow proper storage guidelines for compatibles/incompatibles.
      v. Pretreatment of waste to the lowest possible volume should be practiced whenever possible. Consult "Hazardous Laboratory Chemicals: Disposal Guide" by M.A. Armour, seek advice
      From the Chemistry Department Safety Officer and/or the Faculty.

5. Drain Disposal – only neutralized acid/base solutions or non-hazardous aqueous salt solutions as described in "Vogel's Qualitative Inorganic Analysis" by G. Svehla (6^{th} edition) should be disposed of down the drain and only with excess amounts of water.

6. **Waste Collections**

a. All waste bottles must be labeled with the standardized fluorescent yellow (chartreuse) "Villanova University Hazardous Waste" label before pickup. Waste will not be picked up without this label. This label should only be affixed when the waste container is finished being filled. Fill out the label as completely as possible. No abbreviations for chemicals should be used (eg. NaCl,) but the full name should be written out (sodium chloride, etc.).



VILLANOVA UNIVERSITY HAZARDOUS WASTE LABEL

STATE AND FEDERAL LAWS PROHIBIT IMPROPER DISPOSAL

If found, contact the nearest police or public safety authority or the U.S. Environmental Protection Agency.

Advisor's Name_____ Dept_____

Bldg_____ Room_____ Phone _____

Contents (full name only, no formulas) / Approx. Amounts (%)

Circle all that apply

Acid – Aqueous – Caustic – Reagent – Solvent – Lab Trash – Other

Check all that apply

☐ Flammable ☐ Reactive
☐ Corrosive ☐ Carcinogen
☐ Poison ☐ Liquid
☐ Oxidizer ☐ Solid
☐ Liquid/Solid Mixture ☐ Other _____

Date Started _____ Date Filled _____

Temporary, red and white "hazardous waste" labels are usually already placed on available containers to be used for waste. These labels should be used while the waste bottle is still being filled (many times solvent drips will cause the ink on these temporary labels to run. These labels are cheap and are covered over by the yellow label when the bottle is full.

Both labels can be picked up from the chemical storeroom (Mendel 312) or the equipment storeroom (Mendel 212) or from the Chemical Hygiene Officer (Cian Watts, 9-6348).

b. Research Laboratory wastes are picked up on a regular basis by the Chemical Hygiene Officer. If you have something that you would like removed right away, please contact the Chemistry Department Chemical Hygiene Officer (Cian Watts, cian.watts@villanova.edu, 9-6348) for pickup.

c. Laboratory personnel will be notified in writing 4 weeks prior to a waste shipment to begin preparing accumulated waste for disposal to be completed by the given deadline.

7. **Waste Shipments**

a. Waste shipments occur semi-annually in conjunction with the Environmental Health & Safety Office.

b. An accurate list of materials to be disposed of is compiled and submitted to potential vendors for bid.

c. Once a vendor is chosen, the waste is collected and organized safely in a central location for lab packing, manifesting and labeling.

d. Completed copies of all shipping papers and notification are sent to the appropriate agencies. A complete set of documents is forwarded to the Environmental Health & Safety Office and one is retained by the Chemistry Department CHO.

K. Safety Data Sheets

1. Employers must maintain a copy of the SDS for every hazardous chemical used on-site. SDS provide specific information on the hazards of the chemicals used by employees.

2. SDS are readily available in the following departments:

a. Biology
    a. Mendel G-9, Biology Storeroom
    b. Mendel 175, Biology Conference Room
b. Chemistry - Mendel 212 – Chemistry Storeroom
c. Chemical Engineering – Room 217, Main Chemical Engineering Office
d. Electrical Engineering – Room 411, Main Electrical Engineering Office
e. Mechanical Engineering – Tolentine 14
f. Physics – Mendel 260, Main Physics Office
g. Psychology – Tolentine 453

L. Labeling

1. All chemicals received will be properly labeled with the date received or generated, the responsible person, and the contents.

2. Solutions/mixtures prepared on-site must be labeled at the time of preparation with the following:
    a. Name of the material(s)
    b. Name or initials of the person preparing it
    c. Date prepared
    d. Course and/or laboratory in which it is to be used
    e. Hazards: flammable, corrosive, toxic, reactive, etc.

M. Signage

Prominent signs and labels of the following types must be posted or affixed.

1. Door signs – name of the laboratory supervisor/research advisor, campus extension, Public Safety extension, and the types of hazards located in each lab must be displayed outside the lab on the signs provided.
2. Eye wash/safety showers
3. Fire extinguishers
4. Exits
5. First Aid Kits
6. Warning signs in areas or at equipment where there are special or unusual hazards.

III. Hazard-Specific Standard Operating Procedures

Where they exist, laboratory procedures must contain a written description of specific safety practices. All involved should read and understand these practices before commencing a procedure. In all cases, appropriate personal protection equipment will be used when handling any of these chemicals.

A. Procedures for Toxic Chemicals

The MSDSs for many of the chemicals used in the laboratory state recommended limits or OSHA mandated limits, or both, as guidelines for exposure. Typical 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 in working with toxic chemicals

B. Procedures for Flammable Chemicals

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

1. Chemicals with a flash point below 200 °F (90 °C) will be considered “fire-hazard chemicals”.

2. OSHA standards and the National Fire Protection Association (NFPA) guidelines on whether a chemical is considered flammable apply to the use of flammable chemicals in the laboratory. In all work with fire-hazard chemicals, follow the requirements of 29 CFR, subparts H and L; NFPA Manual 30, *Flammable and Combustible Liquids Code*; and NFPA Manual 45, *Fire Protection For Laboratories Using Chemicals.*

3. Fire-hazard chemicals must be stored in a flammable-solvent storage area or in storage cabinets designed for flammable materials.

4. Fire-hazard chemicals should be used only in vented hoods and away from sources of ignition.

5. For more information, see **Section II. I, Chemical Storage**.

C. Procedures for Reactive Chemicals

A convenient reference on chemical reactivity is found in the current edition of *Handbook of Reactive Chemical Hazards* by L. Bretherick, published by Butterworths. Reactivity information is sometimes given in manufacturer's SDS and on labels. Guidelines on which chemicals are reactive can be found in regulations promulgated by the Department of Transportation (DOT) in 49 CFR and by the Environmental Protection Agency (EPA) in 40 CFR. Also see NFPA Manual 325M, *Fire Hazard Properties of Flammable Liquids, Gases, Volatile Solids*; Manual 49, *Hazardous Chemicals Data*; and Manual 491M, *Manual of Hazardous Chemical Reactions*.

1. A *reactive chemical* is a chemical substance that will vigorously polymerize, decompose, condense, or become self-reactive due to shock, pressure, or temperature.
    a. Is so identified or described in the MSDS or on the label
    b. Is ranked by the NFPA as 3 or 4 for reactivity.
    c. Is identified by the DOT as:
        - An oxidizer
        - An organic peroxide, or
        - An explosive, Class A, B or C
    d. Fits the EPA definition of reactive in 40 CFR 261.23
    e. Fits the OSHA definition of unstable in 29 CFR 1910.1450, OR
    f. Is known or found to be reactive with other substances.

2. Handle reactive chemicals with all proper safety precautions, including segregation in storage and prohibition on mixing even small quantities with other chemicals without prior approval and appropriate personal protection and precautions.

D. Procedures for Corrosive Chemicals and Contact-Hazard Chemicals

Corrosivity, allergenic, and sensitizer information is sometimes given in manufacturer's SDS 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.

1. A *corrosive chemical* is one that causes visible destruction of or irreversible alternations in living tissue by chemical action at the site of contact and
    a. Fits the OSHA definition of corrosive in Appendix A of 29 CFR 1910.1200, Hazardous Communication Standard.
    b. Fits the EPA definition of corrosive in 40 CFR 261.22 (has a pH greater than 12 or less than 2.5), OR
    c. Is known or found to be corrosive to living tissue.

2. A *contact-hazard chemical* is an allergen or sensitizer that:
    a. Is so identified or described in the SDS or on the label.
    b. Is so identified or described in the medical or industrial hygiene literature, OR
    c. Is known or found to be an allergen or sensitizer.

3. Handle corrosive chemicals with proper safety precautions including wearing both safety goggles and face shield, gloves tested for absence of pin holes and known to be resistant to permeation or penetration, and a laboratory apron or laboratory coat.

4. For more information, see **Section II.I, Chemical Storage**.

E. Control Measures and Equipment

Chemical safety is achieved by continual awareness of chemical hazards and by keeping the chemicals under control by using precautions, including engineering safeguards such as hoods. Laboratory personnel should be familiar with the precautions to be taken. Engineering safeguards and controls must be inspected annually be the Environmental Health and Safety Office.

1. ***Ventilation – Laboratory Hood Guidelines***

   a. Laboratory ventilation should be at least eight air changes per hour (calculated). This flow is not necessarily sufficient to prevent accumulation of chemical vapors. Work with toxic chemicals that have low air concentration limits or that have high vapor pressures should always be done in a hood.

   b. Fume hoods should provide 75 linear feet per minute of air flow.

   c. Faculty, staff, and students in laboratories with fume hoods should understand that:
      1) A fume hood is a safety backup for condensers, traps, or other devices that collect vapors and fumes. It is NOT used to "dispose" of chemicals by evaporation unless the vapors are trapped and recovered for proper waste disposal.
      2) All apparatus inside the hood should be placed on the floor of the hood at least six inches away from the front edge.
      3) Fume hood windows should be lowered at all times except when necessary for adjusting the apparatus that is inside the hood.
      4) 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.
      5) There are steps to be taken in the event of a power failure or other hood failure and should be familiar with these steps.
      6) Hood vent ducts and fans must be inspected at frequent intervals to be sure they are both clean and clear of obstructions.
      7) Hoods should never be used as storage areas for chemicals, apparatus, or other materials unless reserved exclusively for that use.

   d. Fume hoods are inspected annually.

2. Flammable-Liquid Storage

a. Fire-hazard chemicals in quantities greater than 500 mL should be kept in metal safety cans designed for such storage. The cans should be used only as recommended by the manufacturer. The following safety practices should be enforced:
    1) Never disable the spring-loaded closure
    2) Always keep the flame-arrestor screen in place; replace if punctured or damaged.

b. 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:
    1) Store only compatible materials inside a cabinet.
    2) Do not store paper or cardboard or other combustible packaging material in a flammable-liquid storage cabinet.
    3) Do not overload a cabinet. The manufacturer establishes quantity limits for various sizes of flammable-liquid storage cabinets.
    4) See Section II.H, Protocol For Chemical Storage.

3. Eyewash Fountains and Safety Showers

a. All laboratories should be equipped with eyewashes and safety showers. These must be located so they can be easily reached from any point in the laboratory, as specified in ANSI Z358.1.
b. Check the functioning of eyewash fountains and safety showers and measure the water flow at intervals specified in ANSI Z358.1. Promptly repair any facility that does not meet the water flow requirements of ANSI Z358.1.
c. Be sure that access to eyewash fountains and safety showers is not restricted or blocked by temporary storage of objects or in any other way.
d. Eyewashes should be tested weekly by laboratory personnel to ensure that they are working and that the water is clean, should an emergency use become necessary.
e. Eyewashes and safety showers should be inspected annually by EHS.

4. Respirators

When exposures to dust, fumes, mists, radionuclides, gases, and vapors are expected to exceed established limits of exposure, respiratory protection is required. With the exception of spill cleanup involving volatile or irritating materials, respirators are not expected to be needed for routine operations at Villanova University. Those personnel who assist with spill or other emergency situations and may need to don a respirator must follow the requirements of 29 CFR 1910.134, Respiratory Protection, including:

a. A medical evaluation.
b. Fit-testing of the respirator.
c. Training in the proper use, inspection, and maintenance of the respirator.

For those routine operations which may require use of respirators, special permission must be obtained from the Chemical Hygiene Officer. Training will be performed by

the CHO or her/his designee. A copy of the Villanova University Respiratory Protection program is located at EHS**.**

5. Vapor Detection

Do not use odor as a means of determining that inhalation exposure limits are or are not being exceeded. Whenever there is reason to suspect that a toxic chemical inhalation limit might be exceeded, evacuate the room and notify the supervisor.

F. Procedures for Carcinogens, Reproductive Toxins, Substances That Have a High Degree of Acute Toxicity, and Chemicals of Unknown Toxicity

Follow the procedures described in this section when performing laboratory work with ***greater than 10 mg*** of any carcinogen, reproductive toxin, substance that has a high degree of acute toxicity, or a chemical which is reasonably suspected of being toxic.

1. The following definitions will apply:

    a. *Select carcinogen*: any substance defined as such by 29 CFR 1910.1450 and any other substance described as such in the applicable SDS.

    b. *Reproductive toxin*: any substance described as such in the applicable SDS.

    c. *Substance with a high degree of acute toxicity*: any substance for which the LD_{50} (lethal dose) data described in the applicable SDS 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 know statistically significant study conducted in accordance with established scientific principles that establishes its toxicity.

    e. For the purpose of this CHP, chemicals in these four categories will be called *inimical*.

    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 inimical chemicals in excess of the specified limit shall be conducted.

2. Designated areas shall be posted and their boundaries clearly marked. Only those persons trained to work with inimical chemicals will work with those chemicals in a designated area. All such persons will:

    a. Wear appropriate personnel protective equipment.
    b. Use the smallest amount of chemical that is consistent with the requirements of the work to be done.
    c. Use high-efficiency particulate air (HEPA) filters or high efficiency scrubber systems to protect vacuum lines and pumps.
    d. Store inimical chemicals or remove them from storage.
    e. Decontaminate a designated area when work is completed.

f. Prepare wastes from work with inimical chemicals for waste disposal in accordance with the Resource Conservation and Recovery Act (RCRA) and as designated by Villanova University's hazardous waste officer.

3. Store all inimical chemicals in locked and enclosed spaces with a slight negative pressure compared to the rest of the building.

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

5. Wear long-sleeved disposable clothing, protective dust mask and gloves known to resist permeation by the chemicals to be used when working in designated areas.

6. For more information, see **Appendix F - Carcinogen List and Section II. I, Chemical Storage.**

G. Other Special Precautions

Work with additional classifications of chemicals such as allergens, compressed gases, light sensitive chemicals, peroxide forming compounds, shock sensitive and water reactive chemicals, and hydrofluoric acid, require additional special precautions to be implemented.

1. Allergens

– substances which produce skin and lung hypersensitivity. There is a variety of responses from one individual to another.

a. Wear suitable gloves and clothing to prevent skin contact. Consult the Chemical Resistance Chart in Appendix A and the SDS
b. Use adequate ventilation when handling volatile chemicals from this class.
c. Seek medical attention immediately if signs of an allergic reaction appear.
d. Avoid contact with allergens when cleaning up spills.
e. Examples – formaldehyde, some phenols, picric acid, ntirotoluene, maleic anhydride, diethylene triamine.

2. Compressed Gases

a. Users of compressed gases will wear personal protection equipment appropriate for the gases involved.
b. All pressurized cylinders will be inspected upon receipt for leaks or other defects.
c. Close the main valve when the gas is not in use.
d. Position the cylinder to maintain direct access to the cylinder valve.
e. Use the proper regulator for each cylinder and gas.
f. Store in a cool, dry place, away from direct sunlight and other heat sources.
g. Do not store oxygen cylinders adjacent to flammable gas cylinders.
h. Securely attach cylinders to a wall or laboratory bench 1/3 from the top of the cylinder or supported in an appropriate cylinder stand.
i. Protect the cylinder stem with a cap unless a regulator is attached.

j. Only move gas cylinders that have the safety cap in place.
k. Move large cylinders with cylinder hand carts – never carry or walk them.
l. Cylinders containing flammables and other hazardous gases will be stored in a well-ventilated area.
m. Use small cylinders for acutely toxic gases that can be placed in fume hoods. Exceptions are made for large cylinders of asphyxiants such as nitrogen and carbon dioxide.
n. A list of the size, content, and location of each gas cylinder for each lab shall be provided to the department CHO.

3. Hydrofluoric Acid (HF)

– a non-flammable acid that is difficult to contain because it attacks glass, concrete, and some metals – especially cast iron and silica alloys. It can cause the formation of hydrogen in metallic containers and piping, a fire and explosion hazard

a. Exclude ignition sources from areas having equipment containing HF>
b. Always use a hood and cover all exposed skin surfaces.
c. Use protective equipment such as a face shield and neoprene or polyvinyl chloride gloves that protects the eyes, skin, respiratory system or digestive system. Wash this equipment after each use.
d. If contact is even suspected, flush the exposed area with water and get medical attention immediately.
e. If HF gets under the fingernails it may be necessary to receive calcium gluconate injections.
f. Limit the size of the experiment to eliminate the chance of large spills or exposures.
g. Have the Calgonate Emergency First Aid Kit for Hydrofluoric Acid Burns on hand before beginning any procedure and be familiar will how to use it. This can be obtained from the Chemistry Department Chemical Hygiene Officer, Cian Watts, Mendel 201A, 9-6348.

4. Light Sensitive Chemicals

– degrade upon exposure to light and should be stored in amber containers.

5. Peroxide Forming Compounds

a. <u>General information</u>
   1. Formed by chemicals that react with oxygen present in the atmosphere.
   2. Unstable and pose a risk of explosion.
   3. Affected by heat, shock and friction that can create dangerous situations leading to explosions.
   4. Aldehydes, ethers, most alkenes, and vinyllidene compounds.
   5. Production is affected by the aging of the chemical

b. <u>Safety Precautions</u>
   1. Purchase in small quantities.
   2. Never return unused chemicals to the container.

3. Sensitivity of most peroxides to shock and heat can be reduced by dilution with inert solvents, such as aliphatic hydrocarbons.
4. Solutions in volatile solvents should be handled so as to prevent evaporation of solvent and an increase in the peroxide concentration.
5. Do not use metal spatulas to handle chemicals because metal contamination can lead to explosive decomposition.
6. Do not use in areas where ignition sources are present.
7. Avoid friction, grinding, and other forms of impact.

c. Storage
   1. Store in airtight containers in a cool, dry, dark place.
   2. Do not use glass containers that have screw tops or glass stoppers. Use polyethylene containers.
   3. To minimize the rate of decomposition peroxides should be stored at the lowest temperature consistent with their solubility or freezing point but not lower because they become more sensitive to shock and heat.
   4. Label with the receiving date, the opening date, and the date recommended for disposal.
   5. Never store for periods longer than a year. Discard as a chemical waste after this length of time.

d. Examples – acetal, dioxane, ethyl ether, isopropyl ether, tetrahydrofuran, vinyl ether, cyclohexene, diethyl ether, dimethyl ether and diethylene glycol. **See Appendix E** for more examples.

6. Shock Sensitive

– refers to the susceptibility of the chemical to rapidly decompose or explode when struck, vibrated or otherwise agitated.

a. Read the SDS and label.
b. Write the date received and the date opened on all containers.
c. Open containers should be discarded within 6 months of opening.
d. Closed containers should be discarded after 1 year unless an inhibitor was added by the manufacturer.
e. Wear appropriate personal protective equipment.

7. Water Reactive

– lead to formation of flammable or toxic gases following contact with water.

a. Handle in a manner similar to reactive solids.
b. Post area where compounds are present to alert fire fighting personnel.
c. Store in polyethylene bags and tightly sealed containers.
d. Examples include potassium and sodium metals and many metal anhydrides.

8. Designated Work Areas

- areas established for work involving the use of carcinogens, reproductive toxins, and/or substances with a high degree of acute toxicity.

a. These may be lab hoods or a bench top area.
b. Conduct work and mount apparatus above trays made of a chemically resistant material such as polyethylene, or cover work and storage areas with plastic backed paper.
c. Dispose of this paper as contaminated waste after each work session.
d. Decontaminate all equipment including trays, and replace the paper and trays for future activities.
e. Some operations cannot be conducted in a designated area – in this case, conduct the activity in such a manner that the intent of the designated area is maintained - use trays, diaper paper under equipment, etc.
f. Use and store these substances only in areas of restricted access with warning signs.
g. Thoroughly decontaminate or dispose of contaminated clothing or shoes as hazardous waste.
h. Label designated hoods in the following manner:

THIS HOOD IS TO BE USED FOR WORK WITH CARCINOGENS, REPRODUCTIVE TOXINS AND SUBSTANCES WITH A HIGH DEGREE OF ACUTE TOXICITY.

IV. RECORDS AND RECORDKEEPING:

1. Research or instructional laboratory accident/incident investigations will be conducted by the Chemical Hygiene Officer or other departmental Safety Office with assistance from other personnel as deemed necessary.

2. Accident/incident reports should be documented using the Mendel Science Center Incident Report form and retained for at least as long as the employees affected are employed by the university.

3. Exposure records for hazardous chemicals and harmful, physical agents will be maintained for 30 years per 29 CFR 1910.1020.

4. Medical records for employees exposed to hazardous chemicals and harmful physical agents will be maintained for the duration of employment plus 30 years per 29 CFR 19101.1020 and accessible to employees or their representative.

5. Inventory and usage records for high-risk substances (amounts of substances on-hand, amounts used, and names of workers involved(shall be maintained for at least as long as the employees involved are employed at the university.

6. Records of inspections of equipment will be maintained for the lifetime of the university.

7. Records of training for employees, graduate students and any undergraduate students conducting research in the laboratory will be maintained for at least as long as they are associated with the university.

8. 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 the exposure assessment. Other incidents, which might be documented for future reference, are:

    a. Major safety suggestions from employees.
    b. Near-miss reports.
    c. Repair and maintenance records for control systems.
    d. Complaints from employees, as well as investigations and outcomes of the same.

9. The EPA and other federal and state agencies have special recordkeeping requirements. For example, recordkeeping of allegations and the reporting of suspect hazards from adverse effects of chemical exposure are required under Sections 8(c) and 8 (e) of the Toxic Substances Control Act – see 40 CFR 716 and 717 (Appendix G).

V. EMPLOYEE INFORMATION AND TRAINING:

Villanova has made provisions for informing and training employees about potential health hazards and measures they can take to protect themselves when working with chemicals in the laboratory environment. Training is in accordance with OSHA Laboratory Standard 29 CFR 1910.1450 and Hazard Communication Standard 29 CFR 1910.1200, and Pennsylvania's Right-To-Know laws.

All new employees receive instruction via audio-visual material and classroom training. Additional training is provided prior to assignments involving new hazardous chemicals and/or new laboratory work procedures. Although OSHA does not mandate the content of the training, employees must be able to answer to the issues.

All employees who complete the training must sign the "Acknowledgement" sheet in Appendix G. The CHO keeps these signed sheets. The training program covers the following topics:

1. The content, location, and availability of the Chemistry Department's Chemical Hygiene Plan.

2. Summary of the OSHA Hazard Communication Standard and the OSHA Laboratory Standard as well as the written training program.

3. Chemical and physical properties of hazardous materials (i.e. flash point, reactivity) and methods that can be used to detect the presence or release of chemicals into the lab areas.

4. Physical hazards of chemical (i.e potential for fire, explosion, etc)

5. Health hazards, signs and symptoms of exposure, additive effects of multi-chemical exposure, and any medical condition known to be aggravated by exposure to the chemical.

6. Procedures to protect against hazards (i.e. personal protective equipment required, proper use and maintenance, work practices to assure proper use and handling of chemicals, and emergency response procedures).

7. Proper work procedures to follow to assure protection when cleaning hazardous chemical spills and leaks.

8. The location of SDSs, how to interpret the information on both labels and SDSs, and how employees may obtain additional hazard information.

9. The permissible exposure limits (PEL) for OSHA regulated substances or recommended exposure limits (TLV) for other hazardous chemicals not regulated by OSHA

VI. MEDICAL CONSULTATION AND EXAMINATION

All Villanova employees who work with hazardous chemicals are provided the opportunity to receive medical consultation and examination under the following circumstances:

1. Whenever an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory,

2. Where exposure monitoring suggests that there could have been an exposure above the action level, or PEL if there is no action level, for a chemical for which a substance-specific standard has been established, or

3. Whenever an occurrence such as a spill, leak, explosion, or other uncontrolled release of a hazardous chemical in the laboratory resulted in the likelihood of an exposure.

Medical consultation with a medical professional is provided free to the employee, as is any examination or other attention recommended by the consulting physician, at a reasonable time and place. Records of medical consultations and exposure evaluations must be kept in accordance with the laboratory standard.

VII. APPENDICES

APPENDIX A – GLOVE CHEMICAL COMPATIBILITY CHART

Chemical Resistance Guide For Disposable Gloves

A Warning: This Chemical Resistance Chart is offered as a guide and for reference purposes only by MICROFLEX. The chemical resistance ratings are based on published research data. Microflex cannot certify the accuracy of the date and therefore does not represent nor warrant that this information in the chemical resistance chart is accurate or complete.

References: Chemical Resistance Guide to Elastomers III; A Guide to Chemical Resistance of Rubber and Elastomeric Compounds, Compass Publications, La Jolla, CA 2005. Plastics Design Library-Chemical Reistance of Plastics and Elastomers, 3rd edition, William Andrew Publishing, 2003. Dupont Dow Elastomers Chemical Resistance Guide; The Los Angeles Rubber Group; www.dupont-dow.com

Compatibility Ratings
A — Very Good or Excellent
B — Good
C — Fair
D — Not recommended

Chemical	Latex (natural rubber)	Nitrile (synthetic rubber)		Chemical	Latex (natural rubber)	Nitrile (synthetic rubber)
Acetaldehyde	C	D		Isobutanol	A	B
Acetamide	D	A		Isooctane	D	A
Acetic Acid (50% conc.)	B	B		Isopropanol	A	A
Acetone	D	D		Kerosene	D	A
Acetonitrile	B	D		Ketones	B	D
Acetophenone	D	D		Lactic acid (85% conc.)	A	A
Acetyl chloride	D	D		Lauryl alcohol	A	A
Acrylic acid	B	C		Lauric acid (36% conc.)	D	D
Aluminum nitrate	B	B		Lead acetate	A	B
Ammonia (anhydrous)	D	B		Linoleic acid	D	B
Ammonium benzoate	D	D		Linseed oil	D	B
Ammonium hydroxide (30% conc.)	B	A		Maleic acid	C	C
Ammonium hydroxide (conc.)	D	D		Mercuric chloride	A	A
Ammonium oxalate	no data	A		Mercury	A	A
Ammonium sulfate (aq.)	A	A		Methane	D	A
Amyl acetate	D	D		Methanol	C	B
Aniline	D	D		2-Methoxyethanol	D	C
Antifreeze (methanol base)	A	A		Methyl amine	C	B
Benzaldehyde	D	D		Methyl bromide	C	C
Benzene	D	D		Methyl butyl ketone	D	D
Benzoic acid	D	D		Methylene chloride	D	D
Boric acid	A	A		Methyl chloride	D	D
Bromine	D	D		Methyl ethyl ketone (MEK)	D	D

Chemical	Latex (natural rubber)	Nitrile (synthetic rubber)		Chemical	Latex (natural rubber)	Nitrile (synthetic rubber)
Bromoethane	D	D		Methyl isobutyl ketone (MIBK)	D	D
Butyl acetate	D	D		Methyl methacrylate	D	D
n-Butyl alcohol	B	A		Mineral spirits	D	A
n-Butyl chloride	D	D		Morpholine	D	D
1,3-Butylene glycol	no data	B		Naphtha	D	A
Calcium chloride	A	A		Naphthalene	D	D
Calcium hydroxide	A	A		Nitric acid (50% conc.)	D	D
Carbon dioxide	B	A		Nitromethane	C	D
Carbon disulfide	D	D		Nitropropane	D	D
Carbon tetrachloride	D	D		Octyl alcohol	B	B
Chlorine (wet)	D	D		Oleic acid	C	B
Chlorobenzene	D	D		Oxalic acid	B	B
Chloroform	D	D		Palmitic acid	B	B
o-Chloronaphthalene	D	D		Paraformaldehyde	D	B
Chromic acid (50% conc.)	D	C		Pentane	D	A
Citric acid (10% conc.)	A	A		Perchloric acid (60% conc.)	C	D
Cresols	D	D		Perchloroethylene	D	B
Cupric Sulfate	B	A		Petroleum distillates	D	B
Cyclohexane	D	A		Phenol (0.1% conc.)	A	A
Cyclohexanol	C	B		Phenol (100%)	D	D
Cyclohexanone	D	D		Phenolphthalein	D	D
Decahydronaphthalene (decalin)	D	D		Phosphoric acid (0-50%)	B	B
Denatured alcohol	A	A		Phosphoric acid (50-85%)	B	D
Dibutyl phthalate	D	D		Phosphoric acid (conc.)	D	D
o-dichlorobenzene	D	D		Potassium bromate	A	A
p-dichlorobenzene	D	D		Potassium chloride	A	A
Dichloromethane	D	D		Potassium cyanide	A	A
Diethylamine	C	C		Potassium dichromate (aq.)	B	A
Diethylene glycol	A	A		Potassium hydroxide	B	B
Diisobutyl ketone (DIBK)	D	D		Potassium Iodide	B	A
N,N-dimethyl acetamide	B	B		Potassium permanganate	A	A
Dimethylformamide	D	B		Potassium sulfate	B	A
Dimethyl sulfoxide (DMSO)	D	D		Propyl acetate	D	D
Dioctyl phthalate	D	D		Propyl alcohol	B	A
Dioxane	D	D		Propylene	D	D
EDTA (17% soln)	B	B		Propylene glycol	A	A
Ethanol (95%)	A	A		Pyridine	D	D
Ethanolamine	B	B		Silver nitrate	A	B
2-Ethoxyethanol	B	A		Sodium acetate	A	B
Ethyl acetate	D	D		Sodium azide	A	A
Ethyl ether	D	D		Sodium bicarbonate (aq.)	A	A
Ethylene dichloride	D	D		Sodium chloride (aq.)	A	A
Ethylene glycol	A	A		Sodium cyanide (aq.)	A	A
Ethylene oxide	D	D		Sodium hydroxide (50% conc.)	A	A
Ferric chloride (aq.)	A	A		Sodium hypochlorite	C	C

Chemical	Latex (natural rubber)	Nitrile (synthetic rubber)		Chemical	Latex (natural rubber)	Nitrile (synthetic rubber)
Formaldehyde	B	B		Sodium thiosulfate	B	B
Formalin (40% formaldehyde)	B	B		Styrene	D	D
Formamide	no data	A		Sulfuric acid (50% conc.)	A	A
Formic acid (90% conc.)	B	B		Sulfuric acid (conc.)	D	D
Furfural	D	D		Tannic acid (65% conc.)	A	A
Gasoline (unleaded)	D	A		Tetrachloroethylene	D	C
Glucose	A	A		Tetrahydrofuran	D	D
Glycerin	A	A		Toluene	D	D
Glycerol	A	A		Toluene diisocyanate	C	D
Heptane	D	A		Trichloroethylene	D	D
Hexane	D	B		Triethanolamine	B	B
Hydrochloric acid (conc.)	B	D		Turpentine	D	A
Hydrofluoric acid (conc.)	D	D		Urea	A	B
Hydrogen peroxide (3%)	B	B		Vinyl chloride	D	D
Hydrogen peroxide (30%)	B	D		Water	A	A
Hydroquinone	B	C		Xylene	D	D

APPENDIX B ~ OSHA LABORATORY STANDARD, 1910.1450

Occupational Exposure to Hazardous Chemicals in Laboratories

1910.1450(a)
Scope and application.
1910.1450(a)(1)
This section shall apply to all employers engaged in the laboratory use of hazardous chemicals as defined below.

1910.1450(a)(2)
Where this section applies, it shall supersede, for laboratories, the requirements of all other OSHA health standards in 29 CFR Part 1910, subpart Z, except as follows:

1910.1450(a)(2)(i)
For any OSHA health standard, only the requirement to limit employee exposure to the specific permissible exposure limit shall apply for laboratories, unless that particular standard states otherwise or unless the conditions of paragraph (a)(2)(iii) of this section apply.

1910.1450(a)(2)(ii)
Prohibition of eye and skin contact where specified by any OSHA health standard shall be observed.

1910.1450(a)(2)(iii)
Where the action level (or in the absence of an action level, the permissible exposure limit) is routinely exceeded for an OSHA regulated substance with exposure monitoring and medical surveillance requirements paragraphs (d) and (g)(1)(ii) of this section shall apply.

1910.1450(a)(3)
This section shall not apply to:

..1910.1450(a)(3)(i)

1**910.1450(a)(3)(i)**
Uses of hazardous chemicals which do not meet the definition of laboratory use, and in such cases, the employer shall comply with the relevant standard in 29 CFR Part 1910, subpart Z, even if such use occurs in a laboratory

1910.1450(a)(3)(ii)
Laboratory uses of hazardous chemicals which provide no potential for employee exposure. Examples of such conditions might include:

1910.1450(a)(3)(ii)(A)
Procedures using chemically-impregnated test media such as Dip-and-Read tests where a reagent strip is dipped into the specimen to be tested and the results are interpreted by comparing the color reaction to a color chart supplied by the manufacturer of the test strip; and

1910.1450(a)(3)(ii)(B)
Commercially prepared kits such as those used in performing pregnancy tests in which all of the reagents needed to conduct the test are contained in the kit.

1910.1450(b)
Definitions --

Action level means a concentration designated in 29 CFR Part 1910 for a specific substance, calculated as an eight (8)-hour time-weighted average, which initiates certain required activities such as exposure monitoring and medical surveillance.

Assistant Secretary means the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee.

Carcinogen (***see select carcinogen***).

Chemical Hygiene Officer means an employee who is designated by the employer, and who is qualified by training or experience, to provide technical guidance in the development and implementation of the provisions of the Chemical Hygiene Plan. This definition is not intended to place limitations on the position description or job classification that the designated individual shall hold within the employer's organizational structure.

Chemical Hygiene Plan means a written program developed and implemented by the employer which sets forth procedures, equipment, personal protective equipment and work practices that (i) are capable of protecting employees from the health hazards presented by hazardous chemicals used in that particular workplace and (ii) meets the requirements of paragraph (e) of this section.

Combustible liquid means any liquid having a flashpoint at or above 100 deg. F (37.8 deg. C), but below 200 deg. F (93.3 deg. C), except any mixture having components with flashpoints of 200 deg. F (93.3 deg. C), or higher, the total volume of which make up 99 percent or more of the total volume of the mixture.

Compressed gas means:

(i) A gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psi at 70 deg. F (21.1 deg. C); or

(ii) A gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psi at 130 deg. F (54.4 deg C) regardless of the pressure at 70 deg. F (21.1 deg. C); or

(iii) A liquid having a vapor pressure exceeding 40 psi at 100 deg. F (37.8 C) as determined by ASTM D-323-72.

Designated area means an area which may be used for work with "select carcinogens," reproductive toxins or substances which have a high degree of acute toxicity. A designated area may be the entire laboratory, an area of a laboratory or a device such as a laboratory hood.

Emergency means any occurrence such as, but not limited to, equipment failure, rupture of containers or failure of control equipment which results in an uncontrolled release of a hazardous chemical into the workplace.

Employee means an individual employed in a laboratory workplace who may be exposed to hazardous chemicals in the course of his or her assignments.

Explosive means a chemical that causes a sudden, almost instantaneous release of pressure, gas, and heat when subjected to sudden shock, pressure, or high temperature.

Flammable means a chemical that falls into one of the following categories:

(i) ***Aerosol, flammable*** means an aerosol that, when tested by the method described in 16 CFR 1500.45, yields a flame protection exceeding 18 inches at full valve opening, or a flashback (a flame extending back to the valve) at any degree of valve opening;

(ii) ***Gas, flammable*** means:

(A) A gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of 13 percent by volume or less; or

(B) A gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air wider than 12 percent by volume, regardless of the lower limit.

(iii) ***Liquid, flammable*** means any liquid having a flashpoint below 100 deg F (37.8 deg. C), except any mixture having components with flashpoints of 100 deg. C) or higher, the total of which make up 99 percent or more of the total volume of the mixture.

(iv) ***Solid, flammable*** means a solid, other than a blasting agent or explosive as defined in § 1910.109(a), that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious hazard. A chemical shall be considered to be a flammable solid if, when tested by the method described in 16 CFR 1500.44, it ignites and burns with a self-sustained flame at a rate greater than one-tenth of an inch per second along its major axis.

Flashpoint means the minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite when tested as follows:

(i) Tagliabue Closed Tester (See American National Standard Method of Test for Flash Point by Tag Closed Tester, Z11.24 - 1979 (ASTM D 56-79)) - for liquids with a viscosity of less than 45 Saybolt Universal Seconds (SUS) at 100 deg. F (37.8 deg. C), that do not contain suspended solids and do not have a tendency to form a surface film under test; or

(ii) Pensky-Martens Closed Tester (See American National Standard Method of Test for Flashpoint by Pensky-Martens Closed Tester, Z11.7 - 1979 (ASTM D 93-79)) - for liquids with a viscosity equal to or greater than 45 SUS at 100 deg. F (37.8 deg. C), or that contain suspended solids, or that have a tendency to form a surface film under test; or

(iii) Setaflash Closed Tester (see American National Standard Method of test for Flash Point by Setaflash Closed Tester (ASTM D 3278-78)).

Organic peroxides, which undergo autoaccelerating thermal decomposition, are excluded from any of the flashpoint determination methods specified above.

Hazardous chemical means a chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or

chronic health effects may occur in exposed employees. The term "health hazard" includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic systems, and agents which damage the lungs, skin, eyes, or mucous membranes.

Appendices A and B of the Hazard Communication Standard (29 CFR 1910.1200) provide further guidance in defining the scope of health hazards and determining whether or not a chemical is to be considered hazardous for purposes of this standard.

Laboratory means a facility where the "laboratory use of hazardous chemicals" occurs. It is a workplace where relatively small quantities of hazardous chemicals are used on a non-production basis.

Laboratory scale means work with substances in which the containers used for reactions, transfers, and other handling of substances are designed to be easily and safety manipulated by one person. "Laboratory scale" excludes those workplaces whose function is to produce commercial quantities of materials.

Laboratory-type hood means a device located in a laboratory, enclosure on five sides with a movable sash or fixed partial enclosed on the remaining side; constructed and maintained to draw air from the laboratory and to prevent or minimize the escape of air contaminants into the laboratory; and allows chemical manipulations to be conducted in the enclosure without insertion of any portion of the employee's body other than hands and arms.

Walk-in hoods with adjustable sashes meet the above definition provided that the sashes are adjusted during use so that the airflow and the exhaust of air contaminants are not compromised and employees do not work inside the enclosure during the release of airborne hazardous chemicals.

Laboratory use of hazardous chemicals means handling or use of such chemicals in which all of the following conditions are met:

(i) Chemical manipulations are carried out on a "laboratory scale;"

(ii) Multiple chemical procedures or chemicals are used;

(iii) The procedures involved are not part of a production process, nor in any way simulate a production process; and

(iv) "Protective laboratory practices and equipment" are available and in common use to minimize the potential for employee exposure to hazardous chemicals.

Medical consultation means a consultation which takes place between an employee and a licensed physician for the purpose of determining what medical examinations or procedures, if any, are appropriate in cases where a significant exposure to a hazardous chemical may have taken place.

Organic peroxide means an organic compound that contains the bivalent -O-O- structure and which may be considered to be a structural derivative of hydrogen peroxide where one or both of the hydrogen atoms has been replaced by an organic radical.

Oxidizer means a chemical other than a blasting agent or explosive as defined in § 1910.109(a), that initiates or promotes combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases.

Physical hazard means a chemical for which there is scientifically valid evidence tat it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer pyrophoric, unstable (reactive) or water-reactive.

Protective laboratory practices and equipment means those laboratory procedures, practices and equipment accepted by laboratory health and safety experts as effective, or that the employer can show to be effective, in minimizing the potential for employee exposure to hazardous chemicals.

Reproductive toxins means chemicals which affect the reproductive chemicals which affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis).

Select carcinogen means any substance which meets one of the following criteria:

(i) It is regulated by OSHA as a carcinogen; or

(ii) It is listed under the category, "known to be carcinogens," in the Annual Report on Carcinogens published by the National Toxicology Program (NTP)(latest edition); or

(iii) It is listed under Group 1 ("carcinogenic to humans") by the International Agency for research on Cancer Monographs (IARC)(latest editions); or

(iv) It is listed in either Group 2A or 2B by IARC or under the category, "reasonably anticipated to be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:

(A) After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m(3);

(B) After repeated skin application of less than 300 (mg/kg of body weight) per week; or

(C) After oral dosages of less than 50 mg/kg of body weight per day.

Unstable (reactive) means a chemical which is the pure state, or as produced or transported, will vigorously polymerize, decompose, condense, or will become self-reactive under conditions of shocks, pressure or temperature.

Water-reactive means a chemical that reacts with water to release a gas that is either flammable or presents a health hazard.

1910.1450(c)

Permissible exposure limits. For laboratory uses of OSHA regulated substances, the employer shall assure that laboratory employees' exposures to such substances do not exceed the permissible exposure limits specified in 29 CFR part 1910, subpart Z.

..1910.1450(d)

1910.1450(d)
Employee exposure determination –

1910.1450(d)(1)
Initial monitoring. The employer shall measure the employee's exposure to any substance regulated by a standard which requires monitoring if there is reason to believe that exposure levels for that substance routinely exceed the action level (or in the absence of an action level, the PEL).

1910.1450(d)(2)
Periodic monitoring. If the initial monitoring prescribed by paragraph (d)(1) of this section discloses employee exposure over the action level (or in the absence of an action level, the PEL), the employer shall immediately comply with the exposure monitoring provisions of the relevant standard.

1910.1450(d)(3)
Termination of monitoring. Monitoring may be terminated in accordance with the relevant standard.

1910.1450(d)(4)
Employee notification of monitoring results. The employer shall, within 15 working days after the receipt of any monitoring results, notify the employee of these results in writing either individually or by posting results in an appropriate location that is accessible to employees.

1910.1450(e)
Chemical hygiene plan -- General. (Appendix A of this section is non-mandatory but provides guidance to assist employers in the development of the Chemical Hygiene Plan).

1910.1450(e)(1)
Where hazardous chemicals as defined by this standard are used in the workplace, the employer shall develop and carry out the provisions of a written Chemical Hygiene Plan which is:

1910.1450(e)(1)(i)
Capable of protecting employees from health hazards associated with hazardous chemicals in that laboratory and

1910.1450(e)(1)(ii)
Capable of keeping exposures below the limits specified in paragraph (c) of this section.

1910.1450(e)(2)
The Chemical Hygiene Plan shall be readily available to employees, employee representatives and, upon request, to the Assistant Secretary.

1910.1450(e)(3)
The Chemical Hygiene Plan shall include each of the following elements and shall indicate specific measures that the employer will take to ensure laboratory employee protection;

1910.1450(e)(3)(i)
Standard operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals;

1910.1450(e)(3)(ii)
Criteria that the employer will use to determine and implement control measures to reduce employee exposure to hazardous chemicals including engineering controls, the use of personal protective equipment and hygiene practices; particular attention shall be given to the selection of control measures for chemicals that are known to be extremely hazardous;

1910.1450(e)(3)(iii)
A requirement that fume hoods and other protective equipment are functioning properly and specific measures that shall be taken to ensure proper and adequate performance of such equipment;

..1910.1450(e)(3)(iv)

1910.1450(e)(3)(iv)
Provisions for employee information and training as prescribed in paragraph (f) of this section;

1910.1450(e)(3)(v)
The circumstances under which a particular laboratory operation, procedure or activity shall require prior approval from the employer or the employer's designee before implementation;

1910.1450(e)(3)(vi)
Provisions for medical consultation and medical examinations in accordance with paragraph (g) of this section;

1910.1450(e)(3)(vii)
Designation of personnel responsible for implementation of the Chemical Hygiene Plan including the assignment of a Chemical Hygiene Officer, and, if appropriate, establishment of a Chemical Hygiene Committee; and

1910.1450(e)(3)(viii)
Provisions for additional employee protection for work with particularly hazardous substances. These include "select carcinogens," reproductive toxins and substances which have a high degree of acute toxicity. Specific consideration shall be given to the following provisions which shall be included where appropriate:

1910.1450(e)(3)(viii)(A)
Establishment of a designated area;

1910.1450(e)(3)(viii)(B)
Use of containment devices such as fume hoods or glove boxes;

1910.1450(e)(3)(viii)(C)
Procedures for safe removal of contaminated waste; and

1910.1450(e)(3)(viii)(D)
Decontamination procedures.

1910.1450(e)(4)
The employer shall review and evaluate the effectiveness of the Chemical Hygiene Plan at least annually and update it as necessary.

1910.1450(f)
Employee information and training.

1910.1450(f)(1)
The employer shall provide employees with information and training to ensure that they are apprised of the hazards of chemicals present in their work area.

1910.1450(f)(2)
Such information shall be provided at the time of an employee's initial assignment to a work area where hazardous chemicals are present and prior to assignments involving new exposure situations. The frequency of refresher information and training shall be determined by the employer.

1910.1450(f)(3)
Information. Employees shall be informed of:

1910.1450(f)(3)(i)
The contents of this standard and its appendices which shall be made available to employees;

1910.1450(f)(3)(ii)
the location and availability of the employer's Chemical Hygiene Plan;

..1910.1450(f)(3)(iii)

1910.1450(f)(3)(iii)
The permissible exposure limits for OSHA regulated substances or recommended exposure limits for other hazardous chemicals where there is no applicable OSHA standard;

1910.1450(f)(3)(iv)
Signs and symptoms associated with exposures to hazardous chemicals used in the laboratory; and

1910.1450(f)(3)(v)
The location and availability of known reference material on the hazards, safe handling, storage and disposal of hazardous chemicals found in the laboratory including, but not limited to, Material Safety Data Sheets received from the chemical supplier.

1910.1450(f)(4)
Training.

1910.1450(f)(4)(i)
Employee training shall include:

1910.1450(f)(4)(i)(A)
Methods and observations that may be used to detect the presence or release of a hazardous chemical (such as monitoring conducted by the employer, continuous monitoring devices, visual appearance or odor of hazardous chemicals when being released, etc.);

1910.1450(f)(4)(i)(B)
The physical and health hazards of chemicals in the work area; and

1910.1450(f)(4)(i)(C)
The measures employees can take to protect themselves from these hazards, including specific procedures the employer has implemented to protect employees from exposure to hazardous chemicals, such as appropriate work practices, emergency procedures, and personal protective equipment to be used.

1910.1450(f)(4)(ii)
The employee shall be trained on the applicable details of the employer's written Chemical Hygiene Plan.

1910.1450(g)
Medical consultation and medical examinations.

1910.1450(g)(1)
The employer shall provide all employees who work with hazardous chemicals an opportunity to receive medical attention, including any follow-up examinations which the examining physician determines to be necessary, under the following circumstances:

1910.1450(g)(1)(i)
Whenever an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory, the employee shall be provided an opportunity to receive an appropriate medical examination.

1910.1450(g)(1)(ii)
Where exposure monitoring reveals an exposure level routinely above the action level (or in the absence of an action level, the PEL) for an OSHA regulated substance for which there are exposure monitoring and medical surveillance requirements, medical surveillance shall be established for the affected employee as prescribed by the particular standard.

1910.1450(g)(1)(iii)
Whenever an event takes place in the work area such as a spill, leak, explosion or other occurrence resulting in the likelihood of a hazardous exposure, the affected employee shall be provided an opportunity for a medical consultation. Such consultation shall be for the purpose of determining the need for a medical examination.

..1910.1450(g)(2)

1910.1450(g)(2)
All medical examinations and consultations shall be performed by or under the direct supervision of a licensed physician and shall be provided without cost to the employee, without loss of pay and at a reasonable time and place.

1910.1450(g)(3)
Information provided to the physician. The employer shall provide the following information to the physician:

1910.1450(g)(3)(i)
The identity of the hazardous chemical(s) to which the employee may have been exposed;

1910.1450(g)(3)(ii)
A description of the conditions under which the exposure occurred including quantitative exposure data, if available; and

1910.1450(g)(3)(iii)
A description of the signs and symptoms of exposure that the employee is experiencing, if any.

1910.1450(g)(4)
Physician's written opinion.

1910.1450(g)(4)(i)
For examination or consultation required under this standard, the employer shall obtain a written opinion from the examining physician which shall include the following:

1910.1450(g)(4)(i)(A)
Any recommendation for further medical follow-up;

1910.1450(g)(4)(i)(B)
The results of the medical examination and any associated tests;

1910.1450(g)(4)(i)(C)
Any medical condition which may be revealed in the course of the examination which may place the employee at increased risk as a result of exposure to a hazardous workplace; and

1910.1450(g)(4)(i)(D)
A statement that the employee has been informed by the physician of the results of the consultation or medical examination and any medical condition that may require further examination or treatment.

1910.1450(g)(4)(ii)
The written opinion shall not reveal specific findings of diagnoses unrelated to occupational exposure.

1910.1450(h)
Hazard identification.

1910.1450(h)(1)
With respect to labels and material safety data sheets:

1910.1450(h)(1)(i)
Employers shall ensure that labels on incoming containers of hazardous chemicals are not removed or defaced.

1910.1450(h)(1)(ii)
Employers shall maintain any material safety data sheets that are received with incoming shipments of hazardous chemicals, and ensure that they are readily accessible to laboratory employees.

1910.1450(h)(2)

The following provisions shall apply to chemical substances developed in the laboratory:

..1910.1450(h)(2)(i)

1910.1450(h)(2)(i)
If the composition of the chemical substance which is produced exclusively for the laboratory's use is known, the employer shall determine if it is a hazardous chemical as defined in paragraph (b) of this section. If the chemical is determined to be hazardous, the employer shall provide appropriate training as required under paragraph (f) of this section.

1910.1450(h)(2)(ii)
If the chemical produced is a byproduct whose composition is not known, the employer shall assume that the substance is hazardous and shall implement paragraph (e) of this section.

1910.1450(h)(2)(iii)
If the chemical substance is produced for another user outside of the laboratory, the employer shall comply with the Hazard Communication Standard (29 CFR 1910.1200) including the requirements for preparation of material safety data sheets and labeling.

1910.1450(i)
Use of respirators. Where the use of respirators is necessary to maintain exposure below permissible exposure limits, the employer shall provide, at no cost to the employee, the proper respiratory equipment. Respirators shall be selected and used in accordance with the requirements of 29 CFR 1910.134.

1910.1450(j)
Recordkeeping.

1910.1450(j)(1)
The employer shall establish and maintain for each employee an accurate record of any measurements taken to monitor employee exposures and any medical consultation and examinations including tests or written opinions required by this standard.

1910.1450(j)(2)
The employer shall assure that such records are kept, transferred, and made available in accordance with 29 CFR 1910.1020.

1910.1450(k)
Dates --

1910.1450(k)(1)
Effective date. This section shall become effective May 1, 1990.

1910.1450(k)(2)
Start-up dates.

1910.1450(k)(2)(i)
Employers shall have developed and implemented a written Chemical Hygiene Plan no later than January 31, 1991.

1910.1450(k)(2)(ii)

Paragraph (a)(2) of this section shall not take effect until the employer has developed and implemented a written Chemical Hygiene Plan.

1910.1450(l)

Appendices. The information contained in the appendices is not intended, by itself, to create any additional obligations not otherwise imposed or to detract from any existing obligation.

[55 FR 3327, Jan. 31, 1990; 55 FR 7967, March, 6, 1990; 55 FR 12777, March 30, 1990; 61 FR 5507, Feb. 13, 1996]

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APPENDIX C ~ CHEMISTRY DEPARTMENT CHEMICAL INVENTORY PLAN

This plan outlines procedures for providing a "cradle to grave" inventory of chemicals utilized in departmental research and instructional laboratories, and to develop a computer data base fro handling inventory. Procedures for transfer of chemicals from one area of responsibility to another, and for disposal of excess chemicals are included.

1. All chemicals issued by the storeroom, purchased by the department, or otherwise obtained, will be labeled with individual, non-removable serial number and/or (preferably) bar coded labels and inventoried on receipt. In cases of small containers which cannot be conveniently labeled, a code number will be applied directly to the manufacturer's or provider's label.

2. Computerized inventories for all laboratories will be developed and periodically updated by the storeroom. Clipboard inventories will be prominently displayed in each laboratory. Additionally, the entire department inventory will be available in the storeroom in hard copy as well as on computer disk.

3. The following information will be provided for each item inventoried:
    a. The complete chemical name
    b. The size container (the original amount, if partially used)
    c. The manufacturer and manufacturer's catalog number
    d. Date of receipt
    e. Storage class
    f. Account number of person to which chemical is assigned
    g. Lab number of assignee

In order to develop an efficient and reliable inventory system, it is essential that individual and group responsibilities for developing and maintaining this system be established.

1. Inventory of the storeroom and instructional laboratories will be the responsibility of the storeroom personnel.

2. Initial and updating of research laboratory inventories will be carried out by research personnel. It will be the responsibility of the professor in charge of the laboratory to see that such inventory is carried out and done properly.

3. A full inventory of research laboratories will be conducted biannually by the personnel using the laboratories. It is recommended that such inventories be carried out in conjunction with scheduled cleanup days.

4. All chemicals entering a research laboratory must bear an inventory serial number or bar code label and be promptly recorded on the clipboard for that laboratory.

5. If a chemical is transferred from one laboratory to another, the clipboard entry for that item must be deleted from the list for the laboratory from which it was removed and entered on the list for the laboratory to which it was taken.

6. It is the responsibility of research personnel to properly label all chemicals obtained as products of their research. All samples employed for analytical and spectroscopic studies

are to be clearly labeled with chemical names and structures as well as research notebook code numbers, and stored in properly sealed vials or bottles. Mixtures of uncertain composition are to be labeled as to likely major products, including solvents, as well as generic class. All research samples will be under the control of the professor or laboratory director under whom the research is/was conducted. Research samples should be disposed of as promptly as possible using the guidelines indicated below. They must not be disposed of in the trash containers, regardless of the size of sample.

7. The following items will be inventoried as issued from the storeroom, but need not be entered on the lab clipboards: wash grade acetone and alcohol. Aqueous solutions of common inorganic chemicals such as sodium chloride, sodium bicarbonate, sodium carbonate, sodium thiosulfate, and dilute mineral acids and bases prepared for use in the research laboratories must be properly labeled, but need not be listed on the clipboard.

8. All excess chemicals to be discarded will be returned to the Chemistry Department Safety Officer.

APPENDIX D ~ CLASSES OF INCOMPATIBLE CHEMICALS[a]

A – Any Acid	B – Any Base
Alkali & Alkaline earth metals Carbides Hydrides Hydroxides Oxides Peroxides	Water Acids Halogenated organic compounds Oxidizing agents (see footnotes b) Chromates, dichromates Halogens Halogenating agents Nitric acid, nitrates Perchlorates & chlorates Permanganates Persulfates
Inorganic azides	Acids Heavy metals & their salts Oxidizing agents (see footnote b)
Inorganic cyanides	Acids, strong bases
Inorganic nitrates	Acids Metals Nitrites Sulfur
Inorganic nitrites	Acids Oxidizing agents (see footnote b)
Inorganic sulfides	Acids
Organic compounds	Oxidizing agents (see footnote b)
Organic acyl halides	Bases Organic hydroxy compounds
Organic anhydrides	Bases Organic hydroxyl compounds
Organic halogen compounds	Aluminum metal
Organic nitro compounds	Strong bases
Powdered metals	Acids Oxidizing agents (see footnote b)
Acetylene & monosubstituted acetylene	Halogens

	Group IB & IIB metals and their salts
Ammonia & ammonia hydroxide	Halogens Halogenating agents Silver Mercury
Carbon, activated	Oxidizing agents[b]
Hydrogen peroxide	Metals & their salts
Nitric acid	Metals Sulfuric acid Sulfides Nitrites Other reducing agents Chromic acid & chromates Permanganates
Mercury & its amalgams	Ammonia & ammonia hydroxide Nitric acid Acetylene Sodium azide
Oxalic Acid	Silver Mercury
Phosphorus (yellow)	Oxygen Oxidizing agents[b] Strong bases
Phosphorus pentoxide	Water Halogenating agents
Sulfuric acid	Metals Chlorates Perchlorates Permanganates Nitric acid

[a]Chemicals in columns A and B should be kept separate.
[b]Oxidizing agents include the types of compounds listed in the entry for alkali and alkaline earth metals, etc.
REFERENCE: Prudent Practices For Handling Hazardous Chemicals in Laboratories, NRC (National Research Council)

APPENDIX E ~ EXAMPLES OF COMMON COMPOUNDS THAT FORM PEROXIDES AND RECOMMENDED MAXIMUM STORAGE TIMES[1]

Classes of Compounds That Can From Peroxides Upon Aging	
Class I: Unsaturated materials, especially those of low molecular weight, may polymerize violently and hazardously due to peroxide initiation.	
Acrylic acid	Tetrafluoroethylene*
Acrylonitrile	Vinyl acetate
Butadiene*	Vinyl acetylene
Chlorbutadiene (chloroprene)*	Vinyl chloride
Chlorotrifluoroethylene	Vinyl pyridine
Methyl methacrylate	Vinylidene chloride
Styrene	
Discard at 12 months	
Class II: The following chemicals are a peroxide hazard upon concentration (distillation/evaporation). A test for peroxide should be performed if concentration is intended or suspected.	
Acetal	Dioxane (p-dioxane)
Cumene	Ethylene glycol dimethyl ether (glyme)
Cyclohexene	Furan
Cyclooctene	Methyl acetylene
Cyclopentene	Methyl cyclopentane
Diacetylene	Methyl-i-butyl ketone
Dicyclopentadiene	Tetrahydrofuran
Diethylene glycol dimethyl ether	Tetrahydronaphthalene
Diethyl ether	Vinyl ethers
Discard at 12 months	
Class III: Peroxides derived from the following compounds may explode without concentration.	
Divinyl ether	Potassium metal
Divinyl acetylene	Potassium amide
Isopropyl ether	Sodium amide (sodamide)
Vinylidene chloride	
Discard at 3 Months	
*When stored as a liquid, the peroxide-forming potential increases and the chemical should then be considered a Class III.	

[1]University Texas Medical Branch, http://www.utmb.edu/ehs/EPm/Chemical%20Waste/Perioxides.htm

APPENDIX F ~ CARCINOGEN LIST

Known human carcinogens

International Agency for Research on Cancer "Carcinogenic to humans" (Group 1)

Agents and groups of agents

- 4-Aminobiphenyl
- Arsenic and arsenic compounds (Note: This evaluation applies to the group of compounds as a whole and not necessarily to all individual compounds within the group)
- Asbestos
- Azathioprine
- Benzene
- Benzidine
- Benzo[a]pyrene
- Beryllium and beryllium compounds
- N,N-Bis(2-chloroethyl)-2-naphthylamine (Chlornaphazine)
- Bis(chloromethyl)ether and chloromethyl methyl ether (technical-grade)
- 1,3-Butadiene
- 1,4-Butanediol dimethanesulfonate (Busulphan; Myleran)
- Cadmium and cadmium compounds
- Chlorambucil
- 1-(2-Chloroethyl)-3-(4-methylcyclohexyl)-1-nitrosourea (Methyl-CCNU; Semustine)
- Chromium[VI]
- Ciclosporin
- Cyclophosphamide
- Diethylstilbestrol
- Dyes metabolized to benzidine
- Epstein-Barr virus
- Erionite
- Estrogen-progestogen menopausal therapy (combined)
- Estrogen-progestogen oral contraceptives (combined) (Note: There is also convincing evidence in humans that these agents confer a protective effect against cancer in the endometrium and ovary)
- Estrogens, nonsteroidal (Note: This evaluation applies to the group of compounds as a whole and not necessarily to all individual compounds within the group)
- Estrogens, steroidal (Note: This evaluation applies to the group of compounds as a whole and not necessarily to all individual compounds within the group)
- Estrogen therapy, postmenopausal
- Ethanol in alcoholic beverages
- Ethylene oxide
- Etoposide in combination with cisplatin and bleomycin
- Formaldehyde
- Gallium arsenide
- [Gamma Radiation: see X- and Gamma (g)-Radiation]
- Helicobacter pylori (infection with)
- Hepatitis B virus (chronic infection with)
- Hepatitis C virus (chronic infection with)
- Human immunodeficiency virus type 1 (infection with)
- Human papillomavirus types 16, 18, 31, 33, 35, 39, 45, 51, 52, 56, 58, 59 and 66 (Note: The HPV types that have been classified as carcinogenic to humans can differ by an order of magnitude in risk for cervical cancer)
- Human T-cell lymphotropic virus type I
- Melphalan
- 8-Methoxypsoralen (Methoxsalen) plus ultraviolet A radiation
- Methylenebis(chloroaniline) (MOCA)

- MOPP and other combined chemotherapy including alkylating agents
- Mustard gas (Sulfur mustard)
- 2-Naphthylamine
- Neutrons
- Nickel compounds
- N'-Nitrosonornicotine (NNN) and 4-(N-Nitrosomethylamino)-1-(3-pyridyl)-1-butanone (NNK)
- *Opisthorchis viverrini* (infection with)
- [Oral contraceptives, combined estrogen-progestogen: see Estrogen-progestogen oral contraceptives (combined)]
- Oral contraceptives, sequential
- Phosphorus-32, as phosphate
- Plutonium-239 and its decay products (may contain plutonium-240 and other isotopes), as aerosols
- Radioiodines, short-lived isotopes, including iodine-131, from atomic reactor accidents and nuclear weapons detonation (exposure during childhood)
- Radionuclides, a-particle-emitting, internally deposited (Note: Specific radionuclides for which there is sufficient evidence for carcinogenicity to humans are also listed individually as Group 1 agents)
- Radionuclides, b-particle-emitting, internally deposited (Note: Specific radionuclides for which there is sufficient evidence for carcinogenicity to humans are also listed individually as Group 1 agents)
- Radium-224 and its decay products
- Radium-226 and its decay products
- Radium-228 and its decay products
- Radon-222 and its decay products
- *Schistosoma haematobium* (infection with)
- Silica, crystalline (inhaled in the form of quartz or cristobalite from occupational sources)
- Solar radiation
- Talc containing asbestiform fibres
- Tamoxifen (Note: There is also conclusive evidence that tamoxifen reduces the risk of contralateral breast cancer)
- 2,3,7,8-Tetrachlorodibenzo-para-dioxin
- Thiotepa
- Thorium-232 and its decay products, administered intravenously as a colloidal dispersion of thorium-232 dioxide
- ortho-Toluidine
- Treosulfan
- Vinyl chloride
- X- and Gamma (g)-radiation

Mixtures

- Aflatoxins (naturally occurring mixtures of)
- Alcoholic beverages
- Areca nut
- Betel quid with tobacco
- Betel quid without tobacco
- Coal-tar pitches
- Coal-tars
- Herbal remedies containing plant species of the genus Aristolochia
- Household combustion of coal, indoor emissions from
- Mineral oils, untreated and mildly treated
- Phenacetin, analgesic mixtures containing
- Salted fish (Chinese-style)
- Shale-oils
- Soots
- Tobacco, smokeless
- Wood dust

Exposure circumstances

- Aluminum production
- Arsenic in drinking-water
- Auramine production
- Boot and shoe manufacture and repair
- Chimney sweeping
- Coal gasification
- Coal-tar distillation
- Coke production
- Furniture and cabinet making
- Hematite mining (underground) with exposure to radon
- Involuntary smoking (exposure to secondhand or 'environmental' tobacco smoke)
- Iron and steel founding
- Isopropyl alcohol manufacture (strong-acid process)
- Magenta production
- Painter (occupational exposure as a)
- Paving and roofing with coal-tar pitch
- Rubber industry
- Strong-inorganic-acid mists containing sulfuric acid (occupational exposure to)
- Tobacco smoking and tobacco smoke

National Toxicology Program 11th Report on Carcinogens "Known to be human carcinogens"

- Aflatoxins
- Alcoholic beverage consumption
- 4-Aminobiphenyl
- Analgesic mixtures containing phenacetin
- Arsenic compounds, inorganic
- Asbestos
- Azathioprine
- Benzene
- Benzidine
- Beryllium and beryllium compounds
- 1,3-Butadiene
- 1,4-Butanediol dimethylsulfonate (busulfan, Myleran®)
- Cadmium and cadmium compounds
- Chlorambucil
- 1-(2-Chloroethyl)-3-(4-methylcyclohexyl)-1-nitrosourea (MeCCNU)
- bis(chloromethyl) ether and technical-grade chloromethyl methyl ether
- Chromium hexavalent compounds
- Coal tar pitches
- Coal tars
- Coke oven emissions
- Cyclophosphamide
- Cyclosporin A (Ciclosporin)
- Diethylstilbestrol (DES)
- Dyes metabolized to benzidine
- Environmental tobacco smoke
- Erionite
- Estrogens, steroidal
- Ethylene oxide
- Hepatitis B virus
- Hepatitis C virus
- Human papilloma viruses: some genital-mucosal types
- Melphalan
- Methoxsalen with ultraviolet A therapy (PUVA)
- Mineral oils (untreated and mildly treated)
- Mustard gas
- 2-Naphthylamine
- Neutrons
- Nickel compounds
- Oral tobacco products

- Radon
- Silica, crystalline (respirable size)
- Solar radiation
- Soots
- Strong inorganic acid mists containing sulfuric acid
- Sunlamps or sunbeds, exposure to
- Tamoxifen
- 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD); "dioxin"
- Thiotepa
- Thorium dioxide
- Tobacco smoking
- Vinyl chloride
- Ultraviolet radiation, broad spectrum UV radiation
- Wood dust
- X-radiation and gamma radiation

Probable carcinogens

International Agency for Research on Cancer "Probably carcinogenic to humans" (Group 2A)

Agents and groups of agents

- Acrylamide
  Adriamycin
- Androgenic (anabolic) steroids
- Aristolochic acids (naturally occurring mixtures of)
- Azacitidine
- Bischloroethyl nitrosourea (BCNU)
- Captafol
- Chloramphenicol
- a-Chlorinated toluenes (benzal chloride, benzotrichloride, benzyl chloride) and benzoyl chloride (combined exposures)
- 1-(2-Chloroethyl)-3-cyclohexyl-1-nitrosourea (CCNU)
- 4-Chloro-ortho-toluidine
- Chlorozotocin
  Cisplatin
- *Clonorchis sinensis* (infection with)
- Cyclopenta[cd]pyrene
- Dibenz[a,h]anthracene
- Dibenzo[a,l]pyrene
- Diethyl sulfate
- Dimethylcarbamoyl chloride
- 1,2-Dimethylhydrazine
- Dimethyl sulfate
  Epichlorohydrin
- Ethyl carbamate (urethane)
- Ethylene dibromide
- N-Ethyl-N-nitrosourea
- Etoposide
- Glycidol
- Indium phosphide
  IQ (2-Amino-3-methylimidazo[4,5-f]quinoline)
- Kaposi's sarcoma herpesvirus/human herpesvirus 8
- Lead compounds, inorganic
- 5-Methoxypsoralen
- Methyl methanesulfonate
- N-Methyl-N´-nitro-N-nitrosoguanidine(MNNG)
- N-Methyl-N-nitrosourea
- Nitrate or nitrite (ingested) under conditions that result in endogenous nitrosation
- Nitrogen mustard

- N-Nitrosodiethylamine
- N-Nitrosodimethylamine
- Phenacetin
- Procarbazine hydrochloride
- Styrene-7,8-oxide
- Teniposide
- Tetrachloroethylene
- Trichloroethylene
- 1,2,3-Trichloropropane
- Tris(2,3-dibromopropyl) phosphate
- Ultraviolet radiation A
- Ultraviolet radiation B
- Ultraviolet radiation C
- [Urethane: see Ethyl carbamate]
- Vinyl bromide (Note: For practical purposes, vinyl bromide should be considered to act similarly to the human carcinogen vinyl chloride.)
- Vinyl fluoride (Note: For practical purposes, vinyl fluoride should be considered to act similarly to the human carcinogen vinyl chloride.)

Mixtures

- Creosotes
- Diesel engine exhaust
- High-temperature frying, emissions from
- Hot mate
- Household combustion of biomass fuel (primarily wood), indoor emissions from
- Non-arsenical insecticides (occupational exposures in spraying and application of)
- Polychlorinated biphenyls

Exposure circumstances

- Art glass, glass containers and pressed ware (manufacture of)
- Carbon electrode manufacture
- Cobalt metal with tungsten carbide
- Hairdresser or barber (occupational exposure as a)
- Petroleum refining (occupational exposures in)
- Shiftwork that involves circadian disruption
- Sunlamps and sunbeds (use of)

National Toxicology Program 11th Report on Carcinogens "Reasonably anticipated to be human carcinogens"

- Acetaldehyde
- 2-Acetylaminofluorene
- Acrylamide
- Acrylonitrile
- Adriamycin® (doxorubicin hydrochloride)
- 2-Aminoanthraquinone
- o-Aminoazotoluene
- 1-Amino-2,4-dibromoanthraquinone
- 1-Amino-2-methylanthraquinone
- 2-Amino-3,4-dimethylimidazo[4,5-f]quinoline (MeIQ)
- 2-Amino-3,8-dimethylimidazo[4,5-f]quinoxaline (MeIQx)
- 2-Amino-3-methylimidazo[4,5-f]quinoline (IQ)
- 2-Amino-1-methyl-6-phenylimidazo[4,5-b]pyridine (PhIP)
- Amitrole
- o-Anisidine hydrochloride
- Azacitidine (5-Azacytidine®, 5-AzaC)
- Benz[a]anthracene
- Benzo[b]fluoranthene

- Benzo[j]fluoranthene
- Benzo[k]fluoranthene
- Benzo[a]pyrene
- Benzotrichloride
- Bromodichloromethane
- 2, 2-bis-(bromoethyl)-1,3-propanediol (technical grade)
- Butylated hydroxyanisole (BHA)
- Carbon tetrachloride
- Ceramic fibers (respirable size)
- Chloramphenicol
- Chlorendic acid
- Chlorinated paraffins (C12, 60% chlorine)
- 1-(2-chloroethyl)-3-cyclohexyl-1-nitrosourea
- Bis (chloroethyl) nitrosourea
- Chloroform
- 3-Chloro-2-methylpropene
- 4-Chloro-o-phenylenediamine
- Chloroprene
- p-Chloro-o-toluidine and p-chloro-o-toluidine hydrochloride
- Chlorozotocin
- C.I. basic red 9 monohydrochloride
- Cisplatin
- Cobalt sulfate
- p-Cresidine
- Cupferron
- Dacarbazine
- Danthron (1,8-dihydroxyanthraquinone)
- 2,4-Diaminoanisole sulfate
- 2,4-Diaminotoluene
- Diazoaminobenzene
- Dibenz[a,h]acridine
- Dibenz[a,j]acridine
- Dibenz[a,h]anthracene
- 7H-Dibenzo[c,g]carbazole
- Dibenzo[a,e]pyrene
- Dibenzo[a,h]pyrene
- Dibenzo[a,i]pyrene
- Dibenzo[a,l]pyrene
- 1,2-Dibromo-3-chloropropane
- 1,2-Dibromoethane (ethylene dibromide)
- 2,3-Dibromo-1-propanol
- Tris (2,3-dibromopropyl) phosphate
- 1,4-Dichlorobenzene
- 3,3’-Dichlorobenzidine and 3,3’-dichlorobenzidine dihydrochloride
- Dichlorodiphenyltrichloroethane (DDT)
- 1,2-Dichloroethane (ethylene dichloride)
- Dichloromethane (methylene chloride)
- 1,3-Dichloropropene (technical grade)
- Diepoxybutane
- Diesel exhaust particulates
- Diethyl sulfate
- Diglycidyl resorcinol ether
- 3,3’-Dimethoxybenzidine
- 4-Dimethylaminoazobenzene
- 3,3’-Dimethylbenzidine
- Dimethylcarbamoyl chloride
- 1,1-Dimethylhydrazine
- Dimethyl sulfate
- Dimethylvinyl chloride
- 1,6-Dinitropyrene
- 1,8-Dinitropyrene

- 1,4-Dioxane
- Disperse blue 1
- Dyes metabolized to 3,3’-dimethoxybenzidine
- Dyes metabolized to 3,3’-dimethylbenzidine
- Epichlorohydrin
- Ethylene thiourea
- Di (2-ethylhexyl) phthalate
- Ethyl methanesulfonate
- Formaldehyde (gas)
- Furan
- Glasswool (respirable size)
- Glycidol
- Hexachlorobenzene
- Hexachlorocyclohexane isomoers
- Hexachloroethane
- Hexamethylphosphoramide
- Hydrazine and hydrazine sulfate
- Hydrazobenzene
- Indeno[1,2,3-cd]pyrene
- Iron dextran complex
- Isoprene
- Kepone® (chlordecone)
- Lead and lead compounds
- Lindane and other hexachlorocyclohexane isomers
- 2-Methylaziridine (propylenimine)
- 5-Methylchrysene
- 4,4’-Methylenebis(2-chloroaniline)
- 4-4’-Methylenebis(N,N-dimethyl)benzenamine
- 4,4’-Methylenedianiline and 4,4’-methylenedianiline dihydrochloride
- Methyleugenol
- Methyl methanesulfonate
- N-methyl-N’-nitro-N-nitrosoguanidine
- Metronidazole
- Michler’s ketone [4,4’-(dimethylamino) benzophenone]
- Mirex
- Naphthalene
- Nickel (metallic)
- Nitrilotriacetic acid
- o-Nitroanisole
- Nitrobenzene
- 6-Nitrochrysene
- Nitrofen (2,4-dichlorophenyl-p-nitrophenyl ether)
- Nitrogen mustard hydrochloride
- Nitromethane
- 2-Nitropropane
- 1-Nitropyrene
- 4-Nitropyrene
- N-nitrosodi-n-butylamine
- N-nitrosodiethanolamine
- N-nitrosodiethylamine
- N-nitrosodimethylamine
- N-nitrosodi-n-propylamine
- N-nitroso-N-ethylurea
- 4-(N-nitrosomethylamino)-1-(3-pyridyl)-1-butanone
- N-nitroso-N-methylurea
- N-nitrosomethylvinylamine
- N-nitrosomorpholine
- N-nitrosonornicotine
- N-nitrosopiperidine
- N-nitrosopyrrolidine
- N-nitrososarcosine

- Norethisterone
- Ochratoxin A
- 4,4’-Oxydianiline
- Oxymetholone
- Phenacetin
- Phenazopyridine hydrochloride
- Phenolphthalein
- Phenoxybenzamine hydrochloride
- Phenytoin
- Polybrominated biphenyls (PBBs)
- Polychlorinated biphenyls (PCBs)
- Polycyclic aromatic hydrocarbons (PAHs)
- Procarbazine hydrochloride
- Progesterone
- 1,3-Propane sultone
- beta-Propiolactone
- Propylene oxide
- Propylthiouracil
- Reserpine
- Safrole
- Selenium sulfide
- Streptozotocin
- Styrene-7,8-oxide
- Sulfallate
- Tetrachloroethylene (perchloroethylene)
- Tetrafluoroethylene
- Tetranitromethane
- Thioacetamide
- 4,4’-Thiodianaline
- Thiourea
- Toluene diisocyanate
- o-Toluidine and o-toluidine hydrochloride
- Toxaphene
- Trichloroethylene
- 2,4,6-Trichlorophenol
- 1,2,3-Trichloropropane
- Ultraviolet A radiation
- Ultraviolet B radiation
- Ultraviolet C radiation
- Urethane
- Vinyl bromide
- 4-Vinyl-1-cyclohexene diepoxide
- Vinyl fluoride

Additional resources

More information from your American Cancer Society

The following related information may also be helpful to you. These materials may be viewed on our web site or ordered from our toll-free number, at 1-800-ACS-2345.

- Cancer Clusters

- Environmental and Occupational Cancer Risk Factors: Overview

International organizations and Web sites*

In addition to the American Cancer Society, other sources of information include:

International Agency for Research on Cancer (IARC)
(Centre International de Recherche sur le Cancer (CIRC))
Web site: www.iarc.fr
IARC Carcinogen Monographs: http://monographs.iarc.fr/index.php

National Toxicology Program (NTP)
Web site: http://ntp.niehs.nih.gov/
Report on Carcinogens: http://ntp.niehs.nih.gov/?objectid=72016262-BDB7-CEBA-FA60E922B18C2540

Environmental Protection Agency (EPA)
Web site: www.epa.gov
Integrated Risk Information System: http://cfpub.epa.gov/ncea/iris/index.cfm

Food and Drug Administration (FDA)
Web site: www.fda.gov
Center for Food Safety & Applied Nutrition: www.cfsan.fda.gov

National Institute for Occupational Safety and Health (NIOSH)
Web site: www.cdc.gov/niosh
NIOSH Safety and Health Topic - Cancer: www.cdc.gov/niosh/topics/cancer
NIOSH Carcinogen List: www.cdc.gov/niosh/npotocca.html

**Inclusion on this list does not imply endorsement by the American Cancer Society.*

No matter who you are we can help. Contact us anytime, day or night, for information and support. Call us at **1-800-ACS-2345** (**1-800-227-2345**) or visit www.cancer.org.

References

International Agency for Research on Cancer (IARC). Monograph: Overall Evaluations of Carcinogenicity to Humans. 2008. Available at: http://monographs.iarc.fr/ENG/Classification/crthall.php. Accessed August 27, 2008.

U.S. Department of Health and Human Services. Public Health Service, National Toxicology Program. Report on Carcinogens, Eleventh Edition. 2005. Available at: http://ntp.niehs.nih.gov/ntp/roc/toc11.html. Accessed August 27, 2008.

Last Medical Review: 10/08/2008
Last Revsied: 10/08/2008

APPENDIX G ~ ACKNOWLEDGEMENT OF RECEIPT

I, _____, have read and understand the
(Print name)

requirements of the Villanova University Chemistry Department's Chemical Hygiene Plan.

_____
(Signature)

_____
(Date)

_____
Chemical Hygiene Officer (Signature)

_____
(Date)

Please sign, date and return this sheet to your Department Chemical Hygiene Officer. If you have any questions regarding the Chemical Hygiene Plan, please contact your Department Chemical Hygiene Officer or the Environmental Health & Safety Office.

APPENDIX H ~ DEPARTMENT CHEMICAL HYGIENE OFFICERS

Chemical Hygiene Officers

Name	Phone Number	Department	Location
John Friede	7355	Biology	Mendel 143A
Lijie Zhao	3329	Civil & Environmental Engineering	CEER 311
Pritpal Singh	7378	Electrical & Computer Engineering	Tolentine 411B
Cian Watts	6348	Chemistry	Mendel 201A
Dorothy Skaf	4952	Chemical Engineering	White Hall 319
Chris Townend	4986	Mechanical Engineering	CEER 09A

APPENDIX I ~ ACRONYMS

ANSI	American National Standards Institute
CFR	Code of Federal Regulations
CHP	Chemical Hygiene Plan
CHO	Chemical Hygiene Officer
DOT	Department of Transportation
EHS	Environmental Health & Safety Office
EPA	Environmental Protection Agency
HEPA	High Efficiency Particulate Air
MSDS	Material Safety Data Sheet
NFPA	National Fire Protection Association
OSHA	Occupational Safety & Health Administration
PEL	Permissible Exposure Limit
RCRA	Resource Conservation and Recovery Act
TLV	Threshold Limit Value

APPENDIX J ~ INSTRUCTIONAL LABORATORY STUDENT SAFETY CONTRACT

Safety Contract*

Whenever I am in an area where laboratory reagents are being used, I agree to abide by the following rules

1. Wear safety goggles that have been issued and approved by the Department of Chemistry
2. Wear appropriate clothing as outlined.
3. Use good housekeeping practices (keep work area clear of clutter, etc.)
4. Do only authorized experiments, and work only when the laboratory instructor or another qualified person is present.
5. Treat laboratory reagents as if they are poisonous and corrosive
6. Dispense reagents carefully. Dispose of laboratory reagents as directed.
7. Do not eat, drink, use tobacco, chew gum, or apply cosmetic in the laboratory.
8. Report all incidents (spills, accidents, etc.) to the laboratory instructor.
9. Be familiar with the location and use of all safety equipment
10. Become familiar with each laboratory assignment before coming to the laboratory.
11. Anticipate the common hazards (electrical, chemical & physical) that may be encountered in the laboratory.
12. Become familiar with actions to be taken in the event of incidents in the laboratory.
13. Follow the Department of Chemistry's Chemical Hygiene Plan, as directed by my instructor.

I understand that I may be issued a warning (signature required) for a violation of these policies and that repeat violations will result in dismissal from the lab for the period with an unexceused absence (grade of 0) recorded for that period. The Laboratory Absence Policy will apply in these cases.

Print Student Name _____ Course & Section _____

Student Signature _____ date _____

Laboratory Instructor _____ date _____

*Modified from Rapp, M.W. Practicing Safety in the Organic Chemistry Laboratory; Chemical Education Resources: Palmyra, PA 1997.
Rev. 05/07/12