CONNECTICUT COLLEGE

LABORATORY SAFETY HANDBOOK

(Chemical Hygiene Plan)

Revised: 02/2012

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(Chemical Hygiene Plan)

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Preface

The Connecticut College Laboratory Safety Handbook establishes policies and procedures to protect members of the Connecticut College Community from laboratory hazards and to comply with regulatory Standards.

The Handbook references the requirements of a number of federal and state regulations including the Occupational Safety and Health Administration (OSHA) Standard 29 CFR 1910.1450: *Occupational Exposure to Hazardous Chemicals in Laboratories,* and the Connecticut Department of Environmental Protection, Radiation Division.

While the OSHA Standard applies only to employees of the College, the same standards of protection are established for students and other members of the campus community.

Given the diversity of laboratory operations, this Handbook does not include specific information regarding every potential laboratory hazards that may be encountered. Faculty members are relied upon to use their best judgment in identifying and controlling hazards in the laboratory.

Questions regarding the Handbook should be addressed to the Director of Environmental Health and Safety.

Availability of the Laboratory Safety Handbook

The official version of this Lab Safety Handbook is maintained on the Office of Environmental Health and Safety web site at:
http://www.conncoll.edu/offices/ehs/5957.htm.

A printed copy is available in each Department and program office, and to faculty and staff upon request.

SECTION I – LABORATORY SAFETY PROGRAM OBJECTIVES AND RESPONSIBILITIES

1. Objectives

Connecticut College is committed to protecting the health and safety of its employees, students, and visitors, and to provide a safe environment in which students may learn to be responsible, creative and effective scientists. This commitment includes fulfillment of the College's responsibilities under the Occupational Health and Safety Act of 1970, namely to:

- *furnish to each employee a place of employment that is free from recognized hazards that are causing or are likely to cause death or serious physical harm to its employees;*

- *comply with occupational safety and health standards and all rules, regulation, and orders issued pursuant to the Act that are applicable to its own actions and conduct.*

The Laboratory Safety Handbook has been developed to comply with the OSHA Laboratory Standard[1] and other standards applicable to laboratories, including the American National Standards Institute (ANSI), the American Industrial Hygiene Association (AIHA), and the National Fire Protection (NFPA).

While the OSHA Standard applies only to employees of the College, the same standards of protection are established for students and other members of the Community. Additional safety requirements may be established by Departments, Programs and individual faculty members to ensure the health and safety of the students and staff under their supervision.

This handbook is applicable to all science departments and programs at Connecticut College where laboratory work is performed, including Chemistry/Biochemistry, Biology, Botany, Environmental Studies, Physics, Astronomy, and Neuroscience. The term Department will be used throughout the Handbook to refer to Departments and Programs.

2. Responsibilities

2.1. Director of Environmental Health and Safety

The Director of Environmental Health and Safety serves as the Chemical Hygiene Officer. (Both titles are used interchangeably in this handbook.) The Director of EH&S is responsible for:

- Identifies requirements for new or revised policies and procedures, and works with

the Laboratory Safety Committee developing or revising policies and procedures.
- Maintaining the Laboratory Safety Handbook. Reviews the Handbook annually, and makes appropriate revisions in consultation with the Laboratory Safety Committee.
- Serves as the Chemical Hygiene Officer as defined by the OSHA laboratory standard.
- Determines which activities are encompassed by the OSHA definition of "laboratory use of hazardous chemicals"
- Conducts periodic laboratory compliance reviews.
- Conducts exposure monitoring.
- Provides chemical safety training for all laboratory employees (faculty, staff, and student employees) and support staff (e.g., custodians).
- Assists faculty members in establishing safety procedures for individual laboratories.
- Additional duties with regard to implementation of specific requirements are described throughout the Handbook.

2.2. Faculty

Faculty is responsible for:

- Maintaining an accurate and up-to-date Chemical Inventory of chemicals in their possession.
- Following the policies and procedures of this Safety Handbook in their laboratories.
- Acquiring information needed to recognize and control hazards in the laboratory.
- Utilizing laboratory practices that reduce the risk of injury or chemical, biological, or radiation exposures.
- Informing staff, students or visitors under their supervision, of the specific hazards and required safety procedures associated with the work being performed (Including review of applicable Material Safety Data Sheets).
- Responding immediately to injuries or other emergencies in areas under their supervision.
- Reporting any unsafe conditions that cannot be immediately remedied.
- Attending safety training;
- Ensuring that students and employees under their supervision complete a chemical safety-training course provided by the Office of Environmental Health and Safety.
- Ensuring that all radiation users in their laboratory receive Radiation Safety Training, prior to beginning RAM work.
- Providing required information to all staff and students under their supervision who are exposed to formaldehyde as described in Chapter V(m);
- Establishing guidelines for their laboratory which describe what laboratory procedures require their prior approval, and
- Providing health and safety information requested by the Director of Environmental Health and Safety, Radiation Safety Officer, or Laboratory Safety Committee.

2.3. Laboratory Safety Committee

The Laboratory Safety Committee consists of a representative of each of the departments and programs covered by the Safety Handbook, and the Director of Environmental Health & Safety
The department or program chair designates a representative each year. The Committee meets at least once a semester. The Science Safety Committee is responsible for:

- Reviewing policies and procedures necessary to achieve the safety objectives of the Laboratory Safety Handbook for all Lab safety issues (with the exception of radiation safety and animal use).
- Acting as a liaison with their respective departments and programs in the review and implementation of those policies and procedures.
- Reviewing accident reports submitted.
- Bringing to the Laboratory Safety Committee, any safety concerns raised within their department or program.

2.4. Staff and Student Employees

Staff members and student employees are responsible for:

- Knowing and complying with the policies and procedures of this Safety Handbook and other health and safety policies or procedures established by the Department or supervising faculty member.
- Reporting all accidents, chemical spills, and unsafe conditions to the supervising faculty member.
- Attending health and safety training at the request of the supervising faculty member.
- Working in a safe and responsible manner in the laboratory.
- Performing all work in accordance with the procedures established by the Department and supervising faculty member.
- Wearing required protective equipment (e.g., goggles).
- Following established emergency procedures in the event of an accident or chemical spill.

SECTION II – OSHA LABORATORY STANDARD

OSHA Regulations, 29 CFR 1910.1450, titled “Occupational Exposure to Hazardous Chemicals in Laboratories”, also known as the "Chemical Hygiene Standard, are the regulations that govern safety in laboratories, including the requirements for the safe handling of hazardous laboratory chemicals. All procedures and policies found in this Chemical Hygiene Plan are taken directly from these regulations.

The OSHA Laboratory Standard defines a "hazardous chemical" as one that exhibits physical or health hazards as follows.

> ***"Physical Hazard"*** *- a chemical for which there is scientifically valid evidence that it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, unstable (reactive) or water reactive.*
>
> ***"Health Hazard"*** *- 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...includes ...carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic (blood) system, and agents which damage the lung, skin, eyes, or mucous membranes.*

The term "chemical" is used interchangeably with "hazardous chemical" throughout this manual. Both refer to those chemicals defined as hazardous by OSHA as described above.

The attitude of those working in the laboratory is the most important factor in the safe conduct of laboratory experiments. All stages of an investigation, from design through completion, must consider safety as a guiding principle. The key to designing and carrying out safe laboratory experiments is knowledge of the potential hazards. It is the responsibility of each individual working in the laboratory to become thoroughly familiar with the hazards of the chemicals he/she is using and operations he/she is performing.

This manual discusses general safety guidelines, including use of personal protective equipment, chemical storage, and guidelines for specific chemical hazard categories. Departments or faculty members to may establish additional requirements to address hazards specific to their operations.

SECTION III – GENERAL LABORATORY POLICIES

These policies apply to laboratory work in New London Hall, Hale Laboratory, Olin Science Center, and Bill Hall. Departments or individual faculty members may establish more restrictive policies for spaces under their control.

1. Working Alone and After Hours

Working in laboratories from 9 pm to 7 am is defined as working "after hours". Working in laboratories at all other times is defined as working "during regular hours". Working between midnight and 7 am requires special authorization by the faculty member.

There are no restrictions on the use of laboratories by science faculty, research associates, technicians, or technical staff. They are expected to avoid working alone whenever possible and to use good judgment about performing hazardous procedures when working alone. This in no way implies that other safety requirements are waived; on the contrary, the use of good judgment implies expert knowledge of safe procedures and practices.

Students enrolled in course laboratory sections are not allowed to perform laboratory procedures alone or unsupervised after hours under any circumstances. When working in the laboratory during regular building hours, they must be accompanied by a qualified person; a member of the Connecticut College community who is familiar with emergency procedures and who is aware that s/he is serving in the "buddy" capacity. Properly accompanied students can work in a course laboratory outside of the regular laboratory periods but during regular hours only with the permission of the instructor, who is responsible for ensuring that the students receive sufficient instruction to work safely under the contemplated circumstances.

1.1. Student Independent Research Work

A student may use laboratory facilities for independent research only after the supervising faculty member has reviewed the experimental procedure and any associated hazards, and has determined that the student possesses adequate training in proper experimental and emergency procedures. Students are responsible for performing all their work in accordance with those procedures. They must report all accidents, chemical spills, and unsafe conditions to the supervising faculty member. Students working with chemicals must also satisfactorily complete chemical safety training provided by the Office of Environmental Health & Safety.

Students must have written permission from the supervising faculty member prior to working after hours in a laboratory. Students must complete a copy of **Appendix A,**

"**Permission to Work Independently" form.** If the after hours work involves the use of chemicals, the permission form must also indicate that chemical safety training has been successfully completed.

The permission form must be signed by the responsible faculty member, and kept on file in the department or program office. A copy of the completed form must also be posted in the laboratory, to be available for Campus Safety.

A qualified person, either in the laboratory, or within speaking distance must accompany students working in research laboratories after hours. Campus Safety will require a student to leave the building after hours if the student is working alone or if the student does not have a completed "Permission to Work Independently" form in the laboratory. Independent work students who are conducting laboratory procedures during regular building hours are encouraged to work with a qualified person nearby.

Student laboratory work between midnight and 7 am should only be authorized when the experimental procedure requires that work be done during that time frame. This permission must be noted in the "Hours access is allowed" section of the "Permission to Work Independently" form. A qualified person must accompany authorized students.

2. Pets in Laboratories

Pets are not allowed in chemical, radiation, or biological hazard laboratories anytime.

3. Children in Laboratories

Because of the hazards and the potential for accidents, children under the age 16 are not allowed in laboratories.

4. Personal Hygiene

Good personal hygiene practices are essential to minimize chemical exposure and potential injury from other hazardous conditions in the laboratory such as broken glass.

- The storage or consumption of food or beverages, application of make-up, and smoking are prohibited in all laboratories and chemical storage areas.
- Avoid "routine" exposures. Do not smell, taste, or mouth pipette any chemicals.
- Always wash hands immediately upon contamination, after handling chemicals and before leaving the laboratory.
- Long hair and loose clothing must be confined.

- Wash contaminated clothing or lab coats separate from other clothing. [1]

5. Housekeeping

Keeping the laboratory work area organized and clean is essential to safe handling of chemicals. Only the equipment and chemicals necessary for the particular procedure being performed should be kept in the work area. This is particularly important when working in a fume hood, as storage of numerous containers or pieces of equipment can severely diminish the effectiveness of the hood. If several people are working in the same laboratory, requirements for space and hood access should be discussed and designated work areas agreed upon. This reduces the risk of collision and the resulting chemical spills.

Floors and surfaces should be kept clean, and spills cleaned up immediately as described in Section V. The entire work area should be cleaned and re-organized at the end of each day.

6. Chemical Purchasing, Receipt, Transport and Shipping

Since Connecticut College does not have a centralized chemical purchasing and receipt capability, each faculty member purchases chemicals independently. Therefore, it is incumbent upon the ordering individual to ensure that proper receipt procedures are followed.

Federal law requires that security of hazardous materials be maintained at all times. To prevent access by unauthorized individuals, chemical deliveries by FEDEX or UPS must be:

- Taken directly to the ordering faculty member's lab, or
- Locked in the department Administrative Office, or
- Locked in the Chemical Stock Room, or a "Chemical Receipt" storage cabinet.

6.1. Chemicals Requiring Approval Prior to Purchase

There are two categories of chemical purchases that require approval prior to purchase:

- Chemicals subject to Department of Homeland Security (DHS) reporting as "Chemicals of Interest'" (COI) that have thresholds at or below 15 pounds. (**Appendix B)**.
- Acute toxins as defined in Section VII (1.1.), (**Appendices C-(1)** and **C-(2)**, "Examples of Acute Toxins".

[1] A washing machine designated for washing lab coats available in Bill Hall, Room 315. The door can be unlocked with the "109" key issued to all faculty.

If you need to order an Acute Toxin or COI, send an email to the Chemical Hygiene Officer (with a copy to the department chair) with the following information:

- Name of the chemical
- CAS#
- Vendor and catalog #
- Amount to be purchased
- Storage location
- Brief description of use
- Date when material is needed

Note that many chemicals appear on both the DHS and Acute Toxin lists. Be sure to check both lists before ordering.

If approval to purchase the chemical is granted, an Acute Toxin Protocol (**Appendix F**) must be submitted as described in Section III (1.1.).

7. Transporting Chemicals between Laboratories

A bottle carrier or cart must be used when moving any quantity of an acute toxin, and 1 liter or greater sized containers of flammables or concentrated acids or bases from the stockroom to the laboratory, or between laboratories. The use of a bottle carrier or cart is recommended when moving other chemicals from the stockroom to the laboratory and between laboratories.

When moving chemicals between floors, utilize the elevator instead of the stairs. This minimizes the risk of accidents.

8. Shipping Hazardous Materials Off-Campus

Shipments of hazardous materials (e.g., chemicals, biological or radiological materials) from Connecticut College to other locations, must comply with all Department of Transportation (DOT) and International Air Transport Association (IATA) requirements. The Chemical Hygiene Officer can provide assistance in regulatory compliance.

9. Chemical Inventory

Newly received chemicals must be entered into the "CEMS" (Chemical Environmental Management System) Inventory. Bar code labels should be affixed to containers at the time of initial receipt into the laboratory or department inventory.

It is vital that faculty keep their Chemical Inventory current and up to date. In the event of a laboratory fire or other emergency, responding Fire Department personnel will require a detailed inventory of chemicals stored in the affected laboratory. Campus Safety can access the CEMS inventory system from a computer in the Gatehouse, and quickly provide the fire department with the needed information.

To enter a new container:

- Log in to the CEMS Chemical Inventory: http://cems.conncoll.edu.
- Click on "Add Inventory."
- Enter the chemical's product or catalog number, then click "Find Matches." Alternately, enter the CAS (Chemical Abstracts Service) number in the appropriate box.
- Find the appropriate chemical from the drop-down box. The remainder of the boxes on this page should "auto-populate." If it does not, find the information from the drop-down boxes.
- The "Is Hidden" box should always be "no."
- Check the remainder of the boxes for accuracy. Adjust the "Container Type" if necessary.
- **Important:** Double-check the "Quantity" box for accuracy. The system automatically keeps track of the quantity of "Chemicals of Interest"(COI) on campus, as required by the Department of Homeland Security (DHS).
- In the "Memo" box, enter the location within the laboratory where the chemical is stored (e.g., "Refrigerator, Shelf 1", or "Cabinet 3, Shelf 2",)
- Select the "Owner" from the drop-down box.
- Select the laboratory from the "Location" drop-down box.
- Enter the Barcode number.
- Click "Save Container."
- When a chemical container is emptied, it must be removed from the CEMS Chemical Inventory System

To remove an empty container from the inventory, update container location or to change container owner:

- Log in.
- Click "Update Inventory" at the top of the page.
- Enter the barcode number(s) of the containers to be updated, and click "next."
- Make the appropriate changes.

You can also delete individual containers from the "Search Inventory" page.

Note: If an empty container is to be reused for waste collection, the bar code label must be removed, and the manufacturers label defaced or removed.

Assistance with the Chemical Inventory is available from the Chemical Hygiene Officer.

10. Chemical Storage

Storage of chemicals is an important aspect of chemical safety. Chemicals should always be segregated into compatible groups during storage to prevent dangerous reactions in the event of an accident. Storage areas and shelves should be clearly labeled as to their appropriate hazard class.

Appendix G is a chemical storage scheme taken from the Coast Guard's *CHRIS Hazardous Chemical Data,* which shows chemicals broken into a storage plan based on 24 segregated groups. **Appendix H** is a table of examples of incompatible chemicals. Storage precautions for specific high hazard chemicals are found in Section VII.

10.1. Chemical Storage Areas

Chemical storage areas should be isolated from working areas whenever possible. Exposure to heat or sunlight should be avoided; and storage areas for volatile chemicals should be ventilated when feasible. Bench tops should not be used for storage, and hazardous chemicals should not be stored on shelves between bench tops. Shelving should be sturdy and firmly anchored.

Storage in fume hoods severely reduces effective ventilation, and is prohibited in hoods that are used for chemical handling. Hoods used to store noxious or acutely hazardous materials should be designated exclusively for storage.

All chemicals stored in hoods, on counters with a sink, or in any other area where a spill could reach a drain must be stored in secondary containment. Secondary containment must provide for separation of chemicals that are incompatible. Chemicals should not be stored on the floor with the exception of 5-gallon pails in secondary containment, or in containment in areas well protected from foot traffic. Trays for use as secondary containment are available from the Chemical Hygiene Officer.

10.2. Periodic Evaluation of Chemical Containers

Faculty and departments should periodically review the chemicals stored in their laboratories and chemical storage areas. The review should answer the following questions:

Is the chemical still in use? - If the answer is yes…

- Check the original manufacturer's label to verify that it is in good condition and legible.

- If in a secondary container (contents transferred from an original container), verify that the container is labeled properly – At a minimum, the chemical name, and the hazard(s) if >1L.
- Verify that the container remains in good condition (no rust, discoloration, disfigurement, contamination on the exterior etc.)
- Verify that the container is correctly stored, and not with incompatible chemicals.

If the answer is no (the chemical is no longer being used)…

Is the chemical still useable? – If the answer is no, (due to age, contamination, deterioration etc.)…

- Designate as waste. Perform a "Waste Determination" (required by RCRA), by way of laboratory testing , checking to see if it is listed in 40 CFR, or by knowledge of the material to quantify the hazard.
- Affix a properly completed "Hazardous Waste" label (as described in Section X).

If the answer is yes (chemical is still usable)…

Will I use the chemical in this laboratory in the future? - If the answer is no…

- Transfer the chemical to the Chemical Stockroom for use by others.
- If the chemical is not in the original manufacturer labeled container, then the hazards must be determined (a hazardous waste determination is required by RCRA), and the chemical labeled and managed as waste.

11. Bulk Ethyl Alcohol

Because ethanol is purchased under a license issued by the Bureau of Alcohol, Tobacco and Firearms, the Director of Environmental Health and Safety (Chemical Hygiene Officer) maintains custody of the bulk stock of ethyl alcohol. Ethanol is released to individual faculty members upon request.

12. Unattended Operations

Whenever possible, avoid leaving hazardous laboratory operations unattended. When it is necessary to leave an experiment unattended, provide for containment of hazardous chemicals in the event of equipment failure. In additional, leave the lights on and place a warning sign on the door with a brief description of the unattended process, and the potential hazards.

13. Reporting of Unsafe Conditions

All laboratory workers should be alert to unsafe conditions, and take necessary actions to prevent injury (e.g., alerting others and evacuating the lab, turning off faulty equipment, and/or posting signs, etc.).

If an unsafe condition is noted that cannot be immediately remedied, it should be reported to the responsible faculty member, the Department Chair, and/or the Chemical Hygiene Officer.

SECTION IV - EMERGENCY PLANNING

Effective emergency response requires pre-emergency planning. It is the responsibility of each faculty member to evaluate the hazards of the experiments being performed, to determine appropriate emergency procedures, and to make all employees and students aware of those procedures. A list of emergency telephone numbers is included on the first page of this document.

1. Laboratory Doors

Laboratory door windows (to the hallway) should not be covered unless necessary to block light for an experimental procedure. Once the experiment is completed, the covering must be removed. An important safety factor is the ability to see into a lab during an emergency.

Laboratory doors must be kept closed at all times to help maintain negative air pressure in fume hoods, and to prevent the spread of smoke and flames in the event of a fire.

2. Laboratory Ventilation

Work must be halted in laboratories and other areas where chemicals are used or stored whenever the ventilation in the room is not working.

The required face velocity of laboratory fume hoods is a minimum of 100 CFM. The Chemical Hygiene Officer will check the face velocity and certify all hoods on an annual basis. Laboratory workers should ensure that their fume hoods are working at the beginning of the day by means of the "tissue test". Open the sash to the normal working height of 15 inches, and hold a tissue or "kimwipe" in the opening, to see if there is adequate air intake.

If the laboratory loses power, or the fume hood isn't working properly, close the sash and place an "out of order" sign on it and submit a work order with Physical Plant for repairs. Notify the Chemical Hygiene Officer, who will test the face velocity and re-certify the hood after repairs.

3. Emergency Equipment

Easy access to emergency equipment is essential to quick response. Emergency equipment (e.g., fire extinguishers, eyewash stations, drench showers) should never be blocked. Faculty, with the assistance of the Chemical Hygiene Officer, should determine the appropriate extinguishers for their laboratories (see Section IV(3.3.) below). Aisle space must also be maintained to ensure that the equipment can be reached. A quick check should be made of the

laboratory each time it is entered to ensure that emergency equipment is accessible. Any obstructions should be removed immediately. If any equipment is missing or damaged, it should be reported immediately to the Department Chair or Office, or the Director of Environmental Health & Safety.

In laboratory courses, the instructor must demonstrate the use of fire extinguishers, safety showers, and eyewash stations at the beginning of each semester. Activation of the safety equipment is not required during demonstration. To assist with this instruction, a YouTube video on how to use a fire extinguisher is linked from the EH&S website at: http://www.conncoll.edu/offices/ehs/5955.htm

3.1. Spill Control Supplies

Specific spill response procedures are outlined in Section V(3.1.). Spill control supplies for use in cleaning up spills that can be controlled by laboratory personnel are located on top of the Hazardous Waste Cabinet, in the 180-Day Waste Storage Area, in Bill Hall, New London Hall and Hale Laboratory. There are two spill kits in Olin Science Center; one for the Chemistry Department, stored in the Prep Room, Room 320, and the other for the Botany and Biology labs, stored in the Chemical Storage Room, Room 322.

The spill kits contain:

- Nitrile gloves
- Tyvek protective suits
- Chemical splash goggles
- Vapor barrier absorbent pads
- Acid, base and solvent neutralizer (Ampho-Mag™)
- 1-gallon Ziploc bags and a plastic pail for waste disposal.
- pH paper
- Absorbent "Kitty Litter"

Please notify the Chemical Hygiene Officer when supplies are used, so they can be replaced.

Note: Mercury spills require specific clean-up and reporting procedures. In the event of a mercury spill, leave the fume hood sash open, secure the room ventilation, evacuate the lab and contact the Chemical Hygiene Officer. See Section V(3.3) for further information.

3.2. Eyewash and Deluge Shower Units

All laboratories are equipped with eyewash stations**. Laboratory faculty and staff are responsible for flushing eyewash stations** in their laboratories, on a weekly basis for at least three minutes.

Laboratories in Hale Lab, Olin Science Center and Bill Hall are equipped with deluge showers. Deluge showers for New London Hall are located in the hallway outside the laboratories. Physical Plant tests and flushes emergency showers twice a year.

The faculty member will provide instruction in the proper use of eyewash stations and emergency showers at the beginning of the semester in all laboratory courses.

3.3. Fire Extinguishers

Each faculty member should review the hazards in his/her laboratory on an ongoing basis to determine if the fire extinguisher(s) present are appropriate. If additional or different class extinguishers are needed, the faculty member should contact Physical Plant.

3.3.1. Classes of Fire Extinguishers

Class A - wood, cloth, paper, rubber, and plastics.
Class B - flammable liquids, oils, greases, tars, oil-base paints, and flammable gases.
Class C - energized electrical equipment.
Class D - combustible metals such as magnesium, titanium, zirconium, sodium, lithium, and potassium.

Physical Plant hires a contractor to perform annual extinguisher maintenance and hydrostatic testing, in accordance with OSHA 29 CFR 1910.157. The inspection verifies that the fire extinguisher:

- Is located in its designated place,
- Is not obstructed in access or visibility,
- Has visible operating instructions and nameplate,
- Has unbroken seals,
- Indicates pressure is in the operable range, and
- Has no physical damage, corrosion or leakage.

At the beginning of each laboratory course, the instructor should demonstrate how to use a fire extinguisher.[2]

If extinguishers are to be discharged during the demonstration, a separate extinguisher should be requested from Physical Plant. The extinguisher stationed in the hall should not be used. The Chemical Hygiene Officer can also provide a electronic extinguisher training system, provided adequate notice is given.

[2] A YouTube video demonstrating the proper procedures for using a fire extinguisher can be found on the EH&S web page at: http://www.conncoll.edu/offices/ehs/5955.htm.

General Purpose Class ABC fire extinguishers are located outside of laboratories in the hallways of all science buildings. Faculty and staff should familiarize themselves with the location of the nearest extinguisher.

In the Chemistry Department, there is a Class D extinguisher on a portable cart for extinguishing combustible or flammable metal fires, such as magnesium, potassium, sodium titanium, and alkyllithiums. Type D fires burn at high temperatures, and these metals will react violently with water, air, and/or other chemicals. Type D fire extinguishers work by simply smothering the fire with powdered copper metal or sodium chloride (NaCl).

If combustible metals are being used, the responsible PI should insure that this extinguisher is in close proximity to his or her lab.

Important Note: Only attempt to fight a fire if it can be done safely. That is, only if the fire is small in size, and can be fought with an escape route available. Also, only after the fire alarm has been pulled and the room/building is being evacuated. See Section V(5) for emergency procedures for fire.[3]

3.4. Emergency Gas Shut-Offs

Laboratories in Olin Science Center and New London Hall are equipped with emergency gas shutoffs located on the wall next to the door. In the event of a fire in the laboratory, the faculty member or instructor should immediately shut off the gas in the room by pressing the button.

Laboratories in Hale Laboratory and Bill Hall are not equipped with emergency gas shut-offs. If a fire occurs in these buildings, faculty and instructors should attempt to shut off the gas at the bench if it can be done safely. But in all cases, the fire alarm should be pulled immediately and the building evacuated.

3.5. First Aid Kits

First aid kits are maintained by the Laboratory Supervisor or PI, and stored in the laboratory. These kits should be used to treat minor injuries. But again, ALL injuries, regardless of type and severity must be reported to the Occupational Health Manager or Student Health Services.

3.6. Oxygen Sensors in Cryogen Use and Storage Areas

This section intentionally left blank.

[3] A YouTube video demonstrating the proper procedures for using a fire extinguisher can be found on the EH&S web page at: http://www.conncoll.edu/offices/ehs/5955.htm.

3.7. Emergency Communication

Emergency fire alarm pull boxes are located in all hallways. These boxes sound an alarm throughout the building signaling evacuation, and directly alerting Campus Safety. The emergency number, 111, should also be called from a telephone a safe distance from the emergency to provide Campus Safety with details.

Campus telephones are located either in the lab, or in the hall outside the lab.

An Emergency Contact Card providing emergency contact information, as well as graphical pictograms indicating the hazards inside, is posted at the entrance to every laboratory. Departments are responsible for notifying the Director of EH&S of any changes (new hazards, new faculty, phone numbers, etc.).

Campus Safety maintains a list of emergency contact information for critical locations including all areas with alarmed equipment. Campus Safety updates this information annually.

At the beginning of each semester instructors should inform students of the location of emergency alarm boxes and telephones, and that immediate evacuation is mandatory upon hearing the alarm.

SECTION V - EMERGENCY PROCEDURES

1. Basic Emergency Response

The first priority in emergency response is the protection of life and health. The following four basic steps apply to all emergency situations. Additional procedures for specific situations follow.

- Make sure everyone in the immediate vicinity is aware of the problem.
- Contain the emergency if it can be done safely.
- Pull the alarm to evacuate the building if the emergency cannot be contained, or there is any doubt as to the severity of the situation.
- Summon assistance – Call Campus Safety by dialing 111 for all emergencies.

2. Building Evacuation

In the event of a building evacuation, the each faculty member will make every effort to ensure that students and laboratory employees under his/her responsibility are accounted for. Missing individuals will be reported to Campus Safety, or the senior fire department official.

2.1. Designated Assembly Areas

The Designated Assembly Areas for evacuations for the various science buildings are:

- Hale Laboratory - Lawn area, south of Olin Science Center. (Near Gatehouse)
- Olin Science Center - Lawn area, south of Olin Science Center. (Near Gatehouse)
- New London Hall – Temple Green, west of building.
- Bill Hall – College Green – west of building.

2.2. Persons with Special Needs

At the beginning of the semester, faculty should discuss laboratory and building evacuation procedures with any mobility-impaired persons, to determine their needs for assistance.

3. Chemical Spills

Faculty should evaluate the hazards and quantities of the chemicals in use in their laboratories to determine what level of response would be required in the event of a chemical release. Particular attention should be devoted to procedures for releases of substances

defined as “Particularly Hazardous Substances”, Section VII(1), and “Reactive” chemicals, Section VII(3).

Employees and students must be informed of any emergency that would require immediate evacuation of the room or building. The Chemical Hygiene Officer can provide assistance in evaluating specific hazards and appropriate emergency response procedures upon request.

Spills are classified into two categories: ***Emergencies*** or ***Incidents.***

An **emergency** is any occurrence that may require a response effort by individuals from outside the College (i.e., the Fire Department or a chemical spill clean-up contractor). Examples of emergency spills include:

- Releases that pose, or has the potential to pose, conditions that are Immediately Dangerous to Life and Health (IDLH)
- Releases that pose a serious threat of fire or explosion
- Releases that may result in exposure to “Acutely Toxic” substances
- Situations where there is uncertainty whether those working in the area can safety handle the hazard
- The situation is unclear, or data is lacking on important factors

An **incident** usually involves the release of hazardous materials in a situation where (1) the substance can be absorbed, neutralized, or otherwise controlled at the time of release by properly trained and equipped laboratory personnel, or (2) a release where there is no potential safety or health hazard.

The Chemical Hygiene Officer can provide assistance in evaluating specific hazards and appropriate emergency response procedures. EH&S should be notified of all incidents, regardless of severity.

While most chemical releases in the laboratory are incidental releases (as described above) and can be cleaned with minimal risk by laboratory personnel with vapors controlled by laboratory ventilation, some releases can pose serious fire or health hazards to lab personnel and building occupants. The following procedures for notification and spill cleanup should be followed to ensure the safety of all building occupants, and minimize potential property damage.

3.1. Spill Procedures

- Make everyone in the laboratory aware of the release and instruct them to stay away from the area, or, if there is a fire or health threat, to evacuate the laboratory.

- Notify the Chemical Hygiene Officer of any and all spills. The Chemical Hygiene Officer and the responsible faculty member will jointly evaluate the situation, and determine if the spill is an incidental release, or requires an emergency response.
- **If there is a threat of fire, or an immediate or significant health hazard, immediately pull the fire alarm to evacuate the building. This will automatically alert Campus Safety and the Fire Department.** If the release is not confined to the laboratory in which it occurs (e.g., vapor release to the hallway), or there is any doubt regarding a potential fire or health threat, pull the fire alarm to evacuate the building.
- If the release is determined to be an incidental release, the responsible faculty member will proceed and cleanup the spill.
- If the release is determined to be a bone fide **emergency** (as described above), immediate assistance from the New London Fire Department and/or the designated Spill Response Contractor (Clean Harbors Environmental) will be requested.
- If the release occurs after hours, and/or the Chemical Hygiene Officer is not available, the responsible faculty member will classify the spill him/herself and take appropriate action.
- If the building fire alarm is activated, or if instructed by Campus Safety or fire department officials, all building occupants will immediately evacuate the building. Occupants may not reenter the building until authorized by the fire department or Campus Safety.

Again, if there is any doubt regarding the potential fire or health threat, evacuate the building until the potential hazard can be assessed.

3.2. Spill Cleanup

If the release is determined to be an **incidental r**elease, spill cleanup response should be done under the immediate supervision of the faculty member responsible for the laboratory, or another qualified faculty or staff member.

- Assign specific tasks and keep everyone else away from the area.
- Obtain the supplies and equipment needed. (Spill kits are stored on top of the 180-Day Hazardous Waste Storage Cabinets.)
- Review the Material Safety Data Sheet (MSDS) for the chemical. (MSDS' for laboratory chemicals can be found online at http://cems.conncoll.edu)
- Don appropriate PPE (Personal Protective Equipment). The minimum level of protective equipment is:
    - Lab coat
    - Chemical splash goggles
    - Nitrile or other chemical resistant gloves (do not use disposable latex gloves)
- Contain the spilled material to as small an area as possible.
- Clean up the spilled material using absorbent, neutralizers, etc.. Only use neutralizers if you have been specifically trained in proper application techniques.

- Collect all spilled material and contaminated material for proper disposal as Hazardous Waste (See Section X).

Again, if the spill is determined to be an emergency, Campus Safety (or the Chemical Hygiene Officer) will contact outside resources for assistance as described above.

3.3. Mercury Spills

Metallic mercury is toxic by skin absorption, inhalation and ingestion. Exposure to low concentrations of vapor is harmful, especially to young children and unborn babies because their nervous systems are still developing, and the nervous system is a target organ for mercury, and could result in brain damage, behavioral and developmental problems.

There are two levels of response, depending upon the quantity of mercury spilled:

- **Small Spills:** Less than or equal to the amount in a thermometer. Cleaned by the Chemical Hygiene Officer (Director of EH&S), or qualified alternate.

- **Medium Spills:** More than the amount in a thermometer, but less than one pound (2 tablespoons) or **Large Spills** (greater than one pound (2 tablespoons)) will be remediated by a licensed HAZMAT spill response contractor.

Because particular care is required to ensure that the area is properly decontaminated, and because there are specific regulatory reporting requirements, the Chemical Hygiene Officer will clean all (small; e.g., broken thermometer) mercury spills.

In the event of a **SMALL** mercury spill, the responsible faculty member, while awaiting the arrival of the Chemical Hygiene Officer, should take the following immediate action:

- Provide maximum ventilation in the contaminated area.
- If the mercury is spilled in an oven or other heated device, turn off the unit, and evacuate unnecessary personnel from the laboratory.
- Avoid contamination of shoes or other items in the area.
- Never sweep with a broom, as this breaks up the droplets and results in increased vaporization.
- Try to push pools of mercury together.

If the Chemical Hygiene Officer is not immediately available, and the spill is the amount found in a thermometer or less, the responsible faculty should:

- Vacuum the pools and droplets of mercury with a mercury pump, found in the spill kit located in the 180-Day Storage Areas in Hale Laboratory and New London Hall.
- Transfer the mercury into a jar with a bottle or jar with a tight fitting screw top.

- Use "mercury clean-up powder" from the Mercury Spill Kit, to form an amalgam of the residual that can then be picked up.
- Report the spill to the Chemical Hygiene Officer, who will follow up to ensure the spill was properly remediated, and make the appropriate regulatory reports.

As described in Section X, mercury, and mercury clean-up debris must be disposed of as hazardous waste. This includes mercury-contaminated debris, such as empty mercury containers or columns.

In the event of a **MEDIUM or LARGE** mercury spill, leave the fume hood on and evacuate the room. Immediately contact Physical Plant to secure the building ventilation. The Chemical Hygiene Officer will request assistance from the spill response contractor.

3.3.1. Mercury Reduction

Connecticut College is committed to reducing the amount of mercury used and stored on campus. By reducing the amount of mercury containing equipment, particularly in science laboratories, we can substantially reduce or eliminate the risk of spills.

- Wherever possible, substitute non-mercury temperature measuring devices in teaching and research laboratories, e.g., alcohol or digital thermometers.
- Wherever possible, specify the use of non-mercury devices for measuring pressure, etc.
- Wherever possible, identify mercury devices or mercury metal that is no longer needed. If unused or unneeded, designate mercury-containing devices for disposal (recycling), rather than storage.
- Procure mercury in the smallest quantities available which meet the maximum usage requirements. It is more economical for Connecticut College to repurchase additional quantities of mercury when needed than to declare excess quantities of mercury for disposal.
- Wherever possible, eliminate the use of mercury measuring devices, wetted switches and relays.

4. Loss of Power

In the event of power loss, all operations that could result in the release hazardous vapors, or result in hazardous chemical reactions should be immediately halted**. Do not continue to work in inoperable fume hoods.**

5. Fire

Removing the source of ignition, or smothering the flames in a vessel by covering with a watch glass or beaker can control many small laboratory fires. If the fire does not involve chemicals, simply dousing with water may be appropriate.

If your clothing is on fire, drop to the floor and roll, or use the deluge shower to extinguish the flames.

- Close the sash if the fire is in a fume hood.
- Pull the alarm to initiate building evacuation and to notify Campus Safety of the Emergency.
- Decide if the fire can be safely fought with a fire extinguisher based on the guidelines listed below.
- Assist Campus Safety and the fire department by providing them with information on the exact location of the fire, and any other pertinent information, such as the location of emergency gas shutoffs and known hazards.

Upon hearing the fire alarm, laboratory and building occupants should:

- Shut off ignition sources, close laboratory doors when everyone is out, and immediately exit the building using the nearest exit.
- Everyone present in the building at the time of the alarm should assemble in class groups outside the building at the "Designated Assembly Area."
- Faculty members should confirm that all students in their classes are outside.
- No one should leave the area unless specifically told to by Campus Safety.

Note: It is extremely important that faculty keep their Chemical Inventory current and up to date. In the event of a fire, responding Fire Department personnel will require a detailed inventory of chemicals stored in the affected laboratory. Campus Safety can access the CEMS inventory system from a computer in the Gatehouse, and quickly provide the fire department with the needed information.

5.1. Using Fire Extinguishers

Fire extinguishers are in the staged in the hallways, and are intended to extinguish small, incipient fires, and more importantly, to assist in the evacuation of laboratory occupants. They should be used to fight a fire only if **ALL** the following are true.

- Someone has been sent to pull the alarm for evacuation and to call Campus Safety at extension 111.

- The fire is small and confined to the immediate area where it started (e.g., in a wastebasket).
- There are no flammable chemicals or other combustible materials near the fire area.
- You can fight the fire while maintaining a safe escape route.
- You have had training in the use of the extinguisher and are confident that you can operate it effectively. (Use the P.A.S.S. SYSTEM).[4]
    - **PULL** the Pin.
    - **AIM** at the base of the fire (the fuel source).
    - **SQUEEZE the handle.**
    - **SWEEP** the nozzle back and forth as you spray.

6. Personal Injury

In the event that someone is injured, take the following actions. Additional procedures for responding to chemical contamination are listed below.

- Seek assistance from other faculty or staff.
- Remove the victim from dangerous situations, if it can be done safely.
- Dial 111 to notify Campus Safety. (All Campus Safety officers have first aid training.)
- For minor injuries, treat with supplies from first aid kits, located in the hallways outside the laboratory.

Note: Notify the Chemical Hygiene Officer at x-2252 if the first aid kit is used, so it can be restocked.

6.1. Reporting Injuries or Incidents

In addition to the Department Chair and the Chemical Hygiene Officer, all accidents or injuries, regardless of severity or type, must be reported to the Occupational Health Coordinator and the Chemical Hygiene Officer by submitting a completed Occupational Incident Reporting Form. The form should also be completed for incidents involving students, but they should be referred to Student Health Services for treatment. (Contact phone numbers are found on the first page of this manual.) The Occupational Incident Reporting Form is found in **Appendix I**. It can also be found online at: www.conncoll.edu/offices/ehs.

6.2. Medical Treatment Facilities

If necessary, emergency medical treatment may be obtained at L&M Hospital or Pequot Walk-In Health Clinic. Students with minor injuries may walk to the Health Center if accompanied.

[4] A YouTube video demonstrating the proper procedures for using a fire extinguisher can be found on the EH&S web page at: http://www.conncoll.edu/offices/ehs/5955.htm.

During the summer and semester breaks when the Warnshuis Health Center is closed, Campus Safety will arrange transport students to L&M Hospital. The phone numbers for these facilities are found on the first page of this document.

- A teaching assistant, faculty member or other person with knowledge of the incident should accompany injured/contaminated individuals to the ER or Health Center.
- The treatment facility should be notified that the individual is coming and the nature of the injury. If a chemical is involved, documentation (e.g., MSDS or lab handout) for the chemical should be brought with the patient to the treatment facility.
- Serious injuries should be taken directly to L&M Hospital. Campus Safety will request an ambulance when needed.

7. Chemical Contamination

Spills of hazardous chemicals that involve personal contamination pose a risk of exposure, especially if the chemical can be absorbed through the skin. The following procedures are recommended in the event of personal chemical contamination. Ensure that all accidents are documented on the Connecticut College Occupational Incident Reporting Form (See **Appendix I**).

Familiarity with the chemical, and review of the chemical's "Hazard Information" and "Symptom of Exposure" sections of the MSDS are valuable tools to determine the hazards associated with chemicals and establish protocols to minimize exposure.

7.1. Eyes

- Immediately go to the nearest eyewash station and flush the eye for **a minimum of 15 minutes** (the 15 minute flushing time is essential to prevent damage to the eyes).
- The eyes should be held open (remove contact lenses).
- Call Campus Safety for assistance at ext. 111.
- Immediate medical attention is required for <u>all</u> cases of eye contamination.

7.2. Contamination of the Skin or Clothing

- Use the safety shower, hose or laboratory sink to thoroughly flush the area.
- Immediately remove contaminated clothing. If the head has been contaminated, leave safety (chemical splash) goggles on so that the chemical contaminant is not flushed into the eyes.
- Once the skin contamination has been cleaned, the individual should put on a Tyvek suit, found in the Laboratory Spill Kit. Contaminated clothing may or may not be disposed as hazardous waste, depending upon the contaminant.

- Call Campus Safety at ext. 111 to report the incident and to request assistance.
- Notify the Chemical Hygiene Officer at x-2252.
- Immediate medical attention is required for cases with visible tissue damage, contamination of a large area, or contamination with an acutely toxic substance. The contaminated area must be thoroughly flushed prior to transport. Campus Safety will transport, or arrange for transport to the appropriate medical facility.

7.3. Inhalation of Hazardous Chemicals

Respiratory exposure may result through contact with gasses, aerosols, particles, and vapors. While many of these materials have an odor that can serve as a warning sign, toxicity and odor vary for different substances, and the permissible exposure limit may sometimes be lower than the odor threshold. If a material does pose an inhalation hazard, engineering controls (like a fume hood or other shielded ventilation system) should be used to minimize contact. In the event of a possible inhalation exposure:

- Immediately remove the affected individual(s) from the area.
- As soon as practical, notify Campus Safety and EH&S.
- Try to determine the material inhaled and obtain a copy of the MSDS.
- If the employee is conscious and there is no threat to health, move the employee to fresh air.
- If an employee is found unconscious in an area of the laboratory where chemical vapors are likely to be trapped, do not enter the space. Immediately call Campus Safety for assistance.
- Monitor the employee from a safe distance.
- Seek medical attention as soon as possible. A co-worker should escort the affected person to receive medical attention.

SECTION VI – HAZARD COMMUNICATION

In addition to the "Occupational Exposure to Hazardous Chemicals in Laboratories" standard, (29 CFR 1910.1450), laboratory workers are subject to the requirements of the "Hazard Communication Standard (29 CFR 1910.1200). The HAZCOM Standard discusses the requirement for providing employees (and others), information regarding hazards (chemical or otherwise) in the laboratory, and how to protect them.

The Hazard Communication Standard covers information such as training requirements, labels, signage, Material Safety Data Sheets (MSDS) and Standard Operating Procedures (SOP's). This section will outline those requirements and Connecticut College's policies and procedures to comply with them, but detailed information will be covered during Laboratory Safety and Hazard Communication training for faculty and staff.

1. Labels

EPA and OSHA regulations require that every container that appears to have a chemical in it, to be labeled, and easily identified by every user within the lab.

There are two types of chemical container labels: Primary (Manufacturer's), and Secondary.

Primary container labels are the main and initial source of information regarding the physical and health hazards of a particular chemical. Manufacturer's labels contain important information such as warning statements/pictograms, Chemical Abstract (CAS) numbers, and first aid procedures. Manufacturers labels should never be removed or defaced until the container is empty, and decontaminated if necessary. Chemical storage areas should be inspected frequently to ensure that labels are tightly affixed to the container. Labels that are loose should be immediately re-attached using clear packing tape.

Secondary containers are smaller containers into which chemicals are transferred from larger bulk containers, or are solutions that are prepared. At a minimum, secondary containers must be labeled with the chemical name. The name should be spelled out, instead of using chemical or scientific notation.

Chemical Containers must also be labeled with appropriate hazard warning(s). The hazard warning may be a commercial label in the form of a pictogram, a HMIS or NFPA label with the appropriate hazard rating indicated (See Figures 1 and 2 below), or simply the hazard spelled out (e.g., "Corrosive."). All labeling should be done with a marker resistant to the contents of the container, or the label covered with clear tape.

Pictograms and labels can be ordered from Sigma Aldrich, Fisher, VWR, Lab Safety Supply, Emedco, and many others.

Important: Unknowns for instructional use should be labeled with the hazards of the constituents, or those hazards otherwise communicated to those handling the samples. A key identifying each unknown must be kept by the responsible faculty or staff member.

1.1. HMIS and NFPA Warning Labels and Classifications

The HMIS (Hazardous Material Information System) and NFPA (National Fire Protection Association) are labeling systems that utilize a color-coded and numerical (0 to 4) rating

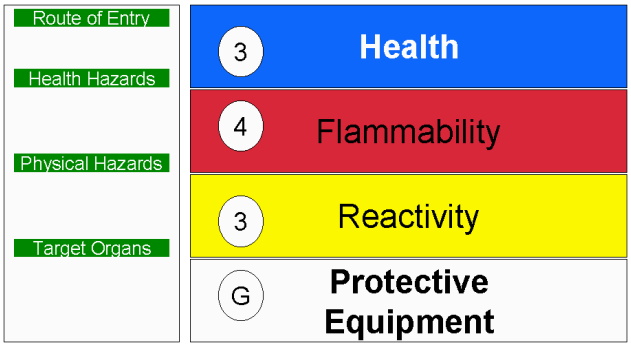


Figure 1 HMIS Label

system for indicating the health, flammability and reactivity hazards of chemicals.

Figure 2 NFPA Label

Many chemical containers already have these markings (or their equivalents) on the manufacturer's label. Faculty and staff are encouraged to fill out and affix a NFPA or HMIS label to all "secondary" containers.

1.1.1. Health Ratings

4 – Extreme Hazard	Highly toxic material. Will have one or more of the following characteristics: • On very short exposure could cause death or major residual injury even though prompt medical treatment is given. • A known or suspected **human** carcinogen, mutagen or teratogen.
3 – Serious Hazard	Toxic material. Will have one or more of the following characteristics: • May cause serious temporary or residual injury on short term exposure even though prompt medical attention is given. • A known or suspected **small animal** carcinogen, mutagen or teratogen.
2 – Moderate Hazard	Moderately toxic material. Will have one or both of the following characteristics: • Intense or continued exposure could cause temporary incapacitation or possible residual injury unless prompt medical treatment is given.

1 – Slight Hazard	Slightly toxic material. Will have one or more of the following characteristics: • May cause irritation but only minor residual injury even without treatment. • Recognized innocuous material when used with responsible care.
0 – Minimal or No Hazard.	

1.1.2. Flammability Ratings

The flammability rating is found in the top, red portion of the diamond. The flammability rating is related to the "flashpoint"[5] of the chemical. The lower the flashpoint, the more hazardous it is.

4 – Extreme Hazard	**Extremely flammable**. Flash point below 73 F (22.8 C)
3 – Serious Hazard	**Flammable**. Will have one or more of the following characteristics: • Vaporizes readily and can be ignited under almost all ambient conditions. • May form explosive mixtures with or burn rapidly in air. • May burn rapidly due to self-contained oxygen. • May ignite spontaneously in air. • Flash point at or above 73 F (22.8 C) but less than 100 F (37.8 C).
2 – Moderate Hazard	**2 – Moderate Hazard - Combustible**. Will have one or more of the following characteristics: • Must be moderately heated or exposed to relatively high temperatures for ignition to occur. • Solids which readily give off flammable vapors. • Flash point at or above 100 F (37.8 C) but less than 200 F (93.4 C).
1 – Slight Hazard	**Slightly combustible**. Will have one or more of the following characteristics: • Must be preheated for ignition to occur. • Will burn in air when exposed at 1500 F (815.5 C) for 5 minutes. • Flash point at or above 200 F (93.4 C).
0 – Minimal or No Hazard.	Will have one or more of the following characteristics • Will not burn. • Will not exhibit a flash point. • Will not burn in air when exposed at 1500 F (815.5 C) for 5 minutes.

1.1.3. Reactivity Ratings

Reactivity information is displayed on the right, yellow portion of the diamond. The reactivity hazard is ranked, as are the fire and health hazards, using an ordinal ranking system with values of 0 to 4.

[5] The **flash point** of a volatile material is the lowest temperature at which it can vaporize to form an ignitable mixture in air. Measuring a flash point requires an ignition source. At the flash point, the vapor may cease to burn when the source of ignition is removed.

4 – Extreme Hazard	Will have one or more of the following characteristics: • Can explode or decompose violently at normal temperature and pressure. • Can undergo a violent self-accelerating exothermic reaction with common materials or by itself. • May be sensitive to mechanical or local thermal shock at normal temperature and pressure.
3 – Serious Hazard	Will have one or more of the following characteristics: • Can detonate or explode but requires a strong initiating force or confined heating before initiation. • Readily promotes oxidation with combustible materials and may cause fires. • Is sensitive to thermal or mechanical shock at elevated temperatures. • May react explosively with water without requiring heat or confinement.
2 – Moderate Hazard	Will have one or more of the following characteristics: • Normally unstable and readily undergoes violent change but does not detonate. • May undergo chemical change with rapid release of energy at normal temperature and pressure. • May react violently with water. Forms potentially explosive mixtures with water
1 – Slight Hazard	Will have one or more of the following characteristics: • Normally stable material which can become unstable at high temperature and pressure.
0 – Minimal or No Hazard.	Normally stable material which is not reactive with water.

1.1.4 Special or Specific Hazards

The lower, white portion of the diamond is used to note "Special Hazards" such as:

• **W**	Water Reactive/Use NO WATER
• **ALK**	Alkali
• **ACD**	Acid
• **COR**	Corrosive
• **OXY**	Oxidizing Agent
• ☢	Radioactive

Some suppliers of laboratory chemicals display the NFPA diamond on container labels. Fisher Scientific does this and also includes a yellow storage code for reactives and oxidizing reagents.

2. Material Safety Data Sheets (MSDS)

Determination of the specific hazards of a chemical is the responsibility of the manufacturer, but it is incumbent on the chemical user to be fully aware of the hazards associated with the material. Hazard information of a chemical can be found on the label, the manufacturer's **Material Safety Data Sheet (MSDS)**, and in reference publications listed in the Bibliography.

The container label is the initial source of information for a specific chemical, but the MSDS contains important information that may not be listed on the label, such as the physical properties, permissible exposure limits (PEL) and disposal considerations. Additional information on how to read an MSDS, can be found on the Environmental Health & Safety website at: http://www.conncoll.edu/offices/ehs/6102.htm.

OSHA regulations require that employees have ready access to Material Safety Data Sheets for all chemicals used and stored in the workplace. In addition, emergency responders or physicians may need a printed copy of an MSDS in the event of a release or injury. MSDS' may be available electronically or hard copy, so long as they are readily available. Since Connecticut College maintains MSDS' electronically (printed copies are provided for employees without ready access to a computer).

Laboratory workers are strongly encouraged to adhere to the following guidelines:

- Have the Connecticut College MSDS website(s) bookmarked for quick access. MSDS for laboratory chemicals used at Connecticut College are integral to the online "Chemical Environmental Management System" (CEMS), found at: http://cems.conncoll.edu.
- (MSDS for chemical products used by other departments on campus, are found on a separate page on the EH&S website.)
- Print and maintain copies in the laboratory of MSDS's for chemicals that are listed in **Appendix J**, **"Particularly Hazardous Substances with with Skin Absorption Designation**", or any Particularly Hazardous Substance that is listed in **Appendices C, D and E**. Lab personnel should be able to obtain <u>any</u> MSDS quickly (within 3 minutes or less).

In addition to the inventory and MSDS modules, CEMS also includes chemical "Fact Sheets" for Acute Toxins. (Detailed information regarding CEMS is found in Section III (10.).

Note: When a chemical is entered into CEMS, and a message appears that no MSDS is available in the inventory database, send an email to the Chemical Hygiene Officer, with the chemical, product number and manufacturer. The CHO will promptly locate and upload the MSDS to the database.

3. Controlling Sources of Exposure

All experiments must be designed and carried out to minimize chemical exposure. The three primary methods of controlling exposure are, in order of preference:

1. Source reduction
2. Engineering controls, and
3. Protective equipment

The following are examples of source reduction and engineering control techniques.

3.1. Source Reduction

- Use the least hazardous chemical that will serve the intended purpose.
- Design experiments to use the minimum amount of chemical required.
- Always close containers tightly when not in use.
- Minimize the surface area of open containers (e.g., use of flask vs. beaker).

3.2. Engineering Controls

While minimum levels of personal protective equipment are required as described below in Section VI (4.), it should be recognized that source reduction and engineering controls are generally more effective means of exposure control, and should always be the control method of choice.

- Use fume hoods whenever possible.
- Do not use fume hoods for long-term storage of equipment or chemicals.
- Avoid the release of chemical vapors in cold rooms, as they have re-circulating air systems.
- Use equipment and glassware only for its designed purpose. Never use damaged equipment or glassware.
- If operations must be left unattended, provide for containment of hazardous chemicals in the event of equipment failure.

4. Personal Protective Equipment (PPE)

Personal Protective equipment must be worn to guard against injury from routine or accidental events in the laboratory. Each faculty or supervising staff member is responsible for choosing appropriate protective equipment for his or her staff and students. The following guidelines will assist in selecting personal protective equipment.

4.1. Eye Protection

Faculty or staff members in charge of individual students or classes will be responsible for (1) identifying potential hazards, and (2) informing students of the type of eye protection required. All laboratory work must be assessed as to potential dangers from these hazards and eyewear required must meet the ANSI Standard Z87.1 (see list below). When there is a doubt as to whether or what type of eye protection is required, the chemical hygiene officer should be consulted.

Faculty and staff must wear splash proof safety goggles whenever particularly hazardous operations are being carried out, when a splash hazard exists, or when glassware under pressure or vacuum is being used. Approved safety glasses with side shields or prescription eye glasses (meeting ANSI Standard Z87.1) with side shields may be worn whenever operations of low hazard are being performed.

Table 1 – Protective Eyewear

SUMMARY OF ANSI Z87.1-89 **Approved Protective Eyewear**	
1. **Safety Spectacles**, *with side shields* 2. **Goggles**, *flexible fit, regular ventilation* 3. **Goggles**, *flexible fit, hooded ventilation*	4. **Goggles**, *rigid body, cushion fit* 5. **Face Shield**, *plastic window* 6. **Chipping Goggles**, *eyecup type*
HAZARDS	**APPROVED EYEWEAR**
IMPACT: *flying objects, fragments, particles*	1,2,3,4,5,6
HEAT: *hot sparks*	1,2,3,4,5,6
HEAT: *high temperature*	5
CHEMICAL: *splash*	3,4,5 (with 3 or 4)
CHEMICAL: *irritating mists*	4
DUSTS: *airborne particles*	3,4,6
IR/UV RADIATION: *welding, soldering, brazing, cutting*	Refer to ANSI Z87.1
LASERS:[6] *thermal injuries*	Refer to ANSI Z87.1

All acids represent a potential splash hazard. Splash goggles MUST be worn whenever acids are being handled. Splash goggles and a full face-shield must be used when using hydrofluoric acid. (See Section VII (4.1.) for further information.)

In research laboratories, faculty are responsible for assessing the hazards associated with their research, determining the appropriate eye protection, and communicating those

[6] Specific laser safety requirements are discussed in Section IX (2).

requirements to their research students and staff. In the case of shared labs, the faculty members should discuss appropriate eye protection to protect against all laboratory hazards.

Ordinary prescription glasses or contact lenses do not offer adequate protection and may not be substituted for safety splash goggles. The minimum level of eye protection meeting ANSI Standard Z87.1 is summarized above.

4.2. Gloves

No single glove can be used as protection from all chemicals. A glove may protect against a specific chemical, but it may not protect the wearer from another. If a glove protects the wearer, it will not protect the wearer forever, as the glove material will deteriorate. Therefore, the following factors must be considered when choosing gloves to protect against chemical exposures:

- Chemical to be used: Consult the compatibility charts to ensure that the gloves will offer the best protection.
- Dexterity needed: The thicker the glove, typically the better the chemical protection, as the glove will be more resistant to physical damage, like tears and cracks, but it will harder be to handle and feel the work.
- Extent of the protection required: Determine if a wrist length glove provides adequate protection, or will a glove that extends further up the arm be required.
- Type of work to be done: gloves are specific to the task. Ensure the correct glove is chosen to avoid injuries. Examples: A nylon cryogenic glove will be damaged if a hot item is handled, where as a "hot mitt" will not protect the wearer when liquid nitrogen is used, as it may be too porous.

5. Rules for Glove Use in the Laboratory:

- Wear the correct gloves when needed.
- Wear disposable gloves no longer than 2 hours.
- Wash hands once gloves have been removed.
- Disposable gloves must be discarded once removed, and not saved for future use.
- Dispose of gloves into the proper container (biologically contaminated gloves will need to go into a red bag, while chemically contaminated gloves may need to be managed as hazardous waste.)
- Non-disposable/reusable gloves must be washed and dried, and then inspected for tears and holes prior to reuse.
- Remove gloves before touching personal items, such as phones, computers, pens, and especially one's skin. Remember the "designated area rule" where "science" does not mix with personal space (one's desk or lunch space). Gloves used in research are considered "science".

- Do not leave the lab while wearing gloves. If gloves are needed to transport anything, wear one glove to handle the transported item. The free hand is then used to touch door knobs, elevator buttons, etc. If you are wearing gloves to "protect your sample from you" and are in the hall, no one else understands this and will be concerned about the items you have contaminated with those gloves.
- If for any reason a glove fails, and chemicals come into contact with skin, consider it an exposure and immediately seek medical attention.

6. Glove Selection and Use

Choosing the appropriate hand protection can be a challenge in a laboratory setting. Considering the fact that dermatitis or inflammation of the skin accounts for 40-45% of all work-related diseases, selecting the right glove for the job is important.

Not only can many chemicals cause skin irritation or burns, but absorption through the skin can be a significant route of exposure to certain chemicals. Dimethyl sulfoxide (DMSO), nitrobenzene, and many other organic solvents are examples of chemicals that can be readily absorbed through the skin into the bloodstream, where the chemical may cause harmful effects.

7. Selecting the Appropriate Glove Material

When selecting the appropriate glove, the following characteristics should be considered:

- Degradation rating
- Breakthrough time
- Permeation rate

Degradation is the change in one or more of the physical properties of a glove caused by contact with a chemical. Degradation typically appears as hardening, stiffening, swelling, shrinking or cracking of the glove. Degradation ratings indicate how well a glove will hold up when exposed to a chemical. When looking at a chemical compatibility chart, degradation is usually reported as E (excellent), G (good), F (fair), P (poor), NR (not recommended) or NT (not tested).

Breakthrough time is the elapsed time between the initial contact of the test chemical on the surface of the glove and the analytical detection of the chemical on the inside of the glove.

Permeation rate is the rate at which the test chemical passes through the glove material once breakthrough has occurred and equilibrium is reached. Permeation involves absorption of the chemical on the surface of the glove, diffusion through the glove, and

desorption of the chemical on the inside of the glove. Permeation rate is usually reported as E (excellent), G (good), F (fair), P (poor) or NR (not recommended). If chemical breakthrough does not occur, then permeation rate is not measured and is reported ND (none detected).

Manufacturers stress that permeation and degradation tests are done under laboratory test conditions, which can vary significantly from actual end-use conditions. Users may opt to conduct their own tests, particularly when working with highly toxic materials. For mixtures, it is recommended that the glove material be selected based on the shortest breakthrough time.

8. Where to Find Compatibility Information

Most glove manufacturers have chemical compatibility charts available for their gloves. These charts may be found in laboratory supply catalogs such as Fisher Scientific and Lab Safety Supply. Probably the best example of a glove compatibility chart, is the Permeation/Degradation Resistance Guide for Ansell Chemical Resistant Gloves, 7th Ed." A link to which can be found online at: http://www.conncoll.edu/offices/ehs.

The following table includes major glove types and their general uses. This list is not exhaustive, and the user should refer to the specific glove manufacturer's compatibility chart. In most cases, the MSDS will specify the proper glove for that particular chemical.

Table 2 – Glove Types and Uses

Butyl	Offers the highest resistance to permeation by most gases and water vapor. Especially suitable for use with esters and ketones. Poor for aliphatic, aromatic hydrocarbons, halogenated hydrocarbons, and gasoline.	**PVA**	Highly impermeable to gases. Excellent protection from aromatic and chlorinated solvents. Cannot be used in water or water-based solutions to gases. Excellent protection from aromatic and chlorinated solvents. Cannot be used in water or water-based solutions.
Neoprene	Good for acids and bases, peroxides, fuels, hydrocarbons, alcohols, phenols. Poor for halogenated and aromatic hydrocarbons	**Viton**	Exceptional resistance to chlorinated and aromatic solvents. Good resistance to cuts and abrasions.
Nitrile	Excellent general duty glove. Provides protection from a wide variety of solvents, oils, petroleum products, and some corrosives. Excellent resistance to cuts, snags, punctures, and abrasions	**Silver Shield**	Resists a wide variety of toxic and hazardous chemicals. Provides the highest level of overall chemical resistance.
PVC	Provides excellent abrasion resistance and protection from most fats, acids, and petroleum hydrocarbons. Poor for most organics.	**4H**	Same as Silver Shield, but offers better dexterity.

	Latex	Good for very dilute acids and bases. Poor for organics.

8.1. Protective Clothing

The purpose of protective clothing is to prevent contamination of the skin, prevent transport of contaminants outside the laboratory, and to protect the laboratory worker in the event of fire or explosion. Street clothing made from cotton, silk, linen or wool should be worn when working in the laboratory. Clothing made from synthetic materials should never be worn in the lab, because they readily burn or melt.

Clothing that exposes bare skin should be minimized. Long trousers that cover the legs and ankles, and closed toed footwear are required. Wearing of sandals or "flip-plops" is not allowed in the laboratory.

9. Lab Coats

Use of laboratory coats is **mandatory** whenever handling Select Carcinogens, Reproductive Toxins, or Acute Toxins with Skin Absorption Designation (See **Appendix J**), concentrated (as supplied by the manufacturer) acids and bases, and flammable or pyrophoric chemicals. The responsible PI or Laboratory Supervisor is responsible for ensuring that all laboratory workers comply with this requirement.

Specialized protective clothing may be necessary in certain high hazard operations, such as using hydrofluoric acid. Contact the Director of EH&S (Chemical Hygiene Officer) for further guidance.

9.1. Respiratory Protection

Respiratory protection is generally not required in the laboratory. Chemical handling should be done in the fume hoods whenever feasible. Contact the Chemical Hygiene Officer to evaluate any process outside of the fume hood where harmful vapors may be generated.

10. Training

10.1. Faculty, Staff, And Research Assistants

Under the OSHA Laboratory and Hazard Communication Standards, all employees working in laboratories must receive specific information and training regarding chemical hazards, safe handling methods, and emergency procedures. Employees include anyone who receives compensation from Connecticut College for their services; this includes faculty, staff, and students on work-study or who are grant funded. Students doing independent research must also receive this training.

New faculty and staff meet with the Chemical Hygiene Officer to review the requirements of the Safety Handbook. Departments provide the Chemical Hygiene Officer with the names of all new faculty and staff; the Chemical Hygiene Officer then schedules a training meeting.

10.2. Students

Student training has two components, an interactive online training program administered by the Chemical Hygiene Officer and individual instruction by the faculty member with regard to specific hazards, handling procedures and emergency procedures in their laboratory. Training must be accomplished prior to working with hazardous chemicals in the laboratory.

Faculty members are responsible for providing safety information and training to their students including information on:

- Hazards of the chemicals being used
- Safe handling procedures
- Use of personal protective equipment
- Emergency procedures (see Chapter III), and
- Sources of additional information (e.g., labels, MSDS, this Safety Handbook).

Specific information must be given if an experiment involves the use of a “Particularly Hazardous Substance (Section VII (1); acute toxins, select carcinogen or reproductive toxin.)

At the beginning of each semester in laboratory courses, the faculty member must demonstrate the use of safety showers, eyewash stations, fire blankets, and fire extinguishers; and indicate the location of emergency exits, pull boxes, and evacuation routes. Activation of the safety equipment is not necessary as part of the demonstration.

10.3. Special Training Requirements For Formaldehyde

The OSHA Formaldehyde Standard requires annual training for all users of formaldehyde containing products containing greater than 0.1 percent formaldehyde, or capable of releasing vapors in excess of 0.1 ppm. That training is the responsibility of the faculty member supervising the use of formaldehyde containing products. The training must include:

- A discussion of the contents of the regulation (required for employees only) and the MSDS,
- A description of the potential health effects of symptoms of exposure,
- Reporting requirements for symptoms of exposure,
- Description of safe work practices and engineering controls (e.g., fume hoods),
- The purpose of personal protective equipment (e.g., goggles and gloves), and
- Instructions for handling emergencies.
-

The CEMS Homepage provides a link to all "Particularly Hazardous Chemicals" including formaldehyde. These documents may be used to accomplish this training, and should be distributed or posted in all laboratories using formaldehyde in concentrations greater than 0.1 percent.

SECTION VII – CHEMICAL SAFETY AND PROCEDURES

1. Particularly Hazardous Substances (PHS)

The Occupational Safety and Health Administration (OSHA) has established three categories of Particularly Hazardous Substances: Acute Toxins, Select Carcinogens and Reproductive Toxins.

1.1. ACUTE TOXINS

As defined by the Laboratory Standard, acute toxins are chemicals which may be fatal as a result of a single exposure or exposure of short duration. The OSHA Hazard Communication Standard, 29 CFR 1910.1200, defines a similar category, highly toxic chemicals, based on animal (rat) toxicity data using the following criteria:

LD_{50} - ingestion: < 50 mg/kg
LD_{50} - contact (24hrs): < 200 mg/kg
LD_{50} - inhalation: <200ppm/1hr

However, a review of Material Safety Data Sheets reveals that this toxicity data is not available for many laboratory chemicals. As there is no definitive list of acute toxins, they will be defined here as a chemical which meets one or more of the following four criteria.

- Animal toxicity data is available and meets the LD50 criteria listed above.
- The container label or Material Safety Data Sheet identifies the substance as "acutely toxic", "highly toxic", "may be fatal if inhaled", "may be fatal if enters the bloodstream", or similar warning of acute toxicity.
- It is on the list of examples in **Appendices C-(1)** and **C-(2)**, which was compiled from several sources as referenced, and includes: all DOT Poison A chemicals, and chemicals with a National Fire Protection Association "Health" rating of 4 for highly toxic chemicals.
- The faculty member has knowledge that the chemical is an acute toxin.

1.1.1. Purchase Approval

As mentioned in Section III, there are two categories of chemical purchases that require approval prior to purchase:

- **Appendix B**, “Chemicals Subject to Department of Homeland Security (DHS) Reporting as “Chemicals of Interest”, with possession (facility-wide) thresholds at or below 15 pounds.

- **Appendices C-(1)** and **C-(2)**, "Examples of Acute Toxins", as defined above (sorted alphabetically, and by CAS number).

Even though it may not appear on the list of examples, be sure to review the criteria that defines an Acute Toxin, to determine if a chemical meets the criteria To obtain approval, email Environmental Health & Safety, with a copy to the department chair, with the following information:

- Name of the chemical
- CAS#
- Vendor and catalog #
- Quantity of chemical to be purchased
- Storage location
- Brief description of use
- Date when material is needed

If approval to purchase the chemical is granted, an acute toxin protocol must be submitted. A written protocol is required for any use of an acute toxin. The protocol must include the experiment procedure, necessary protective equipment, safety precautions, emergency procedures, user training and waste disposal. The protocol must be submitted to the Chemical Hygiene Officer and reviewed with other faculty, students and staff working in the lab. A protocol form is included in **Appendix F.**

1.2. Acute Toxin Protocols and PPE

Protective Clothing. Laboratory coats must be worn when handling greater than one liter of an acute toxin that is readily absorbed through the skin, as indicated by an "s" on the list found in **Appendix V-B**. Laboratory coats used for this purpose must not be worn outside of the laboratory. Contaminated clothing must be removed immediately and disposed of or laundered separately from street clothes.

Gloves. If hand contact is possible, gloves appropriate for the task and with resistance to the chemical involved must be worn. Disposable gloves must be discarded after every use and immediately after overt contact with an acute toxin. Non-disposable gloves must be designated for use only with acute toxins and must be decontaminated after every use. Contaminated gloves must be disposed of as hazardous waste.

Eye Protection. Appropriate eye protection must be worn as described in Section VI (4.1.).

Personal Hygiene. Hands must be washed with soap and water immediately after overt contact, at the completion of any procedure, and prior to leaving the laboratory.

1.2.1. Work Area Identification And Access

Work areas or laboratories where acute toxins are used on a regular basis, areas that have not been decontaminated or where experiments involving acute toxins are left in progress,must be labeled with a sign with the following or similar warning:

Caution -- Acute Toxin
Authorized Personnel Only

1.2.2. Handling And Storage Procedures

Work Surfaces. All work surfaces on which non-volatile acute toxins are used should be a smooth nonporous material or covered with stainless steel or plastic trays. The work surface or trays should always be decontaminated after the procedure is complete.

Containment Equipment. Procedures using volatile acute toxins and those involving solid or liquid acute toxins that may result in the generation of aerosols or airborne particles should be conducted in a fume hood, glove box or other containment device. Examples of aerosol generation procedures include: transfer operations, blending, open vessel centrifugation, and injection.

Vacuum Lines. Vacuum lines, other than water aspirators, should be protected (e.g., with an absorbent or liquid trap and a HEPA filter) to prevent entry of any acute toxin into the system.

Decontamination. Equipment and contaminated materials should be decontaminated using procedures that deactivate the acute toxin, if such procedures are available. If deactivation procedures are not available, the equipment should be rinsed with an appropriate solvent and the solvent collected as hazardous waste. Decontamination of the work area must be done whenever there has been overt contamination and at the end of each experiment. Ideally, the work area should be decontaminated daily. If a work area is not decontaminated prior to leaving for the day, a “Do Not Enter” sign must be posted, as described in Section F above.

Container Labeling. Containers in which acute toxins are stored must be labeled with, at a minimum, the chemical name and a warning indicating it is an acute toxin. In lieu of labeling individual containers, entire storage areas may be labeled.

1.2.3. Training

Prior to conducting any work with any Acute Toxin, the Principal Investigator must provide training to his/her laboratory personnel specific to the hazards involved with this chemical. This training must include:

- Work area decontamination
- A review of the Material Safety Data Sheet, with particular attention paid to:
    - Health effects
    - Emergency and First Aid procedures
    - Required PPE
    - Routes of exposure:
    - Skin absorption
    - Ingestion
    - Inhalation
    - Storage and handling procedures
    - Spill procedures

The faculty must ensure that laboratory personnel have attended appropriate laboratory safety training or refresher training within the last two years. The Chemical Hygiene officer (Director of EH&S) will coordinate Laboratory Safety training for faculty every two years, and can assist in the training of students upon request.

1.3. Special Precautions for Osmium Tetroxide

OsO4 is highly poisonous, even at low exposure levels, (It is also a severe oxidizer), and must be handled with appropriate precautions. In particular, inhalation at concentrations well below those at which a smell can be perceived, can lead to pulmonary edema, and subsequent death. Osmium tetroxide is regarded as a substance with poor warning properties, and noticeable symptoms can take hours to appear after exposure. OsO_4 also stains the human cornea, which can lead to blindness if proper safety precautions are not observed.

The PI must ensure that all workers receive specific instruction regarding the hazards of osmium tetroxide as described in Section VII (1.1.4.) above.

1.3.1. Control Measures

- Osmium tetroxide solutions must be prepared and handled in a certified fume hood.
- Choose a hood with minimal equipment or obstructions, to ensure good capture and

exhaust of vapors.

- Working surfaces should be protected with plastic backed absorbent pads to insure containment of any spills.
- Post a warning sign on the hood to alert others to that osmium tetroxide is present. The sign should include the hazards of osmium. The Emergency Information Card posted in the hall at the entrance to the lab should also reflect the use of this material.
- Ensure that the safety shower and eyewash unit are operational, and access is unblocked.

1.3.2. Personal Protective Equipment

- Lab coat, buttoned and sleeves rolled down, safety goggles, and double (two pair) nitrile gloves must be worn.

1.3.3. Safe Use Procedures

- Because of its high acute toxicity and powerful oxidizing ability, osmium tetroxide must be handled in the laboratory using prudent practices. In particular, all work with osmium tetroxide must be conducted in a fume hood to prevent exposure by inhalation, and personal protective equipment (see above) must be worn at all times to prevent eye and skin contact.
- Osmium tetroxide should be purchased as a liquid to avoid particulate exposure from the powdered form. The solutions should be stored in labeled tightly sealed containers, and these should be placed in secondary containment.
- Secondary containment should be used anytime the material is transported to another lab location.
- When osmium tetroxide is freshly prepared and active, it is colorless to pale yellow in color. When the material reacts and causes oxidation, it turns black. This is helpful to know, especially in the event of a splash or spill or inadvertent dermal exposure (black dots will appear on the skin).

1.3.4. Spills

In the event of a spill, it is most important to think through an appropriate response to avoid exposure of osmium tetroxide to anyone and to avoid further contamination of the location.

Small Spills: If the spill is small and manageable, (less than 2 ml), lab personnel will:

- Alert personnel in the immediate area.
- Isolate the area to prevent the spread of contamination.

- Don appropriate PPE (At a minimum, double gloves, buttoned lab coat and safety goggles).
- Cover the spill with inert absorbent (Speedi-Dri", or kitty litter) that has been infused with vegetable oil (corn oil is preferred).
- Scoop the contaminated material up and place it in a glass or plastic container (jar or pail) with a tight fitting lid. The Director of EH&S can assist in obtaining an appropriate waste container.
- Wash the area with an aqueous solution of sodium sulfite.
- Clean the area again with detergent solution.
- Remove contaminated PPE carefully and place it in the waste container.
- Label the container with a completed hazardous waste label/
- Take the waste container to the 180-Day Hazardous Waste Storage Area.
- Notify the Director of EH&S (Chemical Hygiene Officer).

Large Spills[7]**:** When the quantity spilled is greater than 2 ml, lab personnel will:

- Evacuate the area, and close all doors leading to lab upon exiting.
- Place a sign stating "OSMIUM TETROXIDE SPILL; DO NOT ENTER" on the door to warn others of the spill.
- Call Campus Safety, who will request assistance from the NLFDF Hazmat Team.
- Notify the Director of EH& (Chemical Hygiene Officer)

1.3.5. Personnel Exposure

- Immediately seek medical attention for **<u>any</u>** exposure.
- **Skin exposure:** Flush exposed skin with water for at least 15 minutes while removing any contaminated clothing.
- **Eye exposure:** Flush eyes with water for at least 15 minutes. Affected individuals may need help holding their eyes open under water.
- Accidental Exposure to Osmium Tetroxide
- Inhalation exposures: If osmium tetroxide vapor has been inhaled from a spill, move the victim to fresh air immediately.

1.3.6. Handling and Storage Procedures

Pure osmium tetroxide and concentrated solutions should be stored in a location that is secure to unauthorized access, such as a locked drawer or cabinet, or a refrigerator within a laboratory that is locked when authorized personnel are not present. A refrigerator containing osmium tetroxide must be labeled with a caution sign noting the presence of osmium tetroxide and its hazards.

[7] The relatively small quantity that constitutes a "Large" spill, is due to Osmium tetroxide's low OSHA Permissible Exposure Limit of 0.002 mg/m3 of air.

Store pure osmium tetroxide and its concentrated solutions in appropriate, sealed glass containers within unbreakable secondary containment (i.e., a bottle or vial within a sealed compatible plastic jar or metal can with lid). Label all containers, including secondary containment, with the chemical name and hazard warning.

1.3.7. Handling and Solution Preparation

- When moving pure osmium tetroxide to a chemical hood, do not remove it from the secondary containment until it is in the hood.
- Prepare the smallest amount of solution necessary for the procedure, typically 50 ml or less. Prepare the solution volumetrically rather than gravimetrically. If a balance must be used, weighing must take place in the chemical hood.
- Pure osmium tetroxide or its concentrated solutions must be opened only in a chemical hood that has been certified within the last 12 months. During use, the sash must be lowered to operating height.
- All lab ware that has contacted osmium tetroxide must be decontaminated by rinsing or dipping in corn oil or aqueous solutions of sodium sulfide or sodium sulfite before removing from the hood.
- Immediately after work with osmium tetroxide, decontaminate any spills with kitty litter soaked with corn oil. Discard kitty litter as hazardous waste. Or use aqueous solutions of sodium sulfide or sodium sulfite.

1.3.8. Personal Protective Equipment

The following minimum Personal Protective Equipment must be worn during operations with pure osmium tetroxide and concentrated solutions:

- **Chemical goggles** (safety glasses alone are not adequate protection because of osmium tetroxide's severe effects on the eyes).
- **Disposable nitrile gloves (NOT latex).** Double-gloving is recommended when working with pure osmium tetroxide or concentrated solutions. Change gloves frequently and when contaminated, punctured or torn. Wash hands immediately after removing gloves.
- **Standard or disposable laboratory coat or disposable coveralls.** A standard laboratory coat may be reused before laundering if it has not been contaminated with osmium tetroxide. If a garment is contaminated, remove, place in chemical hood, and decontaminate with corn oil or aqueous solutions of sodium sulfide or sodium sulfite before disposing of in hazardous waste or laundering.

1.3.9. Neutralizing Osmium Tetroxide

To reduce hazards involved in discarding osmium tetroxide, the following neutralization procedure should be used:

- A 2% solution of osmium tetroxide can be fully neutralized by twice its volume of vegetable oil (corn oil is preferred because of its high percentage of unsaturated bonds). For every 10 mL of 2% osmium textroxide solution, 20 ml of corn oil is required. Pour the corn oil into the osmium tetroxide solution, and wait for the oil to completely turn black.
- To test if osmium tetroxide is fully neutralized, hold a piece of filter paper soaked in corn oil over the solution. Blackening indicates that osmium tetroxide is still present and more corn oil should be added.
- Aqueous solutions contaminated with osmium tetroxide can be fully neutralized by adding sodium sulfide or sodium sulfite to reduce osmium tetroxide to less hazardous forms.
- Dispose of neutralized solutions as hazardous waste.

1.4. SELECT CARCINOGENS

These guidelines apply to all substances defined as "select carcinogens" by the OSHA Laboratory Standard, and include:

- All OSHA regulated carcinogens (29 CFR Subpart Z),
- All substances the National Toxicology Program (NTP) lists as "known to be carcinogens",
- All substances the International Agency for Research on Cancer (IARC) defines as Group 1, "carcinogenic to humans",
- All substances NTP lists as "reasonably anticipated to be carcinogens", and
- All substances IARC lists as Group 2A, "probably carcinogenic to humans" or 2B, "possibly carcinogenic to humans".

Appendices D-1 and **D-(2),** are compilations of the lists from the sources listed above. With the exception of approved exemption petitions all substances listed must be handled in accordance with the following guidelines. These guidelines are adapted from the National Institute of Health: "*NIH Guidelines for the Laboratory Use of Chemical Carcinogens*".

1.4.1. Employee/Student Notification

The supervising faculty member is responsible for informing all employees and students that the chemical they are working with is a select carcinogen.

1.4.2. Personal Protective Equipment

Protective Clothing. Laboratory coats must be worn when handling greater than one liter of a select carcinogen, which is readily absorbed through the skin, as indicated by an "s" on the list (**Appendices D-1** and **D-(2)**). Laboratory coats used for this purpose should not be worn outside of the laboratory. Contaminated clothing must be removed immediately and disposed of, or laundered separately from street clothes.

Gloves. If hand contact is possible, gloves appropriate for the task, and with resistance to the chemical involved must be worn. Disposable gloves must be discarded after every use and immediately after overt contact with a select carcinogen. (Contaminated gloves must be disposed of as Hazardous Waste.) Non-disposable gloves must be designated for use only with select carcinogens, and must be decontaminated after every use.

Eye Protection. Appropriate eye protection must be worn as described in Section IV (4.1.)

1.4.3. Personal Hygiene

Hands must be washed with soap and water immediately after overt contact, at the completion of any procedure, and prior to leaving the laboratory. If eyes or other parts of the body are contaminated they must be immediately washed or flushed as described in Chapter III.

1.4.4. Work Area Identification And Access

Each work area or laboratory where select carcinogens are being used on a regular basis must be labeled with a sign with the following or similar warning:

CAUTION -- POTENTIAL CANCER HAZARD

When work areas have not been decontaminated or experiments involving select carcinogens are left in progress, a DO NOT ENTER sign listing the name and phone number of the person to be contacted in case of emergency must be posted on the exterior door.

1.4.5. Handling And Storage Procedures

Work Surfaces. All work surfaces on which non-volatile select carcinogens are used should be smooth and nonporous or covered with stainless steel or plastic trays. The work surface or trays should be decontaminated after the procedure is complete.

Containment Equipment. Procedures using volatile select carcinogens and those involving solid or liquid select carcinogens that may result in the generation of aerosols or

airborne particles should be conducted in a fume hood, glove box or other containment device. Examples of aerosol generation procedures include: transfer operations, blending, open vessel centrifugation, and injection.

Vacuum Lines. Vacuum lines, other than water aspirators, should be protected (e.g., with an absorbent or liquid trap and a HEPA filter) to prevent entry of any select carcinogen into the system.

Decontamination. Equipment and contaminated materials should be decontaminated by procedures that deactivate the select carcinogen, if such procedures are available. If deactivation procedures are not available, the equipment should be rinsed with an appropriate solvent and the solvent collected as hazardous waste. Decontamination of the work area must be done whenever there has been overt contamination and at the end of each experiment. Ideally, the work area should be decontaminated daily. If a work area is not decontaminated prior to leaving for the day, a **DO NOT ENTER** sign must be posted, as described above.

Container Labeling. Containers in which select carcinogens are stored must be labeled with, at a minimum, the chemical name and a warning indicating it is a select carcinogen or, alternately, a particularly hazardous substance. In lieu of labeling containers, storage areas may be labeled.

1.5. REPRODUCTIVE TOXINS

The third of OSHA's three categories of Particularly Hazardous Substances, are substances that affect reproductive capability and include four general categories.

- **Mutagens** - substances that may cause a change (mutation) in the genetic material of a cell.
- **Teratogens** - substances that may affect the viability or cause physical or metabolic defects in the developing embryo or fetus when a pregnant female is exposed to that substance.
- **Sterility/Infertility** - substances that may affect female or male fertility.
- **Lactation** - substances that may be transferred from the mother to the child through the breast milk and cause adverse health effects in the child.

Reproductive toxins include physical agents (e.g. radiation), biological agents (e.g. viruses), maternal metabolic imbalances, and chemical agents. This section will focus on chemical reproductive toxins.

There are numerous references on reproductive toxicology but, unfortunately, no scientific or government agency has established a definitive method for classifying potential human chemical reproductive toxins as they have done for carcinogens. It is, therefore, impossible to give an exhaustive list of all chemicals that should be considered reproductive toxins.

The list in **Appendices E-(1) and E-(2)** are examples of chemicals known or suspected to be human reproductive toxins. The list does not take into account the chemical form, concentration, toxicity, or length of exposure.

A large number of chemicals have been reported to be animal reproductive toxins in various species, but since there is no established method for defining when animal evidence is sufficient to relate to human reproductive toxicity potential, it cannot be meaningfully organized here. Container labels and Material Safety Data Sheets should be consulted for the manufacturer's assessment of animal reproductive toxicity, and precautions should be taken to minimize exposure.

As there is no definitive list of human reproductive toxins, they will be defined here as a chemical which meets one or more of the following criteria:

- It is listed in **Appendices E-(1) and E-(2)** as an "Example of Known or Suspected Human Reproductive Toxins".
- The container label or Material Safety Data Sheet reports positive findings of human reproductive toxicity.
- The faculty member has knowledge that the chemical is a human reproductive toxin.

1.5.1. Employee/Student Notification

The supervising faculty member is responsible for informing all employees and students that the chemical they are working with is considered a human reproductive toxin.

1.5.2. Personal Protective Equipment

Protective Clothing. Laboratory coats must be worn when greater than 1 liter or 100 grams of a human reproductive toxin that is readily absorbed through the skin, as indicated by an “s” in **Appendices E-(1) and E-(2)**. Lab coats used for this purpose must not be worn outside of the laboratory. Contaminated clothing must be removed immediately and disposed of or laundered separately from street clothing.

Gloves. If hand contact is possible, gloves appropriate for the task and with resistance to the reproductive toxin involved must be worn. Disposable gloves must be discarded after every use and immediately after overt contact with a human reproductive toxin. Non-disposable gloves must designated for use only with human reproductive toxins and must be decontaminated after every use.

Eye Protection. Appropriate eye protection must be worn as described in Section VI 4.1.).

1.5.3. Personal Hygiene

Hands must be washed with soap and water immediately after overt contact, at the completion of any procedure, and prior to leaving the laboratory. If other parts of the body are contaminated they must be immediately washed or flushed, in the case of eye contamination, described in Section III.

1.5.4. Work Area Identification And Access

Each work area or laboratory where human reproductive toxins are being used on a regular basis must be labeled with a warning sign.

CAUTION — POTENTIAL REPRODUCTIVE TOXIN IN USE

When work areas have not been decontaminated or experiments involving human reproduction toxins are left in progress, a **DO NOT ENTER** sign listing the name and phone number of the person to be contacted in case of emergency must be posted on the exterior door.

1.5.5. Handling And Storage Procedures

Work Surfaces. All work surfaces on which human reproductive toxins are used should be smooth and nonporous or covered with stainless steel or plastic trays. The work surface or trays should be decontaminated after the procedure is complete.

Containment Equipment. Procedures using volatile human reproductive toxins and those involving solid or liquid human reproductive toxins that may result in the generation of aerosols or airborne particles should be conducted in a fume hood, glove box or other containment device. Examples of aerosol generation procedures include: transfer operations, blending, open vessel centrifugation, and injection.

Vacuum Lines. Vacuum lines, other than water aspirators, should be protected (e.g., with an absorbent or liquid trap and a HEPA filter) to prevent entry of any human reproductive toxin into the system.

Decontamination. Equipment and contaminated materials should be decontaminated by procedures that deactivate the human reproductive toxin if such procedures are available. Decontamination of the work area must be done whenever there has been overt contamination and at the end of each experiment. Ideally, the work area would be

decontaminated daily. If a work area is not decontaminated prior to leaving for the day a DO NOT ENTER sign must be posted as described above.

Container Labeling. All containers in which a human reproductive toxin are stored must be labeled with, at a minimum, the chemical name and a warning indicating it is a reproductive toxin, or alternately, a particularly hazardous substance. In lieu of labeling containers, entire storage areas may be labeled.

1.5.6. Waste Disposal

Waste Minimization. One goal of experimental design should always be the minimization of waste produced. Using the least amount of the reproductive toxin possible and limiting the use of disposable equipment are effective methods.

Deactivation. When possible wastes should be deactivated to form non-toxic degradation products. Deactivation procedures for some human reproductive toxins which are also carcinogens are described in the following publications and others may be available from the manufacturer.

2. FLAMMABLES AND COMBUSTIBLES

In planning for the safe use and storage of flammable materials, it is helpful to understand the established nomenclature. There are a number of important definitions in the evaluation of fire hazard. First, one must understand that for a fire to occur, three conditions must be met:

- The concentration of the flammable vapor must be between the lower and upper flammable limits,
- An oxidizing agent (e.g. the air in the room or a chemical oxidizer) must be available, and,
- There must be a source of ignition or the material at its auto ignition temperature.

2.1. Definitions

Flammable Solid - a non-explosive material that is capable of producing fire as a result of friction, water exposure, air exposure or retained heat from synthesis or processing, or when ignited burns so vigorously and persistently so as to create a hazard.

Flammable Gas - gases of which mixtures in air of 13 percent or less, by volume, forms a flammable mixture; or the flammable range (explosive range) in air is wider than 12 percent regardless of the lower limit (U.S. Department of Transportation definition).

Boiling point - the temperature at which the vapor of the liquid is in equilibrium with atmospheric pressure: the lower the boiling point the greater the fire hazard.

Flash point - 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 - also applies to certain solids that evaporate or volatilize: the lower the flashpoint the greater the fire hazard.

Auto Ignition Temperature - the minimum temperature that will initiate a self-sustained combustion of liquid, gas or solid in the absence of a spark or flame: the lower the auto ignition temperature the greater the fire hazard.

Flammable or Explosion Limits - the range of concentration of a gas or vapor in air, by volume percent in air, in which a fire or explosion can occur upon ignition in a confined area: the larger the range of the explosion limits the greater the fire hazard.

Vapor Density - the weight of a volume of pure vapor or gas compared to the weight of an equal volume of dry air at the same temperature and pressure: vapor densities greater than one indicate the vapor or gas is heavier than air.

Information on the physical characteristics of flammable chemicals can be found on manufacturer's container labels, and on Material Safety Data Sheets.

2.2. Classes of Flammable and Combustible Liquids

Flammable and combustible liquids are divided into several classes based on the chemical's flash point. Table 2 describes these classes.

Table 2 - Classes of Flammable and Combustible Liquids

Class	Boiling Point °C (°F)	Flash Point °C (°F)	Example
Flammable 1A	<37.8 (100)	<22.8 (73)	ethyl ether pentane
Flammable 1B	≥37.8 (100)	<22.8 (73)	acetone ethyl alcohol
Flammable 1C	-----	22.8 (73) ≤ to ≤37.8 (100)	butanol isoamyl acetate
Combustible 2	-----	7.8 (100)≤ to <60 (140)	formalin cyclohexanone
Combustible 3A	-----	60 (140) ≤	phenol dichlorobenzene
Combustible 3B	-----	≥93.3 (200)	ethylene glycol mineral oil

Source: National Fire Protection Association, 2003, *Flammable and Combustible Liquids Code, NFPA 30.*

2.3. Laboratory Storage of Flammable Liquids

The main objective in working safely with flammable liquids is to avoid accumulation of vapors and to control sources of ignition. To this end, flammable and combustible chemicals must be stored in flammable storage cabinets or appropriate flammable safety cans.

The quantity of flammable chemicals, liquids, solids and gases, stored in laboratories should be kept at an absolute minimum. If chemicals are purchased in multiple lots for future use, excess containers should be stored in the Chemical Stockroom, or a flammable storage cabinet until needed.

For flammable liquids that must be stored in the laboratory, the preferred storage method is in flammable storage cabinets meeting NFPA standards for liquids or solvents, or in UL or FM approved flammable safety cans. Storage in flammable storage cabinets should not exceed the rated capacity of the cabinet.

Under NFPA Standard 45, a limited quantity of flammable liquids can be stored in the laboratory, in addition to that stored in flammable storage cabinets and safety cans. No containers larger than 5 gallons, may be stored in the laboratory.

Table 3 - Laboratory Storage Limits of Flammable and Combustible Liquids *(Outside of flammable storage cabinets and safety cans)*[8]

Lab Type	Liquid Class	Per 100 ft² floor space*
Instructional	1A, 1B, 1C (total)	1 gallon
	1A-C, 2, 3A (total)	1gallons
All Others	1A,1 B, 1C (total)	2 gallons
(NFPA Class C)	1A-C, 2, 3A (total)	4 gallons

Source: National Fire Protection Association, 2004. *Fire Protection for Laboratories Using Chemicals*, NFPA 45.

Storage of flammable liquids must not obstruct any exit.

If refrigeration of volatile flammable chemicals is required, the refrigerator or freezer must meet NFPA Standards for flammable storage. (See Subsection 2.6. below.)

The following precautions should always be followed when working with flammable chemicals.

- Minimize the release and accumulation of flammable vapors.

[8] The maximum amount that may be stored within a laboratory outside approved safety cans, storage cabinets, or flammable storage rooms is 10 gallons. Approved flammable storage cabinets may contain a maximum of 50 gallons of Class I and II liquids, or 120 gallons of Class I, II, and III combined. Only three cabinets are allowed in a fire area.

Bulk quantities of flammable liquids, such as 30 or 55 gallon drums, must be stored in properly designed indoor storage rooms or outside storage areas. Indoor storage rooms containing flammable and combustible liquids must meet the requirements of OSHA Standard 1910-106(d). These standards include spill control measures, spark-proof electrical fixtures, fire suppression equipment, and ventilation requirements.

- Use flammable liquids in fume hoods whenever possible, particularly when transferring large quantities, or heating in open containers.
- Always use flammable gases in a fume hood.
- Never use open flames in the same room where flammables are being used.
- Control other sources of ignition and heat in the laboratory such as electric motors and ovens in areas where flammable vapors are expected to exceed 10% of the lower flammability limit.
- Use non-sparking equipment and control static electricity.
- Use steam baths, heating baths, or explosion proof heating equipment for heating.
- When transferring flammable liquids in metal containers, ground and bond the containers.
- Minimize the generation of dust when handling flammable solids.
- Minimize the amount of flammable chemical or other combustible materials (e.g., paper) in the vicinity of the handling area.

2.4. Bulk Storage and Dispensing of Flammable Liquids

Flammable liquids that are dispensed from bulk containers (≥ 5 gallons) into must be done safely. Only faculty, staff, or students specifically trained by the faculty may dispense these solvents. These solvents can only be dispensed into approved (Underwriters Lab or Factory Mutual) flammable safety cans, equipped with spring loaded covers and flame arresters, with the sole exception being when contamination from the metal container is a concern. The dispensing drum must be grounded and the receiving metal container bonded (connection between the drum and safety can) to prevent accumulation of static electricity. (See 9.4.1.2 below.)

2.5. Grounding and Bonding of Flammable Containers

The act of pouring flammable liquids can also generate static electricity. The development of static electricity is related to the humidity levels in the area. Cold, dry atmospheres are more likely to facilitate static electricity. Bonding or using ground straps for metallic or non-metallic containers can prevent static generation. When transferring flammable liquids from one metal container to another, electrically bond them together. Bonding can be direct, as a wire attached to both containers, or indirect, as through a common ground system. When grounding non-metallic containers, contact must be made directly to the liquid, rather than to the container. In the rare circumstance that static cannot be avoided, proceed slowly to give the charge time to disperse or conduct the procedure in an inert atmosphere.

2.6. Flammable (Explosion-Proof) Storage Refrigerators

Ordinary refrigerators are not protected against electrical shorts that could cause internal sparking, and are not sealed against the release of vapors that could ignite the contents from external sources. Specially constructed “Flammable Materials” refrigerators and freezers have

spark free interiors. In addition to internal spark shielding, “Explosion-Proof” units are also designed for use in environments where there is risk of ignition from outside the refrigerator.

Refrigerators designed for flammable storage should be clearly marked as "approved for flammable storage". Conversely, units not approved, should be clearly marked "Not for Flammable Storage", or other similar wording.

3. REACTIVE CHEMICALS

Reactive chemicals are chemicals that can, under certain conditions, release very large and potentially dangerous amounts of energy. Reactive chemicals can lead to reactions that differ from the routine, mainly in the rate at which they progress. A chemical reaction can be considered routine if the reaction rate is relatively slow or can be easily controlled. It is this question of rate of reaction and ability to control that rate that marks certain chemicals as warranting special precautions and the label “reactive chemical”.

Reactive chemicals can undergo an uncontrollable hazardous reaction under a variety of conditions. Some chemicals are simply unstable and can vigorously polymerize, decompose or condense, or become self-reactive. Others can react violently when exposed to common environmental chemicals or conditions such as water or the components of the atmosphere. Many pure metals, for example, will oxidize on exposure to the atmosphere. Other chemicals are stable except when combined with certain other chemicals. Examples of hazardous combinations are listed in the table “Incompatible Chemicals” in **Appendix H**.

Some reactive chemicals require very little energy of activation to initiate a spontaneous reaction. If the reaction is exothermic, the energy initially produced may accelerate a continued reaction and a release of energy too violent to be controlled. Temperature, shock, static, or light may trigger an uncontrollable reaction. In some combinations one chemical will act as a catalyst reducing the amount of energy normally needed to initiate or sustain a reaction.

Spontaneous decomposition or changes in physical state, even at a slow rate, may create a reactive hazard by creating a less stable chemical. For some chemicals this decomposition is rapid and violent. For others it is so slow as to be imperceptible but results in a byproduct with a much higher reactivity hazard. Peroxides that can form when certain organic chemicals are exposed to air radically increases the hazards of working with those chemicals. The formation of shock sensitive picric acid crystals from an aqueous solution is a serious hazard created by a simple physical state change in the same chemical.

There are some additional hazardous conditions that are not usually attributed to “reactive chemicals” but should be mentioned. Extreme differences in physical state can cause an uncontrollable release of energy. For example, bringing a hot liquid such as oil into contact with a liquid with a lower boiling point such as water will cause instantaneous vaporization of the lower boiling point liquid and a violent release of energy.

3.1. General Safety Procedures for Reactive Chemicals

Faculty and laboratory supervisors must ensure that lab workers are familiar with these procedures whenever working with reactive chemicals:

- Find out as much as possible about the reagents and procedures before the experiment.
- Investigate the purity of the materials. Determine whether impurities or spontaneous decomposition products (such as peroxides) will make the experiment more hazardous.
- Conduct small-scale preliminary experiments, to assess the thermodynamic and physical properties of the reaction.
- Use as little of the chemical or as dilute a solution as possible.
- Consider all methods of controlling reaction variables. The rate of addition can be controlled as well as the rate at which the energy of activation is supplied. Cool exothermic reactions adequately to control the reaction rate. Remember to provide cooling arrangements for both liquid and vapor stages if appropriate. Pressure relief valves should be included in pressurized systems and checked before adding chemicals to the system.
- Determine the proper degree of agitation and mixing rate. Add oxidants slowly with appropriate cooling or mixing.
- Use a face shield in addition to goggles when appropriate.
- Work in a fume hood using the sash as a protective shield.
- Have emergency equipment at hand. Be certain that you know where the nearest fire extinguisher is and that it is appropriate for the type of potential fire hazard (See Section IV, for Classes of Fire Extinguishers). It is important to consider not only which type of extinguisher would be most effective but also if a particular type of extinguishing medium would cause an increased hazard. For example, diborane, pentaborane, and diethyl zinc react violently with halogenated extinguishing agents.
- Notify people in the laboratory of any new or unique hazards that could potentially be created by use of a reactive chemical.

Appendix M provides examples of reactive chemicals, compiled from several general references. The Material Safety Data Sheet should always be consulted to determine a specific chemical's reactive characteristics.

3.2. Oxidizers

Oxidizers are chemicals that can readily provide reactive oxygen under certain conditions. When contaminated with organic materials, (e.g., wood. paper, organic chemicals), or other easily oxidizable chemicals, (e.g., metal powders), oxidizers can form unstable and explosive compounds sensitive to shock.

bromine and compounds chlorine and compounds	nitric acid nitrites

chromates and dichromates chromium trioxide chromic acid fluorine iodine and compounds manganese dioxide nitrates	nitrogen trioxide permanganates peroxides persulfates phosphomolybdic acid picrates sodium bismuthate sulfuric acid

3.3.Water Exposure Sensitive

Water reactive chemicals can develop pressure; generate flammable, explosive, corrosive or toxic gases; or ignite or explode when exposed to water or moisture.

alkali and alkaline-earth metals (sodium, lithium, calcium, potassium, magnesium) aluminum chloride anhydrous metal halides (aluminum tribromide, germanium tetrachloride) anhydrous metal oxides (calcium oxide) benzoyl chloride	calcium carbide calcium oxide nonmetal halides (boron tribromide, phosphorous pentachloride) nonmetal halide oxides (inorganic acid halides, phosphoryl chloride, sulfuryl chloride, chlorosulfonic acid) non-metal oxides (acid anhydrides, trioxide)

3.4. Pyrophoric (Air Exposure Sensitive)

Pyrophoric liquids, solids and gasses are materials that may ignite or react violently when exposed to air. Many pyrophoric chemicals are also water reactive.

alkylmetal derivatives (ethoxydiethylaluminum and dimethylbismuth chloride) analogous derivatives of nonmetals including diborane, dimethylphosphine, triethylarsine, dichloro(methyl)silane carbonylmetals (pentacarbonyliron and octacarbonyldicobalt) finely divided metals (calcium, titanium) metal hydrides (potassium hydride and germane)	partially or fully alkylated metal hydrides (diethylaluminum hydride, triethylbismuth) sodium methoxide sec-butyl lithium triethylaluminum white phosphorus

3.4.1. Special Handling and Storage Precautions for Pyrophoric Chemicals

A glove box may be used with pyrophoric material if an inert environment is required. The lab principal investigator is responsible for ensuring that laboratory staff and students are trained and competent before using a glove box.

If the potential exists for explosion or a high thermal reaction, additional shielding should be utilized. This may involve the use of shielding in a glove box or in the case of a fume

hood with the sash in the lowest possible position. Portable shields may also be used for additional protection.

Store pyrophoric material away from heat/flames, oxidizers and water sources. Keep containers closed and ensure that manufacturer's labels and warnings remain intact. Always check the MSDS for incompatibilities when storing pyrophorics.

Avoid storing pyrophoric material by exits.

3.4.2. Decontamination Procedures

Cleanup and decontamination may require the use of activated carbon adsorbent or other nonreactive material. Review the MSDS for additional guidance.

3.4.3. Pyrophoric Waste Disposal

Handling and disposal of pyrophoric chemicals should be done in accordance with lab protocol established by the principal investigator (PI). Removal of potentially pyrophoric material from a glove box may involve placing material in a zip-lock bag, quenching materia or placing material under water. The PI must ensure that these procedures are clearly communicated and that the supplies necessary are available prior to using the pyrophoric.

3.5. Temperature Sensitive

Temperature sensitive chemicals may decompose when held above their maximum safe storage temperature resulting in pressure buildup, flammable or explosive gas generation, ignition or explosion.

certain oxidizers (perchlorates, chlorates, nitrates, bromates, chlorites, iodates) certain "azo" compounds	lithium nitrate organic peroxides phenylhydrazine hydrochloride

3.6. Spontaneous Decomposition Susceptible

Spontaneous Decomposition - chemicals which change structure over time and with no apparent stimulation will develop pressure, generate flammable or explosive gases, ignite or explode.

benzoyl peroxide (dry) contaminated concentrated hydrogen peroxide nitroglycerine	

3.7. Shock, Friction and Static Discharge Sensitive

Shock, Friction, and Static Discharge Sensitive are chemicals that will violently decompose when initiated by shock, friction, or static discharge.

acetylides azides contaminated oxidizers diazo compounds explosives fulminates halamine	nitro compounds nitroso compounds organic nitrates organic and inorganic peroxides (see below) ozonide picric acid (trinitrophenol)

3.8. Peroxide Formers

Many common laboratory compounds can form peroxides when exposed to air over a period of time. A single opening of a container to remove some of the contents can introduce enough air for peroxide formation to occur. Since they may have been packaged in an air atmosphere, peroxides can form even if the container has not been opened. Other peroxide forming chemicals are explosive only when concentrated (e.g. after distillation). Many explosions have occurred during distillation of peroxide-containing substances particularly when the distillation has been taken to or near to dryness.

Crystal formation or cloudy appearance inside a container is a possible sign of peroxide formation. Crystal formation is most likely (and most hazardous) around the cap. Friction caused just by turning the cap to open the container can cause an explosion that ignites flammable solvent in the container.

Accidental preparation of organic peroxides can occur by mixing ketone solvents (most commonly acetone) with waste materials containing hydrogen peroxide or other oxidizers and leaving the mixture standing for several hours.

Peroxide formation can also occur in many polymerizable unsaturated compounds. These peroxides can initiate an uncontrolled, and sometimes explosive, polymerization reaction.

Organic peroxides tend to react, explosively, with metals, such as cobalt, copper, iron and metal oxides. They also react with salts and acids.

Organic peroxides are sensitive to light and have to be stored in darkness. Some decompose at room temperature and release gaseous products; gas ejectors on the lids of the containers are required. Based on the Self Accelerating Decomposition Temperature[9], some peroxides have to be stored refrigerated.

Structural Groups of chemicals that can form peroxides, (listed in order of decreasing hazard) include:

[9] The **self-accelerating decomposition temperature** (**SADT**) is the lowest temperature at which an organic peroxide in a typical vessel or shipping package will undergo a self-accelerating decomposition. This reaction can be violent, usually rupturing the vessel or container dispersing peroxide, liquid and gaseous decomposition products considerable distances. The heat generated may auto-ignite flammable vapors.

Organic Structures:	Inorganic Structures:
ethers and acetals with alpha hydrogen atoms olefins with allylic hydrogen atoms chloroolefins and fluoroolefins vinyl halides, esters, and ethers dienes vinylacetylenes with alpha hydrogen atoms alkylacetylenes with alpha hydrogen atoms alkylarenes that contain tertiary hydrogen atoms alkanes and cycloalkanes that contain tertiary hydrogen atoms acrylates and methacrylates secondary alcohols ketones that contain alpha hydrogen atoms aldehydes ureas, amides, and lactams that have a hydrogen atom on a carbon atom attached to nitrogen.	alkali metals, especially potassium, rubidium, and cesium metal amides organometallic compounds with a metal atom bonded to carbon metal alkoxides

While no definitive amount of peroxide concentration is given in the literature, a good rule of thumb to follow is that peroxide levels of 10 ppm and below are considered safe. Peroxides detected above 10 ppm should be disposed as hazardous waste. A concentration of 50 ppm or more should be considered dangerous.

Compounds that are suspected of having very high peroxide levels because of age, unusual viscosity, discoloration, or crystal formation should be considered extremely dangerous. If you discover a container that meets this description, DO NOT attempt to open or move the container. Notify other people in the lab about the potential explosion hazard and notify EH&S at extension 2252 immediately.

Other chemicals, such as dinitroglycerine and germane, are “shock-sensitive”, meaning that they can rapidly decompose or explode when struck, vibrated or otherwise agitated. These compounds become more shock-sensitive with age.

A list of common peroxide forming chemicals and their recommended disposal schedule can be found in **Appendix K**. Every effort should be made to follow this schedule

3.9. Student Use Protocols

If a student will be using reactive chemicals, the faculty member must develop a written protocol outlining the experimental procedure to be followed, necessary protective equipment and safety precautions and emergency procedures. This protocol must be provided to, and reviewed with the student.

3.10. Special Handling and Storage Precautions For Peroxide Forming Chemicals

- As with any hazardous chemical, but particularly with peroxide forming chemicals, the amount of chemical purchased and stored should be kept to an absolute minimum. Only order the quantity of peroxide forming chemical that you can use within 18 months (the maximum limit for unopened containers.)
- Strictly adhere to the storage time limits for the chemical, and discard opened containers according to the schedule in **Appendix K.**
- Affix a "Peroxide Warning label (Figure 5, below), and record the date when the container is received into stock, and again when it is first opened.

Figure 3 - Peroxide Warning label

WARNING - PEROXIDE FORMING MATERIAL

Store, manage and dispose of this chemical according to the schedule listed in the Laboratory Safety Handbook, **Appendix K**. Keep in tightly closed original container. Avoid excessive exposure to light, air and heat. If the container has visible evidence of crystals, or contains a precipitate, **DO NOT OPEN OR DISTURB THE CONTAINER**. Call the Director of EH&S at Ext. 2252.

DATE PURCHASED: _____ DATE OPENED: _____

PEROXIDE TEST RESULTS

Once opened, test for peroxides every 6 months.

Date: _____ **Date: _____**

Test Results: _____ **Test Results: _____**

- Inventory chemical storage areas at least twice a year to detect forgotten items, leaking containers, and those that need to be discarded.
- Minimize peroxide formation in ethers by storing in tightly sealed containers placed in a cool place in the absence of light. Do not store ethers at or below the temperature at which the peroxide freezes or the solution precipitates.
- Know the properties and hazards of all chemicals you are using through adequate research and study, including reading the label and the MSDS, including the "Self Accelerating Decomposition Temperature".
- Visually or chemically check for peroxides of any opened containers before use. Peroxide Test Strips are available from many sources (Sigma-Aldrich, Fisher Scientific, Lab Safety Supply, etc.). Opened containers should be checked with peroxide test strips, at a minimum, every 6 months.
- Avoid the distillation of peroxide formers without first testing for the existence of peroxides in the material. Most explosions with the use of peroxide formers occur when a material is distilled to dryness. Leave at least 10-20% bottoms. Stir such distillations with a mechanical stirrer or a bubbling inert gas. Air or an oxygen containing mixture should never be used for bubbling as a stirring.

- Do not use solutions of peroxides in volatile solvents under conditions in which the solvent might be vaporized. This could increase the concentration of peroxide in the solution.
- Do not use metal spatulas or magnetic stirring bars (which may leach out iron) with peroxide forming compounds, since contamination with metals can lead to explosive decomposition. Ceramic, Teflon or wooden spatulas and stirring blades are usually safe to use.
- When working with peroxidizable compounds, wear impact-resistant safety eyewear and face shields. Visitor specs are intended only for slight and brief exposure, and should not be used when working with peroxidizable compounds.
- Clean up spills immediately. The safest method is to absorb the material onto vermiculite or a similar loose absorbent.
- Do not use glass containers with screw-top lids or glass stoppers. Instead, use polyethylene bottles with screw-top caps.

3.10.1. Spills

Clean up peroxide forming chemical spills immediately.

- Don PPE.
- Absorb the spill with an inert material (vermiculite, "Speedi-Dri," or kitty litter, found in the spill kit.
- Before scooping up the absorbent, wet it thoroughly with water.
- Scoop up and dispose of the contaminated absorbent into a plastic bag-lined pail that has a snap-on or screw- on lid. (Use the pail the absorbent was stored in, or call the Director of EH&S for another).
- Add additional water to the absorbent in the pail to ensure that is thoroughly wetted.
- Tie the bag, and screw the lid on the pail tightly.
- Wash the spill area with water and detergent, then rinse again to ensure that there is no residue remaining.
- Label the waste container (pail) with a Hazardous Waste label, and take to the 180-Day Storage Area.
- Report the spill to the Chemical Hygiene Officer.

4. CORROSIVES

Corrosives are one of the most commonly encountered hazards in the laboratory. Corrosives are chemicals that can cause visible destruction of, or irreversible alteration in living tissue, as well as destruction of other materials. The major classes of corrosive chemicals are:

- Strong acids and bases,

- Dehydrating agents, and
- Oxidizing agents.

Some chemicals, such as sulfuric acid, belong to more than one class. In addition many corrosives have other hazards such as reactivity (e.g., perchloric acid), flammability (e.g., organic acids), or toxicity (e.g., phenol).

The strength of acids and bases is defined as the degree of ionization of the acid or base in water. The inorganic or mineral acids, such as hydrochloric acid, a strong acid, generally ionize more than the organic acids, such as acetic acid, a weak acid. Similarly, sodium hydroxide is highly ionized and classified as a strong base, whereas ammonium hydroxide is slightly ionized and characterized as a weak base. The concentration of the acid or base, which is unrelated to its strength, refers to the percentage of the chemical dissolved in water. The corrosivity of acids and bases is dependent on their strength and concentration.

Dehydrating agents, such as sulfuric acid, sodium hydroxide, calcium oxide, and glacial acetic acid, are corrosive because of their strong affinity for water. This reaction with water is extremely exothermic. Because of this exothermic reaction with water, concentrated acids should always be added slowly to water. If water is added to the concentrated acid, the rapid generation of heat can cause the water to vaporize, causing the hot concentrated acid solution to splash.

Many oxidizing agents such as halogens, peroxides, nitric acid, and chromic acid are also corrosive, in addition to their fire and explosion hazard.

Corrosives can damage human tissue in their solid, liquid and vapor state. Acute hazards can be manifested as burns, ulceration, permanent tissue damage, or toxic effects. Many corrosives also have chronic hazards, as repeated exposure to even dilute solutions or vapors can cause dermatitis, bronchitis, or eye damage. Acid burns are generally perceived as more painful, which is due to the formation of a protective protein layer, which resists further penetration of the acid. In fact, tissue damage from bases is often more serious, as no protective layer is formed, and the injury penetrates deeper. The destructive effect of corrosives is greatly increased when they are used at elevated temperatures.

In addition to the health hazards, the physical hazards posed by many corrosives must also be remembered. For example, many inorganic acids release flammable hydrogen gas when in contact with metals, posing a serious fire and explosion hazard.
The following are examples of some of the hazards of commonly used corrosives. The list is by no means exhaustive. The hazards of each corrosive should be thoroughly investigated prior to its use.

Sulfuric Acid is a strong acid, a dehydrating agent, and an oxidizing agent when heated. As a dehydrating agent, it is highly water-reactive, generating tremendous amounts of heat on contact with water. It is very destructive to tissue and metals, and releases flammable hydrogen gas on contact with active metals (e.g., Rb, K, Ca, Mg, Al, Mn, Zn, Fe, Ni, Na). Fuming sulfuric acid is even more hazardous and produces extremely hazardous vapors.

Nitric Acid is a strong acid and powerful oxidizing agent. It can release hydrogen on contact with most metals. Nitric acid is extremely corrosive and its vapors toxic. The vapors contain nitrogen oxides which can cause delayed respiratory distress, pulmonary edema (fluid in the lungs) and death. Nitrogen oxides can also be released as a reaction with metals. Fuming nitric acid is more dangerous than regular nitric acid, again due to the presence of nitrogen oxides. Fuming nitric acid is listed as an acute toxin in Chapter V(h).

The Halogen Acids **include hydrofluoric, hydrochloric, hydrobromic, and hydriotic acid**. The corresponding acid gases hydrogen fluoride, hydrogen chloride, hydrogen bromide, and hydrogen iodide are very soluble in water; upon exposure to moisture on the body, formation of the acid occurs. All are strong acids and release hydrogen on contact with active metals.

Hydrofluoric acid is extremely corrosive and attacks glass as well as metal. It is extremely dangerous in all concentrations. It causes severe, slow-healing burns, to tissue that may not be noticed for several hours. It can also cause severe and permanent damage to the respiratory system, including fatal pulmonary edema, and blindness. In addition to these corrosive effects, it can cause delayed systemic poisoning including depletion of tissue calcium and magnesium.

HF is listed as an Acute Toxin in **Appendices C-(1) and C-(2).** Special handling instructions are included later in this Section.

Perchloric Acid is a strong acid and at temperatures above 160oC a strong oxidizing and dehydrating agent. It may decompose explosively when heated; and if distilled, dried, or reacted with dehydrating agents or any oxidizable materials, the mixture may spontaneously explode. It forms flammable hydrogen gas on contact with many metals; and forms explosive metal perchlorates on contact with certain metals. Perchloric Acid is especially hazardous at concentrations above 70%.

Acetic Acid is a severe irritant to the skin and eyes. Severe irritation can occur at 25 ppm, but eye damage can occur at lower concentrations. Glacial (100%) acetic acid causes severe eye and tissue damage, is a dehydrating agent, reacts violently with oxidizing agents, and has a flash point of 110oF.

Phenol is a crystalline solid that adsorbs moisture from the air. In addition to being corrosive, it is highly toxic and readily absorbed through the skin in liquid or vapor phase.

Sodium and Potassium Hydroxide are strong corrosives and often referred to as caustics, a term referring to hydroxides. They are both solids which readily absorb water; and can absorb enough water from the skin to cause severe injury if not washed off immediately. They are both dehydrating agents. They cause severe and permanent eye damage. At low

concentrations, the sensation of irritation may not occur for several hours, and can result in severe ulceration. They are even more hazardous in heated solutions.

- Always investigate the additional hazards such as flammability and reactivity.
- If only a small amount is needed, purchase in small quantities for easier handling and storage.
- Purchase in plastic coated bottles whenever possible.
- Always use a bottle carrier or some other means of containment when moving chemicals from the stockroom to the laboratory, or between laboratories.
- Store separately from incompatible materials.
- Wear appropriate protective equipment, always including splash goggles.
- Always add chemicals slowly, and always add acid to water, never water to concentrated acid.
- Keep ignition sources away from inorganic acid spills which may produce flammable hydrogen gas on contact with metals, and from glacial acetic acid which is itself a fire hazard.
- When neutralizing corrosives, never add a concentrated acid to base or a concentrated base to acid.

4.1. Special Precautions For Perchloric Acid[10]

- Prior to use of perchloric acid at concentration greater than 70%, or involving heating of the acid above 160°C, you should consult with the Chemical Hygiene Officer.
- The number of people using the acid should be limited to the extent possible, and all users should be familiar with the chemistry of the acid, its hazards, proper handling procedures and emergency procedures.
- Direct flame heating or use of oil baths is prohibited.
- Perchloric acid should never be used in areas where the material would be absorbed if spilled.
- Perchloric acid should be purchased on an as-needed basis in small containers and must be stored separately from incompatible materials.
- Prior to performing experiments using perchloric acid, disposal procedures should be defined. In general, concentrated acid should be stirred into cold water until the concentration in less than 5%, the acid should then be neutralized with an aqueous solution of sodium hydroxide. The resulting solution should be disposed of as hazardous waste.
- Spilled solutions must not be allowed to dry. They should be neutralized and then soaked up with rags or paper towels. The area should then be rinsed with a large quantity of water. The wet rags or paper towels should be placed in a container, and the container filled with water and tightly closed. The container should be disposed

[10] Refer to Furr A.K. (ed.), 1990. CRC Handbook of Laboratory Safety, 3rd Edition., and Schilt, A.A., 1979. Perchloric Acid and Perchlorates.

of as hazardous waste.

4.2. Special Precautions For Hydrofluoric Acid

- A written protocol is required for the use of hydrofluoric acid. The protocol must be submitted to the Chemical Hygiene Officer and reviewed with all laboratory faculty, staff, and students. Protocols for Acute Toxins found in Section V are required for HF.
- The number of people using the acid should be limited to the extent possible, and all users should be familiar with the chemistry of the acid, its hazards, proper handling procedures and emergency procedures.
- When possible the acid should be purchased at the concentration to be used to avoid preparation of solutions.
- Hydrofluoric acid should be purchased on an as-needed basis in small containers.
- Always use in a functioning fume hood with the sash as low as possible and no higher than 15 inches.
- Only use in a room equipped with an eyewash station and safety shower.
- Keep ignition sources away from the area.
- Wear chemical splash goggles, a face shield providing face and neck protection, neoprene or polyvinyl chloride gloves, and non-absorbent resistant clothing.
- Dispose of protective clothing and wash thoroughly after each use.
- Use only resistant equipment (e.g., polyethylene, Teflon. Do not use glass).
- First aid procedures listed in **Appendix L** must be posted in the area of use.
- **Calcium gluconate** must also be available in the area of use.

Prior to performing experiments using hydrofluoric acid, disposal procedures should be defined. In general, waste acid should be collected as hazardous waste.

Spills should be contained and diluted with water, and the resulting solution neutralized with lime prior to disposal.

4.3. Storage

There are several factors that should be taken into consideration when storing acids and bases. First and most important, is to make sure that acids and bases are not stored together. If there were to be a spill, chemical reactions could occur if they are stored in the same storage area. Second, make sure you check the MSDS of the acid or base to determine you are not storing incompatible chemicals together.

Mineral acids, including phosphoric, hydrochloric, nitric, sulfuric, and perchloric acid should be stored in a cabinet designed for Corrosive Acids. These non-metallic cabinets

have no internal metallic parts, and include an acid resistant coating, and a cabinet floor constructed to be able to contain spillage.

Volatile acids, such as oleum or fuming nitric acid, should be stored either in an acid cabinet or in a vented cabinet, such as the fume hood base, particularly after they have been opened. Concentrated mineral acids can be very reactive, even with each other, and should be segregated in separate trays within the cabinet.

Concentrated acids can even react vigorously with dilute solutions of the same acid, if mixed together rapidly. For example: concentrated sulfuric acid mixed quickly with 1 molar sulfuric acid will generate a lot of heat. Different concentrated acids should be stored apart. If stored within the same cabinet, they should be segregated in separate plastic trays, tubs or buckets within the cabinet.

Acetic acid is an organic acid and should be stored separately from mineral acids. Since it is also flammable, it is best stored with other flammable liquids.

Picric Acid can form explosive salts with many metals, or by itself when dry.

Perchloric Acid is an extremely powerful oxidizer and must be kept away from all organic materials, including wood.

Inorganic Bases (hydroxides, carbonates, etc.) should be stored in a Bases or Corrosive Cabinet. If they cannot be stored separately, use secondary containment to separate from other acids and bases. (for example: inorganic acids, oxidizing acids)

5. COMPRESSED GASES

Compressed gases are a high-energy source hazard due to the great amount of pressure in the cylinder, and can pose a chemical hazard due to the hazard of gas itself. Large cylinders may weight 130 pounds or more and can pose a crush hazard to hands and feet.

- Always attach the proper regulator, designed for the particular gas that is being used. Cylinder valves have been standardized for specific families of gases to prevent the interchange of regulator equipment between gases that are not compatible. Do not force the fitting of a regulator to a cylinder.
- Before attaching the regulator, "crack" a secured cylinder by opening the valve slightly then closing it immediately to blow out dust or dirt from the valve outlet. Use two hands on the valve and stand at the side of the valve - never stand directly in front of or behind the valve outlet.
- Do not crack fuel gases near ignition sources.
- Never crack hydrogen cylinders since the release of compressed hydrogen may ignite by itself.

- Be sure that all components of a distribution system are compatible with the gas in use. Corrosive gases require special attention to the materials in the distribution system.
- Bond and ground all cylinders and piping containing flammable gases to prevent the hazards caused by the buildup of static electricity.
- Door signs should be posted in rooms in which flammable compressed gases are present.
- Never mix gases in a cylinder, unless it is a specially designed cylinder such as for calibration gases.
- Never completely empty a cylinder. Leave a slight pressure (about 25 pounds) to keep out contaminates that may react with the contents or corrode the cylinder.
-

5.1. Compressed Gas Cylinders Storage

5.1.1. Delivery Area Storage

- Storage areas for compressed gases must be in a secured area. Storage in hallways is not allowed.
- Oxygen (or other oxidizers) and flammable gases should be stored in areas separated by at least 20 feet, or by a noncombustible wall.
- The valve protection cap must be kept on at all times, except when a cylinder is in use.
- Store cylinders away from heat sources
- Each cylinder must be chained or strapped tightly in place to prevent it from falling over. Cylinders must be secured individually. The attachment point must be below the neck and tapered portion of the cylinder, in such a manner as to prevent any possibility of falling.
- Corrosive gases should be stored for the shortest possible time period; preferably three months or less.
-

5.1.2. Laboratory Storage

Cylinders storage in the laboratory should be limited to lecture bottle size cylinders. These cylinders pose the same hazards as larger cylinders, and storage should comply with the standards listed above for Delivery Area Storage. Large cylinders should be stored in the laboratory only if they are in active use.

5.1.3. Inspection Of Cylinders

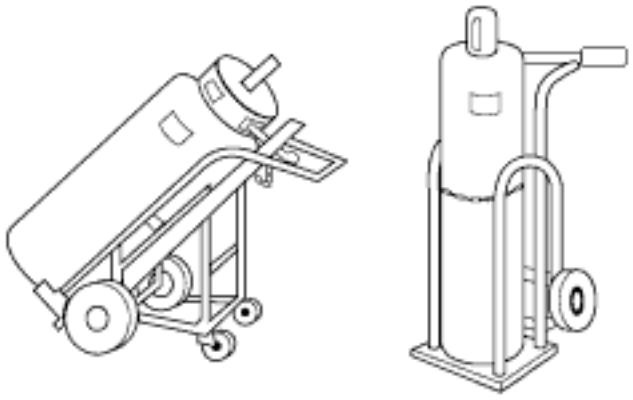
Before moving, inspect cylinders for:

- Signs of damage or corrosion.
- Presence of a valve protection cap
- A DOT or ICC label
- The date of the last hydrostatic test (usually stamped on the cylinder just below the serial number)[11]
- Labels or stenciling identifying the contents. Color-coding is not acceptable as a contents label, because there is no universal color code for identifying gas cylinders.
- Identity of the manufacturer.

5.1.4. Moving Cylinders

Faculty, staff, or trained students will move large cylinders from the Delivery Area to the laboratory.

- Always consider cylinders full and handle them accordingly; the same hazards exist even if the cylinder is only partially full.
- Use a hand truck or trolley to transport cylinders that cannot be easily carried. Do not drag, roll, or slide cylinders.
- The valve protection cap should remain on until the cylinder has been secured in its final position and is ready for use.
- Never drop a cylinder or permit cylinders to strike each other violently.
- Protect cylinders from any object that will produce a cut or abrasion in the surface of the metal.



Cylinder Trolleys

- Mount cylinders so that the valve is easily accessible and the label is readable.
- Always chain or strap cylinders immediately. Cylinders must be secured individually. The attachment point must be below the neck and tapered portion of the cylinder. Never use or move a cylinder into a laboratory if equipment is not available to secure it.

5.2. Special Precautions For Acetylene

Acetylene is the most common gas used for fueling cutting torches, and when mixed with pure oxygen in a cutting torch assembly, an acetylene flame can theoretically reach over 5700°F. Users of this type of equipment are generally familiar with the fire hazards

11 Most cylinders must be tested every five years. Cylinders that only require testing every ten years have a five pointed star stamped next to the date.

associated hot flames and the production of hot slag. However, many users may not be aware of the unique characteristics of acetylene itself that create special hazards compared to other fuel gases.

An acetylene molecule is composed of two carbon atoms and two hydrogen atoms. The two carbon atoms are held together by what is known as a triple carbon bond. This bond is useful in that it stores substantial energy that can be released as heat during combustion. However, the triple carbon bond is unstable, making acetylene gas very sensitive to conditions such as excess pressure, excess temperature, static electricity, or mechanical shock.

- Acetylene in cylinders is dissolved in acetone, and stabilized in vermiculite inside the cylinder. If stored or used on its side, the acetone in the tank can be burned off, causing the acetylene to become unstable. Acetylene tanks should always be used in an upright position. Do not use a cylinder that has been stored or handled in a non-upright position until it has remained in an upright position for at least 30 minutes.
- Gaseous acetylene under pressure may also decompose with explosive force, and should not be used at pressures in excess of 15 psig (30 psi absolute pressure). Acetylene pressure gauges should have a warning red line at this point.
- A flash arrester must protect the outlet line of an acetylene cylinder.
- Use the correct kind of tubing to transport the gaseous acetylene. Some tubing materials, such as copper, form explosive acetylides.

5.3. Special Precautions For Oxidizing Gases

Oxidizers under pressure (oxygen, chlorine, etc.) will rapidly oxidize organic material, such as oil or grease, resulting in an explosion. Never use oil or grease on valves or gauges intended for oxygen cylinders.

6. CRYOGENS

Cryogenics is the science of very low temperatures. An accepted temperature used to distinguish between refrigeration and cryogenics is -73.3oC (-100oF). Low temperatures in the cryogenic range are generally obtained by the liquidification or solidification of gases. The most commonly used cryogens and their properties are listed in Table 3.

The primary hazard of cryogenic materials is their extreme coldness, which can result in frostbite and severe tissue damage. Accumulated vapors may also act as an asphyxiant. Liquid gases are extremely concentrated relative to room temperature gases and, consequently, their potential hazards are magnified. Liquefied inert gases, such as nitrogen, in contact with cold metal surfaces can cause condensation of oxygen from the room air resulting in an oxygen enriched atmosphere and, consequently, an increase fire hazard. The

low temperatures involved also affect the properties of other materials; for example, rubber may become brittle and disintegrate and some metal alloys may become brittle.

Table 3 – Commonly Used Cryogens

Gas	Normal Boiling Point (°-C)	Flammable	Toxic	Odor
Carbon dioxide	-78	No	Yes	Slightly pungent
Hydrogen	-252.7	Yes	No	No
Nitrogen	-195.8	No	No	No
Helium-3	-269.9	No	No	No
Argon	-185.7	No	No	No
Fluorine	-187.0	No	Yes	Sharp
Oxygen	-183.0	No (Oxidizer)	No	No
Methane	-161.4	Yes	No	No

Cryogens have very high liquid:vapor expansion ratios. For example, liquid nitrogen expands to 700 times its initial volume when it vaporizes. For liquid hydrogen, 22 cubic feet can expand to fill 16,000 cubic feet. This rapid expansion can cause a displacement of oxygen and consequently a life threatening asphyxiant atmosphere.

6.1. Storage And Handling Precautions

These are general precautions. The faculty or supervising staff member responsible for the cryogenic operation should establish more specific safety guidelines.

- Store and use cryogens only in containers and equipment recommended for cryogenic service.
- Avoid confined areas where vaporization occurs (e.g., do not put your head in the dry ice container).
- Ensure that all apparatus is properly vented to prevent accumulation of pressure and be cognizant of ice blocks that could block vent lines.
- Always wear chemical splash goggles and a face shield in cases where there is a likelihood of contact.
- Always wear long sleeves and/or a lab coat.
- Watches, rings, or other jewelry that could trap the material next to the skin should not be worn.
- If gloves are necessary to handle containers or cold metal parts, they should be impervious and loose enough to be thrown off in the case of contamination.
- Liquid nitrogen, liquid air, or any other cryogen with a normal boiling point of < 183oC should be used to cool a flammable mixture in the presence of air, as oxygen can condense from the air leading to an explosive mixture.
- Equipment must be kept clean to avoid contamination of organics with a cryogenic oxidant (e.g., liquid oxygen) or oxidants with cryogenic fuel (e.g., liquefied natural gas).

- When flammable cryogens are being used, eliminate potential ignition sources.
- Flammable and toxic gases should only be used in a fume hood.
- If liquid nitrogen has a blue tint, it has been contaminated with oxygen and should be replaced. The contaminated material is dangerous and potentially explosive.
- When spilled, liquid oxygen soaks into materials it comes into contact with, and the resulting mixture may be explosive.

SECTION VIII – BIOLOGICAL SAFETY

The Recombinant DNA/Biological Safety Manual provides guidance and information regarding biological safety at Connecticut College. Oversight for biological safety issues is the responsibility of the Connecticut College Institutional Biosafety Committee (IBC). The responsibilities of the IBC include addressing biosafety issues and policies supporting the safe use of biological materials, and the elimination or reduction of exposure to potentially biohazardous materials and agents. The IBC facilitates the registration of biological research by providing materials and information to Principal Investigators, and reviews, approves and oversee research utilizing recombinant DNA and biohazardous materials, in accordance with NIH/BMBL Guidelines

The **Connecticut College Institutional Biosafety Manual** provides guidance for laboratory staff engaged in Recombinant DNA research and work with biohazardous materials.

1. Recombinant DNA Research

All recombinant DNA research must be conducted in accordance with the National Institute of Health's NIH Guidelines for Research Involving Recombinant DNA Molecules (September 2009)

2. Microbiological Laboratories

Microbiological Laboratories must comply with the Center for Disease Control's Biosafety in Microbiological and Biomedical Laboratories, 4th Edition (May 1999), and the Connecticut College Institutional Biosafety Manual.

2.1. Laboratory Use Of Human Blood, Blood Products, Body Fluids And Tissue

Human blood, blood products, body fluids and tissue may contain bloodborne pathogens such as the hepatitis B (HBV) and HIV viruses. Special precautions are required to protect students, faculty and staff from exposure to these sources of infection. The Connecticut College Bloodborne Pathogen Exposure Control Program describes procedures for

protection of employees exposed to bloodborne pathogens as required by the OSHA Bloodborne Pathogen Standard, 29 CFR 1910.1030. That Program does not address potential student exposure in the laboratory when human blood, blood products, body fluids and tissue are used. This policy establishes procedures for the use of human blood and tissue in academic laboratories. The procedures described below do not cover the isolation or use of infectious viruses in research. Such use would require more detailed and protective control methods.

2.2. Employee And Research Student Laboratory Use

All faculty, staff, and research students who are potentially exposed to bloodborne pathogens in the laboratory, with the exception of the use of their own blood or tissue, are covered by the Connecticut College Bloodborne Pathogen (BBP) Exposure Control Program, and must comply with its requirements including work practice controls, use of personal protective equipment, housekeeping, labeling, waste disposal, and training. As participants in that Program they are eligible for hepatitis B vaccinations and post-exposure medical evaluation and follow-up.

Prior to the use of human blood, blood products, body fluids, or tissue in any laboratory, the responsible faculty member must contact the Director of Environmental Health and Safety to register her/himself and the potentially exposed staff and research students s/he supervises as participants in the BBP Program. Training must be completed prior to potential exposure.

2.3. Student Laboratory Use

Students may only use their own blood and tissue in the laboratory. Samples must be collected by the student (e.g., finger prick, cheek scraping), or at the Health Center and can only be handled by that student or a trained faculty or staff member. All students in the laboratory must be informed of the potential hazards of bloodborne pathogen exposure.

If samples are collected at the Student Health Center, they must be placed in a second plastic container with a closed lid and a biohazard label, and carried by the student to the laboratory.

Each student must be assigned a discrete laboratory space and all student work is restricted to that location. Each student must also be provided with all equipment and supplies necessary for the experiment. Equipment and supplies cannot be shared between students. Procedures that could result in splashing or generation of aerosols (e.g., open tube centrifugation) are not allowed.

Written instructions must be developed detailing the experimental procedures and describing procedures to prevent contamination of adjacent spaces or other areas of the

laboratory, and to properly decontaminate, or dispose of, all work areas, supplies and equipment.

2.4. Personal Protective Equipment And Personal Hygiene

All students, faculty and staff must wear gloves when in areas or performing operations where there is the potential for contamination. Gloves worn in a potentially contaminated area must be removed or changed before moving to another area of the laboratory. Contaminated gloves must be collected and autoclaved or incinerated as biomedical waste. All student, faculty and staff must thoroughly wash their hands prior to leaving the laboratory. Eating, drinking, applying cosmetics or lip balm or handling contact lenses are prohibited in the laboratory.

2.5. Decontamination And Waste Disposal

All work surfaces and reusable equipment must be decontaminated with a hospital-use rated disinfectant. (Disinfectants with this rating are considered effective against both HIV and HBV). A 1% solution of bleach (1/4 cup per gallon of water) with a 10-minute contact time may be used. (Remember the chemical splash hazard: goggles should be worn when using bleach). Each student must be responsible for decontaminating his or her own work area and equipment. As an alternative, each student could place equipment into the disinfectant and a trained faculty or staff member complete the cleaning process. The faculty member will supervise all decontamination procedures. The used bleach may be discharged to the sewer.

All contaminated sharps (e.g., lancets) must be placed in a needle (Sharps) disposal container designed specifically for that purpose. Full needle containers must be closed securely and disposed of as biomedical waste. All other disposable supplies must be collected in red bags and autoclaved by a trained faculty or staff member, or collected as biomedical waste for incineration.

2.6. Emergency Procedures

In the event that any one in the laboratory becomes contaminated with blood or tissue from another person, the body area should be flushed with water (eyes and mucous membranes) or soap and water (skin), and the person should seek medical attention. For employee exposures, the employee should contact the Occupational Heath and Wellness Manager (x-2793) to report the incident and for referral to Pequot Medical Center for post-exposure evaluation. Students should go directly to the Student Health Center.

3. Select Agents

The Public Health Security and Bioterrorism Preparedness Act of 2002, and the USA Patriot Act of 2001, require that academic and research institutions collect information regarding "select agents" and register and obtain approval for possession with the federal government. The list of select agents is found in **Appendix N**.

In order for Connecticut College to comply with the DHHS Select Agent Regulations (42 CFR 73), and the USDA Agricultural Bioterrorism Protection Act of 2002 regulations (7CFR 331 and 9CFR 121), you must notify and obtain approval from the Institutional Biosafety Committee (IBC) prior to possession of any agent on the list of Select Biological Agents and Toxins, High Consequence Pathogens and Toxins, or Plant Pathogens.

If you are proposing to possess an agent on the list of Select Biological Agents and Toxins, High Consequence Pathogens and Toxins, or Plant Pathogens, the initial step is to file a Select Agent Registration Form (**Appendix O)** to the IBC. Registration with the CDC is required, so you should anticipate a significant delay in obtaining approval, due both to security requirements and procedures that will need to be established at the College, and to extensive review of the application by the CDC. Because of facility restrictions and security requirements, there may be requests that the College cannot accommodate.

All registration requests trigger a Center for Disease Control (CDC) security risk assessment. The CDC Select Agent Program web site has a set of FAQs where you can learn more.

SECTION IX – RADIATION SAFETY

1. Radiation Safety Program

In order to protect the health and safety of Connecticut College employees and the general public, the use of radioactive material (RAM) and radiation producing equipment must adhere to stringent safety procedures. To ensure that Connecticut College's Radiation Safety Program complies with State and Federal regulations and established safe practices, the College has established a Radiation Use Committee (RUC). This committee is responsible for ensuring adherence to policies and procedures for the conducting research involving the use of radiation and RAM.

Specific guidelines for use of RAM and radiation producing equipment are detailed in the "**Radiation Use Program, Policy and Procedures Manual,** and the **Accelerator Safety Manual.**

1.1. Special Storage and Handling Precautions for Uranyl Compounds

Uranyl acetate and uranyl nitrate are water-soluble uranium compounds, and are often used as stains in electron microscopy. Even with the relatively small amounts used in microscopy, there are associated chemical and radiological hazards which require some basic safety precautions to be adopted; with the emphasis on avoiding the possibility of inhalation or ingestion of the material. Uranyl nitrate is also a strong oxidizer.

Uranyl acetate and uranyl nitrate principally contain the isotope 238U of uranium. The specific activity of 238U in laboratory grade uranium chemicals does not exceed 10,000 Bq per gram (where Bq refers to disintegrations per second).

238U is an alpha emitter, but there are also beta and gamma emitting decay products. Typical laboratory quantities of uranyl compounds do not represent a significant external radiation hazard, as alpha particles do not penetrate the external dead layer of skin. The beta energy is very low, and also do not have enough energy to penetrate the skin. The amount of gamma radiation is minimal.

The primary radiological hazard arises from inhalation or ingestion of the uranium compound, which leads to irradiation of lung and bone cells causing an increased risk of cancer. A chemical hazard also arises from inhalation or ingestion, as uranium is a heavy metal and can damage the kidneys.

- Gloves must always be worn when handling uranium salts.
- Always prepare uranyl solutions in a properly working fume hood.
- Avoid contamination of bench surfaces by using spill trays (metal or plastic) with disposable coverings such as benchcote and clean the surface after use.
- After working with uranyl compounds, use a calibrated GM survey meter to monitor for contamination. Apply the same principles when working in solution.
- Label any stock solution or powder with a radioactive warning label.
- Always store uranyl compounds securely in a locked cabinet, or in the chemical Stockroom. Store in secondary containment, to prevent contamination.
- Very old containers that have remained unopened for some time, may contain significant levels of radon (a radioactive gas) and should be opened in a fume hood.

1.2. Waste Disposal

- Uranyl Acetate, Uranyl Nitrate, Thorium Nitrate and solutions containing concentration of these, must be collected and disposed of as radioactive waste. Never combine waste containing uranyl or thorium compounds, with any other chemical waste. Refer to the Waste disposal section of the **Radiation Use Program, Policy and Procedures Manual.**
- If methanol is used to create a uranyl acetate solution, the percentage of methanol must be kept below 10%. If other solvents must be used, contact the Chemical Hygiene Officer beforehand.

- All contaminated solid (dry) waste such as paper towels; pipettes, gloves and other plastic ware must be collected in a plastic bag and labeled with a radioactive waste label.

2. Lasers

Lasers can present a serious hazard to the eyes and skin. High power lasers can produce a fire hazard. There are other associated hazards inherent with certain laser systems such as electrical, chemical, air contaminants, compressed gases, and cryogenics.
It is important that laboratories implement the appropriate control measures to reduce the chance of exposure to these hazards.

Eye Hazards: Injuries can occur to various parts of the eye depending on the laser wavelength. Corneal and retinal injuries can occur from acute exposure, and more subtle injuries such as lenticular opacities (cataracts) are possible from chronic exposures to laser radiation. Within the visible and near-infrared wavelengths (ocular hazard region), light entering the eye can be focused and amplified (100,000 times) onto a small area on the retina. The following table summarizes the effects of laser radiation on the eye:

Wavelength	***Effected Area***
200nm - 315nm	***cornea***
315nm - 400nm	***lens***
400nm - 1,400nm	***retina***
1,400nm - 3,000nm	***cornea/lens***

Skin Hazards. Skin injuries are possible from acute exposure to high-powered laser systems. Chronic skin exposure to wavelengths in the ultraviolet region may lead to carcinogenesis and accelerated skin aging. If the laser system represents a serious skin hazard, appropriate barriers and/or skin protection must be implemented.

Fire Hazards. Class 4 lasers may present a fire hazard. Fire hazards are usually associated with continuous wave lasers operating with a power density of > 2W/cm2. Laser systems with embedded class 4 lasers can result in a potential fire hazard. Flame retardant materials should be used within the enclosure to withstand ignition from the associated laser system. Laser curtains and other barriers can be used to prevent the laser beam from leaving the useful work area during operation. It is important to note that these barriers are usually constructed to withstand only a short duration of high power levels before they are damaged or fail to contain the laser beam.

Electrical Hazards. The high-energy electrical power supply associated with many lasers represents a potential lethal hazard. Injuries from electrical hazards most often occur during laser set-up and servicing when protective housings are removed, exposing active components. Only qualified personnel should be allowed to work the laser's electrical components. The OSHA Lockout/Tagout standard "1910.147" should be followed when

servicing laser systems. Contact the Chemical Hygiene Officer for further information regarding this standard.

Chemical Hazards. Dyes used in lasing medium for dye lasers can be toxic or carcinogenic. These dyes are mixed with a solvent and pumped through the cavity of the dye laser. Procedures in the lab need to be established for handling these materials. Consideration should also be given to the proper disposal of hazardous material. Contact the Chemical Hygiene Officer for information on the safe handling and disposal of these materials.

Compressed Gases. The gases used in operating excimer lasers such as fluorine and HCL can pose a significant hazard in the laboratory. Gas storage, containment, and room exhaust need to be considered when setting up the laser system.

Air Contaminants. High power lasers used for cutting, welding or drilling may give rise to respiratory hazards in the form of toxic fumes and gases. Isolation of the process, exhaust ventilation and respiratory protection are control measures used to protect personnel involved with this kind of operation.

Cryogenic Liquids. The use of cryogenic coolants with laser systems can cause skin burns, displacement of oxygen in poor ventilated areas and explosions because of bad connections.

The **Connecticut College Laser Safety Manual** describes procedures and requirements for personnel protection from laser radiation and other associated hazards. These requirements are designed to comply with 29 CFR___, and ANSI Z136.1.

SECTION X – WASTE DISPOSAL

1. Hazardous (Chemical) Waste

In order to determine proper handling procedures and disposal, a decision must be made regarding whether the chemical waste is a hazardous waste or otherwise regulated. Connecticut Department of Energy and Environmental Protection (CT DEEP) and federal EPA regulations define various categories of hazardous and regulated chemical waste.

Hazardous Waste: A hazardous waste as defined by RCRA is any discarded material that is not excluded by the regulations and that meets any of the following criteria:

It exhibits the characteristics of hazardous waste:

- **Ignitability** – (Flashpoint ≤140 degrees F. Oxidizers are also in this classification.)
- **Corrosivity** – (pH ≤2 or ≥12.5)

- **Reactivity** – (Materials that are unstable under normal conditions, and can explode or create toxic fumes when mixed with water.)
- **Toxicity** – Materials that are harmful or fatal when ingested or absorbed, and have the potential of contaminating drinking water, as determined by TCLP testing. (Toxicity Characteristic Leaching Procedure.) These include:
    - Metals
    - Pesticides
    - Solvents (Particularly Chlorinated solvents.), or;

It is specifically listed in the RCRA section of: "Title III, Consolidated List of Chemicals Subject to the Emergency Planning and Community Right-To-Know Act (EPCRA)." (AKA, The "List of Lists.")

The generator is responsible for determining whether the waste they generate is defined as a "hazardous" waste by regulation. Contact the Chemical Hygiene Officer prior to generating any new waste streams, or for questions regarding existing waste streams.

1.1. Generator Status

Connecticut College is a "Small Quantity Generator" (SQG). A small quantity generator is one who generates greater than 100 kilograms, but less than 1,000 kilograms of hazardous waste in a calendar month, provided that such waste does not include more than:

- a total of one kilogram (or 1 liter) of acute hazardous wastes, or
- a total of 100 kilograms of any residue or contaminated soil, waste, or other debris resulting from the clean-up of a spill, into or on any land or water, of any acute hazardous waste, provided that there is no more than a total of one kilogram of acute hazardous waste contained in that residue, soil, waste or debris.

A small quantity generator may accumulate hazardous waste on-site for 180 days or less, provided that the quantity of waste accumulated on-site never exceeds 1,000 kilograms.

1.2. Hazardous Waste Collection

A Satellite Accumulation Area (SAA) is the location <u>at or near the point of generation</u>, where containers of waste are accumulating as waste is generated. In the laboratory, this is usually in a fume hood.

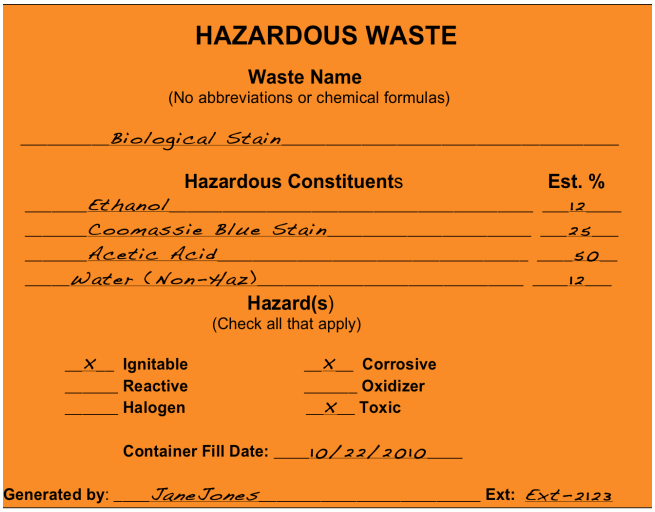
While the waste is being accumulated, it is the responsibility of the supervisor of the area generating the waste to ensure that the waste is properly labeled and managed until it is delivered to the 180-Day Storage Facility:

- Waste must be stored in containers, which are compatible with the waste and have a tight fitting cap or cover.
- Waste containers, which are going to be used as the shipping container must be DOT approved.
- Waste containers must be in a secure location and under the control of the person generating the waste.
- Waste containers must be in good condition, and not leaking, or damaged.
- Waste containers must be stored in secondary containment.
- Waste containers must be tightly closed, except when waste is being added.
- No more than one container of a particular waste can be kept at one time.
- When a container of waste is full, or when the process that generated the waste has ended, it must be taken to the waste storage area within three days (72 hours).
- Only trained personnel may transport Hazardous Waste to the to the 180-Day Storage Facility. Because of this requirement, only faculty or laboratory staff may move waste containers.

To minimize the hazard of incompatible chemical reactions, wastes should not be mixed without prior approval from the Environmental Health and Safety Office.

Waste containers must be labeled with an orange "HAZARDOUS WASTE" label, or tag. The label must contain:

- **Waste name** – A specific chemical name or generic name, e.g. chlorinated solvents.
- **Waste constituents –** All chemicals present must be identified; no abbreviations or chemical formulas.
- **Hazard(s)** (e.g., ignitable, corrosive, reactive, toxic).
- **Estimated percentage** of the chemical(s) present, and
- **The name and telephone extension of the generator** of the waste. In laboratories, this is the responsible faculty member. STUDENTS ARE NOT GENERATORS!


HAZARDOUS WASTE

Waste Name
(No abbreviations or chemical formulas)

Biological Stain

Hazardous Constituents	Est. %
Ethanol	12
Coomassie Blue Stain	25
Acetic Acid	50
Water (Non-Haz)	12

Hazard(s)
(Check all that apply)

_X_ Ignitable	_X_ Corrosive
____ Reactive	____ Oxidizer
____ Halogen	_X_ Toxic

Container Fill Date: 10/22/2010

Generated by: Jane Jones Ext: Ext-2123

The "Date Filled" space must be filled in when the container is full. (Again, the container must be transported to the Hazardous Waste Storage Area within three days (72 hours) of being filled, or otherwise designated as waste.) Indelible markers should be used for labeling.

1.3.Waste Storage and Disposal

There are five, 180-Day Hazardous Waste Storage Facilities at Connecticut College. Four storage facilities are located in academic buildings, of which three are located in science buildings (Hale Laboratory, New London Hall and Bill Hall). The fourth academic building with a HAZWASTE Storage facility is Cummings Art Center.

The non-academic Hazardous Waste Storage Facility is located at the Service Building at the south end of campus. There are separate storage bays in the facility for different types of waste. All liquids, and lead acid batteries are stored on secondary containment.

180-Day Storage Facilities are inspected on a weekly basis by the Chemical Hygiene Officer. In addition to assessing storage and container compliance, the Director uses this weekly inspection to ensure that accumulation limits are not exceeded. Emergency information is posted on the main door of the facility, including:

- Emergency phone number of Campus Safety (Extension 2222 or 111, from any campus phone),
- Name and contact information of the emergency coordinator,
- Location of fire extinguishers and fire alarm pull station,
- Location of spill control materials, and
- Location of the eyewash and deluge shower.

Wastes are shipped off-site using a licensed hazardous waste transporter. All hazardous waste is taken to licensed facilities that treat, recycle, incinerate, or otherwise dispose of the materials using EPA approved methods for the particular waste type. Waste is shipped at least every 180 days, or more frequently to comply with storage limits.

1.4. Recycling and/or Disposal of Connecticut Regulated, Universal and Other Wastes

Following are other regulated wastes that are managed at Connecticut College:

- Electronic ballasts (from light fixtures)
- Use oil
- Spent antifreeze,
- Asbestos
- Fluorescent lamp tubes.
- Pesticides
- Used computers and unwanted electronics (They contain heavy metals and toxins.)
- Recyclable batteries (lead acid, NiCad, niMH, etc. Basically, any rechargeable battery. Alkaline batteries may go into the regular trash.)
-

1.5. Disposal of Non-Hazardous Laboratory Waste

Liquid wastes which are non-hazardous, are water soluble, and do not contain solids may be flushed to the sewer with copious amounts of water. Liquids which are not water soluble must be solidified (absorbed) and disposed of as a solid. Non-hazardous solid waste must be labeled "non-hazardous" and can then be put in the trash. Please check with the Director of Environmental Health and Safety prior to disposal to make sure the material is appropriate for sewer or trash disposal.

1.6. Disposal of Empty Containers

Under Hazardous Waste regulations, chemical containers are considered empty when no more content can be poured out, and an inch or less of content remains. These containers can be recycled or disposed of in the regular trash. This does not apply to containers that have held acutely toxic chemicals, as listed in the RCRA Hazardous Waste List. Empty Acute Toxin containers must be:

- Triple rinsed with a compatible solvent, with the rinsate collected and disposed of as Hazardous Waste, or
- Dispose of the container itself as hazardous waste. Place these containers in the tray on top of the waste cabinet in the 180 Storage Area. Contact the Director of Environmental Health and Safety for further information.

1.7. Disposal of Empty Gas Cylinders and Aerosol Cans

Prior to purchase of gas cylinders (lecture bottles and large tanks), arrangements should be made with the distributor for return of empty cylinders. Empty non-returnable small propane cylinders must be taken to Physical Plant, where they will have the valve stem removed, and disposed of in the metals recycling dumpster.

Aerosol cans are accumulated in the Physical Plant storeroom. Periodically, the aerosol cans are de-pressurized using an can puncturing device, and the liquid contents accumulated as hazardous waste. The empty cans are placed of in the metals recycling dumpster. Containers (or equipment) containing CFCs be not be discharged to the atmosphere.

1.8.Disposal of Unknown Chemicals

It is extremely difficult and costly to identify the content and hazards of unlabeled materials. As discussed in Section VI, it is crucial that maintaining labels be a standard

laboratory practice. If you do have unknowns, please contact the Chemical Hygiene Officer immediately upon their discovery.

1.9.Waste Minimization

Section 3002(b) of the Resource Conservation and Recovery Act (RCRA) requires generators of hazardous wastes, or who transport their waste off-site, to certify on their hazardous waste manifests that they have a waste minimization program in place, to reduce the volume or quantity and toxicity of hazardous waste generated to the extent economically practicable.

Beyond simply complying with regulatory mandates, a waste minimization plan can create a positive environmental impact and save the College money. A better managed inventory and closer lifecycle management of chemicals can reduce the costs associated with purchasing; inventory control; and waste management—including off-site transportation, treatment, and disposal.

Waste minimization is a waste management approach that focuses on reducing the amount and toxicity of hazardous waste that is generated. In addition to hazardous wastes regulated under RCRA, the EPA encourages waste minimization techniques that focus on preventing waste from ever being created, (source reduction) and recycling.

1.9.1. Source Reduction

Changing practices and processes to reduce or eliminate the generation of hazardous wastes and materials is referred to as source reduction. Some source reduction methods include chemical substitution, process modification, and improved operating procedures:

- Maintain a current inventory of all chemicals in your laboratory, and always check the inventory before ordering chemicals. Check the inventory of other faculty, to see if the chemical might be available elsewhere on campus. Another department may have an excess of the chemical that you need, and it doesn't cost anything to ask if they would be willing to share.
- Only order the quantity of the material that you need. Larger containers or amounts may appear as a cost savings for the department, however, the cost to the College, including additional disposal expenses, storage space and labor costs, may eliminate any departmental cost savings.
- Substitute a non-hazardous or a less hazardous material whenever possible. Use a flammable liquid with a higher flash point, use a less toxic reagent if one is available.
- Never purchase cylinders or lecture bottles if they cannot be returned to the vendor. The disposal of compressed gasses is <u>extremely</u> costly.
- Never mix hazardous and non-hazardous waste streams. Doing so increases the amount of hazardous waste to be disposed of. Example: If you add flammable or

toxic solvent waste to a container of non-flammable "non-hazardous" waste pump oil," the entire volume becomes "hazardous."

- Dispose of materials as soon as you determine that they are no longer needed. Do not hold a material so long that the container begins to degrade and the material is of no use. Let other faculty know that you have unwanted materials. There may be a use somewhere else on campus.
- Improperly or unlabeled bottles (unknowns) are very costly to dispose of due to the necessity of performing analytical screening test on each bottle to determine the proper DOT shipping category. (Unlabeled containers can also result in major penalties from the EPA or Connecticut DEEP.)
-

1.9.2. Micro/mini Scale Chemistry

Whenever possible, consider the use of micro or mini scale laboratory chemistry when planning experiments. Micro scale chemistry is a method of performing chemical processes using very small quantities of chemicals, without compromising the quality and standard of chemical applications in the laboratory.

Micro scale chemistry offers many benefits:

- It reduces the amount of chemical used, resulting in waste reduction at the source.
- It offers vastly improved laboratory safety by improving laboratory air quality, reducing exposure to hazardous chemicals, reducing the risk of fire and explosion, and reduces the risk of chemical spills.
- It sharply reduces laboratory costs. (Chemical purchase and disposal costs)
- It requires shorter experiment time.
- It provides for a cleaner and more organized laboratory environment.
- It promotes the principle of 3Rs: Reduce, Recover and Recycle, enhancing the goal of 'Green Chemistry'.

1.9.3. Substitution

Chemical Substitution is when a non-hazardous chemical or a chemical of a lesser toxicity can be used in place of another. Evaluate procedures to see if less hazardous chemicals can be substituted for ones that are used. A less toxic chemical may reduce cost of disposal as well as a reduced exposure to lab workers. Some Examples of Chemical Substitution are shown in Table 4 below.

Table 4 – Waste Substitutions

Procedure	Chemical	Safer Substitute
Cleaning Laboratory Glassware	Chromic-sulfuric Acid	Ultrasonic baths Alconox or similar detergents, NoChrom Mix
Temperature	Mercury Thermometers	Alcohol (red liquid) Digital or thermocouple thermometers
Specimen Storage	Formaldehyde, Formalin	Ethanol, Glycerin, Commercial Fixatives, Carosafe, or Formalternate
Extractions and Other Solvent Uses	Halogenated Solvents	Non-Halogenated Solvents
Radioactive Studies	Toluene Based Scintillation Cocktails	Non-ignitable Scintillation Cocktails
Organic Synthesis	Ethyl Ether	Methyl t-butyl Ether
Some Oxidation Reactions	Sodium Dichromate	Sodium Hypochlorite
Parts Cleaning	Solvents	Detergents and hot water

1.9.4. Recycling

Another method of waste minimization is recycling. Recycling is when a waste material is used for another purpose, treated and reused in the same process, or reclaimed for another process. Some examples include:

- Purchasing gas cylinders, including lecture bottles from manufacturers who will accept the return of the partially used or empty cylinders.
- Collecting ballasts, electronic equipment, and lead acid, mercury, lithium, and nickel-cadmium batteries for commercial recycling.
- Reclaiming metallic mercury if the mercury is not mixed with any other waste streams.
- Redistilling used solvents.
- Redistributing unused, unwanted or surplus chemicals within your department, or elsewhere on campus.

1.9.5. Treatment

Per 40 CFR Part 264, treatment of chemical wastes to make them non-hazardous, such as neutralizing acids or bases is unlawful ***unless it is part of the end step of an experiment, and is done according to documented procedures***. Please do not "treat" hazardous waste,

unless specifically authorized by the Chemical Hygiene Officer.

2. Medical And Biological Waste

The following wastes are defined as infectious or physically dangerous medical or biological waste.

Blood and Blood Products: Discarded human bulk blood and blood products in free draining, liquid state; body fluids contaminated with visible blood; and materials saturated/dripping with blood (includes antibodies developed in primates).
Pathological Waste: Human anatomical parts, organs, tissues and body fluids removed and discarded during surgery or autopsy, or other medical procedures and specimens of body fluids and their containers.
Cultures and Stocks of Infections Agents and Associated Biologicals:

- All discarded cultures and stocks of infectious agents and associated biologicals (e.g., vaccines)
- Biotechnological by-product effluents
- Cultures of specimens from medical and pathological laboratories
- Cultures and stocks of infectious agents from research laboratories
- Wastes from the production of biologicals
- Discarded live and attenuated vaccines intended for human use

Contaminated Animal Carcasses, Body Parts and Bedding: The contaminated carcasses, body parts and bedding of all research animals known to be exposed to pathogens.
Sharps: Discarded medical articles that may cause puncture or cuts, including but not limited to all used and discarded hypodermic needles and syringes, pasteur pipettes, broken medical glassware, scalpel blades, disposable razors, and suture needles.
Biotechnology By-Product Effluents: Any discarded preparations made from genetically altered living organisms and their products.

2.1. Biological Waste Storage

In the laboratory, biological wastes stored in leak proof (liquid wastes), rodent proof, fly tight containers ensuring that no release of waste occurs or other nuisance is created. All containers must be marked with the international biohazard symbol.

All sharps are segregated in puncture-resistant, rigid, shatterproof, leak proof "sharps" containers. All waste containing liquids are stored in rigid, leak proof containers. All biohazard wastes must be collected in 3-mil (minimum) polyethylene "biohazard bags", or rigid plastic containers.

When biological waste or sharps container in the laboratory becomes full, the PI should notify the Chemical Hygiene Officer, who will transport the waste to a freezer in the Biohazard Waste Storage facility, located in the basement of Warnshuis Student Health Center, pending shipment off-site for incineration. The door to this facility is identified with a "Biohazard" sign.

A covered 32-gallon trashcan is located in the Autoclave Room in New London Hall. Faculty and staff should place autoclaved bags of laboratory waste in this container. When it is full, the Chemical Hygiene Officer will transport the waste to the freezer in the Biohazard Waste Storage facility.

2.2. Biological Waste Disposal Procedures

Options for disposal of biological waste generated are listed below along with specific requirements for that option.

Sewer Discharge. Free draining blood and blood products are disposed of down the sink into the sanitary sewer and the drain flushed with water.
Steam Sterilization. Steam sterilization (autoclave) is used for treatment of potentially hazardous laboratory wastes. Autoclaves are located in New London Hall Room 405.1, and Olin Science Center, Room 303. After sterilization, liquid wastes are discharged to the sewer. Solid waste bags and containers are marked, "Non-infectious Medical and Biological Waste", and placed in the 32-gallon garbage container discussed in Section 2.1, "Biological Waste Storage", above for eventual shipment off-campus for incineration.
Off-Campus Incineration. In addition to medical and biological wastes not discharged to the sewer, and autoclaved or un-autoclaved solid waste, all other animal carcasses and organs are sent for off-site incineration.

Autoclave users will maintain a log, documenting temperature, dwell time, as well as monthly cleaning and spore testing, as well as any maintenance performed on the autoclave.

On an annual basis, the Chemical Hygiene Officer will submit a report to the CT DEEP regarding the waste type and waste volume for the preceding year.

2.3. Shipment Of Waste Off-Site

A contractor transports wastes to a licensed off-site incinerator. All waste is packaged in two 3-mil bags, and a cardboard box provided by the contractor. A label is affixed to the inner identifying Connecticut College as the generator. The exterior of the cardboard boxes are labeled with the international biohazard symbol and shipping label provided by the contractor.

All waste shipments are accompanied by a manifest supplied by the contractor. The Environmental Health and Safety Office maintain all disposal records. Manifest records are kept for a minimum of three years.

APPENDIX A Permission to Work Independently

SECTION I: STUDENT

Name: _____ Campus Box: _____
(please print)

Supervising Faculty Member: _____

Short Description Of Work To Be Done: _____

_____

_____

_____

I have read the "Laboratory Working Alone and After Hours Policies" and agree to abide by their restrictions. **Under no conditions will I work alone 'after hours' in the laboratory**. I have received training in the proper experimental and emergency procedures and understand those procedures for the work I am authorized to do after hours.

Student Signature:_____Date:_____

SECTION II: FACULTY PERMISSION

The student has been trained in proper experimental and emergency procedures for the work to be performed after hours and understands the requirements of the "Laboratory Working Alone and After Hours Policies".
I approve this request for permission to work after hours.

Building/Room(s): _____ Hours Access is Allowed: _____

Date Authorization Expires: _____

Restriction(s) on Independent Work: _____

_____

Faculty Signature: _____ Date:_____

Campus Extension: _____Emergency Number_____

SECTION III: LABORATORY SAFETY TRAINING (required for Chemical Use)

This student has completed laboratory safety training provided by the Office of Environmental Health & Safety (EH&S).

Training Date: _____

EH&S Signature: _____ Date: _____

APPENDIX B Department of Homeland Security Chemicals of Interest (DHS COI)

Appendix A to Part 27. -- DHS Chemicals of Interest [1]

Chemicals of Interest (COI)	Synonym	Chemical Abstract Service (CAS) #	Release		Theft		Sabotage		Security Issue						
			Minimum Concentration (%)	Screening Threshold Quantities (in pounds)	Minimum Concentration (%)	Screening Threshold Quantities (in pounds unless otherwise noted)	Minimum Concentration (%)	Screening Threshold Quantities	Release -- Toxic	Release -- Flammables	Release -- Explosives	Theft -- CW/CWP	Theft -- WME	Theft -- EXP/IEDP	Sabotage/Contamination
Acetaldehyde		75-07-0	1.00	10,000						X					
Acetone cyanohydrin, stabilized		75-86-5					ACG	APA							X
Acetyl bromide		506-96-7					ACG	APA							X
Acetyl chloride		75-36-5					ACG	APA							X
Acetyl iodide		507-02-8					ACG	APA							X
Acetylene	[Ethyne]	74-86-2	1.00	10,000						X					
Acrolein	[2-Propenal] or Acrylaldehyde	107-02-8	1.00	5,000					X						
Acrylonitrile	[2-Propenenitrile]	107-13-1	1.00	10,000						X					
Acrylyl chloride	[2-Propenoyl chloride]	814-68-6	1.00	10,000						X					
Allyl alcohol	[2-Propen-1-ol]	107-18-6	1.00	15,000					X						
Allylamine	[2-Propen-1-amine]	107-11-9	1.00	10,000						X					
Allyltrichlorosilane, stabilized		107-37-9					ACG	APA							X
Aluminum (powder)		7429-90-5			ACG	100								X	
Aluminum bromide, anhydrous		7727-15-3					ACG	APA							X
Aluminum chloride, anhydrous		7446-70-0					ACG	APA							X
Aluminum phosphide		20859-73-8					ACG	APA							X
Ammonia (anhydrous)		7664-41-7	1.00	10,000					X						
Ammonia (conc. 20% or greater)		7664-41-7	20.00	20,000					X						
Ammonium nitrate, [with more than 0.2 percent combustible substances, including any organic substance calculated as carbon, to the exclusion of any other added substance]		6484-52-2	ACG	5,000	ACG	400					X			X	

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Ammonium nitrate, solid [nitrogen concentration of 23% nitrogen or greater]		6484-52-2			33.00	2000								X	
Ammonium perchlorate		7790-98-9	ACG	5,000	ACG	400					X			X	
Ammonium picrate		131-74-8	ACG	5,000	ACG	400					X			X	
Amyltrichlorosilane		107-72-2					ACG	APA							X
Antimony pentafluoride		7783-70-2					ACG	APA							X
Arsenic trichloride	[Arsenous trichloride]	7784-34-1	1.00	15,000	30.00	2.2			X			X			
Arsine		7784-42-1	1.00	1,000	0.67	15			X				X		
Barium azide		18810-58-7	ACG	5,000	ACG	400					X			X	
1,4-Bis(2-chloroethylthio)-n-butane		142868-93-7			CUM 100g							X			
Bis(2-chloroethylthio)methane		63869-13-6			CUM 100g							X			
Bis(2-chloroethylthiomethyl)ether		63918-90-1			CUM 100g							X			
1,5-Bis(2-chloroethylthio)-n-pentane		142868-94-8			CUM 100g							X			
1,3-Bis(2-chloroethylthio)-n-propane		63905-10-2			CUM 100g							X			
Boron tribromide		10294-33-4			12.67	45	ACG	APA					X		X
Boron trichloride	[Borane, trichloro]	10294-34-5	1.00	5,000	84.70	45			X				X		
Boron trifluoride	[Borane, trifluoro]	7637-07-2	1.00	5,000	26.87	45			X				X		
Boron trifluoride compound with methyl ether (1:1)	[Boron, trifluoro [oxybis (methane)]-,T-4-]	353-42-4	1.00	15,000					X						
Bromine		7726-95-6	1.00	10,000					X						
Bromine chloride		13863-41-7			9.67	45							X		
Bromine pentafluoride		7789-30-2					ACG	APA							X
Bromine trifluoride		7787-71-5			6.00	45	ACG	APA					X		X
Bromotrifluorethylene	[Ethene, bromotrifluoro-]	598-73-2	1.00	10,000						X					

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1,3-Butadiene		106-99-0	1.00	10,000						X					
Butane		106-97-8	1.00	10,000						X					
Butene		25167-67-3	1.00	10,000						X					
1-Butene		106-98-9	1.00	10,000						X					
2-Butene		107-01-7	1.00	10,000						X					
2-Butene-cis		590-18-1	1.00	10,000						X					
2-Butene-trans	[2-Butene, (E)]	624-64-6	1.00	10,000						X					
Butyltrichlorosilane		7521-80-4					ACG	APA							X
Calcium hydrosulfite	[Calcium dithionite]	15512-36-4					ACG	APA							X
Calcium phosphide		1305-99-3					ACG	APA							X
Carbon disulfide		75-15-0	1.00	20,000					X						
Carbon oxysulfide	[Carbon oxide sulfide (COS); carbonyl sulfide]	463-58-1	1.00	10,000						X					
Carbonyl fluoride		353-50-4			12.00	45							X		
Carbonyl sulfide		463-58-1			56.67	500							X		
Chlorine		7782-50-5	1.00	2,500	9.77	500			X				X		
Chlorine dioxide	[Chlorine oxide, (ClO2)]	10049-04-4	1.00	1,000			ACG	APA	X						X
Chlorine monoxide	[Chlorine oxide]	7791-21-1	1.00	10,000						X					
Chlorine pentafluoride		13637-63-3			4.07	15							X		
Chlorine trifluoride		7790-91-2			9.97	45							X		
Chloroacetyl chloride		79-04-9					ACG	APA							X
2-Chloroethylchloro-methylsulfide		2625-76-5			CUM 100g							X			
Chloroform	[Methane, trichloro-]	67-66-3	1.00	20,000					X						
Chloromethyl ether	[Methane, oxybis(chloro-)]	542-88-1	1.00	1,000					X						
Chloromethyl methyl ether	[Methane, chloromethoxy-]	107-30-2	1.00	5,000					X						
1-Chloropropylene	[1-Propene, 1-chloro-]	590-21-6	1.00	10,000						X					
2-Chloropropylene	[1-Propene, 2-chloro-]	557-98-2	1.00	10,000						X					

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			Minimum Concentration (%)	Screening Threshold Quantities (in pounds)	Minimum Concentration (%)	Screening Threshold Quantities (in pounds unless otherwise noted)	Minimum Concentration (%)	Screening Threshold Quantities	Release -- Toxic	Release -- Flammables	Release -- Explosives	Theft -- CW/CWP	Theft -- WME	Theft -- EXP/IEDP	Sabotage/Contamination
Chlorosarin	[o-Isopropyl methylphosphonochloridate]	1445-76-7			CUM 100g							X			
Chlorosoman	[o-Pinacolyl methylphosphonochloridate]	7040-57-5			CUM 100g							X			
Chlorosulfonic acid		7790-94-5					ACG	APA							X
Chromium oxychloride		14977-61-8					ACG	APA							X
Crotonaldehyde	[2-Butenal]	4170-30-3	1.00	10,000						X					
Crotonaldehyde, (E)-	[2-Butenal], (E)-]	123-73-9	1.00	10,000						X					
Cyanogen	[Ethanedinitrile]	460-19-5	1.00	10,000	11.67	45				X			X		
Cyanogen chloride		506-77-4	1.00	10,000	2.67	15			X				X		
Cyclohexylamine	[Cyclohexanamine]	108-91-8	1.00	15,000					X						
Cyclohexyltrichlorosilane		98-12-4					ACG	APA							X
Cyclopropane		75-19-4	1.00	10,000						X					
DF	Methyl phosphonyl difluoride	676-99-3			CUM 100g							X			
Diazodinitrophenol		87-31-0	ACG	5,000	ACG	400					X			X	
Diborane		19287-45-7	1.00	2,500	2.67	15			X				X		
Dichlorosilane	[Silane, dichloro-]	4109-96-0	1.00	10,000	10.47	45				X			X		
N,N-(2-diethylamino)ethanethiol		100-38-9			30.00	2.2						X			
Diethyldichlorosilane		1719-53-5					ACG	APA							X
o,o-Diethyl S-[2-(diethylamino)ethyl] phosphorothiolate		78-53-5			30.00	2.2						X			
Diethyleneglycol dinitrate		693-21-0	ACG	5,000	ACG	400					X			X	
Diethyl methylphosphonite		15715-41-0			30.00	2.2						X			
N,N-Diethyl phosphoramidic dichloride		1498-54-0			30.00	2.2						X			
N,N-(2-diisopropylamino)ethanethiol	N,N-diisopropyl-(beta)-aminoethane thiol	5842-07-9			30.00	2.2						X			

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Difluoroethane	[Ethane, 1,1-difluoro-]	75-37-6	1.00	10,000						X					
N,N-Diisopropyl phosphoramidic dichloride		23306-80-1			30.00	2.2						X			
1,1-Dimethylhydrazine	[Hydrazine, 1, 1-dimethyl-]	57-14-7	1.00	10,000						X					
Dimethylamine	[Methanamine, N-methyl-]	124-40-3	1.00	10,000						X					
N,N-(2-dimethylamino)ethanethiol		108-02-1			30.00	2.2						X			
Dimethyldichlorosilane	[Silane, dichlorodimethyl-]	75-78-5	1.00	10,000			ACG	APA		X					X
N,N-Dimethyl phosphoramidic dichloride	[Dimethylphosphoramido-dichloridate]	677-43-0			30.00	2.2						X			
2,2-Dimethylpropane	[Propane, 2,2-dimethyl-]	463-82-1	1.00	10,000						X					
Dingu	[Dinitroglycoluril]	55510-04-8	ACG	5,000	ACG	400					X			X	
Dinitrogen tetroxide		10544-72-6			3.80	15							X		
Dinitrophenol		25550-58-7	ACG	5,000	ACG	400					X			X	
Dinitroresorcinol		519-44-8	ACG	5,000	ACG	400					X			X	
Diphenyldichlorosilane		80-10-4					ACG	APA							X
Dipicryl sulfide		2217-06-3	ACG	5,000	ACG	400					X			X	
Dipicrylamine [or] Hexyl	[Hexanitrodiphenylamine]	131-73-7	ACG	5,000	ACG	400					X			X	
N,N-(2-dipropylamino)ethanethiol		5842-06-8			30.00	2.2						X			
N,N-Dipropyl phosphoramidic dichloride		40881-98-9			30.00	2.2						X			
Dodecyltrichlorosilane		4484-72-4					ACG	APA							X
Epichlorohydrin	[Oxirane, (chloromethyl)-]	106-89-8	1.00	20,000					X						
Ethane		74-84-0	1.00	10,000						X					
Ethyl acetylene	[1-Butyne]	107-00-6	1.00	10,000						X					
Ethyl chloride	[Ethane, chloro-]	75-00-3	1.00	10,000						X					
Ethyl ether	[Ethane, 1,1-oxybis-]	60-29-7	1.00	10,000						X					
Ethyl mercaptan	[Ethanethiol]	75-08-1	1.00	10,000						X					

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Ethyl nitrite	[Nitrous acid, ethyl ester]	109-95-5	1.00	10,000						X					
Ethyl phosphonyl difluoride		753-98-0			CUM 100g							X			
Ethylamine	[Ethanamine]	75-04-7	1.00	10,000						X					
Ethyldiethanolamine		139-87-7			80.00	220						X			
Ethylene	[Ethene]	74-85-1	1.00	10,000						X					
Ethylene oxide	[Oxirane]	75-21-8	1.00	10,000						X					
Ethylenediamine	[1,2-Ethanediamine]	107-15-3	1.00	20,000					X						
Ethyleneimine	[Aziridine]	151-56-4	1.00	10,000						X					
Ethylphosphonothioic dichloride		993-43-1			30.00	2.2						X			
Ethyltrichlorosilane		115-21-9					ACG	APA							X
Fluorine		7782-41-4	1.00	1,000	6.17	15			X				X		
Fluorosulfonic acid		7789-21-1					ACG	APA							X
Formaldehyde (solution)		50-00-0	1.00	15,000					X						
Furan		110-00-9	1.00	10,000						X					
Germane		7782-65-2			20.73	45							X		
Germanium tetrafluoride		7783-58-6			2.11	15							X		
Guanyl nitrosaminoguanylidene hydrazine			ACG	5,000	ACG	400					X			X	
Hexaethyl tetraphosphate and compressed gas mixtures		757-58-4			33.37	500							X		
Hexafluoroacetone		684-16-2			15.67	45							X		
Hexanitrostilbene		20062-22-0	ACG	5,000	ACG	400					X			X	
Hexolite	[Hexotol]	121-82-4	ACG	5,000	ACG	400					X			X	
Hexyltrichlorosilane		928-65-4					ACG	APA							X
HMX	[Cyclotetramethylene-tetranitramine]	2691-41-0	ACG	5,000	ACG	400					X			X	

Appendix A to Part 27. -- DHS Chemicals of Interest [1]

Chemicals of Interest (COI)	Synonym	Chemical Abstract Service (CAS) #	Release		Theft		Sabotage		Security Issue						
			Minimum Concentration (%)	Screening Threshold Quantities (in pounds)	Minimum Concentration (%)	Screening Threshold Quantities (in pounds unless otherwise noted)	Minimum Concentration (%)	Screening Threshold Quantities	Release -- Toxic	Release -- Flammables	Release -- Explosives	Theft -- CW/CWP	Theft -- WME	Theft -- EXP/IEDP	Sabotage/Contamination
HN1 (nitrogen mustard-1)	[Bis(2-chloroethyl)ethylamine]	538-07-8			CUM 100g							X			
HN2 (nitrogen mustard-2)	[Bis(2-chloroethyl)methylamine]	51-75-2			CUM 100g							X			
HN3 (nitrogen mustard-3)	[Tris(2-chloroethyl)amine]	555-77-1			CUM 100g							X			
Hydrazine		302-01-2	1.00	10,000						X					
Hydrochloric acid (conc. 37% or greater)		7647-01-0	37.00	15,000					X						
Hydrocyanic acid		74-90-8	1.00	2,500					X						
Hydrofluoric acid (conc. 50% or greater)		7664-39-3	50.00	1,000					X						
Hydrogen		1333-74-0	1.00	10,000						X					
Hydrogen bromide (anhydrous)		10035-10-6			95.33	500							X		
Hydrogen chloride (anhydrous)		7647-01-0	1.00	5,000	ACG	500			X				X		
Hydrogen cyanide	[Hydrocyanic acid]	74-90-8			4.67	15							X		
Hydrogen fluoride (anhydrous)		7664-39-3	1.00	1,000	42.53	45			X				X		
Hydrogen iodide, anhydrous		10034-85-2			95.33	500							X		
Hydrogen peroxide (concentration of at least 35%)		7722-84-1			35.00	400								X	
Hydrogen selenide		7783-07-5	1.00	10,000	0.07	15				X			X		
Hydrogen sulfide		7783-06-4	1.00	10,000	23.73	45			X				X		
Iodine pentafluoride		7783-66-6					ACG	APA							X
Iron, pentacarbonyl-	[Iron carbonyl (Fe (CO)5), (TB5-11)-]	13463-40-6	1.00	10,000						X					
Isobutane	[Propane, 2-methyl]	75-28-5	1.00	10,000						X					
Isobutyronitrile	[Propanenitrile, 2-methyl-]	78-82-0	1.00	20,000					X						
Isopentane	[Butane, 2-methyl-]	78-78-4	1.00	10,000						X					
Isoprene	[1,3-Butadiene, 2-methyl-]	78-79-5	1.00	10,000						X					

Appendix A to Part 27. -- DHS Chemicals of Interest [1]

Chemicals of Interest (COI)	Synonym	Chemical Abstract Service (CAS) #	Release		Theft		Sabotage		Security Issue						
			Minimum Concentration (%)	Screening Threshold Quantities (in pounds)	Minimum Concentration (%)	Screening Threshold Quantities (in pounds unless otherwise noted)	Minimum Concentration (%)	Screening Threshold Quantities	Release -- Toxic	Release -- Flammables	Release -- Explosives	Theft -- CW/CWP	Theft -- WME	Theft -- EXP/IEDP	Sabotage/Contamination
Isopropyl chloride	[Propane, 2-chloro-]	75-29-6	1.00	10,000						X					
Isopropyl chloroformate	[Carbonochloridic acid, 1-methylethyl ester]	108-23-6	1.00	15,000					X						
Isopropylamine	[2-Propanamine]	75-31-0	1.00	10,000						X					
Isopropylphosphonothioic dichloride		1498-60-8			30.00	2.2						X			
Isopropylphosphonyl difluoride		677-42-9			CUM 100g							X			
Lead azide		13424-46-9	ACG	5,000	ACG	400					X			X	
Lead styphnate	[Lead trinitroresorcinate]	15245-44-0	ACG	5,000	ACG	400					X			X	
Lewisite 1	[2-Chlorovinyldichloroarsine]	541-25-3			CUM 100g							X			
Lewisite 2	[Bis(2-chlorovinyl)chloroarsine]	40334-69-8			CUM 100g							X			
Lewisite 3	[Tris(2-chlorovinyl)arsine]	40334-70-1			CUM 100g							X			
Lithium amide		7782-89-0					ACG	APA							X
Lithium nitride		26134-62-3					ACG	APA							X
Magnesium (powder)		7439-95-4			ACG	100								X	
Magnesium diamide		7803-54-5					ACG	APA							X
Magnesium phosphide		12057-74-8					ACG	APA							X
MDEA	[Methyldiethanolamine]	105-59-9			80.00	220						X			
Mercury fulminate		628-86-4	ACG	5,000	ACG	400					X			X	
Methacrylonitrile	[2-Propenenitrile, 2-methyl-]	126-98-7	1.00	10,000					X						
Methane		74-82-8	1.00	10,000						X					
2-Methyl-1-butene		563-46-2	1.00	10,000						X					
3-Methyl-1-butene		563-45-1	1.00	10,000						X					
Methyl chloride	[Methane, chloro-]	74-87-3	1.00	10,000						X					
Methyl chloroformate	[Carbonochloridic acid, methyl ester]	79-22-1	1.00	10,000						X					
Methyl ether	[Methane, oxybis-]	115-10-6	1.00	10,000						X					
Methyl formate	[Formic acid Methyl ester]	107-31-3	1.00	10,000						X					

Appendix A to Part 27. -- DHS Chemicals of Interest [1]

Chemicals of Interest (COI)	Synonym	Chemical Abstract Service (CAS) #	Release		Theft		Sabotage		Security Issue						
			Minimum Concentration (%)	Screening Threshold Quantities (in pounds)	Minimum Concentration (%)	Screening Threshold Quantities (in pounds unless otherwise noted)	Minimum Concentration (%)	Screening Threshold Quantities	Release -- Toxic	Release -- Flammables	Release -- Explosives	Theft -- CW/CWP	Theft -- WME	Theft -- EXP/IEDP	Sabotage/Contamination
Methyl hydrazine	[Hydrazine, methyl-]	60-34-4	1.00	15,000					X						
Methyl isocyanate	[Methane, isocyanato-]	624-83-9	1.00	10,000					X						
Methyl mercaptan	[Methanethiol]	74-93-1	1.00	10,000	45.00	500				X			X		
Methyl thiocyanate	[Thiocyanic acid, methyl ester]	556-64-9	1.00	20,000					X						
Methylamine	[Methanamine]	74-89-5	1.00	10,000						X					
Methylchlorosilane		993-00-0			20.00	45							X		
Methyldichlorosilane		75-54-7					ACG	APA							X
Methylphenyldichlorosilane		149-74-6					ACG	APA							X
Methylphosphonothioic dichloride		676-98-2			30.00	2.2						X			
2-Methylpropene	[1-Propene, 2-methyl-]	115-11-7	1.00	10,000						X					
Methyltrichlorosilane	[Silane, trichloromethyl-]	75-79-6	1.00	10,000			ACG	APA		X					X
Sulfur mustard (Mustard gas (H))	[Bis(2-chloroethyl)sulfide]	505-60-2			CUM 100g							X			
O-Mustard (T)	[Bis(2-chloroethylthioethyl)ether]	63918-89-8			CUM 100g							X			
Nickel Carbonyl		13463-39-3	1.00	10,000						X					
Nitric acid		7697-37-2	80.00	15,000	68.00	400			X					X	
Nitric oxide	[Nitrogen oxide (NO)]	10102-43-9	1.00	10,000	3.83	15			X				X		
Nitrobenzene		98-95-3			ACG	100								X	
5-Nitrobenzotriazol		2338-12-7	ACG	5,000	ACG	400					X			X	
Nitrocellulose		9004-70-0	ACG	5,000	ACG	400					X			X	
Nitrogen mustard hydrochloride	[Bis(2-chloroethyl)methylamine hydrochloride]	55-86-7			30.00	2.2						X			
Nitrogen trioxide		10544-73-7			3.83	15							X		
Nitroglycerine		55-63-0	ACG	5,000	ACG	400					X			X	
Nitromannite	[Mannitol hexanitrate, wetted]	15825-70-4	ACG	5,000	ACG	400					X			X	
Nitromethane		75-52-5			ACG	400								X	
Nitrostarch		9056-38-6	ACG	5,000	ACG	400					X			X	
Nitrosyl chloride		2696-92-6			1.17	15							X		

Appendix A to Part 27. -- DHS Chemicals of Interest [1]

Chemicals of Interest (COI)	Synonym	Chemical Abstract Service (CAS) #	Release		Theft		Sabotage		Security Issue						
			Minimum Concentration (%)	Screening Threshold Quantities (in pounds)	Minimum Concentration (%)	Screening Threshold Quantities (in pounds unless otherwise noted)	Minimum Concentration (%)	Screening Threshold Quantities	Release -- Toxic	Release -- Flammables	Release -- Explosives	Theft -- CW/CWP	Theft -- WME	Theft -- EXP/IEDP	Sabotage/Contamination
Nitrotriazolone		932-64-9	ACG	5,000	ACG	400					X			X	
Nonyltrichlorosilane		5283-67-0					ACG	APA							X
Octadecyltrichlorosilane		112-04-9					ACG	APA							X
Octolite		57607-37-1	ACG	5,000	ACG	400					X			X	
Octonal		78413-87-3	ACG	5,000	ACG	400					X			X	
Octyltrichlorosilane		5283-66-9					ACG	APA							X
Oleum (Fuming Sulfuric acid)	[Sulfuric acid, mixture with sulfur trioxide]	8014-95-7	1.00	10,000					X						
Oxygen difluoride		7783-41-7			0.09	15							X		
1,3-Pentadiene		504-60-9	1.00	10,000						X					
Pentane		109-66-0	1.00	10,000						X					
1- Pentene		109-67-1	1.00	10,000						X					
2-Pentene, (E)-		646-04-8	1.00	10,000						X					
2-Pentene, (Z)-		627-20-3	1.00	10,000						X					
Pentolite		8066-33-9	ACG	5,000	ACG	400					X			X	
Peracetic acid	[Ethaneperoxic acid]	79-21-0	1.00	10,000						X					
Perchloromethylmercaptan	[Methanesulfenyl chloride, trichloro-]	594-42-3	1.00	10,000					X						
Perchloryl fluoride		7616-94-6			25.67	45							X		
PETN	[Pentaerythritol tetranitrate]	78-11-5	ACG	5,000	ACG	400					X			X	
Phenyltrichlorosilane		98-13-5					ACG	APA							X
Phosgene	[Carbonic dichloride] or [carbonyl dichloride]	75-44-5	1.00	500	0.17	15			X				X		
Phosphine		7803-51-2	1.00	10,000	0.67	15				X			X		
Phosphorus		7723-14-0			ACG	400								X	
Phosphorus oxychloride	[Phosphoryl chloride]	10025-87-3	1.00	5,000	80.00	220	ACG	APA	X			X			X
Phosphorus pentabromide		7789-69-7					ACG	APA							X
Phosphorus pentachloride		10026-13-8					ACG	APA							X
Phosphorus pentasulfide		1314-80-3					ACG	APA							X

Appendix A to Part 27. -- DHS Chemicals of Interest [1]

Chemicals of Interest (COI)	Synonym	Chemical Abstract Service (CAS) #	Release		Theft		Sabotage		Security Issue						
			Minimum Concentration (%)	Screening Threshold Quantities (in pounds)	Minimum Concentration (%)	Screening Threshold Quantities (in pounds unless otherwise noted)	Minimum Concentration (%)	Screening Threshold Quantities	Release -- Toxic	Release -- Flammables	Release -- Explosives	Theft -- CW/CWP	Theft -- WME	Theft -- EXP/IEDP	Sabotage/Contamination
Phosphorus trichloride		7719-12-2	1.00	15,000	3.48	45	ACG	APA	X				X		X
Picrite	[Nitroguanidine]	556-88-7	ACG	5,000	ACG	400					X			X	
Piperidine		110-89-4	1.00	10,000						X					
Potassium chlorate		3811-04-9			ACG	400								X	
Potassium cyanide		151-50-8					ACG	APA							X
Potassium nitrate		7757-79-1			ACG	400								X	
Potassium perchlorate		7778-74-7			ACG	400								X	
Potassium permanganate		7722-64-7			ACG	400								X	
Potassium phosphide		20770-41-6					ACG	APA							X
Propadiene	[1,2-Propadiene]	463-49-0	1.00	10,000						X					
Propane		74-98-6	1.00	60,000						X					
Propionitrile	[Propanenitrile]	107-12-0	1.00	10,000					X						
Propyl chloroformate	[Carbonchloridic acid, propylester]	109-61-5	1.00	10,000						X					
Propylene	[1-Propene]	115-07-1	1.00	10,000						X					
Propylene oxide	[Oxirane, methyl-]	75-56-9	1.00	10,000						X					
Propyleneimine	[Aziridine, 2-methyl-]	75-55-8	1.00	10,000					X						
Propylphosphonothioic dichloride		2524-01-8			30.00	2.2						X			
Propylphosphonyl difluoride		690-14-2			CUM 100g							X			
Propyltrichlorosilane		141-57-1					ACG	APA							X
Propyne	[1-Propyne]	74-99-7	1.00	10,000						X					
QL	[o-Ethyl-o-2-diisopropylaminoethyl methylphosphonite]	57856-11-8			CUM 100g							X			
RDX	[Cyclotrimethylenetrinitramine]	121-82-4	ACG	5,000	ACG	400					X			X	
RDX and HMX mixtures		121-82-4	ACG	5,000	ACG	400					X			X	
Sarin	[o-Isopropyl methylphosphonofluoridate]	107-44-8			CUM 100g							X			
Selenium hexafluoride		7783-79-1			1.67	15							X		

Appendix A to Part 27. -- DHS Chemicals of Interest [1]

Chemicals of Interest (COI)	Synonym	Chemical Abstract Service (CAS) #	Release		Theft		Sabotage		Security Issue						
			Minimum Concentration (%)	Screening Threshold Quantities (in pounds)	Minimum Concentration (%)	Screening Threshold Quantities (in pounds unless otherwise noted)	Minimum Concentration (%)	Screening Threshold Quantities	Release – Toxic	Release – Flammables	Release – Explosives	Theft – CW/CWP	Theft – WME	Theft – EXP/IEDP	Sabotage/Contamination
Sesquimustard	[1,2-Bis(2-chloroethylthio)ethane]	3563-36-8			CUM 100g							X			
Silane		7803-62-5	1.00	10,000						X					
Silicon tetrachloride		10026-04-7					ACG	APA							X
Silicon tetrafluoride		7783-61-1			15.00	45							X		
Sodium azide		26628-22-8			ACG	400								X	
Sodium chlorate		7775-09-9			ACG	400								X	
Sodium cyanide		143-33-9					ACG	APA							X
Sodium hydrosulfite	[Sodium dithionite]	7775-14-6					ACG	APA							X
Sodium nitrate		7631-99-4			ACG	400								X	
Sodium phosphide		12058-85-4					ACG	APA							X
Soman	[o-Pinacolyl methylphosphonofluoridate]	96-64-0			CUM 100g							X			
Stibine		7803-52-3			0.67	15							X		
Strontium phosphide		12504-16-4					ACG	APA							X
Sulfur dioxide (anhydrous)		7446-09-5	1.00	5,000	84.00	500			X				X		
Sulfur tetrafluoride	[Sulfur fluoride (SF4), (T-4)-]	7783-60-0	1.00	2,500	1.33	15			X				X		
Sulfur trioxide		7446-11-9	1.00	10,000					X						
Sulfuryl chloride		7791-25-5					ACG	APA							X
Tabun	[o-Ethyl-N,N-dimethylphosphoramido-cyanidate]	77-81-6			CUM 100g							X			
Tellurium hexafluoride		7783-80-4			0.83	15							X		
Tetrafluoroethylene	[Ethene, tetrafluoro-]	116-14-3	1.00	10,000						X					
Tetramethyllead	[Plumbane, tetramethyl-]	75-74-1	1.00	10,000					X						
Tetramethylsilane	[Silane, tetramethyl-]	75-76-3	1.00	10,000						X					
Tetranitroaniline		53014-37-2	ACG	5,000	ACG	400					X			X	
Tetranitromethane	[Methane, tetranitro-]	509-14-8	1.00	10,000						X					
Tetrazene	[Guanyl nitrosaminoguanyltetrazene]	109-27-3	ACG	5,000	ACG	400					X			X	

Appendix A to Part 27. -- DHS Chemicals of Interest [1]

Chemicals of Interest (COI)	Synonym	Chemical Abstract Service (CAS) #	Release		Theft		Sabotage		Security Issue						
			Minimum Concentration (%)	Screening Threshold Quantities (in pounds)	Minimum Concentration (%)	Screening Threshold Quantities (in pounds unless otherwise noted)	Minimum Concentration (%)	Screening Threshold Quantities	Release – Toxic	Release – Flammables	Release – Explosives	Theft – CW/CWP	Theft – WME	Theft – EXP/IEDP	Sabotage/Contamination
1H-Tetrazole		288-94-8	ACG	5,000	ACG	400					X			X	
Thiodiglycol	[Bis(2-hydroxyethyl)sulfide]	111-48-8			30.00	2.2						X			
Thionyl chloride		7719-09-7					ACG	APA							X
Titanium tetrachloride	[Titanium chloride (TiCl4) (T-4)-]	7550-45-0	1.00	2,500	13.33	45	ACG	APA	X				X		X
TNT	[Trinitrotoluene]	118-96-7	ACG	5,000	ACG	400					X			X	
Torpex	[Hexotonal]	67713-16-0	ACG	5,000	ACG	400					X			X	
Trichlorosilane	[Silane, trichloro-]	10025-78-2	1.00	10,000			ACG	APA		X					X
Triethanolamine		102-71-6			80.00	220						X			
Triethanolamine hydrochloride		637-39-8			80.00	220						X			
Triethyl phosphite		122-52-1			80.00	220						X			
Trifluoroacetyl chloride		354-32-5			6.93	45							X		
Trifluorochloroethylene	[Ethene, chlorotrifluoro]	79-38-9	1.00	10,000	66.67	500				X			X		
Trimethylamine	[Methanamine, N,N-dimethyl-]	75-50-3	1.00	10,000						X					
Trimethylchlorosilane	[Silane, chlorotrimethyl-]	75-77-4	1.00	10,000			ACG	APA		X					X
Trimethyl phosphite		121-45-9			80.00	220						X			
Trinitroaniline		26952-42-1	ACG	5,000	ACG	400					X			X	
Trinitroanisole		606-35-9	ACG	5,000	ACG	400					X			X	
Trinitrobenzene		99-35-4	ACG	5,000	ACG	400					X			X	
Trinitrobenzenesulfonic acid		2508-19-2	ACG	5,000	ACG	400					X			X	
Trinitrobenzoic acid		129-66-8	ACG	5,000	ACG	400					X			X	
Trinitrochlorobenzene		88-88-0	ACG	5,000	ACG	400					X			X	
Trinitrofluorenone		129-79-3	ACG	5,000	ACG	400					X			X	
Trinitro-meta-cresol		602-99-3	ACG	5,000	ACG	400					X			X	
Trinitronaphthalene		55810-17-8	ACG	5,000	ACG	400					X			X	
Trinitrophenetole		4732-14-3	ACG	5,000	ACG	400					X			X	
Trinitrophenol		88-89-1	ACG	5,000	ACG	400					X			X	
Trinitroresorcinol		82-71-3	ACG	5,000	ACG	400					X			X	
Tritonal		54413-15-9	ACG	5,000	ACG	400					X			X	
Tungsten hexafluoride		7783-82-6			7.10	45							X		

Appendix A to Part 27. -- DHS Chemicals of Interest [1]

Chemicals of Interest (COI)	Synonym	Chemical Abstract Service (CAS) #	Release		Theft		Sabotage		Security Issue						
			Minimum Concentration (%)	Screening Threshold Quantities (in pounds)	Minimum Concentration (%)	Screening Threshold Quantities (in pounds unless otherwise noted)	Minimum Concentration (%)	Screening Threshold Quantities	Release -- Toxic	Release -- Flammables	Release -- Explosives	Theft -- CW/CWP	Theft -- WME	Theft -- EXP/IEDP	Sabotage/Contamination
Vinyl acetate monomer	[Acetic acid ethenyl ester]	108-05-4	1.00	10,000						X					
Vinyl acetylene	[1-Buten-3-yne]	689-97-4	1.00	10,000						X					
Vinyl chloride	[Ethene, chloro-]	75-01-4	1.00	10,000						X					
Vinyl ethyl ether	[Ethene, ethoxy-]	109-92-2	1.00	10,000						X					
Vinyl fluoride	[Ethene, fluoro-]	75-02-5	1.00	10,000						X					
Vinyl methyl ether	[Ethene, methoxy-]	107-25-5	1.00	10,000						X					
Vinylidene chloride	[Ethene, 1,1-dichloro-]	75-35-4	1.00	10,000						X					
Vinylidene fluoride	[Ethene, 1,1-difluoro-]	75-38-7	1.00	10,000						X					
Vinyltrichlorosilane		75-94-5					ACG	APA							X
VX	[o-Ethyl-S-2-diisopropylaminoethyl methyl phosphonothiolate]	50782-69-9			CUM 100g							X			
Zinc hydrosulfite	[Zinc dithionite]	7779-86-4					ACG	APA							X

[1] The acronyms used in this appendix have the following meaning: ACG = A Commercial Grade; APA = A Placarded Amount; CW/CWP = Chemical Weapons/Chemical Weapons Precursors; WME = Weapons of Mass Effect; EXP/IEDP = Explosives/Improvised Explosive Device Precursors

APPENDIX C-(1)　List of Acute Toxins (Alphabetical)

EXAMPLES OF ACUTE TOXINS (by Alpha)

Key: SA -- Readily Absorbed Through the Skin

Revised: 11/2010

CHEMICAL NAME	CAS #	SA	TARGET ORGAN
ABRIN	001393-62-0		systemic
ACETONE CYANOHYDRIN, STABILIZED	000075-86-5		systemic
ACROLEIN	000107-02-8	x	systemic,pulmonary
ACRYLONITRILE	000107-13-1	x	systemic
ADIPONITRILE	000111-69-3		systemic,blood
AFLATOXINS	000000-00-0		systemic
ALUMINUM PHOSPHIDE	020859-73-8		systemic
AMINOPYRIDINE,4-	000504-24-5	x	systemic
AMMONIA (GAS)	007664-41-7		pulmonary
ANILINE	000062-53-3	x	blood
ANILINE AND COMPOUNDS	000000-00-0	x	blood
ARSENIC ACID	007778-39-4	x	systemic
ARSENIC ACID AND SALTS	000000-00-0	x	systemic
ARSENIC ACID, CALCIUM SALT (2:3)	007778-44-1	x	systemic
ARSENIC ACID, MONOPOTASSIUM SALT	007784-41-0	x	systemic
ARSENIC ACID, SODIUM SALT	007631-89-2	x	systemic
ARSENIC PENTAFLUORIDE	007784-36-3		systemic
ARSENIC PENTOXIDE	001303-28-2		systemic
ARSENIC TRICHLORIDE	007784-34-1		systemic
ARSENIC TRIOXIDE	001327-53-3		systemic
ARSENIUOS ACID AND SALTS	000000-00-0		systemic
ARSENIUOS ACID, CALCIUM SALT	027152-57-4		systemic
ARSENIUOS ACID, MONOSODIUM SALT	007784-46-5		systemic
ARSINE	007784-42-1		systemic
ARSONIC ACID	000097-44-9		systemic
ARSONIC ACID AND SALTS	000000-00-0		systemic
ARSONIC ACID, CALCIUM SALT (1:1)	052740-16-6		systemic
ATROPINE	000051-55-8	x	CNS
BIS(2-CHLOROETHYLTHIO)METHANE	063869-13-6		systemic
BIS(2-CHLOROETHYLTHIO)-N-BUTANE, 1,4-	142868-93-7		systemic
BIS(2-CHLOROETHYLTHIO)-N-PENTANE,1,5-	142868-94-8		systemic
BIS(2-CHLOROETHYLTHIO)-N-PROPANE, 1,3-	063905-10-2		systemic
BIS(2-CHLOROETHYLTHIOMETHYL)ETHER	063918-90-1		systemic
BISCHLOROETHYL NITROSOUREA (BCNU)	000154-93-8		systemic
BORON TRIBROMIDE	010294-33-4		pulmonary
BORON TRIFLUORIDE	007637-07-2		pulmonary
BOTULINUM TOXINS	000000-00-0		systemic
BROMINE	007726-95-6		pulmonary,skin
BROMINE PENTAFLUORIDE	007789-30-2		pulmonary
BROMOACETONE	000598-31-2		pulmonary
CALCIUM PHOSPHIDE	001305-99-3		systemic
CHLORINE	007782-50-5		pulmonary
CHLORINE PENTAFLUORIDE	013637-63-3		systemic
CHLORINE TRIFLUORIDE	007790-91-2		pulmonary
CHLOROETHYLCHLORO-METHYLSULFIDE,2-	002625-76-5		systemic
CHLOROPICRIN	000076-06-2		pulmonary

EXAMPLES OF ACUTE TOXINS (by Alpha)

Key: SA -- Readily Absorbed Through the Skin

Revised: 11/2010

CHEMICAL NAME	CAS #	SA	TARGET ORGAN
CHLOROSARIN	001445-76-	x	systemic
CHLOROSOMAN	007040-57-	x	systemic
COLCHICINE	000064-86-		pulmonary,systemic
CYANAMIDE	000420-04-	x	systemic
CYANIDE	000057-12-	x	blood
CYANIDE AND COMPOUNDS	000000-00-	x	blood
CYANOGEN	000460-19-		blood
CYANOGEN AND COMPOUNDS	000000-00-		blood
CYANOGEN CHLORIDE	000506-77-	x	systemic
DECABORANE	017702-41-	x	CNS
DIACETOXYSCIRPENOL	002270-40-		systemic
DIAZOMETHANE	000334-88-		pulmonary
DIBORANE	019287-45-		pulmonary
DICHLOROACETYLENE	007572-29-		pulmonary
DICHLORVOS	000062-73-	x	systemic
DIETHYL METHYLPHOSPHONITE	015715-41-	x	systemic
DIETHYL S-[2-(DIETHYLAMINO)ETHYL]PHOSPHOROTHIOLATE	000078-53-		systemic
DIGITOXIN	000071-63-	x	systemic
DIMETHYL MERCURY	000593-74-	x	CNS,systemic
DIMETHYL SULFATE	000077-78-	x	pulmonary,skin,eyes
DINITROGEN TETROXIDE	010544-72-		systemic
DINITROPHENOL, 2,4-	000051-28-	x	systemic
ENDOSULFAN	000115-29-	x	CNS
ENDRIN	000072-20-	x	CNS
ETHYL O-2-DIISOPROPYLAMINOETHYL METHYLPHOSPHONITE,	057856-11-	x	systemic
ETHYL PHOSPHONYL DIFLUORIDE	000753-98-	x	systemic
ETHYLENE CHLOROHYDRIN	000107-07-	x	systemic
ETHYL-S-DIMETHYLAMINOETHYLMETHYLPHOSPHONOTHIOLATE(	050782-69-	x	systemic
FLUORINE	007782-41-		pulmonary,skin
GERMANE	007782-65-		pulmonary,blood
GERMANIUM TETRAFLUORIDE	007783-58-	x	systemic
HEPTACHLOR	000076-44-	x	systemic
HEPTACHLOR EPOXIDE	001024-57-	x	systemic
HN1 (NITROGEN MUSTARD-1)	000538-07-	x	systemic
HN2 (NITROGEN MUSTARD-2)	000051-75-	x	systemic
HN3 (NITROGEN MUSTARD-3)	000555-77-	x	systemic
HYDROGEN CYANIDE	000074-90-	x	systemic
HYDROGEN FLUORIDE	007664-39-	x	pulmonary,skin,system
HYDROGEN SELENIDE	007783-07-	x	pulmonary
HYDROGEN SULFIDE	007783-06-		systemic
ISOPROPYLPHOSPHONOTHIOIC DICHLORIDE	001498-60-	x	systemic
ISOPROPYLPHOSPHONYL DIFLUORIDE	000677-42-	x	systemic
LEWISITE 1	000541-25-	x	systemic
LEWISITE 2	040334-69-	x	systemic
LEWISITE 3	040334-70-	x	systemic
MANGANESE TRICARBONYL METHYLCYCLOPENTADIENYL	012108-13-	x	CNS
METHYL BROMIDE	000074-83-	x	pulmonary

EXAMPLES OF ACUTE TOXINS (by Alpha)

Key: SA -- Readily Absorbed Through the Skin

Revised: 11/2010

CHEMICAL NAME	CAS #	SA	TARGET ORGAN
METHYL DIFLUOROPHOSPHITE (DF)	000676-99-3	x	systemic
METHYL HYDRAZINE	000060-34-4	x	pulmonary,CNS,blood
METHYL ISOCYANATE	000624-83-9	x	systemic
METHYL MERCURY	022967-92-6	x	CNS
METHYL MERCURY AND COMPOUNDS	000000-00-0	x	CNS
METHYLAZIRIDINE, 2- (PROPYLENEIMINE)	000075-55-8	x	systemic
METHYLDICHLOROARSINE	000593-89-9		systemic
METHYLFLUOROSULFONATE	000421-20-5		systemic
MITOMYCIN C	000050-07-7		systemic
NICKEL CARBONYL	013463-39-3		pulmonary,CNS
NICOTINE	000054-11-5	x	CNS
NITRIC ACID (FUMING)	007697-37-2	x	pulmonary,skin
NITRIC OXIDE	010102-43-9		systemic
NITROGEN DIOXIDE	010102-44-0		systemic
NITROGEN MUSTARD HYDROCHLORIDE	000055-86-7	x	systemic
NITROGEN MUSTARD N-OXIDE	000126-85-2	x	systemic
NITROGEN MUSTARD N-OXIDE HYDROCHLORIDE	000302-70-5	x	systemic
NITROGEN TETROXIDE	010544-72-6		systemic
NITROGEN TRIOXIDE	010544-73-7	x	systemic
NITROSOMETHYLVINYLAMINE, N-	004549-40-0		systemic
OCHRATOXIN A	000303-47-9		systemic
OSMIUM TETROXIDE	020816-12-0		systemic
OXYGEN DIFLUORIDE	007783-41-7		systemic
OZONE	010028-15-6		pulmonary
PARATHION	000056-38-2	x	CNS
PENTABORANE	019624-22-7		CNS
PENTACHLOROPHENOL	000087-86-5	x	systemic
PHOSGENE	000075-44-5		pulmonary
PHOSPHINE	007803-51-2		systemic
PHOSPHORUS (YELLOW)	007723-14-0		pulmonary
PHOSPHORUS TRICHLORIDE	007719-12-2		systemic
PROPARGYL BROMIDE	000106-96-7		systemic
PROPIONIC NITRILE	000107-12-0	x	systemic
PROPYLENE OXIDE	000075-56-9	x	pulmonary
PROPYLPHOSPHONOTHIOIC DICHLORIDE	002524-01-8	x	systemic
PROPYLPHOSPHONYL DIFLUORIDE	000690-14-2	x	systemic
RICIN	009009-86-3		systemic
SARIN	000107-44-8	x	systemic
SAXITOXIN	035523-89-8		systemic
SELENIUM HEXAFLUORIDE	007783-79-1		pulmonary
SESQUIMUSTARD	003563-36-8		systemic
SODIUM AZIDE *	026628-22-8	x	systemic
SODIUM FLUOROACETATE	000062-74-8	x	systemic
SOMAN	000096-64-0	x	systemic
STIBINE	007803-52-3		systemic,blood
STRYCHNINE	000057-24-9		systemic,CNS
SULFUR MUSTARD (MUSTARD GAS (H))	000505-60-2	x	pulmonary

EXAMPLES OF ACUTE TOXINS (by Alpha)

Key: SA -- Readily Absorbed Through the Skin

Revised: 11/2010

CHEMICAL NAME	CAS #	SA	TARGET ORGAN
SULFUR TETRAFLUORIDE	007783-60-0		systemic
TABUN	000077-81-1	x	systemic
TELLURIUM HEXAFLUORIDE	007783-80-4	x	systemic
TETRACHLORODIBENZO-para-DIOXIN, 2,3,7,8- (TCCD)	001746-01-6	x	systemic
TETRAETHYL LEAD	000078-00-2	x	CNS
TETRAETHYL PYROPHOSPHATE	000107-49-3	x	systemic
TETRAMETHYL SUCCINONITRILE	003333-52-6	x	CNS
TETRODOTOXIN	004368-28-9		systemic
THIOPHENOL	000108-98-5	x	CNS,systemic
THIOTEPA	000052-24-4		systemic
TOLUIDINE, ORTHO-	000095-53-4	x	blood
TUBOCURARINE CHLORIDE HYDRATE,(+)-	000057-94-3	x	systemic
VANADIUM PENTOXIDE	001314-62-1		systemic
VENOM, SNAKE, CROTALUS ADAMANTEUS	000000-00-0		systemic
VENOM, SNAKE, CROTALUS ATROX	000000-00-0		systemic
XYLIDINE	001300-73-8	x	blood

***** Requirements of sections B, C, D, F, and section G's container labeling requirements do not apply to chemicals in which sodium azide is used in small amounts as a preservative. Sodium azide and solutions containing sodium azide should not be put into the sewer system. They should be collected as hazardous waste.

APPENDIX C-(2)　List of Acute Toxins (By CAS Number)

EXAMPLES OF ACUTE TOXINS (by CAS#)

Key: SA -- Readily Absorbed Through the Skin

Revised: 11/2010

CHEMICAL NAME	CAS #	SA	TARGET ORGAN
AFLATOXINS	000000-00-0		systemic
ANILINE AND COMPOUNDS	000000-00-0	x	blood
ARSENIC ACID AND SALTS	000000-00-0	x	systemic
ARSENIUOS ACID AND SALTS	000000-00-0		systemic
ARSONIC ACID AND SALTS	000000-00-0		systemic
BOTULINUM TOXINS	000000-00-0		systemic
CYANIDE AND COMPOUNDS	000000-00-0	x	blood
CYANOGEN AND COMPOUNDS	000000-00-0		blood
METHYL MERCURY AND COMPOUNDS	000000-00-0	x	CNS
VENOM, SNAKE, CROTALUS ADAMANTEUS	000000-00-0		systemic
VENOM, SNAKE, CROTALUS ATROX	000000-00-0		systemic
MITOMYCIN C	000050-07-7		systemic
DINITROPHENOL, 2,4-	000051-28-5	x	systemic
ATROPINE	000051-55-8	x	CNS
HN2 (NITROGEN MUSTARD-2)	000051-75-2	x	systemic
THIOTEPA	000052-24-4		systemic
NICOTINE	000054-11-5	x	CNS
NITROGEN MUSTARD HYDROCHLORIDE	000055-86-7	x	systemic
PARATHION	000056-38-2	x	CNS
CYANIDE	000057-12-5	x	blood
STRYCHNINE	000057-24-9		systemic,CNS
TUBOCURARINE CHLORIDE HYDRATE,(+)-	000057-94-3	x	systemic
METHYL HYDRAZINE	000060-34-4	x	pulmonary,CNS,blood
ANILINE	000062-53-3	x	blood
DICHLORVOS	000062-73-7	x	systemic
SODIUM FLUOROACETATE	000062-74-8	x	systemic
COLCHICINE	000064-86-8		pulmonary,systemic
DIGITOXIN	000071-63-6	x	systemic
ENDRIN	000072-20-8	x	CNS
METHYL BROMIDE	000074-83-9	x	pulmonary
HYDROGEN CYANIDE	000074-90-8	x	systemic
PHOSGENE	000075-44-5		pulmonary
METHYLAZIRIDINE, 2- (PROPYLENEIMINE)	000075-55-8	x	systemic
PROPYLENE OXIDE	000075-56-9	x	pulmonary
ACETONE CYANOHYDRIN, STABILIZED	000075-86-5		systemic
CHLOROPICRIN	000076-06-2		pulmonary
HEPTACHLOR	000076-44-8	x	systemic
DIMETHYL SULFATE	000077-78-1	x	pulmonary,skin,eyes
TABUN	000077-81-6	x	systemic
TETRAETHYL LEAD	000078-00-2	x	CNS
DIETHYL S-[2-(DIETHYLAMINO)ETHYL]PHOSPHOROTHIOLATE	000078-53-5		systemic
PENTACHLOROPHENOL	000087-86-5	x	systemic
TOLUIDINE, ORTHO-	000095-53-4	x	blood
SOMAN	000096-64-0	x	systemic
ARSONIC ACID	000097-44-9		systemic
PROPARGYL BROMIDE	000106-96-7		systemic

EXAMPLES OF ACUTE TOXINS (by CAS#)

Key: SA -- Readily Absorbed Through the Skin

Revised: 11/2010

CHEMICAL NAME	CAS #	SA	TARGET ORGAN
ACROLEIN	000107-02-8	x	systemic,pulmonary
ETHYLENE CHLOROHYDRIN	000107-07-3	x	systemic
PROPIONIC NITRILE	000107-12-0	x	systemic
ACRYLONITRILE	000107-13-1	x	systemic
SARIN	000107-44-8	x	systemic
TETRAETHYL PYROPHOSPHATE	000107-49-3	x	systemic
THIOPHENOL	000108-98-5	x	CNS,systemic
ADIPONITRILE	000111-69-3		systemic,blood
ENDOSULFAN	000115-29-7	x	CNS
NITROGEN MUSTARD N-OXIDE	000126-85-2	x	systemic
BISCHLOROETHYL NITROSOUREA (BCNU)	000154-93-8		systemic
NITROGEN MUSTARD N-OXIDE HYDROCHLORIDE	000302-70-5	x	systemic
OCHRATOXIN A	000303-47-9		systemic
DIAZOMETHANE	000334-88-3		pulmonary
CYANAMIDE	000420-04-2	x	systemic
METHYLFLUOROSULFONATE	000421-20-5		systemic
CYANOGEN	000460-19-5		blood
AMINOPYRIDINE,4-	000504-24-5	x	systemic
SULFUR MUSTARD (MUSTARD GAS (H))	000505-60-2	x	pulmonary
CYANOGEN CHLORIDE	000506-77-4	x	systemic
HN1 (NITROGEN MUSTARD-1)	000538-07-8	x	systemic
LEWISITE 1	000541-25-3	x	systemic
HN3 (NITROGEN MUSTARD-3)	000555-77-1	x	systemic
DIMETHYL MERCURY	000593-74-8	x	CNS,systemic
METHYLDICHLOROARSINE	000593-89-5		systemic
BROMOACETONE	000598-31-2		pulmonary
METHYL ISOCYANATE	000624-83-9	x	systemic
METHYL DIFLUOROPHOSPHITE (DF)	000676-99-3	x	systemic
ISOPROPYLPHOSPHONYL DIFLUORIDE	000677-42-9	x	systemic
PROPYLPHOSPHONYL DIFLUORIDE	000690-14-2	x	systemic
ETHYL PHOSPHONYL DIFLUORIDE	000753-98-0	x	systemic
HEPTACHLOR EPOXIDE	001024-57-3	x	systemic
XYLIDINE	001300-73-8	x	blood
ARSENIC PENTOXIDE	001303-28-2		systemic
CALCIUM PHOSPHIDE	001305-99-3		systemic
VANADIUM PENTOXIDE	001314-62-1		systemic
ARSENIC TRIOXIDE	001327-53-3		systemic
ABRIN	001393-62-0		systemic
CHLOROSARIN	001445-76-7	x	systemic
ISOPROPYLPHOSPHONOTHIOIC DICHLORIDE	001498-60-8	x	systemic
TETRACHLORODIBENZO-para-DIOXIN, 2,3,7,8- (TCCD)	001746-01-6	x	systemic
DIACETOXYSCIRPENOL	002270-40-8		systemic
PROPYLPHOSPHONOTHIOIC DICHLORIDE	002524-01-8	x	systemic
CHLOROETHYLCHLORO-METHYLSULFIDE,2-	002625-76-5		systemic
TETRAMETHYL SUCCINONITRILE	003333-52-0	x	CNS
SESQUIMUSTARD	003563-36-8		systemic
TETRODOTOXIN	004368-28-9		systemic

EXAMPLES OF ACUTE TOXINS (by CAS#)

Key: SA -- Readily Absorbed Through the Skin

Revised: 11/2010

CHEMICAL NAME	CAS #	SA	TARGET ORGAN
NITROSOMETHYLVINYLAMINE, N-	004549-40-0		systemic
CHLOROSOMAN	007040-57-5	x	systemic
DICHLOROACETYLENE	007572-29-4		pulmonary
ARSENIC ACID, SODIUM SALT	007631-89-2	x	systemic
BORON TRIFLUORIDE	007637-07-2		pulmonary
HYDROGEN FLUORIDE	007664-39-3	x	pulmonary,skin,system
AMMONIA (GAS)	007664-41-7		pulmonary
NITRIC ACID (FUMING)	007697-37-2	x	pulmonary,skin
PHOSPHORUS TRICHLORIDE	007719-12-2		systemic
PHOSPHORUS (YELLOW)	007723-14-0		pulmonary
BROMINE	007726-95-6		pulmonary,skin
ARSENIC ACID	007778-39-4	x	systemic
ARSENIC ACID, CALCIUM SALT (2:3)	007778-44-1	x	systemic
FLUORINE	007782-41-4		pulmonary,skin
CHLORINE	007782-50-5		pulmonary
GERMANE	007782-65-2		pulmonary,blood
HYDROGEN SULFIDE	007783-06-4		systemic
HYDROGEN SELENIDE	007783-07-5	x	pulmonary
OXYGEN DIFLUORIDE	007783-41-7		systemic
GERMANIUM TETRAFLUORIDE	007783-58-6	x	systemic
SULFUR TETRAFLUORIDE	007783-60-0		systemic
SELENIUM HEXAFLUORIDE	007783-79-1		pulmonary
TELLURIUM HEXAFLUORIDE	007783-80-4	x	systemic
ARSENIC TRICHLORIDE	007784-34-1		systemic
ARSENIC PENTAFLUORIDE	007784-36-3		systemic
ARSENIC ACID, MONOPOTASSIUM SALT	007784-41-0	x	systemic
ARSINE	007784-42-1		systemic
ARSENIUOS ACID, MONOSODIUM SALT	007784-46-5		systemic
BROMINE PENTAFLUORIDE	007789-30-2		pulmonary
CHLORINE TRIFLUORIDE	007790-91-2		pulmonary
PHOSPHINE	007803-51-2		systemic
STIBINE	007803-52-3		systemic,blood
RICIN	009009-86-3		systemic
OZONE	010028-15-6		pulmonary
NITRIC OXIDE	010102-43-9		systemic
NITROGEN DIOXIDE	010102-44-0		systemic
BORON TRIBROMIDE	010294-33-4		pulmonary
DINITROGEN TETROXIDE	010544-72-6		systemic
NITROGEN TETROXIDE	010544-72-6		systemic
NITROGEN TRIOXIDE	010544-73-7	x	systemic
MANGANESE TRICARBONYL METHYLCYCLOPENTADIENYL	012108-13-3	x	CNS
NICKEL CARBONYL	013463-39-3		pulmonary,CNS
CHLORINE PENTAFLUORIDE	013637-63-3		systemic
DIETHYL METHYLPHOSPHONITE	015715-41-0	x	systemic
DECABORANE	017702-41-9	x	CNS
DIBORANE	019287-45-7		pulmonary
PENTABORANE	019624-22-7		CNS

EXAMPLES OF ACUTE TOXINS (by CAS#)

Key: SA -- Readily Absorbed Through the Skin

Revised: 11/2010

CHEMICAL NAME	CAS #	SA	TARGET ORGAN
OSMIUM TETROXIDE	020816-12-0		systemic
ALUMINUM PHOSPHIDE	020859-73-8		systemic
METHYL MERCURY	022967-92-0	x	CNS
SODIUM AZIDE *	026628-22-8	x	systemic
ARSENIUOS ACID, CALCIUM SALT	027152-57-4		systemic
SAXITOXIN	035523-89-8		systemic
LEWISITE 2	040334-69-8	x	systemic
LEWISITE 3	040334-70-1	x	systemic
ETHYL-S-DIMETHYLAMINOETHYLMETHYLPHOSPHONOTHIOLATE(	050782-69-9	x	systemic
ARSONIC ACID, CALCIUM SALT (1:1)	052740-16-0		systemic
ETHYL O-2-DIISOPROPYLAMINOETHYL METHYLPHOSPHONITE,	057856-11-8	x	systemic
BIS(2-CHLOROETHYLTHIO)METHANE	063869-13-0		systemic
BIS(2-CHLOROETHYLTHIO)-N-PROPANE, 1,3-	063905-10-2		systemic
BIS(2-CHLOROETHYLTHIOMETHYL)ETHER	063918-90-1		systemic
BIS(2-CHLOROETHYLTHIO)-N-BUTANE, 1,4-	142868-93-7		systemic
BIS(2-CHLOROETHYLTHIO)-N-PENTANE,1,5-	142868-94-8		systemic

* Requirements of sections B, C, D, F, and section G's container labeling requirements do not apply to chemicals in which sodium azide is used in small amounts as a preservative. Sodium azide and solutions containing sodium azide should not be put into the sewer system. They should be collected as hazardous waste.

APPENDIX D-(1) Select Carcinogens (Alphabetical)

SELECT CARCINOGENS (Alphabetical)

Key: IARC (INTERNATIONAL AGENCY FOR RESEARCH ON CANCER)
1 -- CARCINOGENIC TO HUMANS
2A -- PROBABLY CARCINOGENIC TO HUMANS
2B -- POSSIBLY CARCINOGENIC TO HUMANS
NTP (NATIONAL TOXICOLOGY PROGRAM)
A -- KNOWN TO BE CARCINOGENS
B -- REASONABLY ANTICIPATED TO BE CARCINOGENS
"s" - readily absorbed through the skin

LIST DOES NOT INCLUDE INDUSTRIAL PROCESSES, RADIATION OR MEDICAL TREATMENT
Revised: 3/2009

CHEMICAL NAME	CAS #	OSHA	IARC 1	IARC 2A	IARC 2B	NTP A	NTP B
ACETALDEHYDE	000075-07-0				X		X
ACETAMIDE	000060-35-5				X		
ACETYLAMINOFLUORENE,2-	000053-96-3	X					X
ACRYLAMIDE "s"	000079-06-1			X			X
ACRYLONITRILE "s"	000107-13-1	X			X		X
ADRIAMYCIN	025316-40-9			X			X
AFLATOXIN B1	001162-65-8		X				
AFLATOXIN M1	006795-23-9				X		
AFLATOXINS	001402-68-2		X			X	
AMINO-2,4-DIBROMOANTHRAQUINONE,1-	000081-49-2						X
AMINO-2-METHYLANTHRAQUINONE, 1-	000082-28-0						X
AMINO-3,4-DIMETHYL-3h-IMIDAZO(4,5f)QUINOLINE,2-	077094-11-2				X		X
AMINO-3,8-DIMETHYL-3H-IMIDAZO(4,5-f)QUINOXALINE, 2-	077500-04-0				X		X
AMINO-5-(5-NITRO-2-FURYL)-1,3,4-THIADIAZOLE, 2-	000712-68-5				X		
AMINOANTHRAQUINONE, 2-	000117-79-3						X
AMINOAZOBENZENE,para-	000060-09-3				X		
AMINOAZOTOLUENE,ortho-	000097-56-3				X		X
AMINODIPHENYL,4- "s"	000092-67-1	X	X			X	
AMITROLE	000061-82-5				X		X
AMMONIUM DICHROMATE (VI) "s"	007789-09-5		X			X	
AMSACRINE	051264-14-3				X		
ANISIDINE HYDROCHLORIDE, o-	000134-29-2				X		X
ANISIDINE, ortho- "s"	000090-04-0				X		
ANTHRAQUINONE, 1,8-DIHYDROXY	000117-10-2				X		X
ARAMITE	000140-57-8				X		
ARECA NUT	000000-00-0		X				
ARISTOLOCHIC ACIDS	000000-00-0			X			
ARSENEOUS ACID, CALCIUM SALT	027152-57-4	X	X			X	
ARSENEOUS ACID, POTASSIUM SALT	010124-50-2	X	X			X	
ARSENIC ACID	007778-39-4	X	X			X	
ARSENIC ACID, CALCIUM SALT (2:3)	007778-44-1	X	X			X	
ARSENIC ACID, DISODIUM SALT, HEPTAHYDRATE	010048-95-0	X	X			X	
ARSENIC ACID, LEAD(2+) SALT (1:1)	007784-40-9	X	X			X	
ARSENIC ACID, MONOPOTASSIUM SALT	007784-41-0	X	X			X	
ARSENIC ACID, SODIUM SALT	007631-89-2	X	X			X	
ARSENIC AND COMPOUNDS	007440-38-2	X	X			X	
ARSENIC PENTAFLUORIDE	007784-36-3	X	X			X	
ARSENIC PENTOXIDE	001303-28-2	X	X			X	
ARSENIC TRICHLORIDE "s"	007784-34-1	X	X			X	
ARSENIC TRIOXIDE	001327-53-3	X	X			X	
ARSENIOUS ACID, CALCIUM SALT	027152-57-4	X	X			X	
ARSENIUOS ACID, MONOSODIUM SALT	007784-46-5	X	X			X	
ARSONIC ACID	000097-44-9	X	X			X	
ARSONIC ACID, CALCIUM SALT (1:1)	052740-16-6	X	X			X	
ASBESTOS	001332-21-4	X	X			X	
ASBESTOS, ACTINOLITE	077536-66-4	X	X			X	
ASBESTOS, AMOSITE	012172-73-5	X	X			X	
ASBESTOS, ANTHOPHYLLITE	077536-67-5	X	X			X	
ASBESTOS, CHRYSOTILE	012001-29-5	X	X			X	
ASBESTOS, CROCIDOLITE	012001-28-4	X	X			X	
ASBESTOS, TREMOLITE	077536-68-6	X	X			X	
AURAMINE, TECHNICAL-GRADE	000492-80-8				X		

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			IARC			NTP	
CHEMICAL NAME	CAS #	OSHA	1	2A	2B	A	B
AZACYTIDINE	000320-67-2			X			
AZASERINE	000115-02-6				X		
AZATHIOPRINE	000446-86-6		X			X	
AZIRIDINE "s"	000151-56-4				X		
BARIUM CHROMATE(VI)	010294-40-3		X			X	
BENZ[a]ANTHRACENE "s"	000056-55-3				X		X
BENZ[c]PHENANTHRENE	000195-19-7				X		
BENZ[j]ACEANTHRYLENE	000202-33-5				X		
BENZ0YLTRICHLORIDE "s"	000098-07-7			X			X
BENZENE "s"	000071-43-2	X	X			X	
BENZIDINE "s"	000092-87-5	X	X			X	
BENZIDINE-BASED DYES "s"	000092-87-5			X			
BENZO[a]PYRENE	000050-32-8		X				X
BENZO[b]FLUORANTHENE	000205-99-2				X		X
BENZO[j]FLUORANTHENE	000205-82-3				X		X
BENZO[k]FLUORANTHENE	000207-08-9				X		X
BENZOFURAN	000271-89-6				X		
BENZOYL CHLORIDE	000098-88-4			X			
BENZYL CHLORIDE	000100-44-7			X			
BENZYL VIOLET 4B	001694-09-3				X		
BERYLLIUM ALUMINUM ALLOY	012770-50-2		X			X	X
BERYLLIUM ALUMINUM SILICATE	001302-52-9		X			X	
BERYLLIUM AND COMPOUNDS	007440-41-7		X			X	
BERYLLIUM CHLORIDE	007787-47-5		X			X	
BERYLLIUM FLUORIDE	007787-49-7		X			X	
BERYLLIUM HYDROGEN PHOSPHATE (1:1)	013598-15-7		X			X	
BERYLLIUM HYDROXIDE	013327-32-7		X			X	
BERYLLIUM OXIDE	001304-56-9		X			X	
BERYLLIUM OXIDE CARBONATE	066104-24-3		X			X	
BERYLLIUM SULFATE (1:1)	013510-49-1		X			X	
BERYLLIUM SULFATE, TETRAHYDRATE (1:1:4)	007787-56-6		X			X	
BERYLLIUM ZINC SILICATE	039413-47-3		X			X	
BISCHLOROETHYL NITROSOUREA (BCNU)	000154-93-8			X			X
BLEOMYCIN SULFATE	009041-93-4				X		
BLEOMYCIN, HYDROCHLORIDE	067763-87-5				X		
BLEOMYCINS	011056-06-7				X		
BRACKEN FERN	000000-00-0				X		
BROMODICHLOROMETHANE	000075-27-4				X		X
BUTADIENE,1,3-	000106-99-0	X	X			X	
BUTANEDIOL DIMETHANESULPHONATE,1,4- (BUSULFAN)	000055-98-1		X			X	
BUTYLATED HYDROXYANISOLE (BHA)	025013-16-5				X		X
BUTYRIC ACID, 4-(N-BUTYL-N-NITROSAMINO)-	038252-74-3						X
BUTYROLACTONE,BETA-	003068-88-0				X		
C.I. BASIC RED 9	000569-61-9				X		X
CADMIUM AND COMPOUNDS	007440-43-9	X	X			X	
CADMIUM CARBONATE	000513-78-0	X	X			X	
CADMIUM CHLORIDE "s"	010108-64-2	X	X			X	
CADMIUM FLUOBORATE	014486-19-2	X	X			X	
CADMIUM NITRATE	010325-94-7	X	X			X	
CADMIUM OXIDE	001306-19-0	X	X			X	
CADMIUM SULFATE (1:1)	010124-36-4	X	X			X	
CADMIUM SULFIDE	001306-23-6	X	X			X	
CAFFEIC ACID	000331-39-5				X		
CALCIUM CHROMATE (VI)	013765-19-0		X			X	

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CHEMICAL NAME	CAS #	OSHA	IARC 1	IARC 2A	IARC 2B	NTP A	NTP B
CAPTAFOL	002425-06-1			X			
CARBON BLACK	001333-86-4				X		
CARBON TETRACHLORIDE "s"	000056-23-5				X		X
CARRAGEENAN, DEGRADED	009000-07-1				X		
CATECHOL "s"	000120-80-9				X		
CERAMIC FIBERS (RESPIRABLE SIZE)	000000-00-0				X		
CHLORAMBUCIL	000305-03-3		X			X	
CHLORAMPHENICOL	000056-75-7			X		X	
CHLORDANE "s"	000057-74-9				X		
CHLORDANE, ALPHA "s"	005103-71-9				X		
CHLORDANE, BETA "s"	005103-74-2				X		
CHLORDANE, GAMMA "s"	005566-34-7				X		
CHLORENDIC ACID	000115-28-6				X		X
CHLORINATED PARAFFINS (CARBON-12, 60% CHLORINE)	108171-26-2				X		X
CHLORINATED TOULENES, ALPHA-	000000-00-0			X			
CHLORO-2-METHYLPROPENE, 3-	000563-47-3						X
CHLORO-2-METHYLPROPENE,1-	000513-37-1				X		X
CHLORO-4-(DICHLOROMETHYL)-5-HYDROXY-2(5H)FURANONE, 3-	077439-76-0				X		
CHLOROANILINE, para, "s"	000106-47-8				X		
CHLOROETHYL(2)-3-(4-METHYLCYCLOHEXYL)-1-NITROSOUREA, 1-	013909-09-6		X			X	
CHLOROETHYL(2)-3-CYCLOHEXYL-1-NITROSOUREA,1- (CCNU)	013010-47-4			X			X
CHLOROFORM	000067-66-3				X		X
CHLOROMETHYL ETHER,BIS- "s"	000542-88-1	X	X			X	
CHLOROMETHYL METHYL ETHER	000107-30-2	X	X			X	
CHLORO-ortho-PHENYLENEDIAMINE,4-	000095-83-0				X		X
CHLORO-ortho-TOLUIDINE, para-	000095-69-2			X			X
CHLORO-O-TOLUIDINE HYDROCHLORIDE, 4-	003165-93-3		X				X
CHLOROPHENOLS "s"	000000-00-0				X		
CHLOROPHENOXY HERBICIDES "s"	000000-00-0				X		
CHLOROPRENE "s"	000126-99-8				X		X
CHLOROTHALONIL	001897-45-6				X		
CHLOROZOTOCIN	054749-90-5			X			
CHROMATE(1-),HYDROXYOCTAOXODIZINCATEDI-, POTASSIUM	011103-86-9		X			X	
CHROMIC ACID, DISODIUM SALT "s"	007775-11-3		X			X	
CHROMIUM (III) OXIDE (2:3)	001308-38-9		X			X	
CHROMIUM (VI) CHLORIDE	014986-48-2		X			X	
CHROMIUM (VI) OXIDE (1:3)	001333-82-0		X			X	
CHROMIUM CARBONATE	029689-14-3		X			X	
CHROMIUM PHOSPHATE	007789-04-0		X			X	
CHROMIUM TRIACETATE	001066-30-4		X			X	
CHROMIUM, DICHLORODIOXO-	014977-61-8		X			X	
CHROMIUM, HEXAVALENT AND COMPOUNDS	007440-47-3		X			X	
CHRYSENE	000218-01-9				X		
CI ACID RED 114	006485-34-3				X		
CI DIRECT BLUE 15	002429-74-5				X		
CICLOSPORIN	079217-60-0		X				
CISPLATIN	015663-27-1			X			X
CITRUS RED NO. 2	006358-53-8				X		
COAL TAR "s"	065996-89-6		X			X	
COAL TAR DISTILLATE "s"	065996-92-1		X			X	
COAL-TAR "s"	008007-45-2		X			X	
COAL-TAR PITCHES "s"	065996-93-2		X			X	
COBALT (2+) SULFIDE	001317-42-6				X		
COBALT (II) ACETATE	006147-53-1				X		

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COBALT (III) OXIDE	001308-04-9				X		
COBALT ACETATE	000071-48-7				X		
COBALT ALLOY, CO, CR	011114-92-4				X	X	
COBALT AND COMPOUNDS	007440-48-4				X		
COBALT CARBONATE	000513-79-1				X		
COBALT CARBONATE, COBALT DIHYDROXIDE (2:3)	012602-23-2				X		
COBALT CARBONYL	017786-31-1				X		
COBALT DINITRATE HEXAHYDRATE	010026-22-9				X		
COBALT HYDROXIDE	001307-86-4				X		
COBALT HYDROXIDE OXIDE	012016-80-7				X		
COBALT MOLYBDATE (VI)	013762-14-6				X		
COBALT NAPHTHATE	061789-51-3				X		
COBALT OXIDE	001308-06-1				X		
COBALT TRIACETATE	000917-69-1				X		
COBALT(2+) OXIDE	001307-96-6				X		
COBALT(II) CHLORIDE	007646-79-9				X		
COBALT(II) CHLORIDE, HEXAHYDRATE	007791-13-1				X		
COBALT(II) HYDROXIDE	021041-93-0				X		
COBALT(II) NITRATE (1:2)	010141-05-6				X		
COBALT(II) SULFATE (1:1)	010124-43-3				X		X
COBALT, (MU(CARBONATO(2-)-O:O'))DIHYDROXYDI	012069-68-0				X		
COBALT, DI-MU-CARBONYLNONACARBONYL	010210-68-1				X		
COBALT-CHROMIUM-MOLYBDENUM ALLOY	012629-02-6				X	X	
COBALT-CHROMIUM-NICKEL-TUNGSTEN ALLOY	012638-07-2				X	X	
CONESTORAL	000438-67-5					X	
CREOSOTE, WOOD	008021-39-4			X		X	
CREOSOTES	008001-58-9			X		X	
CRESIDINE, para-	000120-71-8				X		X
CUPFERRON	000135-20-6						X
CYCASIN	014901-08-7				X		
CYCLOPENTA[CD]PYRENE	027208-37-3			X			
CYCLOPHOSPHAMIDE	006055-19-2		X			X	
CYCLOSPORIN A	059865-13-3		X			X	
DACARBAZINE	004342-03-4				X		X
DAUNOMYCIN	020830-81-3				X		
DDT "s"	000050-29-3				X		X
DECABROMOBIPHENYL	013654-09-6						X
DI(2-ETHYLHEXYL)PHTHALATE	000117-81-7				X		X
DIACETYLBENZIDINE,N,N'-	000613-35-4				X		
DIAMINOANISOLE SULPHATE, 2,4-	039156-41-7						X
DIAMINOANISOLE, 2,4- (AND ITS SALTS)	000615-05-4				X		
DIAMINOBENZENE	000136-35-6						X
DIAMINODIPHENYL ETHER, 4,4-	000101-80-4				X		X
DIAMINOTOLUENE, 2,4-	000095-80-7				X		X
DIAZOAMINOBENZENE	000136-35-6						X
DIBENZ[a,h]ACRIDINE	000226-36-8				X		X
DIBENZ[a,h]ANTHRACENE	000053-70-3			X			X
DIBENZ[a,j]ACRIDINE	000224-42-0				X		X
DIBENZO[a,e]PYRENE	000192-65-4				X		X
DIBENZO[a,h]PYRENE	000189-64-0				X		X
DIBENZO[a,i]PYRENE	000189-55-9				X		X
DIBENZO[a,l]PYRENE	000191-30-0						X
DIBENZO[c,g]CARBAZOLE, 7H-	000194-59-2				X		X
DIBROMO-1-PROPANOL,2,3-	000096-12-9						X

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DIBROMO-3-CHLOROPROPANE,1,2- "s" (DBCP)	000096-12-8	X			X		X
DICHLORO-4,4'-DIAMINODIPHENYL ETHER, 3,3'-	028434-86-8				X		
DICHLOROBENZENE, para-	000106-46-7				X		X
DICHLOROBENZIDINE, DIHYDROCHLORIDE, 3,3'-	000612-83-9						X
DICHLOROBENZIDINE,3,3'- "s"	000091-94-1	X			X		X
DICHLOROETHANE, 1,2- "s"	000107-06-2				X	X	
DICHLOROMETHANE	000075-09-2				X		X
DICHLOROPROPENE, 1,3- (TECHNICAL-GRADE) "s"	000542-75-6				X		X
DICHLORVOS "s"	000062-73-7				X		
DIEPOXYBUTANE "s"	001464-53-5						X
DIESEL EXHAUST	000000-00-0			X			X
DIESEL FUEL MARINE	000000-00-0				X		
DIESEL FUELS, DISTILLATE (LIGHT)	000000-00-0				X		
DIETHYL SULFATE "s"	000064-67-5			X			X
DIETHYLHYDRAZINE, 1,2-	001615-80-1				X		
DIETHYLSTILBOESTROL "s"	000056-53-1		X			X	
DIGLYCIDYL RESORCINOL ETHER	000101-90-6				X		X
DIHYDROSAFROLE	000094-58-6				X		
DIMETHOXYBENZIDINE, 3,3'- (o-DIANISIDINE)	000119-90-4				X		X
DIMETHYL SULFATE	000077-78-1			X			X
DIMETHYLAMINOAZOBENZENE, PARA	000060-11-7	X			X		X
DIMETHYLBENZIDINE, 3,3'- (o-TOLIDINE) "s"	000119-93-7				X		X
DIMETHYLCARBAMOYL CHLORIDE	000079-44-7			X			X
DIMETHYLHYDRAZINE, 1,1- "s"	000057-14-7				X		X
DINITROFLUOROANTHENE, 3,7-	105735-71-5			X			
DINITROPYRENE, 1,6-	042397-64-8				X		X
DINITROPYRENE, 1,8-	042397-65-9				X		
DINITROTOLUENE, 2,4- "s'	000121-14-2				X		
DIOXANE, 1,4- "s"	000123-91-1				X		X
DIRECT BLACK 38	001937-37-7					X	
DIRECT BLUE 6	002602-46-2					X	
DISPERSE BLUE 1	002475-45-8				X		X
DYES METABOLIZED TO BENZIDINE "s"	000000-00-0		X				
E-GLASS	000000-00-0				X		
EPICHLOROHYDRIN "s"	000106-89-8			X			X
EPOXYBUTANE, 1,2-	000106-88-7				X		
ERIONITE	066733-21-9		X			X	
ESTRA-1,2,5(10),7-TETRAEN-17-ONE,3-(SULFOOXY)-,SODIUM SALT	016680-47-0					X	
ETHYL ACRYLATE "s"	000140-88-5				X		
ETHYL METHANESULFONATE	000062-50-0				X		X
ETHYLENE DIBROMIDE "s"	000106-93-4			X			X
ETHYLENE OXIDE	000075-21-8	X	X			X	
ETHYLENE THIOUREA	000096-45-7				X		X
ETHYL-N-NITROSOUREA,N-	000759-73-9			X			X
ETOPOSIDE	033419-42-0				X		
FORMALDEHYDE "s"	000050-00-0	X	X				X
FOWLER'S SOLUTION	001332-10-1		X				
FUMONISIN B1	116355-83-0				X		
FURAN "s"	000110-00-9				X		X
FURYLAMIDE	003688-53-7				X		
GALLIUM ARSENIDE	001303-00-0		X				
GASOLINE "s"	008006-61-9				X		
GASOLINE, ENGINE EXHAUST FUMES	000000-00-0				X		
GLASS FIBERS, SPECIALTY (E-GLASS, '475')	000000-00-0				X		

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GLASSWOOL (RESPIRABLE SIZE)	000000-00-0				X		X
GLU-P-1(2-AMINO-6-METHYLDIPYRIDO[1,2-A:3',2'-D]IMIDZOLE	067730-11-4				X		
GLU-P-2 (2-AMINODIPYRIDO[1,2-a:3',2'-d]IMIDAZOLE	067730-10-3				X		
GLYCIDALDEHYDE "s"	000765-34-4				X		
GLYCIDOL "s"	000556-52-5						X
GRISEOFULVIN	000126-07-8				X		
HC BLUE 1	002784-94-3				X		
HEPATITIS B VIRUS	000000-00-0		X			X	
HEPATITIS C VIRUS	000000-00-0		X			X	
HEPTACHLOR "s'	000076-44-8				X		
HEPTACHLOR EPOXIDE "s"	001024-57-3				X		
HEXACHLOROBENZENE "s"	000118-74-1				X		X
HEXACHLOROBENZENE, GAMMA "s"	000058-89-9						X
HEXACHLOROCYCLOHEXANES "s"	000000-00-0				X		X
HEXACHLOROETHANE	000067-72-1				X		X
HEXACHLOROHEXANE (ALL ISOMERS)	000608-73-1				X		X
HEXAMETHYLPHOSPHORAMIDE "s"	000680-31-9				X		X
HUMAN IMMUNODEFICIENCY VIRUS TYPE 1	000000-00-0		X				
HUMAN PAPILLOMAS VIRUSES: SOME GENITAL-MUCOSAL	000000-00-0		X			X	
HYDRAZINE "s"	000302-01-2				X		X
HYDRAZINE SULFATE (1:1) "s"	010034-93-2						X
HYDRAZOBENZENE	000122-66-7						X
INDENO[1,2,3-cd]PYRENE	000193-39-5				X		X
INIDIUM PHOSPHIDE	022398-80-7			X			
IQ(2-AMINO-3-METHYLIMIDAZO[4,5-f]QUINOLINE)	076180-96-6			X			
IRON-DEXTRAN COMPLEX	009004-66-4				X		X
ISOPRENE	000078-79-5				X		X
KEPONE (CHLORDECONE) "s"	000143-50-0				X		X
LASIOCARPINE	000303-34-4				X		
LEAD ACETATE	000301-04-2				X		X
LEAD ACETATE (II) TRIHYDRATE	006085-56-4				X		X
LEAD AND COMPOUNDS	007439-92-1			X			X
LEAD CHROMATE	007758-97-6		X			X	
LEAD CHROMATE (VI) OXIDE	018454-12-1		X			X	
LEAD PHOSPHATE	007446-27-7				X		X
LINDANE, ALPHA	000319-84-6						X
LINDANE, BETA	000319-85-7						X
MAGENTA (CONTAINING CI BASIC RED 9)	000632-99-5				X		
MeA-ALPHA-C(2-AMINO-3-METHYL-9H-PYRIDO[2,3-b]INDOLE)	068006-83-7				X		
MEDROXYPROGESTERONE ACETATE	000071-58-9				X		
MELPHALAN	000148-82-3		X			X	
MERPHALAN	000531-76-0				X		
METHLYEUGENOL	000093-15-2						X
METHOXYPSORALEN,5-	000484-20-8			X			
METHYL MERCURY AND COMPOUNDS "s"	022967-92-6				X		
METHYL METHANESULPHONATE	000066-27-3			X			X
METHYL-1-NITROANTHRAQUINONE, 2- (UNCERTAIN PURITY)	000129-15-7				X		
METHYLAZIRIDINE, 2- (PROPYLENEIMINE) "s"	000075-55-8				X		X
METHYLAZOXYMETHANOL	000590-96-5				X		
METHYLAZOXYMETHANOL ACETATE	000592-62-1				X		
METHYLCHRYSENE, 5-	003697-24-3				X		X
METHYLENE BIS(2-CHLOROANILINE), 4,4- (MOCA) "s"	000101-14-4		X				X
METHYLENE BIS(2-METHYLANILINE), 4,4'-	000838-88-0				X		
METHYLENEBIS(N,N-DIMETHYL)BENZENAMINE	000101-61-1		X				X

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CHEMICAL NAME	CAS #	OSHA	IARC 1	IARC 2A	IARC 2B	NTP A	NTP B
METHYLENEDIANILINE, 4,4'	000101-77-9	X			X		X
METHYLENEDIANILINE,4,4'- DIHYDROCHLORIDE	013552-44-8						X
METHYL-N-NITRO-N'-NITROSOGUANIDINE,N- (MNNG)	000070-25-7			X			X
METHYL-N-NITROSOUREA,n-	000684-93-5			X			X
METHYLTHIOURACIL	000056-04-2				X		
METHY-N-NITROSOURETHANE,n-	000615-53-2				X		
METRONIDAZOLE	000443-48-1				X		X
MICHLER'S KETONE	000090-94-8		X				X
MICROCYSTIN	101043-37-2				X		
MINERAL OILS,UNTREATED AND MILDLY TREATED	000000-00-0		X			X	
MIREX "s"	002385-85-5				X		X
MITOMYCIN C	000050-07-7				X		
MONOCROTALINE	000315-22-0				X		
MUSTARD GAS "s"	000505-60-2		X			X	
N-[4-(5-NITR-2-FURYL)-2-THIAZOLYL]ACETAMIDE	000531-82-8				X		
NAFENOPIN	003771-19-5				X		
NAPHTHALENE	000091-20-3				X		X
NAPHTHLYAMINE,N,N-BIS(2CHLOROETHYL)-2-	000494-03-1		X				
NAPHTHYLAMINE,2- "s"	000091-59-8	X	X			X	
NAPHTHYLAMINE,ALPHA- "s"	000134-32-7	X					
NICKEL (II) ACETATE (1:2)	000373-02-4		X			X	
NICKEL (II) CARBONATE (1:1)	003333-67-3		X			X	
NICKEL (II) HYDROXIDE	012054-48-7		X			X	
NICKEL (II) OXIDE (1:1)	001313-99-1		X			X	
NICKEL (III) HYDROXIDE	012125-56-3		X			X	
NICKEL BISCYCLOPENDADIENE	001271-28-9		X			X	
NICKEL CARBONYL	013463-39-3		X			X	
NICKEL COMPOUNDS	000000-00-0		X			X	
NICKEL HYDROXIDE	011113-74-9		X			X	
NICKEL SULFIDE (3:2)	012035-72-2		X			X	
NICKEL, METALLIC AND ALLOYS	007440-02-0				X	X	
NIRIDAZOLE	000061-57-4				X		
NITRILOACETIC ACID, SODIUM SALT	010042-84-9				X		
NITRILOTRIACETIC ACID AND SALTS	000139-13-9				X		X
NITRILOTRIACETIC ACID, DISODIUM SALT	015467-20-6				X		X
NITRILOTRIACETIC ACID, DISODIUM SALT, MONOHYDRATE	023255-03-0				X		X
NITRILOTRIACETIC ACID, MONOSODIUM SALT	018994-66-6				X		X
NITRILOTRIACETIC ACID, TRISODIUM SALT	005064-31-3				X		X
NITRILOTRIACETIC ACID, TRISODIUM SALT, MONOHYDRATE	018662-53-8				X		X
NITROACENAPHTHENE, 5-	000602-87-9				X		
NITROANISOLE, 2-	000091-23-6				X		X
NITROBENZENE "s"	000098-95-3				X		X
NITROBIPHENYL,4-	000092-93-3	X					
NITROCHRYSENE, 6-	007496-02-8				X		X
NITROFEN (TECHNICAL-GRADE) "s"	001836-75-5				X		X
NITROFLUORENE, 2-	000607-57-8				X		
NITROFURFURYLIDIENE(5)-AMINO-2-IMIDAZOLIDINONE, 1-	000555-84-0				X		
NITROGEN MUSTARD "s"	000051-75-2			X			
NITROGEN MUSTARD HYDROCHLORIDE "s"	000055-86-7			X			X
NITROGEN MUSTARD N-OXIDE	000126-85-2				X		
NITROMETHANE	000075-52-5				X		X
NITROPROPANE, 2-	000079-46-9				X		X
NITROPYRENE, 1-	005522-43-0				X		X
NITROPYRENE, 4-	057835-92-4				X		X

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NITROSOBUTYLBUTANOLAMINE,N-	003817-11-6						X
NITROSODIETHANOLAMINE, N-	001116-54-7				X		X
NITROSODIETHYLAMINE,N-	000055-18-5			X			X
NITROSODIMETHYLAMINE,N-	000062-75-9	X		X			X
NITROSODI-n-BUTYLAMINE, N-	000924-16-3				X		X
NITROSODI-n-PROPYLAMINE, n-	000621-64-7				X		X
NITROSOMETHYLETHYLAMINE, N-	010595-95-6				X		
NITROSOMETHYLVINYLAMINE, N-	004549-40-0				X		X
NITROSOMORPHOLINE, N-	000059-89-2				X		X
NITROSONORNICOTINE, N'-	016543-55-8		X				X
NITROSOPIPERIDINE, N-	000100-75-4				X		X
NITROSOPYRROLIDINE, N-	000930-55-2				X		X
NITROSOSACOSINE, N-	013256-22-9				X		X
N-NITROSOMETHYLAMINO-1-(30PYRIDYL)-1-BUTANONE, 4- (NNK)	064091-91-4		X				X
N-NITROSOMETHYLAMINO-PROPIONITRILE, 3-	060153-49-3				X		
NORETHISTERONE	000068-22-4						X
OCHRATOXIN A	000303-47-9				X		X
OCTABROMOBIPHENYL	061288-13-9						X
OIL ORANGE SS	002646-17-5				X		
OXAZEPAM	000604-75-1			X			
OXAZOLIDININE,2,5-(MORPHOLINOMETHYL)-3-[(5-NITROFURYLIDENE)	003795-88-8				X		
OXYMETHOLONE	000434-07-1						X
PALYGORSKITE (fibers > 5 micrometers)	012174-11-7				X		
PANFURAN containing DIHYDROXMETHYLFURATRIZINE	000794-93-4				X		
PCB (AROCLOR 1254)	011097-69-1			X			X
PCB (AROCLOR 1260)	011096-82-5						X
PENTACHLOROBIPHENYL	025429-29-2				X		X
PHENACETIN	000062-44-2			X			X
PHENAZOPYRIDINE HYDROCHLORIDE	000136-40-3				X		X
PHENOBARBITAL	000050-06-6				X		
PHENOTHALEIN	000077-09-8						X
PHENOXYBENZAMINE HYDROCHLORIDE	000063-92-3				X		X
PHENYL GLYCIDYL ETHER "s"	000122-60-1				X		
PHENYTOIN	000057-41-0				X		X
PHLP(2-AMINO-1-METHYL-6-PHENYLIMIDAZO[4,5-B]PYRIDINE)	105650-23-5				X		X
PIPERAZINE ESTRONE SULFATE	007280-37-7					X	
POLYBROMINATED BIPHENYL (FF-1)	067774-32-7						X
POLYBROMINATED BIPHENYLS	059536-65-1				X		
POLYCHLORINATED BIPHENYLS	001336-36-3			X			X
POLYCHLOROPHENOLS	000000-00-0				X		X
POLYCYCLIC AROMATIC HYDROCARBONS	000000-00-0						X
PONCEAU 3R	003564-09-8				X		
PONCEAU MX	003761-53-3				X		
POTASSIUM BROMATE	007758-01-2				X		
POTASSIUM CHROMATE (VI)	007789-00-6		X			X	
POTASSIUM DICHROMATE (VI)	007778-50-9		X			X	
PROCARBAZINE HYDROCHLORIDE	000366-70-1			X			X
PROGESTERONE	000057-83-0						X
PROPANE SULTONE, 1,3- "s"	001120-71-4				X		X
PROPANEDIOL,2,2-BIS-(BROMOETHYL)-1,3-	003296-90-0						X
PROPIOLACATONE, BETA	000057-57-8	X			X		X
PROPRIONIC ACID,2-(2,4-DICHLOROPHENOXY)	000120-36-5				X		
PROPYLENE OXIDE "s"	000075-56-9				X		X
PROPYLTHIOURACIL	000051-52-5				X		X

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QUARTZ [SILICA, CRYSTALLINE (RESPIRABLE)]	014808-60-7			X		X	
RADON AND ITS DECAY PRODUCTS	010043-92-2		X			X	
REFRACTORY CERAMIC FIBERS	000000-00-0				X		
RESERPINE	000050-55-5						X
RIDDELLIINE	023246-96-0				X		
ROCKWOOL	000000-00-0				X		
SACCHARIN	000081-07-2				X		
SACCHARIN, SODIUM SALT	000128-44-9				X		
SAFROLE	000094-59-7				X		X
SENARMONITE	012412-52-1				X		
SHALE-OILS "s"	068308-34-9		X				
SILICA, CRYSTALLINE (RESPIRABLE)	000000-00-0			X		X	
SILICA, CRYSTALLINE CRISTOBALITE	014464-46-1		X			X	
SILICA, CRYSTALLINE TRIDYMITE	015468-32-3			X		X	
SILICA, CRYSTALLINE TRIPOLI	001317-95-9			X		X	
SILICIC ACID BERYLLIUM SALT	015191-85-2		X				
SODIUM DICHROMATE (VI) "s"	010588-01-9		X			X	
SODIUM ortho-PHENYLPHENATE	000132-27-4				X		
SOOTS,TARS, MINERAL OILS	000000-00-0					X	
STERIGMATOCYSTIN	010048-13-2				X		
STREPTOZOTOCIN	018883-66-4				X		
STRONTIUM CHROMATE (VI)	007789-06-2		X			X	
STYRENE "s"	000100-42-5				X		
STYRENE-7,8-OXIDE "s"	000096-09-3			X			
SULFALLATE "s"	000095-06-7				X	X	
SULFUR TRIOXIDE	007446-11-9		X				
SULFURIC ACID	007664-93-9		X				
SULFURIC ACID, DIISOPROPYL ESTER "s"	002973-10-6				X		
SULFURIC ACID, FUMING, MISTS	008014-95-7		X				
TALC CONTAINING ASBESTIFORM FIBRES	014807-96-6		X				
TAMOXIFEN	010540-29-1					X	
TENIPOSIDE	029767-20-2				X		
TETRACHLORODIBENZO-para-DIOXIN, 2,3,7,8- (TCCD) "s"	001746-01-6		X			X	
TETRACHLOROETHYLENE "s"	000127-18-4				X		X
TETRAETHYL LEAD "s"	000078-00-2				X		
TETRAFLUOROETHYLENE	000116-14-3					X	
TETRANITROMETHANE	000509-14-8				X		X
THIAZOLE,2(2-FORMLYLHYDRAZIN0)-4-(5-NITRO-2-FURYL)	003570-75-0				X		
THIOACETAMIDE	000062-55-5				X		X
THIODIANILINE, 4,4'-	000139-65-1				X		X
THIOTEPA	000052-24-4			X		X	
THIOURACIL	000141-90-2				X		
THIOUREA	000062-56-6				X		X
THORIUM DIOXIDE	001314-20-1					X	
TITANIUM DIOXIDE	013463-67-7				X		
TOBACCO PRODUCTS, SMOKELESS	000000-00-0		X				
TOBACCO SMOKE	000000-00-0		X			X	
TOLUENE DIISOCYANATE, 1,3-	026471-62-5				X		X
TOLUENE DIISOCYANATE, 2,4-	000584-84-9				X		
TOLUENE DIISOCYNATE, 2,6-	000091-08-7				X		
TOLUIDINE HYDROCHLORIDE, O-	000636-21-5						X
TOLUIDINE, ORTHO- "s"	000095-53-4		X				X
TOXAPHENE (POLYCHLORINATED CAMPHENES) "s"	008001-35-2				X		X
TREOSULPHAN	000299-75-2		X				

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TRICHLOROETHYLENE	000079-01-6			X			X
TRICHLOROMETHINE	000817-09-4				X		
TRICHLOROPHENOL, 2,4,6- "s"	000088-06-2						X
TRICHLOROPROPANE, 1,2,3- "s"	000096-18-4			X			X
TRIS (2,3-DIBROMOPROPYL)PHOSPHATE, (TRIS) "s"	000126-72-7			X			X
TRP-P-1(3-AMINO-1,4-DIMETHYL-5H-PYRIDO[4,3-b]INDOLE)	062450-06-0				X		
TRP-P-2(3-AMINO-1-METHYL-5H-PYRIDO[4,3-b]INDOLE)	062450-07-1				X		
TRYPAN BLUE	000072-57-1				X		
URACIL MUSTARD	000066-75-1				X		
URETHANE	000051-79-6				X		X
VALENTINITE	001317-98-2				X		
VINYL ACETATE	000108-05-4				X		
VINYL BROMIDE	000593-60-2			X		X	
VINYL CHLORIDE	000075-01-4	X	X			X	
VINYL FLUORIDE	000075-02-5			X		X	
VINYL-1-CYCLOHEXENE DIEPOXIDE, 4- "s"	000106-87-6				X		X
VINYLCYCLOHEXENE, 4-	000100-40-3				X		
WELDING FUMES	000000-00-0				X	X	
WOOD DUST	000000-00-0					X	
XYLIDINE "s"	000087-62-7				X		
ZALCITABINE	007481-89-2				X		
ZIDOVUDINE(AZT)	030516-87-1				X		
ZINC CHROMATE	013530-65-9		X			X	
ZINC CHROMATE (VI) HYDROXIDE	001300-73-8		X			X	
ZINC CHROMATE (VI) HYDROXIDE	015930-94-6		X			X	
ZIRCONIUM TETRACHLORIDE	010026-11-6			X			

REFERENCE:
International Agency for Rearch on Cancer, 2009, *Overall Evaluations of Carcinogencity to Humans. (Monographs Volumes 1-99)*
Sax, Richard, 1999. *Dangerous Properties of Industrial Materials*.
National Toxicology Program, 2005. *11th Annual Report on Carcinogens.*

APPENDIX D-(2) Select Carcinogens (By CAS Number)

SELECT CARCINOGENS (CAS #)

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ARECA NUT	000000-00-0		X				
ARISTOLOCHIC ACIDS	000000-00-0			X			
BRACKEN FERN	000000-00-0				X		
CERAMIC FIBERS (RESPIRABLE SIZE)	000000-00-0				X		
CHLORINATED TOULENES, ALPHA-	000000-00-0			X			
CHLOROPHENOLS "s"	000000-00-0				X		
CHLOROPHENOXY HERBICIDES "s"	000000-00-0				X		
DIESEL EXHAUST	000000-00-0			X			X
DIESEL FUEL MARINE	000000-00-0				X		
DIESEL FUELS, DISTILLATE (LIGHT)	000000-00-0				X		
DYES METABOLIZED TO BENZIDINE "s"	000000-00-0		X				
E-GLASS	000000-00-0				X		
GASOLINE, ENGINE EXHAUST FUMES	000000-00-0				X		
GLASS FIBERS, SPECIALTY (E-GLASS, '475')	000000-00-0				X		
GLASSWOOL (RESPIRABLE SIZE)	000000-00-0				X		X
HEPATITIS B VIRUS	000000-00-0		X			X	
HEPATITIS C VIRUS	000000-00-0		X			X	
HEXACHLOROCYCLOHEXANES "s"	000000-00-0				X		X
HUMAN IMMUNODEFICIENCY VIRUS TYPE 1	000000-00-0		X				
HUMAN PAPILLOMAS VIRUSES: SOME GENITAL-MUCOSAL	000000-00-0		X			X	
MINERAL OILS,UNTREATED AND MILDLY TREATED	000000-00-0		X			X	
NICKEL COMPOUNDS	000000-00-0		X			X	
POLYCHLOROPHENOLS	000000-00-0				X		X
POLYCYCLIC AROMATIC HYDROCARBONS	000000-00-0						X
REFRACTORY CERAMIC FIBERS	000000-00-0				X		
ROCKWOOL	000000-00-0				X		
SILICA, CRYSTALLINE (RESPIRABLE)	000000-00-0			X		X	
SOOTS,TARS, MINERAL OILS	000000-00-0					X	
TOBACCO PRODUCTS, SMOKELESS	000000-00-0		X				
TOBACCO SMOKE	000000-00-0		X			X	
WELDING FUMES	000000-00-0				X	X	
WOOD DUST	000000-00-0					X	
FORMALDEHYDE "s"	000050-00-0	X	X				X
PHENOBARBITAL	000050-06-6				X		
MITOMYCIN C	000050-07-7				X		
DDT "s"	000050-29-3				X		X
BENZO[a]PYRENE	000050-32-8		X				X
RESERPINE	000050-55-5						X
PROPYLTHIOURACIL	000051-52-5				X		X
NITROGEN MUSTARD "s"	000051-75-2			X			
URETHANE	000051-79-6				X		X
THIOTEPA	000052-24-4			X		X	
DIBENZ[a,h]ANTHRACENE	000053-70-3			X			X
ACETYLAMINOFLUORENE,2-	000053-96-3	X					X
NITROSODIETHYLAMINE,N-	000055-18-5			X			X
NITROGEN MUSTARD HYDROCHLORIDE "s"	000055-86-7			X			X
BUTANEDIOL DIMETHANESULPHONATE,1,4- (BUSULFAN)	000055-98-1		X			X	
METHYLTHIOURACIL	000056-04-2				X		
CARBON TETRACHLORIDE "s"	000056-23-5				X		X
DIETHYLSTILBOESTROL "s"	000056-53-1		X			X	
BENZ[a]ANTHRACENE "s"	000056-55-3				X		X
CHLORAMPHENICOL	000056-75-7			X		X	

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DIMETHYLHYDRAZINE, 1,1- "s"	000057-14-7				X		X
PHENYTOIN	000057-41-0				X		X
PROPIOLACATONE, BETA	000057-57-8	X			X		X
CHLORDANE "s"	000057-74-9				X		
PROGESTERONE	000057-83-0						X
HEXACHLOROBENZENE, GAMMA "s"	000058-89-9						X
NITROSOMORPHOLINE, N-	000059-89-2				X		X
AMINOAZOBENZENE,para-	000060-09-3				X		
DIMETHYLAMINOAZOBENZENE, PARA	000060-11-7	X			X		X
ACETAMIDE	000060-35-5				X		
NIRIDAZOLE	000061-57-4				X		
AMITROLE	000061-82-5				X		X
PHENACETIN	000062-44-2			X			X
ETHYL METHANESULFONATE	000062-50-0				X		X
THIOACETAMIDE	000062-55-5				X		X
THIOUREA	000062-56-6				X		X
DICHLORVOS "s"	000062-73-7				X		
NITROSODIMETHYLAMINE,N-	000062-75-9	X		X			X
PHENOXYBENZAMINE HYDROCHLORIDE	000063-92-3				X		X
DIETHYL SULFATE "s"	000064-67-5			X			X
METHYL METHANESULPHONATE	000066-27-3			X			X
URACIL MUSTARD	000066-75-1				X		
CHLOROFORM	000067-66-3				X		X
HEXACHLOROETHANE	000067-72-1				X		X
NORETHISTERONE	000068-22-4						X
METHYL-N-NITRO-N'-NITROSOGUANIDINE,N- (MNNG)	000070-25-7			X			X
BENZENE "s"	000071-43-2	X	X			X	
COBALT ACETATE	000071-48-7				X		
MEDROXYPROGESTERONE ACETATE	000071-58-9				X		
TRYPAN BLUE	000072-57-1				X		
VINYL CHLORIDE	000075-01-4	X	X			X	
VINYL FLUORIDE	000075-02-5			X		X	
ACETALDEHYDE	000075-07-0				X		X
DICHLOROMETHANE	000075-09-2				X		X
ETHYLENE OXIDE	000075-21-8	X	X			X	
BROMODICHLOROMETHANE	000075-27-4				X		X
NITROMETHANE	000075-52-5				X		X
METHYLAZIRIDINE, 2- (PROPYLENEIMINE) "s"	000075-55-8				X		X
PROPYLENE OXIDE "s"	000075-56-9				X		X
HEPTACHLOR "s'	000076-44-8				X		
PHENOTHALEIN	000077-09-8						X
DIMETHYL SULFATE	000077-78-1			X			X
TETRAETHYL LEAD "s"	000078-00-2				X		
ISOPRENE	000078-79-5				X		X
TRICHLOROETHYLENE	000079-01-6			X			X
ACRYLAMIDE "s"	000079-06-1			X			X
DIMETHYLCARBAMOYL CHLORIDE	000079-44-7			X			X
NITROPROPANE, 2-	000079-46-9				X		X
SACCHARIN	000081-07-2				X		
AMINO-2,4-DIBROMOANTHRAQUINONE,1-	000081-49-2						X
AMINO-2-METHYLANTHRAQUINONE, 1-	000082-28-0						X
XYLIDINE "s"	000087-62-7				X		
TRICHLOROPHENOL, 2,4,6- "s"	000088-06-2						X
ANISIDINE, ortho- "s"	000090-04-0				X		

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MICHLER'S KETONE	000090-94-8		X				X
TOLUENE DIISOCYNATE, 2,6-	000091-08-7				X		
NAPHTHALENE	000091-20-3				X		X
NITROANISOLE, 2-	000091-23-6				X		X
NAPHTHYLAMINE,2- "s"	000091-59-8	X	X			X	
DICHLOROBENZIDINE,3,3'- "s"	000091-94-1	X			X		X
AMINODIPHENYL,4- "s"	000092-67-1	X	X			X	
BENZIDINE "s"	000092-87-5	X	X			X	
BENZIDINE-BASED DYES "s"	000092-87-5			X			
NITROBIPHENYL,4-	000092-93-3	X					
METHLYEUGENOL	000093-15-2						X
DIHYDROSAFROLE	000094-58-6				X		
SAFROLE	000094-59-7				X		X
SULFALLATE "s"	000095-06-7				X	X	
TOLUIDINE, ORTHO- "s"	000095-53-4		X				X
CHLORO-ortho-TOLUIDINE, para-	000095-69-2			X			X
DIAMINOTOLUENE, 2,4-	000095-80-7				X		X
CHLORO-ortho-PHENYLENEDIAMINE,4-	000095-83-0				X		X
STYRENE-7,8-OXIDE "s"	000096-09-3			X			
DIBROMO-3-CHLOROPROPANE,1,2- "s" (DBCP)	000096-12-8	X			X		X
DIBROMO-1-PROPANOL,2,3-	000096-12-9						X
TRICHLOROPROPANE, 1,2,3- "s"	000096-18-4			X			X
ETHYLENE THIOUREA	000096-45-7				X		X
ARSONIC ACID	000097-44-9	X	X			X	
AMINOAZOTOLUENE,ortho-	000097-56-3				X		X
BENZ0YLTRICHLORIDE "s"	000098-07-7			X			X
BENZOYL CHLORIDE	000098-88-4			X			
NITROBENZENE "s"	000098-95-3				X		X
VINYLCYCLOHEXENE, 4-	000100-40-3				X		
STYRENE "s"	000100-42-5				X		
BENZYL CHLORIDE	000100-44-7			X			
NITROSOPIPERIDINE, N-	000100-75-4				X		X
METHYLENE BIS(2-CHLOROANILINE), 4,4- (MOCA) "s"	000101-14-4		X				X
METHYLENEBIS(N,N-DIMETHYL)BENZENAMINE	000101-61-1		X				X
METHYLENEDIANILINE, 4,4'	000101-77-9	X			X		X
DIAMINODIPHENYL ETHER, 4,4-	000101-80-4				X		X
DIGLYCIDYL RESORCINOL ETHER	000101-90-6				X		X
DICHLOROBENZENE, para-	000106-46-7				X		X
CHLOROANILINE, para, "s"	000106-47-8				X		
VINYL-1-CYCLOHEXENE DIEPOXIDE, 4- "s"	000106-87-6				X		X
EPOXYBUTANE, 1,2-	000106-88-7				X		
EPICHLOROHYDRIN "s"	000106-89-8			X			X
ETHYLENE DIBROMIDE "s"	000106-93-4			X			X
BUTADIENE,1,3-	000106-99-0	X	X			X	
DICHLOROETHANE, 1,2- "s"	000107-06-2				X	X	
ACRYLONITRILE "s"	000107-13-1	X			X		X
CHLOROMETHYL METHYL ETHER	000107-30-2	X	X			X	
VINYL ACETATE	000108-05-4				X		
FURAN "s"	000110-00-9				X		X
AZASERINE	000115-02-6				X		
CHLORENDIC ACID	000115-28-6				X		X
TETRAFLUOROETHYLENE	000116-14-3					X	
ANTHRAQUINONE, 1,8-DIHYDROXY	000117-10-2				X		X
AMINOANTHRAQUINONE, 2-	000117-79-3						X

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DI(2-ETHYLHEXYL)PHTHALATE	000117-81-7				X		X
HEXACHLOROBENZENE "s"	000118-74-1				X		X
DIMETHOXYBENZIDINE, 3,3'- (o-DIANISIDINE)	000119-90-4				X		X
DIMETHYLBENZIDINE, 3,3'- (o-TOLIDINE) "s"	000119-93-7				X		X
PROPRIONIC ACID,2-(2,4-DICHLOROPHENOXY)	000120-36-5				X		
CRESIDINE, para-	000120-71-8				X		X
CATECHOL "s"	000120-80-9				X		
DINITROTOLUENE, 2,4- "s'	000121-14-2				X		
PHENYL GLYCIDYL ETHER "s"	000122-60-1				X		
HYDRAZOBENZENE	000122-66-7						X
DIOXANE, 1,4- "s"	000123-91-1				X		X
GRISEOFULVIN	000126-07-8				X		
TRIS (2,3-DIBROMOPROPYL)PHOSPHATE, (TRIS) "s"	000126-72-7			X			X
NITROGEN MUSTARD N-OXIDE	000126-85-2				X		
CHLOROPRENE "s"	000126-99-8				X		X
TETRACHLOROETHYLENE "s"	000127-18-4				X		X
SACCHARIN, SODIUM SALT	000128-44-9				X		
METHYL-1-NITROANTHRAQUINONE, 2- (UNCERTAIN PURITY)	000129-15-7				X		
SODIUM ortho-PHENYLPHENATE	000132-27-4				X		
ANISIDINE HYDROCHLORIDE, o-	000134-29-2				X		X
NAPHTHYLAMINE,ALPHA- "s"	000134-32-7	X					
CUPFERRON	000135-20-6						X
DIAMINOBENZENE	000136-35-6						X
DIAZOAMINOBENZENE	000136-35-6						X
PHENAZOPYRIDINE HYDROCHLORIDE	000136-40-3				X		X
NITRILOTRIACETIC ACID AND SALTS	000139-13-9				X		X
THIODIANILINE, 4,4'-	000139-65-1				X		X
ARAMITE	000140-57-8				X		
ETHYL ACRYLATE "s"	000140-88-5				X		
THIOURACIL	000141-90-2				X		
KEPONE (CHLORDECONE) "s"	000143-50-0				X		X
MELPHALAN	000148-82-3		X			X	
AZIRIDINE "s"	000151-56-4				X		
BISCHLOROETHYL NITROSOUREA (BCNU)	000154-93-8			X			X
DIBENZO[a,i]PYRENE	000189-55-9				X		X
DIBENZO[a,h]PYRENE	000189-64-0				X		X
DIBENZO[a,l]PYRENE	000191-30-0						X
DIBENZO[a,e]PYRENE	000192-65-4				X		X
INDENO[1,2,3-cd]PYRENE	000193-39-5				X		X
DIBENZO[c,g]CARBAZOLE, 7H-	000194-59-2				X		X
BENZ[c]PHENANTHRENE	000195-19-7				X		
BENZ[j]ACEANTHRYLENE	000202-33-5				X		
BENZO[j]FLUORANTHENE	000205-82-3				X		X
BENZO[b]FLUORANTHENE	000205-99-2				X		X
BENZO[k]FLUORANTHENE	000207-08-9				X		X
CHRYSENE	000218-01-9				X		
DIBENZ[a,j]ACRIDINE	000224-42-0				X		X
DIBENZ[a,h]ACRIDINE	000226-36-8				X		X
BENZOFURAN	000271-89-6				X		
TREOSULPHAN	000299-75-2		X				
LEAD ACETATE	000301-04-2				X		X
HYDRAZINE "s"	000302-01-2				X		X
LASIOCARPINE	000303-34-4				X		
OCHRATOXIN A	000303-47-9				X		X

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CHLORAMBUCIL	000305-03-3		X			X	
MONOCROTALINE	000315-22-0				X		
LINDANE, ALPHA	000319-84-6						X
LINDANE, BETA	000319-85-7						X
AZACYTIDINE	000320-67-2			X			
CAFFEIC ACID	000331-39-5				X		
PROCARBAZINE HYDROCHLORIDE	000366-70-1			X			X
NICKEL (II) ACETATE (1:2)	000373-02-4		X			X	
OXYMETHOLONE	000434-07-1						X
CONESTORAL	000438-67-5					X	
METRONIDAZOLE	000443-48-1				X		X
AZATHIOPRINE	000446-86-6		X			X	
METHOXYPSORALEN,5-	000484-20-8			X			
AURAMINE, TECHNICAL-GRADE	000492-80-8				X		
NAPHTHLYAMINE,N,N-BIS(2CHLOROETHYL)-2-	000494-03-1		X				
MUSTARD GAS "s"	000505-60-2		X			X	
TETRANITROMETHANE	000509-14-8				X		X
CHLORO-2-METHYLPROPENE,1-	000513-37-1				X		X
CADMIUM CARBONATE	000513-78-0	X	X			X	
COBALT CARBONATE	000513-79-1				X		
MERPHALAN	000531-76-0				X		
N-[4-(5-NITR-2-FURYL)-2-THIAZOLYL]ACETAMIDE	000531-82-8				X		
DICHLOROPROPENE, 1,3- (TECHNICAL-GRADE) "s"	000542-75-6				X		X
CHLOROMETHYL ETHER,BIS- "s"	000542-88-1	X	X			X	
NITROFURFURYLIDIENE(5)-AMINO-2-IMIDAZOLIDINONE, 1-	000555-84-0				X		
GLYCIDOL "s"	000556-52-5						X
CHLORO-2-METHYLPROPENE, 3-	000563-47-3						X
C.I. BASIC RED 9	000569-61-9				X		X
TOLUENE DIISOCYANATE, 2,4-	000584-84-9				X		
METHYLAZOXYMETHANOL	000590-96-5				X		
METHYLAZOXYMETHANOL ACETATE	000592-62-1				X		
VINYL BROMIDE	000593-60-2			X		X	
NITROACENAPHTHENE, 5-	000602-87-9				X		
OXAZEPAM	000604-75-1			X			
NITROFLUORENE, 2-	000607-57-8				X		
HEXACHLOROHEXANE (ALL ISOMERS)	000608-73-1				X		X
DICHLOROBENZIDINE, DIHYDROCHLORIDE, 3,3'-	000612-83-9						X
DIACETYLBENZIDINE,N,N'-	000613-35-4				X		
DIAMINOANISOLE, 2,4- (AND ITS SALTS)	000615-05-4				X		
METHY-N-NITROSOURETHANE,n-	000615-53-2				X		
NITROSODI-n-PROPYLAMINE, n-	000621-64-7				X		X
MAGENTA (CONTAINING CI BASIC RED 9)	000632-99-5				X		
TOLUIDINE HYDROCHLORIDE, O-	000636-21-5						X
HEXAMETHYLPHOSPHORAMIDE "s"	000680-31-9				X		X
METHYL-N-NITROSOUREA,n-	000684-93-5			X			X
AMINO-5-(5-NITRO-2-FURYL)-1,3,4-THIADIAZOLE, 2-	000712-68-5				X		
ETHYL-N-NITROSOUREA,N-	000759-73-9			X			X
GLYCIDALDEHYDE "s"	000765-34-4				X		
PANFURAN containing DIHYDROXMETHYLFURATRIZINE	000794-93-4				X		
TRICHLOROMETHINE	000817-09-4				X		
METHYLENE BIS(2-METHYLANILINE), 4,4'-	000838-88-0				X		
COBALT TRIACETATE	000917-69-1				X		
NITROSODI-n-BUTYLAMINE, N-	000924-16-3				X		X
NITROSOPYRROLIDINE, N-	000930-55-2				X		X

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HEPTACHLOR EPOXIDE "s"	001024-57-3				X		
CHROMIUM TRIACETATE	001066-30-4		X			X	
NITROSODIETHANOLAMINE, N-	001116-54-7				X		X
PROPANE SULTONE, 1,3- "s"	001120-71-4				X		X
AFLATOXIN B1	001162-65-8		X				
NICKEL BISCYCLOPENDADIENE	001271-28-9		X			X	
ZINC CHROMATE (VI) HYDROXIDE	001300-73-8		X			X	
BERYLLIUM ALUMINUM SILICATE	001302-52-9		X			X	
GALLIUM ARSENIDE	001303-00-0		X				
ARSENIC PENTOXIDE	001303-28-2	X	X			X	
BERYLLIUM OXIDE	001304-56-9		X			X	
CADMIUM OXIDE	001306-19-0	X	X			X	
CADMIUM SULFIDE	001306-23-6	X	X			X	
COBALT HYDROXIDE	001307-86-4				X		
COBALT(2+) OXIDE	001307-96-6				X		
COBALT (III) OXIDE	001308-04-9				X		
COBALT OXIDE	001308-06-1				X		
CHROMIUM (III) OXIDE (2:3)	001308-38-9		X			X	
NICKEL (II) OXIDE (1:1)	001313-99-1		X			X	
THORIUM DIOXIDE	001314-20-1					X	
COBALT (2+) SULFIDE	001317-42-6				X		
SILICA, CRYSTALLINE TRIPOLI	001317-95-9			X		X	
VALENTINITE	001317-98-2				X		
ARSENIC TRIOXIDE	001327-53-3	X	X			X	
FOWLER'S SOLUTION	001332-10-1		X				
ASBESTOS	001332-21-4	X	X			X	
CHROMIUM (VI) OXIDE (1:3)	001333-82-0		X			X	
CARBON BLACK	001333-86-4				X		
POLYCHLORINATED BIPHENYLS	001336-36-3			X			X
AFLATOXINS	001402-68-2		X			X	
DIEPOXYBUTANE "s"	001464-53-5						X
DIETHYLHYDRAZINE, 1,2-	001615-80-1				X		
BENZYL VIOLET 4B	001694-09-3				X		
TETRACHLORODIBENZO-para-DIOXIN, 2,3,7,8- (TCCD) "s"	001746-01-6		X			X	
NITROFEN (TECHNICAL-GRADE) "s"	001836-75-5				X		X
CHLOROTHALONIL	001897-45-6				X		
DIRECT BLACK 38	001937-37-7					X	
MIREX "s"	002385-85-5				X		X
CAPTAFOL	002425-06-1			X			
CI DIRECT BLUE 15	002429-74-5				X		
DISPERSE BLUE 1	002475-45-8				X		X
DIRECT BLUE 6	002602-46-2					X	
OIL ORANGE SS	002646-17-5				X		
HC BLUE 1	002784-94-3				X		
SULFURIC ACID, DIISOPROPYL ESTER "s"	002973-10-6				X		
BUTYROLACTONE,BETA-	003068-88-0				X		
CHLORO-O-TOLUIDINE HYDROCHLORIDE, 4-	003165-93-3		X				X
PROPANEDIOL,2,2-BIS-(BROMOETHYL)-1,3-	003296-90-0						X
NICKEL (II) CARBONATE (1:1)	003333-67-3		X			X	
PONCEAU 3R	003564-09-8				X		
THIAZOLE,2(2-FORMLYLHYDRAZIN0)-4-(5-NITRO-2-FURYL)	003570-75-0				X		
FURYLAMIDE	003688-53-7				X		
METHYLCHRYSENE, 5-	003697-24-3				X		X
PONCEAU MX	003761-53-3				X		

SELECT CARCINOGENS (CAS #)

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Revised: 3/2009

			IARC			NTP	
CHEMICAL NAME	CAS #	OSHA	1	2A	2B	A	B
NAFENOPIN	003771-19-5				X		
OXAZOLIDININE,2,5-(MORPHOLINOMETHYL)-3-[(5-NITROFURYLIDENE)	003795-88-8				X		
NITROSOBUTYLBUTANOLAMINE,N-	003817-11-6						X
DACARBAZINE	004342-03-4				X		X
NITROSOMETHYLVINYLAMINE, N-	004549-40-0				X		X
NITRILOTRIACETIC ACID, TRISODIUM SALT	005064-31-3				X		X
CHLORDANE, ALPHA "s"	005103-71-9				X		
CHLORDANE, BETA "s"	005103-74-2				X		
NITROPYRENE, 1-	005522-43-0				X		X
CHLORDANE, GAMMA "s"	005566-34-7				X		
CYCLOPHOSPHAMIDE	006055-19-2		X			X	
LEAD ACETATE (II) TRIHYDRATE	006085-56-4				X		X
COBALT (II) ACETATE	006147-53-1				X		
CITRUS RED NO. 2	006358-53-8				X		
CI ACID RED 114	006485-34-3				X		
AFLATOXIN M1	006795-23-9				X		
PIPERAZINE ESTRONE SULFATE	007280-37-7					X	
LEAD AND COMPOUNDS	007439-92-1			X			X
NICKEL, METALLIC AND ALLOYS	007440-02-0				X	X	
ARSENIC AND COMPOUNDS	007440-38-2	X	X			X	
BERYLLIUM AND COMPOUNDS	007440-41-7		X			X	
CADMIUM AND COMPOUNDS	007440-43-9	X	X			X	
CHROMIUM, HEXAVALENT AND COMPOUNDS	007440-47-3		X			X	
COBALT AND COMPOUNDS	007440-48-4				X		
SULFUR TRIOXIDE	007446-11-9		X				
LEAD PHOSPHATE	007446-27-7				X		X
ZALCITABINE	007481-89-2				X		
NITROCHRYSENE, 6-	007496-02-8				X		X
ARSENIC ACID, SODIUM SALT	007631-89-2	X	X			X	
COBALT(II) CHLORIDE	007646-79-9				X		
SULFURIC ACID	007664-93-9		X				
POTASSIUM BROMATE	007758-01-2				X		
LEAD CHROMATE	007758-97-6		X			X	
CHROMIC ACID, DISODIUM SALT "s"	007775-11-3		X			X	
ARSENIC ACID	007778-39-4	X	X			X	
ARSENIC ACID, CALCIUM SALT (2:3)	007778-44-1	X	X			X	
POTASSIUM DICHROMATE (VI)	007778-50-9		X			X	
ARSENIC TRICHLORIDE "s"	007784-34-1	X	X			X	
ARSENIC PENTAFLUORIDE	007784-36-3	X	X			X	
ARSENIC ACID, LEAD(2+) SALT (1:1)	007784-40-9	X	X			X	
ARSENIC ACID, MONOPOTASSIUM SALT	007784-41-0	X	X			X	
ARSENIUOS ACID, MONOSODIUM SALT	007784-46-5	X	X			X	
BERYLLIUM CHLORIDE	007787-47-5		X			X	
BERYLLIUM FLUORIDE	007787-49-7		X			X	
BERYLLIUM SULFATE, TETRAHYDRATE (1:1:4)	007787-56-6		X			X	
POTASSIUM CHROMATE (VI)	007789-00-6		X			X	
CHROMIUM PHOSPHATE	007789-04-0		X			X	
STRONTIUM CHROMATE (VI)	007789-06-2		X			X	
AMMONIUM DICHROMATE (VI) "s"	007789-09-5		X			X	
COBALT(II) CHLORIDE, HEXAHYDRATE	007791-13-1				X		
TOXAPHENE (POLYCHLORINATED CAMPHENES) "s"	008001-35-2				X		X
CREOSOTES	008001-58-9			X		X	
GASOLINE "s"	008006-61-9				X		
COAL-TAR "s"	008007-45-2		X			X	

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CHEMICAL NAME	CAS #	OSHA	IARC 1	IARC 2A	IARC 2B	NTP A	NTP B
SULFURIC ACID, FUMING, MISTS	008014-95-7		X				
CREOSOTE, WOOD	008021-39-4			X		X	
CARRAGEENAN, DEGRADED	009000-07-1				X		
IRON-DEXTRAN COMPLEX	009004-66-4				X		X
BLEOMYCIN SULFATE	009041-93-4				X		
ZIRCONIUM TETRACHLORIDE	010026-11-6			X			
COBALT DINITRATE HEXAHYDRATE	010026-22-9				X		
HYDRAZINE SULFATE (1:1) "s"	010034-93-2						X
NITRILOACETIC ACID, SODIUM SALT	010042-84-9				X		
RADON AND ITS DECAY PRODUCTS	010043-92-2		X			X	
STERIGMATOCYSTIN	010048-13-2				X		
ARSENIC ACID, DISODIUM SALT, HEPTAHYDRATE	010048-95-0	X	X			X	
CADMIUM CHLORIDE "s"	010108-64-2	X	X			X	
CADMIUM SULFATE (1:1)	010124-36-4	X	X			X	
COBALT(II) SULFATE (1:1)	010124-43-3				X		X
ARSENEOUS ACID, POTASSIUM SALT	010124-50-2	X	X			X	
COBALT(II) NITRATE (1:2)	010141-05-6				X		
COBALT, DI-MU-CARBONYLNONACARBONYL	010210-68-1				X		
BARIUM CHROMATE(VI)	010294-40-3		X			X	
CADMIUM NITRATE	010325-94-7	X	X			X	
TAMOXIFEN	010540-29-1					X	
SODIUM DICHROMATE (VI) "s"	010588-01-9		X			X	
NITROSOMETHYLETHYLAMINE, N-	010595-95-6				X		
BLEOMYCINS	011056-06-7				X		
PCB (AROCLOR 1260)	011096-82-5						X
PCB (AROCLOR 1254)	011097-69-1			X			X
CHROMATE(1-),HYDROXYOCTAOXODIZINCATEDI-, POTASSIUM	011103-86-9		X			X	
NICKEL HYDROXIDE	011113-74-9		X			X	
COBALT ALLOY, CO, CR	011114-92-4				X	X	
ASBESTOS, CROCIDOLITE	012001-28-4	X	X			X	
ASBESTOS, CHRYSOTILE	012001-29-5	X	X			X	
COBALT HYDROXIDE OXIDE	012016-80-7				X		
NICKEL SULFIDE (3:2)	012035-72-2		X			X	
NICKEL (II) HYDROXIDE	012054-48-7		X			X	
COBALT, (MU(CARBONATO(2-)-O:O'))DIHYDROXYDI	012069-68-0				X		
NICKEL (III) HYDROXIDE	012125-56-3		X			X	
ASBESTOS, AMOSITE	012172-73-5	X	X			X	
PALYGORSKITE (fibers > 5 micrometers)	012174-11-7				X		
SENARMONITE	012412-52-1				X		
COBALT CARBONATE, COBALT DIHYDROXIDE (2:3)	012602-23-2				X		
COBALT-CHROMIUM-MOLYBDENUM ALLOY	012629-02-6				X	X	
COBALT-CHROMIUM-NICKEL-TUNGSTEN ALLOY	012638-07-2				X	X	
BERYLLIUM ALUMINUM ALLOY	012770-50-2		X			X	X
CHLOROETHYL(2)-3-CYCLOHEXYL-1-NITROSOUREA,1- (CCNU)	013010-47-4			X			X
NITROSOSACOSINE, N-	013256-22-9				X		X
BERYLLIUM HYDROXIDE	013327-32-7		X			X	
NICKEL CARBONYL	013463-39-3		X			X	
TITANIUM DIOXIDE	013463-67-7				X		
BERYLLIUM SULFATE (1:1)	013510-49-1		X			X	
ZINC CHROMATE	013530-65-9		X			X	
METHYLENEDIANILINE,4,4'- DIHYDROCHLORIDE	013552-44-8						X
BERYLLIUM HYDROGEN PHOSPHATE (1:1)	013598-15-7		X			X	
DECABROMOBIPHENYL	013654-09-6						X
COBALT MOLYBDATE (VI)	013762-14-6				X		

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CALCIUM CHROMATE (VI)	013765-19-0		X			X	
CHLOROETHYL(2)-3-(4-METHYLCYCLOHEXYL)-1-NITROSOUREA, 1-	013909-09-6		X			X	
SILICA, CRYSTALLINE CRISTOBALITE	014464-46-1		X			X	
CADMIUM FLUOBORATE	014486-19-2	X	X			X	
TALC CONTAINING ASBESTIFORM FIBRES	014807-96-6		X				
QUARTZ [SILICA, CRYSTALLINE (RESPIRABLE)]	014808-60-7			X		X	
CYCASIN	014901-08-7				X		
CHROMIUM, DICHLORODIOXO-	014977-61-8		X			X	
CHROMIUM (VI) CHLORIDE	014986-48-2		X			X	
SILICIC ACID BERYLLIUM SALT	015191-85-2		X				
NITRILOTRIACETIC ACID, DISODIUM SALT	015467-20-6				X		X
SILICA, CRYSTALLINE TRIDYMITE	015468-32-3			X		X	
CISPLATIN	015663-27-1			X			X
ZINC CHROMATE (VI) HYDROXIDE	015930-94-6		X			X	
NITROSONORNICOTINE, N'-	016543-55-8		X				X
ESTRA-1,2,5(10),7-TETRAEN-17-ONE,3-(SULFOOXY)-,SODIUM SALT	016680-47-0					X	
COBALT CARBONYL	017786-31-1				X		
LEAD CHROMATE (VI) OXIDE	018454-12-1		X			X	
NITRILOTRIACETIC ACID, TRISODIUM SALT, MONOHYDRATE	018662-53-8				X		X
STREPTOZOTOCIN	018883-66-4				X		
NITRILOTRIACETIC ACID, MONOSODIUM SALT	018994-66-6				X		X
DAUNOMYCIN	020830-81-3				X		
COBALT(II) HYDROXIDE	021041-93-0				X		
INIDIUM PHOSPHIDE	022398-80-7			X			
METHYL MERCURY AND COMPOUNDS "s"	022967-92-6				X		
RIDDELLIINE	023246-96-0				X		
NITRILOTRIACETIC ACID, DISODIUM SALT, MONOHYDRATE	023255-03-0				X		X
BUTYLATED HYDROXYANISOLE (BHA)	025013-16-5				X		X
ADRIAMYCIN	025316-40-9			X			X
PENTACHLOROBIPHENYL	025429-29-2				X		X
TOLUENE DIISOCYANATE, 1,3-	026471-62-5				X		X
ARSENEOUS ACID, CALCIUM SALT	027152-57-4	X	X			X	
ARSENIOUS ACID, CALCIUM SALT	027152-57-4	X	X			X	
CYCLOPENTA[CD]PYRENE	027208-37-3			X			
DICHLORO-4,4'-DIAMINODIPHENYL ETHER, 3,3'-	028434-86-8				X		
CHROMIUM CARBONATE	029689-14-3		X			X	
TENIPOSIDE	029767-20-2				X		
ZIDOVUDINE(AZT)	030516-87-1				X		
ETOPOSIDE	033419-42-0				X		
BUTYRIC ACID, 4-(N-BUTYL-N-NITROSAMINO)-	038252-74-3						X
DIAMINOANISOLE SULPHATE, 2,4-	039156-41-7						X
BERYLLIUM ZINC SILICATE	039413-47-3		X			X	
DINITROPYRENE, 1,6-	042397-64-8				X		X
DINITROPYRENE, 1,8-	042397-65-9				X		
AMSACRINE	051264-14-3				X		
ARSONIC ACID, CALCIUM SALT (1:1)	052740-16-6	X	X			X	
CHLOROZOTOCIN	054749-90-5			X			
NITROPYRENE, 4-	057835-92-4				X		X
POLYBROMINATED BIPHENYLS	059536-65-1				X		
CYCLOSPORIN A	059865-13-3		X			X	
N-NITROSOMETHYLAMINO-PROPIONITRILE, 3-	060153-49-3				X		
OCTABROMOBIPHENYL	061288-13-9						X
COBALT NAPHTHATE	061789-51-3				X		
TRP-P-1(3-AMINO-1,4-DIMETHYL-5H-PYRIDO[4,3-b]INDOLE)	062450-06-0				X		

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CHEMICAL NAME	CAS #	OSHA	IARC 1	IARC 2A	IARC 2B	NTP A	NTP B
TRP-P-2(3-AMINO-1-METHYL-5H-PYRIDO[4,3-b]INDOLE)	062450-07-1				X		
N-NITROSOMETHYLAMINO-1-(30PYRIDYL)-1-BUTANONE, 4- (NNK)	064091-91-4		X				X
COAL TAR "s"	065996-89-6		X			X	
COAL TAR DISTILLATE "s"	065996-92-1		X			X	
COAL-TAR PITCHES "s"	065996-93-2		X			X	
BERYLLIUM OXIDE CARBONATE	066104-24-3		X			X	
ERIONITE	066733-21-9		X			X	
GLU-P-2 (2-AMINODIPYRIDO[1,2-a:3',2'-d]IMIDAZOLE	067730-10-3				X		
GLU-P-1(2-AMINO-6-METHYLDIPYRIDO[1,2-A:3',2'-D]IMIDZOLE	067730-11-4				X		
BLEOMYCIN, HYDROCHLORIDE	067763-87-5				X		
POLYBROMINATED BIPHENYL (FF-1)	067774-32-7						X
MeA-ALPHA-C(2-AMINO-3-METHYL-9H-PYRIDO[2,3-b]INDOLE)	068006-83-7				X		
SHALE-OILS "s"	068308-34-9		X				
IQ(2-AMINO-3-METHYLIMIDAZO[4,5-f]QUINOLINE)	076180-96-6			X			
AMINO-3,4-DIMETHYL-3h-IMIDAZO(4,5f)QUINOLINE,2-	077094-11-2				X		X
CHLORO-4-(DICHLOROMETHYL)-5-HYDROXY-2(5H)FURANONE, 3-	077439-76-0				X		
AMINO-3,8-DIMETHYL-3H-IMIDAZO(4,5-f)QUINOXALINE, 2-	077500-04-0				X		X
ASBESTOS, ACTINOLITE	077536-66-4	X	X			X	
ASBESTOS, ANTHOPHYLLITE	077536-67-5	X	X			X	
ASBESTOS, TREMOLITE	077536-68-6	X	X			X	
CICLOSPORIN	079217-60-0		X				
MICROCYSTIN	101043-37-2				X		
PHLP(2-AMINO-1-METHYL-6-PHENYLIMIDAZO[4,5-B]PYRIDINE)	105650-23-5				X		X
DINITROFLUOROANTHENE, 3,7-	105735-71-5			X			
CHLORINATED PARAFFINS (CARBON-12, 60% CHLORINE)	108171-26-2				X		X
FUMONISIN B1	116355-83-0				X		

REFERENCE:
International Agency for Rearch on Cancer, 2009, *Overall Evaluations of Carcinogencity to Humans. (Monographs Volumes 1-99)*
Sax, Richard, 1999. *Dangerous Properties of Industrial Materials*.
National Toxicology Program, 2005. *11th Annual Report on Carcinogens.*

APPENDIX E-(1) Human Reproductive Toxins (Alphabetical)

EXAMPLES OF KNOWN OR SUSPECT HUMAN REPRODUCTIVE TOXINS (alphabetical)

Key:
F -- Fertility
T -- Teratogens
M -- Mutagens
L -- Lactation
SA -- Readily Absorbed Through the Skin

revised: 10/2007

CHEMICAL NAME	CAS #	F	T	M	L	SA
2,4,5-T	000093-76-5		x			x
ACETOHYDROXAMIC ACID	000546-88-3		x			x
ACROLEIN	000107-02-8			x		x
ACRYLONITRILE	000107-13-1			x		x
ACTINOMYCIN D	000050-76-0			x		x
ALL-TRANS RETINOIC ACID	000302-79-4		x	x		x
ALPRAZOMAN	028981-97-7		x			x
AMANTADINE HYDROCHLORIDE	000665-66-7		x			x
AMINOAZOTOLUENE,ortho-	000097-56-3			x		
AMINODIPHENYL,4-	000092-67-1			x		x
AMINOGLUTETHIMIDE	000125-84-8		x			x
AMINOPTERIN	000054-62-6		x			
ANGIOTENSIN CONVERTING ENZYME (ACE) INHIBITORS	000000-00-0		x			
ANISINDIONE	000117-37-3		x			
ARSENEOUS ACID, CALCIUM SALT	027152-57-4		x			x
ARSENEOUS ACID, POTASSIUM SALT	010124-50-2		x			x
ARSENIC ACID	007778-39-4		x			x
ARSENIC ACID, CALCIUM SALT (2:3)	007778-44-1		x			x
ARSENIC ACID, DISODIUM SALT, HEPTAHYDRATE	010048-95-0		x			x
ARSENIC ACID, LEAD(2+) SALT (1:1)	007784-40-9		x			x
ARSENIC ACID, MONOPOTASSIUM SALT	007784-41-0		x			x
ARSENIC ACID, SODIUM SALT	007631-89-2		x			x
ARSENIC AND COMPOUNDS	007440-38-2		x			x
ARSENIC PENTAFLUORIDE	007784-36-3		x			x
ARSENIC PENTOXIDE	001303-28-2		x			x
ARSENIC TRICHLORIDE	007784-34-1		x			x
ARSENIC TRIOXIDE	001327-53-3		x			x
ARSENIUOS ACID, CALCIUM SALT	027152-57-4		x			x
ARSENIUOS ACID, MONOSODIUM SALT	007784-46-5		x			x
ARSINE	007784-42-1		x			x
ARSONIC ACID	000097-44-9		x			x
ARSONIC ACID, CALCIUM SALT (1:1)	052740-16-6		x			x
ASPRIN	000050-78-2		x			
ATENOLO	029122-68-7		x			x
AURAMINE	000492-80-8			x		
AURANOFIN	034031-32-8			x		
AZATHIOPRINE	000446-86-6			x		
AZIRIDINE	000151-56-4					x
BARBITURATES	000000-00-0		x			
BECLOMETHASONE DIPROPIONATE	005534-09-8	x	x			
BENOMYL	017804-35-2	x	x	x		x

EXAMPLES OF KNOWN OR SUSPECT HUMAN REPRODUCTIVE TOXINS (alphabetical)

Key:
F -- Fertility
T -- Teratogens
M -- Mutagens
L -- Lactation
SA -- Readily Absorbed Through the Skin

revised: 10/2007

CHEMICAL NAME	CAS #	F	T	M	L	SA
BENZENE	000071-43-2			x		x
BENZO[a]PYRENE	000050-32-8			x		
BENZYL CHLORIDE	000100-44-7		x			
BISCHLOROETHYL NITROSOUREA (BCNU)	000154-93-8			x		
BROMODEOXYURIDINE	000059-14-3		x	x		
BROMODICHLOROMETHANE	000075-27-4			x		
BUTANEDIOL DIMETHANESULFONATE, 1,4- (BUSULFAN)	000055-98-1	x	x	x		
CADMIUM AND COMPOUNDS	007440-43-9	x	x			
CADMIUM CARBONATE	000513-78-0	x	x			
CADMIUM CHLORIDE	010108-64-2	x	x			x
CADMIUM FLUOBORATE	014486-19-2	x	x			
CADMIUM NITRATE	010325-94-7	x	x			
CADMIUM OXIDE	001306-19-0	x	x			
CADMIUM SULFATE (1:1)	010124-36-4	x	x			
CADMIUM SULFIDE	001306-23-6	x	x			
CARBAMAZEPINE	000298-46-4		x			
CARBON DISULFIDE	000075-15-0	x	x			x
CARBON MONOXIDE	000630-08-0		x			
CHLORAMBUCIL	000305-03-3		x			
CHLORAMPHENICOL	000056-75-7			x		
CHLORDANE	000057-74-9			x		x
CHLORDANE, ALPHA	005103-71-9					x
CHLORDANE, BETA	005103-74-2					x
CHLORDANE, GAMMA	005566-34-7					x
CHLORO-2-METHYLPROPENE, 3-	000563-47-3			x		
CHLOROFORM	000067-66-3			x		
CHLOROMETHYL ETHER,BIS-	000542-88-1			x		x
CHLOROMETHYL METHYL ETHER	000107-30-2			x		
CHLORO-O-PHENYLENEDIAMINE,4-	000095-83-0			x		
CHLORO-O-TOLUIDINE, 4-	000095-69-2			x		
CHLOROPRENE	000126-99-8	x	x	x		x
CISPLATIN	015663-27-1			x		
CLOMIPHENE CITRATE	000050-41-9		x	x		
COLCHICINE	000064-86-8			x		
CYCLOHEXIMIDE	000066-81-9			x		x
CYCLOPHOSPHAMIDE	006055-19-2		x			
DANAZOL	017230-88-5	x				
DAUNOMYCIN	020830-81-3			x		
DDT	000050-29-3	x	x			x
DEMECLOCYCLINE HYDROCHLORIDE (INTERNAL USE)	000064-73-3		x			
DIAMINOANISOLE, 2,4- (AND ITS SALTS)	000615-05-4			x		
DIAMINOTOLUENE, 2,4-	000095-80-7			x		

EXAMPLES OF KNOWN OR SUSPECT HUMAN REPRODUCTIVE TOXINS (alphabetical)

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CHEMICAL NAME	CAS #	F	T	M	L	SA
DIAZEPAM	000439-14-5		x			x
DIBENZ[a,h]ANTHRACENE	000053-70-3			x		
DIBROMO-3-CHLOROPROPANE,1,2-	000096-12-8	x		x		x
DIBROMOPROPYL (2,3) PHOSPHATE	000126-72-7			x		x
DICHLOROBENZIDINE, 3,3-	000091-94-1			x		x
DICHLOROETHANE, 1,2-	000107-06-2			x		x
DICHLOROMETHANE	000075-09-2			x		
DICHLORVOS	000062-73-7			x		x
DICUMAROL	000066-76-2		x			
DIEPOXYBUTANE	001464-53-5			x		x
DIETHYLSTILBOESTROL	000056-53-1	x	x			x
DIGITOXIN	000071-63-6		x			x
DIMETHANESULFONATE, 1,4-	000299-75-2		x			
DIMETHYL MERCURY	000593-74-8					x
DIMETHYL SULFATE	000077-78-1			x		x
DIMETHYLAMINOAZOBENZENE, 4-	000060-11-7			x		
DIMETHYLCARBAMOYL CHLORIDE	000079-44-7			x		
DIMETHYLFORMAMIDE	000068-12-2			x		x
DIMETHYLHYDRAZINE, 1,1-	000057-14-7			x		x
DIMETHYLHYDRAZINE, 1,2-	000540-73-8			x		x
DINITROPYRENE, 1,6-	042397-64-8			x		
DINITROPYRENE, 1,8-	042397-65-9			x		
DOXORUBICIN HYDROCHLORIDE (ADRIAMYCIN)	023214-92-8			x		
DOXYCYCLINE AND COMPOUNDS (INTERNAL USE)	000564-25-0			x		
ENDOSULFAN	000115-29-7			x		x
EPICHLOROHYDRIN	000106-89-8			x		x
ERGOTAMINE TARTRATE	000379-79-3			x		
ETHIDIUM BROMIDE	001239-45-8			x		
ETHIONAMIDE	000536-33-4		x			
ETHYL METHANESULPHONATE	000062-50-0			x		
ETHYLENE DIBROMIDE	000106-93-4	x	x	x		x
ETHYLENE GLYCOL ETHERS	000000-00-0	x	x			
ETHYLENE OXIDE	000075-21-8		x			
ETHYLENEIMINE	009002-98-6			x		x
ETHYL-N-NITROSOUREA,N-	000759-73-9			x		
ETOPOSIDE	033419-42-0			x		
ETRETINATE	054350-48-0			x		
FLUOROURACIL	000051-21-8		x	x		
FLUOXYMESTERONE	000076-43-7	x				
FORMALDEHYDE	000050-00-0			x		x
FOWLER'S SOLUTION	001332-10-1		x			
FURYLAMIDE	003688-53-7			x		

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GLU-P-1 (2-AMINO-6-METHYLDIPYRIDO[1,2-a:3',2'-d]IMIDAZOLE)	067730-11-4			x		
GLU-P-2(2-AMINODIPYRIDO[1,2-A:3',2'-D]IMIDAZOLE)	067730-10-3			x		
GLYCIDOL	000556-52-5			x		x
GOSSYPOL	000303-45-7	x		x		
GRISEOFULVIN	000126-07-8			x		
HALOPERIDOL	000052-86-8		x			
HALOTHANE	000151-67-7		x			
HEPTACHLOR	000076-44-8			x		x
HEPTACHLOR EPOXIDE	001024-57-3			x		x
HEXACHLOROBENZENE	000118-74-1				x	x
HEXACHLOROBENZENE, GAMMA	000058-89-9					x
HEXAMETHYLPHOSPHORAMIDE	000680-31-9			x		x
HYDRAZINE	000302-01-2			x		x
HYDRAZINE SULFATE (1:1)	010034-93-2			x		x
IFOSFAMIDE	003778-73-2			x		
ISOTRETINOIN	004759-48-2		x	x		
KEPONE (CHLORDECONE)	000143-50-0	x				x
LASIOCARPINE	000303-34-4			x		
LEAD PHOSPHATE	007446-27-7	x	x	x	x	
LEAD ACETATE	000301-04-2	x	x	x	x	
LEAD ACETATE (II) TRIHYDRATE	006085-56-4	x	x	x	x	
LEAD AND COMPOUNDS	007439-92-1	x	x	x	x	
LEAD CHROMATE (VI) OXIDE	018454-12-1	x	x	x	x	
LEVODOPA	000059-92-7			x		
LITHIUM AND COMPOUNDS	007439-93-2		x			
LORAZEPAM	000846-49-1		x			
MEBENDAZOLE	031431-39-7			x		
MEDROXYPROGESTERONE ACETATE	000071-58-9		x	x		
MEGESTROL ACETATE	000595-33-5	x				
MELPHALAN	000148-82-3	x				
MERCURY AND COMPOUNDS	007439-97-6	x	x			x
MESTRANOL	000072-33-3	x				
METHIMAZOLE	000060-56-0		x	x		
METHOTREXATE SODIUM	015475-56-6			x		
METHYL BROMIDE	000074-83-9			x		x
METHYL CHLORIDE	000074-87-3			x		
METHYL HYDRAZINE	000060-34-4			x		x
METHYL MERCURY AND COMPOUNDS "s"	022967-92-6				x	x
METHYL METHANESULPHONATE	000066-27-3			x		
METHYLAMINOPTERIN	000059-05-2		x	x		
METHYLAZIRIDINE, 2- (PROPYLENEIMINE)	000075-55-8			x		x
METHYLAZOXYMETHYL ACETATE	000592-84-7			x		

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CHEMICAL NAME	CAS #	F	T	M	L	SA
METHYLDICHLOROARSINE	000593-89-5		x			x
METHYL-N-NITRO-N'-NITROSOGUANIDINE,N- (MNNG)	000070-25-7			x		
METHYL-N-NITROSOUREA,N-	000684-93-5			x		
METHYLTESTOSTERONE	000058-18-4		x			
METHYLTHIOURACIL	000056-04-2		x			
METRONIDAZOLE	000443-48-1			x		
METRONIDIZOL	000443-81-1			x		
MIREX	002385-85-5	x				x
MITOMYCIN C	000050-07-7			x		
MITOXANTRONE HYDROCHLORIDE	070476-82-3			x		x
MONOCROTALINE	000315-22-0			x		
MUSTARD GAS (SULPHUR MUSTARD)	000505-60-2			x		x
NAPHTHYL METHYLCARBAMATE	000063-25-2	x		x		
NAPHTHYLAMINE, 2-	000091-59-8			x		x
NICKEL SULFIDE (3:2)	012035-72-2			x		
NICOTINE	000054-11-5		x			x
NIFEDIPINE	021829-25-4		x			
NITROFLUORENE,2-	000607-57-8			x		
NITROGEN MUSTARD	000051-75-2			x		x
NITROGEN MUSTARD HYDROCHLORIDE	000055-86-7			x		x
NITROGEN MUSTARD N-OXIDE	000126-85-2			x		x
NITROGEN MUSTARD N-OXIDE HYDROCHLORIDE	000302-70-5			x		x
NITROPYRENE, 1-	005522-43-0			x		
NITROSO-N-METHYLUREA, N-	000684-93-5			x		
NITROSODIETHYLAMINE,N-	000055-18-5			x		
NITROSODIMETHYLAMINE,N-	000062-75-9			x		
NITROSODI-n-BUTYLAMINE, N-	000924-16-3			x		
NITROSODI-n-PROPYLAMINE, N-	000621-64-7			x		
NITROSOMORPHOLINE, N-	000059-89-2			x		
NITROSOPIPERIDINE, N-	000100-75-4			x		
NITROSOPYRROLIDINE, N-	000930-55-2			x		
NORETHISTERONE	000068-22-4	x		x		
NORGESTREL	006533-00-2	x				
OXYTETRACYCLINE AND COMPOUNDS (INTERNAL USE)	000079-57-2		x			
OZONE	010028-15-6			x		
PARAMETHADIONE	000115-67-3		x			
PARATHION	000056-38-2			x		x
PCB (AROCLOR 1254)	011097-69-1					x
PCB (AROCLOR 1260)	011096-82-5					x
PENICILLAMINE	002219-30-9		x			
PENTOSTATIN	053910-25-1			x		
PHENOBARBITAL	000050-06-6		x	x		

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PHENOXYBENZAMINE HYDROCHLORIDE	000062-92-3	x				
PHENYTOIN	000057-41-0		x			
PIPOBROMAN	000054-91-1			x		
PLICAMYCIN	018378-89-7			x		
POLYBROMINATED BIPHENYL (FF-1)	067774-32-7		x			
POLYBROMINATED BIPHENYLS	059536-65-1		x			x
POLYCHLORINATED BIPHENYLS	001336-36-3	x	x		x	x
POTASSIUM CHROMATE (VI)	007789-00-6			x		
POTASSIUM DICHROMATE (VI)	007778-50-9			x		
PROGESTERONE	000057-83-0		x			
PROPANE SULTONE, 1,3-	001120-71-4			x		x
PROPIOLACTONE, BETA	000057-57-8			x		
PROPYLENE OXIDE	000075-56-9			x		x
PROPYLTHIOURACIL	000051-52-5		x	x		
RESERPINE	000050-55-5		x			
RETINOIC ACID, 1,3-CIS-	004759-48-2		x			
RIFAMPIN	013292-46-1			x		
SAFROLE	000094-59-7			x		
SODIUM AZIDE	026628-22-8			x		x
SODIUM DICHROMATE	010588-01-9			x		x
STERIGMATOCYSTIN	010048-13-2			x		
STREPTOZOTOCIN	018883-66-4			x		
STYRENE	000100-42-5			x		x
STYRENE-7,8-OXIDE	000096-09-3			x		x
TAMOXIFEN AND SALTS	010540-29-1		x			
TENIPOSIDE	029767-20-2			x		
TESTOSTERONE ENANTHATE	000315-37-7	x				
TETRACHLORODIBENZO-para-DIOXIN, 2,3,7,8- (TCDD)	001746-01-6		x			x
TETRACHLOROETHYLENE	000127-18-4				x	x
TETRACYCLINES	000060-54-8		x			
TETRAETHYL LEAD	000078-00-2					x
TETRAETHYLTHIURAM DISULFIDE	000097-77-8		x			x
THALIDOMIDE	000050-35-1		x			x
THIOACETAMIDE	000062-55-5			x		
THIOGUANINE	000154-42-7			x		
THIOTEPA	000052-24-4			x		
THIOURACIL	000141-90-2			x		
THIOUREA	000062-56-6			x		
TOBACCO SMOKE (NOT PASSIVE)	000000-00-0	x	x			
TOLUENE	000108-88-3		x	x		x
TOLUENE DIISOCYANATE, 1,3-	026471-62-5			x		
TOXAPHENE (POLYCHLORINATED CAMPHENES)	008001-35-2			x		x

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TREOSULPHAN	000299-75-2			x		
TRICHLOROETHYLENE	000079-01-6			x		
TRIMETHADIONE	000127-48-0		x			
TRIS (2,3-DIBROMOPROPYLPHOSPHATE)	000126-72-7					x
TRP-P-2(3-AMINO-1-METHYL-5H-PYRIDO[4,3-b]INDOLE)	062450-06-0			x		
URETHANE	000051-79-6			x		
VALPROIC ACID	000099-66-1		x			
VINBLASTINE SULFATE	000143-67-9			x		
VINCRISTINE SULFATE	002068-78-2			x		
VINYL ACETATE	000108-05-4			x		
VINYL CHLORIDE	000075-01-4	x		x		
WARAFIN	000081-81-2		x			x
ZINC CHROMATE (VI) HYDROXIDE HYDRATE	015930-94-6			x		
ZINC CHROMATE (VI)HYDROXIDE	001300-73-8			x		

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APPENDIX E-(2) Human Reproductive Toxins (By CAS Number)

EXAMPLES OF KNOWN OR SUSPECT HUMAN REPRODUCTIVE TOXINS (cas #)

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CHEMICAL NAME	CAS #	F	T	M	L	SA
ANGIOTENSIN CONVERTING ENZYME (ACE) INHIBITORS	000000-00-0		x			
BARBITURATES	000000-00-0		x			
ETHYLENE GLYCOL ETHERS	000000-00-0	x	x			
TOBACCO SMOKE (NOT PASSIVE)	000000-00-0	x	x			
FORMALDEHYDE	000050-00-0			x		x
PHENOBARBITAL	000050-06-6		x	x		
MITOMYCIN C	000050-07-7			x		
DDT	000050-29-3	x	x			x
BENZO[a]PYRENE	000050-32-8			x		
THALIDOMIDE	000050-35-1		x			x
CLOMIPHENE CITRATE	000050-41-9		x	x		
RESERPINE	000050-55-5		x			
ACTINOMYCIN D	000050-76-0			x		x
ASPRIN	000050-78-2		x			
FLUOROURACIL	000051-21-8		x	x		
PROPYLTHIOURACIL	000051-52-5		x	x		
NITROGEN MUSTARD	000051-75-2			x		x
URETHANE	000051-79-6			x		
THIOTEPA	000052-24-4			x		
HALOPERIDOL	000052-86-8		x			
DIBENZ[a,h]ANTHRACENE	000053-70-3			x		
NICOTINE	000054-11-5		x			x
AMINOPTERIN	000054-62-6		x			
PIPOBROMAN	000054-91-1			x		
NITROSODIETHYLAMINE,N-	000055-18-5			x		
NITROGEN MUSTARD HYDROCHLORIDE	000055-86-7			x		x
BUTANEDIOL DIMETHANESULFONATE, 1,4- (BUSULFAN)	000055-98-1	x	x	x		
METHYLTHIOURACIL	000056-04-2		x			
PARATHION	000056-38-2			x		x
DIETHYLSTILBOESTROL	000056-53-1	x	x			x
CHLORAMPHENICOL	000056-75-7			x		
DIMETHYLHYDRAZINE, 1,1-	000057-14-7			x		x
PHENYTOIN	000057-41-0		x			
PROPIOLACTONE, BETA	000057-57-8			x		
CHLORDANE	000057-74-9			x		x
PROGESTERONE	000057-83-0		x			
METHYLTESTOSTERONE	000058-18-4		x			
HEXACHLOROBENZENE, GAMMA	000058-89-9					x
METHYLAMINOPTERIN	000059-05-2		x	x		
BROMODEOXYURIDINE	000059-14-3		x	x		

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NITROSOMORPHOLINE, N-	000059-89-2			x		
LEVODOPA	000059-92-7			x		
DIMETHYLAMINOAZOBENZENE, 4-	000060-11-7			x		
METHYL HYDRAZINE	000060-34-4			x		x
TETRACYCLINES	000060-54-8		x			
METHIMAZOLE	000060-56-0		x	x		
ETHYL METHANESULPHONATE	000062-50-0			x		
THIOACETAMIDE	000062-55-5			x		
THIOUREA	000062-56-6			x		
DICHLORVOS	000062-73-7			x		x
NITROSODIMETHYLAMINE,N-	000062-75-9			x		
PHENOXYBENZAMINE HYDROCHLORIDE	000062-92-3	x				
NAPHTHYL METHYLCARBAMATE	000063-25-2	x		x		
DEMECLOCYCLINE HYDROCHLORIDE (INTERNAL USE)	000064-73-3		x			
COLCHICINE	000064-86-8			x		
METHYL METHANESULPHONATE	000066-27-3			x		
DICUMAROL	000066-76-2		x			
CYCLOHEXIMIDE	000066-81-9			x		x
CHLOROFORM	000067-66-3			x		
DIMETHYLFORMAMIDE	000068-12-2			x		x
NORETHISTERONE	000068-22-4	x		x		
METHYL-N-NITRO-N'-NITROSOGUANIDINE,N- (MNNG)	000070-25-7			x		
BENZENE	000071-43-2			x		x
MEDROXYPROGESTERONE ACETATE	000071-58-9		x	x		
DIGITOXIN	000071-63-6		x			x
MESTRANOL	000072-33-3	x				
METHYL BROMIDE	000074-83-9			x		x
METHYL CHLORIDE	000074-87-3			x		
VINYL CHLORIDE	000075-01-4	x		x		
DICHLOROMETHANE	000075-09-2			x		
CARBON DISULFIDE	000075-15-0	x	x			x
ETHYLENE OXIDE	000075-21-8		x			
BROMODICHLOROMETHANE	000075-27-4			x		
METHYLAZIRIDINE, 2- (PROPYLENEIMINE)	000075-55-8			x		x
PROPYLENE OXIDE	000075-56-9			x		x
FLUOXYMESTERONE	000076-43-7	x				
HEPTACHLOR	000076-44-8			x		x
DIMETHYL SULFATE	000077-78-1			x		x
TETRAETHYL LEAD	000078-00-2					x
TRICHLOROETHYLENE	000079-01-6			x		
DIMETHYLCARBAMOYL CHLORIDE	000079-44-7			x		
OXYTETRACYCLINE AND COMPOUNDS (INTERNAL USE)	000079-57-2		x			

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CHEMICAL NAME	CAS #	F	T	M	L	SA
WARAFIN	000081-81-2		x			x
NAPHTHYLAMINE, 2-	000091-59-8			x		x
DICHLOROBENZIDINE, 3,3-	000091-94-1			x		x
AMINODIPHENYL,4-	000092-67-1			x		x
2,4,5-T	000093-76-5		x			x
SAFROLE	000094-59-7			x		
CHLORO-O-TOLUIDINE, 4-	000095-69-2			x		
DIAMINOTOLUENE, 2,4-	000095-80-7			x		
CHLORO-O-PHENYLENEDIAMINE,4-	000095-83-0			x		
STYRENE-7,8-OXIDE	000096-09-3			x		x
DIBROMO-3-CHLOROPROPANE,1,2-	000096-12-8	x		x		x
ARSONIC ACID	000097-44-9		x			x
AMINOAZOTOLUENE,ortho-	000097-56-3			x		
TETRAETHYLTHIURAM DISULFIDE	000097-77-8		x			x
VALPROIC ACID	000099-66-1		x			
STYRENE	000100-42-5			x		x
BENZYL CHLORIDE	000100-44-7		x			
NITROSOPIPERIDINE, N-	000100-75-4			x		
EPICHLOROHYDRIN	000106-89-8			x		x
ETHYLENE DIBROMIDE	000106-93-4	x	x	x		x
ACROLEIN	000107-02-8			x		x
DICHLOROETHANE, 1,2-	000107-06-2			x		x
ACRYLONITRILE	000107-13-1			x		x
CHLOROMETHYL METHYL ETHER	000107-30-2			x		
VINYL ACETATE	000108-05-4			x		
TOLUENE	000108-88-3		x	x		x
ENDOSULFAN	000115-29-7			x		x
PARAMETHADIONE	000115-67-3		x			
ANISINDIONE	000117-37-3		x			
HEXACHLOROBENZENE	000118-74-1				x	x
AMINOGLUTETHIMIDE	000125-84-8		x			x
GRISEOFULVIN	000126-07-8			x		
DIBROMOPROPYL (2,3) PHOSPHATE	000126-72-7			x		x
TRIS (2,3-DIBROMOPROPYLPHOSPHATE)	000126-72-7					x
NITROGEN MUSTARD N-OXIDE	000126-85-2			x		x
CHLOROPRENE	000126-99-8	x	x	x		x
TETRACHLOROETHYLENE	000127-18-4				x	x
TRIMETHADIONE	000127-48-0		x			
THIOURACIL	000141-90-2			x		
KEPONE (CHLORDECONE)	000143-50-0	x				x
VINBLASTINE SULFATE	000143-67-9			x		
MELPHALAN	000148-82-3	x				

EXAMPLES OF KNOWN OR SUSPECT HUMAN REPRODUCTIVE TOXINS (cas #)

Key:
F -- Fertility
T -- Teratogens
M -- Mutagens
L -- Lactation
SA -- Readily Absorbed Through the Skin

revised: 10/2007

CHEMICAL NAME	CAS #	F	T	M	L	SA
AZIRIDINE	000151-56-4					x
HALOTHANE	000151-67-7		x			
THIOGUANINE	000154-42-7			x		
BISCHLOROETHYL NITROSOUREA (BCNU)	000154-93-8			x		
CARBAMAZEPINE	000298-46-4		x			
DIMETHANESULFONATE, 1,4-	000299-75-2		x			
TREOSULPHAN	000299-75-2			x		
LEAD ACETATE	000301-04-2	x	x	x	x	
HYDRAZINE	000302-01-2			x		x
NITROGEN MUSTARD N-OXIDE HYDROCHLORIDE	000302-70-5			x		x
ALL-TRANS RETINOIC ACID	000302-79-4		x	x		x
LASIOCARPINE	000303-34-4			x		
GOSSYPOL	000303-45-7	x		x		
CHLORAMBUCIL	000305-03-3		x			
MONOCROTALINE	000315-22-0			x		
TESTOSTERONE ENANTHATE	000315-37-7	x				
ERGOTAMINE TARTRATE	000379-79-3			x		
DIAZEPAM	000439-14-5		x			x
METRONIDAZOLE	000443-48-1			x		
METRONIDIZOL	000443-81-1			x		
AZATHIOPRINE	000446-86-6			x		
AURAMINE	000492-80-8			x		
MUSTARD GAS (SULPHUR MUSTARD)	000505-60-2			x		x
CADMIUM CARBONATE	000513-78-0	x	x			
ETHIONAMIDE	000536-33-4		x			
DIMETHYLHYDRAZINE, 1,2-	000540-73-8			x		x
CHLOROMETHYL ETHER,BIS-	000542-88-1			x		x
ACETOHYDROXAMIC ACID	000546-88-3		x			x
GLYCIDOL	000556-52-5			x		x
CHLORO-2-METHYLPROPENE, 3-	000563-47-3			x		
DOXYCYCLINE AND COMPOUNDS (INTERNAL USE)	000564-25-0			x		
METHYLAZOXYMETHYL ACETATE	000592-84-7			x		
DIMETHYL MERCURY	000593-74-8					x
METHYLDICHLOROARSINE	000593-89-5		x			x
MEGESTROL ACETATE	000595-33-5	x				
NITROFLUORENE,2-	000607-57-8			x		
DIAMINOANISOLE, 2,4- (AND ITS SALTS)	000615-05-4			x		
NITROSODI-n-PROPYLAMINE, N-	000621-64-7			x		
CARBON MONOXIDE	000630-08-0		x			
AMANTADINE HYDROCHLORIDE	000665-66-7		x			x
HEXAMETHYLPHOSPHORAMIDE	000680-31-9			x		x
METHYL-N-NITROSOUREA,N-	000684-93-5			x		

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revised: 10/2007

CHEMICAL NAME	CAS #	F	T	M	L	SA
NITROSO-N-METHYLUREA, N-	000684-93-5			x		
ETHYL-N-NITROSOUREA,N-	000759-73-9			x		
LORAZEPAM	000846-49-1		x			
NITROSODI-n-BUTYLAMINE, N-	000924-16-3			x		
NITROSOPYRROLIDINE, N-	000930-55-2			x		
HEPTACHLOR EPOXIDE	001024-57-3			x		x
PROPANE SULTONE, 1,3-	001120-71-4			x		x
ETHIDIUM BROMIDE	001239-45-8			x		
ZINC CHROMATE (VI)HYDROXIDE	001300-73-8			x		
ARSENIC PENTOXIDE	001303-28-2		x			x
CADMIUM OXIDE	001306-19-0	x	x			
CADMIUM SULFIDE	001306-23-6	x	x			
ARSENIC TRIOXIDE	001327-53-3		x			x
FOWLER'S SOLUTION	001332-10-1		x			
POLYCHLORINATED BIPHENYLS	001336-36-3	x	x		x	x
DIEPOXYBUTANE	001464-53-5			x		x
TETRACHLORODIBENZO-para-DIOXIN, 2,3,7,8- (TCDD)	001746-01-6		x			x
VINCRISTINE SULFATE	002068-78-2			x		
PENICILLAMINE	002219-30-9		x			
MIREX	002385-85-5	x				x
FURYLAMIDE	003688-53-7			x		
IFOSFAMIDE	003778-73-2			x		
ISOTRETINOIN	004759-48-2		x	x		
RETINOIC ACID, 1,3-CIS-	004759-48-2		x			
CHLORDANE, ALPHA	005103-71-9					x
CHLORDANE, BETA	005103-74-2					x
NITROPYRENE, 1-	005522-43-0			x		
BECLOMETHASONE DIPROPIONATE	005534-09-8	x	x			
CHLORDANE, GAMMA	005566-34-7					x
CYCLOPHOSPHAMIDE	006055-19-2		x			
LEAD ACETATE (II) TRIHYDRATE	006085-56-4	x	x	x	x	
NORGESTREL	006533-00-2	x				
LEAD AND COMPOUNDS	007439-92-1	x	x	x	x	
LITHIUM AND COMPOUNDS	007439-93-2		x			
MERCURY AND COMPOUNDS	007439-97-6	x	x			x
ARSENIC AND COMPOUNDS	007440-38-2		x			x
CADMIUM AND COMPOUNDS	007440-43-9	x	x			
LEAD PHOSPHATE	007446-27-7	x	x	x	x	
ARSENIC ACID, SODIUM SALT	007631-89-2		x			x
ARSENIC ACID	007778-39-4		x			x
ARSENIC ACID, CALCIUM SALT (2:3)	007778-44-1		x			x
POTASSIUM DICHROMATE (VI)	007778-50-9			x		

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CHEMICAL NAME	CAS #	F	T	M	L	SA
ARSENIC TRICHLORIDE	007784-34-1		x			
ARSENIC PENTAFLUORIDE	007784-36-3		x			
ARSENIC ACID, LEAD(2+) SALT (1:1)	007784-40-9		x			x
ARSENIC ACID, MONOPOTASSIUM SALT	007784-41-0		x			x
ARSINE	007784-42-1		x			x
ARSENIUOS ACID, MONOSODIUM SALT	007784-46-5		x			x
POTASSIUM CHROMATE (VI)	007789-00-6			x		
TOXAPHENE (POLYCHLORINATED CAMPHENES)	008001-35-2			x		x
ETHYLENEIMINE	009002-98-6			x		x
OZONE	010028-15-6			x		
HYDRAZINE SULFATE (1:1)	010034-93-2			x		x
STERIGMATOCYSTIN	010048-13-2			x		
ARSENIC ACID, DISODIUM SALT, HEPTAHYDRATE	010048-95-0		x			x
CADMIUM CHLORIDE	010108-64-2	x	x			x
CADMIUM SULFATE (1:1)	010124-36-4	x	x			
ARSENEOUS ACID, POTASSIUM SALT	010124-50-2		x			x
CADMIUM NITRATE	010325-94-7	x	x			
TAMOXIFEN AND SALTS	010540-29-1		x			
SODIUM DICHROMATE	010588-01-9			x		x
PCB (AROCLOR 1260)	011096-82-5					x
PCB (AROCLOR 1254)	011097-69-1					x
NICKEL SULFIDE (3:2)	012035-72-2			x		
RIFAMPIN	013292-46-1			x		
CADMIUM FLUOBORATE	014486-19-2	x	x			
METHOTREXATE SODIUM	015475-56-6			x		
CISPLATIN	015663-27-1			x		
ZINC CHROMATE (VI) HYDROXIDE HYDRATE	015930-94-6			x		
DANAZOL	017230-88-5	x				
BENOMYL	017804-35-2	x	x	x		x
PLICAMYCIN	018378-89-7			x		
LEAD CHROMATE (VI) OXIDE	018454-12-1	x	x	x	x	
STREPTOZOTOCIN	018883-66-4			x		
DAUNOMYCIN	020830-81-3			x		
NIFEDIPINE	021829-25-4		x			
METHYL MERCURY AND COMPOUNDS "s"	022967-92-6				x	x
DOXORUBICIN HYDROCHLORIDE (ADRIAMYCIN)	023214-92-8			x		
TOLUENE DIISOCYANATE, 1,3-	026471-62-5			x		
SODIUM AZIDE	026628-22-8			x		x
ARSENEOUS ACID, CALCIUM SALT	027152-57-4		x			x
ARSENIUOS ACID, CALCIUM SALT	027152-57-4		x			x
ALPRAZOMAN	028981-97-7		x			x
ATENOLO	029122-68-7		x			x

EXAMPLES OF KNOWN OR SUSPECT HUMAN REPRODUCTIVE TOXINS (cas #)

Key:
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CHEMICAL NAME	CAS #	F	T	M	L	SA
TENIPOSIDE	029767-20-2			x		
MEBENDAZOLE	031431-39-7			x		
ETOPOSIDE	033419-42-0			x		
AURANOFIN	034031-32-8			x		
DINITROPYRENE, 1,6-	042397-64-8			x		
DINITROPYRENE, 1,8-	042397-65-9			x		
ARSONIC ACID, CALCIUM SALT (1:1)	052740-16-6		x			x
PENTOSTATIN	053910-25-1			x		
ETRETINATE	054350-48-0			x		
POLYBROMINATED BIPHENYLS	059536-65-1		x			x
TRP-P-2(3-AMINO-1-METHYL-5H-PYRIDO[4,3-b]INDOLE)	062450-06-0			x		
GLU-P-2(2-AMINODIPYRIDO[1,2-A:3',2'-D]IMIDAZOLE)	067730-10-3			x		
GLU-P-1 (2-AMINO-6-METHYLDIPYRIDO[1,2-a:3',2'-d]IMIDAZOLE)	067730-11-4			x		
POLYBROMINATED BIPHENYL (FF-1)	067774-32-7		x			
MITOXANTRONE HYDROCHLORIDE	070476-82-3			x		x

References:

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Paul M., M.D., Himmelstein, J., M.D., 1988. *Reproductive hazards in the Workplace: What the Practioner Needs to Know About Chemical Exposures* . Obstetrics and Gynecology, v. 71, p. 921-938.

Hemminki, K., 1980. *Occupational Chemicals Tested for Teratogenicity* . International Archives of Occupational and Environmental Health, v. 47, p. 191-207.

Plog, B.A. (ed), 1995. *Fundamentals of Industrial Hygiene, Third Edition.* National Safety Council.

Sax, N. I., 1999. *Dangerous Properties of Industrial Materials* .

U.S. Government Accounting Office, 1991. *Reproductive and Developmental Toxicants* . GAO/PEMD-92-3.

U.S. Occupational Safety and Health Administration, 1990. *29 CFR 1910.1000 Limits for Air Contaminants*.

APPENDIX F Acute Toxin Protocol

You may use this form, or a simply submit a written request that includes the following information to the Chemical Hygiene Officer.

Faculty Name:_____ Date: _____

Chemical Name: _____ CEMS #: _____

Storage Location _____Qty Stored: _____

Use Location: _____

Other Lab Occupants: _____

_____

Experimental Procedure: _____

_____

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Emergency Procedures:_____

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User Training: _____

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Protective Equipment: _____

_____

_____

Waste Disposal: _____

_____

_____

APPENDIX G Chemical Storage Groups

Group 1: Inorganic Acids:	
Chlorosulfonic acid	Hydrochloric acid
Hydrofluoric acid	Hydrogen chloride
Hydrogen fluoride	Nitric acid
Sulfuric acid	Phosphoric acid
Group 2: Organic acids:	
Acetic acid	Butyric acid
Formic acid	Propionic acid
Group 3: Caustics (basic):	
Sodium hydroxide	Ammonium hydroxide solution
Group 4: Amines and Alkanolamines:	
Aminoethylethanolamine	Aniline
Diethanolamine .55	Diethylamine
Dimethylamine	Ethylenediamine
2-Methyl-5-ethylpyridine	Monoethanolamine
Pyridine	Triethanolamine
Triethylamine	Triethylenetetramine
Group 5: Halogenated Compounds	
Allyl chloride	Carbon tetrachloride Chlorobenzene
Methylene chloride	Monochlorodifluoromethane
1,2,4-Trichlorobenzene	1,1,1-Trichloroethane Trichloroethylene
Group 6: Alcohols, Glycols and Glycol Ether	
1,4-Butanediol	Butanol (iso, n, sec, tert) Diacetone alcohol
Ethyl alcohol	Ethyl butanol
Ethylene glycol	Furfuryl alcohol
Isoamyl alcohol	Isooctyl alcohol
Methyl alcohol	Methylamyl alcohol
Nonanol	Octanol
Propyl alcohol (n-, iso-)	Propylene glycol
Group 7:	
Aldehydes Acetaldehyde	Acrolein
Butyraldehyde	Crotonaldehyde
Formaldehyde	Furfural
Paraformaldehyde	Propionaldehyde

Group 8: Ketones	
Acetone	Acetophenone
Diisobutyl ketone	Isophorone
Mesityl oxide	Methyl ethyl ketone

Group 9: Saturated Hydrocarbons	
Butane	Cyclohexane
Ethane	Heptane
Hexane	Isobutane
Methane	Nonane
Paraffins	Paraffin wax
Pentane	Petroleum ether
Group 10: Aromatic Hydrocarbons	
Benzene	Cumene
Dodecyl benzene	Ethyl benzene
Naphtha	Naphthalene
Toluene	Xylene
Group 11: Olefins	
Butylene	1-Decene 1-Dodecene
Group 12: Petroleum Oils	
Asphalt	Gasoline
Jet fuels	Kerosene
Oils	Mineral Oil
Group 13: Esters	
Amyl acetate	Butyl acetates
Castor oil	Cottonseed oil
Dimethyl sulfate	Dioctyl adipate
Ethyl acetate	Methyl acetate
Group 14: Monomers and Polymerizable Esters	
Acrylic acid	Acrylonitrile
Butadiene	Butyl acrylate
Ethyl acrylate	Isodecyl acrylate
Isoprene	Methyl acrylate
Group 15: Phenols	
Carbolic acid	Cresote
Cresols	Phenol
Group 16: Alkylene Oxides	
Ethylene oxide	Propylene oxide
Group 17: Cyanohydrins	
Acetone cyanohydrin	Ethylene cyanohydrin
Group 18: Nitriles	
Acetonitrile	Adiponitrile
Group 19: Ammonia/Ammonium hydroxide	
Group 20: Halogens	
Group 21: Ethers (including THF)	

Group 22: Phosphorus, elemental
Group 23: Sulfur, molten
Group 24 : Acid anhydride Acetic anhydride Propionic anhydride

APPENDIX H Table of Incompatible Chemicals

Chemical	Incompatible with:	Chemical	Incompatible with:
Acetic Acid	Chromic Acid, nitric acid, hydroxylcontaining compounds, ethylene glycol, perchloric acid, peroxides, and permanganates.	Acetone	Bromine, chlorine, nitric acid, sulfuric acid, and hydrogen peroxide.
Acetylene	Bromine, chlorine, copper, mercury, fluorine, iodine, and silver.iodine, and silver.	Alkaline and Alkaline Earth Metals such as: calcium, lithium, magnesium, sodium, potassium, powdered aluminum	Carbon dioxide, carbon tetrachloride and other chlorinated hydrocarbons, water, Bromine, chlorine, fluorine, and iodine. **Do not use CO2, water or dry chemical fire extinguishers.** Use Class D extinguisher (e.g., Met-L-X) or dry sand.
Aluminum and its Alloys (especially powders)	Acid or alkaline solutions, ammonium persulfate and water, chlorates, chlorinated compounds, nitrates, and organic compounds in nitrate/nitrate salt baths.	Ammonia (anhydrous)	Bromine, chlorine, calcium hypochlorite, hydrofluoric acid, iodine, mercury, and silver.
Ammonium nitrate	Acids, metal powders, flammable liquids, chlorates, nitrates, sulfur and finely divided organics or other combustibles.	Aniline	Hydrogen peroxide or nitric acid.
Bromine	Acetone, acetylene, ammonia, benzene, butadiene, butane and other petroleum gases, hydrogen, finely divided metals, sodium carbide, turpentine.	Calcium oxide	Water
Carbon (activated)	Calcium hypochlorite, all oxidizing agents.	Caustic (soda)	Acids (organic and inorganic).
Chlorates or Perchlorates	Acids, aluminum, ammonium salts, cyanides, phosphorous, metal powders, oxidizable organics or other combustibles, sugar, sulfides, and sulfur.	Chlorine	Acetone, acetylene, ammonia, benzene, butadiene, butane and other petroleum gases, hydrogen, finely divided metals, sodium carbide, turpentine.

Chlorine Dioxide	Ammonia, methane, phosphine, hydrogen sulfide.	Chromic acid	Acetic acid, naphthalene, camphor, alcohol, glycerine, turpentine and other flammable liquids.
Copper	Acetylene, hydrogen peroxide.	Cumene hydroperoxide	Acids
Cyanides	Acids	Flammable Liquids	Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, bromine, chlorine, fluorine, iodine.
Fluorine	Isolate from everything.	Hydrazine	Hydrogen peroxide, nitric acid, and other oxiding agents.
Hydrocarbons	Bromine, chlorine, chromic acid, fluorine, hydrogen peroxide, and sodium peroxide.	Hydrocyanic Acid	Nitric acid, alkali.
Hydrofluoric Acid	Ammonia, aqueous or anhydrous.	Hydrogen Peroxide (anhydrous)	Chromium, copper, iron, most metals or their salts, aniline, any flammable liquids, combustible materials, nitromethane, and all other organic material.
Hydrogen Sulfide	Fuming nitric acid, oxidizing gases.	Iodine	Acetylene, ammonia (aqueous or anhydrous), hydrogen.
Mercury	Mercury Acetylene, alkali metals, ammonia, fulminic acid, nitric acid with ethanol, hydrogen, oxalic acid.	Nitrates	Nitrates Combustible materials, esters, phosphorous, sodium acetate, stannous chloride, water, zinc powder.
Nitric acid (concentrated)	Acetic acid, acetone, alcohol, aniline, chromic acid, flammable gases and liquids, hydrocyanic acid, hydrogen sulfide and nitratable substances.	Nitrites	Potassium or sodium cyanide.
Nitroparaffins	Inorganic bases, amines.	Oxalic acid	Silver, mercury, and their salts.
Oxygen (liquid or enriched air)	Flammable gases, liquids, or solids such as acetone, acetylene, grease, hydrogen, oils, phosphorous.	Perchloric Acid	Acetic anhydride, alcohols, bismuth and its alloys, paper, wood, grease, oils or any organic materials and reducing agents.
Peroxides	Acid (inorganic or organic).	Phosphorus	Air, oxygen.

(organic)	Also avoid friction and store cold.	(white)	
Phosphorus pentoxide	Alcohols, strong bases, water.	Potassium	Air (moisture and/or oxygen) or water, carbon tetrachloride, carbon dioxide.
Potassium Chlorate	Sulfuric and other acids.	Potassium Perchlorate	Acids.
Potassium Permanganate	Benzaldehyde, ethylene glycol, glycerol, sulfuric acid.	Silver and silver salts	Acetylene, oxalic acid, tartaric acid, fulminic acid, ammonium compounds.
Sodium	See Alkali Metals	Sodium Chlorate	Acids, ammonium salts, oxidizable materials and sulfur.
Sodium Nitrite	Ammonia compounds, ammonium nitrate, or other ammonium salts.	Sodium Peroxide	Any oxidizable substances, such as ethanol, methanol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerol, ethylene glycol, ethyl acetate, methyl acetate, furfural, etc.
Sulfides	Acids.	Sulfur	Any oxidizing materials.
Sulfuric Acid	Chlorates, perchlorates, permanganates, compounds with light metals such as sodium, lithium, and potassium.	Water	Acetyl chloride, alkaline and alkaline earth metals, their hydrides and oxides, barium peroxide, carbides, chromic acid, phosphorous oxychloride, phosphorous pentachloride, phosphorous pentoxide, sulfuric acid, sulfur trioxide.

APPENDIX I Occupational Incident Report

CONNECTICUT COLLEGE
OCCUPATIONAL INCIDENT REPORT

Full Name (Please PRINT)	Department	Date of Hire	Occupation	Supervisor

Date of Birth	Age	Sex	Marital Status	For Office use only

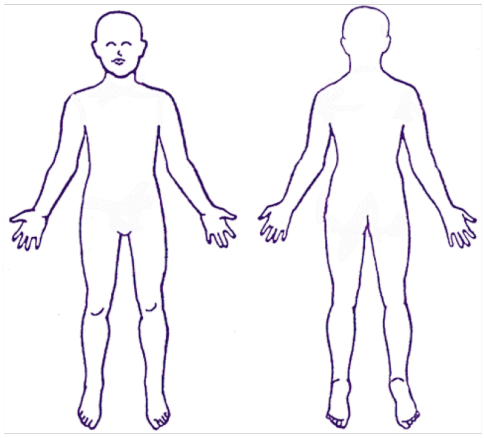
Home Address	City	State	Zip	Home Phone	Work Phone

Date & Time of Incident	Date & time Reported	Location of Incident

Did the employee lose time from work as a result of this incident? If yes, complete the boxes below. ☐ **Yes** ☐ **No**

Last day worked	Days away from work		Subtotal (days)	Restricted work activities		Subtotal (days)	Total lost work days
	Date began	Date returned		Date began	Date returned		

Briefly describe **how** the injury/illness occurred (Struck by…Fell from…Exposed to…)



Type of injury (i.e., strain, sprain, burn, bruise, cut , puncture, etc.,)

Describe the exact location of the injury, and circle the location on the chart. (ex. Left upper arm…Right lower leg…Right index finger, Mid lower back, etc.)

Was medical care required?: (Check one) ☐ **Yes** ☐ **No**

Date seen: _____

Where?: (Check one)
- ☐ **College Health Services**
- ☐ **Pequot Occupational Health Clinic**
- ☐ **Other (Specify)**

Employee disposition: (Check one)
- ☐ **Returned to full duty**
- ☐ **Returned to modified duty**
- ☐ **Sent home per Dr.'s order**

Witness(s) to incident:

What action of the employee or unsafe physical condition (s) contributed to this incident?

Suggestions for prevention or correction of future incidents:

Supervisor's Signature: Date:

Employee's Signature: Date:

Send the original report to the Worker's Compensation Manager **within 24 hours** of the injury/incident. **PLEASE COMPLETE ALL QUESTIONS.** For questions, contact Mary DeBriae at extension 2793.

APPENDIX J Particularly Hazardous Substances with Skin Absorption Designation

(Use of these chemicals requires Protective Clothing)

Name	CAS #	Hazard
2,4,5-T	000093-76-5	RT
ACROLEIN	000107-02-8	SC
ACRYLAMIDE	000079-06-1	SC
ACRYLONITRILE	000107-13-1	AT,SC,RT
AMINODIPHENYL,4-	000092-67-1	SC,RT
AMMONIUM DICHROMATE (VI)	007789-09-5	SC
ANILINE AND COMPOUNDS	000062-53-3	AT
ANISIDINE, ORTHO-	000090-04-0	SC
ARSENEOUS ACID, CALCIUM SALT	027152-57-4	SC,RT
AZIRIDINE	000151-56-4	SC
BENZ[a]ANTHRACENE	000056-55-3	SC
BENZENE	000071-43-2	SC,RT
BENZIDINE	000092-87-5	SC
BENZIDINE-BASED DYES	000000-00-0	SC
BENZYLTRICHLORIDE	000098-07-7	SC
CADMIUM CHLORIDE	010108-64-2	SC,RT
CARBON DISULFIDE	000075-15-0	RT
CARBON TETRACHLORIDE	000056-23-5	SC
CATECHOL	000120-80-9	SC
CHLORDANE AND ISOMERS	000057-74-9	SC,RT
CHLOROMETHYL ETHER,BIS-	000542-88-1	SC,RT
CHLOROANILINE, PARA	000106-47-8Z	SC
CHLOROPHENOLS	000095-57-8	SC
CHLOROPHENOXY HERBICIDES	000000-00-0	SC
CHLOROPRENE	000126-99-8	SC,RT
CHROMIC ACID, DISODIUM SALT	007775-11-3	SC
COAL-TAR AND DISTILLATE, DYE, PITCHES	008007-45-2	SC
CYANAMIDE	000420-04-2	AT
CYANIDE AND COMPOUNDS	000057-12-5	AT
DDT	000050-29-3	SC,RT
DECABORANE	017702-41-9	AT
DIAZEPAM	000439-14-5	RT
DIBROMO-3-CHLOROPROPANE,1,2-	000096-12-8	SC,RT
DICHLORO-2,2-BIS(P-CHLOROPHENYL)ETHANE, 1,1- (DDD)	000072-54-8	SC
DICHLOROBENZIDINE, DIHYDROCHLORIDE, 3,3' -	000612-83-9	SC
DICHLOROBENZIDINE,3,3'-	000091-94-1	SC
DICHLOROETHANE, 1,2-	000107-06-2	SC,RT
DICHLOROPROPENE, 1,3- (TECHNICAL-GRADE)	000542-75-6	SC
DICHLORVOS	000062-73-7	AT,SC,RT
DIEPOXYBUTANE	001464-53-5	SC,RT
DIEPOXYBUTANE, 1,2:3,4-	000298-18-0	SC,RT
DIEPOXYBUTANE, 3,4-,MESO 1,2	000564-00-1	SC,RT
DIETHYL SULPHATE	000064-67-5	SC
DIETHYLSTILBOESTROL	000056-53-1	SC,RT
DIMETHYL MERCURY	000593-74-8	AT,RT
DIMETHYL SULFATE	000077-78-1	AT,SC,RT
DIMETHYL SULFOXIDE	000067-68-5	RT
DIMETHYLBENZIDINE, 3,3'- (o-TOLIDINE)	000119-93-7	SC
DIMETHYLFORMAMIDE	000068-12-2	SC,RT
DIMETHYLHYDRAZINE, 1,1-	000057-14-7	SC,RT
DIMETHYLHYDRAZINE, 1,2-	000540-73-8	SC,RT
DINITROTOLUENE, 2,4-	000121-14-2	SC
DIOXANE, 1,4-	000123-91-1	SC
ENDOSULFAN	000115-29-7	AT,RT
ENDRIN	000072-20-8	AT
EPICHLOROHYDRIN	000106-89-8	SC,RT
ETHYL ACRYLATE	000140-88-5	SC
ETHYLENE CHLOROHYDRIN	000107-07-3	AT

ETHYLENE DIBROMIDE	000106-93-4	SC
FORMALDEHYDE	000050-00-0	SC,RT
FURAN	000110-00-9	SC
GASOLINE	008006-61-9	SC
GLYCIDALDEHYDE	000765-34-4	SC
GLYCIDOL	000556-52-5	SC,RT
HEPTACHLOR	000076-44-8	AT,SC,RT
HEPTACHLOR EPOXIDE	001024-57-3	AT,SC,RT
HEXACHLOROBENZENE	000118-74-1	SC,RT
HEXACHLOROBENZENE, GAMMA	000058-89-9	SC,RT
HEXACHLOROCYCLOHEXANES	000000-00-0	SC
HEXACHLOROHEXANES	000608-73-1	SC
HEXAMETHYLPHOSPHORAMIDE	000680-31-9	SC,RT
HYDRAZINE	000302-01-2	SC,RT
HYDRAZINE, SULFATE	010034-93-2	SC,RT
HYDROGEN CYANIDE	000074-90-8	AT
HYDROGEN FLUORIDE	007664-39-3	AT
HYDROGEN SELENIDE	007783-07-5	AT
KEPONE (CHLORDECONE)	000143-50-0	SC,RT
MANGANESE TRICARBONYL METHYLCYCLOPENTADIENYL	012108-13-3	AT
MECOPROP	000093-65-2	SC
MERCURY AND COMPOUNDS	007439-97-6	RT
METHYL BROMIDE	000074-83-9	AT,RT
METHYL HYDRAZINE	000060-34-4	AT,RT
METHYL ISOCYANATE	000624-83-9	AT
METHYL MERCURY AND COMPOUNDS "s"	022967-92-6	AT,SC,RT
METHYLAZIRIDINE, 2-	000075-55-8	AT,SC,RT
METHYLENE BIS(2-CHLOROANILINE), 4,4- (MBOAC)	000101-14-4	SC
MINERAL OILS,UNTREATED AND MILDLY TREATED	000000-00-0	SC
MIREX	002385-85-5	SC,RT
MUSTARD GAS (SULPHUR MUSTARD)	000505-60-2	AT,SC,RT
NAPHTHYLAMINE, 2-	000091-59-8	SC,SC
NAPHTHYLAMINE, ALPHA-	000134-32-7	
NICOTINE	000054-11-5	AT,RT
NITRIC ACID (FUMING)	007697-37-2	AT
NITROBENZENE	000098-95-3	SC
NITROFEN (TECHNICAL-GRADE)	001836-75-5	SC
NITROGEN MUSTARD	000051-75-2	AT,SC,RT
NITROGEN MUSTARD HYDROCHLORIDE	000055-86-7	AT,SC,RT
NITROGEN MUSTARD N-OXIDE	000126-85-2	AT,SC,RT
NITROGEN MUSTARD N-OXIDE HYDROCHLORIDE	000302-70-5	AT,SC,RT
PARATHION	000056-38-2	AT,RT
PCB (AROCLOR 1254)	011097-69-1	SC,RT
PCB (AROCLOR 1260)	011096-82-5	SC,RT
PENTACHLOROPHENOL	000087-86-5	AT,SC
PHENYL GLYCIDYL ETHER	000122-60-1	SC
PROPANE SULTONE, 1,3-	001120-71-4	SC,RT
PROPIONIC NITRILE	000107-12-0	AT
PROPYLENE OXIDE	000075-56-9	AT,SC,RT
SHALE-OILS	068308-34-9	SC
SODIUM AZIDE	026628-22-8	AT,RT
SODIUM DICHROMATE (VI)	010588-01-9	SC,RT
SODIUM FLUOROACETATE	000062-74-8	AT
STYRENE	000100-42-5	SC,RT
STYRENE-7,8-OXIDE	000096-09-3	SC,RT
SULFALLATE	000095-06-7	SC
SULFURIC ACID, DIISOPROPYL ESTER	002973-10-6	SC
TETRACHLORODIBENZO-para-DIOXIN, 2,3,7,8- (TCCD)	001746-01-6	AT,SC,RT
TETRACHLOROETHYLENE	000127-18-4	SC,RT
TETRAETHYL LEAD	000078-00-2	AT,SC,RT
TETRAETHYL PYROPHOSPHATE	000107-49-3	AT
TETRAMETHYL SUCCINONITRILE	003333-52-6	AT
TETRAETHYLTHIURAM DISULFIDE	000097-77-8	RT
THALIDOMIDE	000050-35-1	RT
THIOPHENOL	000108-98-5	AT
TOLUENE	000108-88-3	RT
TOLUIDINE, ORTHO-	000095-53-4	AT,SC
TOXAPHENE (POLYCHLORINATED CAMPHENES)	008001-35-2	SC,RT
TRICHLOROPHENOL, 2,4,6-	000088-06-2	SC
TRICHLOROPROPANE, 1,2,3-	000096-18-4	SC
TRIS-1,2,3-DIBROMOPROPYL PHOSPHATE	000126-72-7	SC
VINYL-1-CYCLOHEXENE DIEPOXIDE, 4-	000106-87-6	SC
WARAFIN	000081-81-2	RT

XYLIDINE	001300-73-8	AT,SC

AT - acute toxin
SC - select carcinogen
RT - reproductive toxin

APPENDIX K Storage Time Limits for Peroxide Forming Chemicals

Storage Time Limits for Peroxide Forming Chemicals	
Unopened containers from manufacturer	18 months (or expiration date)
Opened containers:	
Class A chemicals	3 months
Class B chemicals	6 months
Class C chemicals	6 months
Inhibited Class C chemicals (Do not store under an inert atmosphere)	12 months
Class D chemicals	24 months

Class A – Severe Peroxide Hazard – May spontaneously decompose and become explosive with exposure to air without concentration.		
Butadiene (liquid monomer) Chloroprene (liquid monomer) Divinyl acetylene	Isopropyl ether Potassium amide Potassium metal	Sodium amide (sodamide) Tetrafluoroethylene (liquid monomer) Vinylidene chloride
Class B – Concentration Hazard - Requires external energy for spontaneous decomposition. Form explosive peroxides when distilled, evaporated or otherwise concentrated.		
Acetal Acetaldehyde Benzyl alcohol 2-Butanol Cumene Cyclohexanol Cyclohexene 2-Cyclohexen-1-ol Decahydronaphthalene Diacetylene Dicyclopentadiene	Diethylene glycol dimethyl ether (diglyme) Diethyl ether Dioxanes Ethylene glycol dimethyl ether (glyme) Furan 4-Heptanol 2-Hexanol Methylacetylene 3-Methyl-1-butanol Methylcyclopentane	Methyl isobutyl ketone 4-Methyl-2-pentanol 2-Pentanol 4-Penten-1-ol 1-Phenylethanol 2-Phenylethanol 2-Propanol Tetrahydrofuran Tetrahydronaphthalene Vinyl ethers Other secondary alcohols
Class C – Shock and Heat Sensitive - Highly reactive and can auto-polymerize as a result of internal peroxide accumulation. The peroxides formed in these reactions are extremely shock and heat sensitive.		
Acrylic acid Acrylonitrile Butadiene (gas) Chloroprene Chlorotrifluoroethylene	Methyl methacrylate Styrene Tetrafluoroethylene (gas) Vinyl acetate	Vinylacetylene (gas) Vinyladiene chloride Vinyl chloride (gas) Vinylpyridine
Class D – Potential Peroxide Forming Chemicals - May form peroxides but cannot be clearly categorized in Class A, B, or C.		
Acrolein Allyl ether Allyl ethyl ether Allyl phenyl ether p-(n-Amyloxy)benzoyl chloride n-Amyl ether Benzyl n-butyl ether Benzyl ether	p-Chlorophenetole Cyclooctene Cyclopropyl methyl ether Diallyl ether p-Di-n-butoxybenzene 1,2-Dibenzyloxyethane p-Dibenzyloxybenzene 1,2-Dichloroethyl ethyl ether	4,5-Hexadien-2-yn-1-ol n-Hexyl ether o.p-Iodophenetole Isoamyl benzyl ether Isoamyl ether Isobutyl vinyl ether Isophorone b-Isopropoxypropionitrile

Benzyl ethyl ether	2,4-Dichlorophenetole	Isopropyl-2,4,5-trichlorophenoxy acetate
Benzyl methyl ether	Diethoxymethane	n-Methylphenetole
Benzyl-1-napthyl ether	2,2-Diethoxypropane	2-Methyltetrahydrofuran
1,2-Bis(2-chloroethoxyl)ethane	Diethyl ethoxymethylenemalonate	2-Methoxyethanol
Bis(2-ethoxyethyl)ether	Diethyl fumarate	3-Methoxy-1-butyl acetate
Bis(2-(methoxyethoxy)ethyl) ether	Diethyl acetal	3-Methoxyethyl acetate
Bis(2-chloroethyl) ether	Diethylketene	2-Methoxyethyl vinyl ether
Bis(2-ethoxyethyl) adipate	Diethoxybenzene (m-,o-,p-)	Methoxy-1,3,5,7-cyclooctatetraene
Bis(2-methoxyethyl) carbonate	1,2-Diethoxyethane	b-Methoxypropionitrile
Bis(2-methoxyethyl) ether	Dimethoxymethane	m-Nitrophenetole
Bis(2-methoxyethyl) phthalate	1,1-Dimethoxyethane	1-Octene
Bis(2-methoxymethyl) adipate	Di(1-propynl) ether	Oxybis(2-ethyl acetate)
Bis(2-n-butoxyethyl) phthalate	Di(2-propynl) ether	Oxybis(2-ethyl benzoate)
Bis(2-phenoxyethyl) ether	Di-n-propoxymethane	b,b-Oxydipropionitrile
Bis(4-chlorobutyl) ether	1,2-Epoxy-3-isopropoxypropane	1-Pentene
Bis(chloromethyl) ether	1,2-Epoxy-3-phenoxypropane	Phenoxyacetyl chloride
2-Bromomethyl ethyl ether	p-Ethoxyacetophenone	a-Phenoxypropionyl chloride
beta-Bromophenetole	1-(2-Ethoxyethoxy)ethyl acetate	Phenyl-o-propyl ether
o-Bromophenetole	2-Ethoxyethyl acetate	p-Phenylphenetone
p-Bromophenetole	(2-Ethoxyethyl)-a-benzoyl benzoate	n-Propyl ether
3-Bromopropyl phenyl ether	1-Ethoxynaphthalene	n-Propyl isopropyl ether
tert-Butyl methyl ether	o,p-Ethoxyphenyl isocyanate	Sodium 8-11-14-eicosatetraenoate
n-Butyl phenyl ether	1-Ethoxy-2-propyne	Sodium ethoxyacetylide
n-Butyl vinyl ether	3-Ethoxypropionitrile	Tetrahydropyran
Chloroacetaldehyde diethylacetal	2-Ethylacrylaldehyde oxime	Triethylene glycol diacetate
2-Chlorobutadiene	2-Ethylbutanol	Triethylene glycol dipropionate
1-(2-Chloroethoxy)-2-phenoxyethane	Ethyl-b-ethoxypropionate	1,3,3-Trimethoxypropene
Chloroethylene	Ethylene glycol monomethyl ether	1,1,2,3-Tetrachloro-1,3-butadiene
Chloromethyl methyl ether	2-Ethylhexanal	4-Vinyl cyclohexene
beta-Chlorophenetole	Ethyl vinyl ether	Vinylene carbonate
o-Chorophenol	2,5-Hexadiyn-1-ol	

APPENDIX L Emergency Procedures for Hydrofluoric Acid Exposure

Hydrofluoric Acid - Emergency Response

Note: First Aid must be started within seconds of HF contact in any form!

Hydrogen Fluoride and Hydrofluoric Acid cause severe, deeply penetrating burns to the skin, eyes and lungs. Although concentrated forms of these chemicals are readily pereceived by an immediate burning sensation, more dilute concentrations are often imperceptible for many hours. This potential delay between exposure recognition and treatment can lead to insidious and difficult to treat burns.
If you work with Hydrogen Fluoride or Hydrofluoric Acid, make certain you and your co-workers are familiar with these first aid procedures, and know where the Calcium Gluconate is stored.
Click here for the MSDS for Hydrofluoric Acid.

Skin Exposure:

1. Remove contaminated clothing.
2. Immediately flush the affected body area with cool water for a minimum of 15 minutes.
3. Gently apply 2.5% Calcium Gluconate ointment to the affected area. (This ointment is found in all labs using HF, and in the chemical stockroom, taped to the Acid Cabinet.)
4. Call or have a co-worker call for medical assistance. (Dial 911 or 2222 from any campus phone.)
5. Continue to apply the ointment until emergency medical responders arrive.
6. If calcium gluconate is not immediately available, continue rinsing the affected area with copious amounts of water until emergency medical responders arrive.
7. Inform responders and all others that the exposure involved Hydrogen Fluoride/Hydrofluoric Acid.

Eye or Inhalalation Exposure:

1. Flush eyes with cool, clean water for at least 15 minutes.
2. Move inhalation exposure victims to fresh air.
3. Call or have a co-worker call for medical assistance. (Dial 911 or 2222 from any campus phone.)
4. Await emergency medical responders, informing them and all others that the exposure involved Hydrogen Fluoride/Hydrofluoric Acid.

APPENDIX M Examples of Chemicals Meeting the NFPA Rating for REACTIVITY

NFPA 4	
acetyl peroxide	1,2 dinitrobenzene
ammonium perchlorate	dinitrochlorobenzene
benzoyl peroxide	ethyl nitrate
3-bromopropene	ethyl nitrite
tert-butyl hydroperoxide	nitroglycerine
tert-butyl peracetate	m-nitrotoluene
tert-butyl perbenzoate	o-nitrotoluene
tert-butylperoxypivalate	2-nitro-p-toluidine
1-chloro-2,4-dinitrobenzene	peracetic acid, diluted with 60% acetic acid
cumene hydroperoxide	picric acid
diazomethane	propargyl bromide
diethyl peroxide	trinitrobenzene
diisopropyl peroxydicarbonate	
NFPA 3	
acetylene	ethylene oxide
ammonium permanganate	fluorine
butyl nitrate	hydroxylamine
tert-butylperoxide	isano oil
cellulose nitrate, wet with alcohol	methylaluminum sesquibromide
chlorine monoxide	methylaluminum sesquichloride
chlorine trifluoride	methyl isocyanate
chloropicrin	nickel carbonyl
2-chloro-5-nitrobenzo-trifluoride	p-nitroaniline
1-chloro-1-nitroethane	nitrocellulose
1-chloro-1-nitropropane	p-nitorchlorobenzene
2-chloro-2-nitropropane	nitrocyclohexane
cyanimide	nitroethane
cyanogen	nitromethane
diborane	1-pentyne
1,1-dichloro-1-nitroethane	perchloric acid
1,1-dichloro-1-nitropropane	piperidine
diethylaluminum chloride	proargyl alcohol
diethylaluminum hydride	propyl nitrate
diethylzinc	tetraethyl lead compounds
diisobutylaluminum hydride	tetramethyl lead compounds
2,4-dinitroanline	triethylaluminum
2,4-dinitrotoluene	triethylborane
dipropylaluminum hydride	triisobutylaluminum
divinal acetylene	trimethylaluminum
ethylaluminum dichloride	tripropyl aluminum
ethylaluminum sesquichloride	vinyl acetylene
NFPA 2	
acrolein	epichlorohydrin
acrylonitrile	ethyl acrylate
cyanogen	styrene

NFPA 1	
glacial acetic acid	tetrahydrofuran
ethyl ether	1,1,1-trichloroethane
NFPA 0	
acetone	mineral spirits
benzene	naphthalene
ethyl acetate	toluene
ethyl alcohol	trichloroethylene
ethylene glycol	xylene

A more complete summary of NFPA hazard codes for chemicals can be found in NFPA 325M, Fire Hazard Properties of Flammable Liquids, Gases, and Volatile Solids and in NFPA 49, Hazardous Chemical Data.

APPENDIX N List of HHS and USDA Select Agents and Toxins

HHS AND USDA SELECT AGENTS AND TOXINS
7 CFR Part 331, 9 CFR Part 121, and 42 CFR Part 73

HHS SELECT AGENTS AND TOXINS

Abrin
Botulinum neurotoxins
Botulinum neurotoxin producing species of *Clostridium*
Cercopithecine herpesvirus 1 (Herpes B virus)
Clostridium perfringens epsilon toxin
Coccidioides posadasii/Coccidioides immitis
Conotoxins
Coxiella burnetii
Crimean-Congo haemorrhagic fever virus
Diacetoxyscirpenol
Eastern Equine Encephalitis virus
Ebola virus
Francisella tularensis
Lassa fever virus
Marburg virus
Monkeypox virus
Reconstructed replication competent forms of the 1918 pandemic influenza virus containing any portion of the coding regions of all eight gene segments (Reconstructed 1918 Influenza virus)
Ricin
Rickettsia prowazekii
Rickettsia rickettsii
Saxitoxin
Shiga-like ribosome inactivating proteins
Shigatoxin
South American Haemorrhagic Fever viruses
- Flexal
- Guanarito
- Junin
- Machupo
- Sabia

Staphylococcal enterotoxins
T-2 toxin
Tetrodotoxin
Tick-borne encephalitis complex (flavi) viruses
- Central European Tick-borne encephalitis
- Far Eastern Tick-borne encephalitis
- Kyasanur Forest disease
- Omsk Hemorrhagic Fever
- Russian Spring and Summer encephalitis

Variola major virus (Smallpox virus)
Variola minor virus (Alastrim)
Yersinia pestis

OVERLAP SELECT AGENTS AND TOXINS

Bacillus anthracis
Brucella abortus
Brucella melitensis
Brucella suis
Burkholderia mallei (formerly *Pseudomonas mallei*)
Burkholderia pseudomallei (formerly *Pseudomonas pseudomallei*)
Hendra virus
Nipah virus
Rift Valley fever virus
Venezuelan Equine Encephalitis virus

USDA SELECT AGENTS AND TOXINS

African horse sickness virus
African swine fever virus
Akabane virus
Avian influenza virus (highly pathogenic)
Bluetongue virus (exotic)
Bovine spongiform encephalopathy agent
Camel pox virus
Classical swine fever virus
Ehrlichia ruminantium (Heartwater)
Foot-and-mouth disease virus
Goat pox virus
Japanese encephalitis virus
Lumpy skin disease virus
Malignant catarrhal fever virus (Alcelaphine herpesvirus type 1)
Menangle virus
Mycoplasma capricolum subspecies *capripneumoniae* (contagious caprine pleuropneumonia)
Mycoplasma mycoides subspecies *mycoides* small colony (*Mmm*SC) (contagious bovine pleuropneumonia)
Peste des petits ruminants virus
Rinderpest virus
Sheep pox virus
Swine vesicular disease virus
Vesicular stomatitis virus (exotic): Indiana subtypes VSV-IN2, VSV-IN3
Virulent Newcastle disease virus[1]

USDA PLANT PROTECTION AND QUARANTINE (PPQ) SELECT AGENTS AND TOXINS

Peronosclerospora philippinensis (*Peronosclerospora sacchari*)
Phoma glycinicola (formerly *Pyrenochaeta glycines*)
Ralstonia solanacearum race 3, biovar 2
Rathayibacter toxicus
Sclerophthora rayssiae var zeae
Synchytrium endobioticum
Xanthomonas oryzae
Xylella fastidiosa (citrus variegated chlorosis strain)

11/17/2008

[1] A virulent Newcastle disease virus (avian paramyxovirus serotype 1) has an intracerebral pathogenicity index in day-old chicks (Gallus gallus) of 0.7 or greater or has an amino acid sequence at the fusion (F) protein cleavage site that is consistent with virulent strains of Newcastle disease virus. A failure to detect a cleavage site that is consistent with virulent strains does not confirm the absence of a virulent virus.

APPENDIX O Select Agent Registration Form

Connecticut College
Office of Environmental Health & Safety

In order to comply with federal law, Principal investigators must register the possession of Select Agents. Failure to comply may result in criminal penalties. Select Agents include:

1. Microorganisms listed as Select Agents by the CDC.
2. Genetically modified microorganisms or genetic elements from organisms on the list, shown to produce or encode for a factor associated with a disease, and
3. Genetically modified microorganisms or genetic elements that contain nucleic acid sequences coding for any of the toxins on the list or their toxic subunits.

The USA Patriot Act of 2001 prohibits "Restricted Persons" from possessing, shipping, transporting or receiving Select Agents. Finally, the Patriot Act prohibits the possession of a "Biological Agent, Toxin or Delivery System" of a type or in a quantity that, under the circumstances, is not reasonably justified by a prophylactic, protective, bona fide research, or other peaceful purpose. (As used here, "Biological Agent, Toxin or Delivery System" is broader than Select Agents.)

Principal Investigators must fill out and sign this SELECT AGENT Registration Form. Send the signed form to the Director of Environmental Health & Safety.

Date: _____

Last Name: _____ First Name: _____ MI: ____

Department: _____ email: _____ Ph: _____

Lab Location(s) (Bldg./Room): _____

Authorized Laboratory Personnel:

Last Name:	First Name:	Position Title:

Microorganisms/Infectious Agents to be used:

Agent (Genus & Species)	Strain	Recombinant?	Antibiotic Resistant? (specify)
		☐ Yes ☐ No	
		☐ Yes ☐ No	
		☐ Yes ☐ No	
		☐ Yes ☐ No	