SUNY DOWNSTATE Medical Center

Laboratory Safety Manual

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Prepared by: The Office of Environmental Health & Safety

SECTION 1: Laboratory Safety at SUNY Downstate Medical Center

Introduction

SUNY Downstate is committed to providing a safe laboratory environment for its faculty, staff, students and visitors. The goal of the University Laboratory Safety Program is to minimize the risk of injury or illness to laboratory workers by ensuring that they have the training, information, support, and equipment needed to work safely in the laboratory.

The three basic elements of the Laboratory Safety Program are:

- The departmental safety program led by the Chemical Hygiene Office
- Laboratory safety support and training by Environmental Health and Safety
- Instruction and oversight by an individual's supervisor or Principal Investigator (PI)

All laboratory workers, including faculty, staff and students, are required to attend Laboratory Safety Training given by the Office of Environmental Health and Safety (EH&S) staff. This training gives an overview of general laboratory safety principles, references, and resources for more specific safety information, and details about several support programs, such as the hazardous waste disposal program. The training supplements instruction given by Supervisors and Principal Investigators regarding safe work practices for specific chemicals and equipment.

EH&S provides training, resources and consultation for a variety of laboratory safety issues, including Chemical Safety, Biological Safety, Radiation Safety and Chemical Safety and other topics.

NYS Department of Labor/OSHA Laboratory Standard

The NYS Department of Labor – Public Employee Safety and Health (PESH) Bureau adapts and enforces all Occupational Safety and Health (OSHA) promulgated regulations.

The goal of the OSHA promulgated Occupational Exposure to Hazardous Chemicals in Laboratories standard (29 CFR 1910.1450), otherwise known as the Laboratory Standards,is to ensure that laboratory workers are informed about the hazards of chemicals in their workplace and are protected from chemical exposures exceeding allowable levels (e.g., OSHA Permissible Exposure Limits), that an inventory of hazardous chemicals and safety data sheets (SDS) is maintained, that hea;th and safety information and training is available for laboratory workers, to provide medical consultation for employees and to appoint a responsible person to oversee the program.

All individuals who work with hazardous chemicals in all laboratories are obligated to comply with the Lab Standard. Work with chemicals outside of laboratories is governed by the NYS Right-to-Know Law/OSHA Hazard Communication Standards.

SUNY Downstate Medical Center Policies

Environmental Health and Safety Policy

SUNY Downstate Medical Center is committed to providing a safe and healthful environment for its employees, students, researchers, volunteers and visitors and managing the University in an environmentally sensitive and responsible manner. We further recognize an obligation to demonstrate safety and environmental leadership by maintaining the highest standards and serving as an example to our students as well as the community at large.

The University will strive to continuously improve our safety and environmental performance by adhering to the following policy objectives:

- Developing and improving programs and procedures to assure compliance with all applicable laws and regulations
- Ensuring that personnel are properly trained and provided with appropriate safety and emergency equipment
- Taking appropriate action to correct hazards or conditions that endanger health, safety, or the environment
- Considering safety and environmental factors in all operating decisions including planning and acquisition
- Using energy efficiently throughout our operations
- Encouraging personal accountability and emphasizing compliance with standards and conformance with University policies and best practices during employee training and in performance reviews
- Communicating our desire to continuously improve our performance and fostering the expectation that every employee, student, and contractor on University premises will follow this policy and report any environmental, health, or safety concern to the Office of Environmental Health and Safety.
- Monitoring our progress through periodic evaluations

Laboratory Security Policy

Safeguarding University resources from unauthorized access, misuse or removal is a duty of all faculty and staff. In laboratories, this obligation rests primarily with the Principal Investigator; however, all laboratory personnel have a responsibility to take reasonable precautions against theft or misuse of materials, particularly those that could threaten the public. Any extraordinary laboratory security measures should be commensurate with the potential risks and imposed in a manner that does not unreasonably hamper research.

At a minimum, the institution expects all laboratory personnel to comply with the following University Police/Public Safety security procedures:

- Question the presence of unfamiliar individuals in laboratories and report all suspicious activity immediately to Public Safety at 270-2626. After normal business hours, all laboratories must be locked when not in use
- Laboratory building exterior doors are secured after normal business hours. To minimize the likelihood of unauthorized access, all after-hours building users should:
    - Avoid providing building access to unfamiliar individuals
    - Secure doors behind them
    - Immediately report any building security problem to Public Safety at 270-2626

Research or other activities involving the use of lab space, materials or equipment without the knowledge and approval of the responsible Principal Investigator is strictly prohibited. Violation of this prohibition may result in disciplinary action up to and including termination.

Roles and Responsibilities

Departmental Laboratory Safety Officer

- Establish and implement a Chemical Hygiene Plan
- Review and update the Chemical Hygiene Plan at least annually
- Investigate accidents and chemical exposures within the department
- Act as a liaison between the department and EH&S for laboratory safety issues
- Maintain records of training, exposure monitoring and medical examinations
- Ensure laboratory workers receive chemical and procedure-specific training
- Review and approve use of Particularly Hazardously Substance

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Principal Investigators

- Ensure laboratory workers attend general training given by EH&S
- Ensure laboratory workers understand how to work with chemicals safely. Provide chemical and procedure-specific training, as needed
- Provide laboratory workers with appropriate and personal protective equipment needed to work safely with hazardous materials. Ensure such equipment is used correctly
- Designating individuals to function as laboratory Chemical Hygiene Officers (CHOs)
- Informing the ICHO of the use of extremely hazardous substances in the laboratory
- Ensure that emergency equipment and personal protective equipment (PPE) is provided and properly maintained
- Informing employees of air monitoring results
- Review and approve work with particularly hazardous substances

Environmental Health and Safety (EH&S)

- Serves as the Institutional Chemical Hygiene Officer (ICHO)
- Provide general training
- Audit the departmental program periodically
- Provide safe working guidelines for laboratory workers
- Review the model Chemical Hygiene Plan, at least annually
- Inspect fume hoods & biological cabinets annually (Contracted Vendor)
- Maintain a complete inventory of hazardous chemicals for the facility
- Provide consultation for safe work practices for hazardous chemicals and how to obtain safety data sheets
- Conduct limited laboratory safety inspections annually
- Monitoring the use and disposal of chemicals in the laboratories
- Develop and maintain the Laboratory Safety Manual
- Provide consultation for emergency spill response and training
- Conduct exposure monitoring, as needed, ensuring OSHA PELs are not exceeded

Laboratory Worker

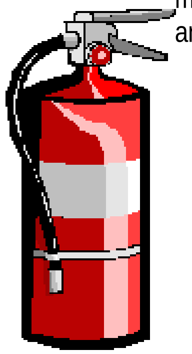
- Attend laboratory safety training
- Review the Chemical Hygiene Plan.
- Follow procedures and laboratory practices outlined in the Chemical Hygiene Plan and Laboratory Safety Manual and as provided by supervisors and principal investigators
- Use engineering controls and personal protective equipment, as appropriate
- Report all incidents, accidents, potential chemical exposures and near miss situations to the principal investigator and the Chemical Hygiene OfficerDocument specific operating procedures for work with particularly Hazardous Substances, including carcinogens, reproductive toxins and chemicals with high toxicity.

SECTION 2: Emergency Procedures

There are many types of emergencies that could occur in a laboratory, including fires, chemical spills, injuries, accidents, explosions, medical emergencies and others. For emergency assistance, dial University Police at 718-270-2626. Public Safety personnel will respond and determine the need for additional assistance.

FIRE PREVENTION

The most effective way of fighting a fire is by preventing the fire from starting in the first place. All staff members must make a concerted effort to neither create nor tolerate conditions that could cause or fuel a fire. Follow and enforce these rules:



- Patients, visitors, and employees must strictly observe the "No Smoking policy."
- Poor housekeeping breeds fire. Do not permit trash, paper, or dirt to accumulate. Any build up of trash should be reported to the Assistant Vice President of Ambulatory Care.
- Never try to repair electrical cords, plugs, appliances, or equipment yourself. Report defective wiring or equipment to your supervisor. Use of extension cords is PROHIBITED.
- Keep all stairwell doors closed at all times.
- Do not block corridors, exit doors, and/or stairwells with carts, portable equipment, or other obstructions.
- Be sure to report all fires to the Emergency Dispatcher 999-3333 or 911.
- Do not use elevators during a fire emergency. Use stairways only.
- Do not use space heaters.

Smoking Policy

Downstate Medical Center – Basic Science Building, is a non-smoking facility. Administration expects compliance from all staff, patients, and visitors regarding its rules and regulations governing smoking.

Employees Fire Instructions

Immediately Upon Discovering A Fire Or Smoke Condition, Cause An Alarm:

A-larm	-	Shout "Code Red" to alert co-workers. Go to the nearest pull station and pull on the lever, dial 718-270-2626 Identify yourself and give the operator the exact location of the fire, building, floor, room number, and your name.
R-escue/Remove	-	Rescue or assist anyone in immediate danger of fire or smoke.
C-ontain	-	Contain the fire by closing doors and windows. Close all doors and windows to confine the fire, smoke, heat or gases. Keep office doors closed.
E-xtinguish	-	Evacuate or Extinguish fire with appropriate extinguisher if possible. Remain calm and begin a full evacuation. The Fire Department will direct and assist in all room searches and the removal of all persons to the nearest fire exit.

If a fire extinguisher can be used to extinguish an incipient fire, remember to follow the PASS SYSTEM

1. Pull the pin
2. Aim the hose at the base of the fire
3. Squeeze the handle
4. Sweep side to side

FIRE RESPONSE PROCEDURES

Notification

Any employee discovering fire or the presence of heat and/or smoke must immediately sound the fire alarm. The alarm must be sounded regardless of the apparently insignificant stage of the fire. The visible fire may only be an external sign of a much larger hidden smoldering fire ready to burst into intense flame.

How to Sound the Interior Fire Alarm

Pull the lever all the way down and let go.

Remember the fire alarm must be pulled on sight of smoke or fire.

Evacuation

All evacuations will be directed by the Floor Wardens with the assistance of the Assistant Wardens. **The fire floor and the floor immediately above shall be evacuated immediately**. Evacuation shall be via the stairs, furthest away from the areas of immediate danger as directed by the Fire Warden.

Vertical Evacuation

- Employees, clients, and visitors are to move downward and out of the building.
- Fire Team members will escort ambulatory persons to the exits.
- **Elevators are not to be used for evacuation.**
- All employees and visitors are to move far enough from the building to prevent possible injury from fire and falling debris.

If You Hear The Fire Alarm Bells (You did not create the alarm)

Count the bells and determine the exact location of the alarm from the fire alarm code chart. If the fire is on your floor, on the floor below or above:

- Prepare to evacuate.
- Turn off gas and extinguish all open flames.
- Close all doors and windows where possible.
- Clear any obstruction in the aisles.
- Evacuate towards an exit staircase away from the alarmed zone or as directed by Fire Warden. (I.e. evacuate towards the west wing if the alarm is activated in the east wing.)

MEDICAL EMERGENCIES

In the event of any injury or illness where assistance is needed, contact Public Safety at 270-2626 or 911

CHEMICAL EXPOSURES

The following procedures should be followed in the event of chemical exposure. In all cases, the incident should be reported to your laboratory manager, supervisor or principal investigator, regardless of severity. Consult your department manager to determine whether or not a First Report of Accidental Injury or Occupational Illness form should be completed.

Chemicals on Skin or Clothing

- Immediately flush with water for no less than 15 minutes (except for Hydrofluoric Acid, Flammable Solids or >10% Phenol). For larger spills, the safety shower should be used.
- While rinsing, quickly remove all contaminated clothing or jewelry. Seconds count. Do not waste time because of modesty.
- Use caution when removing pullover shirts or sweaters to prevent contamination of the eyes.
- Check the Safety Data Sheet, then separate from other clothing. Leather garments or accessories cannot be decontaminated and SDS should be checked to determine if any delayed effects should be expected.
- Discard contaminated clothing or launder.

Do not use solvents to wash skin. They remove the natural protective oils from the skin and can cause irritation and inflammation. In some cases, washing with a solvent may facilitate absorption of a toxic chemical.

For **flammable solids** on skin, first brush off as much of the solid as possible, and then proceed as described above.

For **hydrofluoric acid**, rinse with water for 5 minutes and apply calcium gluconate gel, then get immediate medical attention. If no gel is available, rinse for 15 minutes and go immediately to University Hospital

For **phenol** concentrations more than 10%, flush with water for 15 minutes or until the affected area turns from white to pink. Apply polyethylene glycol, if available. Do not use ethanol. Proceed as described above.

<u>Chemicals in Eyes</u>

- Immediately flush eye(s) with water for at least fifteen minutes. The eyes must be forcibly held open to wash, and the eyeballs must be rotated so all surface area is rinsed. The use of an eye wash fountain is desirable so hands are free to hold the eyes open. If eyewash is not available, pour water on the eye, rinsing from the nose outward to avoid contamination of the unaffected eye.
- Remove contact lenses while rinsing. Do not lose time removing contact lenses before rinsing. Do not attempt to rinse and reinsert contact lenses.
- Seek medical attention regardless of the severity or apparent lack of severity. Explain carefully what chemicals were involved.

<u>Chemical Inhalation</u>

- Close containers, open windows or otherwise increase ventilation, and move to fresh air.
- If symptoms, such as headaches, nose or throat irritation, dizziness, or drowsiness persist, seek medical attention by calling Public Safety at 718-270-2626 or going to University Hospital. Explain carefully what chemicals were involved.
- Review the SDS to determine what health effects are expected, including delayed effects.

<u>Accidental Ingestion of Chemicals</u>

- Immediately go to University Hospital or contact the Poison Control Center at 800-222-1222 for instructions.
- Do not induce vomiting unless directed to do so by a health care provider.

<u>Accidental Injection of Chemicals</u>

- Wash the area with soap and water and seek medical attention, if necessary.

<u>REPORTING ACCIDENTS AND INJURIES</u>

All accidents, injuries, or near misses should be reported to your supervisor or Principal Investigator.

If a laboratory worker believes that he or she has been over-exposed to a chemical, the worker or supervisor should contact EHS at 718-221-5212, regardless of whether or not signs or symptoms are noted. EH&S will contact the individual and lab manager to conduct an incident investigation.

If an individual calls from home to report a work-related injury or illness, the information necessary to complete the first report should be obtained at that time. Individuals should be advised to call Employee Health for referrals to approved medical care. Complete a Chemical Overexposure form, regardless of whether or not signs or symptoms are noted. Copies of the form should be given to medical care providers.

Section 3: Chemical and Hazard Identification

Chemical manufacturers are required to perform an assessment of the physical and health hazards of the chemicals they produce. This information must be made available in two places: the chemical label and the safety data sheet (SDS). Thus, the information found on the original container label and the SDS may provide a great deal of information about the identity of the chemical constituents and their health and physical hazards.

<u>Labels</u>

The manufacturer's label should be kept intact. Do not intentionally deface or obscure the label or the hazard warnings. When a chemical is transferred from the original container into a secondary container for storage, the new container should be labeled with the name of the product, the chemical constituents and the primary hazard warnings.

<u>Material Safety Data Sheets</u>

All chemical manufacturers or distributors are required to conduct a hazard evaluation of their products and include the information on a safety data sheet (SDS). The manufacturer or distributor is required to provide an SDS with the initial shipment of their products. Any SDSs received by the laboratory must be maintained in a central location in the laboratory or the department. The Chemical Hygiene Plan outlines what to do with SDSs received by a particular laboratory.

SDSs are sometimes difficult to interpret. For more information about understanding and using a SDS, see Appendix A.

If an SDS is not on hand, check the Downstate web page for connections to on-line web source for SDSs (http://www.dolphinrtk.com/frame.asp). If the SDS cannot be found, contact the manufacturer or distributor at the number listed on the container label and request an SDS.

<u>On-line Chemical Information Resources</u>

The SDS sections are available on the SUNY Downstate Website. Directions on how to access this resource is available in Appendix A.

SECTION 4: Health Hazards of Chemicals

<u>Introduction</u>

The decisions you make concerning the use of chemicals in the laboratory should be based on an objective analysis of the hazards, rather than merely the perception of the risks involved. Once this has been accomplished, a reasonable means of controlling the hazards through experimental protocol, work practices, ventilation, use of to assess protective clothing, etc., can be determined.

In order to understand the hazards of a particular chemical, both the physical and health hazards of the chemical must be considered.

Before using any chemical, the safety data sheet (SDS) or other appropriate resource should be reviewed to determine what conditions of use might pose a hazard. Accidents with hazardous chemicals can happen quickly and may be quite severe. The key to prevention of these accidents is awareness. Once the hazards are known, the risk of an accident may be reduced significantly by using safe work practices.

Basic Toxicology

The health effects of hazardous chemicals are often less clear than the physical hazards. Data on the health effects of chemical exposure, especially from chronic exposure, are often incomplete. When discussing the health effects of chemicals, two terms are often used interchangeably - toxicity and hazard. However, the actual meanings of these words are quite different. Toxicity is an inherent property of a material, similar to its physical constants. It is the ability of a chemical substance to cause an undesirable effect in a biological system. The toxicity of a substance depends on three factors: its chemical and physical structure, the extent to which the substance is absorbed by the body and the body's ability to detoxify and remove the substance. Hazard is the likelihood that a material will exert its toxic effects under the conditions of use. Thus, with proper handling, highly toxic chemicals can be used safely. Conversely, less toxic chemicals can be extremely hazardous if handled improperly.

Risk = Toxicity X Exposure

The actual health risk of a chemical is a function of the toxicity and the actual exposure. No matter how toxic the material may be, there is littlerisk involved unless it enters the body. An assessment of the toxicity of the chemicals and the possible routes of entry will help determine protective measures should be taken.

ROUTES OF ENTRY

Skin and Eye Contact

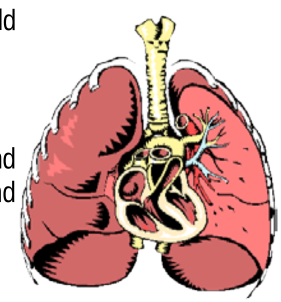
The simplest way for chemicals to enter the body is through direct contact with the skin or eyes. Skin contact with a chemical may result in a local reaction, such as a burn or rash, or absorption into the bloodstream. Absorption into the bloodstream may then allow the chemical to cause toxic effects on other parts of the body. The SDS usually includes information regarding whether or not skin absorption is a significant route of exposure.

The absorption of a chemical through intact skin is influenced by the health of the skin and the properties of the chemical. Skin that is dry or cracked or has lacerations offers less resistance. Fat-soluble substances, such as many organic solvents, can easily penetrate skin and, in some instances, can alter the skin's ability to resist absorption of other substances.

Wear gloves and other protective clothing to minimize skin exposure. See Personal Protective Equipment (PPE) for more information. Symptoms of skin exposure include dry, whitened skin, redness and swelling, rashes or blisters, and itching. In the event of chemical contact on skin, rinse the affected area with water for at least 15 minutes, removing clothing while rinsing, if necessary. Seek medical attention if symptoms persist.

Avoid use of solvents for washing skin. They remove the natural protective oils from the skin and can cause irritation and inflammation. In some cases, washing with a solvent may facilitate absorption of a toxic chemical.

Chemical contact with eyes can be particularly dangerous, resulting in painful injury or loss of sight. Wearing safety goggles or a face shield can reduce the risk of eye contact. Eyes that have been in contact with chemicals should be rinsed immediately with water continuously for at least 15 minutes. Contact lenses should be removed while rinsing. Medical attention is necessary if symptoms persist.



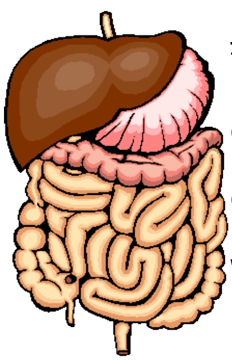
Inhalation

The respiratory tract is the most common route of entry for gases, vapors, particles, and aerosols (smoke, mists and fumes). These materials may be transported into the lungs and exert localized effects, or be absorbed into the bloodstream. Factors that influence the absorption of these materials may include the vapor pressure of the material, solubility, particle size, its concentration in the inhaled air, and the chemical properties of the material. The vapor pressure is an indicator of how quickly a substance evaporates into the air and how high the concentration in air can become – higher concentrations in air cause greater exposure in the lungs and greater absorption in the bloodstream.

Most chemicals have an odor that is perceptible at a certain concentration, referred to as the odor threshold; however, there is no relationship between odor and toxicity. There is considerable individual variability in the perception of odor. Olfactory fatigue may occur when exposed to high concentrations or after prolonged exposure to some substances. This may cause the odor to seem to diminish or disappear, while the danger of overexposure remains.

Symptoms of over-exposure may include headaches, increased mucus production, and eye, nose and throat irritation. Narcotic effects, including confusion, dizziness, drowsiness, or collapse, may result from exposure to some substances, particularly many solvents. In the event of exposure, close containers or otherwise increase ventilation, and move to fresh air. If symptoms persist, seek medical attention.

Volatile hazardous materials should be used in a well-ventilated area, preferably a fume hood, to reduce the potential of exposure. Occasionally, ventilation may not be adequate and a fume hood may not be practical, necessitating the use of a respirator. The Occupational Safety and Health Administration Respiratory Protection Standard regulate the use of respirators; thus, use of a respirator is subject to prior review by EH&S according to University policy. See Personal Protective Equipment for more information.



<u>Ingestion</u>

The gastrointestinal tract is another possible route of entry for toxic substances. Although direct ingestion of a laboratory chemical is unlikely, exposure may occur as a result of ingesting contaminated food or beverages, touching the mouth with contaminated fingers, or swallowing inhaled particles, which have been cleared from the respiratory system. The possibility of exposure by this route may be reduced by not eating, drinking, smoking, or storing food in the laboratory, and by washing hands thoroughly after working with chemicals, even when gloves were worn.

Direct ingestion may occur as a result of the outdated and dangerous practice of mouth pipetting. In the event of accidental ingestion, immediately go to University Hospital or contact the Poison Control Center, at 800-222-1222 for instructions. Do not induce vomiting unless directed to do so by a health care provider.

<u>Injection</u>

The final possible route of exposure to chemicals is by accidental injection. Injection effectively bypasses the protection provided by intact skin and provides direct access to the bloodstream, thus, to internal organ systems. Injection may occur through mishaps with syringe needles, when handling animals, or through accidents with pipettes, broken glassware or other sharp objects that have been contaminated with toxic substances.

If accidental injection has occurred, wash the area with soap and water and seek medical attention, if necessary. Cautious use of any sharp object is always important. Substituting cannulas for syringes and wearing gloves may also reduce the possibility of injection.

Toxic Effects of Chemical Exposure

How a chemical exposure affects a person depends on many factors. The dose is the amount of a chemical that actually enters the body. The actual dose that a person receives depends on the concentration of the chemical and the frequency and duration of the exposure. The sum of all routes of exposure must be considered when determining the dose.

In addition to the dose, the outcome of exposure is determined by (1) the way the chemical enters the body, (2) the physical properties of the chemical, and (3) the susceptibility of the individual receiving the dose.

Toxic Effects of Chemicals

A toxic chemical may cause local effects, systemic effects or both. Local injuries involve the area of the body in contact with the chemical caused by reactive or corrosive chemicals, such as strong acids, alkalis or oxidizing agents. Systemic injuries involve tissues or organs unrelated to or removed from the contact site when toxins have been transported through the bloodstream. For example, methanol that has been ingested may cause blindness, while a significant skin exposure to nitrobenzene may affect the central nervous system.

Certain chemicals may affect a target organ. For example, lead primarily affects the central nervous system, kidney and red blood cells; isocyanates may induce an allergic reaction (immune system); and chloroform may cause tumors in the liver and kidneys.

It is important to distinguish between acute and chronic exposure and toxicity. Acute toxicity results from a single, short exposure or a few short exposures, usually occurring within the same 24 hour period. Effects usually appear quickly and are often reversible. Chronic toxicity results from repeated exposure over a long period of time. Effects are usually delayed and gradual, and may be irreversible. For example, the acute effect of alcohol exposure (ingestion) is intoxication, while the chronic effect is cirrhosis of the liver. Acute and chronic effects are distinguished in the SDS, usually with more information about acute exposures than chronic.

Relatively few chemicals have been evaluated for chronic effects, given the complexity of that type of study. Chronic exposure may have very different effects than acute exposure. Usually, studies of chronic exposure evaluate its cancer causing potential or other long-term health problems.

Evaluating Toxicity Data

Most estimates of human toxicity are based on animal studies, which may or may not relate to human toxicity. In most animal studies, the effect measured is usually death. This measure of toxicity is often expressed as an LD_{50} (lethal dose 50) – the dose required to kill 50% of the test population. The LD_{50} is usually measured in milligrams of the material per kilogram of body weight of the test animal. The concentration in air that kills half of the population is the LC_{50}.

To estimate a lethal dose for a human based on animal tests, the LD_{50} must be multiplied by the weight of an average person. Using this method, it is evident that just a few drops of a highly toxic substance, such as dioxin, may be lethal, while much larger quantities of a slightly toxic substance, such as acetone, would be necessary for the same effect.

Susceptibility of Individuals

Factors that influence the susceptibility of an individual to the effects of toxic substances include nutritional habits, physical condition, obesity, medical conditions, drinking and smoking, and pregnancy. Due to individual variation and uncertainties in estimating human health hazards, it is difficult to determine a dose of a chemical that is totally risk-free.

Regular exposure to some substances can lead to the development of an allergic rash, breathing difficulty, or other reactions. This phenomenon is referred to as sensitization. Over time, these effects may occur with exposure to smaller and smaller amounts of the chemical, but will disappear soon after the exposure stops. For reasons not fully understood, not everyone exposed to a sensitizer will experience this reaction. Examples of sensitizers include epoxy resins, nickel salts, isocyanates and formaldehyde.

Particularly Hazardous Substances

The OSHA Laboratory Standard defines a particularly hazardous substance as "select carcinogens", reproductive toxins, and substances that have a high degree of acute toxicity. Further information about working with Particularly Hazardous Substances is outlined in Particularly Hazardous Substances.

Where To Find Toxicity Information

Toxicity information may be found in SDSs, under the "Health Hazard Data" section, on product labels, and in the Registry of Toxic Effects of Chemical Substances (RTECS).

SECTION 5: Controlling Chemical Exposures

Chemical Exposure Determination

OSHA establishes exposure limits for several hundred substances. Laboratory workers must not be exposed to substances in excess of the permissible exposure limits (PEL) specified in OSHA Subpart Z, Toxic and Hazardous Substances. PELs refer to airborne concentrations of substances averaged over an eight-hour day. Some substances also have "action levels" below the PEL requiring certain actions such as medical surveillance or routine air sampling.

The SDS for a particular substance indicates whether any of the chemicals are regulated through OSHA and, if so, the permissible exposure limit(s) for the regulated chemical(s). This information is also available in the OSHA Table Z list of regulated chemicals.

Exposure Monitoring

Exposure monitoring must be conducted if there is reason to believe that exposure levels for a particular substance may routinely exceed either the action level or the PEL. EH&S and the principal investigator or supervisor may use professional judgment, based on the information available about the hazards of the substance and the available control measures, to determine whether exposure monitoring must be conducted.

When necessary, exposure monitoring is conducted by EH&S according to established industrial hygiene practices. Results of the monitoring are made available to the individual monitored, his or her supervisor, and the Departmental Chemical Hygiene Officer within 15 working days of the receipt of analytical results.

Based on the monitoring results, periodic air sampling may be scheduled at the discretion of EH&S, in accordance with applicable federal, State and local regulations.

EHS maintains records of all exposure-monitoring results. Departmental Chemical Hygiene Officers should keep records of monitoring conducted for their department operations.

General Principles

There are three general methods for controlling one's exposure to hazardous substances:

- Personal Protective Equipment

- Work Practices and Administrative Controls
- Engineering Controls

In the laboratory, these methods or a combination of them can be used to keep exposure below permissible exposure limits.

Personal Protective Equipment

When engineering controls are not sufficient to minimize exposure, personal protective equipment, including gloves, eye protection, respirators and other protective clothing should be used. See Personal Protective Equipment for more information.

Work Practice and Administrative Controls

Using good laboratory work practices, such as those outlined in this manual, help to reduce the risk of exposure to chemicals.

Administrative controls involve rotating job assignments and adjusting work schedules so that workers are not overexposed to a chemical. Given the nature of work in a research laboratory, administrative controls are not usually a realistic approach to controlling exposure.

Engineering Controls

Engineering controls include the following:

- Substitution of a less toxic material
- Change in process to minimize contact with hazardous chemicals
- Isolation or enclosure of a process or operation
- Use of wet methods to reduce generation of dusts or other particulates
- General dilution ventilation
- Local exhaust, including the use of fume hoods

The use of engineering controls is the preferred method for reducing worker exposure to hazardous chemicals, but with the exception of chemical fume hoods, may not be feasible in the laboratory.

Fume Hoods and Laboratory Ventilation

One of the primary safety devices in a laboratory is a chemical fume hood. A well-designed hood, when properly installed and maintained, can offer a substantial degree of protection to the user, provided that it is used appropriately and its limitations are understood.

This section covers a number of topics aimed at helping laboratory workers understand the limitations and proper work practices for using fume hoods and other local ventilation devices safely.

Hood Face Velocity

Based on a number of studies and the recommendations of several laboratory safety guidance documents, the following face velocity criteria are recommended:

- Above 150 feet per minute (fpm): Unacceptable for laboratory use.
- 95-125 fpm: Provides adequate control of inhalation exposure to most hazardous substances, including radioactive materials and particularly hazardous substances.
- 80-95 and 125-150 fpm: Adequate for manipulation of laboratory quantities of hazardous materials except radioactive materials and particularly hazardous substances.

Using Chemical Fume Hoods

A fume hood is used to control exposure of the hood user and lab occupants to hazardous or odorous chemicals and prevent their release into the laboratory. A secondary purpose is to limit the effects of a spill by partially enclosing the work area and drawing air into the enclosure by means of an exhaust fan. This inward flow of air creates a dynamic barrier that minimizes the movement of material out of the hood and into the lab.

In a well-designed, properly functioning fume hood, only about 0.0001% to 0.001% of the material released into the air within the hood actually escapes from the hood and enters the laboratory.

<u>When is a Fume Hood Necessary?</u>
The determination that a fume hood is necessary for a particular experiment should be based on a hazard analysis of the planned work. Such an analysis should include:

- A review of the physical characteristics, quantity and toxicity of the materials to be used - hoods should always be used when handling large quantities of hazardous chemicals (over 500 milliliters of liquid or 30 grams of a solid);
- The experimental procedure;
- The volatility of the materials present during the experiment;
- The probability of their release;
- The number and sophistication of manipulations; and
- The skill and expertise of the individual performing the work.

<u>Good Work Practices</u>
The level of protection provided by a fume hood is affected by the manner in which the fume hood is used. No fume hood, however well designed, can provide adequate containment unless good laboratory practices are used, as follows:

- Adequate planning and preparation are key. The hood user should know the Standard Operating Configuration (SOC) of the hood and should design experiments so that the SOC can be maintained whenever hazardous materials might be released. The SOC refers to the position of the sash. A schematic drawing of the SOC is displayed on the front of each chemical fume hood.
- Before using the hood, the hood user should check the hood survey sticker to determine if the face velocity is adequate for the particular use of a hood. For work with hazardous materials, the fume hood should have a face velocity of 95 - 125 feet per minute at a sash height that is adequate for the procedure.
- The hood user should also check the magnehelic gauge or other hood performance indicator and compare its reading to the reading indicated on the hood survey sticker. If the reading differs significantly (15% or more for a magnehelic gauge) from that on the sticker, the hood may not be operating properly.
- All improperly functioning fume hoods should be reported to the laboratory supervisor. Contact the ICHO.
- Chemicals or equipment in hoods must not block vents
- Hoods must not be used as a method of disposal by venting hazardous waste
- Hoods should be closed when not in use. Keep the sash down as far as possible during use to improve the overall performance of the hood. If chemicals remain in the hood after use, they should be placed in the rear of the hood and the fan must be left on
- Reduce turbulence in and around the hood by closing nearby doors and windows when possible, opening and closing the sash slowly and smoothly, and by avoiding rapid movements inside the hood
- Connect electrical equipment to outlets outside the hood when possible. In the event of an emergency, one can disconnect equipment without creating a spark inside the hood
- Was the hood work platform as often as necessary to maintain a clean, dry surface

Items contaminated with odorous or hazardous materials should be removed from the hood only after decontamination or if placed in a closed outer container to avoid releasing contaminants into the laboratory air.

DO NOT USE A HOOD FOR ANY FUNCTION FOR WHICH IT WAS NOT INTENDED. Certain chemicals or reactions require specially constructed hoods.Examples are perchloric acid or high-pressure reactions. Most special use hoods are labeled with the uses for which they are designed.

Common Misuses and Limitations

Used appropriately, a fume hood can be a very effective device for containment hazardous materials, as well as providing some protection from splashes and minor explosions. Even so, the average fume hood does have several limitations.

- Particulates: A fume hood is not designed to contain high velocity releases of particulate contaminants unless the sash is fully closed.
- Pressurized systems: Gases or vapors escaping from pressurized systems may move at sufficient velocity to escape from the fume hood.
- Explosions: The hood is not capable of containing explosions, even when the sash is fully closed. If an explosion hazard exists, the user should provide anchored barriers, shields or enclosures of sufficient strength to deflect or contain it. Such barriers can significantly affect the airflow in the hood.
- Perchloric Acid: A conventional fume hood must not be used for perchloric acid. Perchloric acid vapors can settle on ductwork, resulting in the deposition of perchlorate crystals. Perchlorates can accumulate on surfaces and have been known to detonate on contact, causing serious injury to researchers and maintenance personnel. Specialized perchloric acid hoods, made of stainless steel and equipped with a washdown system must be used for such work.
- Air Foil Sills: Many fume hoods are equipped with flat or rounded sills or air foils which direct the flow of air smoothly across the work surface. Sills should not be removed or modified by the hood user. Objects should never be placed on these sills. Materials released from containers placed on the sills may not be adequately captured. In addition, an object on the sill may prevent the quick and complete closure of the sash in an emergency.
- Spill Containment Lips: Most modern fume hoods have recessed work surfaces or spill containment lips to help contain minor liquid spills. In many cases, these lips are several inches wide. Containers of liquids should not be placed on the hood lip.
- Horizontal Sliding Sashes: The hood user should never remove sliding sashes. Horizontal sash hoods are designed and balanced with no more than half the face open at any time. Removal of sashes may reduce the face velocity below acceptable levels.
- Tubing for Exhaust: Tubing is frequently used to channel exhaust to the hood from equipment located some distance away. This is not an effective control method.
- Connections to the Exhaust System: Occasionally, a researcher may need local exhaust ventilation other than that provided by an existing fume hood. A new device may not be connected to an existing fume hood without the explicit approval of the department's facilities manager or Special Facilities supervisor. Adding devices to even the simplest exhaust system without adequate evaluation and adjustment will usually result in decreased performance of the existing hood and/or inadequate performance of the additional device.
- Microorganisms: Work involving harmful microorganisms should be done in a biosafety cabinet, rather than a chemical fume hood. See the Biosafety Manual for more information.
- Highly Hazardous Substances: A well designed fume hood will contain 0.999 - 0.9999% of the contaminants released within it when used properly. When working with highly dangerous substances needing more containment than a fume hood offers, consider using a glove box.
- Pollution Control: An unfiltered fume hood is not a pollution control device. All contaminants that are removed by the ventilating system are released directly into the atmosphere. Apparatus used in hoods should be fitted with condensers, traps or scrubbers to contain and collect waste solvents or toxic vapors or dusts.
- Waste Disposal: A fume hood should not be used for waste disposal. It is a violation of environmental regulations to intentionally send waste up the hood stack. As described above, the hood is not a pollution control device.

The Fume Hood as a Storage Device

Fume hoods are designed specifically to provide ventilation for the protection of lab occupants during chemical manipulations. The airflow they provide is greatly in excess of that needed for storage of closed containers of even the most toxic of volatile materials. Storing materials in this way is, therefore, a misuse of an expensive piece of equipment.

In general, the storage of chemicals in fume hoods is strongly discouraged. See Flammable Materials for more information about proper storage of flammable, toxic, or odorous chemicals.

The realities of available space and equipment in some laboratories may make it difficult or impossible to completely prohibit the use of hood workspaces for storage. In such a case, the following general policy is recommended:

Hoods Actively in Use for Experimentation

Storage of materials should be minimized or eliminated altogether. Materials stored in the hood can adversely affect the containment provided. In addition, the hood is frequently the focus of the most hazardous activities conducted in the laboratory. The presence of stored flammables or volatiles, highly toxic materials can only exacerbate the problems resulting from an explosion or fire in the hood. Even if they are not directly involved in such an event, attempts to control or extinguish a fire may result in the spilling of stored materials.

Hoods Not in Active Use

Materials requiring ventilated storage (e.g., volatile and highly toxic, or odorous substances) may be stored in a hood if they are properly segregated and the hood is posted to prohibit its use for experimental work.

Hood Survey Sticker

Every chemical fume hood on campus should have a survey sticker affixed to the front of the hood in a conspicuous location. The sticker contains basic information about hood performance as of the most recent survey and should be consulted each time the hood is used.

The EH&S Hood Number is a unique identifier for the particular hood. Refer to this number when discussing problems with a particular hood.

The Average Face Velocity is the average velocity with the hood sash in the Standard Operating Configuration (SOC).

The Opening for 100 fpm face velocity is the sash height, in inches, to which the sash must be lowered in order for the hood to achieve 100 fpm face velocity.

The Inspected on date is the date of the last hood survey. Hoods that have not been inspected within the past year should not be used until tested by the contracted vendor or contact EH&S.

If hood performance is judged to be unsuitable for use with hazardous chemicals, a sticker with this information is placed on the hood instead of the survey sticker.

Do not use a hood that has no vendor sticker. If a survey is needed, call EH&S at 221-5212 or x3389.

EVALUATION AND MAINTENANCE PROGRAM

Hood Surveys
EH&S has contracted a vendor to conduct inspection each fume hood annually. The face velocity of the fume hood is measured with the sash in the Standard Operating Configuration (SOC) and this measurement, as well as the reading of the continuous monitoring device, is recorded on the hood sticker. A smoke test is done to further evaluate the containment of the hood.

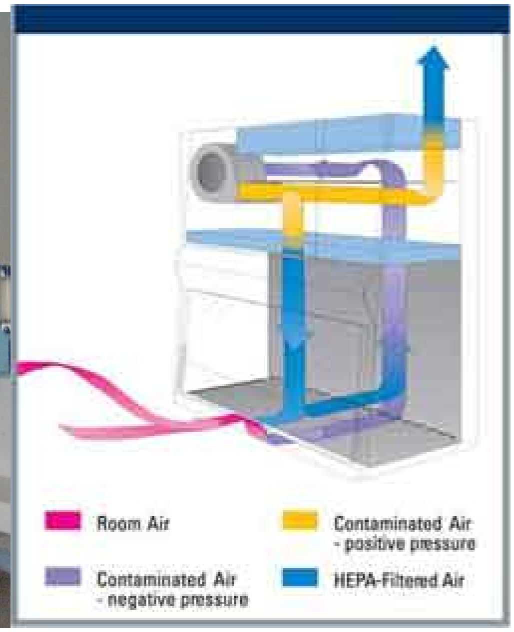
After each performance survey, a written report of the results is furnished to the individual responsible for the hood (e.g., the Principal Investigator or laboratory manager), the Laboratory Safety Officer for the department, and the Office of Environmental Health & Safety.

Glove Box
There are two general types of glove boxes, one operating under negative pressure, and the other operating under positive pressure. Glove boxes consist of a small chamber with sealed openings fitted with arm-length gloves. The materials are placed inside the chamber and manipulated using the gloves.

A glove box operating under negative pressure is used for highly toxic gases, when a fume hood might not offer adequate protection. A rule of thumb is that a fume hood will offer protection for up to 10,000 times the immediately hazardous concentration of a chemical.

The airflow through the box is relatively low, and the exhaust usually must be filtered or scrubbed before release into the exhaust system. A glove box operating under positive pressure may be used for experiments that require protection from moisture or oxygen. If this type of glove box is to be used with hazardous chemicals, the glove box must be tested for leaks before each use. A pressure gauge should be installed to be able to check the integrity of the system.

Biosafety Cabinets
A conventional fume hood should not be used for work with viable biological agents. A biosafety cabinet is specially designed and constructed to offer protection to both the worker and the biological materials.



Similarly, a biosafety cabinet should generally not be used for work with hazardous chemicals. Most biosafety cabinets exhaust the contaminated air through high efficiency particulate air (HEPA) filters back into the laboratory. This type of filter will not contain most hazardous materials, particularly gases, fumes or vapors. Even when connected to the building exhaust system, a ducted biosafety cabinet may not achieve a face velocity of 95 - 125 feet per minute, making it inappropriate for use with hazardous chemicals.

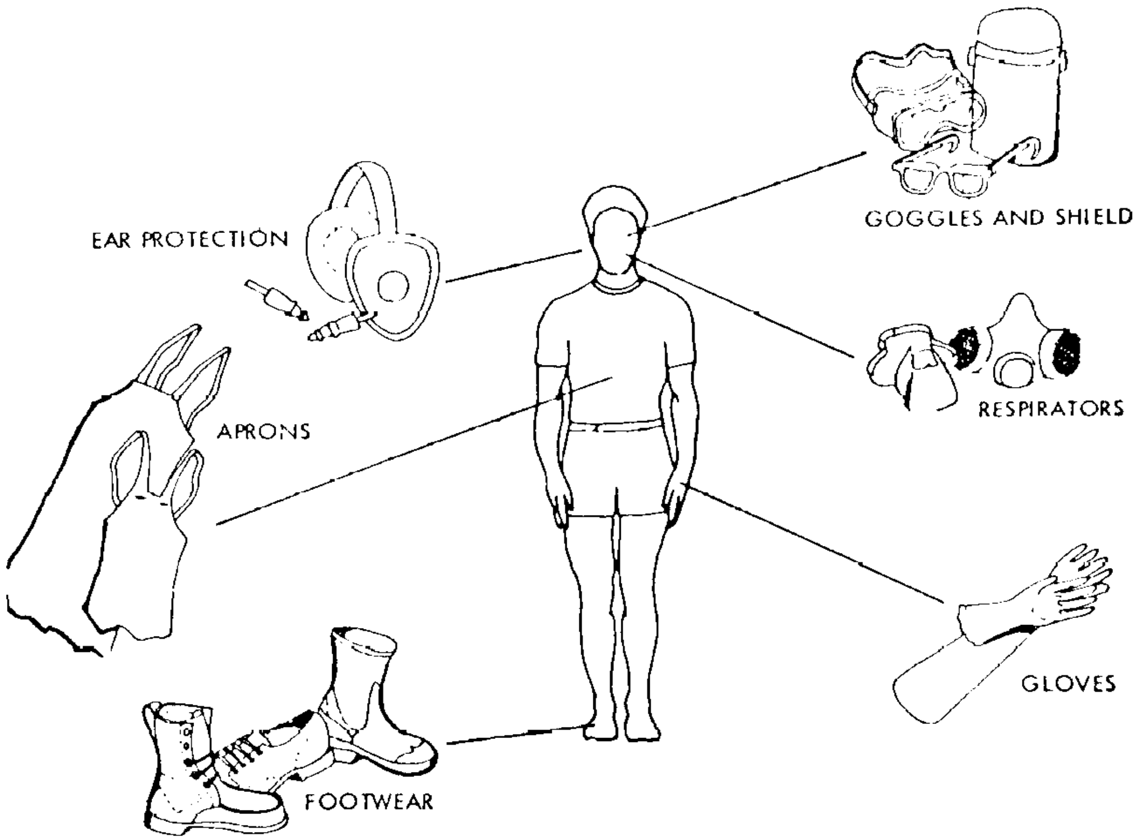
<u>Biological Safety Cabinet Certifications:</u>
All biological safety cabinets must be certified to ensure proper operation. Certification is recommended:

- Before a cabinet is put into service
- After a cabinet has been repaired or relocated
- After a filter has been replaced
- At least annually

SECTION 6: Controlling Chemical Exposure

Personal Protective Equipment

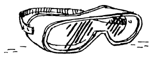
Personal protective equipment (PPE) is special gear used to protect the wearer from specific hazards of a hazardous substance. It is a last resort protection system, to be used when substitution or engineering controls are not feasible. PPE does not reduce or eliminate the hazard, protects only the wearer, and does not protect anyone else.



PPE includes gloves, respiratory protection, eye protection, and protective clothing. The need for PPE is dependent upon the type of operations and the nature and quantity of the materials in use, and must be assessed on a case-by-case basis. Workers who rely on PPE must understand the functioning, proper use, and limitations of the PPE used. All clothing and equipment must meet standards set by the American National Standards Institute (ANSI). All respiratory protective equipment must be chosen in conjunction with EH&S to ensure compliance with legal requirements concerning the use and distribution of these devices.

EYE PROTECTION

Safety Glasses



Safety glasses look very much like normal glasses buy have lenses that are impact resistant and frames that are far stronger than standard street-wear glasses. Safety glasses must have side shields and should be worn whenever there is the possibility of objects striking the eye, such as particles, glass, or metal shards. Many potential eye injuries have been avoided by wearing safety glasses.

Standard street-wear eyeglasses fitted with side shields are not sufficient. Safety glasses come in a variety of styles to provide the best fit and comfort, including some designed to fit over prescription glasses.

Safety glasses do not provide adequate protection from significant chemical splashes. They do not seal to the face, resulting in gaps at the top, bottom and sides, where chemicals may seep through (see Anecdotes for an actual incident where this occurred). Safety glasses may be adequate when the potential splash is minimal, such as when opening eppendorf tubes.

Safety glasses are also not appropriate for dusts and powders, which can get by the glasses in ways similar to those described above. Safety goggles are best used for this type of potential exposure.

Chemical Splash Goggles

Chemical Splash Goggles should be worn when there is potential for splash from a hazardous material. Like safety glasses, goggles are impact resistant. Chemical splash goggles should have indirect ventilation so hazardous substances cannot drain into the eye area. Some may be worn over prescription glasses. Goggles come in a variety of styles for maximum comfort and splash protection. Visorgogs are a hybrid of a goggle and safety glasses. They offer more splash protection than safety glasses, but not as much as goggles. They fit close to the face, but do not seal at the bottom as goggles do.

Face Shields

Face shields are in order when working with large volumes of hazardous materials, either for protection from splash to the face or flying particles. Face shields must be used in conjunction with safety glasses or goggles. A few incidents where a face shield would have prevented injury are described in Anecdotes.

Contact Lenses

Contact lenses may be worn in the laboratory, but do not offer any protection from chemical contact. If a contact lens becomes contaminated with a hazardous chemical, rinse the eye(s) using eyewash and remove the lens immediately. Contact lenses that have been contaminated with a chemical must be discarded.

PROTECTIVE CLOTHING & FOOTWEAR

Protective Clothing

When the possibility of chemical contamination exists, protective clothing that resists physical and chemical hazards should be worn over street clothes. Lab coats are appropriate for minor chemical splashes and spills, while plastic or rubber aprons are best for protection from corrosive or irritating liquids. Disposable outer garments (i.e., Tyvek suits) may be useful when cleaning and decontamination of reusable clothing is difficult. Lab supervisors and directors are responsible for setting requirements for their use.

Loose clothing (such as overlarge lab coats or ties), skimpy clothing (such as shorts), torn clothing and unrestrained hair may pose a hazard in the laboratory.

Footwear

Shoes should be worn at all times in buildings where chemicals are stored or used. Perforated shoes, sandals or cloth sneakers should not be worn in laboratories or where mechanical work is conducted. Such shoes offer no barrier between the laboratory worker and chemicals or broken glass.

Chemical resistant overshoes or boots may be used to avoid possible exposure to corrosive chemical or large quantities of solvents or water that might penetrate normal footwear (e.g., during spill cleanup). Leather shoes tend to absorb chemicals and may have to be discarded if contaminated with a hazardous material.

Although generally not required in most laboratories, steel-toed safety shoes may be necessary when there is a risk of heavy objects falling or rolling onto the feet, such as in bottle-washing operations or animal care facilities.

Gloves

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 also absorption through the skin can be a significant route of exposure to certain chemicals. Dimethyl sulfoxide (DMSO), nitrobenzene, and many solvents are examples of chemicals that can be readily absorbed through the skin into the bloodstream, where the chemical may cause harmful effects.

When Should Gloves Be Worn

Protective gloves should be worn when handling hazardous materials, chemicals of unknown toxicity, corrosive materials, rough or sharp-edged objects, and very hot or very cold materials. When handling chemicals in a laboratory, disposable latex, vinyl or nitrile examination gloves are usually appropriate for most circumstances. These gloves will offer protection from incidental splashes or contact.

When working with chemicals with high acute toxicity, working with corrosives in high concentrations, handling chemicals for extended periods of time or immersing all or part of a hand into a chemical, the appropriate glove material should be selected, based on chemical compatibility.

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. Resistance to 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 conditions in the work environment. 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.

The following table includes major glove types and their general uses. This list is not exhaustive. Before you begin every laboratory worker should observe the following rules:

- Know the potential hazards and appropriate safety precautions before beginning work. Ask and be able to answer the following questions:
    - What are the hazards?
    - What are the worst things that could happen?
    - What do I need to do to be prepared?
    - What work practices, facilities or personal protective equipment are needed to minimize the risk?
- Know the location and how to use emergency equipment, including safety showers and eyewash stations.
- Familiarize yourself with the emergency response procedures, facility alarms and building evacuation routes.
- Know the types of personal protective equipment available and how to use them for each procedure.
- Be alert to unsafe conditions and actions and bring them to the attention of your supervisor or lab manager immediately so that corrections can be made as soon as possible.
- Prevent pollution by following waste disposal procedures. Chemical reactions may require traps or scrubbing devices to prevent the release of toxic substances to the laboratory or to the environment.
- Position and clamp reaction apparatus thoughtfully in order to permit manipulation without the need to move the apparatus until the entire reaction is completed. Combine reagents in the appropriate order and avoid adding solids to hot liquids.

Glove Material	General Uses
Butyl	Offers the highest resistance to permeation by most gases and water vapor. Especially suitable for use with esters and ketones.
Neoprene	Provides moderate abrasion resistance but good tensile strength and heat resistance. Compatible with many acids, caustics and oils.
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.
PVC	Provides excellent abrasion resistance and protection from most fats, acids, and petroleum hydrocarbons.
PVA	Highly impermeable to gases. Excellent protection from aromatic and chlorinated solvents. Cannot be used in water or water-based solutions.
Viton	Exceptional resistance to chlorinated and aromatic solvents. Good resistance to cuts and abrasions.
Silver Shield	Resists a wide variety of toxic and hazardous chemicals. Provides the highest level of overall chemical resistance.

Where to Find Compatibility Information

Most glove manufacturers have chemical compatibility charts available for their gloves. These charts may be found in laboratory safety supply catalogs such as Fisher Scientific and Lab Safety Supply. Best Gloves offers copies of their glove compatibility charts upon request. To obtain a copy, call them directly at 800-241-0323.

Most safety data sheets (SDS) recommend the most protective glove material in their Protective Equipment section. There are SDSs for many laboratory chemicals available on the web through the Downstate Medical Center home page (http://www.dolphinrtk.com/frame.asp) found on the Administration tab under "Intranet."

Other Considerations

There are several factors besides glove material to consider when selecting the appropriate glove. The amount of dexterity needed to perform a particular manipulation must be weighed against the glove material recommended for maximum chemical resistance. In some cases, particularly when working with delicate objects where fine dexterity is crucial, a bulky glove may actually be more of a hazard.

Glove thickness, usually measured in mils or gauge, is another consideration. A 10-gauge glove is equivalent to 10 mils or 0.01 inches. Thinner, lighter gloves offer better touch sensitivity and flexibility, but may provide shorter breakthrough times. Generally, doubling the thickness of the glove quadruples the breakthrough time.

Glove length should be chosen based on the depth to which the arm will be immersed or where chemical splash is likely. Gloves longer than 14 inches provide extra protection against splash or immersion.

Glove size may also be important. One size does not fit all. Gloves, which are too tight tend to cause fatigue, while gloves which are too loose will have loose finger ends which make work more difficult. The circumference of the hand, measured in inches, is roughly equivalent to the reported glove size. Glove color, cuff design, and lining should also be considered for some tasks.

Glove Inspection, Use and Care

All gloves should be inspected for signs of degradation or puncture before use. Test for pinholes by blowing or trapping air inside and rolling them out. Do not fill them with water, as this makes the gloves uncomfortable and may make it more difficult to detect a leak when wearing the glove.

Disposable gloves should be changed when there is any sign of contamination. Reusable gloves should be washed frequently if used for an extended period of time.

While wearing gloves, be careful not to handle anything but the materials involved in the procedure. Touching equipment, phones, wastebaskets or other surfaces may cause contamination. Be aware of touching the face, hair, and clothing as well.

Before removing them, wash the outside of the glove. To avoid accidental skin exposure, remove the first glove by grasping the cuff and peeling the glove off the hand so that the glove is inside out. Repeat this process with the second hand, touching the inside of the glove cuff, rather than the outside. Wash hands immediately with soap and water.

Follow the manufacturer's instructions for washing and caring for reusable gloves.

Latex Gloves and Related Allergies

Allergic reactions to natural rubber latex have been increasing since 1987, when the Centers for Disease Control recommended the use of universal precautions to protect against potentially infectious materials, bloodborne pathogens and HIV. Increased glove demand also resulted in higher levels of allergens due to changes in the manufacturing process. In addition to skin contact with the latex allergens, inhalation is another potential route of exposure. Latex proteins may be released into the air along with the powders used to lubricate the interior of the glove.

In June 1997, the National Institute of Occupational Safety and Health (NIOSH) issued an alert Preventing Allergic Reactions to Latex in the Workplace (publication number DHHS (NIOSH) 97-135).

Latex exposure symptoms include skin rash and inflammation, respiratory irritation, asthma and shock. The amount of exposure needed to sensitize an individual to natural rubber latex is not known, but when exposures are reduced, sensitization decreases.

NIOSH recommends the following actions to reduce exposure to latex:

- Whenever possible, substitute another glove material.
- If latex gloves must be used, choose reduced-protein, powder-free latex gloves.
- Wash hands with mild soap and water after removing latex gloves.

Respiratory Protection

A respirator may only be used when engineering controls, such as general ventilation or a fume hood, are not feasible or do not reduce the exposure of a chemical to acceptable levels. Since the use of a respirator is regulated by the OSHA Respiratory Protection Standard, respirator use at SUNY is subject to prior review by EH&S, according to university policy.

Any worker who believes that respiratory protection is needed must notify EH&S for evaluation of the hazard. This program involves procedures for respirator selection, medical assessment of employee health, employee training, proper fitting, respirator inspection and maintenance, and record-keeping.

CHEMICAL STORAGE

Many local, State and federal regulations have specific requirements that affect the handling and storage of chemicals in laboratories.

General Considerations

In general, store materials and equipment in cabinets and on shelving provided for such storage.

- Avoid storing materials and equipment on top of cabinets. If you must place things there, however, you must maintain a clearance of at least 18 inches from the sprinkler heads or (if no sprinkler heads are present) 24 inches from the ceiling.
- Be sure that the weight of the chemicals does not exceed the load capacity of the shelf or cabinet. Some incidents where shelving or a cabinet collapsed due to overload are described in Anecdotes.
- Wall-mounted shelving must have heavy-duty brackets and standards. This type of shelving is not recommended for chemical storage.
- Cabinets for chemical storage must be of solid, sturdy construction, preferably hardwood or metal.
- Do not store materials on top of high cabinets where they will be hard to see or reach.
- Do not store corrosive liquids above eye level.
- Provide a specific storage location for each type of chemical, and return the chemicals to those locations after each use.
- Avoid storing chemicals in the workspace within a laboratory hood, except for those chemicals currently in use.
- If a chemical does not require a ventilated cabinet, store it inside a closable cabinet or on a shelf that has a lip to prevent containers from sliding off in the event of an accident or fire.
- Do not expose chemicals to heat or direct sunlight.
- Observe all precautions regarding the storage of incompatible chemicals.
- Use corrosion resistant storage trays or secondary containers to collect materials if the primary container breaks or leaks.
- Distinguish between refrigerators used for chemical storage and refrigerators used for food storage. Each refrigerator should be labeled "No Food" or "Food Only". Labels are available from EH&S by calling 718-221-5212
- Do not store flammable liquids in a refrigerator unless it is approved for such storage. Such refrigerators are designed with non-sparking components to avoid an explosion.
- Chemical storage cabinets located outside the laboratory (e.g., in hallways) should be labeled with the name of the laboratory group that owns and uses it.

Segregation of Chemicals

Incompatible chemicals should not be stored together. Storing chemicals alphabetically, without regard to compatibility, can increase the risk of a hazardous reaction, especially in the event of container breakage.

Use common sense when setting up chemical storage. Segregation that disrupts normal workflow can increase the potential for spills.

There are several possible storage plans for segregation. In general, dry reagents, liquids and compressed gases should be stored separately, then by hazard class, then alphabetically (if desired).

Segregate dry reagents as follows:

- Oxidizing salts
- Flammable solids

- Water-reactive solids
- All other solids

Segregate liquids as follows:
- Acids -Separate mineral acids (hydrochloric, sulfuric) from organic acids (picric, acetic)
- Bases
- Oxidizers
- Perchlorates
- Flammable or combustible liquids
- All other liquids

Segregate compressed gases as follows:
- Toxic gases
- Flammable gases
- Oxidizing and inert gases

Chemical Incompatibility Chart
Mixing these chemicals purposely or as a result of a spill can result in heat, fire, explosion, and/or toxic gases. This is a partial list.

Acetic Acid	Chromic Acid, nitric acid, hydroxyl-containing 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.
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 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	Acetylene, alkali metals, ammonia, fulminic acid, nitric acid with ethanol, hydrogen, oxalic acid.
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 (organic)	Acid (inorganic or organic). Also avoid friction and store cold.
Phosphorus (white)	Air, oxygen.
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.

Flammable Liquids

Flammable liquids require special storage considerations:

- The quantity of flammable liquids allowed in a lab is determined by the FDNY lab type. Limits range from 5 to 30 gallons for labs built prior to 2008. Labs constructed to comply with the 2008 fire code must store all flammables in flammable storage cabinets. For these labs, the quantity depends on lab type and square footage of the lab.
- Never store flammable liquids on the floor or other areas that create a spill hazard.
- Do not store flammable materials in a refrigerator unless it is explosion proof.
- An emergency spill kit for flammable liquids shall be available nearby.

Oxidizers

- Oxidizers must be stored away from incompatible materials such as:
  - Flammable and combustible materials
  - Greases
  - Paper trash bins
  - Finely divided metals
  - Organic liquids

- Nitric acid, sulfuric acid, and perchloric acid shall be stored separately from organic acids in rooms, cabinets, or break-resistant containers and placed in acidic-resistant trays.

  Strong oxidizing agents shall be stored and used in glass or other inert containers. Corks and rubber stoppers shall not be used. High energy oxidizers shall be segregated.

Acids

Mineral acids, including phosphoric, hydrochloric, nitric, sulfuric, and perchloric acid can be stored in a cabinet designed for Corrosive Acids. These non-metallic cabinets have no internal metallic parts, acid resistant coating and a cabinet floor constructed to be able to contain spillage. Volatile acids, such as nitric or sulfuric 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. 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, plastic trays, tubs or buckets work well to keep different acids apart 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.

Toxics

- Extremely toxic substances must be stored in unbreakable chemically resistant secondary containers.
- These chemicals include corrosives, dehydrating agents, carcinogens, allergic sensitizers, and reproductive hazards. They also include chemicals known to affect the nervous system.
- Adequate ventilation shall be provided in storage areas especially for toxics that have a high vapor pressure.
- All dispensing of these materials shall be conducted in a fume hood.

Unstable Chemicals

Ethers and some ketones and olefins may form peroxides when exposed to air or light. Since they may have been packaged in an air atmosphere, peroxides can form even if the container has not been opened.

Some 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.

For any potentially unstable chemical:

- On the label, write the date the container was received and the date it was opened
- Discard containers within 6 months of opening them
- Discard unopened containers after one year, unless an inhibitor was added

More information about unstable chemicals is available in Peroxide Forming Compounds and Reactives.

Designated Areas

Any area where particularly hazardous substances, including carcinogens, acutely toxic chemicals and reproductive toxins, are stored or used must be posted as a Designated Area. These materials should be stored separately from other chemicals, as space permits. See Particularly Hazardous Substances for more information.

Compressed Gases

Compressed gases pose a chemical hazard due to the gases themselves and a high energy source hazard due to the great amount of pressure in the cylinder. Large cylinders may weigh 130 pounds or more and can pose a crush hazard to hands and feet.

- All cylinders must be secured to a wall, bench or other support structure using a chain or strap. Alternatively, a cylinder stand may be used.
- The names of compressed gases must be prominently posted.
- Segregate cylinders by gas type (e.g., flammable, inert, etc.).
- Store cylinders away from heat sources and extreme weather conditions.
- Empty cylinders shall be separated from non-empty cylinders and labeled “empty.”
- A hand truck shall be available for transporting gas cylinders to and from storage areas.

Combustible Materials

Common combustible materials, such as paper, wood, corrugated cardboard cartons and plastic lab-ware, if allowed to accumulate, can create a significant fire hazard in the laboratory. Combustible materials not stored in metal cabinets should be kept to a minimum. If possible, store large quantities of such supplies in a separate room.

Personal Behavior

Professional standards of personal behavior are required in any laboratory:

- Avoid distracting or startling other workers
- Do not allow practical jokes or horseplay

- Use laboratory equipment only for its designated purpose
- Do not allow visitors, including children and pets, in laboratories where hazardous substances are stored or are in use or hazardous activities are in progress.
- Do not prepare, store (even temporarily), or consume food or beverages in any chemical laboratory
- Do not smoke in any chemical laboratory. Additionally, be aware that tobacco products in opened packages can absorb chemical vapors.
- Do not apply cosmetics when in the laboratory
- Never wear or bring lab coats or jackets into areas where food is consumed.
- Confine long hair and loose clothing in the laboratory. Wear shoes at all times. Open-toed shoes or sandals are not appropriate.
- Under no circumstances should mouth suction be used to pipette chemicals or to start a siphon. Use a pipette bulb or a mechanical pipetting device to provide a vacuum.
- Wash well before leaving the laboratory. Do not use solvents for washing skin.
- Keep work areas clean and free from obstruction. Clean up spills immediately.
- Do not block access to exits, emergency equipment, controls, electrical panels etc.
- Avoid working alone.

<u>Transporting Chemicals</u>

Spills and chemical exposures can occur if chemicals are transported incorrectly, even when moving chemicals from one part of the laboratory to another. One example of such an incident is described in Anecdotes. To avoid this type of incident, consider the following:

- Use a bottle carrier, cart or other secondary container when transporting chemicals in breakable containers (especially 250 ml or more) through hallways or between buildings. Secondary containers are made of rubber, metal or plastic, with carrying handle(s), and are large enough to hold the entire contents of the chemical containers in the event of breakage. A variety of such containers are available from the Chemistry stockroom or from laboratory supply catalogs.
- Transport of hazardous chemicals in individual containers exceeding four liters between buildings is strongly discouraged.
- When moving in the laboratory, anticipate sudden backing up or changes in direction by others. If you should stumble or fall while carrying glassware or chemicals, try to project them away from yourself and others.
- The individual transporting the chemical should be knowledgeable about the hazards of the chemical and should know how to handle a spill of the material.
- When transporting compressed gas cylinders, the cylinder should always be strapped in a cylinder cart and the valve protected with a cover cap. Do not attempt to carry or roll cylinders from one area to another.
- Transport chemicals in freight elevators rather than passenger elevators, if available.
- Keep chemicals in their original packing when transporting, if possible.

<u>Unattended Experiments</u>

Laboratory operations involving hazardous substances are sometimes carried out continuously or overnight with no one present. It is the responsibility of the worker to design these experiments so as to prevent the release of hazardous substances in the event of interruptions in utility services such as electricity, cooling water, and inert gas.

- Laboratory lights should be left on, and signs should be posted identifying the nature of the experiment and the hazardous substances in use.
- If appropriate, arrangements should be made for other workers to periodically inspect the operation.
- The Emergency Information Poster should include contact information for the responsible individual in the event of an emergency.
- Carefully examine how chemicals and apparatus are stored, considering the possibility for fire, explosion or unintended reactions. A description of a fire that occurred in a fume hood when an experiment was left unattended for several days may be found in Anecdotes.

Working Alone
Individuals using hazardous chemicals should not work alone. Another individual capable of coming to the aid of the worker should be in visual or audio contact.

> If working alone is absolutely necessary, the worker should have a phone immediately available and should be in contact with another person (who knows that he or she is being relied upon) at least every 30 minutes. If no one from the laboratory is available, contact Public Safety at 718-270-2626 and request that the dispatcher check back by phone at regular intervals.

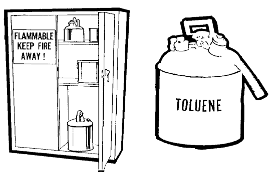
The laboratory supervisor or PI is responsible for determining whether the work requires special precautions, such as having two people in the same room for particular operations.

SECTION 7A: Flammable Materials

Properties of Flammable and Combustible Liquids
Flammable and combustible liquids vaporize and form flammable mixtures with air when in open containers, when leaks occur, or when heated. To control these potential hazards, several properties of these materials, such as volatility, flashpoint, and flammable range and auto ignition temperatures must be understood. Information on the properties of a specific liquid can be found in that liquid's safety data sheet (SDS), or other reference material.

Storage of Flammable and Combustible Liquids
Flammable and combustible liquids should be stored only in approved containers. Approval for containers is based on specifications developed by organizations such as the US Department of Transportation (DOT), OSHA, the National Fire Protection Agency (NFPA) or American National Standards Institute (ANSI). Containers used by the manufacturers of flammable and combustible liquids generally meet these specifications.

Safety Cans and Closed Containers



Many types of containers are required depending on the quantities and classes of flammable or combustible liquids in use. A safety can is an approved container of not more than 5 gallons capacity that has a spring closing lid and spout cover. Safety cans are designed to safely relieve internal pressure when exposed to fire conditions. A closed container is one sealed by a lid or other device so that liquid and vapor cannot escape at ordinary temperatures.

Flammable Liquid Storage Cabinets

A flammable liquid storage cabinet is an approved cabinet that has been designed and constructed to protect the contents from external fires. Storage cabinets are usually equipped with vents, which are plugged by the cabinet manufacturer. Since venting is not required by any code or the by local municipalities and since venting may actually prevent the cabinet from protecting its contents, vents should remain plugged at all times. Storage cabinets must also be conspicuously labeled "FLAMMABLE – KEEP FIRE AWAY".

Refrigerators
Use only those refrigerators that have been designed and manufactured for flammable liquid storage. Standard household refrigerators must not be used for flammable storage because internal parts could spark and ignite. Refrigerators must be prominently labeled as to whether or not they are suitable for flammable liquid storage.

Storage Considerations:

- Quantities should be limited to the amount necessary for the work in progress.
- No more than 10 gallons of flammable and combustible liquids, combined, should be stored outside of a flammable storage cabinet unless safety cans are used. When safety cans are used, up to 25 gallons may be stored without using a flammable storage cabinet.
- Storage of flammable liquids must not obstruct any exit.
- Flammable liquids should be stored separately from strong oxidizers, shielded from direct sunlight, and away from heat sources.

Handling Precautions

The main objective in working safely with flammable liquids is to avoid accumulation of vapors and to control sources of ignition.

Besides the more obvious ignition sources, such as open flames from Bunsen burners, matches and cigarette smoking, less obvious sources, such as electrical equipment, static electricity and gas-fired heating devices should be considered.

Some electrical equipment, including switches, stirrers, motors, and relays can produce sparks that can ignite vapors. Although some newer equipment have spark-free induction motors, the on-off switches and speed controls may be able to produce a spark when they are adjusted because they have exposed contacts. One solution is to remove any switches located on the device and insert a switch on the cord near the plug end.

Pouring flammable liquids can 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.

- Control all ignition sources in areas where flammable liquids are used. Smoking, open flames and spark producing equipment should not be used.
- Whenever possible use plastic or metal containers or safety cans.
- When working with open containers, use a laboratory fume hood to control the accumulation of flammable vapor.
- Use bottle carriers for transporting glass containers.
- Use equipment with spark-free, intrinsically safe induction motors or air motors to avoid producing sparks. These motors must meet National Electric Safety Code (US DOC, 1993) Class 1, Division 2, Group C-D explosion resistance specifications. Many stirrers, Variacs, outlet strips, ovens, heat tape, hot plates and heat guns do not conform to these code requirements.
- Avoid using equipment with series-wound motors, since they are likely to produce sparks.
- Do not heat flammable liquids with an open flame. Steam baths, salt and sand baths, oil and wax baths, heating mantles and hot air or nitrogen baths are preferable.
- Minimize the production of vapors and the associated risk of ignition by flashback. Vapors from flammable liquids are denser than air and tend to sink to the floor level where they can spread over a large area.
- Electrically bond metal containers when transferring flammable liquids from one to another. 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.

Flammable Aerosols

Flammable liquids in pressurized containers may rupture and aerosolize when exposed to heat, creating a highly flammable vapor cloud. As with flammable liquids, these should be stored in a flammable storage cabinet.

Flammable and Combustible Solids

Flammable solids often encountered in the laboratory include alkali metals, magnesium metal, metallic hydrides, some organometallic compounds, and sulfur. Many flammable solids react with water and cannot be extinguished with conventional dry chemical or carbon dioxide extinguishers.

- Ensure Class D extinguishers, e.g., Met-L-X, are available where flammable solids are used or stored.
- Sand can usually be used to smother a fire involving flammable solids. Keep a container of sand near the work area.
- If a flammable, water-reactive solid is spilled onto skin, brush off as much as possible, then flush with copious amounts of water.
- NEVER use a carbon dioxide fire extinguisher for fires involving lithium aluminum hydride (LAH). LAH reacts explosively with carbon dioxide.

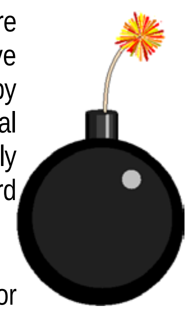
Catalyst Ignition

Some hydrogenated catalysts, such as palladium, platinum oxide, and Raney nickel, when recovered from hydrogenation reactions, may become saturated with hydrogen and present a fire or explosion hazard.

- Carefully filter the catalyst.
- Do not allow the filter cake to become dry.
- Place the funnel containing moist catalyst into a water bath immediately.

Purge gases, such as nitrogen or argon, may be used so that the catalyst can be filtered and handled in an inert atmosphere.

7B: Peroxide Forming Compounds and Reactive



Certain chemicals can form dangerous peroxides on exposure to air and light. Since they are sometimes packaged in an atmosphere of air, peroxides can form even though the containers have not been opened. Peroxides may detonate with extreme violence when concentrated by evaporation or distillation, when combined with other compounds, or when disturbed by unusual heat, shock or friction. Formation of peroxides in ethers is accelerated in opened and partially emptied containers. Refrigeration will not prevent peroxide formation and stabilizers will only retard formation.

Peroxide formation may be detected by visual inspection for crystalline solids or viscous liquids, or by using chemical methods or specialized kits for quantitative or qualitative analysis. If you suspect that peroxides have formed, do not open the container to test since peroxides deposited on the threads of the cap could detonate. \

Recommended Work Practices

The following recommendations should be followed to control the hazards of peroxides.

- Know the properties and hazards of all chemicals you are using through adequate research and study, including reading the label and SDS.
- Inventory all chemical storage at least twice a year to detect forgotten items, leaking containers, and those that need to be discarded.
- Identify chemicals that form peroxides or otherwise deteriorate or become more hazardous with age or exposure to air. Label containers with the date received, the date first opened and the date for disposal as recommended by the supplier.

- 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.
- Choose the size container that will ensure use of the entire contents within a short period of time.
- Visually or chemically check for peroxides of any opened containers before use.
- Clean up spills immediately. The safest method is to absorb the material onto vermiculite or a similar loose absorbent.
- 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.
- 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.
- Do not use glass containers with screw-top lids or glass stoppers. Polyethylene bottles with screw-top lids may be used.

<u>Examples of Peroxidizable Compounds</u>

Peroxide Hazard on Storage: Discard After Three Months	
Divinyl acetylene Divinyl ether Isopropyl ether	Potassium metal Sodium amide Vinylidene chloride
Peroxide Hazard on Concentration: Discard After One Year	
Acetal Cumene Cyclohexene Cyclooxyene Cyclopentene Diacetylene Dicyclopentadiene Diethyl ether Diethylene glycol dimethyl ether (diglyme)	Dioxane Ethylene glycol dimethyl ether (glyme) Furan Methyl acetylene Methylcyclopentane Methyl isobutyl ketone Tetrahydronaphtalene (Tetralin) Tetrahydrofuran Vinyl ethers
Hazardous Due to Peroxide Initiation of Polymerization*: Discard After One Year	
Acrylic acid Acrylonitrile Butadiene Chloroprene Chlorotrifluoroethylene Methyl methacrylate	Styrene Tetrafluoroethylene Vinyl acetylene Vinyl acetate Vinyl chloride Vinyl pyridine

- Under storage conditions in the liquid state the peroxide-forming potential increases and certain of these monomers (especially butadiene, chloroprene, and tetrafluoroethylene) should be discarded after three months.

Detection of Peroxides
If there is any suspicion that peroxide is present, do not open the container or otherwise disturb the contents. Call EH&S for disposal. The container and its contents must be handled with extreme care. If solids, especially crystals, for example, are observed either in the liquid or around the cap, peroxides are most likely present.

If not peroxide is suspected but the chemical is a peroxide former, the chemical can be tested by the lab to ensure no peroxide has formed.

Peroxide test strips, which change color to indicate the presence of peroxides, may be purchased through most laboratory reagent distributors. For proper testing, reference the manufacturer's instruction. Do not perform a peroxide test on outdated materials that potentially have dangerous levels of peroxide formation

Removal of Peroxides

If peroxides are suspected, the safest route is to alery EH&S for treatment and disposal of the material. Attempting to remove peroxides may be very dangerous under some conditions.

7C: Corrosive Materials

Many chemicals commonly used in the laboratory are corrosive or irritating to body tissue. They present a hazard to the eyes and skin by direct contact, to the respiratory tract by inhalation or to the gastrointestinal system by ingestion.

Corrosive Liquids
Corrosive liquids (e.g. mineral acids, alkali solutions and some oxidizers) represent a very significant hazard because skin or eye contact can readily occur from splashes and their effect on human tissue generally takes place very rapidly. Bromine, sodium hydroxide, sulfuric acid and hydrogen peroxide are examples of highly corrosive liquids. See Chemical Specific Issues for specific corrosive liquids such as Hydrofluoric Acid and Phenol.
The following should be considered:

- The eyes are particularly vulnerable. It is therefore essential that approved eye and face protection be worn in all laboratories where corrosive chemicals are handled.
- Gloves and other chemically resistant protective clothing should be worn to protect against skin contact.
- To avoid a flash steam explosion due to the large amount of heat evolved, always add acids or bases to water (and not the reverse).
- Acids and bases should be segregated for storage.
- Liquid corrosives should be stored below eye level.
- Adequate quantities of spill control materials should be readily available. Specialized spill kits for acids and bases are available through most chemical and laboratory safety supply catalogs.

Corrosive Gases and Vapors
Corrosive gases and vapors are hazardous to all parts of the body; certain organs (e.g. the eyes and the respiratory tract) are particularly sensitive. The magnitude of the effect is related to the solubility of the material in the body fluids. Highly soluble gases (e.g. ammonia, hydrogen chloride) cause severe nose and throat irritation, while substances of lower solubility (e.g. nitrogen dioxide, phosgene, sulfur dioxide) can penetrate deep into the lungs.

- Warning properties such as odor or eye, nose or respiratory tract irritation may be inadequate with some substances. Therefore, they should not be relied upon as a warning of overexposure.
- Perform manipulations of materials that pose an inhalation hazard in a chemical fume hood to control exposure or wear appropriate respiratory protection.

- Protect all exposed skin surfaces from contact with corrosive or irritating gases and vapors.
- Regulators and valves should be closed when the cylinder is not in use and flushed with dry air or nitrogen after use.
- When corrosive gases are to be discharged into a liquid, a trap, check valve, or vacuum break device should be employed to prevent dangerous reverse flow.

Corrosive Solids

Corrosive solids, such as sodium hydroxide and phenol, can cause burns to the skin and eyes. Dust from corrosive solids can be inhaled and cause irritation or burns to the respiratory tract. Many corrosive solids, such as potassium hydroxide and sodium hydroxide, can produce considerable heat when dissolved in water.

- Wear gloves and eye protection when handling corrosive solids.
- When mixing with water, always slowly add the corrosive solid to water, stirring continuously. Cooling may be necessary.
- If there is a possibility of generating a significant amount of dust, conduct work in a fume hood.

Compressed Gases

Compressed gases can be toxic, flammable, oxidizing, corrosive, inert or a combination of hazards. In addition to the chemical hazards, compressed gases may be under a great deal of pressure. The amount of energy in a compressed gas cylinder makes it a potential rocket. Appropriate care in the handling and storage of compressed gas cylinders is essential.

Hazards

The following is an overview of the hazards to be avoided when handling and storing compressed gases:

- Asphyxiation: Simple asphyxiation is the primary hazard associated with inert gases. Because inert gases are colorless and odorless, they can escape into the atmosphere undetected and quickly reduce the concentration of oxygen below the level necessary to support life. The use of oxygen monitoring equipment is strongly recommended for enclosed areas where inert gases are being used.
- Fire and Explosion: Fire and explosion are the primary hazards associated with flammable gases, oxygen and other oxidizing gases. Flammable gases can be ignited by static electricity or by a heat source, such as a flame or a hot object. Oxygen and other oxidizing gases do not burn, but will support combustion of organic materials. Increasing the concentration of an oxidizer accelerates the rate of combustion. Materials that are nonflammable under normal conditions may burn in an oxygen-enriched atmosphere.
- Chemical Burns: Corrosive gases can chemically attack various materials, including fire-resistant clothing. Some gases are not corrosive in their pure form, but can become extremely destructive if a small amount of moisture is added. Corrosive gases can cause rapid destruction of skin and eye tissue.
- Chemical Poisoning: Chemical poisoning is the primary hazard of toxic gases. Even in very small concentrations, brief exposure to these gases can result in serious poisoning injuries. Symptoms of exposure may be delayed.
- High Pressure: All compressed gases are potentially hazardous because of the high pressure stored inside the cylinder. A sudden release of pressure can cause injuries by propelling a cylinder or whipping a line.
- Cylinder Weight: A full size cylinder may weigh more than 130 pounds. Moving a cylinder manually may lead to back or muscle injury. Dropping or dragging a cylinder could cause serious injury.

Handling Precautions

- Avoid dropping, dragging or sliding cylinders. Use a suitable hand truck or cart equipped with a chain or belt for securing the cylinder to the cart, even for short distances.
- Do not permit cylinders to strike each other violently. Cylinders should not be used as rollers for moving material or other equipment.

- Cylinder caps should be left on each cylinder until it has been secured against a wall or bench or placed in a cylinder stand, and is ready for installation of the regulator. Cylinder caps protect the valve on top of the cylinder from damage if knocked.
- Never tamper with pressure relief devices in valves or cylinders.
- Use only wrenches or tools provided by the cylinder supplier to remove a cylinder cap or to open a valve. Never use a screwdriver or pliers.
- Keep the cylinder valve closed except when in use.
- Position cylinders so that the cylinder valve is accessible at all times.
- Use compressed gases only in a well-ventilated area. Toxic, flammable and corrosive gases should be carefully handled in a hood or gas cabinet. Proper containment systems should be used and minimum quantities of these products should be kept on-site.
- When discharging gas into a liquid, a trap or suitable check valve should be used to prevent liquid from getting back into the cylinder or regulator.
- Where more than one type of gas is in use, label gas lines. This is particularly important when the gas supply is not in the same room or area as the operation using the gases.
- Do not use the cylinder valve itself to control flow by adjusting the pressure.

<u>Storage of Compressed Gas Cylinders</u>

- All cylinders must be secured to a wall, bench or fixed support using a chain or strap placed 2/3 of the way up. Cylinder stands are an alternative to straps.
- Cylinders should be strapped individually.
- Do not store full and empty cylinders together.
- Oxidizers and flammable gases should be stored in areas separated by at least 20 feet or by a noncombustible wall.
- Cylinders should not be stored near radiators or other heat sources. If storage is outdoors, protect cylinders from weather extremes and damp ground to prevent corrosion.
- No part of a cylinder should be subjected to a temperature higher than 125^{o}F. A flame should never be permitted to come in contact with any part of a compressed gas cylinder.
- Do not place cylinders where they may become part of an electric circuit.
- Keep the number of cylinders in a laboratory to a minimum to reduce the fire and toxicity hazards.
- Lecture bottles should always be returned to the distributor or manufacturer promptly when no longer needed or discarded if at atmospheric pressure.
- Ensure that the cylinder is properly and prominently labeled as to its contents.
- NEVER place acetylene cylinders on their side.

<u>Using Compressed Gas Cylinders</u>

Before using cylinders, read all label information and safety data sheets (SDSs) associated with the gas being used. The cylinder valve outlet connections are designed to prevent mixing of incompatible gases. The outlet threads vary in diameter; some are internal and some are external; some are right-handed and some are left-handed. Generally, right-handed threads are used for fuel gases.

To set up and use the cylinder, follow these steps:

- Attach the closed regulator to the cylinder. Never open the cylinder valve unless the regulator is completely closed. Regulators are specific to the gas involved. A regulator should be attached to a cylinder without forcing the threads. If the inlet of a regulator does not fit the cylinder outlet, no effort should be made to try to force the fitting. A poor fit may indicate that the regulator is not intended for use on the gas chosen.
- Turn the delivery pressure adjusting screw counter-clockwise until it turns freely. This prevents unintended gas flow into the regulator.

- Open the cylinder slowly until the inlet gauge on the regulator registers the cylinder pressure. If the cylinder pressure reading is lower than expected, the cylinder valve may be leaking.
- With the flow control valve at the regulator outlet closed, turn the delivery pressure adjusting screw clockwise until the required delivery pressure is reached.
- Check for leaks using Snoop or soap solution. At or below freezing temperatures, use a glycerin and water solution, such as Snoop, rather than soap. Never use an open flame to detect leaks.
- When finished with the gas, close the cylinder valve and release the regulator pressure.

<u>Assembly of Equipment and Piping</u>

- Do not force threads that do not fit exactly.
- Use Teflon tape or thread lubricant for assembly. Teflon tape should only be used for tapered pipe thread, not straight lines or metal-to-metal contacts.
- Avoid sharp bends of copper tubing. Copper tubing hardens and cracks with repeated bending.
- Inspect tubing frequently and replace when necessary.
- Tygon and plastic tubing are not appropriate for most pressure work. These materials can fail under pressure or thermal stress.
- Do not mix different brands and types of tube fittings. Construction parts are usually not interchangeable.
- Do not use oil or lubricants on equipment used with oxygen.
- Do not use copper piping for acetylene.
- Do not use cast iron piping for chlorine.

<u>Leaking Cylinders</u>

Most leaks occur at the valve in the top of the cylinder and may involve the valve threads valve stem, valve outlet, or pressure relief devices. Lab personnel should not attempt to repair leaking cylinders.

Where action can be taken without serious exposure to lab personnel:

- Move the cylinder to an isolated, well-ventilated area (away from combustible materials if the cylinder contains a flammable or oxidizing gas).
- Contact Environmental Health & Safety at 718-221-5212.

Whenever a large or uncontrollable leak occurs, evacuate the area and immediately contact Public Safety at 718-270-2626.

<u>Empty Cylinders</u>

- Remove the regulator and replace the cylinder cap.
- Mark the cylinder as empty or MT and store in a designated area for return to the supplier.
- Do not store full and empty cylinders together.
- Do not have full and empty cylinders connected to the same manifold. Reverse flow can occur when an empty cylinder is attached to a pressurized system.
- Do not refill empty cylinders. Only the cylinder supplier should refill gases.
- Do not empty cylinders to a pressure below 25 psi (172 Kpa). The residual contents may become contaminated with air.
- Lecture bottles should always be returned to the distributor or manufacturer promptly when no longer needed. Do not purchase lecture bottles that cannot be returned.

<u>Flammable Gases</u>

- Keep sources of ignition away from the cylinders.
- Oxidizers and flammable gases should be stored in areas separated by at least 20 feet or by a non-combustible wall.

- Bond and ground all cylinders, lines and equipment used with flammable compressed gases.

Highly Toxic Gases

Highly toxic gases, such as arsine, diborane, fluorine, hydrogen cyanide, phosgene, and silane, can pose a significant health risk in the event of a leak.

The following additional precautions must be taken:

- Use and store in a specially ventilated gas cabinet or fume hood.
- Use coaxial (double walled) tubing with nitrogen between the walls for feed lines operating above atmospheric pressure.
- Regulators should be equipped with an automatic shut-off to turn off gas supply in the event of sudden loss of pressure in the supply line.
- Ensure storage and use areas are posted with Designated Area signage.

Gases Requiring Special Handling

The following gases present special hazards either due to their toxicity or physical properties. Review this information before using these gases.

- Acetylene
- Arsine
- Diborane
- Fluorine
- Hydrogen Cyanide
- Germane
- Oxygen
- Phosgene
- Silane

7D: CRYOGENICS

Cryogenic liquids have boiling points less than -73ºC (-100ºF). Liquid nitrogen, liquid oxygen and carbon dioxide are the most common cryogenic materials used in the laboratory. Hazards may include fire, explosion, embrittlement, pressure buildup, frostbite and asphyxiation.

Many of the safety precautions observed for compressed gases also apply to cryogenic liquids. Two additional hazards are created from the unique properties of cryogenic liquids:

- Extremely Low Temperatures –The cold boil-off vapor of cryogenic liquids rapidly freezes human tissue. Most metals become stronger upon exposure to cold temperatures, but materials such as carbon steel, plastics and rubber become brittle or even fracture under stress at these temperatures. Proper material selection is important. Cold burns and frostbite caused by cryogenic liquids can result in extensive tissue damage.
- Vaporization - All cryogenic liquids produce large volumes of gas when they vaporize. Liquid nitrogen will expand 696 times as it vaporizes. The expansion ratio of argon is 847:1, hydrogen is 851:1 and oxygen is 862:1. If these liquids vaporize in a sealed container, they can produce enormous pressures that could rupture the vessel. For this reason, pressurized cryogenic containers are usually protected with multiple pressure relief devices.

- Vaporization of cryogenic liquids (except oxygen) in an enclosed area can cause asphyxiation. Vaporization of liquid oxygen can produce an oxygen-rich atmosphere, which will support and accelerate the combustion of other materials. Vaporization of liquid hydrogen can form an extremely flammable mixture with air.

Handling Cryogenic Liquids

Most cryogenic liquids are odorless, colorless, and tasteless when vaporized. When cryogenic liquids are exposed to the atmosphere, the cold boil-off gases condense the moisture in the air, creating a highly visible fog.

- Always handle these liquids carefully to avoid skin burns and frostbite. Exposure that may be too brief to affect the skin of the face or hands may damage delicate tissues, such as the eyes.
- Boiling and splashing always occur when charging or filling a warm container with cryogenic liquid or when inserting objects into these liquids. Perform these tasks slowly to minimize boiling and splashing. Use tongs to withdraw objects immersed in a cryogenic liquid.
- Never touch uninsulated pipes or vessels containing cryogenic liquids. Flesh will stick to extremely cold materials. Even nonmetallic materials are dangerous to touch at low temperatures.
- Cylinders and dewars should not be filled to more than 80% of capacity, since expansion of gases during warming may cause excessive pressure buildup.
- Check cold baths frequently to ensure they are not plugged with frozen material.

Cooling Baths and Dry Ice

- Neither liquid nitrogen nor liquid air should be used to cool a flammable mixture in the presence of air, because oxygen can condense from the air, leading to an explosion hazard.
- Wear insulated, dry gloves and a face shield when handling dry ice.
- Add dry ice slowly to the liquid portion of the cooling bath to avoid foaming over. Do not lower your head into a dry ice chest, since suffocation can result from carbon dioxide buildup.

Liquid Nitrogen Cooled Traps

Traps that open to the atmosphere condense liquid air rapidly. If you close the system, pressure builds up with enough force to shatter glass equipment. Therefore, only sealed or evacuated equipment should use liquid nitrogen cooled traps.

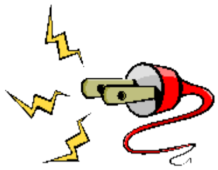
7E: ELECTRICAL SAFETY

Electrically powered equipment, such as hot plates, stirrers, vacuum pumps, electrophoresis apparatus, lasers, heating mantles, ultra-sonicators, power supplies, and microwave ovens are essential elements of many laboratories. These devices can pose a significant hazard to laboratory workers, particularly when mishandled or not maintained. Many laboratory electrical devices have high voltage or high power requirements, carrying even more risk. Large capacitors found in many laser flash lamps and other systems are capable of storing lethal amounts of electrical energy and pose a serious danger even if the power source has been disconnected.

Accounts of incidents on campus that resulted in electrical shock, including a near fatal incident, are described in Anecdotes.

Electrical Hazards

The major hazards associated with electricity are electrical shock and fire. Electrical shock occurs when the body becomes part of the electric circuit, either when an individual comes in contact with both wires of an electrical circuit, one wire of an energized circuit and the ground, or a metallic part that has become energized by contact with an electrical conductor.



The severity and effects of an electrical shock depend on a number of factors, such as the pathway through the body, the amount of current, the length of time of the exposure, and whether the skin is wet or dry. Water is a great conductor of electricity, allowing current to flow more easily in wet conditions and through wet skin. The effect of the shock may range from a slight tingle to severe burns to cardiac arrest. The chart below shows the general relationship between the degree of injury and amount of current for a 60-cycle hand-to-foot path of one second's duration of shock. While reading this chart, keep in mind that most electrical circuits can provide, under normal conditions, up to 20,000 milliamperes of current flow.

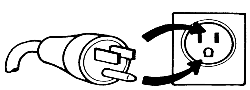
In addition to the electrical shock hazards, sparks from electrical equipment can serve as an ignition source for flammable or explosive vapors or combustible materials.

Preventing Electrical Hazards

There are various ways of protecting people from the hazards caused by electricity, including insulation, guarding, grounding, and electrical protective devices. Laboratory workers can significantly reduce electrical hazards by following some basic precautions:

- Inspect wiring of equipment before each use. Replace damaged or frayed electrical cords immediately.
- Use safe work practice every time electrical equipment is used.
- Know the location and how to operate shut-off switches and/or circuit breaker panels. Use these devices to shut off equipment in the event of a fire or electrocution.
- Limit the use of extension cords. Use only for temporary operations and then only for short periods of time. In all other cases, request installation of a new electrical outlet.
- Multi-plug adapters must have circuit breakers or fuses.
- Place exposed electrical conductors (such as those sometimes used with electrophoresis devices) behind shields.
- Minimize the potential for water or chemical spills on or near electrical equipment.

Grounding



Only equipment with three-prong plugs should be used in the laboratory. The third prong provides a path to ground for internal electrical short circuits, thereby protecting the user from a potential electrical shock.

The ground-fault circuit interrupter, or GFCI, is designed to shutoff electric power if a ground fault is detected, protecting the user from a potential electrical shock. The GFCI is particularly useful near sinks and wet locations. Since GFCIs can cause equipment to shutdown unexpectedly, they may not be appropriate for certain apparatus. Portable GFCI adapters (available in most safety supply catalogs) may be used with a non-GFCI outlet.

Safe Work Practices

The following practices may reduce risk of injury or fire when working with electrical equipment:

- Avoid contact with energized electrical circuits.
- Disconnect the power source before servicing or repairing electrical equipment.
- When it is necessary to handle equipment that is plugged in be sure hands are dry and, when possible, wear nonconductive gloves and shoes with insulated soles.
- If it is safe to do so, work with only one hand, keeping the other hand at your side or in your pocket, away from all conductive material. This precaution reduces the likelihood of accidents that result in current passing through the chest cavity.
- Minimize the use of electrical equipment in cold rooms or other areas where condensation is likely. If equipment must be used in such areas, mount the equipment on a wall or vertical panel.

- If water or a chemical is spilled onto equipment, shut off power at the main switch or circuit breaker and unplug the equipment.
- If an individual comes in contact with a live electrical conductor, do not touch the equipment, cord or person. Disconnect the power source from the circuit breaker or pull out the plug using a leather belt.

Refrigerators and Freezers

The potential hazards posed by laboratory refrigerators and freezers involve vapors from the contents, the possible presence of incompatible chemicals and spillage.

Only refrigerators and freezers specified for laboratory use should be utilized for the storage of chemicals. These refrigerators have been constructed with special design factors, such as heavy-duty cords and corrosion resistant interiors to help reduce the risk of fire or explosions in the lab.

Standard refrigerators have electrical fans and motors that make them potential ignition sources for flammable vapors. Do not store flammable liquids in a refrigerator unless it is approved for such storage. Flammable liquid-approved refrigerators are designed with spark-producing parts on the outside to avoid accidental ignition. If refrigeration is needed inside a flammable-storage room, you should use an explosion-proof refrigerator.

Frost-free refrigerators should also be avoided. Many of them have a drain or tube or hole that carries water and possibly any spilled materials to an area near the compression, which may spark. Electric heaters used to defrost the freezing coils can also spark.

Only chemicals should be stored in chemical storage refrigerators; lab refrigerators should not be used for food storage or preparation. Refrigerators should be labeled for their intended purpose; labels reading “No Food or Drink to be Stored in this Refrigerator” or “Refrigerator For Food Only” are available from EH&S by calling 221-5212.

All materials in refrigerators or freezers should be labeled with the contents, owner, date of acquisition or preparation and nature of any potential hazard. Since refrigerators are often used for storage of large quantities of small vials and test tubes, a reference to a list outside of the refrigerator could be used. Labels and ink used to identify materials in the refrigerators should be water-resistant.

All containers should be sealed, preferably with a cap. Containers should be placed in secondary containers, or catch pans should be used.

Loss of electrical power can produce extremely hazardous situations. Flammable or toxic vapors may be released from refrigerators and freezers as chemicals warm up and/or certain reactive materials may decompose energetically upon warming.

Stirring and Mixing Devices

The stirring and mixing devices commonly found in laboratories include stirring motors, magnetic stirrers, shakers, and small pumps for fluids and rotary evaporators for solvent removal. These devices are typically used in laboratory operations that are performed in a hood, and it is important that they be operated in a way that precludes the generation of electrical sparks.

Only spark-free induction motors should be used in power stirring and mixing devices or any other rotating equipment used for laboratory operations. While the motors in most of the currently marketed stirring and mixing devices meet this criterion, their on-off switches and rheostat-type speed controls can produce an electrical spark because they have exposed electrical conductors. The speed of an induction motor operating under a load should not be controlled by a variable autotransformer.

Because stirring and mixing devices, especially stirring motors and magnetic stirrers, are often operated for fairly long periods without constant attention, the consequences of stirrer failure, electrical overload or blockage of the motion of the stirring impeller should be considered.

Heating Devices

Most labs use at least one type of heating device, such as ovens, hot plates, heating mantles and tapes, oil baths, salt baths, sand baths, air baths, hot-tube furnaces, hot-air guns and microwave ovens. Steam-heated devices are generally preferred whenever temperatures of 100^{o} C or less are required because they do not present shock or spark risks and can be left unattended with assurance that their temperature will never exceed 100^{o} C. A number of general precautions need to be taken when working with heating devices in the laboratory. When working with heating devices, consider the following:

- The actual heating element in any laboratory-heating device should be enclosed in such a fashion as to prevent a laboratory worker or any metallic conductor from accidentally touching the wire carrying the electric current.
- Heating device becomes so worn or damaged that its heating element is exposed; the device should be either discarded or repaired before it is used again.
- Laboratory heating devices should be used with a variable autotransformer to control the input voltage by supplying some fraction of the total line voltage, typically 110 V.
- The external cases of all variable autotransformers have perforations for cooling by ventilation and, therefore, should be located where water and other chemicals cannot be spilled onto them and where they will not be exposed to flammable liquids or vapors.

Fail-safe devices can prevent fires or explosions that may arise if the temperature of a reaction increases significantly because of a change in line voltage, the accidental loss of reaction solvent or loss of cooling. Some devices will turn off the electric power if the temperature of the heating device exceeds some preset limit or if the flow of cooling water through a condenser is stopped owing to the loss of water pressure or loosening of the water supply hose to a condenser.

Ovens

Electrically heated ovens are commonly used in the laboratory to remove water or other solvents from chemical samples and to dry laboratory glassware. Never use laboratory ovens for human food preparation.

- Laboratory ovens should be constructed such that their heating elements and their temperature controls are physically separated from their interior atmospheres.
- Laboratory ovens rarely have a provision for preventing the discharge of the substances volatilized in them. Connecting the oven vent directly to an exhaust system can reduce the possibility of substances escaping into the lab or an explosive concentration developing within the oven.
- Ovens should not be used to dry any chemical sample that might pose a hazard because of acute or chronic toxicity unless special precautions have been taken to ensure continuous venting of the atmosphere inside the oven.
- To avoid explosion, glassware that has been rinsed with an organic solvent should be rinsed again with distilled water before being dried in an oven.
- Bimetallic strip thermometers are preferred for monitoring oven temperatures. Mercury thermometers should not be mounted through holes in the top of ovens so that the bulb hangs into the oven. Should a mercury thermometer be broken in an oven of any type, the oven should be closed and turned off immediately, and it should remain closed until cool. All mercury should be removed from the cold oven with the use of appropriate cleaning equipment and procedures in order to avoid mercury exposure.

Hot Plates

Laboratory hot plates are normally used for heating solutions to 100^{o} C or above when inherently safer steam baths cannot be used. Any newly purchased hot plates should be designed in a way that avoids electrical sparks.

However, many older hot plates pose an electrical spark hazard arising from either the on-off switch located on the hot plate, the bimetallic thermostat used to regulate the temperature or both. Laboratory workers should be warned of the spark hazard associated with older hot plates.
In addition to the spark hazard, old and corroded bimetallic thermostats in these devices can eventually fuse shut and deliver full, continuous current to a hot plate.

- Do not store volatile flammable materials near a hot plate
- Limit use of older hot plates for flammable materials.
- Check for corrosion of thermostats. Corroded bimetallic thermostats can be repaired or reconfigured to avoid spark hazards. Contact EH&S for more info.

Heating Mantles

Heating mantles are commonly used for heating round-bottomed flasks, reaction kettles and related reaction vessels. These mantles enclose a heating element in a series of layers of fiberglass cloth. As long as the fiberglass coating is not worn or broken, and as long as no water or other chemicals are spilled into the mantle, heating mantles pose no shock hazard.

- Always use a heating mantle with a variable autotransformer to control the input voltage. Never plug them directly into a 110-V line.
- Be careful not to exceed the input voltage recommended by the mantle manufacturer. Higher voltages will cause it to overheat, melt the fiberglass insulation and expose the bare heating element.
- If the heating mantle has an outer metal case that provides physical protection against damage to the fiberglass, it is good practice to ground the outer metal case to protect against an electric shock if the heating element inside the mantle shorts against the metal case.
- Some older equipment might have asbestos insulation rather than fiberglass. Contact EH&S for proper disposal of the asbestos.

Centrifuges

Centrifuges should be properly installed and must be operated only by trained personnel. It is important that the load is balanced each time the centrifuge is used and that the lid be closed while the rotor is in motion. The disconnect switch must be working properly to shut off the equipment when the top is opened, and the manufacturer's instructions for safe operating speeds must be followed.

For flammable and/or hazardous materials, the centrifuge should be under negative pressure to a suitable exhaust system.

Autoclaves

The use of an autoclave is a very effective way to decontaminate infectious waste. Autoclaves work by killing microbes with superheated steam. The following are recommended guidelines when using an autoclave:

- Do not put sharp or pointed contaminated objects into an autoclave bag. Place them in an appropriate rigid sharps disposal container.
- Use caution when handling an infectious waste autoclave bag, in case sharp objects were inadvertently placed in the bag. Never lift a bag from the bottom to load it into the chamber. Handle the bag from the top.
- Do not overfill an autoclave bag. Steam and heat cannot penetrate as easily to the interior of a densely packed autoclave bag. Frequently the outer contents of the bag will be treated but the innermost part will be unaffected.
- Do not overload an autoclave. An over packed autoclave chamber does not allow efficient steam distribution. Considerably longer sterilization times may be required to achieve decontamination if an autoclave is tightly packed.

- Conduct autoclave sterility testing on a regular basis using appropriate biological indicators (B. stearothermophilus spore strips) to monitor efficacy. Use indicator tape with each load to verify it has been autoclaved.
- Do not mix contaminated and clean items together during the same autoclave cycle. Clean items generally require shorter decontamination times (15-20 minutes) while a bag of infectious waste (24" x 36") typically requires 45 minutes to an hour to be effectively decontaminated throughout.
- Always wear personal protective equipment, including heat-resistant gloves, safety glasses and a lab coat when operating an autoclave. Use caution when opening the autoclave door. Allow superheated steam to exit before attempting to remove autoclave contents.
- Be on the alert when handling pressurized containers. Superheated liquids may spurt from closed containers. Never seal a liquid container with a cork or stopper. This could cause an explosion inside the autoclave.
- Agar plates will melt and the agar will become liquefied when autoclaved. Avoid contact with molten agar. Use a secondary tray to catch any potential leakage from an autoclave bag rather than allowing it to leak onto the floor of the autoclave chamber.
- If there is a spill inside the autoclave chamber, allow the unit to cool before attempting to clean up the spill. If glass breaks in the autoclave, use tongs, forceps or other mechanical means to recover fragments. Do not use bare or gloved hands to pick up broken glassware.
- Do not to leave an autoclave operating unattended for a long period of time. Always be sure someone is in the vicinity while an autoclave is cycling in case there is a problem.
- Autoclaves should be placed under preventive maintenance contracts to ensure they are operating properly.

Electrophoresis Devices

Precautions to prevent electric shock must be followed when conducting procedures involving electrophoresis. Lethal electric shock can result when operating at high voltages such as in DNA sequencing or low voltages such as in agarose gel electrophoresis (e.g., 100 volts at 25 milliamps). These general guidelines should be followed:

- Turn the power off before connecting the electrical leads
- Connect one lead at a time, using one hand only
- Ensure that hands are dry while connecting leads
- Keep the apparatus away from sinks or other water sources
- Turn off power before opening lid or reaching inside chamber
- Do not override safety devices
- Do not run electrophoresis equipment unattended.
- If using acrylamide, purchase premixed solutions or pre-weighed quantities whenever possible
- If using ethidium bromide, have a hand-held UV light source available in the laboratory. Check working surfaces after each use.
- Mix all stock solutions in a chemical fume hood.
- Provide spill containment by mixing gels on a plastic tray
- Decontaminate surfaces with ethanol. Dispose of all cleanup materials as hazardous waste.

Glassware

Although glass vessels are frequently used in low-vacuum operations, evacuated glass vessels may collapse violently, either spontaneously from strain or from an accidental blow. Therefore, pressure and vacuum operations in glass vessels should be conducted behind adequate shielding. It is advisable to check for flaws such as star cracks, scratches and etching marks each time a vacuum apparatus is used. Only round-bottomed or thick-walled (e.g., Pyrex) evacuated reaction vessels specifically designed for operations at reduced pressure should be used. Repaired glassware is subject to thermal shock and should be avoided. Thin-walled, Erlenmeyer or round-bottomed flasks larger than 1 L should never be evacuated.

7F: Particularly Hazardous Substances

As a matter of good practice, and to satisfy regulatory requirement, particularly hazardous substances require additional planning and considerations.

Definitions

The OSHA Laboratory Standard defines particularly hazardous substances as:

- Carcinogens – A carcinogen is a substance capable of causing cancer. Carcinogens are chronically toxic substances; that is, they cause damage after repeated or long-duration exposure, and their effects may become evident only after a long latency period.

  A chemical is considered a carcinogen, for the purpose of the Laboratory Safety Manual, if it is included in any of the following carcinogen lists:

  OSHA-regulated carcinogens as listed in Subpart Z of the OSHA standards.

  Under the category "known to be carcinogens" in the Annual Report of Carcinogens published by the National Toxicology Program (NTP) latest edition

  Group 1 ("carcinogenic to humans") of the International Agency for Research on Cancer (IARC), latest edition. Chemicals listed in Group 2A or 2B ("reasonably anticipated to be carcinogens") that cause significant tumor incidence in experimental animals under specified conditions are also considered carcinogens under the OSHA Laboratory Standard.

- Reproductive Toxins – Reproductive toxins are substances that have adverse effects on various aspects of reproduction, including fertility, gestation, lactation, and general reproductive performance. When a pregnant woman is exposed to a chemical, the fetus may be exposed as well because the placenta is an extremely poor barrier to chemicals. Reproductive toxins can affect both men and women. Male reproductive toxins can in some cases lead to sterility.
- Substances with a High Acute Toxicity – High acute toxicity includes any chemical that falls within any of the following OSHA-defined categories:

  A chemical with a median lethal dose (LD_{50}) of 50 mg or less per kg of body weight when administered orally to certain test populations.

  A chemical with an LD_{50} of 200 mg less per kg of body weight when administered by continuous contact for 24 hours to certain test populations.

  A chemical with a median lethal concentration (LC_{50}) in air of 200 parts per million (ppm) by volume or less of gas or vapor, or 2 mg per liter or less of mist, fume, or dust, when administered to certain test populations by continuous inhalation for one hour, provided such concentration and/or condition are likely to be encountered by humans when the chemical is used in any reasonably foreseeable manner.

Approval Procedure

Laboratory workers planning to use a particularly hazardous substance must first receive explicit written approval from their Principal Investigator and/or Chemical Hygiene Officer, per the Departmental Chemical Hygiene Plan. The following steps must be taken:

1. Laboratory workers must complete a Particularly Hazardous Substance Use Approval Form. Information required on the form includes:
   - Identity, physical characteristics, and health hazards of the substances involved
   - Consideration of exposure controls such as fume hoods, glove boxes and personal protective equipment
   - Designation of an area (hood, glove box, portion of lab, entire lab) specifically for experimental procedures with the substances involved

- Plans for storage and secondary containment
- Procedures for safe removal of contaminated waste
- Decontamination procedures

2. The laboratory worker submits the form to the Chemical Hygiene Officer and/or Principal Investigator and receives approval.
3. The area where the PHS will be used is posted as a designated area. Signs for this purpose are available through EH&S or may be made by the department or laboratory worker, as long as it includes the following information:

DANGER DESIGNATED AREA for select carcinogens, reproductive toxins and high acute toxicity chemicals AUTHORIZED PERSONNEL ONLY

4. The laboratory worker proceeds with the experiment, following the practices outlined in the Particularly Hazardous Substance Use Approval form, as well as the appropriate work practices included in the remainder of the Safe Work Practices and Procedures section of this manual. All work is conducted within the Designated Area.
5. The laboratory worker decontaminates all equipment and disposes of waste promptly accordingly to the Univeristy's Disposal Program.

Working Safely with Particularly Hazardous Substances

The increased hazard risk associated with Particularly Hazardous Substances (PHS) calls for more strict operating procedures in the laboratory:

Work Habits

- There should be no eating, drinking, smoking, chewing of gum or tobacco, application of cosmetics or storage of utensils, food or food containers in laboratory areas where PHS are used or stored.
- All personnel should wash their hands and arms immediately after the completion of any procedure in which a PHS has been used and when they leave the laboratory.
- Each procedure should be conducted with the minimum amount of the substance, consistent with the requirements of the work.
- The laboratory worker should keep records of the amounts of each highly hazardous material used, the dates of use and the names of the users.
- Work surfaces, including fume hoods, should be fitted with a removable liner of absorbent plastic-backed paper to help contain spilled materials and to simplify subsequent cleanup and disposal.

Personal Protective Equipment

- PHS may require more stringent use of personal protective equipment. Check the MSDS for information on proper gloves, lab clothing and respiratory protection.
- Proper personal protective equipment must be worn at all times when handling PHS.
- Lab clothing that protects street clothing, such as a fully fastened lab coat or a disposable jumpsuit, should be worn when PHS are being used. Laboratory clothing used while manipulating PHS should not be worn outside the laboratory area.
- When methods for decontaminating clothing are unknown or not applicable, disposable protective clothing should be worn. Disposable gloves should be discarded after each use and immediately after overt contact with a PHS.

Storage and Transportation

- Stock quantities of PHS should be stored in a designated storage area or cabinet with limited access. Additional storage precautions (i.e., a refrigerator, a hood, a flammable liquid storage cabinet) may be required for certain compounds based upon other properties.
- Containers must be clearly labeled.
- Double containment should also be considered. Double containment means that the container will be placed inside another container that is capable of holding the contents in the event of a leak and provides a protective outer covering in the event of contamination of the primary container.
- Containers should be stored on trays or pans made of polyethylene or other chemically resistant material.
- Persons transporting PHS from one location to another should use double containment to protect against spills and breakage.

Decontamination and Disposal

- Contaminated materials should either be decontaminated by procedures that decompose the PHS to produce a safe product or be removed for subsequent disposal.
- All work surfaces must be decontaminated at the end of the procedure or workday, whichever is sooner.
- Prior to the start of any laboratory activity involving a PHS, plans for the handling and ultimate disposal of contaminated wastes and surplus amounts of the PHS should be completed. EH&S can assist in selecting the best methods available for disposal.

SECTION 8: Chemical Spills

This section contains information regarding:

- Spill Response and Clean-up Procedures
- Developing a Spill Response Plan
- Recommended Spill Control Materials Inventory

Pre-planning is essential. Before working with a chemical, the laboratory worker should know how to proceed with spill cleanup and should ensure that there are adequate spill control materials available.

Preventing Spills

Most spills are preventable. The following are some tips that could help to prevent or minimize the magnitude of a spill:

- Place chemical containers in a hood or lab bench in a manner that reduces the possibility of accidentally knocking over a container.
- Plan your movements. Look where you are reaching to ensure you will not cause a spill.
- Follow the procedures outlined for transporting chemicals safely.
- Place absorbent plastic backed liners on bench tops or in fume hoods where spills can be anticipated. For volumes of liquid larger than what can be absorbed by liners, use trays.

Hazardous Waste Disposal Procedures

The following procedures apply to any chemical substances generated from University operations (including laboratories, administrative units, and physical plant operations) that are classified as hazardous based on the criteria described below. This procedure does not apply to disposal of radioactive or biohazardous wastes.

In order to responsibly manage chemical waste each employee must be familiar with the following:

- Hazardous Waste Characteristics
- Properly Packaging Waste Materials
- Effective Labelling
- Waste Collection Protocol

Classification of Waste as Hazardous

Waste is considered hazardous if:

- It is on either of two lists of specific chemical substances developed by the Federal Environmental Protection Agency (EPA). Most commonly used organic solvents (e.g. acetone, methanol, toluene, Xylene, Methylene chloride etc.) are included (see list). For further information contact Environmental Health & Safety.
- It is on a list of nonspecific sources that includes a broad range of spent homogenate and non-homogenate solvents (see list).
- It is on a list of specific sources that includes primarily industrial processes.
- It exhibits any of the following characteristics as defined by the EPA (definitions are abbreviated):

    Ignitable

        a liquid with a flash point less than 60 degrees Centigrade
        not a liquid and capable under normal conditions of causing fire through friction, absorption of moisture or spontaneous chemical changes
        an ignitable compressed gas
        an oxidizer

    Corrosive

        it is aqueous and has a pH less than or equal to 2 or greater than or equal to 12.5
        It is a liquid and corrodes steel at a rate greater than 0.250 inches per year at 55 degrees Centigrade

    Reactive

        it is normally unstable
        it reacts violently with water
        it forms potentially explosive mixtures with water
        it generates toxic gases, vapors or fumes when mixed with water
        cyanide or sulfide wastes that generate toxic gases, vapors or fumes at pH conditions between 2 and 12.5
        it is capable of detonation or explosive decomposition if subjected to strong initiation or under standard temperature and pressure
        it is classified as a Department of Transportation explosive

    Toxicity Characteristic

        if an extract of the waste is found to contain certain metals, pesticides or selected organics above specified levels (see list).
        if it is otherwise capable of causing environmental or health damage if improperly disposed (this is a judgment you must make based upon your knowledge of the material from the Material Safety Data Sheet or the literature).

Packaging Chemical Wastes

Place hazardous waste in sealable containers. Waste disposal cost is based on volume, not weight, therefore, whenever possible, containers should be filled, leaving headspace for expansion of the contents. Often the original container is perfectly acceptable.

If you routinely generate significant quantities of compatible solvents or other liquids, bulking of waste in five-gallon carboys provided by EH&S may be practical. Savings to the University from this practice are substantial. If you are interested, please call EH&S at 270-1216.

The container should not react with the waste being stored (e.g. no hydrofluoric acid in glass). Similar wastes may be mixed if they are compatible (e.g. non-halogenated solvents).

Whenever possible, wastes from incompatible hazard classes should not be mixed (e.g. organic solvents with oxidizers). Certain metals also cause disposal problems when mixed with flammable liquids or other organic liquids (see special wastes).

Containers must be kept closed except during actual transfers. Do not leave a hazardous waste container with a funnel in it. See Storage of Chemical Waste for more information.

Chemical containers that have been triple-rinsed and air-dried in a ventilated area can be placed in the trash or recycled. If the original contents were highly toxic, the container should be rinsed first with an appropriate solvent and the washings disposed of as hazardous waste. See Disposal of Empty Glass Chemical Containers for more information.

Labeling of Chemical Waste Containers

Containers containing hazardous waste must be labeled with the words HAZARDOUS WASTE along with the names of the principal chemical constituents and the approximate percentage.

Waste container labels (see below) can be obtained by contacting Environmental Health & Safety at 718-270-5212. Use of these labels is preferred but not mandatory unless the waste will be placed in storage before disposal. If you choose not to use the standard labels, the container still must be labeled with the words HAZARDOUS WASTE.

Do not list reactants, only products. For example, if cyanide was used in a reaction but all of the material was oxidized to a cyanate before disposal, do not list cyanide on the label.

Use IUPAC or common names, not symbols, structural diagrams or product trade names.

Labeling should be accurate and legible and should include the name of the generator, the name of the lab group or PI, the department, and an extension where someone who is knowledgeable about that specific waste can be reached on the day of the pickup in case questions arise during packaging for disposal.

Special Hazardous Wastes

Mercury, Thallium, Beryllium, and Osmium pose special disposal problems - especially when in combination with other wastes. If you will be generating wastes containing these elements please contact EH&S before you begin.

Metallic mercury is a recyclable waste.

Used oil is not disposed as part of the hazardous waste program, with the following exceptions:

- vacuum pump oil
- cutting oils
- PCB contaminated oil
- oil mixed with hazardous waste

Do not label used oil as hazardous waste. Instead, label the container with the words "Used Oil", not "waste oil", along with the names of any other constituents. .

Silica gel, molecular sieves and desiccants are not considered hazardous waste unless they are grossly contaminated. Contaminated silica gel can be recycled. See Disposal of Silica Gel, Molecular Sieves and Desiccants for more information.

Uranium and thorium compounds, such as uranyl acetate, uranyl nitrate, uranyl formate, uranium oxide, thorium nitrate and thorium oxide, are considered radioactive waste, rather than chemical waste.

Chemical waste not properly identified is unacceptable. It is the chemical user's responsibility to identify and properly label all chemical wastes. The disposal company cannot legally transport or dispose of unidentified/unknown waste.

Storage of Chemical Waste

Containers of hazardous waste may be stored in an area of a laboratory or facilities operation near the point of generation. This area must be controlled by the principal investigator or workers generating the waste. State and federal regulations stipulate how waste generators store chemical waste and require the following:

Any container used to store hazardous waste must be labeled with the words "hazardous waste" (regardless of its location) as soon as accumulation begins. Labels for this purpose are available from EH&S by calling 270-1216.

Be sure that the container is compatible with the chemical waste. Use containers that are made of or lined with materials, which will not react with, and are otherwise compatible with, the hazardous waste to be stored. For example, do not place hydrofluoric acid in glass. Often the original container is suitable.

Waste containers must be closed at all times, except when being filled. Do not leave funnels in the containers.

Be sure that containers in the waste storage area do not leak. Consider the use of secondary containment, such as a tray, larger container or basin. If a leaking container is found, immediately clean up any spilled material according to established spill cleanup procedures and transfer the waste into a container that is in good condition.

No more than one quart of an acutely hazardous waste (P-listed wastes) or 55 gallons of other hazardous wastes may be stored (per waste stream) in the waste storage area. If this threshold quantity is reached, the worker must transfer the waste to a 90-day storage area or send it out to an off-site authorized commercial facility within three days. The container must bear a hazardous waste label with the accumulation date (either the date the threshold quantity was reached or the date it was placed in the 90-day storage area) marked on the container.

Like any chemical storage in the laboratory or work area, be sure to segregate the containers according to the type of waste.

Waste stored near drains (floor, sink, cup sink) should have secondary containment. If you have a sink or drain that is not in use, contact maintenance to explore possibilities for plugging or sealing the drain. Secondary containers must be compatible with the waste. Contact EH&S for more information.

90-Day Storage Areas

There is one 90-day storage area on campus. Wastes stored in this room will shipped to an off-site authorized commercial facility within 90 days from the accumulation date.

Disposal of Empty Chemical Containers

Chemical containers that have been emptied (generally this means drained of their contents by normal methods including pouring, pumping, aspirating, etc.) are not regulated as hazardous waste; however they should not necessarily be disposed of in the regular solid waste dumpsters. Generally, the primary container (the container that actually held the chemical, as opposed to a container that the primary chemical was packed in) must be triple rinsed with water or other suitable solvent and air-dried before disposal. For volatile organic solvents (e.g. acetone, ethanol, ethyl acetate, ethyl ether, hexane, methanol, methylene chloride, petroleum ether, toluene, xylene, etc.) not on the list of acutely hazardous wastes, the emptied container can be air-dried in a ventilated area (e.g. a chemical fume hood) without triple rinsing.

The waste generator must determine whether the washings must be collected and disposed of as hazardous waste. Generally, if the chemical is on the list of acutely hazardous wastes or if the material is known to have high acute toxicity, the washings must be collected.

Glass Containers

Glass containers must be triple-rinsed with water or other suitable solvent and air-dried to ensure that it is free of liquid or other visible chemical residue. Intact containers (with caps removed) meeting these criteria should be placed in glass recycling receptacles. If a suitable glass-recycling receptacle is not available, place the containers in a box marked "recyclable glass" and place the box in the hallway for removal by Building Services personnel. Glass bottle receptacles, consisting of a 20-gallon rubber container with a half lid, are available from Building Services.

If the glass container has visible residue and this residue is hazardous, the container should be disposed as medical waste. Labeled medical waste cardboard boxes with plastic liners are available through Building Services.

Broken glass containers that are free of chemical residue should be placed in broken glass receptacles or placed in a puncture resistant container, such as a rigid plastic container or corrugated cardboard box. The plastic container or box should be sealed and placed in regular laboratory trash.

Metal Containers

Metal containers must be triple-rinsed with water or other suitable solvent and air-dried. If the container is free of hazardous chemical residues, it may be placed in the regular laboratory trash. Otherwise, it should be disposed as medical waste.

Secondary Containers

Containers that were used as overpack for the primary chemical container may be placed in regular trash or recyclable trash. Any packing materials, such as vermiculite, perlite, clay, styrofoam, etc., may be placed in the regular trash unless it was contaminated with the chemical as a result of container breakage or leak. Packing materials contaminated with hazardous materials should be disposed of as hazardous waste.

If you have any questions, please contact Environmental Health & Safety (718-270-1216)

APPENDIX A: HOW TO ACCESS ONLINE AND UNDERSTAND SDSs

Please follow all instructions carefully. If any difficulties are encountered while trying to gain access to this information, please call the Office of Environmental Health and Safety at x5212 or x1216

1. Go to www.downstate.edu

2. On the left side of the computer screen, there is a list of services offered by SUNY. Click on "Administration"

3. Click on "Safety Data Sheets," located under Intranet

4. A search page comes-up with the following information:

Product Name: ______________________________

Manufacturer: ______________________________

5. Type in name of chemical or product, or the manufacturers' name, whichever is applicable/available. Then click on the 'Search option'

Chemical manufacturers are required by law to supply "Safety Data Sheets" (OSHA Form 174 or its equivalent) upon request by their customers. These sheets have nine sections giving a variety of information about the chemical. Following is a section-by-section reproduction and explanation of a Safety Data Sheet (SDS).

U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration
MATERIAL SAFETY DATA SHEET
Required For compliance with OSHA Act of 1970
Public Law 91-596 (CFR 1910)

SECTION I	
Product Name	Size
Chemical Name	
Formula	
Manufacturer	
Address	
For Information on Health Hazards Call	
For Other Information Call	
Signature and date	

This section gives the name and address of the manufacturer and an emergency phone number where questions about toxicity and chemical hazards can be directed. Large chemical manufacturers have 24-hour hotlines manned by chemical safety professionals who can answer questions regarding spills, leaks, chemical exposure, fire hazard, etc. Other information that may be contained in Section I include:

- Trade Name: This is the manufacturer's name for the product.

- **Chemical Name and Synonyms:** This refers to the generic or standard names for the chemical.
- **Chemical Family:** This classification allows one to group the substance along with a class of similar substances, such as mineral dusts, acids, caustics, etc. The potential hazards of a substance can sometimes be gauged by experience with other chemicals of that hazard class.

SECTION II - HAZARDOUS INGREDIENTS OF MIXTURES		
Principal Hazardous component(s)	%	TVL (Units)

This section describes the percent composition of the substance, listing chemicals present in the mixture. It lists Threshold Limit Values for the different chemicals that are present.

Threshold Limit values (TLV's) are values for airborne toxic materials that are used as guides in the control of health hazards. They represent concentrations to which nearly all workers (workers without special sensitivities) can be exposed to for long periods of time without harmful effect. TLV's are usually expressed as parts per million (ppm), the parts of gas or vapor in each million parts of air. TLV's are also expressed as mg/m^3 the milligrams of dust or vapor per cubic meter of air.

SECTION III - PHYSICAL DATA	
Boiling Point (^oF)	Specific Gravity (H_2O=1)
Vapor Pressure (mm Hg)	Percent Volatile By Volume (%)
Vapor Density (Air=1)	Evaporation Rate (Butyl Acetate=1)
Solubility in Water	
Appearance and Odor	

This section gives information about the physical characteristics of the chemical. This information can be very useful in determining how a chemical will behave in a spill situation and what appropriate steps should be taken.

- **Vapor Pressure:** Vapor pressure (VP) can be used as a measure of how volatile a substance is…how quickly it evaporates. VP is measured in units of millimeters of mercury (mm Hg). For comparison, the VP of water (at 20^o Centigrade) is 17.5 mm Hg. The VP of Vaseline (a nonvolatile substance) would be close to zero mm Hg, while the VP of diethyl ether (a very volatile substance) is 440 mm Hg.
- **Vapor Density:** Vapor density describes whether the vapor is lighter or heavier than air. The density of air is 1.0. A density greater than 1.0 indicates a heavier vapor, a density less than 1.0 indicates a lighter vapor. Vapors heavier than air (gasoline vapor for instance) can flow along just above the ground and can collect in depressions where they may pose a fire and explosion hazard.
- **Specific Gravity:** Specific gravity describes whether the liquid is lighter or heavier than water. Water has a specific gravity of 1.0.
- **Percent Volatile by Volume:** Describes how much of the substance will evaporate

SECTION IV - FIRE AND EXPLOSION HAZARD DATA			
Flash Point (^oF)	Flammable Limits in Air (% by Vol.)	Lower	Upper
Extinguisher Media		Autoignition Temperature (^oF)	
Special Fire Fighting Procedures			

Explosion Hazards

This section gives information, which is important for preventing and extinguishing fires and explosions. If a fire does occur, this information should be made available to fire fighters.

- Flash Point: Flash point is the lowest temperature at which a liquid gives off enough vapor to ignite when a source of ignition is present. A fire or explosion hazard may exist if the substance is at or above this temperature and used in the presence of spark or flame.
- Flammable Limits: In order to be flammable, a substance must be mixed with a certain amount of air (as in an automobile carburetor). A mixture that is too "lean" (not enough chemical) or too "rich" (not enough air) will not ignite. The Lower Explosive Limit (LEL) and the Upper Explosive Limit (UEL) define the range of concentration in which combustion can occur. The wider the range between the LEL and UEL, the more flammable the substance is.

SECTION V - HEALTH HAZARD DATA
Threshold Limit Value
Effects of Overexposure
Acute Overexposure
Chronic Overexposure
Emergency and First Aid Procedures
Inhalation
Eyes
Skin
Ingestion

This section describes the potential health effects resulting from overexposure to the chemical and gives emergency and first aid procedures. The symptoms and effects listed are the effects of exposure at hazardous levels. Most chemicals are safe in normal use and the vast majority of workers never suffer toxic effects. However, any chemical can be toxic in high concentrations, and the precautions outlined in the SDS should be followed.

The health hazards section often contains information on the toxicity of the substance. The data most often presented are the results of animal experiments. For example, "LD50 (mouse) = 250 mg/kg." The usual measure of toxicity is dose level expressed as weight of chemical per unit body weight of the animal-usually milligrams of chemical per kilogram of body weight (mg/kg). The LD50 describes the amount of chemical ingested or absorbed by the skin in test animals that causes death in 50% of test animals used during a toxicity test study. Another common term is LC50, which describes the amount of chemical inhaled by test animals that causes death in 50% of test animals used during a toxicity test study. The LD50 and LC50 values are then used to infer what dose is required to show a toxic effect on humans.

As a general rule of thumb, the lower the LD50 or LC50 number, the more toxic the chemical. Note there are other factors (concentration of the chemical, frequency of exposure, etc.) that contribute to the toxicity of a chemical, including other hazards the chemical may possess.

Health hazard information may also distinguish the effects of acute and chronic exposure. Acute toxicity is generally thought of as a single, short-term exposure where effects appear immediately and the effects are often reversible.

Chronic toxicity is generally thought of as frequent exposures where effects may be delayed (even for years), and the effects are generally irreversible. Chronic toxicity can also result in acute exposures, with long-term chronic effects.

SECTION VI - REACTIVITY DATA		
Stability	Unstable	Conditions to Avoid
	Stable	
Incompatibility (Materials to Avoid)		
Hazardous Decomposition Products		
Hazardous Polymerization		Conditions to Avoid
May Occur	Will Not Occur	

This section gives information on the reactivity of the chemical – with other chemicals, air, or water, which is important when responding to a spill or fire. Chemical substances may be not only hazardous by themselves, but may also be hazardous when they decompose (break down into other substances) or when they react with other chemicals.

- Stability: Unstable indicates that a chemical can decompose spontaneously under normal temperatures, pressures, and mechanical shocks. Rapid decomposition may be hazardous because it produces heat and may cause a fire or explosion. Stable compounds do not decompose under normal conditions.
- Incompatibility: Certain chemicals should never be mixed because the mixture creates hazardous conditions. Incompatible chemicals should not be stored together where an accident could cause them to mix.
- Hazardous Decomposition Products: Other chemical substances may be created when a chemical burns or decomposes.
- Hazardous Polymerization: Some chemicals can undergo a type of chemical reaction (rapid polymerization), which may produce enough heat to cause containers to explode. Conditions to avoid are listed in this section.

SECTION VII - SPILL OR LEAK PROCEDURES
Steps to be Taken in Case Material is Released or Spilled
Waste Disposal Method

This section can provide specific information about how to clean up a spill of the chemical and how the chemical should be properly disposed.

SECTION VIII - SPECIAL PROTECTION INFORMATION		
Respiratory Protection (Specify type)		
Ventilation	Local Exhaust	Special
	Mechanical (general)	Other

Protective Gloves	Eye protection
Other Protective clothing or Equipment	

This section gives information for any special protection that needs to be taken when handling this chemical including ventilation requirements and the type of personal protective equipment that should be worn.

SECTION IX - SPECIAL PRECAUTIONS
Precautions to be Taken in Handling and Storing
Other Precautions

This section describes other precautionary measures that may need to be taken. Some of the precautions presented are intended for large-scale users and may not be necessary for use with small quantities of the chemical. Any questions about precautions or health effects should be referred to Environmental Health & Safety at 718-221-5212.

APPENDIX B: GUIDELINES FOR THE ALLOCATION OF RESEARCH LABORATORY SPACE IN THE COLLEGE OF MEDICINE

Principles:

A) Though the ultimate authority for space allocation resides with the Dean of the College of Medicine, Departmental Chairs have been given the primary responsibility for assigning or reassigning space, in accordance with the principles outlined below.

B) Space assignments are not deeded for "life" but will be periodically reviewed and adjusted, when necessary, to reflect changes in (1) research direction, (2) the size, scope and nature of research that is ongoing, and (3) the magnitude of funding and the source of that funding (peer-reviewed full indirect cost-bearing grants being most valuable to the institution). The Department Chair is responsible, in the first instance, for this periodic review of the space allocation/usage within his/her department, using available qualitative and quantitative measures of productivity relating to research.

C) As a rule, faculty members and staff personnel should be assigned space appropriate to their needs by their department chair. When those needs change, e.g., when an individual no longer applies for or is unable to secure peer-reviewed indirect cost-bearing extramural funds, the chair will re-assign space that is more appropriately sized to accommodate his/her needs. If a faculty member or staff member is unwilling to accept space offered to him/her by his/her chair, the issue should be referred to the Dean or appropriate administrative officer for adjudication.

D) In order to enjoy the continued use of laboratory space, faculty members must meet two threshold conditions:
   1) They must have published at least one paper reporting the results of their laboratory-based research in a peer-reviewed journal as first or senior author in the previous two years.
   2) They must be fully compliant (or become compliant within 30 days of notification of non-compliance) with all applicable EPA, OSHA, PESH, Fire Marshal, and other regulatory authorities.

E) Once these threshold conditions have been met, laboratory research space should be allocated according to the following criteria (in descending priority):
   1) Investigators who have secured peer-reviewed grants that bear full indirect costs. Expenditure of these monies should be directly related to the use of the space provided.
   2) Investigators who have secured peer-reviewed grants that bear indirect costs at less than the current federal rate. Expenditure of these monies should be directly related to the use of the space provided.
   3) Currently unfunded investigators who have persistently pursued indirect cost-bearing extramural funding (at least one application per year) after expiration of their grants and who continue to publish research findings as first or senior author in peer-reviewed journals.

F) New faculty should be allowed a minimum of three years to obtain extramural funding. Biotech research per se that does not attract indirect cost-bearing extramural funding is not sufficient justification for allocation of research space within the medical center.

G) When possible, small amounts of lab space may be made available to unfunded faculty with major teaching responsibilities who are pursuing small research projects.

H) There should be a relationship between the proven ability to acquire peer-reviewed indirect cost-bearing extramural research support (or the pursuit of that support) and space needs described therein and the quality and size of research space that is allocated. In particular, we affirm the principle that research lab space allocation should be commensurate with and proportional to research productivity and demonstrated research need.

I) Faculty with reduced 'wet laboratory' research activity will be expected to relinquish underutilized research lab space and make it available for other uses. Inadequate utilization of research space could be identified by one or both of the following criteria: (1) a lack of papers published as first or senior author over a period of three or more consecutive years, or (2) a lack of extramural research funding, in particular a lack of attempts to obtain such funding, over a period of two or more consecutive years.

J) Scholarly and academic pursuits that do not require wet laboratories for their execution are not a sufficient basis for the retention of previously allocated research laboratory space. Longevity of space retention is not a justifiable basis for retaining that space. No individual has an inviolate claim to space solely because he/she has occupied that space in the past.

K) Re-consideration of space that is assigned to faculty should be triggered by the failure to apply for peer-reviewed extramural support within a one-year period (unless of course such monies are on hand for that period of time). In such cases, the Chair is expected, within 60 days, to review the faculty member's plan for securing peer-reviewed, indirect cost-bearing support and report to the Dean on their assessment of:
   1) the merit of the plan itself;
   2) the aggressiveness of the timeframe and the level of effort that the faculty member is prepared to commit, in light of their other responsibilities; their assessment of the likelihood of success; and
   3) the milestones by which progress toward the eventual goal could be measured.

   The Dean will then approve or modify the Chair's recommendation.

L) In any case, a faculty member who loses research support should be given at least one year from the time that funding was lost to obtain extramural funding before the space is re-allocated.

General Recommendations:

It is recognized that sharing of space in basic science departments with clinical departments is necessary if Downstate is to grow its research enterprise. However, every effort should be made to ensure that there are meaningful collaborations among co-located investigators. It is important that allocation of research space to clinician scientists be accompanied by an explicitly stated commitment by their department, e.g., protected time, which will maximize the likelihood that the research for which space is being provided will be successfully completed. The willingness of pre-clinical departments to join forces with their clinical counterparts should be matched by an equivalent commitment from the relevant clinical chair and space occupied by clinical departments should be subjected to the guidelines outlined above and evaluated accordingly.