

**University of Illinois
at Urbana-Champaign**

Chemical Safety Guide

Emergency reference numbers:

Police, Fire, or Ambulance.....9-911
Chemical Safety.....333-2755

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Table of Contents

Chapter 1: Introduction	3
• Purpose.....	3
• What's in this Guide.....	3
• Overview of the Chemical Safety Section.....	4
• Basic chemical safety practices.....	4
Chapter 2: Chemical Safety Principles and Concepts	6
• Introduction.....	6
• Physical Hazards.....	6
• Health Hazards.....	7
• Factors Affecting Toxicity.....	8
• Routes of Exposure.....	9
• Controlling Chemical Exposures.....	10
Chapter 3: Standard Operating Procedures	11
• General Procedures.....	11
• Pollution Prevention/Waste Minimization.....	14
• Personal Protective Equipment and Personal Hygiene.....	14
• Hazard Assessments.....	15
• Handling and Storage of Chemicals.....	15
• Fume hoods and other engineering controls.....	17
• Prior approval for use of certain hazardous materials.....	18
• Special provisions (select carcinogens, reproductive toxins, and acutely toxic chemicals).....	18
• Chemical hygiene officers.....	20
Chapter 4: Training and Information	21
• Initial Training.....	21
• Material Safety Data Sheets (MSDSs)	21
• Other Sources of Information.....	22
Chapter 5: Medical Consultation	24
• Medical Emergencies.....	24
• Accidents Involving Chemicals.....	24
• Medical Surveillance.....	25
Chapter 6: Emergency Procedures	26
• Responding to a Chemical Spill or Emergency.....	26
• Complicated Spills.....	26
• Simple Spills.....	27
• Mercury Spills.....	28
• Preparing for Spills.....	28
• Preventing Spills.....	30
Appendix 1: OSHA Laboratory Standard (complete text).....	31
Appendix 2: Campus Policies and DRS Guidance Materials.....	40
Appendix 3: Chemical Safety References Available from DRS.....	42
Appendix 4: Chemical Resistivity Chart for Gloves.....	43
Appendix 5: Sample PPE Hazard Assessment and Certification Forms.....	44
Appendix 6: List of Peroxide Forming Chemicals.....	45
Appendix 7: Sample Emergency Contact Sign.....	47

UIUC Chemical Safety Guide

Chapter 1: Introduction

Purpose

The purpose of the UIUC Chemical Safety Guide is to provide chemical safety information and recommended work practices and procedures to protect workers and students at the University of Illinois at Urbana-Champaign (UIUC) from health hazards associated with hazardous chemicals.

The Occupational Safety and Health Administration (OSHA) has established two programs for employees who work with chemicals. The OSHA Laboratory Standard applies to employees who work with hazardous chemicals in laboratories, while the OSHA Hazard Communication Standard (or Worker Right-to-Know) applies to all other employees who work with hazardous chemicals. In Illinois, both programs are administered by the Illinois Department of Labor (IDOL).

The OSHA Laboratory Standard is available online at <http://www.osha.gov/>. For a quick overview of the standard, please review the Laboratory Standard Fact Sheet, also available online at <http://www.osha.gov/>.

The UIUC Division of Research Safety (DRS) has developed programs to assist the campus community in complying with government regulations. In addition to providing chemical safety information and recommending safe procedures, this guide contains information on the basis for regulatory compliance programs.

This guide will be updated periodically. You may view the most recent version of the **UIUC Chemical Safety Guide** on the **DRS website**. From the DRS website, you can easily navigate to the **Chemical Safety Section** page to find this guide.

What's in this Guide?

The first edition of the UIUC Chemical Safety Guide was produced in December 1998. It contains six chapters and an index.

Chapter 1 contains an introduction to chemical safety; information specific to UIUC's philosophy on chemical safety; and basic chemical safety practice.

Chapter 2 contains general information about chemical safety principles. Topics addressed are physical hazards; health hazards; routes of exposure; acute and chronic exposures; factors affecting toxicity; and methods for controlling chemical exposures.

Chapter 3 presents standard operating procedures. This section contains the core information about recommended procedures at UIUC. Topics addressed are general procedures; personal protective equipment; handling and storage of chemicals; fume hoods; prior approval; special provisions for select carcinogens, reproductive toxins and acutely toxic chemicals; and chemical hygiene officers.

Chapter 4 addresses training and information. This section describes when training is required; what training is required; and sources of information, particularly Material Safety Data Sheets.

Chapter 5 addresses medical consultation. This section describes how UIUC provides medical services and medical surveillance for the campus community.

Chapter 6 addresses emergency procedures. Topics included are spill preparedness; spill response; and who to contact in the event of an emergency.

Overview of the Chemical Safety Section

The mission of the Chemical Safety Section (CSS) of the Division of Research Safety (DRS) is to work with the campus community to develop and implement an efficient, convenient, comprehensive, and forward-looking chemical safety program. Priorities are as follows:

- Develop chemical safety programs that protect the health and well being of students, faculty, staff, and visitors at UIUC.
- Develop programs to minimize chemical hazards and chemical wastes.
- Provide guidance for the safe handling, storage, and disposal of chemicals used on campus.
- Dispose of chemical wastes in an environmentally sound and cost-effective manner.
- Assist the campus community in complying with federal, state, and local regulations.

Basic chemical safety practices

The following five steps are fundamental to using chemicals safely. More detailed information on these and other safety practices can be found in subsequent chapters of this document.

- **Develop and follow a written safety plan:** If you work in a laboratory, this would be a chemical hygiene plan; in other work areas, this would be a hazard communication plan.
- **Know where the Material Safety Data Sheets (MSDSs) and other information sources for the chemicals you work with can be found.** Knowing the hazards of the chemicals you work with are fundamental to working with chemicals safely.
- **Make sure all your chemical containers are labeled.** Each container must be labeled with the chemical name(s) and hazard warning(s).
- **Maintain good housekeeping.** Good housekeeping is the most important step one can take to improve safety. It also provides a good impression for visitors.

- **Document training of employees.** Train new employees on the OSHA Hazard Communication standard or the OSHA Laboratory Standard, as appropriate. Provide refresher training annually or when new procedures are implemented.

Government inspectors periodically visit campus for regulatory compliance inspections. When this happens, it is possible that they may visit your work place and speak with you. If this occurs, please call DRS immediately at 333-2755. DRS will provide assistance in addressing the concerns of the inspector.

UIUC Chemical Safety Guide

Chapter 2: Chemical Safety Principals and Concepts Introduction

Introduction

The hazards of chemicals vary widely and appropriate caution must always be used. Every chemical can be hazardous in certain circumstances. For example, even water can be a serious health hazard under certain conditions and when the proper personal protective equipment is not used (e.g. drowning). An understanding of the hazards of chemicals and how they enter the body can help those working with chemicals devise procedures to work with them safely.

This chapter presents information on the physical and health hazards associated with chemicals, factors affecting toxicity, routes of exposures, and general measures that can be taken to control chemical exposures.

Physical Hazards

The following terms are frequently used when describing the physical hazards associated with chemicals:

- **Combustible liquid:** Any liquid, or mixture with 1% or more of a liquid, with a flashpoint above 140° F but below 200° F.
- **Compressed gas:** A gas or gas mixture with an absolute pressure exceeding 40 p.s.i. at 70° F, or exceeding 104 p.s.i. at 130° F, or a liquid having a vapor pressure exceeding 40 p.s.i. at 100° F as determined by ASTM D-232-72, a standard of the American Society of Testing and Materials.
- **Explosive:** A chemical that causes a sudden, almost instantaneous release of gas, pressure, and heat when subjected to sudden shock, high temperature or pressure.

Flammable:

- *Aerosol:* A material that can produce a flame or flashback from a valve opening.
- *Gas:* Any gas at ambient conditions that will cause a flammable mixture with air in concentrations of 13% or less.
- *Liquid:* Any liquid, or mixture with 1% or more of a liquid, with a flash point below 141° F.
- *Solid:* A material that is liable to cause fire through friction, contact with moisture, spontaneous reaction, or retained heat, or which can be readily ignited and burns with enough persistence or violence to cause a serious health hazard.

- **Organic peroxides:** An organic compound with a bivalent O-O structure, which may be considered a peroxide derivative with one or both of the hydrogen atoms replaced with an organic molecule. They present dangerous fire and explosion risks; many are strong oxidizers.
- **Oxidizer:** A chemical that initiates or supports combustion of other materials, causing fire by itself or by the release of oxygen or other gasses.
- **Pyrophoric:** A material that will ignite spontaneously in air at or below 130° F.
- **Unstable:** Any material, which will vigorously decompose, polymerize, condense, or will become self reactive when exposed to conditions of shock, pressure, or temperature.
- **Water-reactive:** A material which can react with water or steam to produce a gas which is either toxic or flammable.

Health Hazards

The following are health hazard classes as defined by the Occupational Safety and Health Administration:

- **Carcinogen:** A material which causes or potentially causes cancer according to the International Research on Cancer, or is listed as such in the National Toxicology Program Annual Report on Carcinogens <http://ehis.niehs.nih.gov/roc/> .
- **Corrosives:** Chemicals that cause visible destruction of, or irreversible alterations in, living tissue by chemical action at the site of contact.
- **Irritants:** Chemicals which are not corrosive, but which cause reversible inflammatory effects on living tissue at the site of contact.
- **Mutagen:** A material that damages chromosomes.
- **Sensitizer:** A chemical, which will cause an allergic reaction in a substantial number of exposed people.
- **Target organ effects:**
 - Cutaneous hazards: damage the skin
 - Eye hazards: damage the eye
 - Hematopoietic toxins: damage the blood and/or blood forming organs
 - Hepatotoxic: damage the liver
 - Nephrotoxic: damage the kidneys
 - Neurotoxins: damage the nervous system

- Pulmonary toxins: damage the lungs
- Reproductive toxins: affect the fetus
- **Teratogen:** A material that causes birth defects
- **Toxic:** A chemical with an oral lethal dose of 50-500 mg/kg, a cutaneous lethal dose of 200-1000 mg/kg, or a lethal concentration in air of 200-2000 ppm.
- **Highly toxic:** A material with an oral lethal dose of <50 mg/kg, a cutaneous lethal dose of <200 mg/kg, or lethal concentration in air at <200 ppm.

Factors Affecting Toxicity

All chemicals are hazardous under some conditions. An understanding of the factors that affect toxicity is helpful in devising safe procedures to prevent hazardous exposures. Some of these factors are briefly discussed below:

- **Dose:** Perhaps the single most significant factor of concern is the amount of exposure to the chemical. An exposure to a large amount of the chemical is usually of more concern than exposure to a small amount. For most chemicals, there is a level of exposure below which no adverse effects are likely to be observed.
- **Toxicity:** Chemicals vary widely in how toxic (poisonous) they are. Exposure to small amounts of highly toxic chemicals can be a greater danger than exposure to large amounts of less toxic chemicals.
- **Duration and frequency:** One-time exposures that are of short duration are of less concern than multiple exposures of long duration, all other factors being equal. Thus, when there has been a chemical exposure, an important piece of information concerns duration and frequency.
- **Synergistic effects:** Many situations involve exposure to two or more chemicals at the same time. When this happens, it is possible that the combined exposures are more hazardous than what one might expect from simply adding the two effects together. While information to exposures to a single chemical is often available, good information on the possible toxic effects to chemical mixtures is often not available.
- **Individual characteristics:** Each person is unique. While there are many similarities in response to chemical exposures, responses may vary dramatically among individuals. For examples, males can react differently than females. Special concern is often given for women who are pregnant. Some individuals are allergic or hypersensitive to certain chemicals.
- **Acute and chronic effects:** Acute effects are those that show up immediately after a chemical exposure occurs. A good example of an

acute effect is the spillage of acid on the skin--a chemical burn will occur immediately. Chronic effects are those that occur after a significant amount of time passes and usually are the result of multiple exposures over a period of time. Cancer is a typical example of a chronic effect because cancers caused by chemical exposures often do not show up until 20 or more years after the initial exposure.

Routes of Exposure

There are three major routes of entry for a chemical to enter the body: inhalation; direct contact (to skin and eyes); and ingestion. Injection is a fourth, though much less common, route of entry for chemicals. An understanding of these routes of entries enables one to develop procedures or controls to prevent hazardous exposures to chemicals.

- **Inhalation hazards:** Inhalation of chemicals is the most common route of entry a chemical can take to enter the body. Chemicals that could be inhaled include:
 - Gases
 - the vapors of volatile liquids
 - mists and sprays of both volatile and nonvolatile liquid substances
 - solid chemicals in the form of particles, fibers, and dusts
- **Direct (skin/eye) contact hazards:** Many chemicals (e.g. corrosives) can injure the skin directly, while others may cause irritation or an allergic reaction. In addition to causing local toxic effects, many chemicals may be absorbed through the skin and/or eyes in sufficient quantity to cause systemic effects. The main avenues by which chemicals enter the body through the skin are hair follicles, sebaceous glands, sweat glands, and cuts or abrasions of the skin. Direct contact effects and absorption of chemicals through the skin depend on a number of factors, including:
 - chemical concentration
 - chemical reactivity
 - the solubility of the chemical in fat and water
 - the condition of the skin
 - the duration of contact
- **Ingestion hazards:** Ingestion of chemicals is a less common route of entry into the body. However, persons using chemicals can easily ingest chemicals into the body via contaminated hands if they are not washed prior to eating, drinking, smoking, applying cosmetics, or sticking part of the hand or a writing tool that has become contaminated into the mouth.
- **Injection hazards:** This route is the least likely for chemical exposures. Accidental injection of chemicals through needles is unlikely. However, if needles are contaminated or contaminated glassware breaks, there is the possibility of injecting chemicals into the body. Injections can also occur through high pressure streams of liquids or gases.

Controlling Chemical Exposures

Using the information presented in the earlier sections of this chapter and knowing the specific hazards of the chemicals to be used, one can design procedures to minimize hazards. At no time should any campus employee be exposed to any chemical above the OSHA Permissible Exposure Limit (PEL) or Short Term Exposure Limit (STEL). These limits have been established by OSHA as protective of virtually all workers. You may request assistance from the Division of Research Safety (333-2436) in developing or reviewing procedures to control chemical exposures.

Control techniques fall into three broad classes in order of preference: engineering controls, administrative controls, and personal protective equipment.

- **Engineering controls:** Options for engineering controls are those that eliminate the hazard through methods such as changing the procedures or substituting less hazardous materials for more hazardous materials. Conducting work with hazardous chemicals in a fume hood or glove box, and providing secondary containment in the event of spills are examples of engineering controls.
- **Administrative controls:** Whereas engineering controls are controls that work passively once they are established, administrative controls require that workers take active steps. Examples of administrative controls are posting hazard signs on laboratory doors, minimizing exposure time when working with hazardous chemicals, restricting access to areas where hazardous chemicals are used, working with highly odorous chemicals during non-office hours, and adopting standard operating procedures like those listed in Chapter 3.
- **Personal protective equipment:** Personal protective equipment includes items such as gloves, eye protection, suitable clothing, and respirators. Because such equipment is the last line of defense against exposure to hazardous chemicals, these are the options last employed. Note that selection of appropriate personal protective equipment is not always straightforward. In the case of gloves, there are a wide variety of types depending on the specific application. Although some types of personal protective equipment may be suitable for a wide range of applications, each operation should be assessed individually.

UIUC Chemical Safety Guide

Chapter 3: Standard Operating Procedures

This document represents a minimum set of guidelines for the handling of toxic chemicals on campus. Individual administrative units, laboratories, or research groups are expected to develop more detailed procedures as their situations warrant. Safety references such as those listed in Appendix 3 of this document may be useful in developing additional procedures. As outlined in the Campus Administrative Manual, supervisors and principal investigators are responsible for complying with and/or enforcing appropriate safety and hygiene measures in the work areas they supervise. The Division of Research Safety (DRS) is available for consultative assistance to develop safe procedures for situations not covered in this guide.

Some rules or standard operating procedures, which apply to all work areas on campus, include the following:

General Procedures

Respect and understand the safety and health hazards associated with the chemicals and equipment you use, and practice the following general safety guidelines at ALL times:

Accident response: If an injury requiring emergency medical assistance has occurred, call 9-911. You may obtain 9-911 stickers from the Division of Public Safety at 333-1216. See Chapter 5 for more information.

Chemical spills: If a toxic/hazardous chemical has made contact with the skin, start flushing the area immediately. If emergency assistance is required, call 9-911. Cleanup procedures for chemical spills are presented in Chapter 6.

Children and unauthorized persons: Children and other unauthorized persons should not be in laboratories where hazardous materials or hazardous equipment are being used.

Disposal of chemicals: Requests for collection of chemical waste must be submitted in writing as outlined in the UIUC Chemical Waste Management Guide. Questions about chemical waste management should be directed to the Chemical Safety Section of DRS at 333-2436. A list of DRS-prepared resource materials that address common chemical waste issues is found in [Appendix 2](#).

Electrical: Access to electrical equipment (e.g. plugs, switches and electrical panels) should be maintained free from obstructions to allow immediate access in an emergency. All receptacle outlets in laboratory spaces should be the polarized grounding type. Ground Fault Circuit Interrupters (GFCI's) should be used in those locations involving wet processes or outdoor work, including electrical outlets within six feet of sinks. All electrical hand tools used inside laboratories should be grounded or double insulated.

All electrical extension cords used should be visible and inspected on a periodic basis for damage and/or defects. Cords should not run in aisles or corridors where they might be damaged or create a tripping hazard. Cords should not be run through doors, walls or partitions, under rugs, or above dropped ceilings. They should not be wrapped around fixtures, tied in knots, or draped over pipes, lights, or ventilation ductwork.

Extension cords should not be used as substitution for fixed receptacle outlets. Cords used for 110-120 volt service should be UL listed standard heavy-duty three-wire equipped with a polarized three prong plug. Two-wire type extension cords should not be used.

Emergency eye wash/safety showers: Be certain safety showers/emergency eye washes are properly located and maintained. These units should be located in areas which will be immediately accessible (reachable within 10 seconds). There should be no obstructions that might inhibit the use of this equipment.

Eye washes and safety showers should be flushed on a regular basis to verify that the units are working and to clear the lines of stale water and debris. Whenever these emergency units are checked for proper functioning, written documentation showing the date and person's initials performing the check, should be maintained.

Equipment: Use proper equipment that is in good condition. For example, never use chipped or cracked glassware. Shield pressurized or vacuum apparatus and safeguard against bumping or overheating.

Fire extinguishers: Fire extinguishers must be available, charged, and hung in a location which is immediately accessible (reachable within 10 seconds). There should be no obstructions that might inhibit the use of this equipment. Make sure that all extinguishers are checked annually. Each extinguisher should have a tag indicating the date it was last checked. Contact DRS (217) 333-9711 for assistance.

Food, drink, cosmetics: Eating, drinking and the application of cosmetics are forbidden in areas where hazardous chemicals are used and should be done only in well-defined, designated non-chemical areas. Do not store food in the same refrigerator with chemicals, biohazards or radioactive materials.

Horseplay: Practical jokes or other behavior which might confuse, startle, or distract, another worker is forbidden when hazardous chemicals are present.

Housekeeping: Exits, aisles and safety equipment must NOT be obstructed in any way with equipment, furniture, or other items. Aisles within the laboratory should be 36 inches in clear width. Work areas and floors are not to be used for excessive storage. Doors which are not in use but which are accessible from a corridor or adjacent room should be appropriately labeled if they are blocked on the interior of the room. Hallways are not to be used as storage areas. Refer to **Campus Administrative Manual** (CAM) V/B - 6.2, Departmental Use of Corridors. Items may

be stored in corridors only if prior approval is obtained from the Office of Project Planning and Facilities Management (333-1232).

Mercaptans: To avoid false reporting of natural gas leaks, mercaptans should not be used in such a manner (e.g. scrubbers for effluent) that persons outside of the laboratory could smell the mercaptan and suspect a natural gas leak in the building. All persons using mercaptans should report these uses to the campus telecommunicators (3-1216) prior to actual use.

Mouth pipetting: Mouth pipetting is forbidden.

Perchloric acid: If perchloric acid is heated above ambient temperature it may evaporate and condense on ductwork in the form of explosive perchlorates. Hence, when heating perchloric acid above ambient temperature, a perchloric acid fume hood with a water wash down system or a local scrubbing or trapping system must be used.

Signs: Laboratories where hazardous materials or operations are present must follow the UIUC Laboratory Signage Guideline. An emergency contact card, updated at least annually, should be posted on each laboratory entrance. A recommended form with the information needed by emergency responders is available in [Appendix 7](#).

Smoking: No smoking in laboratories. If you have been using chemicals, be sure to wash your hands before smoking.

Spill preparedness: Before working with chemicals, assess potential spill hazards. Each laboratory worker should be familiar with general spill response procedures. Written protocols should be developed when extremely hazardous or large quantities of chemicals are used. Have readily available all necessary personal protective equipment and spill cleanup materials. See [Chapter 6](#) for more detailed information.

Unattended experiments: If operations involving hazardous substances are carried out with no one present, it is the responsibility of the worker to design procedures to prevent the release of hazardous substances in the event of interruptions in utility services such as electricity, cooling water, and inert gas. Lights should be left on, and signs should be posted identifying the nature of the operation and the hazardous substances in use. If appropriate, arrangements should be made for other workers to periodically inspect the operation.

Similarly, if unattended experiments require the use of running water, the worker should develop procedures to make sure the experiment is checked periodically for water leaking from the system. Unattended experiments involving the use of running water have caused flooding damage at UIUC.

Working alone: When working with hazardous materials, it is advisable to have a second person present, or at a minimum, maintain contact via telephone.

Pollution Prevention/Waste Minimization

Waste minimization strategies usually have the dual benefits of improving safety and reducing chemical purchase and disposal costs.

It is recommended that each unit evaluate its procedures periodically to consider the possible usage of less hazardous or smaller quantities of chemicals. This evaluation may include the following issues:

- Is there good housekeeping where chemicals are used and stored?
- Are all containers properly labeled?
- If appropriate, is there an inventory of all chemicals in the unit?
- Do the chemicals in use present significant hazards to those working with them? (e.g. highly reactive, highly toxic, carcinogenic, and/or corrosive chemicals should be discouraged)
- If applicable, consider substitutes for all uses of mercury and chromic acid cleaning solutions

For further information, see the waste minimization Fact Sheets listed in Appendix 2. Additional technical information on ways to implement waste minimization is available from DRS at (217) 333-2436 or [via email](#).

Personal Protective Equipment and Personal Hygiene

Personal protective equipment and personal hygiene are basic aspects of laboratory safety. Wearing appropriate personal protective equipment and practicing good personal hygiene as described below will minimize exposures to hazardous chemicals during routine use and in the event of an accident.

Attire: Wear a lab coat or apron, cover legs (no shorts or skirts) and feet (no sandals or open-toed shoes), confine loose clothing and long hair. Nylons and/or pantyhose are not recommended because they may melt upon contact with acid.

Eye protection: It is state law and campus policy (section V/B-1.4 of the CAM) that personnel including students, staff and visitors in laboratories wear safety glasses, goggles, or face shields at all times where eye hazards are a possibility. Goggles are recommended when chemical splashes are possible.

Contact lenses may be worn in the laboratory; however, they do not provide any protection of the eyes. Persons who wear contacts must use the same eye protective equipment as persons who do not wear contacts.

Face shields: Full-face shields must be worn when conducting a procedure which may result in a violent reaction. Full-face shields with bottom caps to protect the neck are preferred because they provide the best protection.

Glass tubing: When inserting tubing into stoppers, lubricate tubing and wear leather gloves to protect hands from being cut in the event of the tubing slipping and breaking.

Gloves: Gloves are essential when working with hazardous substances. The proper gloves will prevent skin absorption, infection or burns. Glove materials vary in effectiveness in protecting against chemical hazards. Consult a chemical resistance chart such as the one found in [Appendix 4](#), consult a glove manufacturer, or contact DRS (217) 333-2436 for assistance in appropriate selection.

Personal hygiene: Hands should be washed frequently throughout the day, after glove removal, before leaving the lab, after contact with any hazardous material, and before eating, drinking, smoking, or applying cosmetics.

Respiratory protection: Work in a fume hood or provide adequate ventilation when working with materials that produce hazardous vapors or fumes. If the use of a respirator is required, you must comply with UIUC Respiratory Program, which includes a medical assessment, fit testings, and instructions on proper use.

Hazard Assessments

For each task involving hazardous materials or physical hazards, a written hazard assessment must be conducted and certified. Tasks involving similar hazards may be grouped together on a single assessment form. Sample assessment and certification forms for common chemical hazards are presented in [Appendix 5](#). Note that these sample hazard assessment forms may not cover all the chemical hazards you may encounter.

Supervisors and Principal Investigators are responsible for conducting hazard assessments. Such assessments should not be limited to chemical hazards, but should also include such issues, when applicable, as radiation hazards, biological hazards, heat and cold hazards, and physical hazards.

Handling and Storage of Chemicals

Hazards associated with various chemicals and gases vary widely. Understanding the hazards associated with a compound and minimizing the quantity used and stored in the lab will decrease chance of injury.

Compressed gasses: Use appropriate hand carts to move compressed gas cylinders. Gas cylinders should be capped and secured to a cart during transport. Highly toxic gases should not be moved through the corridors, particularly during business hours. Always consider cylinders as full and handle them with corresponding care.

Gas cylinders should be stored in well-ventilated areas with their protective caps on. Gas cylinders should be secured (e.g., strapped or chained in place) to reduce the chance of being knocked over. Do not store cylinders near heat or high traffic areas. Do not store flammables and oxidizers together. Do not store empty and full

cylinders together. Storage of large quantities of cylinders should be in an approved gas cylinder storage area. Refer to the **Compressed Gas Safety Fact Sheet**.

Containers: Make sure all containers are of good integrity. If deteriorated containers are found, dispose of the chemical or transfer it to a new container. Make sure that the container is appropriate for the chemical stored; for example, hydrofluoric acid must not be stored in glass and some oxidizers should not be stored in plastic containers. Waste halogenated solvents may not be stored in metal safety cans due to the potential for corrosion. Flammable materials, if removed from their original containers, should be stored in appropriate containers, such as safety cans or other Department of Transportation (DOT) approved containers. If in a substantial amount (>4 liters, but less than 20), waste solvents should be stored in poly jerricans (Central Stores stock number 37-38-1800 for the 10 liter size).

Cryogenic liquids: These items present the potential hazards of fire or explosion, pressure buildup, embrittlement of structural materials, frostbite, and asphyxiation. Work areas must be well ventilated. Cryogenic liquids must be stored, shipped, and handled in containers that are designed specifically for this purpose. Because of the extreme cold and splash hazards, skin protection and eye protection - preferably a face shield - should be worn when handling cryogenic liquids. First time users of cryogenic liquids should have direct supervision and instruction from an experienced user when attempting transfers from one container to another.

Handling: Encourage the use of poly coated bottles or use bottle carriers for transporting chemicals which are in glass containers. Close caps securely. Pour chemicals carefully. Never add water to concentrated acid; rather prepare dilute solutions by adding acid to water. Containers holding more than five gallons should be grounded when transferring flammable liquids.

Labels: Make sure all labels are legible. Label all containers with the chemical name and appropriate health hazard warning(s). A chemical is considered to pose a health hazard if it is in one or more of the following classes: carcinogen, corrosive, irritant, sensitizer, toxic, or highly toxic. Information on whether a chemical poses a health hazard may be found on the Material Safety Data Sheet.

Date all peroxidizable and other chemicals which may become unstable over time; test and/or dispose of them when appropriate. Common examples of chemicals that form peroxides upon aging are: ethyl ether, isopropyl ether, tetrahydrofuran, and dioxane. See **Appendix 6** for a more complete listing of chemicals that can form peroxides upon aging.

Storage: Avoid storing chemical containers in hard to reach areas. Chemicals should be segregated by hazard classification. Once segregated by hazard class, chemicals may be stored alphabetically. Basic segregations should keep:

- oxidizers away from organics
- air/water reactives away from air and water
- caustics away from acids

- cyanides, sulfides away from acids

Laboratories with large numbers of hazard classifications may choose to further segregate chemicals.

Volatile chemicals should be stored in volatile storage cabinets, or temporarily in fume hoods when cabinets are unavailable. If volatile substances are stored in a hood, other uses of the hood should be restricted to activities compatible with the chemical and physical properties of the stored or used chemicals. When volatiles must be stored in a cooled atmosphere, flammable material refrigerators, explosion-proof refrigerators or cold rooms designed for this purpose must be used. Refer to the [Facilities & Services Flammable Storage Cabinets](#) webpage.

Fume hoods and other engineering controls

All users of fume hoods at the University of Illinois at Urbana-Champaign (UIUC) campus should comply with the Division of Research Safety (DRS) [Work Practices for Laboratory Chemical Hoods](#). Fume hoods and other engineering controls, such as vented gas cabinets, should be surveyed annually by a qualified person (from DRS, O & M, or an outside contractor) with a written report of the results maintained by the unit in charge of the laboratory.

Fume hood velocities for all hoods on campus are currently evaluated on an annual basis by DRS at no charge to the users. The face velocity of the hoods should fall between 80 and 120 feet per minute (fpm) with the sash positioned at approximately half open, unless specified otherwise. (In general, fume hoods should not be used with the sash fully open.) If the face velocity is between 80 and 120 fpm on the day of the evaluation, the fume hood will bear a green sticker on the fume hood cabinet with an arrow pointing to the appropriate sash position. If the face velocity is between 60 and 79 fpm or above 120 fpm, the hood will have a yellow sticker with an arrow indicating sash position. This indicates that the hood is "Restricted" and should not be used for protection from highly toxic substances. Finally, if the face velocity of the fume hood is below 60 fpm, the hood will display a 5" x 7" DANGER sign, which states that the fume hood should be used for storage only.

Users should be certain that their fume hood has a sticker on it and that the date on the sticker is less than a year old. If the sticker is not green, indicating that the fume hood was not functioning properly when last tested, users should work with their departmental business manager to have the fume hood repaired. For maintenance of fume hoods, users should contact the (PC&M) Service Office at 3-0340. (In most cases, academic units are financially responsible for the maintenance of fume hoods.)

Because the status of the fume hood can change within one year, continuous air flow indicators are recommended. New fume hoods should be equipped with air flow monitoring devices which will alert the user if there is a problem with air flow. For older hoods without air flow monitoring devices, a simple visible test to ensure

flow into fume hoods and other ventilating devices is to tape a tissue to the hood and note its movement when the exhaust fan is turned on.

Protective equipment other than fume hoods should be checked periodically by the laboratory supervisor to ensure that the equipment is functioning properly. DRS will assist upon request. Any questions or requests for assistance in evaluation of fume hoods and other engineering controls may be directed to DRS (217) 244-7560 or the PC & M Service Office (217) 333-0340.

Prior approval for use of certain hazardous materials

The responsibility for approval of the acquisition and use of toxic chemical agents rests with the laboratory supervisor. Certain materials including radioactive materials, recombinant DNA and certain biohazardous materials require prior internal (campus) or external approval. Wastes of hazardous materials with multiple hazards (chemical, radioactive and/or biohazardous) often complicate disposal. The Division of Research Safety (DRS) cannot guarantee that there are outlets for wastes exhibiting multiple hazards and we therefore recommend that you contact us prior to conducting experiments that might generate such wastes. Questions concerning the need for approval should be directed to DRS (217) 333-2755.

Special provisions for select carcinogens, reproductive toxins and acutely toxic chemicals

In addition to the general safety guidelines mentioned above, special precautions are needed when handling **particularly toxic chemicals** - such as select carcinogens, reproductive toxins, and chemicals with a high degree of acute toxicity. The laboratory supervisor should ensure that these and other precautions designed to minimize risk of exposure to these substances are taken. The following are minimum guidelines:

- Quantities of these chemicals used and stored in the laboratory should be minimized, as should their concentrations in solution or mixtures. Work with carcinogens, reproductive toxins and acutely toxic chemicals should be performed within a functioning fume hood, ventilated glove box, sealed system, or other system designed to minimize exposure to these substances. (The exhaust air from the ventilation systems may require scrubbing before being released into the atmosphere.) In all cases, work with these types of chemicals should be done in such a manner that the Occupational Safety and Health Administration's (OSHA) permissible exposure limits or similar standards are not exceeded.
- Compressed gas cylinders that contain acutely toxic chemicals, such as arsine and nitrogen dioxide, should be kept in ventilated gas cabinets.
- The ventilation efficiency of the designated fume hood, glove box, or gas cabinet, and the operational effectiveness of mechanical and electrical equipment used to contain or manipulate these special substances should be evaluated periodically by the laboratory personnel at intervals

determined by the laboratory supervisor. The interval of evaluating systems may vary from weekly to biannually depending upon the frequency of usage, quantities employed and level of hazard.

- Each laboratory utilizing these substances must designate an area for this purpose and sign or mark this area with an appropriate hazard warning. The designated area may be an entire laboratory, an area of the laboratory, or a device such as a fume hood or glove box. The designated area should be marked with a sign stating "DANGER, *specific agent*, AUTHORIZED PERSONNEL ONLY" or comparable warning sign.
- All laboratory workers who work in a laboratory which has an area designated for use with carcinogens, reproductive toxins and/or acutely toxic chemicals must be trained about the deleterious effects of these substances plus signs and symptoms regarding exposure to these substances. This training is required even for those who do not actually work with the substances. Training to ensure the safe handling and storage of these substances is required for those who use these materials. This training is the responsibility of the laboratory supervisor and must be done prior to the use of any of these materials.
- Laboratory workers using these chemicals must have access to appropriate personal protective equipment (available at no expense to the workers) and must be trained on how to properly utilize this equipment.
- Detection equipment may be required in laboratories where highly toxic chemicals (especially poisonous gases) are used.
- All wastes contaminated with these substances should be collected and disposed of promptly as outlined in the UIUC Chemical Waste Management Guide. For disposal assistance, call the DRS Chemical Safety Section (217) 333-2436 contact **via email**. Treatment of waste products to lessen or eliminate their toxicity as part of the experimental protocol is encouraged as a way of minimizing health hazards and the amount of waste, only if such treatment can be performed safely.
- The designated working area shall be thoroughly decontaminated and cleaned at regular intervals determined by the laboratory supervisor. The interval may be as short as one day or as long as six months depending upon the frequency of usage and level of hazard.
- Special precautions to avoid release and exposure to carcinogens, highly toxic chemicals and reproductive toxins must be utilized. For instance, volatile substances should be kept cool and contained. Gas cylinders should have properly functioning valves, check valves, regulators, containment which can withstand pressure buildup, and appropriate piping; and dispersive solids should be kept in closed containers, used in places with minimal air currents, and appropriate contact materials should be used to avoid static charging.

- Emergency response planning for releases or spills should be prepared by the laboratory supervisor and included in the training of the laboratory workers and others who may be affected in the building. DRS and the appropriate Fire Department should be involved in this planning.

Chemical hygiene officers

The Director of the Division of Research Safety or a Division staff person designated by the Director is designated as the Chemical Hygiene Officer for the University of Illinois at Urbana-Champaign (UIUC). The UIUC Chemical Safety Committee will serve as the UIUC Chemical Hygiene Committee.

Academic units that have chemistry laboratories are encouraged to have their own chemical safety officers to help implement their chemical hygiene plans. Likewise, individual research groups or users of significant amounts of chemicals in non-laboratory settings are encouraged to designate chemical safety liaisons to facilitate the flow of safety information throughout the campus community.

UIUC Chemical Safety Guide

Chapter 4: Training and Information

Training

All UIUC employees who work with hazardous chemicals must be apprised of the hazards of chemicals present in their work area. **This training must be provided before initial assignment and before new exposure situations.** Personal protective equipment necessary for the safe handling of hazardous substances must also be provided.

Employees who work with chemicals in laboratories must be trained on the OSHA Laboratory Standard; employees who work with chemicals in places other than laboratories must be trained under the Hazard Communication (Worker Right-to-Know) program. If you are a UIUC employee and have not received such training, request that your supervisor make arrangements to provide you with such training. DRS is available to assist in this **training**.

Topics to be covered during training include the general issues discussed in this guide and the specific hazards that might be encountered on your job.

Refresher Training

Workers trained under the Hazard Communication program are required by the Illinois Department of Labor to receive annual refresher training.

The frequency for refresher training for employees trained under the OSHA Laboratory Standard is left to the discretion of the employer. At UIUC the frequency of refresher training is determined by principal investigators. DRS recommends that refresher training be performed annually.

Additional training is required when new exposure situations arise. Such situations include the use of new chemicals, greater quantities of chemicals, and different procedures.

Material Safety Data Sheets (MSDSs)

MSDSs should be the first source of information about the hazards associated with a chemical.

Typically, MSDSs will contain the following information, usually in separate sections on the sheet:

- name, address, and phone number of manufacturer
- chemical name, synonyms, and Chemical Abstracts (CAS) Number
- physical properties
- a listing of hazardous constituents for mixtures
- health hazard information
- first-aid measures
- fire fighting measures

- handling and storage precautions
- exposure controls/personal protection
- stability and reactivity

Newer MSDSs will contain the following additional information:

- toxicological information
- ecological information
- disposal considerations
- transport information
- regulatory information
- other information

Manufacturers are required to provide a MSDS for each chemical product sold. The Division of Research Safety (DRS) maintains a repository of all the MSDSs received by the campus. If DRS does not have a MSDS for a product you are using, DRS will obtain one. Government regulations specify that MSDSs be readily available to employees. DRS recommends that each unit obtain hard copies of MSDSs for the products most commonly used.

Instructions for electronic access to the DRS repository (for the campus community only) and connections to MSDSs available through the Web can be found on the [DRS website](#). Alternatively, MSDSs may be requested by contacting DRS (217) 333-2436 or [via email](#).

Other Sources of Information

A list of chemical safety references available at DRS are listed in [Appendix 3](#). Of these, Prudent Practices and Safety in Academic Chemistry Laboratories will most likely be of use to laboratory workers.

DRS personnel are also available to visit work areas and consult with individuals or small groups about specific chemical hazards and alternatives for mitigating those hazards.

In addition to [training offered by DRS](#), the following courses are available:

MatSE 392/Chem 393 "Fundamentals of Laboratory Safety", held every Fall and Spring semester. 1 hour undergraduate or 0.25 unit graduate credit, S/U basis.

This short course presents key aspects of lab setup, operating procedures and emergency preparedness necessary for the experimentalist while at the UIUC, and in his/her future career. Topics include: the UIUC Model Chemical Hygiene Plan; lab set up and operating procedures; material safety data sheets; wet chemistry; liquid and compressed gases; vacuum and mechanical equipment; electricity; chemical waste disposal; and a primer on lasers and radiation. The required text is Safety in Academic Chemical Laboratories (American Chemical Society) and is supplemented by articles and class notes. Fire extinguisher training is provided by the appropriate

Fire Department. Cardiac Pulmonary Resuscitation and first aid is provided by the Illini Emergency Medical Services.

Chem 436 Safety Lecture (one of several lectures) 2 hours, open to all Chemistry graduate students, or instructor's approval. Offered at the beginning of each spring semester. Topics include: general lab safety; handling chemicals; chemical laboratory waste handling; safety equipment; and other hazards such as machinery, vacuums, glassware, flame, electrical, radiation, etc.

UIUC Chemical Safety Guide

Chapter 5: Medical Consultation

Medical Emergencies

If emergency medical assistance is needed, call 9-911 (METCAD).

Accidents Involving Chemicals

Campus persons who are paid for their work and suffer a work-related injury or illness should seek treatment at the occupational medicine departments identified by the Workers' Compensation program. Currently, these facilities are:

During normal working hours:

- Occupational Medicine Department at Carle Clinic (602 W. University, Urbana)
- Occupational Health Service at Christie Clinic (101 W. University, Champaign)

After hours:

- The emergency rooms at Provena Covenant Medical Center or Carle Foundation Hospital.

When seeking treatment at any of these facilities, the following information should be brought with you:

1. A note from your supervisor verifying that the injury took place during work OR the name and number of your supervisor, which will be called the following day to verify the injury occurred during work.
2. An MSDS of the chemical involved in the injury. (If an MSDS cannot be found, do not delay seeking medical attention.)

Campus persons, who are involved in activities for which they are not paid and suffer an injury requiring emergency medical treatment (e.g. chemical exposure), should seek treatment at either the Provena Covenant Medical Center or Carle Foundation Hospital emergency rooms. Students may also seek basic medical care at the McKinley Health Center or with their personal physician. However, all unpaid persons may also go to the emergency rooms in this case. Costs associated with most injuries incurred during these activities are the responsibility of the individual through their personal insurance or student insurance.

Supervisors should ensure that an Employee's Injury Report is completed for all work-related injuries or illnesses, however slight, involving activities for which campus persons are paid. If a person suffers an injury during activities for which they are not paid, a Property Damage/Public Injury Report should be completed. These reports should be completed regardless of where or whether the person

received medical follow-up. For more information on Worker's Compensation, contact Claims Management Office at (217) 333-1080.

Medical Surveillance

The UIUC has implemented the Medical Surveillance Program to help prevent occupational disease and to protect the health and safety of its employees. It has also been implemented to meet regulatory requirements, guidelines or established standards of practice pertaining to activities and programs at UIUC. It includes the routine medical examination of employees over a period of time to evaluate occupational exposure to a potential work-related hazard.

Employees of UIUC are eligible for inclusion in this program if they perform work-related tasks that might be reasonably anticipated to cause occupational exposure to a potential hazard. The program does not include pre-employment medical examinations. The medical examinations and tests are provided without cost to the employee and at a reasonable time and place. It is the responsibility of the individual campus unit to bear the full cost associated with the medical examination of its employees.

DRS coordinates the development and implementation of the UIUC Medical Surveillance Program. Specific responsibilities include coordinating the activities of the health care provider and campus units, and to set up specific medication examinations and tests for a particular hazard in consultation with the healthcare provider. For more information about the UIUC Medical Surveillance Program call 244-7801.

UIUC Chemical Safety Guide

Chapter 6: Emergency Procedures

Responding to a chemical spill or emergency

Call 9-911 (METCAD) for assistance in the following kinds of emergencies:

- medical assistance for injuries
- fires
- explosions
- chemical spills for which assistance is required (complicated spill)

METCAD will dispatch the Fire Department and/or ambulances as appropriate. The fire department has the capability to mitigate chemical spills that cannot be managed without assistance.

Complicated Spills

If your spill meets ANY of the following conditions of a complicated spill, call METCAD (9-911) immediately.

METCAD will dispatch a hazardous materials crew from the nearest city fire station. There is no direct charge for this service.

A spill is complicated if:

- a person is injured; or
- identity of the chemical is unknown; or
- multiple chemicals are involved; or
- the chemical is highly toxic, highly flammable or highly reactive; or
- the spill occurs in a "public space" such as corridors; or
- the spill has the potential to spread to other parts of the building such as through the ventilation system; or
- the clean up procedures are not known or appropriate materials are not readily available; or
- the clean up requires a respirator to be worn and no personnel have been fit tested or officially trained to use a respirator (includes cartridge respirators); or
- the spill may endanger the environment such as reaching waterways or outside ground.

Specific spill response measures for complicated spills

1. Evacuate affected area, alert others in the area to have them evacuate too.
2. Close doors and windows (if possible) as you evacuate the area. Open windows can cause fumes and vapors to travel into the hallway.
3. Contact METCAD (9-911). Provide the following information:

- What is the name of the chemical spilled?
 - What quantity of the chemical is spilled?
 - Where is the spill (building name and room number)?
 - Is anyone injured or splashed with the chemical?
 - Is a fire or explosion involved in the spill?
 - What is your name and phone number?
4. Arrange for someone to meet the emergency responders.
 5. Secure the area with signs and warning tape, or post staff outside of the affected area so personnel cannot enter the area until emergency responders arrive.

Simple Spills

If the spill does not meet any of the conditions for a complicated spill, the spill is defined as simple. You may clean up simple spills as described below.

Specific spill response measures for simple spills

1. Prevent the spread of fumes and vapors by closing doors and windows (if possible).
2. Remove all potential sources of ignition (pumps, Bunsen burners, mechanical equipment not designed to be spark proof) if the material is flammable. It may be necessary to shut off power from a remote circuit breaker.
3. Use the necessary personal protective equipment such as appropriate gloves, eye protection and lab coat or apron.
4. Absorb liquids using absorbent material, preferably using sorbent pads or spill pillows. Avoid using any silica product with hydrofluoric acid. 3M™ Chemical Sorbents are good to use for most liquids, although they do not readily absorb acids (it will eventually).
5. Small spills of acids and bases can be absorbed with sorbent pads and placed in a bag. If neutralization is attempted, use the carbonate or bicarbonate of sodium or potassium to neutralize acids and citric acid to neutralize bases. Do not neutralize a spill with a concentrated strong acid or base (i.e., hydrochloric acid or sodium hydroxide) as a violent reaction may occur. Check the pH to verify it has been neutralized.
6. Spills of powders should be swept up carefully to avoid contaminating the air with dusts from the chemical.
7. Collect and contain the clean up materials in a plastic container or thick plastic bag (as long as there are very little free liquids). Place a descriptive label on each container or bag.
8. Decontaminate the area and affected equipment. Ventilate area if necessary. Soap and water can be used to clean most surfaces. Contact the DRS Chemical Safety Section **via email** or call 4-0416 if you have any questions.
9. Dispose wastes by following the instructions in **Chapter 8** for the collection of chemical wastes. If you have questions, contact the DRS Chemical Safety Section **via email** or call 4-0416.

Mercury spills

1. Cordon off the area to prevent mercury from being tracked.
2. If you break a mercury thermometer, a mercury sponge is usually adequate for cleaning up the spill. Use the sponge to absorb the mercury. Place it and the broken thermometer in a sturdy plastic bag. Close and label the bag "Broken mercury thermometer."
3. For small spills of mercury, Hg absorb™ can be used to clean up the spill. Place contaminated items in a sturdy bag and request a chemical waste pickup using the **ChemTrak form CWM-TRK-01**.
4. For spills too large to clean up with Hg absorb™, contact DRS (3-2755). DRS will have to contact the Labor crew of F&S to arrange for clean up using a special mercury vacuum cleaner. DO NOT use a regular vacuum cleaner or shop vac, as harmful mercury vapors will be generated and the vacuums will become contaminated. F&S will charge for the clean up service.

NOTE: The best method of dealing with mercury spills is to prevent them in the first place. Examine all uses of mercury to see if substitutes are available. If not, use trays or other equipment to provide containment in the event of a spill.

Preparing for spills

It is best to proceed in an organized manner for spill response. Establishing protocols and evaluating potential hazards in advance will be well worth the initial effort.

- **Establish spill response protocols**

Before working with chemicals you should determine what could go wrong and how you might respond to a spill. As a result of this evaluation, you should prepare written protocols for use in the event of a spill. These protocols need to be communicated to all persons who might be affected by a spill. The best place to document spill response protocols in the laboratory is in your Chemical Hygiene Plan. If you need a copy of the **UIUC Model Chemical Hygiene Plan**, access it from the **DRS website** or call the DRS Chemical Safety Section at 3-2436.

In addition, you should have basic spill clean up materials readily available should anything go wrong. More information on spill clean up materials is listed below. Always create written spill protocols before using a chemical.

- **Evaluate hazards**

When spills occur, a quick appropriate response can prevent serious consequences. However, the wrong response can make things worse. In order to respond promptly and appropriately, you should evaluate the potential hazards in advance of using the chemicals. The first source of information to consult would be your Material Safety Data Sheets

(MSDSs). [If you need an MSDS, consult DRS **Chemical Safety Section website** or call 3-2436.] Of most concern in spill situations are chemicals which are:

- air reactive
- water reactive
- flammable
- polymerizable
- corrosive
- highly toxic

Based on these hazards, you can then determine:

- appropriate personal protective equipment for spill response (e. g. gloves, respirators, etc.)
 - types of fire suppression equipment
 - appropriate clean up materials
 - first aid procedures
- **Spill clean up materials and equipment**
Prior to starting any work with chemicals, make sure that you have all the necessary personal protective devices, safety equipment, and containment/clean up materials readily available. Each individual who may be involved in spill response or clean up must know the purpose and limitations of all personal protective equipment, safety equipment and clean up materials. Prepackaged spill kits are available from various vendors. The prepackaged kits tend to be expensive, so campus units typically make their own kits. To make your own kit, include the following items at a minimum:

1. Disposable (nitrile or latex) gloves (1 box)
2. Neoprene gloves (1 set)
3. Safety goggles
4. Plastic scoop
5. Plastic dustpan
6. Plastic bags
7. Absorbent material
8. 3M™ Chemical Sorbent (Central Stores Stock No. 39-01-6000) or similar material
9. 5-gallon plastic pail

If mercury containing devices must be used in the lab (please replace all devices, if possible with **non-mercury alternatives**), the spill clean up kit should also contain Hg Absorb™ (available from **Lab Safety Supply**).

The location of spill control kits should be clearly marked and highly visible. Make sure all personnel know the kit's location, are familiar with the kit's contents, and understand its limitations.

Preventing spills

Listed below are some basic spill prevention steps that apply to storage, transportation, and transfer of chemicals.

- **General precautions:**
 - reduce clutter and unnecessary materials in your work areas
 - eliminate tripping hazards and other obstructions
 - have all needed equipment readily available before starting work

- **Storage precautions:**
 - use sturdy shelves
 - larger containers should be stored closer to the floor
 - containers on shelves should be stored back from the edge to reduce the danger of falling
 - storage shelves should have lips to further reduce the danger of falling
 - chemicals should be stored by compatibility class first, then alphabetically
 - inspect the storage area regularly for leaking or defective containers
 - use appropriate storage containers
 - periodically check containers under laboratory chemical hoods, sinks and lab benches for signs of deterioration

- **Transportation precautions:**
 - use carts, where appropriate
 - use safety containers, where appropriate
 - use bottle carriers for any glass bottle greater than 250 ml
 - use straps to secure gas cylinders, where appropriate
 - think about potential hazards before transporting chemicals
 - consider purchasing plastic coated "shatter resistant" bottles

- **Precautions in transferring chemicals:**
 - pay careful attention to the size of container to avoid overfilling
 - use pumps or other mechanical devices rather than simple pouring
 - provide containment to capture leaks and spills

UIUC Chemical Safety Guide
Appendix 1: OSHA Laboratory Standard

29 CFR 1910.1450 Occupational Exposure to Hazardous Chemicals in Laboratories

a. Scope and application.

1. This section shall apply to all employers engaged in the laboratory use of hazardous chemicals as defined below.
2. Where this section applies, it shall supersede, for laboratories, the requirements of all other OSHA health standards in 29 CFR, part 1910, subpart Z, except as follows:
 - i. For any OSHA health standard, only the requirement to limit employee exposure to the specific permissible exposure limit shall apply for laboratories, unless that particular standard states otherwise or unless the conditions of paragraph (a)(2)(iii) of this section apply.
 - ii. Prohibition of eye and skin contact where specified by any OSHA health standard shall be observed.
 - iii. Where the action level (or in the absence of an action level, the permissible exposure limit) is routinely exceeded for an OSHA regulated substance with exposure monitoring and medical surveillance requirements, paragraphs (d) and (g)(1)(ii) of this section shall apply.
3. This section shall not apply to:
 - i. Uses of hazardous chemicals which do not meet the definition of laboratory use, and in such cases, the employer shall comply with the relevant standard in 29 CFR, part 1910, subpart 2, even if such use occurs in a laboratory.
 - ii. Laboratory uses of hazardous chemicals which provide no potential for employee exposure. Examples of such conditions might include:
 - a. Procedures using chemically-impregnated test media such as Dip-and-Read tests where a reagent strip is dipped into the specimen to be tested and the results are interpreted by comparing the color reaction to a color chart supplied by the manufacturer of the test strip; and
 - b. Commercially prepared kits such as those used in performing pregnancy tests in which all of the reagents needed to conduct the test are contained in the kit.

b. Definitions:

1. **Action level** means a concentration designated in 29 CFR, part 1910, for a specific substance, calculated as an eight(8)-hour time-weighted average, which initiates certain required activities such as exposure monitoring and medical surveillance.
2. **Assistant Secretary** means the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee.
3. **Carcinogen** (see "select carcinogen").
4. **Chemical Hygiene Officer** means an employee who is designated by the employer, and who is qualified by training or experience, to provide technical guidance in the development and implementation of the provisions of the Chemical Hygiene Plan. This definition is not

intended to place limitations on the position description or job classification that the designated individual shall hold within the employer's organizational structure.

5. **Chemical Hygiene Plan** means a written program developed and implemented by the employer which sets forth procedures, equipment, personal protective equipment and work practices that (i) are capable of protecting employees from the health hazards presented by hazardous chemicals used in that particular workplace and (ii) meets the requirements of paragraph (e) of this section.
6. **Combustible liquid** means any liquid having a flashpoint at or above 100°F. (37.8°C), but below 200°F. (93.3°C), except any mixture having components with flashpoints of 200°F. 93.3°C.), or higher, the total volume of which make up 99 percent or more of the total volume of the mixture.
7. **Compressed gas** means:
 - i. A gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psi at 70°F. (21.1°C.); or
 - ii. A gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psi at 130°F. (54.4°C.) regardless of the pressure at 70°F. (21.1°C.); or
 - iii. A liquid having a vapor pressure exceeding 40 psi at 100°F. (37.8°C.) as determined by ASTM D-323-72.
8. **Designated area** means an area which may be used for work with "select carcinogens," reproductive toxins or substances which have a high degree of acute toxicity. A designated area may be the entire laboratory, an area of a laboratory, or a device such as a laboratory hood.
9. **Emergency** means any occurrence such as, but not limited to, equipment failure, rupture of containers or failure of control equipment which results in an uncontrolled release of a hazardous chemical into the workplace.
10. **Employee** means an individual employed in a laboratory workplace who may be exposed to hazardous chemicals in the course of his or her assignments.
11. **Explosive** means a chemical that causes a sudden, almost instantaneous release of pressure, gas, and heat when subjected to sudden shock, pressure, or high temperature.
12. **Flammable** means a chemical that falls into one of the following categories:
 - i. **Aerosol, flammable** means an aerosol that, when tested by the method described in 16 CFR 1500.45, yields a flame protection exceeding 18 inches at full valve opening, or a flashback (a flame extending back to the valve) at any degree of valve opening;
 - ii. **Gas, flammable** means:
 - a. A gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of 13 percent by volume or less; or
 - b. A gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air wider than 12 percent by volume, regardless of the lower limit.
 - iii. **Liquid, flammable** means any liquid having a flashpoint below 100°F. (37.8°C.), except any mixture having components with

- flashpoints of 100°F. (37.8°C.) or higher, the total of which make up 99 percent or more of the total volume of the mixture.
- iv. **Solid, flammable** means a solid, other than a blasting agent or explosive as defined in §1910.109(a), that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious hazard. A chemical shall be considered to be flammable solid if, when tested by the method described in 16 CFR 1500.44, it ignites and burns with a self sustained flame at a rate greater than one-tenth of an inch per second along its major axis.
13. **Flashpoint** means the minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite when tested as follows:
- i. Tagliabue Closed Tester (See American National Standard Method of Test for Flash Point by Tag Closed Tester, Z11.24-1979 (ASTMD 56-79))- for liquids with a viscosity of less than 45 Saybold Universal Seconds (SUS) at 100°F. (37.8 °C.), that do not contain suspended solids and do not have a tendency to form a surface film under test; or
 - ii. Pensky-Martens Closed Tester (see American National Standard Method of Test for Flash Point by Pensky-Martens Closed Tester, Z11.7-1979 (ASTM D 93-79)) - for liquids with a viscosity equal to or greater than 45 SUS at 100°F. (37.8°C.), or that contain suspended solids, or that have a tendency to form a surface film under test; or
 - iii. Setaflash Closed Tester (see American National Standard Method of Test for Flash Point by Setaflash Closed Tester (ASTM D 3278-78))
 - iv. Organic peroxides, which undergo auto accelerating thermal decomposition, are excluded from any of the flashpoint determination methods specified above.
14. **Hazardous chemical** means a chemical for which there is statically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. The term "health hazard" includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic systems, and agents which damage the lungs, skin, eyes, or mucous membranes. Appendices A and B of the Hazard Communication Standard (29 CFR 1910.1200) provide further guidance in defining the scope of health hazards and determining whether or not a chemical is to be considered hazardous for purposes of this standard.
15. **Laboratory** means a facility where the "laboratory use of hazardous chemicals" occurs. It is a workplace where relatively small quantities of hazardous chemicals are used on a non-production basis.
16. **Laboratory scale** means work with substances in which the containers used for reactions, transfers, and other handling of substances are designed to be easily and safely manipulated by one person.
17. **Laboratory scale** excludes those workplaces whose function is to produce commercial quantities of materials.

18. **Laboratory-type hood** means a device located in a laboratory, enclosure on five sides with a moveable sash or fixed partial enclosed on the remaining side; constructed and maintained to draw air from the laboratory and to prevent or minimize the escape of air contaminants into the laboratory; and allows chemical manipulations to be conducted in the enclosure without insertion of any portion of the employee's body other than hands and arms. Walk-in hoods with adjustable sashes meet the above definition provided that the sashes are adjusted during use so that the airflow and the exhaust of air contaminants are not compromised and employees do not work inside the enclosure during the release of airborne hazardous chemicals.
19. **Laboratory use of hazardous chemicals** means handling or use of such chemicals in which all of the following conditions are met:
 - i. Chemical manipulations are carried out on a "laboratory scale;"
 - ii. Multiple chemical procedures or chemicals are used;
 - iii. The procedures involved are not part of a production process, nor in any way simulate a production process; and
 - iv. "Protective laboratory practices and equipment" are available and in common use to minimize the potential for employee exposure to hazardous chemicals.
20. **Medical consultation** means a consultation which takes place between an employee and a licensed physician for the purpose of determining what medical examinations or procedures, if any, are appropriate in cases where a significant exposure to a hazardous chemical may have taken place.
21. **Organic peroxide** means an organic compound that contains the bivalent -o-o- structure and which may be considered to be a structural derivative of hydrogen peroxide where one or both of the hydrogen atoms has been replaced by an organic radical.
22. **Oxidizer** means a chemical other than a blasting agent or explosive as defined in §1910.109(a), that initiates or promotes combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases.
23. **Physical hazard** means a chemical for which there is scientifically valid evidence that it is a combustible liquid, a compressed gas, explosive, flammable, or an organic peroxide, an oxidizer, pyrophoric, unstable (reactive) or water-reactive.
24. **Protective laboratory practices and equipment** means those laboratory procedures, practices and equipment accepted by laboratory health and safety experts as effective, or that the employer can show to be effective, in minimizing the potential for employee exposure to hazardous chemicals.
25. **Reproductive toxins** means chemicals which affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis).
26. **Select carcinogen** means any substance which meets one of the following criteria:
 - i. It is regulated by OSHA as a carcinogen; or
 - ii. It is listed under the category, "known to be carcinogens" in the Annual Report on Carcinogens published by the National Toxicology Program (NTP) (latest edition); or

- iii. It is listed under Group 1 ("carcinogenic to humans") by the International Agency for Research on Cancer Monographs (IARC) (latest editions); or
 - iv. It is listed in either Group 2A or 2B by IARC or under the category "reasonably anticipated to be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:
 - a. After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m³;
 - b. After repeated skin application of less than 300 (mg/kg of body weight) per week; or
 - c. After oral dosages of less than 50 mg/kg of body weight per day.
27. **Unstable (reactive)** means a chemical which is the pure state, or as produced or transported, will vigorously polymerize, decompose, condense, or will become self-reactive under conditions of shocks, pressure or temperature.
28. **Water-reactive** means a chemical that reacts with water to release a gas that is either flammable or presents a health hazard.
- c. **Permissible exposure limits**
 - 1. For laboratory users of OSHA regulated substances, the employer shall assure that laboratory employees' exposures to such substances do not exceed the permissible exposure limits specified in 29 CFR, part 1910, subpart Z.
 - d. **Employee exposure determination.**
 - 1. Initial monitoring. The employer shall measure the employee's exposure to any substance regulated by a standard which requires monitoring if there is reason to believe that exposure levels for that substance routinely exceed the action level (or in the absence of an action level, the PEL).
 - 2. Periodic monitoring. If the initial monitoring prescribed by paragraph (d)(1) of this section discloses employee exposure over the action level (or in the absence of an action level, the PEL), the employer shall immediately comply with the exposure monitoring provisions of the relevant standard.
 - 3. Termination of monitoring. Monitoring may be terminated in accordance with the relevant standard.
 - 4. Employee notification of monitoring results. The employer shall, within 15 working days after the receipt of any monitoring results, notify the employee of these results in writing either individually or by posting results in an appropriate location that is accessible to employees.
 - e. **Chemical Hygiene Plan - General**
 - 1. (Appendix A of this section is non-mandatory but provides guidance to assist employers in the development of the Chemical Hygiene Plan.)
 - 2. Where hazardous chemicals as defined by this standard are used in the workplace, the employer shall develop and carry out the provisions of a written Chemical Hygiene Plan which is:
 - i. Capable of protecting employees from health hazards associated with hazardous chemicals in that laboratory and

- ii. Capable of keeping exposures below the limits specified in paragraph c of this section.
- 3. The Chemical Hygiene Plan shall be readily available to employees, employee representatives and, upon request, to the Assistant Secretary.
- 4. The Chemical Hygiene Plan shall include each of the following elements and shall indicate specific measures that the employer will take to ensure laboratory employee protection:
 - i. Standard operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals;
 - ii. Criteria that the employer will use to determine and implement control measures to reduce employee exposure to hazardous chemicals including engineering controls, the use of personal protective equipment and hygiene practices; particular attention shall be given to the selection of control measures for chemicals that are known to be extremely hazardous;
 - iii. A requirement that fume hoods and other protective equipment are functioning properly and specific measures that shall be taken to ensure proper and adequate performance of such equipment;
 - iv. Provisions for employee information and training as prescribed in paragraph (f) of this section;
 - v. The circumstances under which a particular laboratory operation, procedure or activity shall require prior approval from the employer or the employer's designee before implementation;
 - vi. Provisions for medical consultation and medical examinations in accordance with paragraph (g) of this section;
 - vii. Designation of personnel responsible for implementation of the
 - viii. Chemical Hygiene Plan including the assignment of a Chemical
 - ix. Hygiene Officer and, if appropriate, establishment of a Chemical
 - x. Hygiene Committee; and
 - xi. Provisions for additional employee protection for work with particularly hazardous substances. These include "select carcinogens," reproductive toxins and substances which have a high degree of acute toxicity. Specific consideration shall be given to the following provisions which shall be included where appropriate:
 - a. Establishment of a designated area;
 - b. Use of containment devices such as fume hoods or glove boxes;
 - c. Procedures for safe removal of contaminated waste; and
 - d. Decontamination procedures.
- 5. The employer shall review and evaluate the effectiveness of the Chemical Hygiene Plan at least annually and update it as necessary.
- f. **Employee information and training**
 - 1. The employer shall provide employees with information and training to ensure that they are apprised of the hazards of chemicals present in their work areas.
 - 2. Such information shall be provided at the time of an employee's initial assignment to a work area where hazardous chemicals are present and prior to assignments involving new exposure situations. The frequency of refresher information and training shall be determined by the employer.

3. Information. Employees shall be informed of:
 - i. The contents of this standard and its appendices which shall be made available to employees;
 - ii. The location and availability of the employer's Chemical Hygiene Plan;
 - iii. Plan;
 - iv. The permissible exposure limits for OSHA regulated substances or recommended exposure limits for other hazardous chemicals where there is no applicable OSHA standard;
 - v. Signs and symptoms associated with exposures to hazardous chemicals used in the laboratory; and
 - vi. The location and availability of known reference material on the hazards, safe handling, storage and disposal of hazardous chemicals found in the laboratory including, but not limited to,
 - vii. Material Safety Data Sheets received from the chemical supplier.
4. Training
 - i. Employee training shall include:
 - ii. Methods and observations that may be used to detect the presence or release of a hazardous chemical (such as monitoring conducted by the employer, continuous monitoring devices, visual appearance or odor of hazardous chemicals when being released, etc.);
 - iii. The physical and health hazards of chemicals in the work area; and
 - iv. The measures employees can take to protect themselves from these hazards, including specific procedures the employer has implemented to protect employees from exposure to hazardous chemicals, such as appropriate work practices, emergency procedures, and personal protective equipment to be used.
 - v. The employee shall be trained on the applicable details of the employer's written Chemical Hygiene Plan.

g. Medical consultation and medical examinations

1. The employer shall provide all employees who work with hazardous chemicals an opportunity to receive medical attention, including any follow-up examinations which the examining physician determines to be necessary, under the following circumstances:
 - i. Whenever an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory, the employee shall be provided an opportunity to receive an appropriate medical examination.
 - ii. Where exposure monitoring reveals an exposure level routinely above the action level (or in the absence of an action level, the PEL) for an OSHA regulated substance for which there are exposure monitoring and medical surveillance requirements, medical surveillance shall be established for the affected employee as prescribed by the particular standard.
 - iii. Whenever an event takes place in the work area such as a spill, leak, explosion or other occurrence resulting in the likelihood of a hazardous exposure, the affected employee shall be provided an opportunity for a medical consultation. Such consultation shall be for the purpose of determining the need for a medical examination.
2. All medical examinations and consultations shall be performed by or under the direct supervision of a licensed physician and shall be provided without cost to the employee, without loss of pay and at a reasonable time and place.

3. Information provided to the physician. The employer shall provide the following information to the physician:
 - i. The identity of the hazardous chemical(s) to which the employee may have been exposed;
 - ii. A description of the conditions under which the exposure occurred including quantitative exposure data, if available; and
 - iii. A description of the signs and symptoms of exposure that the employee is experiencing, if any.
4. Physician's written opinion.
 - i. For examination of consultation required under this standard, the employer shall obtain a written opinion from the examining physician which shall include the following:
 - a. Any recommendation for further medical follow-up;
 - b. The results of the medical examination and any associated tests;
 - c. Any medical condition which may be revealed in the course of the examination which may place the employee at increased risk as a result of exposure to a hazardous chemical found in the workplace;
 - d. A statement that the employee has been informed by the physician of the results of the consultation or medical examination and any medical condition that may require further examination or treatment.
 - ii. The written opinion shall not reveal specific findings of diagnoses unrelated to occupational exposure.

h. Hazard identification

1. With respect to labels and material safety data sheets:
 - i. Employers shall ensure that labels on incoming containers of hazardous chemicals are not removed or defaced.
 - ii. Employers shall maintain any material safety data sheets that are received with incoming shipments of hazardous chemicals, and ensure that they are readily accessible to laboratory employees.
2. The following provisions shall apply to chemical substances developed in the laboratory:
 - i. If the composition of the chemical substance which is produced exclusively for the laboratory's use is known, the employer shall determine if it is a hazardous chemical as defined in paragraph (b) of this section. If the chemical is determined to be hazardous, the employer shall provide appropriate training as required under paragraph f of this section.
 - ii. If the chemical produced is a byproduct whose composition is not known, the employer shall assume that the substance is hazardous and shall implement paragraph e of this section.
 - iii. If the chemical substance is produced for another user outside of the laboratory, the employer shall comply with the Hazard Communication Standard (29 CFR 1910.1200) including the requirements for preparation of material safety data sheets and labeling.

i. Use of respirators.

1. Where the use of respirators is necessary to maintain exposure below permissible exposure limits, the employer shall provide, at no cost to the employee, the proper respiratory equipment. Respirators

shall be selected and used in accordance with the requirements of 29 CFR 1910.134.

j. Recordkeeping

1. The employer shall establish and maintain for each employee an accurate record of any measurements taken to monitor employee exposures and any medical consultation and examination including tests or written opinions required by this standard.
2. The employer shall assure that such records are kept, transferred, and made available in accordance with 29 CFR 1910.20.

k. Dates

1. Effective date. This section shall become effective May 1, 1990.
2. Start-up dates.
 - i. Employers shall have developed and implemented a written Chemical Hygiene Plan no later than January 31, 1991.
 - ii. Paragraph (a)(2) of this section shall not take effect until the employer has developed and implemented a written Chemical Hygiene Plan.

l. Appendices

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

UIUC Chemical Safety Guide

Appendix 2: Campus Policies and DRS Guidance Materials

Copies of the following policies from the Section V/B "Environmental Health and Safety" of the Campus Administrative Manual and guides written by the Division of Research Safety (DRS) are available from the Division at 333-2755.

Policy Number and Title

Campus Administrative Manual

- 1. Organization and Responsibilities (1.0 - 1.4)
- 3.1 Storm Sewer Usage
- 4.1 Chemical Waste Management
- 5.2 Fire Doors
- 5.4 Fire Safety
- 6.1 Working Alone
- 6.2 Departmental Use of Corridors
- 6.3 Safety Shoes
- 6.4 Eye Protection
- 6.6 Refrigerators
- 6.8 First Aid Supplies
- 6.9 Electrical Safety - Medical Instrumentation and Biological Monitoring Devices
- 6.10 Chemical Hygiene Plan
- 7. Radiological Health (7.1 - 7.3)
- 8. Biohazards (8.1 - 8.4)
- 11.5 Safety Showers, Emergency Eyewash Stations & Drench Hoses

DRS Health and Safety Guides

Asbestos
Electrical Safety
Ergonomics
Fire Extinguishers
Fire Safety
Flammable Storage Cabinets
Gas Cylinder Safety
Laboratory Fume Hood Work Practices
Lead
Respiratory Protection

Chemical Waste Management

Chemical Waste Fact Sheets:

CW-1 Screening Procedures by Labs for Unlabeled Chemicals
CW-2 Gas Cylinder Returns
CW-3 Odor Control Procedures for Campus Facilities
CW-4 Disposal Options for Lecture Bottles
CW-5 Procedures for Handling Chemical Spills and Leaks

Chemical Waste Minimization Fact Sheets:

WM-1 101 Ways to Reduce Hazardous Waste in the Lab
WM-2 ChemCycle - UIUC Chemical Redistribution Program
WM-3 Alternatives to Chromic Acid Cleaning Solutions

WM-4 Alternatives to Mercury and Mercury Compounds
WM-5 Alternatives to DNA Prep with Chloroform Extractions
WM-6 Reducing or Eliminating the Use of Heavy Metals
WM-7 Treatment of Ethidium Bromide
WM-8 Pollution Prevention in Laboratories - The How-to Guide
WM-9 Waste Reduction Techniques for Paint Application
WM-10 Neutralization of Strong Acids and Bases
WM-11 Used Battery Reductions, Recycling and Management
WM-12 Purchasing Guidelines for Lecture Bottles

Videos

List of videos available upon request.

UIUC Chemical Safety Guide

Appendix 3: Chemical Safety References Available at DRS

References available at the Division of Environmental Health and Safety as of October 1998:

Chemical Protective Clothing, Volumes 1 and 2, American Industrial Hygiene Association, Fairfax, Virginia, 1990.

CRC Handbook of Chemistry and Physics, Editor-in-Chief David R. Lide, 1994

1996 North American Emergency Response Guidebook, U.S. Department of Transportation, 1996.

Farm Chemicals Handbook '98, Meister Publishing Company, 1998.

Handbook of Compressed Gases, 3rd Edition, Compressed Gas Association, Arlington, Virginia, 1990.

Handbook of Laboratory Safety, 3rd Edition, Edited by A. Keith Furr, CRC Press, 1990.

Handbook of Reactive Chemical Hazards, Fourth Edition, Edited by L. Bretherick, Butterworths, 1990.

Hawley's Condensed Chemical Dictionary, 13th Edition, Richard J. Lewis, Sr., Van Nostrand Reinhold Company, (Version 1.2 on CD-ROM) 1998.

Industrial Ventilation, 20th Edition, American Conference of Governmental Industrial Hygienists, 1988.

The Merck Index, 11th Edition, Merck and Co., Inc. 1989.

NIOSH Pocket Guide to Chemical Hazards, DHHS (NIOSH), June 1997, DHHS (NIOSH) Publication No. 97-140.

OSHA Safety and Health Standards, (29 CFR 1910), United States Department of Labor, U.S. Government Printing Office, 1988.

Patty's Industrial Hygiene and Toxicology, 4th Edition, Edited by George D. Clayton and Florence E. Clayton, Volumes 1(A,B), 2(A-F), and 3(A,B), Wiley-Interscience, 1994.

Prudent Practices in the Laboratory, National Research Council, National Academy Press, 1995.

Safety in Academic Chemistry Laboratories, 6th Edition, Committee on Chemical Safety, American Chemical Society: Washington, D.C., 1995.

1998 TLVs and BEIs: Threshold Limit Values and Biological Exposure Indices for Chemical Substances and Physical Agents, American Conference of Governmental Industrial Hygienists, 1998.

UIUC Chemical Safety Guide
 Appendix 4: Chemical Resistivity Chart for Glove

Glove	Chemical														
	Breakthrough time under laboratory test conditions (this is the elapsed time between initial contact of chemical on glove surface and analytical detection of chemical inside glove)														
	VITON® (North, 10 mil)	VITON® (Best, 30 mil)	SILVERSHIELD® (North, 4 mil)	NI (Safety 4, 3 mil)	IVA® (Assess Edmont)	BUTYL (Loth Safety Supply, 25 mil)	BUTYL (North, 17 mil)	NEOPRENE (MAPA® Professional, 2.2 mil)	NEOPRENE (Assess Edmont)	NEOPRENE (Best Edmont)	PVC (Assess Edmont)	PVC (Best Neoprene)	NITRILE (Best Huxley)	NITRILE (Loth Safety Supply, 22 mil)	NITRILE (Assess Edmont, 22 mil)
Acetaldehyde	NR	NR	>6 hr.	>240 min.	NR	4 min.	9.6 hr.	21 min.	10 min.	NR	21 min.	NR	13 min.	NT	NR
Acetic Acid (Glacial)	NT	NT	>480 min.	>480 min.	NR	ND	NT	7 hr.	NT	NT	3 hr.	NT	118 min.	270 min.	NT
Acetic Acid (50%)	NT	NT	NT	NT	NT	NT	>480 min.	NT	NT	NT	NT	NT	>480 min.	NT	NT
Acetone	NR	NR	>6 hr.	>24 hr.	NR	ND	>17 hr.	12 min.	5 min.	5 min.	35 min.	NR	7 min.	NT	NR
Acetonitrile	NT	NR	>8 hr.	>24 hr.	150 min.	ND	>8 hr.	40 min.	30 min.	27 min.	65 min.	NR	24 min.	NT	30 min.
Ammonium Hydroxide (29%)	NT	ND	NT	>240 min.	NR	ND	NT	>480 min.	>6 hr.	180 min.	ND	4 hr.	60 min.	>480 min.	ND
Aniline	10 min.	ND	>8 hr.	>24 hr.	ND	ND	>8 hr.	>480 min.	35 min.	49 min.	32 min.	3 hr.	71 min.	72 min.	NR
Benzene	6 hr.	ND	>8 hr.	>24 hr.	ND	NT	31 min.	16 min.	NR	9 min.	15 min.	NR	13 min.	27 min.	NR
Butyl Acetate	NR	NR	>6 hr.	>480 min.	ND	94 min.	1.9 hr.	52 min.	NR	NR	46 min.	NR	33 min.	101 min.	75 min.
p-tert-Butyltoluene	>8 hr.	ND	>8 hr.	NT	NT	91 min.	1.7 hr.	NT	NT	219 min.	158 min.	NT	ND	NT	NT
Carbon Disulfide	>8 hr.	ND	>8 hr.	>24 hr.	ND	<4 min.	7 min.	NT	NR	NR	NR	NR	NR	20 min.	30 min.
Carbon Tetrachloride	>13 hr.	ND	>6 hr.	>24 hr.	ND	NT	NR	31 min.	NR	28 min.	73 min.	25 min.	48 min.	341 min.	150 min.
Chloroform	9.5 hr.	ND	10 min.	>24 hr.	ND	NT	NR	12 min.	NR	4 min.	23 min.	NR	10 min.	NT	NR
Chloronaphthalene	>16 hr.	NT	>8 hr.	NT	ND	NT	NR	NT	NR	NT	NR	NT	NR	NT	NR
Cyclohexane	>7 hr.	ND	>6 hr.	>480 min.	NT	4 min.	1.1 hr.	159 min.	NT	36 min.	228 min.	NT	88 min.	>480 min.	NT
Cyclohexanol	>8 hr.	ND	>6 hr.	>480 min.	ND	ND	>11 hr.	NT	2.5 hr.	ND	ND	6 hr.	ND	NT	ND
Cyclohexanone	29 min.	NR	>6 hr.	>480 min.	NT	ND	>16 hr.	NT	NT	61 min.	108 min.	NT	NR	NT	NT
Dibutyl Phthalate	>8 hr.	ND	>6 hr.	>240 min.	ND	ND	>16 hr.	NT	2 hr.	ND	ND	NR	ND	NT	NR
1,2 Dichloroethane	6.9 hr.	ND	>6 hr.	>240 min.	NT	NT	2 hr.	33 min.	NT	10 min.	16 min.	NT	NR	16 min.	NT
Diisobutyl Ketone (80%)	1.2 hr.	ND	>6 hr.	>240 min.	ND	NT	3.3 hr.	NT	NR	ND	ND	NR	ND	NT	2 hr.
Dimethyl Formamide	8 min.	NR	>8 hr.	>24 hr.	NR	ND	>8 hr.	110 min.	10 min.	97 min.	100 min.	NR	NR	35 min.	NR
Dioxane	23 min.	12 min.	>8 hr.	>480 min.	NR	ND	>20 hr.	28 min.	NR	62 min.	73 min.	NR	41 min.	NT	NR
Divinyl Benzene	>17 hr.	ND	>8 hr.	NT	NT	54 min.	2.2 hr.	NT	NT	NR	NR	NT	37 min.	NT	NT
Ethyl Acetate	NR	NR	>6 hr.	>24 hr.	ND	253 min.	7.6 hr.	34 min.	15 min.	6 min.	24 min.	NR	5 min.	NT	NR
Ethylamine (70% in water)	NR	NT	47 min.	NT	NT	ND	>12 hr.	NT	NT	NT	NT	NT	NT	NT	NT
Ethyl Alcohol	NT	ND	NT	>480 min.	NR	ND	NT	>480 min.	90 min.	71 min.	ND	1 hr.	66 min.	>480 min.	4 hr.
Ethyl Ether	12 min.	29 min.	>6 hr.	NT	ND	NT	8 min.	18 min.	10 min.	9 min.	12 min.	NR	14 min.	64 min.	2 hr.
Formaldehyde (37% in water)	>16 hr.	ND	>6 hr.	>240 min.	NR	NT	16 hr.	>480 min.	2 hr.	ND	ND	80 min.	ND	>480 min.	ND
n-hexane	>11 hr.	ND	>6 hr.	>24 hr.	ND	4 min.	NR	39 min.	45 min.	31 min.	173 min.	NR	29 min.	>480 min.	ND
Hydrazine (70% in water)	NR	ND	>6 hr.	>240 min.	NR	NT	>8 hr.	>480 min.	ND	ND	ND	ND	ND	>480 min.	ND
Hydrochloric Acid (37%)	NT	ND	>6 hr.	>240 min.	NR	ND	NT	>480 min.	ND	ND	ND	>5 hr.	ND	>480 min.	ND
Hydrofluoric Acid	NT	185 min.	>6 hr.	>240 min.	NR	ND	NT	>480 min.	1 hr.	ND	ND	40 min.	110 min.	134 min.	2 hr.
Methylamine (40% in water)	>16 hr.	ND	1.9 hr.	NT	NR	NT	>15 hr.	NT	270 min.	26 min.	ND	135 min.	119 min.	NT	ND
Methylene Chloride	1 hr.	113 min.	>8 hr.	>24 hr.	ND	20 min.	24 min.	6 min.	NR	3 min.	7 min.	NR	NR	NT	NR
MEK	NR	NR	>24 hr.	>24 hr.	90 min.	385 min.	>8 hr.	22 min.	NR	9 min.	30 min.	NR	12 min.	6 min.	NR
Morpholine	1.9 hr.	234 min.	>8 hr.	480 min.	90 min.	NT	>16 hr.	NT	NR	139 min.	91 min.	NR	83 min.	NT	NR
Nitrobenzene	>8 hr.	ND	>8 hr.	>24 hr.	ND	ND	>23 hr.	60 min.	NR	321 min.	100 min.	NR	NR	60 min.	NR
Nitropropane	21 min.	NR	>8 hr.	>240 min.	>6 hr.	ND	>8 hr.	NT	5 min.	175 min.	98 min.	NR	NR	NT	NR
Pentachlorophenol (1% in Kerosene)	>13 hr.	ND	>8 hr.	NT	5 min.	NT	NR	NT	6 min.	ND	ND	3 hr.	ND	NT	ND
n-Pentane	>8 hr.	ND	>6 hr.	>480 min.	ND	NT	NR	38 min.	30 min.	27 min.	84 min.	NR	28 min.	NT	ND
Phenol (85% in water)	>15 hr.	ND	>6 hr.	NT	ND	NT	>20 hr.	>480 min.	3 hr.	147 min.	72 min.	85 min.	164 min.	>480 min.	NR
Propyl Acetate	NR	NR	>6 hr.	>480 min.	2 hr.	109 min.	2.7 hr.	NT	NR	43 min.	39 min.	NR	NR	NT	20 min.
Sodium Hydroxide (50%)	NT	ND	>6 hr.	>480 min.	NR	ND	NT	>480 min.	ND	ND	ND	ND	ND	>480 min.	ND
Sulfuric Acid (25%)	NT	NT	>6 hr.	NT	NR	ND	NT	>480 min.	ND	ND	NT	ND	NT	>480 min.	ND
Tetrachloroethylene	>17 hr.	ND	>6 hr.	>24 hr.	ND	<4 min.	NR	28 min.	NR	14 min.	40 min.	NT	NR	373 min.	>5 hr.
Toluene	>16 hr.	ND	>6 hr.	>24 hr.	ND	28 min.	21 min.	14 min.	NR	6 min.	25 min.	NR	19 min.	28 min.	10 min.
Toluene Diisocyanate	>16 hr.	ND	>6 hr.	>480 min.	ND	NT	>8 hr.	NT	NR	177 min.	201 min.	NR	97 min.	>480 min.	NR
1,1,1-Trichloroethane	>15 hr.	ND	>6 hr.	>480 min.	ND	NT	NR	27 min.	NR	19 min.	51 min.	NR	52 min.	131 min.	90 min.
Trichloroethylene	7.4 hr.	ND	>6 hr.	>24 hr.	ND	NT	18 min.	11 min.	NR	5 min.	12 min.	NR	NR	9 min.	NR
Vinyl Chloride	4.4 hr.	ND	>6 hr.	NT	NT	NT	NR	NT	NT	17 min.	7 min.	NT	19 min.	NT	NT
Xylene	>8 hr.	ND	>24 hr.	>24 hr.	ND	NT	NR	23 min.	NR	NR	37 min.	NR	23 min.	92 min.	75 min.

Key ND=None Detected >=Greater Than NR=Not Recommended <=Less Than NT=Not Tested

Note: This chemical compatibility chart shows how each type of glove material listed below performed in breakthrough tests of this chemical data (North, Best, Safety 4, MAPA® Professional and Assess Edmont) encourage all users to conduct their own

Appendix 5: Sample PPE Hazard Assessment and Certification Forms

The following two links will download Acrobat (PDF) versions of the assessment forms for determining the appropriate personal protective equipment (PPE) when using various amounts and types of chemicals. If you do not have Acrobat Reader, first [download](#) the version for your operating system from Adobe.

[PPE Hazard Assessment and Certification for Hazardous Liquid Chemicals](#)

[PPE Hazard Assessment and Certification for Hazardous Solid Chemicals and Gases](#)

Appendix 6: Peroxides Forming Chemicals

Class I: Unsaturated materials, especially those of low molecular weight, may polymerize violently due to peroxide initiation. Discard or test for peroxides after 6 months (liquids) or 12 months (gases).

- acrylic acid
- acrylonitrile
- butadiene
- chlorobutadiene (chloroprene)
- chlorotrifluoroethylene
- methyl methacrylate
- styrene
- tetrafluoroethylene
- vinyl acetate
- vinyl acetylene
- vinyl chloride
- vinyl pyridine
- vinylidene chloride

Class II: The following chemicals are a peroxide hazard upon concentration (distillation / evaporation). A test for peroxides should be performed if concentration is intended or suspected. Discard or test for peroxides 6 months after container is opened.

- acetal
- cumene
- cyclohexene
- cyclooctene
- cyclopentene
- diacetylene
- dicyclopentadiene
- diethylene glycol dimethyl ether (diglyme)
- diethyl ether
- dioxane (p-dioxane)
- ethylene glycol dimethyl ether (glyme)
- furan
- methyl acetylene
- methyl cyclopentane
- methyl-1-butyl ketone
- tetrahydrofuran
- tetrahydronaphthalene
- vinyl ethers

Class III: Peroxides derived from the following compounds may explode without concentration. Discard 3 months after opening container.

- Organic
 - divinyl ether
 - divinyl acetylene
 - isopropyl ether
 - vinylidene chloride
- Inorganic
 - potassium metal

- o potassium amide
- o sodium amide (sodamide)

Note: Lists are illustrative, but not exhaustive.

Source: National Research Council. Prudent Practices in the Laboratory. National Academy Press. Washington, D.C. 1995.

Peroxide Detection Tests

The following test can detect most (but not all) peroxy compounds, including hydroperoxides. **NONE of these tests should be applied to materials (such as metallic potassium) that may be contaminated with inorganic peroxides.**

- Add 1-3 ml of the liquid to be tested to an equal volume of acetic acid, add a few drops of 5% aqueous potassium iodide solution, and shake. The appearance of a yellow to brown color indicates the presence of peroxides. Alternatively, additional of 1 ml of a freshly prepared 10% solution of potassium iodide to 10 ml of an organic liquid in a 25 ml glass cylinder should produce a yellow color if peroxides are present.
- Add 0.5 ml of the liquid to be tested to a mixture of 1 ml of 10% aqueous potassium iodide solution and 0.5 ml of dilute hydrochloric acid to which has been added a few drops of starch solution just prior to the test. The appearance of a blue or blue-black color within a minute indicates the presence of peroxides.
- Peroxide test strips, which turn to an indicative color in the presence of peroxides, are available commercially. Note that these strips must be air dried until the solvent evaporates and then exposed to moisture for proper operation.

Source: National Research Council. Prudent Practices in the Laboratory. National Academy Press. Washington, D.C. 1995.

Appendix 7: Sample Emergency Contact Sign

Preprinted copies of the following two-sided emergency contact (3-part sign holders) are available to UIUC at no charge from DRS. or email css@uiuc.edu to obtain a copy for your laboratory.

This Side Faces Front	This Side Faces Front
Place in MIDDLE section of 3-slot sign holder	
IN CASE OF EMERGENCY CALL 9-911	
ROOM No. _____	at Supervisor/PI _____
BLDG NAME _____	Office Location _____
DEPARTMENT _____	Current Phone _____
	Home Phone _____
EMERGENCY CONTACTS	
Name & Office Address	Office Phone Home Phone
SPECIAL HAZARDS	LOCAL ALARM(S)
Innocuous: _____	Local alarm present? <input type="checkbox"/> Y <input type="checkbox"/> N <input type="checkbox"/>
_____	Expand what alarm indicates.
_____	_____
Other hazard information on Reverse Side	
Campus Office of Environmental Health & Safety, 203-6755	
Prepared By: _____	Update annually or when information changes
Date Posted/Updated: _____	