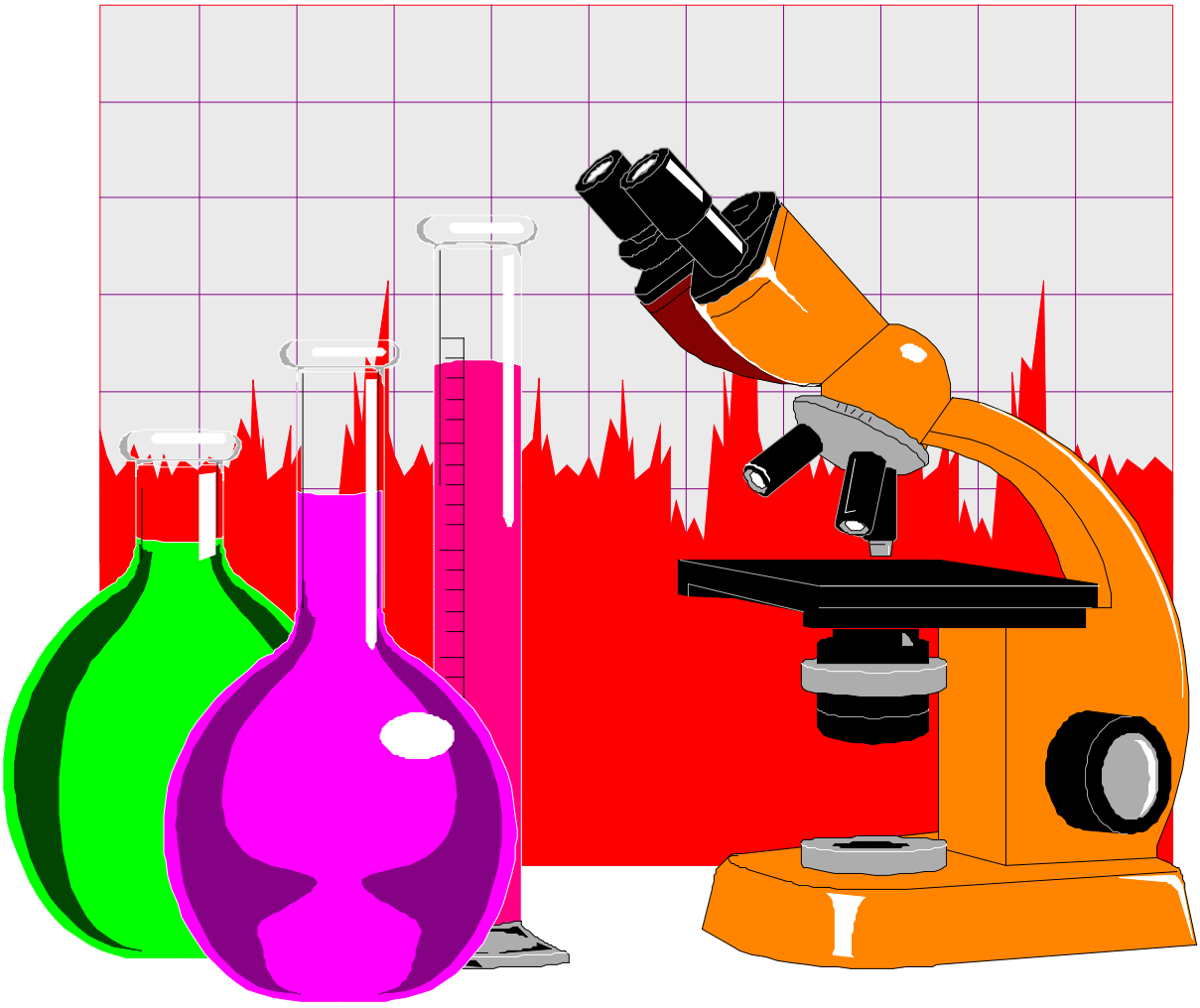
Old Dominion University

Chemical Hygiene Plan



Prepared by:
Environmental Health & Safety Office
(Revised January 2010)

FOREWARD

The Chemical Hygiene Plan represents the commitment by the Administration of Old Dominion University towards protecting the health of employees who may be exposed to hazardous chemicals while working in university laboratories. It provides a comprehensive set of guidelines supporting the Laboratory Health and Safety Program.

The pursuit of scholarly endeavors is encouraged, consistent with safe practices that minimize risk to humans and the environment. To this end, adoption of these policies and procedures in research and teaching is fundamental to achieving compliance with 29 CFR 1910.1450, The Laboratory Standard.

The Administration welcomes comments from laboratory workers regarding this Plan. Modifications to operating procedures, equipment, or facilities, which would substantially and in a cost effective manner enhance the program, will be considered.

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CHEMICAL HYGIENE RESPONSIBILITIES

This section assigns responsibilities for implementing and enforcing the provisions of this Plan. As indicated by the scope of these assignments, responsibility for chemical hygiene rests at all levels.

President, Vice Presidents and Deans

The President, as Chief Executive Officer, has ultimate responsibility for chemical hygiene at Old Dominion University. The President, Vice Presidents and Deans shall provide continuing support for the University's Chemical Hygiene Plan and the Laboratory Health and Safety Program.

Department Head/Chair

The Department Head/Chair is responsible for chemical hygiene in his/her department and provides support to those individuals who shall implement and enforce each laboratory's Chemical Hygiene Plan, including the Chemical Hygiene Officer, and Principal Investigators.

Chemical Hygiene Officer

The Chemical Hygiene Officer is a designated employee in the Environmental Health and Safety Office. The Chemical Hygiene Officer (or his/her designee) is responsible for the following duties:

1. Develops and updates ODU's "generic" Chemical Hygiene Plan and appropriate policies and practices.
2. Provides technical assistance in complying with the Chemical Hygiene Plan and answers questions for employees regarding chemical safety.
3. Assists Principal Investigators in developing appropriate safety precautions for new projects and procedures.
4. Maintains knowledge of current legal requirements concerning OSHA regulated substances used at ODU.
5. Monitors procurement, use, and disposal of chemicals used in laboratories at ODU.
6. Monitors chemical hygiene and housekeeping conditions through regular, formal laboratory evaluations.
7. Performs employee exposure monitoring as required.

8. Determines when an Exposure Evaluation is appropriate and conducts Exposure Evaluations.
9. Provides required information to the examining physician at the time of a medical consultation.
10. Provides general information and training to employees concerning hazards of chemicals.

Principal Investigator

The Principal Investigator has overall responsibility for chemical hygiene in his/her laboratory to include:

1) Developing Section 8 (Laboratory Specific Information) of this Chemical Hygiene Plan by including the required information.
2) Ensuring that workers are informed of chemical hygiene rules, and have access to the laboratory's Chemical Hygiene Plan.
3) Determining required levels of personal protective equipment, and ensuring that the equipment is in good repair and available to the employee.
4) Providing employee training on laboratory-specific operations and procedures, including standard operating procedures (SOPs) and location of emergency equipment.
5) Providing prior approval to employees in accordance with Section 2.1.5 of this Plan.
6) Maintaining knowledge of the current guidelines concerning OSHA regulated substances used in the laboratory.
7) Ensuring that the facilities are adequate for handling and storage of any hazardous material ordered.
8) Ensuring equipment such as fume hoods and eyewashes are functioning properly and submit repair orders as needed.
9) Maintaining an inventory of all chemicals used in the laboratory and submitting this inventory to the EHSO upon request.
10) Maintaining Material Safety Data Sheets (MSDSs) for chemicals used in the laboratory, and ensuring they are accessible to employees.
11) Properly labeling and dating chemical containers.
12) Ensuring that pertinent safety information is posted in the laboratory i.e., emergency phone numbers, emergency phone location, MSDS location, eyewash/safety shower location.

Hazardous Waste Coordinator

The Hazardous Waste Coordinator (HWC) is responsible for proper handling and submission of his/her laboratory's hazardous wastes in accordance with Section 2.1.8 of this Plan.

The HWC may be the Principal Investigator, a person assigned by the Principal Investigator, or it may be one individual for the entire department. The HWC's responsibilities include:

1) Collecting hazardous chemical wastes in appropriate containers which are properly labeled according to the guidelines in **Appendix A**.

2) Properly segregating and storing hazardous chemical wastes.

3) Completing disposal request forms and waste labels, and scheduling pickups with the EHSO.

Laboratory Employee

Employees working with or around hazardous chemicals are responsible for remaining aware of the hazards of those chemicals and handling them in accordance with the practices and procedures described in this Plan. Employees who are unsure of chemical hazards or safety procedures, should consult with their Principal Investigator before proceeding. If the Principal Investigator is also unsure, he/she should consult the MSDS or contact the EHSO for assistance.

GLOSSARY

ACGIH: American Conference of Governmental Industrial Hygienists.

Action level: 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.

Allergen: A substance which produces an allergic reaction upon contact with body tissues.

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

CFR 29 Section 1910 Subpart Z: The section of OSHA regulations addressing Toxic and Hazardous Substances. Contains the Air Contaminants Standard (or PELs) in Section 1910.1000.

Chemical Hygiene Officer: 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.

Chemical Hygiene Plan: 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 the employees from the health hazards presented by hazardous chemicals used in that particular workplace.

Code of Federal Regulations (CFR): The collection of rules and regulations originally published in the Federal Register by various governmental departments and agencies. OSHA regulations are found in 29 CFR; EPA regulations in 40 CFR; and Department of Transportation regulations in 49 CFR.

Combustible Liquid: Any liquid having a flashpoint at or above 100°F, but below 200°F, except any mixture having components with flashpoints of 200°F, or higher, the total volume of which make up 99% or more of the total volume of the mixture.

Compressed Gas: (i) A gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psi at 70°F; or (ii) A gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psi at 130°F regardless of the pressure at 70°F; or (iii) A liquid having a vapor pressure exceeding 40 psi at 100°F as determined by ASTM D-323-72.

Corrosive (EPA): A waste is corrosive if it has either of the following properties: **(1)** It is aqueous and has a pH less than or equal to 2 or greater than or equal to 12.5; **(2)** It is a liquid and corrodes steel (SAE 1020) at a rate greater than 6.35 mm (0.250 inch) per year at a test temperature of 55C (130F).

Corrosive (OSHA): A chemical that causes visible destruction of, or irreversible alterations in, living tissue by chemical action at the site of contact.

Designated area: 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.

DOT: Department of Transportation.

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

Employee: An individual who receives a pay check issued by ODU or ODURF and is employed in a laboratory workplace where he/she may be exposed to hazardous chemicals in the course of his or her assignments.

Employer: ODU or ODURF.

EPA: Environmental Protection Agency.

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

Flammable: 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 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% 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% by volume, regardless of the lower limit. **(iii)** *Liquid flammable* means any liquid having a flashpoint below 100°F, except any mixture having components with flashpoints of 100°F or higher, the total of which make up 99% or more of the total volume of the mixture. **(iv)** *Solid flammable* means a solid, other than 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 burn so vigorously and persistently as to create a serious hazard. A chemical shall be considered to be a flammable solid if, when tested by the method described in 16 CFR 1500.44, it ignites and burns with a self-sustained flame at a rate of one-tenth of an inch per second along its major axis.

Flashpoint: The minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite when tested by one of the following methods: (i) Tagliabue Closed Tester. (ii) Pensky-Martens Closed Tester. (iii) Setaflash Closed Tester. Organic peroxides, which undergo

auto accelerating thermal decomposition, are excluded from any of the flashpoint determination methods specified above.

Graduate Assistants/Graduate Research Assistants: Normally assistantships are paid to individuals as part of their academic performance. Assistantships are awarded for support of the opportunity to pursue educational development. However, for the purpose of this plan, assistantships are considered pay for service. Hiring of these individuals is set by the academic process set by the colleges and departments of ODU. Therefore these individuals are not considered employees of ODURF, regardless of the funding source of their project, and are covered under ODU Workmen's Compensation.

Hazard warning: Any words, pictures, symbols, or combination thereof appearing on a label or other appropriate form of warning which convey the hazard(s) of the chemical(s) in the container(s).

Hazardous chemical: A chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees.

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 system and agents which damage the lungs, skin, eyes, or mucous membranes.

Highly toxic: A chemical falling within any of the following categories: **(a)** A chemical that has a median lethal dose (LD_{50}) of 50 milligrams or less per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each; **(b)** A chemical that has a median lethal dose (LD_{50}) of 200 milligrams or less per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between two and three kilograms each; **(c)** A chemical that has a median lethal concentration (LC_{50}) in air of 200 parts per million by volume or less of gas or vapor, or 2 milligrams per liter or less of mist, fume, or dust, when administered by continuous inhalation for one hour (or less if death occurs within one hour) to albino rats weighing between 200 and 300 grams each.

IARC: International Agency for Research on Cancer.

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

Laboratory scale: 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.

"Laboratory scale" excludes those workplaces whose function is to produce commercial quantities of materials.

Laboratory-type hood: 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 the hands and arms.

Laboratory use of hazardous chemicals: 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.

Material Safety Data Sheet (MSDS): Written or printed material concerning a hazardous chemical which is prepared in accordance with the requirements of the Hazard Communication Standard.

Median Lethal Concentration (LC_{50}): The concentration of a material in air that on the basis of laboratory tests (respiratory route) is expected to kill 50% of a group of test animals as a single exposure in a specified time period.

Median Lethal Dose (LD_{50}): The single dose of a substance that causes the death of 50% of an animal population from exposure to the substance by any route other than inhalation.

Medical consultation: 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.

NFPA: National Fire Protection Association.

ODU: Old Dominion University.

ODURF: Old Dominion Research Foundation.

Old Dominion University Faculty: ODU faculty consist of several categories. They are: teaching, research, administrative, and professional. During the academic year, these personnel perform specific assignments directly for ODU and are paid via the University payroll system. They may also perform services for ODURF as either the project director, principal investigator or co-investigator of a sponsored project. Because the ODURF compensates faculty for such services during the academic year by reimbursing the University, faculty in this status are considered ODU employees and are covered under ODU Workmen's Compensation. Faculty who work for the

ODURF during the summer period, and are paid directly by the ODURF, are considered ODURF employees and are covered under ODURF Workmen's Compensation.

Organic peroxides: 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.

OSHA: Occupational Safety and Health Administration.

Oxidizer: 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 though the release of oxygen or other gases.

Permissible Exposure Limit (PEL): The maximum air contaminant concentration a worker can be exposed to on a repeated basis without developing adverse effects. Published and enforced by OSHA as a legal standard.

Physical hazard: A chemical for which there is scientifically valid evidence that it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer pyrophoric, unstable or water reactive.

Principal investigator: An individual with primary responsibility for a program or project in a specific laboratory.

Protective laboratory practices and equipment: 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.

Reactive (EPA): A waste is reactive if it has <u>any</u> of the following properties: **(1)** It is normally unstable and readily undergoes violent change without detonating; **(2)** It reacts violently with water; **(3)** It forms potentially explosive mixtures with water; **(4)** When mixed with water, it generates toxic gases, vapors or fumes in a quantity sufficient to present a danger to human health or the environment; **(5)** It is a cyanide or sulfide bearing waste which, when exposed to pH conditions between 2 and 12.5, can generate toxic gases, vapors or fumes in a quantity sufficient to present a danger to human health or the environment; **(6)** It is capable of detonation or explosive reaction if it is subjected to a strong initiating source or if heated under confinement; **(7)** It is readily capable of detonation or explosive decomposition or reaction at standard temperature and pressure; **(8)** It is identified by the DOT as a forbidden explosive, Class A explosive, or Class B explosive.

Reproductive Toxins: Chemicals which affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis).

Select carcinogen: Any substance which meets one of the following criteria: **(i)** It is regulated by OSHA as a carcinogen; or **(ii)** It is listed under the category, "known to be carcinogens" in the Annual Report on Carcinogens published by the National Toxicology Program (NTP) (latest edition); or **(iii)** It is listed under Group 1 ("carcinogenic to humans") by the International Agency for Research on Cancer Monographs (IARC) (latest editions); or **(iv)** It is listed in either Group 2A or 2B by IARC or under the category, "reasonably anticipated to be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria: **(A)** After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m^3; **(B)** After repeated skin application of less than 300 (mg/kg of body weight) per week; or **(C)** After oral dosages of less than 50 mg/kg of body weight per day.

Sensitizer: A chemical that causes a substantial proportion of exposed people or animals to develop an allergic reaction in normal tissue after repeated exposure to the chemical.

SFPC: Virginia Statewide Fire Prevention Code.

Threshold Limit Value (TLV): Represents the air concentrations of chemical substances to which it is believed that workers may be exposed daily without adverse effect. Published by the ACGIH.

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

Water Reactive: A chemical that reacts with water to release a gas that is either flammable or presents a health hazard.

1.0 INTRODUCTION

1.1 Background: OSHA's Laboratory Standard

On January 31, 1990 the Occupational Safety and Health Administration (OSHA) promulgated the "Occupational Exposures to Hazardous Chemicals in Laboratories" rule, 29 Code of Federal Regulations (CFR) 1910.1450. This rule, commonly known as the "Laboratory Standard", was developed in recognition of the differences between laboratories and industrial operations in their use and handling of hazardous chemicals. To adequately protect laboratory workers from exposure to hazardous chemicals, OSHA realized it was necessary to use a different regulatory approach from that applied to general industry.

The purpose of the Laboratory Standard is to protect the health of employees exposed to chemicals while working in a laboratory. It applies to all employers engaged in the laboratory use of hazardous chemicals.

The Laboratory Standard requires employers to ensure that laboratory employees' exposures to OSHA regulated substances do not exceed the Permissible Exposure Limits specified in 29 CFR 1910 Subpart Z. If necessary, employers must conduct monitoring to determine employee exposure levels. The standard also requires employers to provide their laboratory employees with information and training, as well as medical consultations and medical examinations under specified conditions.

Under this standard, employers are required to properly identify the hazards of the chemicals their employees may be exposed to in the laboratory. When necessary to protect the health of employees, employers are required to provide respirators in accordance with VOSH's Respiratory Protection Standard 1910.134. Employers are also required to maintain all monitoring and medical records.

The Virginia Occupational Safety and Health Standards for General Industry have adopted 29 CFR 1910.1450 and are responsible for the administration and enforcement of this standard. The Laboratory Standard became effective in Virginia on June 22, 1990. By January 31, 1991 employers were required to have developed and implemented a written program known as the Chemical Hygiene Plan. This Plan has been developed for laboratories at Old Dominion University (ODU) by the Environmental Health and Safety Office (EHSO) in compliance with this standard.

1.2 The Chemical Hygiene Plan

1.2.1 Preparation

Each Principal Investigator at ODU is required to maintain a Chemical Hygiene Plan (CHP) containing both general safety and health guidelines and information specific to their laboratory's functions. This document will serve as the basic Plan covering all generic safety

and health procedures. The Principal Investigator for each laboratory must augment this Plan with the information requested in Section 8.0.

1.2.2 Purpose

This Plan sets forth policies, procedures, control equipment, personal protective equipment and work practices that, when properly implemented, are capable of:

- protecting employees from the health hazards associated with hazardous chemicals used in the laboratory; and,

- Keeping exposures below the Permissible Exposure Limits (PEL's) specified in VOSH 1910, Subpart Z and the American Conference of Governmental Industrial Hygienists Threshold Limit Values (TLVs).

This Plan is designed to ensure the proper selection and implementation of controls to protect the health and safety of ODU's laboratory employees. Every laboratory employee must be trained in the applicable details of this Plan.

1.2.3 Scope

Employees working in a laboratory at ODU, who may be exposed to hazardous chemicals in the course of their assignments, are required to comply with the provisions of this Plan. This includes employees in research and teaching laboratories and their associated support facilities.

Laboratories which have developed and implemented a Chemical Hygiene Plan are exempt from other regulations under 29 CFR 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 (PEL) shall apply for laboratories, unless that particular standard states otherwise or unless the conditions of paragraph (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 PEL in absence of an action level) is routinely exceeded for an OSHA regulated substance with exposure monitoring and medical surveillance requirements paragraphs (d) and (g)(1)(ii) of VOSH 1910.1450.

For example, the Laboratory Standard supersedes the Hazard Communication Standard and the substance-specific standards for laboratories. An exception is laboratories involved in histology, pathology, and human or animal anatomy, which still must comply with the Formaldehyde Standard. This exemption does not apply to any activities which do not match

VOSH's definition of "laboratory use of hazardous chemicals" even if the activity is done in a laboratory.

Laboratories covered by this Chemical Hygiene Plan are located in the following departments: Biological Sciences, Chemistry and Biochemistry, Health Sciences, Geological Sciences, Oceanography, Physics, Medical Laboratory Sciences, Student Health Clinic, Applied Marine Research Labs, and Civil, Mechanical and Electrical Engineering and Technology.

2.0 STANDARD OPERATING PROCEDURES

2.1 General Safety Procedures

2.1.1 Basic Rules

For every chemical they use, employees must know and constantly be aware of:

1) The chemical's hazards, as determined from the MSDS and other appropriate references which shall be made available to employees.
2) Safeguards for using that chemical, including personal protective equipment, as prescribed in the chemical's MSDS.
3) The location and proper use of emergency equipment.
4) How and where to properly store the chemical when it is not in use.
5) Proper personal hygiene practices as outlined in this Plan and the laboratory SOPs.
6) Proper methods of transporting chemicals within the facility.
7) Procedures for emergencies, including evacuation routes, spill cleanup procedures and proper waste disposal.

Employees should not work alone in a laboratory or chemical storage area. If this is not possible, the employee shall notify someone, such as the Principal Investigator, lab supervisor or Public Safety, before such work takes place and when the work is completed and the employee leaves the area. Arrangements should be made to check on the employee at regular intervals during the course of their work.

Appropriate signs must be clearly posted outside of an area or room where an unattended procedure is in progress which involves hazardous chemicals.

2.1.2 Personal Hygiene

Limiting a chemical's ability to contact the body can reduce its ability to do harm. This requires proper use of personal protective equipment against the four routes of entry: inhalation, ingestion, injection and eye/skin contact.

The following personal hygiene practices will minimize chemical exposure:

1. Rinse with water for at least 15 minutes whenever a chemical has contacted the skin or eyes.
2. Wear appropriate eye protection at all times.
3. Use a laboratory fume hood when handling chemicals to prevent inhalation exposure.
4. Do not mouth pipette anything; use a mechanical pipette.
5. Wash well with soap and water before leaving the laboratory; do not wash with solvents.
6. Do not eat, drink, smoke or apply cosmetics in the laboratory.
7. Do not bring food, beverage, tobacco or cosmetic products into laboratories or chemical storage areas.
8. Do not store food or beverages in the same refrigerators, cabinets or counter spaces as chemicals.
9. Avoid practical jokes or other behavior which might confuse, startle or distract other workers.
10. Handle and store glassware with care to prevent damage.
11. Inspect glassware prior to use and discard or repair damaged items.
12. Use mechanical means, such as a broom and dust pan, to pick up broken glass.

2.1.3 Housekeeping

Good housekeeping practices contribute greatly toward a safe and healthy working environment. Good housekeeping practices include:

1. Never block access to emergency equipment, safety showers, eyewashes and exits, not even temporarily.
3. Keep all work areas, especially workbenches, clear of clutter and obstructions.
4. Place all chemicals in proper storage areas at the end of each workday.
6. Properly label wastes and keep them in appropriate containers.
7. Promptly clean up all spills and dispose of the spilled chemical and cleanup materials in accordance with Section 2.1.7.
8. Clean all working surfaces and floors regularly.
9. Do not store chemicals in aisles or stairwells, on desks or laboratory benches, on floors or in hallways, or in fume hoods which are also used as workstations.

10. Dispose of broken glassware in a puncture resistant container that is clearly marked “glass only” to avoid injuring housekeeping personnel.

2.1.4 Labeling

Proper labeling of chemical containers is essential in maintaining a safe laboratory. For the purpose of this Plan and laboratory safety evaluations, chemical containers will be classified in the following manner:

- Manufacturer/Distributor container - manufacturer’s label must remain on the container and the date of receipt should be written on the label.
- Secondary containers - containers in which chemicals will be kept for periods exceeding the normal workday. These containers should display the chemical contents and the hazards associated with the chemical.
- “Fast” containers - containers which will be emptied and cleaned before the end of the workday. These containers should display at least the chemical contents.

2.1.5 Prior Approval for Laboratory Procedures

Employees must obtain prior approval from the Principal Investigator to proceed with a laboratory task whenever:

1. A new laboratory procedure or test is to be performed that involves a hazardous chemical (Non-routine procedures, such as those performed as part of a research project, should be reviewed on an individual basis prior to the start of the procedure and as needed throughout the duration of the project).
2. It is likely that exposures or hazardous reactions may occur.
3. There is a change in a routine procedure or test, even if it is very similar to prior practices. “Change in a procedure or test” means:
    a. A 10% or greater increase in the amount of one or more hazardous chemicals used.
    b. Substituting a hazardous chemical for any of the other chemicals in a procedure.
4. There is a failure of any of the equipment used in the process, especially controls such as laboratory fume hoods.
5. Whenever procedures are performed during times other than normal work hours, the procedures are unattended, and when employees perform procedures by themselves.

2.1.6 Emergency Preparedness

Being prepared for emergencies in the laboratory is the responsibility of each Principal Investigator. The following items are essential for prompt response to emergencies and should be displayed in a conspicuous area of each laboratory:

1. emergency phone numbers and phone location;
2. MSDS location sign;
3. eyewash location sign;
4. safety shower location sign;
5. Chemical spill kit.

Items 1-4 may be obtained from the EHSO.

2.1.7 Spills and Accidents

Spills of toxic substances or accidents involving any hazardous chemical should be resolved immediately according to ODU's "Hazardous Materials Emergency Response Plan". Laboratories should be equipped with materials to control all possible spills. The procedural steps to handle a spill are:

NOTE: These procedures are applicable to spills involving small quantities of material that pose no threat to human health, property or the environment. If the spill is large, involves an extremely hazardous substance, or when in doubt, leave the area and notify Public Safety at 683-4000 immediately.

1. Attempt to stop the flow of material if possible.
2. Contain the release to prevent spread of material.
3. Notify your supervisor and appropriate emergency responders immediately.
4. If contact with the spilled material occurs, remove all contaminated clothing and flush the affected areas with water for at least 15 minutes.
5. Open windows and turn on fume hoods to ventilate the area.
6. Extinguish all sources of ignition if the spilled material is flammable or combustible.
7. Seek medical attention for the following:
    - If an acute overexposure, via inhalation, to a material deemed hazardous by inhalation has occurred.

- If ingestion of a material deemed hazardous by ingestion has occurred.
- In all other cases of acute overexposure.

8. Spill cleanup should be performed by trained in-house teams following the guidelines outlined in ODU's "Hazardous Materials Emergency Response Plan".

2.1.8 Hazardous Waste Disposal

Hazardous chemical wastes are regulated by the Environmental Protection Agency (EPA) under the Resource Conservation and Recovery Act (RCRA) and its amendments. Federal and state regulations promulgated under RCRA classify waste as hazardous if it meets certain criteria as specified in the regulations. If a waste is classified as hazardous, disposal must be in accordance with the regulations.

The EHSO is responsible for managing the University's Hazardous Waste Program. Funding for disposal of "common" hazardous waste streams is through the EHSO's budget. The EHSO is not funded for disposal of "uncommon" waste streams, such as unknown waste and waste requiring stabilization. The EHSO collects hazardous waste generated on campus and transfers it to a storage facility where it is properly stored until picked up by a licensed hazardous waste disposal company.

Generators of hazardous waste are required to complete "**Request for Disposal of Hazardous Waste**" forms and **Hazardous Waste ID Labels** for their waste. The form and labels provide information about the origination and contents of the waste. See **Appendix A** for instructions on completing the form and label. The EHSO cannot dispose of any waste whose ingredients are unknown.

UNKNOWN WASTE CHEMICALS

Laboratory personnel must make every effort to provide an accurate description of all chemicals given to EH&S for handling and disposal. Unknown chemicals will not be accepted by EH&S since they cannot be handled or disposed of in a safe manner. Hazardous waste disposal companies will not accept unknowns without proper analysis and the analysis of a single sample can easily cost $1,000 or more.

It is the responsibility of the generator (individual or department) to accurately identify all chemical unknowns in their laboratory, either by knowledge or analysis. This may require polling laboratory personnel, students and faculty members to ascertain the owner of such unknown waste and its identity. It must be constantly emphasized to researchers that they identify and label all wastes and project products.

Hazardous waste should be handled according to the following guidelines:

- Use the appropriate sized container for accumulating waste. For example, if only 250 ml of waste is to be generated, use a 250 - 300 ml container for accumulation.
- Use the same type of container for waste as that in which the chemical was originally shipped.
- Do not use corks or stoppers to close containers; use properly fitting screw-on lids lined with a material that will not be chemically attacked by the contents.
- Never fill containers to the top. Allow space in the container for expansion. For example, with a 4 L bottle allow an expansion space of at least 1 inch below the neck.
- Keep containers closed except when filling or emptying.
- Segregate and store wastes in accordance with laboratory procedures for storage of hazardous chemicals.
- Do not mix hazardous and nonhazardous waste. This mixture may be regulated as hazardous.
- Accumulate chlorinated and nonchlorinated solvent waste in separate containers. Chlorinated wastes are more expensive to dispose of.
- Avoid mixing different hazardous wastes, even if they are compatible. They may each have different disposal methods.
- Do not mix hazardous and radioactive wastes; this mixture is a special waste which is difficult and very expensive to dispose of.
- Label all waste containers appropriately.
- Handle shock sensitive compounds, such as old ethers and old picric acid, with extreme caution.

2.2 Specific Safety Procedures for Handling Chemicals

2.2.1 Toxic Chemicals

Toxicity is a unique hazard because it can be applicable to all chemicals in the laboratory. Toxicity is the ability of a substance to cause damage to living tissue. Many chemicals used in the laboratory have exposure guidelines that can be found on the MSDS. These include recommended limits, such as the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLVs), regulatory limits established by OSHA, called Permissible Exposure Limits (PELs), lethal concentrations (LC50) and lethal doses (LD50). When such limits exist, they will be used to determine the proper safety precautions, control measures, and safety apparel to be used when working with toxic

chemicals. The Chemical Hygiene Officer can assist you in making these determinations if necessary.

Handling toxic chemicals:

1. Use toxic chemicals in a laboratory fume hood.
2. Wear appropriate personal protective equipment.
3. Use appropriate personal hygiene and housekeeping practices.
4. Be aware of the signs and symptoms of exposure to the chemical being used.

2.2.2 Flammable and Combustible Materials

Flammability is the measure of a solid, liquid or gas' ability to support combustion. Flammable material is capable of being easily ignited and burning at a rapid pace. The easier it is to start a material burning, the more flammable the material is deemed to be. A comprehensive definition of flammable can be found in the glossary of this Plan.

Handling flammable and combustible materials:

1. Use in a laboratory fume hood, away from ignition sources.
2. Wear appropriate personal protective equipment
3. When transferring from one container to another, use a laboratory fume hood or a designated, properly ventilated area and use proper grounding/bonding procedures if necessary!
4. Extinguish all ignition sources in the area. Never use open flames or hot plates to directly heat flammables.
5. Spontaneously flammable materials should be handled in an inert liquid such as mineral oil.
6. Know the location of the nearest fire extinguisher.

2.2.3 Reactive Chemicals

Reactivity describes a substance's tendency to undergo chemical reaction either by itself or with other materials, releasing energy. Undesirable effects such as pressure buildup; temperature increase; explosion; or formation of noxious, toxic, or corrosive byproducts may occur because of the substance's reactivity to heating, burning, direct contact with other materials, or other conditions in use or in storage. Reactive chemicals include explosives, organic peroxides, pressure-generating material, and water reactives. Some chemicals, such as peroxidizable chemicals, can become more reactive with age.

Handling reactive chemicals:

1. Wear appropriate personal protective equipment.
2. Use in a laboratory fume hood to prevent the release of energy or hazardous fumes into the laboratory.
3. Remain aware of the chemical's incompatibilities.
4. Remain aware of the chemical's useful life.

2.2.4 Corrosive and Irritant Chemicals

Corrosive chemicals can burn or destructively attack living tissue when inhaled, ingested, or absorbed by the skin. Irritant chemicals can also cause similar reactions when in contact with living tissue, but usually to a lesser extent.

Handling of corrosive and irritant chemicals:

1. Wear appropriate personal protective equipment.
2. Use in a laboratory fume hood or area with sufficient ventilation to protect from hazardous fumes.
3. Be aware of the signs and symptoms of exposure.
4. Remain aware of the chemical's incompatibilities.
5. Know the location of the nearest safety shower and eyewash.

3.0 CONTROL MEASURES AND EQUIPMENT

Chemical safety is achieved by continual awareness of chemical hazards and by keeping chemicals under control. Laboratory personnel should be familiar with the precautions to be taken to prevent injuries and exposures from chemicals, including the proper use of engineering and administrative controls and personal protective equipment. Principal Investigators should be aware of the proper functioning of their equipment and should arrange for regular inspection and maintenance of the equipment if it is not working properly.

3.1 Engineering Controls

An engineering control is a method of controlling employee exposures by modifying the source or reducing the quantity of contaminants released into the environment.

3.1.1 General Dilution Ventilation

Laboratory ventilation should be at least 8 air changes per hour. General dilution ventilation is not sufficient to provide protection from chemical exposures; it is for this reason that work with chemicals should always be done in a laboratory fume hood.

3.1.2 Laboratory Fume Hoods

Laboratory fume hoods shall provide a minimum face velocity of 80 feet per minute (fpm) with the sash in the "safe operating position". The "safe operating position" is the specific sash height at which a satisfactory face velocity is achieved, and has been designated and marked on each hood. The hood must not be operated with an opening greater than that indicated by the arrow on the sash position label. The EHSO performs quarterly evaluations of all laboratory fume hoods to verify the air flow.

The following safety precautions shall be observed when using a laboratory fume hood:

- Fume hood sashes should be kept at the safe operating position at all times when in use, except when adjusting the equipment inside.
- Hoods should not be used as storage areas for chemicals, apparatuses or other materials.
- Equipment inside the hood should be placed at least six inches away from the sash to prevent air flow obstruction and air turbulence.
- The hood fan should be kept on whenever chemicals are inside the hood, whether or not the chemical is being used in the hood.
- Lab personnel should be aware of the steps to be taken in the event of power failure or other causes of hood failure.
- The fume hood is a safety backup for condensers, traps, or other devices that collect vapors and fumes.
- Fume hoods shall not be used to "dispose" of chemicals by evaporation.
- Hood ducts and fans should be inspected semi-annually to be sure they are clean and clear of obstructions.
- Fume hoods should not be used if they do not have a current inspection sticker.
- Contact the EHSO (3-4495) if a hood does not have a current inspection sticker.

3.1.3 Storage Containers and Cabinets

Certain chemicals, particularly flammable liquids and acids, must be stored in special containers and/or cabinets in order to minimize their hazards. Storage of hazardous chemicals must be in accordance with provisions of the Virginia Statewide Fire Prevention Code (SFPC) and OSHA.

3.1.3a Safety Cans

Flammable liquids in quantities greater than 1 gallon (3.8 liters) should be kept in metal safety cans designed for such storage. The cans shall be used according to the manufacturer's instructions and the following safety practices:

- Keep the can closed except when adding or removing liquid.
- Always keep the flame-arrestor screen in place; replace if punctured or damaged.
- Never disable the spring-loaded enclosure.

3.1.3b Flammable Storage Cabinets

Flammable storage cabinets are recommended for all laboratories with flammable liquids and required for laboratories which have 10 gallons or more of flammable liquids. Cabinets designed for the storage of flammable liquids should be properly used and maintained. The cabinets shall be used according to the manufacturer's instructions and the following safety practices:

- Store only flammable liquids in the cabinet.
- Do not store paper, cardboard or other combustible material in the cabinet.
- Do not overload the cabinet; the manufacturer establishes maximum quantity limits for each cabinet.

3.1.3c Acid Storage Cabinets

Acids should be kept in cabinets specially designed to hold them. Wooden or metal cabinets treated with a corrosion-resistant coating are recommended. The cabinets shall be used according to the manufacturer's instructions and the following safety practices:

- Store only acids in the cabinet.
- Store organic and inorganic acids separately, preferably in different storage cabinets; however they can be stored in the same cabinet if they are separated by distance and a barrier.
- Store nitric acid away from all other acids unless you're cabinet has a separate compartment for nitric acid.
- Store acid waste in an acid storage cabinet and segregate it appropriately.

3.1.3d Gas Cylinder Storage

Storage of pressurized gas cylinders in the laboratory or cylinder storage areas shall be in accordance with the following guidelines:

- Store empty cylinders in an upright position with the caps on and separate from full cylinders.
- Store cylinders in well ventilated areas protected from continuous dampness or corrosive vapors.
- Secure ALL cylinders to a fixed object with chains or straps to prevent movement.
- Store cylinders at least 20 feet away from flames and other ignition sources.

3.2 Administrative Controls

Administrative controls are methods of controlling employee exposures by job rotation, work assignment, time periods away from the hazard or training in specific work practices designed to reduce the exposure.

3.3 Personal Protective Equipment

The most fundamental piece of personal protective equipment is normal clothing worn by the laboratory employee. Clothing should be worn to minimize skin exposure to direct chemical contact. Employees should wear long-sleeved/long-legged clothing and avoid short-sleeved shirts, shorts or short skirts. Shoes should be low-heeled with fully covered "uppers"; shoes with open toes or with uppers constructed of woven material shall not be worn.

Personal protective equipment needed while working in the laboratory shall be identified in the laboratory SOPs and supplied by the Principal Investigator. It is the responsibility of each employee to be certain that the appropriate personal protective equipment is worn as necessary.

Appendix B contains a compatibility chart for the most common materials used to make protective apparel and gloves. This chart can be used for the selection of proper protective apparel and gloves.

3.3.1 Protective Apparel

Appropriate protective apparel is required for most laboratory work and includes lab coats and aprons, arm guards, coveralls, boots, and shoe coverings. Protective apparel protects underlying clothing and skin from minor chemical splashes, and gives the wearer time before skin contact occurs. Protective apparel should meet performance requirements for strength, chemical and thermal resistance, flexibility and ease of cleaning.

3.3.2 Protective Gloves

Appropriate protective gloves shall be worn whenever the potential exists for contact with corrosive, contact-hazard or toxic materials, or materials of unknown toxicity. Gloves should be selected on the basis of their compatibility with the chemicals used, the particular hazard involved, and their suitability for the operation being conducted. Before use, gloves should be inspected for discoloration, punctures and tears. Disposable gloves shall not be reused.

3.3.3 Protective Eyewear

Appropriate protective eyewear shall be worn in all locations where chemicals are handled or stored. The use of eye protection is especially important for contact lens wearers, because of the difficulty in removing the lens following a chemical splash. Based on the chemical and/or physical hazards present in the laboratory, the following types of eye protection may be used:

1. **Safety Glasses** - Shall only be used when working with solid materials, even if equipped with side shields.

Although side shields offer some protection from objects that approach from the side, they do not provide adequate protection from splashes. Safety glasses shall not be used when working with liquid chemicals.

2. **Goggles** - Form a liquid-proof seal around the eyes necessary when working with liquid chemicals. Splash goggles with splash-proof sides should be used for protection from harmful liquid chemicals, particularly corrosive chemicals.

3. **Face Shields** - Protect the face and throat from flying particles and splashed liquid. Should be worn in conjunction with goggles when working with very hazardous chemicals, corrosives, or hot chemicals. The goggles protect the eyes in case a splash is from the side or beneath the shield.

4. **Specialized Eye Protection** - Some protective eyewear protects against specific chemical vapors, fumes and dusts, while others protect against intense light sources (e.g., lasers, ultraviolet light).

3.3.4 Respirators

ODU is required to minimize employee exposure to airborne contaminants through the use of engineering and/or administrative controls; however, if such controls are not feasible or not sufficient to keep contaminant concentrations below regulatory limits, employees shall be provided respirators in accordance with the VOSH Respiratory Protection Standard 1910.134.

ODU's Respiratory Protection Program is managed by the EHSO. An employee must receive authorization from the EHSO prior to wearing a respirator.

3.4 Eyewash Fountains and Safety Showers

Wherever chemicals have the possibility of damaging the skin or eyes, an emergency supply of water must be available. All laboratories where chemicals are used must be equipped with eyewash fountains. Safety showers must be readily accessible (within 100 feet) to all laboratory personnel. To ensure their continued usefulness, eyewashes and safety showers must be maintained in accordance with the following guidelines:

- Ensure that access to eyewash fountains and safety showers is not restricted in any way for any period of time.
- Check eyewash fountains routinely (preferably weekly) to ensure that they are working properly.
- Check safety showers routinely (preferably weekly) to ensure that access is not restricted and the pull chain is within reach.
- Promptly repair or replace malfunctioning eyewashes and safety showers.
- Post signs identifying the location of each eyewash and safety shower.
- Signs indicating the location of the nearest eyewash and safety shower shall be posted in labs that are not equipped with eyewashes or safety showers.

The EHSO shall perform quarterly inspections of eye wash fountains and safety showers in accordance with the most current edition of the American National Standards Institute: "Emergency Eyewash and Shower Equipment" (ANSI Z358.1).

3.5 Fire Extinguishers

All laboratories shall be equipped with an NFPA approved fire extinguisher. Every extinguisher should be labeled for the class of fire for which it is effective. Fires are classified as:

1. **Class A** - involve burning paper, wood, rags and trash. Water extinguishers are most effective against this type of fire.
2. **Class B** - involve burning liquids such as hydrocarbons. Carbon dioxide or dry powder extinguishers are used against this type of fire.
3. **Class C** - involve live electrical equipment and are effectively extinguished using carbon dioxide or dry powder extinguishers.
4. **Class D** - involve flammable metals such as alkali metals, metal hydrides and metal alkyls. Met-L-XR extinguishers or others that consist of special granular formulations are effective against metal fires.

Physical Plant maintenance personnel perform inspections and recharging of fire extinguishers. For further information on the proper use of fire extinguishers, contact the Fire Safety Engineer at 683-3023.

4.0 PROCEDURES FOR SELECT CARCINOGENS, REPRODUCTIVE TOXINS, CHEMICALS WITH HIGH ACUTE TOXICITY, AND CHEMICALS OF UNKNOWN TOXICITY

Laboratory workers are likely to use many chemicals that present serious acute and chronic health hazards. Of particular concern are the possible synergistic effects that may result from exposure to different chemicals simultaneously. To limit possible exposures, special procedures have been developed to provide additional employee protection when working with these extremely hazardous chemicals. Follow the procedures described in this section when performing laboratory work with any "select carcinogen", reproductive toxin, chemical with high acute toxicity, or chemical whose toxic properties are unknown.

4.1 Definitions

The following definitions will apply:

1. **Select carcinogen** - see glossary.
2. **Reproductive toxin** - Any chemical which affects reproductive capabilities; including mutagens which cause chromosomal damage and teratogens which cause effects on fetuses.
3. **Chemical with high acute toxicity** - Any chemical with a LD_{50} <50mg/kg or a LC_{50} <2,000mg/m^3.
4. **Chemical whose toxic properties are unknown** - A chemical for which there is no known statistically significant study conducted in accordance with established scientific principles that establishes its toxicity.

Refer to **Appendix C** to determine if a chemical can be classified into one of the four categories above. For chemicals which are not included on this list, consult the applicable MSDS. Additional assistance may be obtained by contacting the Environmental Health and Safety Office.

4.2 Designated Areas

Special areas must be designated for work with select carcinogens, reproductive toxins, chemicals with high acute toxicity, and chemicals of unknown toxicity. A "designated area" may consist of a fume hood, glove box, portion of a laboratory, or an entire laboratory.

Access to the designated area shall be restricted and signs warning "Authorized Personnel Only" shall be posted at its entrance. Only personnel who are aware of the hazards and trained in the safe handling of these chemicals will be permitted access to the "designated area."

4.3 Decontamination

When work is completed, decontaminate the designated area in accordance with the following guidelines:

1. Return unused chemicals to original containers, if possible; otherwise, properly label the new container or dispose of the unused chemical as hazardous waste.
2. Containerize chemical waste and any contaminated disposable articles and dispose of as hazardous waste.
3. Rinse contaminated glassware with an appropriate solvent (preferably water) and dispose of rinsate as hazardous waste.
4. Clean glassware according to normal practice, usually with hot water and a detergent.
5. Clean all contaminated work surfaces (e.g., bench space, fume hood) and equipment by wiping with a damp cloth.

4.4 Additional Precautions

The following additional precautions shall be observed by all laboratory personnel working with "select carcinogens", reproductive toxins, chemicals with high acute toxicity, and chemicals of unknown toxicity:

1. Use the smallest amount of chemical that is consistent with the requirements of the work to be done.
2. Limit purchases of these chemicals to the minimal amounts necessary to prevent uninterrupted work.
3. Wear long-sleeved disposable clothing and gloves known to resist permeation by the chemicals to be used.
4. Because the decontamination of jewelry may be difficult or impossible, do not wear jewelry when working in designated areas.
5. Workers shall wash before leaving the facility.
6. No food, beverages, tobacco or cosmetic products are permitted in the designated areas.

5.0 EXPOSURE EVALUATIONS AND MEDICAL CONSULTATIONS

5.1 Suspected Exposures to Toxic Substances

There may be times when employees suspect that they have been exposed to a hazardous chemical to a degree and in a manner that might have caused harm. The Chemical Hygiene Officer will initiate actions to formally evaluate suspect exposures.

5.1.1 Criteria for Reasonable Suspicion of Exposure

1. The EHSO shall promptly investigate all employee-reported incidents in which there is even a remote possibility of employee overexposure to a toxic substance.
2. Events or circumstances that might reasonably constitute an exposure include:
   a. A hazardous chemical leaked, was spilled, or was otherwise rapidly released in an uncontrolled manner.
   b. A laboratory employee had direct skin or eye contact with a hazardous chemical.
   c. A laboratory employee manifests symptoms such as headache, rash, nausea, coughing, tearing, irritation or redness of eyes, irritation of nose or throat, dizziness, loss of motor dexterity or judgment, and
      - Some or all of the symptoms disappear when the person is taken away from the exposure area and breathes fresh air, and
      - The symptoms reappear soon after the employee returns to work with the same hazardous chemicals.
   d. Two or more persons in the same laboratory work area have similar complaints.

5.2 Exposure Evaluations

All complaints of possible hazardous chemical exposure will be documented by the Chemical Hygiene Officer, along with the decision of appropriate action. If no further evaluation is deemed necessary, the reason for that decision will be included in the documentation. If the decision is made to investigate, a formal Exposure Evaluation will be initiated.

The purpose of an Exposure Evaluation is to determine that there was, or was not, an exposure that might have caused harm to one or more employees and, if so, to identify the hazardous chemical(s) involved. The results of the Exposure Evaluation can be used with other information to make recommendations that will prevent or mitigate future exposures.

5.2.1 Steps of the Exposure Evaluation

In cases of emergency, Exposure Evaluations will be conducted after the exposed employee(s) have been treated.

Unless circumstances suggest other or additional steps, the following steps constitute the **Exposure Evaluation** which will be conducted by the Chemical Hygiene Officer:

1. Interview the complainant and also the exposed individual, if not the same person.
2. List the essential information about the circumstances of the complaint on the Exposure Evaluation form (CHP-1), which is located in **Appendix D**, and includes the following information:
    a. The date, time, and location.
    b. Name(s) of person(s) involved.
    c. Location description.
    d. The chemical(s) under suspicion.
    e. Other chemicals used by the exposed individual.
    f. Other chemicals stored/used in that area.
    g. Symptoms exhibited or claimed by the exposed individual.
    h. Were control measures, such as fume hoods and personal protective equipment, used (list)? If so, were they used properly?
    i. Were any air sampling or monitoring devices in place (before, during, after)? If so, are their measurements consistent with exposure limits?
3. Monitor or sample the air in the area for suspect chemicals.
4. Determine whether the victim's symptoms compare to the symptoms associated with the suspect chemicals as described in the MSDS or other pertinent scientific literature.
5. Recommend exposed individual seek medical evaluation if necessary.
6. Determine whether the present control measures and safety procedures are adequate.

5.2.2 Notification of Monitoring Results

The Chemical Hygiene Officer shall notify employees of the results of any monitoring within 15 days of receipt of those results. The notification will be in writing, either individually or by posting in an appropriate location accessible to employees.

5.3 Medical Consultation and Examination

NOTE: In emergency situations where injury or illness is obvious, the affected employee shall be provided immediate medical care.

When, from the results of the Exposure Evaluation, it is suspected or known that an employee was overexposed to a hazardous chemical or chemicals, the employee shall be provided an opportunity to receive prompt medical attention. A medical consultation shall be provided by or under the direct supervision of a licensed physician for the purpose of

determining the need for a medical examination. When warranted, the employee shall be provided a medical examination by or under the direct supervision of a licensed physician who is experienced in evaluating and treating chemical overexposures.

Procedures of either ODU or ODU's Research Foundation Workers' Compensation Program will be followed when medical consultation and/or examination is required. Supervisors of exposed or injured employees should notify their Personnel Office by telephone for ODU employees and by an "Employees First Report of Accident" form for ODURF employees within 24 hours of the incident. The details of medical consultations and examinations will be determined by the physician.

All employees who work with hazardous chemicals shall be provided an opportunity to receive medical consultation and examination when:

1. The employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory.
2. Monitoring reveals an exposure level routinely above the action level or PEL if there is no action level, for a chemical for which OSHA has established a substance-specific standard.
3. There is a spill, leak, or other uncontrolled release resulting in the likelihood of exposure to hazardous chemicals.

- At the time of the medical consultation, the Chemical Hygiene Officer shall provide the physician with:
    1. The identity of the hazardous chemical(s) to which the employee may have been exposed.
    2. The exposure conditions, including quantitative data, if available.
    3. The signs and symptoms of exposure the employee is experiencing, if any.
- Following the medical consultation or examination, the examining physician shall provide the Chemical Hygiene Officer with a written opinion which shall include:
    1. Recommendations for follow-up, if any.
    2. A record of the results of the consultation and, if applicable, of the examination and any associated tests.
    3. Conclusions concerning any other medical condition noted that could put the employee at increased risk from exposure to hazardous chemicals in the workplace.
    4. A statement that the employee has been informed of the results of the consultation/examination and of any medical condition that may require further examination or treatment.

The examining physician will notify employees of the results of any medical consultation or examination with regard to any medical condition that exists or might exist as a result of overexposure to a hazardous chemical.

The written statements and medical records shall not reveal specific findings that are not related to an occupational exposure.

5.4 Documentation

All memos, notes, and reports related to a complaint of actual or possible exposure to hazardous chemicals are to be maintained as part of the record in accordance with **Section 7** of this Plan.

6.0 EMPLOYEE INFORMATION AND TRAINING

Principal Investigators shall provide their laboratory employees with information and training concerning the hazards of chemicals present in their laboratories. This information and training will be provided when an employee is initially assigned to a laboratory where hazardous chemicals are present, and also prior to assignments involving new hazardous chemicals and/or new laboratory work procedures. Training will be repeated as needed. A training record, which is in **Appendix E** of this Plan, shall be completed for each training session and a copy shall be forwarded to the EHSO.

6.1 Informational Requirements

Employees shall be informed of:

1. The contents of the Laboratory Standard and its appendices, which shall be made available to employees.
2. The location and availability of the laboratory's Chemical Hygiene Plan.
3. The PEL's, TLV's, and other recommended exposure limits for hazardous chemicals used in the laboratory.
4. Signs and symptoms associated with exposures to hazardous chemicals used in the laboratory.
5. The location and availability of MSDS's and other reference materials on the hazards, safe handling, storage and disposal of hazardous chemicals used in the laboratory.

6.2 Training Requirements

Employee training shall include:

1. The methods and observations that may be used to detect the presence or release of a hazardous chemical (such as monitoring conducted by ODU's EHSO,

continuous monitoring devices, visual appearance or odor of hazardous chemicals when being released, etc.).

2. The physical and health hazards associated with chemicals used in the laboratory.

3. The measures employees can use to protect themselves from these hazards, including specific procedures implemented by ODU to protect its employees from exposure to hazardous chemicals, such as appropriate work practices, emergency procedures, and personal protective equipment to be used.

4. Lab specific details which are applicable to this Plan.

7.0 RECORDS AND RECORDKEEPING

The EHSO shall maintain records of exposure monitoring results, Exposure Evaluation forms, accident investigations and medical consultations and examinations for at least thirty years and shall make them accessible to employees or their representatives. Laboratory evaluations and other records developed internally that document suspected exposures, employee exposure complaints and other incidents and activities shall be kept by the EHSO for at least five years. Examples include:

1. **Complaints from Employees** - Even if the complaint is found to be unjustified, it is useful to keep a record of the complaint, the investigation, and the outcome. The complaints might be about chemical exposure, but could include complaints about inoperative engineering controls or defective personal protective equipment.

2. **Repair and Maintenance Records for Control Systems** - Demonstrate that equipment is well maintained and kept in proper operating order; may suggest corrective actions.

3. **Safety Suggestions from Employees** - Can be valuable to improve laboratory safety. Even when a suggestion is clearly unworkable, it should be taken seriously, examined and recorded.

All important documents related to the distribution and maintenance of Material Safety Data Sheets, to the training of employees, and to significant employee suggestions shall be retained by the EHSO for the lifetime of ODU. The EHSO shall ensure ODU's compliance with the record keeping requirements of the EPA and other federal and state agencies which regulate hazardous chemicals.

8.0 LABORATORY SPECIFIC INFORMATION

This part of the hygiene plan has been designed to be augmented with information that is specific to each laboratory. It is the responsibility of the Principal Investigator of each laboratory to compile and insert information in the following section. **The completeness of this section will be reviewed during annual laboratory evaluations**.

8.1 Laboratory Safety Training Requirements

All employees of ODU or ODURF who work with hazardous chemicals shall understand the topics listed in parts 6.1 and 6.2 of this Plan prior to working with hazardous chemicals and signing the training record located in **Appendix E**. A copy of the signed record should be kept with this plan for the duration of the trainee's employment at ODU.

8.2 Laboratory's Standard Operating Procedures

Laboratory Standard Operating Procedures (SOP) require precautionary measures in order to execute each procedure safely. All laboratory SOPs must contain a written description of specific safety practices incorporating the applicable precautions described in this Plan. This is especially important in hazardous procedures or when using extremely hazardous materials. The employee must read and understand the procedure and its associated safety practices before proceeding. Any questions regarding the safe execution of a procedure must be addressed to the Principal Investigator before attempting to execute the procedure. Examples of what may be used as SOPs include laboratory manuals and procedural protocols. SOPs shall be listed below and copies shall be kept with this Plan. If it is unfeasible to keep copies of SOPs with this Plan, then the location of each SOP shall be listed below.

8.3 Description of Laboratory

Each laboratory has a distinct design or layout that allows the Principal Investigator to conduct their research/instruction with as much efficiency as possible while keeping chemical hygiene as a top priority. This page has been reserved so that a brief summary of laboratory activities and a rough sketch displaying the location of chemical storage and safety equipment may be attached.

8.4 Laboratory's Chemical Inventory

A chemical inventory is an integral part of laboratory safety and emergency preparedness and is effective in minimizing the overstock of hazardous chemicals. Every area of chemical use or storage must have a current chemical inventory. Principal Investigators are required to maintain a working inventory of the chemicals in their labs and submit the inventory to the EHSO annually upon request. **A copy of the inventory shall be included in this Plan below or as an attachment and it shall include the following information**: Name of individual who prepared the inventory, date inventory was prepared/updated, building and room number where chemicals are located, chemical name (as it appears on the label) and it's volume expressed in liters for liquids and mass expressed in grams for solids. The inventory may also include information such as the chemical hazard classification, the date of acquisition, and the storage location.

APPENDIX A

HAZARDOUS WASTE DISPOSAL PROCEDURES

Hazardous chemical wastes are regulated by the Environmental Protection Agency (EPA) under the Resource Conservation and Recovery Act (RCRA) and its amendments. Federal and state regulations promulgated under RCRA classify waste as hazardous if it meets certain criteria as specified in the regulations. If a waste is classified as hazardous, disposal must be in accordance with the regulations.

The EHSO is responsible for managing the University's Hazardous Waste Program. Funding for disposal of "common" hazardous waste streams is through the EHSO's budget. The EHSO is not funded for disposal of "uncommon" waste streams, such as unknown waste and waste requiring stabilization. The EHSO collects hazardous waste generated on campus and transfers it to a storage facility where it is properly stored until picked up by a licensed hazardous waste disposal company.

Hazardous Waste Disposal

Generators of hazardous waste are required to complete a **"Request for Disposal of Hazardous Waste"** form for their waste. The form provides information about the origination and contents of the waste. The EHSO cannot dispose of any waste whose ingredients are unknown.

- **Unknown Waste Chemicals**
  Laboratory personnel must make every effort to provide an accurate description of all chemicals given to EH&S for handling and disposal. Unknown chemicals will not be accepted by EH&S since they cannot be handled or disposed of in a safe manner. Hazardous waste disposal companies will not accept unknowns without proper analysis and the analysis of a single sample can easily cost $1,000 or more.

It is the responsibility of the generator (individual or department) to accurately identify all chemical unknowns in their laboratory, either by knowledge or analysis. This may require polling laboratory personnel, students and faculty members to ascertain the owner of such unknown waste and its identity. It must be constantly emphasized to researchers that they identify and label all wastes and project products.

Hazardous waste should be handled according to the following guidelines:

- Use the appropriate sized container for accumulating waste. For example, if only 250 ml of waste is to be generated, use a 250 - 300 ml container for accumulation.
- Use the same type of container for waste as that in which the chemical was originally shipped.
- Do not use corks or stoppers to close containers; use properly fitting screw-on lids lined with a material that will not be chemically attacked by the contents.
- Never fill containers to the top. Allow space in the container for expansion. For example, with a 4 L bottle allow an expansion space of at least 1 inch below the neck.
- Keep containers closed except when filling or emptying.
- Segregate and store wastes in accordance with laboratory procedures for storage of hazardous chemicals.
- Do not mix hazardous and non-hazardous waste. This mixture may be regulated as hazardous.
- Accumulate chlorinated and non-chlorinated solvent waste in separate containers. Chlorinated wastes are more expensive to dispose of.
- Avoid mixing different hazardous wastes, even if they are compatible. They may each have different disposal methods.

- Do not mix hazardous and radioactive wastes; this mixture is a special waste which is difficult and very expensive to dispose of.
- Label all waste containers appropriately. (Tape can be used, be sure its clearly marked with contents, and secure.)
- Handle shock sensitive compounds, such as old ethers and old picric acid, with extreme caution.

Labeling

A label must be completed for each container of hazardous waste and affixed to the container before pick-up. Use a permanent marker to fill out the label. If an unused chemical is being disposed of, affix the hazardous waste label to the container such that the original label can still be read. All other labels must be removed or defaced.

Refer to the label below while reviewing the following instructions:

- List all contents (liquid and solid) and the approximate quantity or percent of each. Be sure to include water and other inert components. The total percent of the contents should equal 100 or the total volume in the container should equal the sum of the volumes of the contents. DO NOT USE ABBREVIATIONS OR CHEMICAL FORMULAS
- Give the total quantity in the container (preferably in milliliters or liters for liquids and grams or pounds for solids)
- Include the building and room number where the waste was generated.
- Do not mark in the DATE area, EH&S will date the material on pick-up.

HAZARDOUS WASTE

P.I. Name_____

BUILDING:_____ ROOM:_____

CONTENTS	**QUANTITY**
(EHS Use Only) **DATE:**	

The above label is available to print using Avery shipping 2' x 4' labels, just print on regular paper, cut and adhere to containers with tape.

- www.odu.edu/af/ehs/about/HAZWASTELabels.pdf

Completing the "Request for Disposal of Hazardous Waste" Form

University personnel, such as Principal Investigators, lab managers and shop supervisors, are responsible for completing this form in its entirety prior to the pick up of hazardous waste.

The form is available for download at:

- www.odu.edu/af/ehs (Shows on right menu under “Quick Links”).

Completed forms should be sent to the EHSO via campus mail or Fax (683-6025). Upon receipt of the completed form, EHSO personnel will schedule a pickup.

- Fill in the name of the person requesting the pickup (contact), their department, building, room # where the waste is located, phone extension and date the form was completed.
- The "Identification of Waste" section must include the following container and contents information:
    - The hazardous waste label ID # for each container. (Filled out by EHS)
    - All contents (liquid and solid) and the approximate quantity or percent of each. Be sure to include water and other inert components. The total percent of the contents should equal 100 or the total volume in the container should equal the sum of the volumes of the contents. DO NOT USE ABBREVIATIONS OR CHEMICAL FORMULAS**.**
    - The total quantity in the container (preferably in milliliters or liters for liquids and grams or pounds for solids).
    - The size and type of the container (ex. 500 ml glass, 1 L plastic)
    - Check all hazards applicable to the waste.
    - Sign and date the form certifying that the information included on the form is accurate and to the best of your knowledge.
- Send the completed form to the EHSO via campus mail or fax to 3-6025. An On-line form is also available.

REQUEST FOR DISPOSAL OF HAZARDOUS WASTE

(Please send requests to the Environmental Health and Safety Office)

Contact (print name)	**Department**	**Date**
Building	**Room #**	**Phone #**

IDENTIFICATION OF WASTE
****Use chemical or generic name - DO NOT abbreviate or use chemical formulas****

ID # EHS Use Only	**Contents (% or quantity of each)**	**Total quantity in container**	**Size and type of container**

HAZARDS
(check all that apply)

- ☐ Ignitable - flash pt._____
- ☐ Corrosive - pH_____
- ☐ Oxidizer
- ☐ Explosive
- ☐ Reactive
- ☐ Organic peroxide
- ☐ Flammable Solid
- ☐ Irritant - intensive lachrymator
- ☐ Poisonous liquid or solid
- ☐ Compressed gas - nonflammable
- ☐ Compressed gas - poison
- ☐ Compressed gas - flammable
- ☐ Other hazards _____

This waste is properly described, has descriptive labels, and is in a proper container for handling.

_____ _____

(Contact signature and date) **(EHSO personnel signature & date)**

Notes:

APPENDIX B

COMPATIBILITY GUIDE FOR PERSONAL PROTECTIVE EQUIPMENT

COMPATIBILITY GUIDE

This guide describes the most common materials used to make laboratory protective apparel and gloves. Materials not listed in this guide, however, may provide equivalent or even greater protection against certain chemicals used in the laboratory. When selecting protective apparel and gloves, it is recommended that the manufacturer's literature be consulted for more complete information on chemical compatibility.

Protective Apparel:

*****Tyvek

Made of spunbonded olefin, a nonwoven material composed of heat and pressure bonded polyethylene fibers. There are four types of Tyvek: Standard, Perforated, Polylaminated and Saranex-Coated.

> Standard Tyvek offers high tear resistance and water repellence. It resists penetration from dry particulate including biological agents, asbestos, radionuclides, and other toxic dusts. It is not recommended for use with liquids.
>
> Perforated Tyvek is essentially the same material as Standard Tyvek with the addition of tiny air holes which allow air to flow through the fabric and provides for cooler wearing. It is not for use against toxic dusts or liquids and, therefore, should be used only in nonhazardous applications.
>
> Polylaminated Tyvek is Standard Tyvek coated with a polyethylene film. It resists acids, bases and salts and repels water and moisture. It is not recommended for protection against organic
>
> Saranex-Coated Tyvek is Standard Tyvek with a layer of Saranex 23-P laminated to one side. It provides a high level of permeation resistance to many hazardous solvents. Apparel made of this material is ideal for Haz-Mat response.

*****Chemrel

A flexible laminate with a strong, absorbent polymer substrate which provides superior chemical resistance and greater fabric strength. Resistant to various acids, bases and organic solvents, it is ideal for Haz-Mat response.

*****Nomex

Made of an aramid fiber which is flame resistant, and acid and chemical resistant. Nomex apparel is reusable and easily cleaned.

Apparel made of this material is known as "limited-use" protective clothing. The term "limited-use" means the clothing can be worn a limited number of times before it shows signs of contamination and must be discarded.

Protective Gloves:

Neoprene

Protects against a wide range of chemicals including greases, oils and other petroleum distillates, acids, caustics, alcohols and solvents. Resists punctures, cuts and tears, and provides flexibility for work requiring touch sensitivity.

Nitrile

Protects against aromatic, petroleum and chlorinated solvents, oils, fats, greases, acids, caustics and alcohols. Resists abrasion, cuts, punctures, and snags.

Polyvinyl Chloride

Also called PVC or vinyl. Protects against acids and caustics. Provides dexterity and flexibility. Commonly used in disposable gloves.

Latex

Protects against acids, caustics, salts, common alcohols and ketones. Provides durability and dexterity, making it ideal for laboratory analysis and technical work. Commonly used in disposable gloves.

Polyethylene

Protects against moisture and most chemicals, detergents and acids. Commonly used in disposable gloves.

Polyurethane

Protects against a variety of hazardous substances including many alcohols, hydrocarbons and organic solvents. Provides increased strength for a longer wear-life. Commonly used in disposable gloves.

Natural Rubber

Protects against alcohols, caustics, salts and detergents. Tear resistant and waterproof.

Butyl Rubber

Protects against gas and water vapors, aldehydes, alcohols, most organic acids and caustics. Ideal for use with ketones and esters. Provides flexibility and sensitivity.

Viton

Designed specifically for use with chlorinated and aromatic solvents. Also protects against PCB's, water-based solutions, ozone, gas and water vapors.

Polyvinyl Alcohol

Protects against aromatic and chlorinated solvents and ketones. Because PVA is water-soluble, it should not be used with water or water-based solutions.

APPENDIX C

SELECT CARCINOGENS, REPRODUCTIVE TOXINS, & CHEMICALS WITH HIGH ACUTE TOXICITY

SELECT CARCINOGENS, REPRODUCTIVE TOXINS & CHEMICALS WITH HIGH ACUTE TOXICITY COMMONLY USED AT ODU

Following is a list of select carcinogens, reproductive toxins, and chemicals with high acute toxicity commonly used in laboratories at Old Dominion University. Select carcinogens ("SELECT CARC") are identified by the listing agency or agencies - OSHA, NTP and/or IARC. For those carcinogens listed by IARC, the group number is also included. Reproductive toxins ("REPRO TOX") are identified as either known mutagens and teratogens ("MUTA", "TERA") or potential mutagens and teratogens ("PMUTA", "PTERA"). Chemicals with high acute toxicity ("HIGH ACUTE TOX") are identified by "Yes". A "No" in any column means that the chemical does not fit the definition found in Section 6.1 and Appendix A.

CHEMICAL NAME	SELECT CARC	REPRO TOX	HIGH ACUTE TOX
Acacia (Gum Arabic)	No	PMUTA	No
Acetamide	IARC 2B	PMUTA	No
Acetic Acid	No	PMUTA	No
Acetone	No	PMUTA	No
Acetonitrile	No	PMUTA	No
Acetophenone	No	PMUTA	No
Acetylsalicylic Acid	No	PMUTA	No
Acrylamide	IARC 2B	PMUTA	No
Alcohol, Reagent	No	PMUTA	No
Allyl Alcohol	No	PMUTA	No
Aluminum Chloride	No	PMUTA PTERA	No
Aluminum Nitrate, 9-Hydrate	No	No	Yes
Aluminum Potassium Sulfate	No	PTERA	No
Aluminum Sulfate	No	PTERA	No
Aminobenzoic Acid, p- (PABA)	No	PMUTA	No

CHEMICAL NAME	SELECT CARC	REPRO TOX	HIGH ACUTE TOX
Ammonia	No	PMUTA	Yes
Ammonium Bromide	No	PMUTA	No
Ammonium Carbonate	No	No	Yes
Ammonium Chloride	No	PMUTA	Yes
Ammonium Dichromate	NTP IARC 1	No	No
Ammonium Hydroxide	No	PMUTA	Yes
Ammonium Meta-Vanadate	No	PMUTA	Yes
Ammonium Vanadate	No	PMUTA	No
Amyl Alcohol	No	PMUTA	No
Aniline	No	PMUTA	Yes
Anisidine, o-	NTP IARC 2B	PMUTA	No
Anisidine, p-	No	PMUTA	No
Anthracene	No	PMUTA	No
Anthranilic Acid	No	PMUTA	No
Antimony Pentachloride	No	PMUTA	Yes
Antimony Potassium Tartrate	No	PMUTA	No
Arsenic Trioxide	OSHA NTP IARC 1	PMUTA	Yes
Arsenic, Metal	OSHA NTP IARC 1	PMUTA	No
Barium Carbonate	No	PTERA	No

CHEMICAL NAME	SELECT CARC	REPRO TOX	HIGH ACUTE TOX
Barium Hydroxide	No	PTERA PMUTA	No
Benzaldehyde	No	PMUTA	No
Benzene	OSHA NTP IARC 1	MUTA TERA	No
Benzidine	OSHA IARC 1 NTP	PMUTA PTERA	No
Benzoic Acid	No	PMUTA	No
Benzoin	No	PMUTA	No
Benzoquinone	No	PMUTA PTERA	No
Benzoyl Peroxide	No	PMUTA	No
Benzyl Alcohol	No	PMUTA PTERA	No
Benzyl Bromide	No	PMUTA	No
Benzyl Chloride	No	MUTA TERA	Yes
Biphenyl	No	MUTA	No
BIS (2-Methoxyethyl) Ether	No	PMUTA PTERA	No
Bismuth Nitrate	No	PTERA	No
Borax	No	PTERA PMUTA	No
Boric Acid	No	PTERA PMUTA	No

CHEMICAL NAME	SELECT CARC	REPRO TOX	HIGH ACUTE TOX
Bromobenzene	No	PMUTA	No
Bromoform	No	PMUTA	No
Butanol, n-	No	PMUTA	No
Butanol, tert-	No	PTERA	No
Butylphthalate, n-	No	MUTA TERA	No
Butyraldehyde	No	MUTA	No
Butyric Acid, n-	No	PMUTA	No
Cadmium	NTP IARC 2A	MUTA TERA	Yes
Cadmium Chloride	NTP IARC 2A	MUTA TERA	Yes
Cadmium Nitrate	IARC 2A	MUTA	Yes
Cadmium Sulfate, 8-Hydrate	NTP IARC 2A	MUTA TERA	Yes
Caffeine	No	PMUTA PTERA	No
Calcium Chloride	No	PMUTA	No
Calcium Fluoride	No	PMUTA PTERA	No
Calcium Hydroxide	No	PMUTA	No
Calcium Hypochlorite	No	PMUTA	No
Camphene	No	PMUTA	No
Carbon	No	PTERA	No
Carbon Dioxide	No	PTERA	No

CHEMICAL NAME	SELECT CARC	REPRO TOX	HIGH ACUTE TOX
Carbon Disulfide	No	PTERA PMUTA	No
Carbon Tetrachloride	NTP IARC 2B	PMUTA PTERA	No
Chloral Hydrate	No	PMUTA PTERA	No
Chlordane	No	MUTA TERA	Yes
Chlorine	No	PMUTA PTERA	No
Chloro-4-Nitrobenzene, 1-	No	MUTA	No
Chloroaniline, m-	No	PMUTA	No
Chloroaniline, o-	No	PMUTA	No
Chloroaniline, p-	No	PMUTA	No
Chloroform	NTP IARC 2B	MUTA TERA	No
Chlorophenol, o-	IARC 2B	MUTA TERA	No
Chloropropene, 3-	No	PMUTA PTERA	No
Chlorotrimethylsilane	No	MUTA	No
Chromium Chloride	No	PMUTA PTERA	Yes
Chromium Nitrate	No	PMUTA	No
Chromium Oxide	No	PMUTA	No
Chromium Sulfate	No	PMUTA	No

CHEMICAL NAME	SELECT CARC	REPRO TOX	HIGH ACUTE TOX
Chromium Trioxide	IARC 1 NTP	MUTA	No
Cinnamaldehyde	No	PMUTA	No
Cobalt Acetate, Tetrahydrate	No	PMUTA	No
Cobalt Chloride	No	PMUTA	No
Collodion	No	PMUTA	No
Copper	No	PMUTA	No
Cupric Acetate	No	PTERA	No
Cupric Chloride	No	PTERA PMUTA	No
Cupric Nitrate	No	PMUTA	No
Cupric Sulfate	No	PMUTA PTERA	No
Cyclohexane	No	PMUTA	No
Cyclohexanol	No	PMUTA PTERA	No
Cyclohexanone	No	PMUTA PTERA	No
Cymene, p-	No	PMUTA PTERA	No
D-Glucose Anhydrous	No	PMUTA PTERA	No
Dextrose	No	PMUTA PTERA	No
Diazinon	No	PMUTA PTERA	Yes

CHEMICAL NAME	SELECT CARC	REPRO TOX	HIGH ACUTE TOX
Dibromoethane, 1,2-	NTP IARC 2A	PMUTA PTERA	No
Dichlorobenzene, o-	No	PMUTA PTERA	No
Dichlorobenzene, p-	NTP IARC 2B	PMUTA PTERA	No
Dichloroethane, 1,2-	NTP IARC 2B	PMUTA PTERA	No
Dichloromethane	NTP IARC 2B	PMUTA PTERA	No
Diethylamine	No	PMUTA	No
Diethylene Glycol	No	PTERA	No
Dimethoxybenzene, p-	No	PMUTA	No
Dimethoxyethane, 1,2-	No	PTERA	No
Dimethylformamide	IARC 2B	PMUTA PTERA	No
Dimethyl Sulfoxide (DMS0)	No	PMUTA PTERA	No
Dinitroaniline, 2,4-	No	PMUTA PTERA	No
Dinitrobenzene, m-	No	PMUTA PTERA	No
Dioxane	NTP IARC 2B	PMUTA PTERA	No
Diphenylamine	No	PTERA	No
Dylox	No	PMUTA PTERA	Yes

CHEMICAL NAME	SELECT CARC	REPRO TOX	HIGH ACUTE TOX
Ethanol	No	PMUTA PTERA	No
Ethanolamine	No	PMUTA PTERA	No
Ether	No	PMUTA	No
Ethoxyethanol	No	PMUTA PTERA	No
Ethyl Acetate	No	PMUTA	No
Ethyl Alcohol	No	PMUTA PTERA	No
Ethyl Benzene	No	PMUTA PTERA	No
Ethylene Bromide	NTP IARC 2B	PMUTA PTERA	No
Ethylenediamine	No	PMUTA PTERA	Yes
Ethylenediaminetetraacetic Acid (EDTA)	No	PMUTA PTERA	No
Ethylenediaminetetraacetic Acid (EDTA), Disodium Salt	No	PTERA PMUTA	No
Ethylene Dichloride	NTP IARC 2B	PMUTA PTERA	No
Ethylene Glycol	No	PMUTA PTERA	No
Ethylene Glycol Monoethyl Ether	No	PTERA	No
Ferric Ammonium Sulfate	No	PMUTA	No
Ferric Chloride	No	PMUTA PTERA	No

CHEMICAL NAME	SELECT CARC	REPRO TOX	HIGH ACUTE TOX
Ferric Nitrate	No	PMUTA	No
Ferric Sulfate	No	PMUTA	No
Ferrocene	No	PMUTA	No
Ferrous Chloride	No	PMUTA	No
Ferrous Sulfate	No	PMUTA PTERA	No
Formaldehyde	OSHA NTP IARC 2A	MUTA TERA	Yes
Furfuryl Alcohol	No	PMUTA	No
Galactose	No	PTERA	No
Gasoline	IARC 2B	No	No
Gelatin	No	PTERA	No
Glacial Acetic Acid	No	PMUTA	No
Glutaraldehyde	No	PMUTA PTERA	No
Glycerin	No	PMUTA PTERA	No
Guanidine	No	PMUTA	No
Hexachloro-1,3-Butadiene	No	PMUTA PTERA	No
Hexamethylene Tetramine	No	PMUTA	No
Hexane	No	PMUTA PTERA	No
Hexanediamine, 1,6-	No	PTERA	No
Hexanoic Acid	No	PMUTA	No

CHEMICAL NAME	SELECT CARC	REPRO TOX	HIGH ACUTE TOX
Hydrazine Sulfate	NTP IARC 2B	PMUTA	No
Hydrochloric Acid	No	PMUTA PTERA	No
Hydrofluoric Acid	No	PMUTA PTERA	No
Hydrogen Peroxide	No	PMUTA	Yes
Hydroquinone	No	PMUTA PTERA	No
Hydroxylamine Sulfate	No	PMUTA	No
Hydroxyquinoline, 8-	No	PMUTA	No
Imidazole	No	PMUTA	No
Iodine	No	PTERA	No
Isoamyl Alcohol	No	PMUTA	No
Kaolin	No	PTERA	No
Lactic Acid	No	PMUTA	No
Lactose	No	PTERA	No
Lauric Acid	No	PMUTA	No
Lead Acetate	NTP IARC 2B	TERA PMUTA	No
Lead Carbonate	IARC 2B	PTERA	No
Lead Chloride	IARC 2B	PMUTA PTERA	No
Lead Dioxide	IARC 2B	PTERA	No
Lead Nitrate	IARC 2B	PMUTA TERA	No

CHEMICAL NAME	SELECT CARC	REPRO TOX	HIGH ACUTE TOX
Lead Oxide	IARC 2B	PMUTA TERA	No
Lead, Metal	IARC 2B	TERA	No
Lithium Carbonate	No	PMUTA PTERA	No
Lithium Chloride	No	PMUTA PTERA	No
Lithium Hydroxide	No	No	Yes
Magnesium Chloride	No	PMUTA	No
Magnesium Sulfate	No	PMUTA PTERA	No
Maleic Acid	No	PMUTA	No
Maleic Anhydride	No	PMUTA PTERA	No
Maltose	No	PTERA	No
Manganese Chloride	No	PMUTA PTERA	No
Manganese Sulfate	No	PMUTA PTERA	No
Manitol	No	PMUTA	No
Methyl Parathion	No	PMUTA PTERA	No
Mercuric Chloride	No	PMUTA PTERA	Yes
Mercuric Iodide	No	PTERA	No
Mercuric Oxide	No	PTERA	Yes

CHEMICAL NAME	SELECT CARC	REPRO TOX	HIGH ACUTE TOX
Mercury	No	PMUTA PTERA	No
Mesitylene	No	MUTA	No
Methanol	No	PMUTA PTERA	No
Methoxyethanol, 2-	No	PMUTA PTERA	No
Methyl Acetate	No	PMUTA	No
Methyl Ethyl Ketone	No	PMUTA PTERA	No
Methyl Isobutyl Ketone	No	PTERA	No
Methyl Methacrylate	No	PMUTA PTERA	No
Methyl Salicylate	No	PTERA	No
Methyl Sulfoxide	No	PMUTA PTERA	No
Methyl-2-Butanone, 3-	No	PMUTA	No
Methylene Chloride	NTP IARC 2B	PMUTA PTERA	No
Monochloroacetic Acid	No	PMUTA	No
Naphthalene	No	PTERA	No
Naphthol, 1-	No	PMUTA	No
Naphthol, 2-	No	PMUTA	No
Nickel Ammonium Sulfate, Hexahydrate	IARC 1	No	No
Nickel Chloride, Hexahydrate	IARC 1	PMUTA PTERA	No

CHEMICAL NAME	SELECT CARC	REPRO TOX	HIGH ACUTE TOX
Nickel Nitrate, Hexahydrate	IARC 1	PMUTA PTERA	No
Nickel Oxide	NTP IARC 1	PMUTA PTERA	No
Nickel, Metal	NTP IARC 1	PMUTA PTERA	No
Nickel Sulfate	IARC 1	PMUTA	No
Nickel Sulfate, Hexahydrate	IARC 1	PMUTA PTERA	No
Nitric Acid	No	PTERA	No
Nitroaniline, p-	No	PMUTA PTERA	No
Nitrobenzene	No	PMUTA PTERA	No
Nitropropane, 2-	NTP IARC 2B	PMUTA PTERA	No
Nitrotoluene, o-	No	PMUTA	No
Oleic Acid	No	PMUTA	No
Oxalic Acid	No	PTERA	No
Oxygen	No	PMUTA PTERA	No
Paraformaldehyde	No	PMUTA	No
Pentanedione, 2,4-	No	PMUTA	No
Phenol	No	PMUTA PTERA	Yes
Phenyl Isocyanate	No	PMUTA	No
Phenylenediamine, o-	No	PMUTA	No

CHEMICAL NAME	SELECT CARC	REPRO TOX	HIGH ACUTE TOX
Phenylhydrazine	No	PMUTA	No
Phosphorous Pentoxide	No	No	Yes
Phthalic Acid	No	PTERA	No
Picric Acid	No	PMUTA	No
Piperidine	No	PMUTA PTERA	No
Potassium Bromate	IARC 2B	PMUTA	No
Potassium Bromide	No	PMUTA	No
Potassium Chloride	No	PMUTA	No
Potassium Chromate	NTP IARC 1	PMUTA PTERA	No
Potassium Cyanide	No	PMUTA PTERA	Yes
Potassium Dichromate	NTP IARC 1	PMUTA PTERA	No
Potassium Ferricyanide	No	PMUTA	No
Potassium Fluoride	No	PMUTA PTERA	No
Potassium Hydroxide	No	PMUTA	No
Potassium Iodide	No	PMUTA PTERA	No
Potassium Metabisulfate	No	PTERA	No
Potassium Nitrate	No	PMUTA PTERA	No
Potassium Permanganate	No	PMUTA PTERA	No

CHEMICAL NAME	SELECT CARC	REPRO TOX	HIGH ACUTE TOX
Potassium Thiocyanate	No	PTERA	No
Princep	No	PMUTA PTERA	Yes
Propanol, 1-	No	PMUTA PTERA	No
Propanol, 2-	No	PMUTA	No
Propylene Glycol	No	PMUTA PTERA	No
Propylene Oxide	NTP IARC 2A	PMUTA PTERA	No
Pyridine	No	PMUTA	No
Pyrogallic Acid	No	PMUTA PTERA	No
Quinine Sulfate Dihydrate	No	PMUTA PTERA	No
Resorcinol	No	PMUTA PTERA	No
Saccharose (Sucrose)	No	PMUTA PTERA	No
Salicylic Acid	No	PTERA PMUTA	No
Salicylic Acid, Sodium Salt	No	PMUTA PTERA	No
Selenium	No	PTERA	No
Selenous Acid	No	PMUTA	No
Semicarbazide Hydrochloride	No	PMUTA PTERA	No
Silicon Carbide	IARC 2B	No	No

CHEMICAL NAME	SELECT CARC	REPRO TOX	HIGH ACUTE TOX
Silicon Dioxide	No	PMUTA	No
Silver Nitrate	No	PMUTA PTERA	Yes
Sodium Acetate	No	PTERA	No
Sodium Arsenate	OSHA NTP IARC 1	PMUTA PTERA	No
Sodium Arsenite	OSHA NTP IARC 1	PMUTA PTERA	No
Sodium Azide	No	PMUTA	Yes
Sodium Benzoate	No	PMUTA PTERA	No
Sodium Bicarbonate	No	PMUTA PTERA	No
Sodium Bisulfite	No	PMUTA	No
Sodium Borate	No	PMUTA PTERA	No
Sodium Bromide	No	PMUTA	No
Sodium Carbonate	No	PTERA	No
Sodium Chlorate	No	PMUTA	No
Sodium Chloride	No	PTERA	No
Sodium Chromate	NTP IARC 1	PMUTA	No
Sodium Cyanide	No	PTERA	Yes
Sodium Dichromate	NTP IARC 1	PMUTA	Yes

CHEMICAL NAME	SELECT CARC	REPRO TOX	HIGH ACUTE TOX
Sodium Flouride	No	PMUTA PTERA	No
Sodium Hydroxide	No	PMUTA	No
Sodium Hyprochlorite	No	PMUTA	No
Sodium Iodide	No	PTERA	No
Sodium Metabisulfate	No	PMUTA PTERA	No
Sodium Molybdate	No	PMUTA PTERA	No
Sodium Nitrate	No	PMUTA PTERA	No
Sodium Nitrite	No	PMUTA PTERA	Yes
Sodium Nitroprusside	No	No	Yes
Sodium Perchlorate	No	PMUTA	No
Sodium Salicylate	No	PMUTA PTERA	No
Sodium Sulfite	No	PMUTA	No
Sodium Tungstate	No	PMUTA	No
Sorbitol	No	PMUTA	No
Stannous Chloride	No	PMUTA PTERA	No
Sulfanilamide	No	PMUTA PTERA	No
Sulfuric Acid	No	PTERA	Yes
Tannic Acid	No	PMUTA PTERA	No

CHEMICAL NAME	SELECT CARC	REPRO TOX	HIGH ACUTE TOX
Tetrachloroethane, 1,1,2,2-	No	PMUTA	No
Tetrahydrofuran	No	PMUTA	No
Thioacetamide	NTP IARC 2B	PMUTA PTERA	No
Thiourea	NTP IARC 2B	PMUTA PTERA	No
Thymol	No	PMUTA PTERA	No
Toluene	No	PMUTA PTERA	No
Toluidine, o-	NTP IARC 2B	PMUTA	No
Toluidine, p-	No	PMUTA	No
Tributyl Phosphate	No	PMUTA PTERA	Yes
Trichloroacetic Acid	No	PMUTA PTERA	No
Trichloroethane, 1,1,2-	No	PMUTA PTERA	No
Trichloroethylene	No	PMUTA PTERA	No
Triethanolamine	No	PMUTA	No
Triethylamine	No	PMUTA PTERA	No
Triethylene Glycol	No	PTERA	No
Trimethylpentane, 2,2,4-	No	PMUTA	No
Tris(2,3-Dibromopropyl) Phosphate (TRIS)	NTP IARC 2A	PMUTA PTERA	No

CHEMICAL NAME	SELECT CARC	REPRO TOX	HIGH ACUTE TOX
Urea	No	PMUTA PTERA	No
Vinyl Acetate	No	PMUTA PTERA	No
Xylene	No	PTERA	No
Xylene, m-	No	PTERA	No
Xylene, o-	No	PTERA	No
Xylene, p-	No	PTERA	No
Zinc Acetate	No	PTERA	No
Zinc Acetate, Dihydrate	No	PTERA	No
Zinc Carbonate	No	PTERA	No
Zinc Chloride	No	PMUTA PTERA	No
Zinc Oxide	No	PTERA PMUTA	No
Zinc Sulfate	No	PMUTA PTERA	No

APPENDIX D

EXPOSURE EVALUATION FORM

EXPOSURE EVALUATION FORM

Date:___/___/___ Time:_____a.m./p.m.

Location:_____

Name(s) of person(s) involved:

_____

_____

Location Description:

_____

_____

_____

The chemical(s) under suspicion: _____

MSDSs available?_____

Other chemicals used by the individual(s):

_____

_____

Other chemicals stored/used in that area:

_____

_____

_____

Symptoms exhibited or claimed by the exposed individual(s):

_____

_____

_____

_____

_____

EXPOSURE EVALUATION FORM

Were control measures, such as fume hoods and personal protective equipment, used(list)? If so, were they used properly?

_____

_____

_____

_____

Were any air sampling or monitoring devices in place (before, during, after)? If so, are their measurements consistent with exposure limits?

_____

_____

_____

_____

APPENDIX E

TRAINING RECORD

Training Record

Training Topic **Chemical Laboratory Safety**
Date of Training _____
Name of Trainer(s) _____
Department _____
Qualification of Trainer(s)
_____
_____
Summary of Content:
Training covers all content listed in sections 6.1 and 6.2 of the Chemical Hygiene Plan.

TRAINING ROSTER

Name (please print)	UIN#	Signature

APPENDIX F

INCOMPATIABLE CHEMICALS

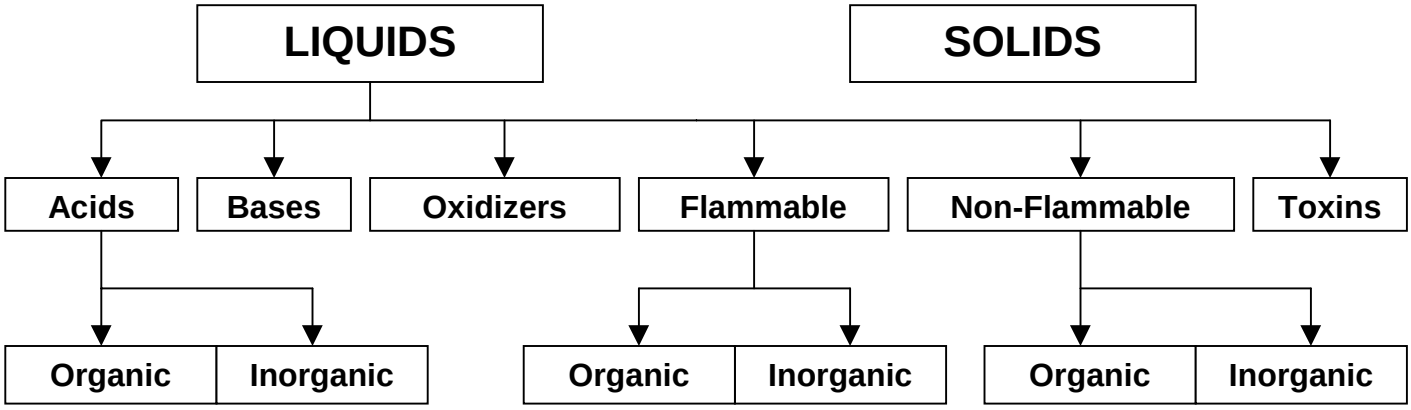
Incompatible Chemicals

The following list is to be used only as a general guideline. Please refer to your Material Safety Data Sheets (**MSDS**) for specific incompatibilities.

Chemical:	Incompatible with:
Acetic acid	Chromic acid, nitric acid, hydroxyl compounds, ethylene glycol, perchloric acid, peroxides, permanganates
Acetylene	Chlorine, bromine, copper, fluorine, silver, mercury
Acetone	Concentrated nitric and sulfuric acid mixtures
Alkali and alkaline earth metals	Water, carbon tetrachloride or other chlorinated hydrocarbons, carbon dioxide, halogens
Ammonia (anhydrous)	Mercury, chlorine, calcium hypochlorite, iodine, bromine, hydrofluoric acid (anhydrous)
Ammonium nitrate	Acids, powdered metals, flammable liquids, chlorates, nitrites, sulfur, finely divided organic combustible materials
Aniline	Nitric acid, hydrogen peroxide
Arsenic materials	Any reducing agent
Azides	Acids
Bromine	See chlorine
Calcium oxide	Water
Carbon (activated)	Calcium hypochlorite, all oxidizing agents
Chlorates	Ammonium salts, acids, powdered metals, sulfur, finely divided organic or combustible materials
Chromic acid and chromium trioxide	Acetic acid, naphthalene, camphor, glycerol, alcohol, flammable liquids in general
Chlorine	Ammonia, acetylene, butadiene, butane, methane, propane(or other petroleum gases), hydrogen, sodium carbide, benzene, finely divided metal, turpentine
Chlorine dioxide	Ammonia, methane, phosphine, hydrogen sulfide
Copper	Acetylene, hydrogen peroxide
Cumene hydroperoxide	Acids (organic or inorganic)
Cyanides	Acids
Flammable liquids	Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens
Fluorine	All other chemicals
Hydrocarbons (such as butane, propane, benzene)	Fluorine, chlorine, bromine, chromic acid, sodium peroxide
Hydrocyanic acid	Nitric acid, alkali
Hydrofluoric acid (anhydrous)	Ammonia (aqueous or anhydrous)
Hydrogen sulfide	Fuming nitric acid, oxidizing gases
Hypochlorites	Acids, activated carbon
Iodine	Acetylene, ammonia (aqueous or anhydrous), hydrogen
Mercury	Acetylene, fulminic acid, ammonia
Nitrates	Acids
Nitric acid (concentrated)	Acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen sulfide, flammable liquids and gases, copper, brass, any heavy metals
Nitrites	Acids
Nitroparaffins	Inorganic bases, amines
Oxalic acid	Silver, mercury
Oxygen	Oils, grease, hydrogen; flammable liquids, solids, and gases
Perchloric Acid	Acetic anhydride, bismuth and its alloys, alchohol, paper, wood, grease, oils
Peroxides, organic	Acids (organic or inorganic), avoid friction, store cold
Phosphorus (white)	Air, oxygen, alkalis, reducing agents
Potassium	Carbon tetrachloride, carbon dioxide, water
Potassium chlorate	Sulfuric and other acids
Potassium perchlorate see also chlorates	Sulfuric and other acids
Potassium permanganate	Glycerol, ethylene glycol, benzaldehyde, sulfuric acid
Selenides	Reducing agents
Silver	Acetylene, oxalic acid, tartaric acid, ammonium compounds, fulminic acid
Sodium	Carbon tetrachloride, carbon dioxide, water
Sodium nitrite	Ammonium nitrate and other ammonium salts
Sodium peroxide	Ethyl or methyl alcohol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerin, ethylene glycol, ethyl acetate, methyl acetate, furfural
Sulfides	Acids
Sulfuric acid	Potassium chlorate, potassium perchlorate, potassium permanganate (similar compounds of light metals, such as sodium, lithium)
Tellurides	Reducing Agents

CHEMICAL STORAGE GUIDELINES

STORE MATERIALS OUTLINED BY BOXES SEPARATELY



SOLIDS: Low tendency for reaction (when dry) so most can be shelved alphabetically, exceptions:

- Sulfides should be stored away from acids
- Cyanide compounds must be segregated from acids, especially liquid acids
- Phenol crystals must be stored separately from oxidizers

LIQUIDS: Store liquid chemicals below shoulder height

Acids

- Separate organic acids from inorganic acids, e.g., acetic from nitric
- Perchloric acid should be stored alone

Flammable Liquids

- The excess of 10 gallons must be stored in safety cabinets or in safety cans

Oxidizers

- Keep away from acids, bases, organics, and metals
- Store in cool place

Chemical waste accumulation

- As much as possible, liquid chemical wastes should be stored by compatibility
- **Do not** accumulate more than 55 gallons of chemical waste, or more than one quart of acutely hazardous waste (P-listed wastes)

METALS:

- **Reactive metals** (ex: potassium, sodium etc) and all powdered metal should be stored in flammable storage cabinets
- **Mercury** must be stored in non-breakable secondary containers and kept on a bottom shelf of a closed cabinet

CONSULT YOUR MATERIAL SAFETY DATA SHEETS (MSDS) FOR SPECIFIC CHEMICAL STORAGE INFORMATION

APPENDIX G

COMMON ORGANIC PEROXIDES

Many ethers and similar compounds tend to react with air and light to form unstable peroxides. Some of the more common peroxide-forming chemicals include p-dioxane, ethyl ether, tetrahydrofuran, acetaldehyde, and cyclohexene. The following storage practices will help minimize hazards associated with these types of chemicals.

- ✓ Store peroxide-forming chemicals in airtight bottles or cans away from light.
- ✓ Label containers with date received and date opened.
- ✓ Discard peroxide formers 3 to 6 months after opening, depending on the chemical (see table below).
- ✓ Discard unopened containers of peroxide-forming chemicals in accordance with the manufacturer's expiration date or 18 months after the date received.

All chemicals received should be checked against the list of peroxide forming chemicals. If a chemical is peroxidizable then the following procedure should be followed:

1. Determine from list if chemical has 3 or 6-month limit after opening.
2. Write date received on a sticker, tape or label.
3. Write a 3 or 6 under the date.

Common Peroxide Forming Chemicals

3 MONTH LIMIT

ABSOLUTE ETHERS (Ethyl Ether Anhydrous)
Bis (2-Methoxyethyl) Ether (Diethylene-Glycol Dimethyl Ether; Diglyme)
DIETHYLENE GLYCOL Dlmethyl ETHER (DIGLYME)
Diethylether (Ethyl Ether; Ether)
Dimethoxyethane (Glyme)
Dioxane (Diethylene Oxide)
Dl-Isopropyl Ether
Divinyl Acetylene
Ethyl Ether
Ethyl Vinyl Ether
Glyme (1 ,2-Di Methoxyethane; Ethylene Glycol Dimethyl Ether)
Isopropyl Ethers
Potassium Amide
Potassium Metal
Sodium Amide (Sodamide)
Tetrahydrofufian (Cyclotetramethylene Oxide)
Vinylidene Chloride (1,1 Dichloroethylene)

6 MONTH LIMIT

Acetal
Acrolein (Propenal; Acrylic Aldehyde; Allyl Aldehyde)
Acrylic Acid
Acrylonitrile (Propene Nitrile; Vinyl Cyanide)
Alkyl-Substituted Cycloaliphatics (Methyl Ethyl Cyclo_____ane)
ALL OTHER ETHERS
Allyl Gylcidyl Ether
n-Amyl Ether
Anisole
Butadiene (Erythrene)
n-Butyl Glycidyl Ether
Butyl Vinyl Ether
2 Chloro 2,3 Butadiene
Chloroethylene
Chloromethyl Ether
Chloroprene (2-Chloro-1, 3-Butadiene; Chlorobutadiene)
Chlorotrifluoroethylene
Cyclopentene
Methycylopentane
Methyl 1-Butylketone (2-Hexanone; N-Butyl Methylketone)
Methyl Acetylene (Allylene; Propyne)
Methyl Ether
Methyl Ether Ether
Methyl Isobutyl Ketone
Methyl Methacrylate
Methylvinyl Ether
Olefins (Unsaturated Hydro Carbon Propene, Hexene, _____ ene)
Perfluoroethylene
Phenyl Ether
Propyne
Styrene (Phenylethylene;Vinylbenzene;Cinnamene)
Tetrafluoroethylene (Perfluoroethylene)
Tetrahydronaphthalene (Tetralin)
Vinyl Acetate
Vinyl Acetylene
Vinyl Chloride (Chloroethylene; Chloroethene)
Vinyl Ethers
Vinyl Pyridine

APPENDIX H

OSHA
LABORATORY STANDARD

The OSHA Laboratory Standard

U.S. Department of Labor
Occupational Safety & Health Administration

Regulations (Standards - 29 CFR) - Table of Contents

- Part Number: 1910
- Part Title: Occupational Safety and Health Standards
- Subpart: Z
- Subpart Title: Toxic and Hazardous Substances
- Standard Number: 1910.1450
- Title: Occupational exposure to hazardous chemicals in laboratories.
- Appendix: A , B

1910.1450(a)
Scope and application.

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

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

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

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

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

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

1910.1450(a)(3)(i)
Uses of hazardous chemicals which do not meet the definition of laboratory use, and in such cases, the employer shall comply with the relevant standard in 29 CFR part 1910, subpart Z, even if such use occurs in a laboratory.

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

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

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

1910.1450(b)
Definitions --

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

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

Carcinogen (see select carcinogen).

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

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

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

Compressed gas means:
(i) A gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psi at 70 deg. F (21.1 deg. C); or
(ii) A gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psi at 130 deg. F (54.4 deg C) regardless of the pressure at 70 deg. F (21.1 deg. C); or
(iii) A liquid having a vapor pressure exceeding 40 psi at 100 deg. F (37.8 C) as determined by ASTM D-323-72.

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

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

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

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

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

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

(ii) Gas, flammable means:

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

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

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

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

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

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

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

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

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

Hazardous chemical means a chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. The term "health hazard" includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic systems, and agents which damage the lungs, skin, eyes, or mucous membranes.

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

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

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

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

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

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

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

(ii) Multiple chemical procedures or chemicals are used;

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

1910.1450(c)
Permissible exposure limits. For laboratory uses of OSHA regulated substances, the employer shall assure that laboratory employees' exposures to such substances do not exceed the permissible exposure limits specified in 29 CFR part 1910, subpart Z.

1910.1450(d)
Employee exposure determination

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

1910.1450(f)
Employee information and training.

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

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

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

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

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

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

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

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

1910.1450(f)(4)
Training.

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

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

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

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

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

1910.1450(g)
Medical consultation and medical examinations.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

1910.1450(h)
Hazard identification.

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

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

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

1910.1450(h)(2)
The following provisions shall apply to chemical substances developed in the laboratory:

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

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

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

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

1910.1450(j)
Recordkeeping.

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

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

1910.1450(k)
Dates --

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

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

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

1910.1450(k)(2)(ii)
Paragraph (a)(2) of this section shall not take effect until the employer has developed and implemented a written Chemical Hygiene Plan.

1910.1450(l)
Appendices. The information contained in the appendices is not intended, by itself, to create any additional obligations not otherwise imposed or to detract from any existing obligation.

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

Occupational Safety & Health Administration
200 Constitution Avenue, NW
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Appendix A to the OSHA Laboratory Standard

U.S. Department of Labor
Occupational Safety & Health Administration

Regulations (Standards - 29 CFR) - Table of Contents

- Part Number: 1910
- Part Title: Occupational Safety and Health Standards
- Subpart: Z
- Subpart Title: Toxic and Hazardous Substances
- Standard Number: 1910.1450 App A
- Title: National Research Council Recommendations Concerning Chemical Hygiene in Laboratories (Non-Mandatory)

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4. Chemicals of High Chronic Toxicity
5. Animal Work with Chemicals of High Chronic Toxicity

F. Safety Recommendations
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Foreword

As guidance for each employer's development of an appropriate laboratory Chemical Hygiene Plan, the following non-mandatory recommendations are provided. They were extracted form "Prudent Practices" for Handling Hazardous Chemicals in Laboratories" (referred to below as "Prudent Practices"), which was published in 1981 by the National Research Council and is available from the National Academy Press, 2101 Constitution Ave., NW,. Washington DC 20418.

"Prudent Practices" is cited because of its wide distribution and acceptance and because of its preparation by members of the laboratory community through the sponsorship of the National Research Council. However, none of the recommendations given here will modify any requirements of the laboratory standard. This Appendix merely presents pertinent recommendations from "Prudent Practices", organized into a form convenient for quick reference during operation of a laboratory facility and during development and application of a Chemical Hygiene Plan. Users of this appendix should consult "Prudent Practices" for a more extended presentation and justification for each recommendation.

"Prudent Practices" deal with both safety and chemical hazards while the laboratory standard is concerned primarily with chemical hazards. Therefore, only those recommendations directed primarily toward control of toxic exposures are cited in this appendix, with the term "chemical Hygiene" being substituted for the word "safety". However, since conditions producing or threatening physical injury often pose toxic risks as well, page references concerning major categories of safety hazards in the laboratory are given in section F.

The recommendations from "Prudent Practices" have been paraphrased, combined, or otherwise reorganized, and headings have been added. However, their sense has not been changed.

Corresponding Sections of the Standard and this Appendix

The following table is given for the convenience of those who are developing a Chemical Hygiene Plan which will satisfy the requirements of paragraph (e) of the standard. It indicates those sections of this appendix which are most pertinent to each of the sections of paragraph (e) and related paragraphs.

Paragraph and topic in laboratory standard	Relevant appendix section
(e)(3)(i) Standard operating procedures for handling toxic chemicals.	C, D, E
(e)(3)(ii) Criteria to be used for implementation of measures to reduce exposures.	D
(e)(3)(iii) Fume hood performance	C4b
(e)(3)(iv) Employee information and training (including emergency procedures).	D10, D9
(e)(3)(v) Requirements for prior approval of laboratory activities.	E2b, E4b
(e)(3)(vi) Medical consultation and medical examinations.	D5, E4f
(e)(3)(vii) Chemical hygiene responsibilities.	B
(e)(3)(viii) Special precautions for work with particularly hazardous substances.	E2, E3, E4

In this appendix, those recommendations directed primarily at administrators and supervisors are given in sections A-D. Those recommendations of primary concern to employees who are actually handling

laboratory chemicals are given in section E. (Reference to page numbers in "Prudent Practices" are given in parentheses.)

A. General Principles for Work with Laboratory Chemicals

In addition to the more detailed recommendations listed below in sections B-E, "Prudent Practices" expresses certain general principles, including the following:

1. It is prudent to minimize all chemical exposures. Because few laboratory chemicals are without hazards, general precautions for handling all laboratory chemicals should be adopted, rather than specific guidelines for particular chemicals (2,10). Skin contact with chemicals should be avoided as a cardinal rule (198).
2. Avoid underestimation of risk. Even for substances of no known significant hazard, exposure should be minimized; for work with substances which present special hazards, special precautions should be taken (10, 37, 38). One should assume that any mixture will be more toxic than its most toxic component (30, 103) and that all substances of unknown toxicity are toxic (3, 34).
3. Provide adequate ventilation. The best way to prevent exposure to airborne substances is to prevent their escape into the working atmosphere by use of hoods and other ventilation devices (32, 198).
4. Institute a chemical hygiene program. A mandatory chemical hygiene program designed to minimize exposures is needed; it should be a regular, continuing effort, not merely a standby or short-term activity (6,11). Its recommendations should be followed in academic teaching laboratories as well as by full-time laboratory workers (13).
5. Observe the PELs, TLVs. The Permissible Exposure Limits of OSHA and the Threshold Limit Values of the American Conference of Governmental Industrial Hygienists should not be exceeded (13).

B. Chemical Hygiene Responsibilities

Responsibility for chemical hygiene rests at all levels (6, 11, 21) including the:

1. Chief executive officer, who has ultimate responsibility for chemical hygiene within the institution and must, with other administrators, provide continuing support for institutional chemical hygiene (7, 11).
2. Supervisor of the department or other administrative unit, who is responsible for chemical hygiene in that unit (7).
3. chemical hygiene officer(s), whose appointment is essential (7) and who must:
   (a) Work with administrators and other employees to develop and implement appropriate chemical hygiene policies and practices (7);
   (b) Monitor procurement, use, and disposal of chemicals used in the lab (8);
   (c) See that appropriate audits are maintained (8);
   (d) Help project directors develop precautions and adequate facilities (10);
   (e) Know the current legal requirements concerning regulated substances (50); and
   (f) Seek ways to improve the chemical hygiene program (8, 11).
4. Laboratory supervisor, who has overall responsibility for chemical hygiene in the laboratory (21) including responsibility to:
   (a) Ensure that workers know and follow the chemical hygiene rules, that protective equipment is available and in working order, and that appropriate training has been provided (21, 22);
   (b) Provide regular, formal chemical hygiene and housekeeping inspections including routine inspections of emergency equipment (21, 171);
   (c) Know the current legal requirements concerning regulated substances (50, 231);
   (d) Determine the required levels of protective apparel and equipment (156, 160, 162); and
   (e) Ensure that facilities and training for use of any material being ordered are adequate (215).
5. Project director or director of other specific operation, who has primary responsibility for chemical hygiene procedures for that operation (7).
6. Laboratory worker, who is responsible for:
   (a) Planning and conducting each operation in accordance with the institutional chemical hygiene procedures (7, 21, 22, 230); and
   (b) Developing good personal chemical hygiene habits (22).

C. The Laboratory Facility

1. Design. The laboratory facility should have:
   (a) An appropriate general ventilation system (see C4 below) with air intakes and exhausts located so as to avoid intake of contaminated air (194);
   (b) Adequate, well-ventilated stockrooms/storerooms (218, 219).
   (c) Laboratory hoods and sinks (12, 162);
   (d) Other safety equipment including eyewash fountains and drench showers (162, 169); and
   (e) Arrangements for waste disposal (12, 240).
2. Maintenance. Chemical-hygiene-related equipment (hoods, incinerator, etc.) should undergo continual appraisal and be modified if inadequate (11, 12).
3. Usage. The work conducted (10) and its scale (12) must be appropriate to the physical facilities available and, especially, to the quality of ventilation (13).
4. Ventilation -
   (a) General laboratory ventilation. This system should: Provide a source of air for breathing and for input to local ventilation devices (199); it should not be relied on for protection from toxic substances released into the laboratory (198); ensure that laboratory air is continually replaced, preventing increase of air concentrations of toxic substances during the working day (194); direct air flow into the laboratory from non-laboratory areas and out to the exterior of the building (194).
   (b) Hoods. A laboratory hood with 2.5 linear feet of hood space per person should be provided for every 2 workers if they spend most of their time working with chemicals (199); each hood should have a continuous monitoring device to allow convenient confirmation of adequate hood performance before use (200, 209). If this is not possible, work with substances of unknown toxicity should be avoided (13) or other types of local ventilation devices should be provided (199). See pp. 201-206 for a discussion of hood design, construction, and evaluation.
   (c) Other local ventilation devices. Ventilated storage cabinets, canopy hoods, snorkels, etc. should be provided as needed (199). Each canopy hood and snorkel should have a separate exhaust duct (207).
   (d) Special ventilation areas. Exhaust air from glove boxes and isolation rooms should be passed through scrubbers or other treatment before release into the regular exhaust system (208). Cold rooms and warm rooms should have provisions for rapid escape and for escape in the event of electrical failure (209).
   (e) Modifications. Any alteration of the ventilation system should be made only if thorough testing indicates that worker protection from airborne toxic substances will continue to be adequate (12, 193, 204).
   (f) Performance. Rate: 4-12 room air changes/hour is normally adequate general ventilation if local exhaust systems such as hoods are used as the primary method of control (194).
   (g) Quality. General air flow should not be turbulent and should be relatively uniform throughout the laboratory, with no high velocity or static areas (194, 195); airflow into and within the hood should not be excessively turbulent (200); hood face velocity should be adequate (typically 60-100 lfm) (200, 204).
   (h) Evaluation. Quality and quantity of ventilation should be evaluated on installation (202), regularly monitored (at least every 3 months) (6, 12, 14, 195), and reevaluated whenever a change in local ventilation devices is made (12, 195, 207). See pp 195-198 for methods of evaluation and for calculation of estimated airborne contaminant concentrations.

D. Components of the Chemical Hygiene Plan

1. Basic Rules and Procedures (Recommendations for these are given in section E, below)
2. Chemical Procurement, Distribution, and Storage
   (a) Procurement. Before a substance is received, information on proper handling, storage, and disposal should be known to those who will be involved (215, 216). No container should be accepted without an adequate identifying label (216). Preferably, all substances should be received in a central location (216).
   (b) Stockrooms/storerooms. Toxic substances should be segregated in a well-identified area with local exhaust ventilation (221). Chemicals which are highly toxic (227) or other chemicals whose containers have been opened should be in unbreakable secondary containers (219). Stored

chemicals should be examined periodically (at least annually) for replacement, deterioration, and container integrity (218-19).

Stockrooms/storerooms should not be used as preparation or repackaging areas, should be open during normal working hours, and should be controlled by one person (219).

(c) Distribution. When chemicals are hand carried, the container should be placed in an outside container or bucket. Freight-only elevators should be used if possible (223).

(d) Laboratory storage. Amounts permitted should be as small as practical. Storage on bench tops and in hoods is inadvisable. Exposure to heat or direct sunlight should be avoided. Periodic inventories should be conducted, with unneeded items being discarded or returned to the storeroom/stockroom (225-6, 229).

3. Environmental Monitoring

Regular instrumental monitoring of airborne concentrations is not usually justified or practical in laboratories but may be appropriate when testing or redesigning hoods or other ventilation devices (12) or when a highly toxic substance is stored or used regularly (e.g., 3 times/week) (13).

4. Housekeeping, Maintenance, and Inspections

(a) Cleaning. Floors should be cleaned regularly (24).

(b) Inspections. Formal housekeeping and chemical hygiene inspections should be held at least quarterly (6, 21) for units which have frequent personnel changes and semiannually for others; informal inspections should be continual (21).

(c) Maintenance. Eye wash fountains should be inspected at intervals of not less than 3 months (6). Respirators for routine use should be inspected periodically by the laboratory supervisor (169). Other safety equipment should be inspected regularly. (e.g., every 3-6 months) (6, 24, 171). Procedures to prevent restarting of out-of-service equipment should be established (25).

(d) Passageways. Stairways and hallways should not be used as storage areas (24). Access to exits, emergency equipment, and utility controls should never be blocked (24).

5. Medical Program

(a) Compliance with regulations. Regular medical surveillance should be established to the extent required by regulations (12).

(b) Routine surveillance. Anyone whose work involves regular and frequent handling of toxicologically significant quantities of a chemical should consult a qualified physician to determine on an individual basis whether a regular schedule of medical surveillance is desirable (11, 50).

(c) First aid. Personnel trained in first aid should be available during working hours and an emergency room with medical personnel should be nearby (173). See pp. 176-178 for description of some emergency first aid procedures.

6. Protective Apparel and Equipment

These should include for each laboratory:

(a) Protective apparel compatible with the required degree of protection for substances being handled (158-161);

(b) An easily accessible drench-type safety shower (162, 169);

(c) An eyewash fountain (162)

(d) A fire extinguisher (162-164);

(e) Respiratory protection (164-9), fire alarm and telephone for emergency use (162) should be available nearby; and

(f) Other items designated by the laboratory supervisor (156, 160).

7. Records

(a) Accident records should be written and retained (174).

(b) Chemical Hygiene Plan records should document that the facilities and precautions were compatible with current knowledge and regulations (7).

(c) Inventory and usage records for high-risk substances should be kept as specified in sections E3e below.

(d) Medical records should be retained by the institution in accordance with the requirements of state and federal regulations (12).

8. Signs and Labels

Prominent signs and labels of the following types should be posted:

(a) Emergency telephone numbers of emergency personnel/facilities, supervisors, and laboratory workers (28);
(b) Identity labels, showing contents of containers (including waste receptacles) and associated hazards (27, 48);
(c) Location signs for safety showers, eyewash stations, other safety and first aid equipment, exits (27) and areas where food and beverage consumption and storage are permitted (24); and
(d) Warnings at areas or equipment where special or unusual hazards exist (27).

9. Spills and Accidents
(a) A written emergency plan should be established and communicated to all personnel; it should include procedures for ventilation failure (200), evacuation, medical care, reporting, and drills (172).
(b) There should be an alarm system to alert people in all parts of the facility including isolation areas such as cold rooms (172).
(c) A spill control policy should be developed and should include consideration of prevention, containment, cleanup, and reporting (175).
(d) All accidents or near accidents should be carefully analyzed with the results distributed to all who might benefit (8, 28).

10. Information and Training Program
(a) Aim: To assure that all individuals at risk are adequately informed about the work in the laboratory, its risks, and what to do if an accident occurs (5, 15).
(b) Emergency and Personal Protection Training: Every laboratory worker should know the location and proper use of available protective apparel and equipment (154, 169).
- Some of the full-time personnel of the laboratory should be trained in the proper use of emergency equipment and procedures (6).
- Such training as well as first aid instruction should be available to (154) and encouraged for (176) everyone who might need it.

(c) Receiving and stockroom/storeroom personnel should know about hazards, handling equipment, protective apparel, and relevant regulations (217).
(d) Frequency of Training: The training and education program should be a regular, continuing activity - not simply an annual presentation (15).
(e) Literature/Consultation: Literature and consulting advice concerning chemical hygiene should be readily available to laboratory personnel, who should be encouraged to use these information resources (14).

11. Waste Disposal Program.
(a) Aim: To assure that minimal harm to people, other organisms, and the environment will result from the disposal of waste laboratory chemicals (5).
(b) Content (14, 232, 233, 240): The waste disposal program should specify how waste is to be collected, segregated, stored, and transported and include consideration of what materials can be incinerated. Transport from the institution must be in accordance with DOT regulations (244).
(c) Discarding Chemical Stocks:
- Unlabeled containers of chemicals and solutions should undergo prompt disposal; if partially used, they should not be opened (24, 27).
- Before a worker's employment in the laboratory ends, chemicals for which that person was responsible should be discarded or returned to storage (226).

(d) Frequency of Disposal: Waste should be removed from laboratories to a central waste storage area at least once per week and from the central waste storage area at regular intervals (14).
(e) Method of Disposal:
- Incineration in an environmentally acceptable manner is the most practical disposal method for combustible laboratory waste (14, 238, 241).
- Indiscriminate disposal by pouring waste chemicals down the drain (14, 231, 242) or adding them to mixed refuse for landfill burial is unacceptable (14).
- Hoods should not be used as a means of disposal for volatile chemicals (40, 200).
- Disposal by recycling (233, 243) or chemical decontamination (40, 230) should be used when possible.

E. Basic Rules and Procedures for Working with Chemicals

The Chemical Hygiene Plan should require that laboratory workers know and follow its rules and procedures. In addition to the procedures of the sub programs mentioned above, these should include the rules listed below.

1. General Rules

The following should be used for essentially all laboratory work with chemicals:

(a) Accidents and spills

- Eye Contact: Promptly flush eyes with water for a prolonged period (15 minutes) and seek medical attention (33, 172).
- Ingestion: Encourage the victim to drink large amounts of water (178).
- Skin Contact: Promptly flush the affected area with water (33, 172, 178) and remove any contaminated clothing (172, 178). If symptoms persist after washing, seek medical attention (33).
- Clean-up. Promptly clean up spills, using appropriate protective apparel and equipment and proper disposal (24, 33). See pp. 233-237 for specific clean-up recommendations.

(b) Avoidance of "routine" exposure:

- Develop and encourage safe habits (23); avoid unnecessary exposure to chemicals by any route (23);
- Do not smell or taste chemicals (32). Vent apparatus which may discharge toxic chemicals (vacuum pumps, distillation columns, etc.) into local exhaust devices (199).
- Inspect gloves (157) and test glove boxes (208) before use.
- Do not allow release of toxic substances in cold rooms and warm rooms, since these have contained recirculated atmospheres (209).

(c) Choice of chemicals: Use only those chemicals for which the quality of the available ventilation system is appropriate (13).

(d) Eating, smoking, etc.:

- Avoid eating, drinking, smoking, gum chewing, or application of cosmetics in areas where laboratory chemicals are present (22, 24, 32, 40); wash hands before conducting these activities (23, 24).
- Avoid storage, handling, or consumption of food or beverages in storage areas, refrigerators, glassware or utensils which are also used for laboratory operations (23, 24, 226).

(e) Equipment and glassware: Handle and store laboratory glassware with care to avoid damage; do not use damaged glassware (25). Use extra care with Dewar flasks and other evacuated glass apparatus; shield or wrap them to contain chemicals and fragments should implosion occur (25). Use equipment only for its designed purpose (23, 26).

(f) Exiting: Wash areas of exposed skin well before leaving the laboratory (23).

(g) Horseplay: Avoid practical jokes or other behavior which might confuse, startle or distract another worker (23).

(h) Mouth suction: Do not use mouth suction for pipeting or starting a siphon (23, 32).

(i) Personal apparel: Confine long hair and loose clothing (23, 158). Wear shoes at all times in the laboratory but do not wear sandals, perforated shoes, or sneakers (158).

(j) Personal housekeeping: Keep the work area clean and uncluttered, with chemicals and equipment being properly labeled and stored; clean up the work area on completion of an operation or at the end of each day (24).

(k) Personal protection:

- Assure that appropriate eye protection (154-156) is worn by all persons, including visitors, where chemicals are stored or handled (22, 23, 33, 154).
- Wear appropriate gloves when the potential for contact with toxic materials exists (157); inspect the gloves before each use, wash them before removal, and replace them periodically (157). (A table of resistance to chemicals of common glove materials is given p. 159).
- Use appropriate (164-168) respiratory equipment when air contaminant concentrations are not sufficiently restricted by engineering controls (164-5), inspecting the respirator before use (169).

- Use any other protective and emergency apparel and equipment as appropriate (22, 157-162).
- Avoid use of contact lenses in the laboratory unless necessary; if they are used, inform supervisor so special precautions can be taken (155).
- Remove laboratory coats immediately on significant contamination (161).

(l) Planning: Seek information and advice about hazards (7), plan appropriate protective procedures, and plan positioning of equipment before beginning any new operation (22, 23).

(m) Unattended operations: Leave lights on, place an appropriate sign on the door, and provide for containment of toxic substances in the event of failure of a utility service (such as cooling water) to an unattended operation (27, 128).

(n) Use of hood:

- Use the hood for operations which might result in release of toxic chemical vapors or dust (198-9).
- As a rule of thumb, use a hood or other local ventilation device when working with any appreciably volatile substance with a TLV of less than 50 ppm (13).
- Confirm adequate hood performance before use; keep hood closed at all times except when adjustments within the hood are being made (200); keep materials stored in hoods to a minimum and do not allow them to block vents or air flow (200).
- Leave the hood "on" when it is not in active use if toxic substances are stored in it or if it is uncertain whether adequate general laboratory ventilation will be maintained when it is "off" (200).

(o) Vigilance: Be alert to unsafe conditions and see that they are corrected when detected (22).

(p) Waste disposal:

- Assure that the plan for each laboratory operation includes plans and training for waste disposal (230).
- Deposit chemical waste in appropriately labeled receptacles and follow all other waste disposal procedures of the Chemical Hygiene Plan (22, 24).
- Do not discharge to the sewer concentrated acids or bases (231); highly toxic, malodorous, or lachrymatory substances (231); or any substances which might interfere with the biological activity of waste water treatment plants, create fire or explosion hazards, cause structural damage or obstruct flow (242).

(q) Working alone: Avoid working alone in a building; do not work alone in a laboratory if the procedures being conducted are hazardous (28).

2. Working with Allergens and Embryotoxins

(a) Allergens (examples: diazomethane, isocyanates, bichromates): Wear suitable gloves to prevent hand contact with allergens or substances of unknown allergenic activity (35).

(b) Embryotoxins (34-5) (examples: organomercurials, lead compounds, formamide):

- If you are a woman of childbearing age, handle these substances only in a hood whose satisfactory performance has been confirmed, using appropriate protective apparel (especially gloves) to prevent skin contact.
- Review each use of these materials with the research supervisor and review continuing uses annually or whenever a procedural change is made.
- Store these substances, properly labeled, in an adequately ventilated area in an unbreakable secondary container.
- Notify supervisors of all incidents of exposure or spills; consult a qualified physician when appropriate.

3. Work with Chemicals of Moderate Chronic or High Acute Toxicity

Examples: diisopropylfluorophosphate (41), hydrofluoric acid (43), hydrogen cyanide (45).

Supplemental rules to be followed in addition to those mentioned above (Procedure B of "Prudent Practices", pp. 39-41):

(a) Aim: To minimize exposure to these toxic substances by any route using all reasonable precautions (39).

(b) Applicability: These precautions are appropriate for substances with moderate chronic or high acute toxicity used in significant quantities (39).

(c) Location:

- Use and store these substances only in areas of restricted access with special warning signs (40, 229).
- Always use a hood (previously evaluated to confirm adequate performance with a face velocity of at least 60 linear feet per minute) (40) or other containment device for procedures which may result in the generation of aerosols or vapors containing the substance (39); trap released vapors to revent their discharge with the hood exhaust (40).

(d) Personal protection: Always avoid skin contact by use of gloves and long sleeves (and other protective apparel as appropriate) (39). Always wash hands and arms immediately after working with these materials (40).

(e) Records: Maintain records of the amounts of these materials on hand, amounts used, and the names of the workers involved (40, 229).

(f) Prevention of spills and accidents:

- Be prepared for accidents and spills (41).
- Assure that at least 2 people are present at all times if a compound in use is highly toxic or of unknown toxicity (39).
- Store breakable containers of these substances in chemically resistant trays; also work and mount apparatus above such trays or cover work and storage surfaces with removable, absorbent, plastic backed paper (40).
- If a major spill occurs outside the hood, evacuate the area; assure that cleanup personnel wear suitable protective apparel and equipment (41).

(g) Waste:

- Thoroughly decontaminate or incinerate contaminated clothing or shoes (41). If possible, chemically decontaminate by chemical conversion (40).
- Store contaminated waste in closed, suitably labeled, impervious containers (for liquids, in glass or plastic bottles half-filled with vermiculite) (40).

4. Work with Chemicals of High Chronic Toxicity

(Examples: dimethylmercury and nickel carbonyl (48), benzo-a-pyrene (51), N-nitrosodiethylamine (54), other human carcinogens or substances with high carcinogenic potency in animals (38).)

Further supplemental rules to be followed, in addition to all these mentioned above, for work with substances of known high chronic toxicity (in quantities above a few milligrams to a few grams, depending on the substance) (47). (Procedure A of "Prudent Practices" pp. 47-50).

(a) Access: Conduct all transfers and work with these substances in a "controlled area": a restricted access hood, glove box, or portion of a lab, designated for use of highly toxic substances, for which all people with access are aware of the substances being used and necessary precautions (48).

(b) Approvals: Prepare a plan for use and disposal of these materials and obtain the approval of the laboratory supervisor (48).

(c) Non-contamination/Decontamination: Protect vacuum pumps against contamination by scrubbers or HEPA filters and vent them into the hood (49). Decontaminate vacuum pumps or other contaminated equipment, including glassware, in the hood before removing them from the controlled area (49, 50).

Decontaminate the controlled area before normal work is resumed there (50).

(d) Exiting: On leaving a controlled area, remove any protective apparel (placing it in an appropriate, labeled container) and thoroughly wash hands, forearms, face, and neck (49).

(e) Housekeeping: Use a wet mop or a vacuum cleaner equipped with a HEPA filter instead of dry sweeping if the toxic substance was a dry powder (50).

(f) Medical surveillance: If using toxicologically significant quantities of such a substance on a regular basis (e.g., 3 times per week), consult a qualified physician concerning desirability of regular medical surveillance (50).

(g) Records: Keep accurate records of the amounts of these substances stored (229) and used, the dates of use, and names of users (48).

(h) Signs and labels: Assure that the controlled area is conspicuously marked with warning and restricted access signs (49) and that all containers of these substances are appropriately labeled with identity and warning labels (48).

(i) Spills: Assure that contingency plans, equipment, and materials to minimize exposures of people and property in case of accident are available (233-4).
(j) Storage: Store containers of these chemicals only in a ventilated, limited access (48, 227, 229) area in appropriately labeled, unbreakable, chemically resistant, secondary containers (48, 229).
(k) Glove boxes: For a negative pressure glove box, ventilation rate must be at least 2 volume changes/hour and pressure at least 0.5 inches of water (48). For a positive pressure glove box, thoroughly check for leaks before each use (49). In either case, trap the exit gases or filter them through a HEPA filter and then release them into the hood (49).
(l) Waste: Use chemical decontamination whenever possible; ensure that containers of contaminated waste (including washings from contaminated flasks) are transferred from the controlled area in a secondary container under the supervision of authorized personnel (49, 50, 233).

5. Animal Work with Chemicals of High Chronic Toxicity
(a) Access: For large scale studies, special facilities with restricted access are preferable (56).
(b) Administration of the toxic substance: When possible, administer the substance by injection or gavage instead of in the diet. If administration is in the diet, use a caging system under negative pressure or under laminar air flow directed toward HEPA filters (56).
(c) Aerosol suppression: Devise procedures which minimize formation and dispersal of contaminated aerosols, including those from food, urine, and feces (e.g., use HEPA filtered vacuum equipment for cleaning, moisten contaminated bedding before removal from the cage, mix diets in closed containers in a hood) (55, 56).
(d) Personal protection: When working in the animal room, wear plastic or rubber gloves, fully buttoned laboratory coat or jumpsuit and, if needed because of incomplete suppression of aerosols, other apparel and equipment (shoe and head coverings, respirator) (56).
(e) Waste disposal: Dispose of contaminated animal tissues and excreta by incineration if the available incinerator can convert the contaminant to non-toxic products (238); otherwise, package the waste appropriately for burial in an EPA-approved site (239).

F. Safety Recommendations

The above recommendations from "Prudent Practices" do not include those which are directed primarily toward prevention of physical injury rather than toxic exposure. However, failure of precautions against injury will often have the secondary effect of causing toxic exposures. Therefore, we list below page references for recommendations concerning some of the major categories of safety hazards which also have implications for chemical hygiene:

1. Corrosive agents: (35-6)
2. Electrically powered laboratory apparatus: (179-92)
3. Fires, explosions: (26, 57-74, 162-64, 174-5, 219-20, 226-7)
4. Low temperature procedures: (26, 88)
5. Pressurized and vacuum operations (including use of compressed gas cylinders): (27, 75-101)

G. Material Safety Data Sheets

Material safety data sheets are presented in "Prudent Practices" for the chemicals listed below. (Asterisks denote that comprehensive material safety data sheets are provided).

o Acetyl peroxide (105)
o Acrolein (106)
o Acrylonitrile
Ammonia (anhydrous)(91)
o Aniline (109)
o Benzene (110)
o Benzo[a]pyrene (112)
o Bis(chloromethyl) ether (113)
Boron trichloride (91)
Boron trifluoride (92)
Bromine (114)
o Tert-butyl hydroperoxide (148)
o Carbon disulfide (116)
Carbon monoxide (92)
o Carbon tetrachloride (118)
*Chlorine (119)
Chlorine trifluoride (94)
o Chloroform (121)
Chloromethane (93)
o Diethyl ether (122)
Diisopropyl fluorophosphate (41)
o Dimethylformamide (123)
o Dimethyl sulfate (125)
o Dioxane (126)
o Ethylene dibromide (128)
o Fluorine (95)
o Formaldehyde (130)
o Hydrazine and salts (132)
Hydrofluoric acid (43)
Hydrogen bromide (98)
Hydrogen chloride (98)
o Hydrogen cyanide (133)
o Hydrogen sulfide (135)
Mercury and compounds (52)
o Methanol (137)
o Morpholine (138)
o Nickel carbonyl (99)
o Nitrobenzene (139)
Nitrogen dioxide (100)
N-nitrosodiethylamine (54)
o Peracetic acid (141)
o Phenol (142)
o Phosgene (143)
o Pyridine (144)
o Sodium azide (145)
o Sodium cyanide (147)
Sulfur dioxide (101)
o Trichloroethylene (149)
o Vinyl chloride (150)

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Appendix B to the OSHA Laboratory Standard

U.S. Department of Labor
Occupational Safety & Health Administration

Regulations (Standards - 29 CFR) - Table of Contents

- Part Number: 1910
- Part Title: Occupational Safety and Health Standards
- Subpart: Z
- Subpart Title: Toxic and Hazardous Substances
- Standard Number: 1910.1450 App B
- Title: References (Non-Mandatory)

The following references are provided to assist the employer in the development of a Chemical Hygiene Plan. The materials listed below are offered as non-mandatory guidance. References listed here do not imply specific endorsement of a book, opinion, technique, policy or a specific solution for a safety or health problem. Other references not listed here may better meet the needs of a specific laboratory.

(a) Materials for the development of the Chemical Hygiene Plan:

1. American Chemical Society, Safety in Academic Chemistry Laboratories, 4th edition, 1985.
2. Fawcett, H.H. and W.S. Wood, Safety and Accident Prevention in Chemical Operations, 2nd edition, Wiley-Interscience, New York, 1982.
3. Flury, Patricia A., Environmental Health and Safety in the Hospital Laboratory, Charles C. Thomas Publisher, Springfield IL, 1978.
4. Green, Michael E. and Turk, Amos, Safety in Working with Chemicals, Macmillan Publishing Co., NY, 1978.
5. Kaufman, James A., Laboratory Safety Guidelines, Dow Chemical Co., Box 1713, Midland, MI 48640, 1977.
6. National Institutes of Health, NIH Guidelines for the Laboratory use of Chemical Carcinogens, NIH Pub. No. 81-2385, GPO, Washington, DC 20402, 1981.
7. National Research Council, Prudent Practices for Disposal of Chemicals from Laboratories, National Academy Press, Washington, DC, 1983.
8. National Research Council, Prudent Practices for Handling Hazardous Chemicals in Laboratories, National Academy Press, Washington, DC, 1981.
9. Renfrew, Malcolm, Ed., Safety in the Chemical Laboratory, Vol. IV, J. Chem. Ed., American Chemical Society, Easlon, PA, 1981.
10. Steere, Norman V., Ed., Safety in the Chemical Laboratory, J. Chem. Ed. American Chemical Society, Easlon, PA, 18042, Vol. I, 1967, Vol. II, 1971, Vol. III, 1974.
11. Steere, Norman V., Handbook of Laboratory Safety, the Chemical Rubber Company Cleveland, OH, 1971.
12. Young, Jay A., Ed., Improving Safety in the Chemical Laboratory, John Wiley & Sons, Inc. New York, 1987.

(b) Hazardous Substances Information:

1. American Conference of Governmental Industrial Hygienists, Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes, 6500 Glenway Avenue, Bldg. D-7, Cincinnati, OH 45211-4438.
2. Annual Report on Carcinogens, National Toxicology Program U.S. Department of Health and Human Services, Public Health Service, U.S. Government Printing Office, Washington, DC, (latest edition).
3. Best Company, Best Safety Directory, Vols. I and II, Oldwick, N.J., 1981.

4. Bretherick, L., Handbook of Reactive Chemical Hazards, 2nd edition, Butterworths, London, 1979.
5. Bretherick, L., Hazards in the Chemical Laboratory, 3rd edition, Royal Society of Chemistry, London, 1986.
6. Code of Federal Regulations, 29 CFR part 1910 subpart Z. U.S. Govt. Printing Office, Washington, DC 20402 (latest edition).
7. IARC Monographs on the Evaluation of the Carcinogenic Risk of chemicals to Man, World Health Organization Publications Center, 49 Sheridan Avenue, Albany, New York 12210 (latest editions).
8. NIOSH/OSHA Pocket Guide to Chemical Hazards. NIOSH Pub. No. 85-114, U.S. Government Printing Office, Washington, DC, 1985 (or latest edition).
9. Occupational Health Guidelines, NIOSH/OSHA. NIOSH Pub. No. 81-123 U.S. Government Printing Office, Washington, DC, 1981.
10. Patty, F.A., Industrial Hygiene and Toxicology, John Wiley & Sons, Inc., New York, NY (Five Volumes).
11. Registry of Toxic Effects of Chemical Substances, U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, Revised Annually, for sale from Superintendent of documents US. Govt. Printing Office, Washington, DC 20402.
12. The Merck Index: An Encyclopedia of Chemicals and Drugs. Merck and Company Inc. Rahway, N.J., 1976 (or latest edition).
13. Sax, N.I. Dangerous Properties of Industrial Materials, 5th edition, Van Nostrand Reinhold, NY., 1979.
14. Sittig, Marshall, Handbook of Toxic and Hazardous Chemicals, Noyes Publications. Park Ridge, NJ, 1981.

(c) Information on Ventilation:

1. American Conference of Governmental Industrial Hygienists Industrial Ventilation (latest edition), 6500 Glenway Avenue, Bldg. D-7, Cincinnati, Ohio 45211-4438.
2. American National Standards Institute, Inc. American National Standards Fundamentals Governing the Design and Operation of Local Exhaust Systems ANSI Z 9.2-1979 American National Standards Institute, N.Y. 1979.
3. Imad, A.P. and Watson, C.L. Ventilation Index: An Easy Way to Decide about Hazardous Liquids, Professional Safety pp 15-18, April 1980.
4. National Fire Protection Association, Fire Protection for Laboratories Using Chemicals NFPA-45, 1982.
   Safety Standard for Laboratories in Health Related Institutions, NFPA, 56c, 1980.
   Fire Protection Guide on Hazardous Materials, 7th edition, 1978.
   National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.
5. Scientific Apparatus Makers Association (SAMA), Standard for Laboratory Fume Hoods, SAMA LF7-1980, 1101 16th Street, NW., Washington, DC 20036.

(d) Information on Availability of Referenced Material:

1. American National Standards Institute (ANSI), 1430 Broadway, New York, NY 10018.
2. American Society for Testing and Materials (ASTM), 1916 Race Street, Philadelphia, PA 19103.

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