



**COLORADO  
COLLEGE**

**CHEMICAL HYGIENE PLAN**

In compliance with the  
OSHA Laboratory Standard

Department of Environmental Health & Safety  
1125 Glen Avenue  
Colorado Springs, CO 80905  
719-389-6678

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## **1.0 INTRODUCTION**

### **1.1 The Laboratory Standard (29 CFR 1910.1450)**

In response to questions about the application of the Hazard Communication Standard in certain laboratory settings, on January 31, 1990, the Department of Labor published in the Federal Register an amendment to 29 CFR 1910 Subpart Z, identified as Section 1910.1450. The title of the amendment is “Occupational Exposure to Hazardous Chemicals in the Laboratory”, better known as the “Laboratory Standard”.

The Laboratory Standard ensures that employees who work in a laboratory setting will be protected from any chemical exposures that exceed permissible exposure limits and that employees will be educated as to the hazardous nature of the chemicals they use in the laboratory. To achieve this goal, the Laboratory Standard requires Colorado College to appoint a Chemical Hygiene Officer to develop, implement and monitor a Chemical Hygiene Plan and Chemical Hygiene Program.

### **1.2 Colorado College Statement of Responsibility**

In compliance with the amendment to 29 CFR 1910 Subpart Z, identified as Section 1910.1450, titled “Occupational Exposure to Hazardous Chemicals in the Laboratory”, better known as the “Laboratory Standard,” Colorado College realizes our responsibility for the protection of our employees. We hereby institute the enclosed Chemical Hygiene Plan to assist us in our safety program.

The Environmental Health and Safety (EHS) Coordinator acts as the College’s Chemical Hygiene Officer. This individual is responsible for the overall Chemical Hygiene Plan for the College and assists lab faculty and staff with implementation of the Plan. The Chemical Hygiene Officer is responsible for ensuring that training is provided in a timely fashion and is responsible for all record keeping associated with the Chemical Hygiene Plan.

Lab faculty and staff in each department are responsible for ensuring that all experiments and analyses conducted under his/her direction do not pose undue risks to individuals performing the work and, that all aspects of the Chemical Hygiene Plan are adhered to in their lab. Also, it is their responsibility to ensure that all individuals working under his/her direction are informed and familiar with the location of all emergency equipment, routes of egress and the specific safety rules and requirements of the Chemical Hygiene Plan in that lab. Each department is responsible for ensuring that any lab-specific procedures needed to supplement this Plan are developed and implemented in a timely manner.

It is the responsibility of each lab worker/student to abide by the general safety requirements set forth in the Chemical Hygiene Plan and as instructed by the lab faculty

and staff, as well as the specific procedures and requirements of the lab in which they work. Laboratory workers/students must realize that their actions may affect the safety of others.

### **1.3 Scope and Application**

This document serves as the written guide for Colorado College's compliance with the Laboratory Standard and the Chemical Hygiene Plan requirements contained therein. All employees at Colorado College engaged in the laboratory use of hazardous chemicals are required to comply with this document.

The primary objective of this document is to provide a general guide for handling hazardous chemicals in laboratories. The Chemical Hygiene Plan establishes the basic safety principles for laboratory procedures, equipment and work practices that are designed to protect employees from physical and health hazards associated with hazardous chemicals in laboratories. This document is intended only to highlight those safety measures necessary for achieving a safe and healthy work environment. Where the scope of hazards is not adequately addressed by this general document, the laboratory supervisor must develop specific Standard Operating Procedures.

This document will hereafter be known as the Colorado College Chemical Hygiene Plan (CCCHP).

#### **Definition of a Laboratory**

This section identifies facilities within the College that are to be considered a laboratory as defined by OSHA. Activities within these facilities must comply with the Laboratory Standard. Other facilities which use or store hazardous materials must comply with other OSHA standards, including the Hazard Communication Standard and the substance specific standards of 29 CFR 1910.

The following are taken directly from the Laboratory Standard, 29 CFR 1910.1450(b) Definitions:

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

- A. Chemical manipulations are carried out on a *laboratory scale*;
- B. Multiple chemical procedures or chemicals are used;

- C. The procedures involved are not part of a production process, nor in anyway simulate a production process; and
- D. *Protective laboratory practices and equipment* are available and in common use to minimize the potential for employee exposure to hazardous chemicals.

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

*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.

#### **1.4 Hazardous Chemical Definitions**

According to the Laboratory Standard, “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 persons. While the Lab Standard is intended to focus on health effects of chemicals, it and other standards and regulations govern the safe handling of more broadly defined hazardous materials. To meet these expanding health and safety requirements, criteria are presented here for identifying materials which are both health hazards and physical hazards.

Health hazards include 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 do damage to the lungs, skin, eyes, or mucous membranes.

Physical hazards include chemicals for which there is scientifically valid evidence that they are combustible liquids, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, unstable (reactive) or water reactive.

##### **1.4.1 Toxic Hazard**

A substance will be considered to be a toxic hazard requiring the use of procedures for toxic chemicals when any one of the following criteria is met:

- A. The SDS or container label identifies or describes the substance as toxic.
- B. The substance meets the definition of toxic in the Hazard Communication Standard (29 CFR 1910.1200 Appendix A):



1. The median lethal dose (LD50) is more than 50 mg/kg of body weight but not more than 500 mg/kg of body weight when administered orally to albino rats weighing between 200 and 300 grams each; or
2. The median lethal dose is more than 200 mg/kg of body weight but not more than 1000 mg/kg 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; or
3. The median lethal concentration (LC50) in air is more than 200 ppm by volume of gas or vapor but not more than 2000 ppm by volume of gas or vapor, or more than two mg/L but not more than 20 mg/L 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.

C. Any substance whose toxic properties are unknown.

#### **1.4.2 Fire Hazard**

A substance will be considered to present a fire hazard requiring the use of procedures for fire hazards when any one of the following criteria is met:

- A. The SDS or container label identifies or describes the substance as flammable or combustible.
- B. The substance fits the definition of “combustible liquid” in the OSHA Laboratory Standard (29 CFR 1910.1450):
  1. Combustible liquid means 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.
- C. The substance fits any of the following definitions of “flammable chemicals” in the OSHA Laboratory Standard (29 CFR 1910.1450):
  1. “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.
  2. “Gas, flammable” means a gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of 13% by volume or less; or 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.

3. "Liquid, flammable" means any liquid having a flashpoint below 100 °F, except any mixture having components with flashpoints of 100 °C or higher, the total of which make up 99% or more of the total volume of the mixture.
4. "Solid, flammable" means a solid, other than a blasting agent or explosive as defined in 29 CFR 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.

### **1.4.3 Reactivity Hazard**

A substance will be considered to present a reactivity hazard requiring the use of procedures for reactive chemicals when any one of the following criteria is met:

- A. The SDS or container label identifies or describes the substance as unstable, reactive, explosive, dangerous when wet, pyrophoric, an oxidizer or an organic peroxide.
- B. The substance fits the definition of unstable (reactive), explosive, organic peroxide, oxidizer or water reactive in the OSHA Laboratory Standard (29 CFR 1910.1450):
  1. Unstable (reactive) means a chemical which in the pure state, or as produced or transported, will vigorously polymerize, decompose, condense, or will become self-reactive under conditions of shock, pressure, or temperature.
  2. Explosive means a chemical that causes sudden, almost instantaneous release of pressure, gas or heat when subjected to sudden shock, pressure or high temperature.
  3. 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 have been replaced by organic radicals.
  4. 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.

5. Water-reactive means a chemical that reacts with water to release a gas that is either flammable or presents a health hazard.
- C. The substance fits the definition of pyrophoric in the Hazard Communication Standard (29 CFR 1910.1200):
1. Pyrophoric means a chemical that will ignite spontaneously in air at a temperature of 130 °F or below.

#### **1.4.4 Corrosivity Hazard**

A substance will be considered to present a corrosivity hazard requiring the use of procedures for corrosive chemicals when any one of the following criteria is met:

- A. The SDS or container label identifies or describes the substance as corrosive
- B. The substance fits the OSHA definition of corrosive in the Hazard Communication Standard (29 CFR 1910.1200 Appendix A):
  1. Corrosive means a chemical that causes visible destruction of, or irreversible alterations in, living tissue by chemical action at the site of contact. For example, a chemical is considered corrosive if, when tested on the skin of albino rabbits by the method described by the U.S. Department of Transportation in Appendix A to 49 CFR part 173, it destroys or changes irreversibly the structure of the tissue at the site of contact following an exposure period of four hours. This term shall not refer to action on inanimate surfaces.

#### **1.4.5 Contact Hazard**

A substance will be considered to present a contact hazard requiring the use of procedures for contact hazards when any one of the following criteria is met:

- A. The SDS or container label identifies or describes the substance as an allergen, irritant or sensitizer.
- B. The substance fits the OSHA definition of an “irritant” or “sensitizer” in the Hazard Communication Standard (29 CFR 1910.1200 Appendix A):
  1. Irritant means a chemical, which is not corrosive, but which causes a reversible inflammatory effect on living tissue by chemical action at the site of contact. A chemical is a skin irritant if, when tested on the intact skin of albino rabbits by the methods of 16 CFR 1500.41 for four hours exposure or by other

appropriate techniques, it results in an empirical score of five or more. A chemical is an eye irritant if so determined under the procedure listed in 16 CFR 1500.42 or other appropriate techniques.

2. Sensitizer means 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.

#### **1.4.6 Particularly Hazardous Substance**

A substance will be considered a particularly hazardous substance requiring the use of procedures for particularly hazardous substances when any of the following criteria are met:

- A. The SDS or container label identifies or describes the substance as a carcinogen, reproductive toxin, or highly toxic.
- B. The substance meets the definition of “highly toxic” in the Hazard Communication Standard (29 CFR 1910.1200):
  1. The median lethal dose (LD50) is equal to or less than 50 mg/kg of body weight when administered orally to albino rats weighing between 200 and 300 grams each; or
  2. The median lethal dose is equal to or less than 200 mg/kg 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; or
  3. The median lethal concentration (LC50) in air is equal to or less than 200 ppm by volume or less of gas or vapor, or equal to or less than 2 mg/L 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.
- C. The substance meets the definition of a “select carcinogen” in the Laboratory Standard (29 CFR 1910.1450):
  1. The substance is regulated by OSHA as a carcinogen; or
  2. The substance is listed under the category, “Known to be Carcinogens,” in the latest Annual Report on Carcinogens published by the National Toxicology Program (NTP); or
  3. The substance is listed under Group 1 (“carcinogenic to humans”) by the latest International Agency for Research on Cancer Monographs (IARC); or

4. The substance 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 less than 10 mg/m<sup>3</sup>.
  - 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.
  
- D. The substance fits the definition of “reproductive toxins” in the OSHA Laboratory Standard (29 CFR 1910.1450):
  1. Reproductive toxins mean chemicals which affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis).

Use the MSDS to address chronic toxicity. For further help in determining the hazard of a chemical, contact your supervisor or the chemical hygiene officer.

#### **1.4.7 Compressed Gas Hazard**

A substance will be considered to present a compressed gas hazard requiring the use of procedures for compressed gases when any of the following criteria are met:

- A. The SDS or container label identifies or describes the substance as a compressed gas.
- B. The substance meets the definition of a “compressed gas” in the Laboratory Standard (29 CFR 1910.1450).
  1. Compressed gas means (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.

### **1.5 RESPONSIBILITY**

- A. **The President of the College** has ultimate responsibility for chemical safety within the institution. General oversight responsibility is assigned to the **Vice President for Finance and Administration**.
- B. **The Chemical Hygiene Officer** advises on matters of material safety policies and practices and:
1. Works with administrators and other employees to develop and implement the appropriate chemical hygiene policies and practices
  2. Monitors procurement, use and disposal of chemicals used in the lab
  3. Ensures that appropriate audits are conducted
  4. Helps laboratory supervisors develop precautions and adequate facilities
  5. Knows the current legal requirements concerning regulated substances
  6. Seeks ways to improve the chemical hygiene plan
  7. Conducts information and general training sessions
  8. Handles requests for monitoring air and/or surface contamination by hazardous materials
  9. Assists with the investigation of accidents involving hazardous materials
  10. Provides necessary information to the healthcare professional when a report of possible overexposure occurs
  11. Schedules testing of laboratory facilities
  12. Oversees services for hazardous waste disposal
  13. Maintains a resource file of references and publications on safety matters
  14. Writes or assists laboratory supervisors in writing standard operating procedures pertinent to their needs
  15. Annually reviews the Chemical Hygiene Plan with input from the covered departments
- C. **The Department Chair** is responsible for chemical hygiene in his or her department and:
1. Ensures that action is taken to correct work practices and conditions that may result in the release of hazardous materials
  2. Implements the CCCHP for those laboratories where the laboratory supervisors do not exercise primary discretion in the choice of hazardous materials used or stored in their laboratories.
- D. **The Laboratory Supervisor** is the faculty or staff member under whose instruction hazardous materials are used and/or stored in the laboratory. The supervisor has a primary responsibility for implementing the CCCHP in the laboratory and:
1. Ensures that workers know and follow the chemical hygiene rules

2. Ensures that training specific to the laboratory's procedures and chemicals has been provided
  3. Ensures that the required level of personal protective equipment is available, in working order and that specific training in its use has been provided
  4. Knows the current legal requirements concerning regulated substances used in the laboratory
  5. Ensures that facilities and training for use of any material being ordered is adequate
  6. Provides for the safety of visitors in the laboratory
  7. Prepares procedures for dealing with accidents that may result in the unexpected exposure of personnel or the environment to a hazardous material
  8. Maintains the inventory of hazardous materials use under his or her supervision
  9. Sees that work areas where particularly hazardous substances or select carcinogens are used or stored are properly identified
  10. Oversees the handling of chemical waste pending proper disposal
- E. **The Stockroom Supervisor** (or other positions depending on the department) has the responsibility for maintaining the department's main chemical inventory and:
1. Maintains the inventory of chemicals stored in the main chemical stock room areas and laboratories
  2. Maintains a file of safety data sheets for hazardous materials used in the department stockrooms and laboratories
  3. Regularly tests and maintains safety showers and eyewashes
- E. **The Laboratory Worker** must be alert to and aware of the hazards of the materials with which he or she is working and
1. Maintain a thorough understanding of the CCCHP
  2. Plan and conduct each operation in accordance with the CCCHP
  3. Report all incidents, whether involving personnel, equipment or facilities to their supervisor
- F. **The Director of Facilities Services** has the responsibility for the continuous operation of the laboratories, including engineered safety devices, and:
1. Regularly tests (or contracts for services to test) fume hoods, fire extinguishers, sprinklers and fire alarm systems
  2. Maintains negative pressure in designated work areas

3. Reviews construction, modification and renovation plans for safety design
- G. **The Director of Campus Safety** has general responsibility for personal safety and:
1. Schedules and conducts fire drills and emergency and disaster drills
  2. Responds to emergency incidents in the labs, provides assessment and determines the appropriate actions
- H. **All Employees of the College** are responsible for ensuring that they follow the procedures and faithfully implement the appropriate responsibilities put forth in the chemical hygiene plan.

Personnel currently in the responsible positions referenced above include:

<b>Position</b>	<b>Name</b>	<b>Phone</b>
Acting Co-Presidents of the College	Robert Moore	x6693
	Mike Edmonds	x6684
VP for Finance and Administration	Robert Moore	x6693
Director of Facilities Services	Amber Brannigan	x6570
Director of Public Safety	Maggie Santos	x6707
Chemistry Department Chair	Habiba Vaghoo	x6746
Molecular Biology Chair	Darrell Killian	x7395
Organismal Biology Chair	Shane Heschel	x6406
Environmental Program Chair	Corina McKendry	x6788
Geology Chair	Christine Siddoway	x6717
Psychology Chair	Tomi-Ann Roberts	x6838
Chemical Hygiene Officer	Sarah Bican (Temp)	x6568
Stockroom Supervisor (Chemistry)	Rachel Wonciar	x6435
Lab Coordinator (Molecular Bio.)	Janna Brown	x6396
Animal Suite Assistant (Organismal Bio.)	Steve Langlois	x6830
Technical Director (EV Program)	Darren Ceckanowicz	x7236
Technical Director (Geology)	Steve Weaver	x6954
Technical Director (Psychology)	Mark Saviano	x6191

## 1.6 Employee Rights

It is the employee's right to receive information about the known physical and health hazards of the hazardous chemicals in their work areas and to receive adequate training to work safely with these substances. Employees have the right to work in a safe environment and inform their laboratory supervisor about potential risks in the laboratory.



## **1.7 Availability**

The Colorado College Chemical Hygiene Plan must be readily available to employees and employee representatives through their supervisor, the Chemical Hygiene Officer or the Colorado College EH&S website.

## **1.8 Periodic Review**

The Colorado College Chemical Hygiene Plan will be reviewed annually by the Colorado College Chemical Hygiene Officer.

## **1.9 Employee Information and Training**

Employees must have access to information and training to ensure that they are apprised of the hazards of chemicals present in the work area. Such information must be provided at the time of an employee's initial assignment to a work area where hazardous chemicals are present and prior to assignment involving new exposure situations. Employees should receive periodic refresher information and training to ensure that they are aware of the risks of exposure to hazardous chemicals.

### **Information**

Information provided by the chemical hygiene officer/department head/lab supervisor to employees must include:

- A. The contents of the The Laboratory Standard and its appendices
- B. The location and availability of the CCCHP
- C. The permissible exposure limits for OSHA regulated substances or recommended exposure limits for other hazardous chemicals where there is no applicable OSHA standard
- D. Signs and symptoms associated with exposures to hazardous chemicals used in the laboratory (available on Safety Data Sheets)
- E. The location and availability of known reference materials on the hazards, safe handling, storage and disposal of hazardous chemicals found in the laboratory, including, but not limited to, Safety Data Sheets received from the supplier

### **Method of Training**

General training will be provided by the Chemical Hygiene Officer and/or individual department designees and may take the form of individual instruction, group seminars, audiovisual presentations, handout material or any combination of the above. Site- specific training shall be provided by laboratory supervisors or an appropriate designee.

## **Training**

**General awareness training** provided by the Chemical Hygiene Officer and/or individual department designees to employees will include:

- A. General chemical handling and sources of hazard information for chemicals in the work area
- B. Handling of hazardous waste
- C. General physical and health hazards of chemicals in the work area
- D. Measures employees can take to protect themselves from these hazards, including specific procedures the college has implemented to protect employees from exposure to hazardous chemicals, such as appropriate work practices and personal protective equipment to be used
- E. Emergency response procedures
- F. The applicable details of the CCCHP

**Site-specific training** provided by laboratory supervisors (or designees) to employees will include:

- A. Site-specific standard operating procedures
- B. Specific physical and health hazards of chemicals in the work area (available on Safety Data Sheets)

**Documentation** The Chemical Hygiene Officer and/or individual department designees will document general awareness training required by the CHP. Site-specific training must be documented and maintained by the laboratory supervisor.

### **1.10 Recordkeeping**

The Chemical Hygiene Officer will retain records of all employees who complete general awareness training. It is required that records of specific laboratory training for individual laboratories be retained by the supervisor in the laboratory or the department.

Accident records for employees should be written and retained within the laboratory or department.

The amount of time a department chooses to retain training records is not specified in the Laboratory Standard. It is recommended by this document that such records be retained for three years or at least one year after an employee leaves a position. Ideally, training records should be retained indefinitely. The Laboratory Standard requires that the following records be maintained for at least thirty (30) years and that they are kept, transferred and made available in accordance with 29 CFR 1910.1020:

- A. air concentration monitoring results
- B. exposure assessments
- C. medical consultations
- D. medical examinations

## **2.0 GENERAL STANDARD OPERATING PROCEDURES**

The college has developed generic standard operating procedures (SOP's) relevant to safety and health considerations when laboratory work involves the use of hazardous chemicals. Where the scope of hazards are not adequately addressed by this general document, department chairs/laboratory supervisors must develop written standard operating procedures for work area specific substances (see Section 4.0). Standard operating procedures must be provided to all affected laboratory employees. **The Standard Operating Procedures in this document specify minimum regulations and recommendations.**

### **2.1 General Safety Principles**

The following guidelines have been established to minimize hazards and to maintain basic safety in the laboratory.

- A. Examine the hazards associated with the materials being used by carefully reading the label and reviewing the Safety Data Sheets.
- B. Know the location and proper use of emergency equipment (e.g. fire alarms, fire extinguishers, emergency eyewash and shower stations) and know the appropriate emergency response procedures.
- C. Use appropriate safeguards for each chemical in use, including personal protective equipment.
- D. Know the proper storage for chemicals when not in use.
- E. Use proper methods of transporting chemicals within the facility.
- F. Always be alert to unsafe conditions and actions and call attention to them so that corrective action can be taken.
- G. Avoid distracting or startling other workers when they are handling hazardous chemicals.
- H. Always inspect equipment for leaks, tears and other damage before handling a hazardous chemical. This includes fume hoods, gloves, goggles, etc.
- I. Use proper personal hygiene practices.

### **2.2 Health and Hygiene**

The following practices have been established to protect laboratory employees from health risks associated with the inhalation, ingestion, injection or absorption of hazardous chemicals:

- A. Avoid direct contact with any hazardous chemical. Know the types of protective equipment available and use the proper type for each job.
- B. Do not mouth pipette.
- C. Do not eat, drink, smoke, chew gum or apply cosmetics in the laboratory.
- D. Wear heavy gloves when inserting glass tubing into cork or rubber stoppers.
- E. Handle broken glass carefully and dispose of it in a broken glass container.
- F. Wear appropriate eye protection at all times.
- G. Confine long hair and loose clothing and always wear footwear that fully covers the feet.
- H. Wash thoroughly with soap and water after handling chemicals, before leaving the laboratory and before eating or drinking.
- I. Wash immediately if skin or eye contact is made with any chemical, regardless of corrosivity.
- J. Do not sit on lab benches.
- K. Remove all personal protective equipment, including gloves and goggles, before leaving the laboratory.

### **2.3 Food and Drink in the Laboratory**

The following statement is the accepted practice on food and drink in laboratories and should be followed at all times:

“There shall be no food, drink, smoking or applying cosmetics in laboratories which have radioactive, biological or chemical hazards present. There shall be no storage, use or disposal of these 'consumable' items in laboratories (including refrigerators within laboratories). Rooms which are adjacent, but separated by floor to ceiling walls, and do not have any radioactive, biological or chemical hazards present, may be used for food consumption, preparation or applying cosmetics at the discretion of the laboratory supervisor responsible for the areas”.

### **2.4 Housekeeping**

Sensible housekeeping practices contribute greatly towards chemical hygiene and safety. Use the following guidelines to maintain an orderly laboratory:

- A. Keep work areas clean and uncluttered with chemicals and equipment.
- B. Clean up work areas upon completion of an operation or at the end of each workday, including floors.
- C. Do not block exits or access to emergency equipment including safety showers, eyewashes and fire extinguishers.
- D. Do not block hallways or stairs.

- E. Clean spills immediately and thoroughly as per the guidelines established in section 5.0 of this document. Ensure that a chemical spill kit is available and that employees know how to use it.
- F. Keep wastes in their proper containers and label them appropriately.
- G. Ensure hazardous chemicals are properly segregated into compatible categories and placed in an appropriate storage area (see section 6.1.3 of this document).
- H. Ensure all chemical containers are labeled with both the name of the chemical(s) and the hazards they present.
- I. Treat any unlabeled containers at the end of the workday as waste.

## **2.5 Chemical Handling and Storage**

The decision to use a hazardous chemical is a commitment to handle and use the chemical properly from initial receipt to disposal.

- A. Information on proper handling, storage and disposal of hazardous chemicals and access to related Safety Data Sheets should be made available to all laboratory employees prior to the use of the chemical.
- B. Always purchase the minimum amount necessary to maintain operations. Conduct periodic inventories and discard unneeded items or return them to the stockroom.
- C. Chemical containers with missing or defaced labels or that violate appropriate packaging regulations should not be accepted.
- D. Chemicals utilized in the laboratory must be appropriate for the laboratory's ventilation system.
- E. Chemicals should not be stored on high shelves and large bottles (3 gallons or larger) should be stored no more than two feet from floor level.
- F. Chemicals shall be segregated by compatibility.
- G. Chemical storage areas must be labeled as to their contents (see section 6.1)
- H. Storage of chemicals at the lab bench or other work areas shall be kept to a minimum.
- I. Avoid exposure of chemicals to heat or direct sunlight.
- J. Any chemical mixture shall be assumed to be as toxic as its most toxic component.
- K. Substances of unknown toxicity shall be assumed to be toxic.

## **2.6 Transporting Chemicals**

When transporting chemicals, precautions should be taken to avoid dropping or spilling chemicals.

- A. Carry glass containers in specially designed bottle carriers or a leak resistant, unbreakable secondary container (e.g. – a five gallon plastic bucket).

- B. When transporting chemicals on a cart, use a cart that is suitable for the load and one that has high edges to contain leaks or spills.
- C. Avoid transporting chemicals in passenger elevators to avoid the possibility of exposing people.

## **2.7 Unattended Operations**

At times, it may be necessary to leave a laboratory operation unattended. Follow these basic guidelines in the design of an experiment to be left unattended:

- A. Develop a protocol for potential interruptions in electric, water, inert gas and other services and provide containment for toxic substances as part of the protocol.
- B. A warning notice must be posted in the vicinity of the experiment if hazardous conditions are present (e.g. – on the laboratory door).
- C. Leave lights on in the laboratory.
- D. Never leave an operation unattended if it involves the use of particularly hazardous substances (as described in section 1.4).

## **2.8 Working Alone**

- A. Avoid working alone whenever possible.
- B. If you must work alone outside of normal working hours, the laboratory supervisor must be notified and Campus Safety should be notified prior to commencing work and when completed with work.
- C. Never work alone with particularly hazardous substances (as described in section 1.4) or substances of unknown toxicity.

## **2.9 Prior Approval**

Any new procedure should be subjected to review to ensure that all safety considerations are in place prior to implementation. Approval from the laboratory supervisor to proceed must be obtained if any of the following criteria are met:

- A. The procedure or task is a new one.
- B. There is a change, substitution or deletion in the procedure or task.
- C. There is a substantial change in the amount of chemicals used.
- D. There is a failure of any of the equipment used in the process or task (e.g. - fume hoods.)
- E. Members of the laboratory staff will be working alone or a procedure or a task will be unattended.
- F. A particularly hazardous substance is used.

## **2.10 Storage and Disposal of Hazardous Waste**

For guidelines on the storage and disposal of hazardous wastes from laboratory operations contact the Chemical Stockroom Supervisor or the Chemical Hygiene Officer. Hazardous waste management plans generally separate waste into three broad groups (chemical, biohazardous and radioactive) described separately below.

Workers who generate hazardous waste must be aware that there may be mixed hazards in their waste. For example, animal carcasses containing radioactive material, a hazardous chemical and perhaps an infectious agent would need to be managed according to the considerations and requirements of all three types of hazards defined below. If you will be generating mixed waste, contact the appropriate safety officer to determine the proper way to handle and manage the material before the waste is generated.

### **2.10.1 Disposal of Chemical Waste**

**Chemical waste** includes a wide range of materials including discarded chemical products and process wastes. Some chemicals are hazardous because they are specifically listed by the EPA, while others are not listed by the EPA but contain one or more of the EPA's 4 hazardous characteristics: ignitability, corrosivity, reactivity and toxicity. The following briefly describes the storage and disposal process for chemical waste:

- A. Individual generators are responsible for the safe collection and storage of hazardous waste at their site. Satellite storage areas may accumulate as much as 55 gallons of hazardous waste (U-list) or one quart of acutely hazardous waste (P-list) in containers provided that the container has a hazardous waste label affixed, is marked with an accumulation start date, has words "Hazardous Waste" and has the specific contents of the container identified.
- B. Waste stored at the point of origin should be kept to a minimum. Containers should be closed and dated when they become full and moved to the hazardous waste storage area (storage shed outside on the north side of Barnes Science Center) as soon as possible. Waste will be removed from the central storage area typically two times per year (usually once in January and once in August) by a licensed hazardous waste contractor.
- C. No quantity of hazardous waste may be transported over public highways without proper packaging, classification, labeling and documentation. Consequently, hazardous waste will be transported from the College for treatment or disposal only by licensed hazardous waste transporters.

### **2.10.2 Disposal of Biohazard Waste**

**Biohazard waste** describes different types of waste that might include infectious agents. The following briefly describes the storage and disposal process for biohazard waste:

- A. Animal parts or whole animals should be placed in biohazard waste buckets for pick up for incineration. (This waste is picked up by a medical waste company).
- B. If animal tissue is held in liquid preservative, the tissue and liquid preservative should be placed in buckets for hazardous waste disposal.
- C. Liquid culture waste can be decontaminated using an autoclave. If the material cannot be decontaminated, it should be placed in biohazard waste bags for incineration.
- D. All other medical/pathological/regulated waste should be placed in biohazard waste bags for proper disposal.

### **2.10.3 Disposal of Radioactive Waste**

Colorado College currently does not generate any radioactive waste. This section will be reserved for future use if needed.

### **2.10.4 Disposal of Controlled Substances**

The United States Drug Enforcement Agency (DEA) issues permits for controlled substances. The following briefly describes the storage and disposal of controlled substances.

- A. All controlled substances must be stored under lock and key within a locked room.
- B. Abandonment of a controlled substance is a violation of the DEA permit under which it is held.
- C. Permission to transfer ownership of a controlled substance must be received from the DEA.
- D. Controlled substances held by a licensed individual to be surrendered for destruction must be disposed of according to federal regulations and DEA policy.
- E. Controlled substances being held by a licensed individual that are lost or stolen must be reported on DEA Form 106 and mailed to the Drug Enforcement Administration. A copy of this form must be sent to the Chemical Hygiene Officer.

## **2.11 Standard Repair/Transfer/Close-out/Transportation Procedures**

### **2.11.1 Repair and Transfer Procedures**

Before a request for equipment repair or transfer to another location is initiated, remove chemical contaminants with an appropriate solvent or cleaning solution to ensure the safety of the employees responsible for repair or transfer.



### **2.11.2 Close-Out Procedures**

Whenever a laboratory worker engaged in scientific investigation leaves the College or is transferred to a different location, proper disposition of hazardous materials is required. This includes faculty, staff and students. The following procedures should be completed before the responsible individual leaves the College or transfers to a different location on campus:

- A. Assure that all containers of chemicals are labeled with the name of the chemical and all known hazards. All containers must be securely closed—all beakers, flasks, evaporating dishes, etc. should be emptied.
- B. Clean chemicals from glassware, assuring that proper waste disposal guidelines are followed.
- C. Remove regulators from gas cylinders, replace cap and return cylinders to the supplier. If cylinders are non-returnable, follow disposal procedures.
- D. Check refrigerators, freezers, cold rooms, fume hoods, glove boxes, storage cabinets and bench tops for chemical containers and dispose of items used by the departing researcher. This includes facilities that are shared with other researchers.
- E. If chemicals are still usable, transfer the responsibility of the chemical to another laboratory worker who is willing to take charge of the chemical.
- F. Remove chemical contaminants from equipment and bench tops with an appropriate solvent or cleaning solution.
- G. Label all hazardous waste according to section 2.10 and contact the Chemical Hygiene Officer or the appropriate personnel for that department for pick up at least one week prior to vacating the lab.
- H. Notify the department when the laboratory or containment area/rooms have been cleared.

### **2.11.3 Transportation Procedures**

A licensed transporter should be contacted to package and deliver materials to a new location on campus. Persons intending to transport chemicals on campus themselves must contact the Chemical Hygiene Officer. Transportation of chemicals off campus is regulated by federal, state and local laws. Contact the Chemical Hygiene Officer when chemicals must be transported off campus.

## **3.0 HAZARD SPECIFIC STANDARD OPERATING PROCEDURES**

### **3.1 Hazard Identification**

Identifying the specific hazard associated with a chemical greatly reduces chances of misuse by regular laboratory employees, new users or visitors to the laboratory. At the

very minimum, hazardous chemical containers must have the chemical name(s) and hazard identification(s) clearly marked. With respect to identifying containers, storage areas and laboratory entrances, the following conditions entail hazard identification:

- A. Laboratory supervisors must ensure that labels on incoming containers of hazardous chemicals for laboratory use are not removed or defaced. Labels contain information on the identity of the chemical(s) in the container and the hazard identification of the chemical(s).
- B. Laboratory supervisors must ensure that laboratory containers (those containers filled from the original shipping container) of chemicals are labeled (see section 3.3.1).
- C. Laboratory supervisors must ensure that employees have access to SDSs. (see section 6.1.1).

### **3.2 Chemicals Developed in the Laboratory**

The following requirements apply to chemical substances developed in the laboratory:

- A. If the composition of the chemical substance which is produced exclusively for the laboratory's use is known, the laboratory supervisor must determine if it is a hazardous chemical. This can be done by a literature search for similar substances. If the chemical is determined to be hazardous, the laboratory supervisor must provide appropriate training to protect employees.
- B. If the chemical produced is a product or a by-product whose composition is not known, the laboratory supervisor must assume that the substance is hazardous and must comply with the requirements of the CCCHP.

### **3.3 Labeling**

#### **3.3.1 Container Labels**

All containers of hazardous chemicals must be labeled with the name of the chemical(s) and the hazard(s), if not provided by the manufacturer. If a chemical has more than one hazard, it must be labeled with all hazards. For example, acetaldehyde is both a flammable and a carcinogen, and must be labeled appropriately. Additionally, these guidelines shall be followed:

- A. All peroxide forming chemicals must be labeled with the date of receipt and upon opening the container. After the recommended disposal date, usually 3 or 12 months, the chemical shall be tested for peroxides and labeled with the test results or disposed of properly.
- B. Date all explosive or shock-sensitive materials upon receipt and upon opening.
- C. As per the Hazard Communication Standard:

1. Anything available over the counter to the general public is exempt from labeling requirements if it has already been labeled by the manufacturer. This includes consumer products such as cans of spray paint or turpentine.
2. Stationary process containers such as tanks may be identified with signs, placards, process sheets or other written materials instead of actually affixing labels to the process containers. The sign or placard must convey the same information that a label would and be visible to employees throughout the work shift.
3. Portable containers into which hazardous chemicals are transferred from labeled containers and which are intended to be under the use and control of the person who transferred it, within the work shift in which it was transferred, are exempt from labels. However, it is recommended that a temporary label identifying the chemical and its primary hazard be affixed to the container.
4. All sample containers or prepared solutions must be labeled. If there is a large quantity of containers with the same chemical, labeling of the container, tray, cupboard or refrigerator will suffice.

### **3.3.2 Waste Containers**

All hazardous chemical waste should be segregated and labeled according to section 2.10. Special attention should be given to the following areas:

- A. Upon initial waste collection, attach a "Hazardous Waste" label marked with the initial accumulation start date, class or professor from which the waste is generated and specific contents of the waste.
- B. Waste containers for non-contaminated glass must be labeled as "Broken Glass" and kept separate from other non-contaminated waste.

## **3.4 Health Hazards**

The Laboratory Standard requires that employers, for laboratory uses of substances regulated by OSHA standards, assure that employees' exposures do not exceed the Permissible Exposure Limits (PELs). The PELs represent Time Weighted Averages (TWA's) in parts per million (ppm) or milligrams of substance per cubic meter of air (mg/m<sup>3</sup>). The TWA represents the ratio between exposure and work shift.

### **3.4.1 Exposure Determination**

Employers must contact the chemical hygiene officer to initiate employee exposure monitoring under the following circumstances:

- A. Initial monitoring must be performed if there is reason to believe employee exposure levels routinely exceed the action level or, in the absence of an action level, the Permissible Exposure Limit (PEL).
- B. Periodic monitoring must be performed when initial monitoring reveals an exposure over the action level or, in the absence of an action level, the PEL. The employer must comply with exposure monitoring provisions of the relevant standard.
- C. Monitoring can be terminated in accordance with the relevant standard.

Employers must notify the employee of the monitoring results within 15 working days after receipt of monitoring results. The results must be either individually distributed in writing or posted in a location accessible to all affected employees.

### **3.4.2 Provisions for Toxic Substances**

To ensure that employee exposures to toxic chemicals (as defined in Section 1.4) do not exceed the Permissible Exposure Limits (PEL) the following precautions shall be taken:

- A. All procedures involving toxic materials shall be conducted in an operating fume hood or other suitable containment device.
- B. Personal protective equipment shall be used in accordance with the recommendations given in the related SDS.
- C. Immediately after working with toxic materials, wash hands and arms.

### **3.4.3 Provisions for Particularly Hazardous Substances**

The Laboratory Standard requires that special precautions for additional employee protection be followed for the laboratory use of particularly hazardous substances (defined in section 1.4). The following general hygiene standards should be observed when using particularly hazardous substances. Consult the SDS for specific precautions and procedures.

#### **Establish a designated area.**

- A. Use and store materials only in designated areas: a restricted access hood, glove box or portion of a lab, designated for use of highly toxic substances. Lab supervisors must assure that all personnel with access are aware of the necessary safety precautions.
- B. Label all containers, storage and use areas appropriately. Follow the guidelines established in sections 3.3.1, 6.1.2 and 6.1.3 of this document.

### **Use proper containment devices.**

- A. Use a fume hood, glove box or other containment device for procedures which may result in the generation of aerosols or vapors.
- B. Trap released vapors to prevent their discharge with fume hood exhaust; protect vacuum pumps against contamination with scrubbers or HEPA filters and vent effluent into the hood.
- C. It is recommended that breakable containers be stored in chemical-resistant trays. Work and mount apparatus above such trays or cover work and storage surfaces with removable, absorbent, plastic backed paper.

### **Removal of Contaminated Waste**

Waste contaminated with particularly hazardous substances shall be segregated from other chemical waste. Contact the Chemical Hygiene Officer for specific disposal procedures.

### **Follow decontamination procedures prior to leaving the designated area.**

- A. On leaving the designated area, remove protective apparel (place it in an appropriate, labeled container) and thoroughly wash hands, forearms, face and neck.
- B. Thoroughly decontaminate or dispose of contaminated clothing or shoes. If possible, chemically decontaminate by chemical conversion to a less toxic product.
- C. Decontaminate vacuum pumps or other contaminated equipment, including glassware, before removing them from the designated area. Decontaminate the designated area before normal work is resumed; vacuum pump oil shall be treated as hazardous waste.
- D. Use a wet mop or a vacuum cleaner equipped with a HEPA filter to decontaminate surfaces. **DO NOT DRY SWEEP SPILLED POWDERS.**

#### **3.4.4 Provisions for Corrosives**

Corrosive materials react with the skin, eyes, and mucous membranes causing tissue damage and/or chemical burns on contact. The following standards shall be observed when handling materials that are a corrosive hazard.

- A. Containers and equipment used for storage and processing of corrosive materials should be corrosion resistant.
- B. Eye protection and rubber gloves shall always be used when handling corrosive materials. A face shield, rubber apron and rubber boots may also be appropriate, depending on the work performed.
- C. Never add water to acid. When mixing concentrated acids with water, add the acid slowly to water.
- D. An eyewash and safety shower must be readily accessible to areas where corrosives are used and stored. See section 6.2.2 "Safety Equipment" for eyewash and safety shower specifications.

### **3.4.5 Provisions for Contact Hazards**

The following standards shall be observed when handling materials that are a contact hazard:

- A. All procedures involving materials that present a contact hazard shall be conducted in an operating fume hood or other suitable containment device.
- B. Personal Protective Equipment shall be used in accordance with the recommendations given in the related SDS.
- C. Immediately after working with materials that present a contact hazard wash hands and arms.

## **3.5 Physical Hazards**

Materials which present a physical hazard (see section 1.4) can be safely used if the specific hazard(s) are understood. If appropriate precautions are not taken, personal injury or property damage may occur. Additionally, certain chemicals cannot be safely mixed or stored with other chemicals because of the danger of violent reaction or a reaction that could generate toxic gas.

### **3.5.1 Provisions for Fire Hazards**

For a fire to occur, three conditions must exist simultaneously: presence of flammable gas in the proper concentration, presence of an oxygen rich environment (usually the air), and a source of ignition. Removal of any one of the three conditions will prevent a fire. The following shall be observed when handling materials that produce a fire hazard.

- A. Eliminate ignition sources such as open flames, hot surfaces, sparks from welding or cutting, operation of electrical equipment and static electricity.

- B. Store in NFPA approved flammable liquid containers or storage cabinets, in an area isolated from ignition sources or in a special storage room designed for flammable materials.
- C. Ensure there is proper bonding and grounding when it is required, such as when transferring or dispensing a flammable liquid from a large container or drum. Assure bonding and grounding is checked periodically.
- D. All procedures involving flammable materials in excess of 100 milliliters should be carried out in an operational fume hood.
- E. Assure appropriate safety equipment (e.g. – fire extinguishers, spill kits) is in the area where the procedure will be carried out.

### **3.5.2 Provisions for Reactive Hazards**

The hazard associated with materials classified as reactive is the variable and potentially high rate at which energy may be released under normal conditions, or when struck, vibrated or otherwise agitated. The following standards shall be observed when handling materials that produce a reactive hazard.

- A. Know the reactivity of the materials involved in the experiment or process. Ensure there are no extraneous materials in the area which could become involved in a reaction.
- B. Quantities should be limited in the initial experiments to assess the level of energy released and potential control problems. Special reviews should be established to examine operational and safety problems involved before an experiment is scaled up.
- C. If the reaction is anticipated to be violent or explosive, use shields or other methods for isolating the materials or the process. Barriers should completely encircle the reaction vessel.
- D. Tongs should be used for handling containers of the hazardous material at a safe distance.
- E. Heavy gloves, such as “electrical” linesman’s gloves, shall be worn when it is unavoidably necessary to reach behind a shielded area while an experiment is in progress.
- F. Laboratory coats should be worn at all times to reduce minor injuries from flying glass or an explosive flash.
- G. A face shield, providing throat protection, shall be worn at all times when a worker is in an exposed position, such as when shields are moved aside, when handling or transporting materials, or when manipulating equipment.
- H. Pyrophoric chemicals should be used and stored in inert environments.
- I. Some chemicals become increasingly shock-sensitive with age. Contact the Stockroom Supervisor when it is suspected that the inadvertent

formation of shock-sensitive materials in chemicals being stored has occurred.

- J. Do not open any peroxidizable container which has obvious solid formation around the lid or crystals in solution.
- K. Addition of an appropriate inhibitor to quench the formation of peroxides is recommended.
- L. Store light-sensitive materials in a cool, dark place in amber colored bottles or other containers which reduce or eliminate penetration of light.
- M. Follow the same basic handling procedures as for flammable materials.

### **3.5.3 Provisions for Compressed Gas and Cryogen Hazards**

Special systems are needed for handling materials under pressure. Cylinders pose physical and/or health hazards, depending on the compressed gas in the cylinder. The following standards shall be observed when handling materials that produce a compressed gas hazard.

- A. Cylinders with regulators must be individually secured. Only cylinders with valve protection caps securely in place may be safely gang-chained.
- B. When storing or moving a cylinder, have the valve protection cap securely in place to protect the stem.
- C. Cylinders must be secured in an upright position at all times. Use suitable racks, straps, chains or stands to support cylinders against an immovable object, such as a bench or a wall, during use and storage. Do not allow cylinders to fall or lean against one another.
- D. Use an appropriate cart to move cylinders.
- E. Never bleed a cylinder completely empty. Leave a slight pressure to keep contaminants out.
- F. Oil or grease on the high-pressure side of an oxygen cylinder can cause an explosion. Do not lubricate an oxygen regulator or use a fuel gas regulator on an oxygen cylinder. Use an oxygen approved regulator.
- G. Always wear goggles or safety glasses with side shields when handling compressed gases.
- H. Always use appropriate gauges, fittings, and materials compatible with the particular gas being handled.
- I. When working with a toxic, corrosive or reactive gas, the SDS should be reviewed for information concerning specific handling requirements. Generally, these gases will need to be used and stored with local exhaust ventilation such as a lab hood or a gas cabinet designed for that purpose.

Liquefied gases that condense oxygen from the air create an oxygen rich atmosphere and increase potential for fire if flammable or combustible materials



and a source of ignition are present. Pressure is also a hazard due to the large expansion ratio from liquid to gas, causing pressure build up in containers. Many materials become brittle at extremely low temperatures. Brief contact with materials at extremely low temperatures can cause burns similar to thermal burns. Some of the hazards associated with cryogenics are fire, pressure, weakening of materials and skin or eye burns upon contact with the liquid. The following standards shall be observed when handling materials that produce a liquefied gas (cryogen) hazard.

- A. Equipment should be kept clean, especially when working with liquid or gaseous oxygen.
- B. Mixtures of gases or fluids should be strictly controlled to prevent formation of flammable or explosive mixtures.
- C. Always wear safety glasses with side shields or goggles when handling. If there is a chance of a splash or spray, a full-face shield, an impervious apron or coat, cuffless trousers and high topped shoes should be worn. Watches, rings and other jewelry should not be worn. Gloves should be impervious and sufficiently large to be readily thrown off should a cryogen spill. Potholders could also be used.
- D. Containers and systems containing cryogenics should have pressure relief mechanisms.
- E. Containers and systems should be capable of withstanding extreme cold without becoming brittle.

### **3.6 Biological Material Hazards**

Use of biological materials at or above Biosafety Level 2 at Colorado College is strictly controlled. Contact the Chemical Hygiene Officer if you plan to use biological materials at or above Biosafety Level 2.

### **3.7 Radioactive Material Hazards**

Colorado College currently does not use radioactive materials. Contact the Chemical Hygiene Officer if you plan to use radioactive materials.

## **4.0 SUBSTANCE SPECIFIC STANDARD OPERATING PROCEDURES**

Substance specific standard operating procedures shall be prepared by laboratory supervisors and are required for any lab work involving hazardous substances that fall outside of the chemical hygiene plan's general or hazard specific standard operating procedures. Substance specific standard operating procedures shall be added to the CCCHP to make it lab specific. The substance specific standard operating procedure must provide the following information:

- A. **Identification of the SOP** including the chemical name, principle researcher's/instructor's name, lab location and contact information. Additionally, common synonyms, structures, formulas, CAS numbers and chemical and physical properties for the chemical should be included.
- B. **Process/Procedure** identifying chemical use.
- C. **Potential Hazards** including both health and physical hazards. Additionally, PEL, TLV and REL values, routes of exposure and symptoms of overexposure should be included.
- D. **Personal Protective Equipment**, identify the level required during transportation and use.
- E. **Engineering Controls** to be used to prevent or reduce employee exposure, including ventilation, shielding and containment
- F. **Storage and Handling Requirements** including hygiene practices, incompatibilities, labeling requirements, purchasing limits and special precautions (refrigeration, desiccator, glove box, etc.).
- G. **Emergency Procedures** including firefighting techniques and recommended extinguishing media; first aid procedures for skin and eye contact, ingestion, inhalation; spill control procedures; include location of emergency equipment.
- H. **Decontamination Procedures** for equipment (fume hoods, glove boxes, bench tops, etc.) and clothing.
- I. **Waste Disposal Procedures**

If the substance is a particularly hazard substance, the following sections must also be included:

- J. **Designated Area** where the substance will be used, signs that must be posted warning of the hazard and how access to the area will be controlled.
- K. **Qualified Personnel** who have been trained and may work with the substance.

## 5.0 EMERGENCY / MEDICAL PROCEDURES

### 5.1 Basic Steps for Emergency and Spill Response

Releases of hazardous substances that pose a significant threat to health and safety or that requires an emergency response regardless of the circumstances surrounding the release or the mitigating factors are emergency situations. Any one of the following criteria indicate an emergency situation:

- A. The situation is unclear to the person causing or discovering the spill.
- B. The release requires evacuation of persons.
- C. The release involves or poses a threat of:
  1. Fire, suspected fire, explosion or other imminent danger.
  2. Conditions that are Immediately Dangerous to Life and Health (IDLH) without direct contact.
  3. High levels of exposure to toxic substances.

4. Endangering the environment (e.g. by entering the sewer or soil).
- D. The person(s) in the work area is uncertain they can handle the severity of the hazard with the personal protective equipment (PPE) and response equipment that has been provided and/or the exposure limit could easily be exceeded.

Conversely, releases that do not pose significant safety or health hazards to person(s) in the immediate vicinity or to the person(s) cleaning up the spill or do not have the potential to become emergencies within a short time frame are not emergency situations

### **5.1.1 Emergency Situation – Fire**

The following steps are basic protocol for handling a fire or fire-related emergency situation in the laboratory:

- A. Pull the fire alarm.
- B. Evacuate.
- C. Do NOT attempt to extinguish a fire unless you have first warned others and/or activated an alarm and are trained to do so.
- D. Call 911 from a safe location.
- E. Contact Campus Safety at x6707 and the Chemical Hygiene Officer at x6678.

A fire in a small vessel can usually be suffocated by covering the vessel with some sort of lid. If the fire is burning over an area too large to be suffocated simply and quickly (within 30 to 45 seconds), leave the firefighting to those who have been trained and equipped. If you have been trained in the use of fire extinguishers, fight the fire from a position from which you can escape, and only if you are confident that you will be successful. It is easy to underestimate a fire.

### **5.1.2 Emergency Situation – Spill**

If a spill meets the definition of an emergency as described above, execute the following:

- A. Pull the fire alarm.
- B. Isolate the spill area and close doors to the room where the spill occurred.
- C. Call 911 from a safe location.
- D. Contact Campus Safety at x6707 and the Chemical Hygiene Officer at x6678.
- E. Remove ignition sources and shut down equipment.
- F. Evacuate.

### **Attend to victims for a body splash:**

1. Remove person(s) from spill area to fresh air only if attempts to rescue victim(s) does not present a danger to the rescuers.
2. Remove contaminated clothing while under an emergency shower.
3. Flood affected area with cold water for at least 15 minutes or longer if pain persists.
4. Wash skin with mild soap and water - do not use neutralizing chemicals, creams or lotions.
5. Contact emergency response personnel (911) and assure they know the name(s) of the chemical(s) involved.
6. Contact Campus Safety at x6707 and the Chemical Hygiene Officer at x6678.

### **Attend to victims for an eye splash:**

1. Remove victim(s) from spill area to fresh air only if attempts to rescue victim(s) does not present a danger to the rescuers.
2. Lead the victim(s) immediately to an emergency eye wash facility.
3. Hold eye lids open.
4. Flush eyes for at least 15 minutes or longer if pain persists.
5. Contact emergency response personnel (911) and assure they know the name(s) of the chemical(s) involved.
6. Contact Campus Safety at x6707 and the Chemical Hygiene Officer at x6687.

### **5.1.3 Mercury Spills**

For very small spills, less than 1 cc, such as a broken thermometer:

- A. First, notify the Stockroom Supervisor.
- B. Use mercury absorb sponges or powder, to pick up mercury droplets.
- C. Cover small droplets in inaccessible areas such as cracks with Hg vapor absorbent. Test and repeat if an Hg vapor level remains.
- D. Place residue in container for hazardous waste collection and give to the Stockroom Supervisor for proper disposal.

**For large spills, i.e. greater than 1 cc, contact the Chemistry Stockroom Supervisor or the Chemical Hygiene Officer for spill cleanup, instructions or assistance.**

### **5.1.4 Biohazard Spills**

A biohazard spill occurs anytime there is an unplanned release of blood or other potentially infectious material into the work environment. Procedures for biohazard spills are included in the Colorado College Exposure Control Plan (coming soon).

#### **5.1.5 Spill Kits**

Ready access to a chemical spill kit is recommended in laboratories that work with hazardous chemicals. Minimally, such a kit should contain:

- splash resistant goggles
- chemical resistant gloves
- plastic bags
- multi-chemical absorbent (enough for 2 gallon spill)
- scoop

**Most spills greater than 1 liter in volume require assistance from trained personnel.**

Spill kits should be kept in a readily accessible location and each employee should be trained on how to use the spill kit. Kits are always available in the main chemical stockrooms.

#### **5.1.6 Non-Emergency Situation – Spill**

If the spill does not meet the definition of an emergency as described above, and you have been trained in spill response, cleanup and disposal and feel comfortable doing it, execute the following:

- A. Locate the appropriate spill kit.
- B. Choose the proper protective equipment:
  - Always wear gloves and protective eye wear
  - Use additional protective equipment such as an apron, coveralls, or boots as needed. Note: If you need a respirator, you do not have a non-emergency spill and should request outside assistance.
- C. Confine or contain the spill.
- D. Dispose of spilled materials, clean up materials and disposable personal protective equipment.
- E. Restock spill kit and personal protective equipment.

**For non-hazardous spills:**

- A. Cover liquid spills with spill kit absorbent and scoop into a plastic disposal bag.
- B. Sweep solid materials into a dustpan and place in a sealed container.
- C. Dispose of waste as normal trash as long as substance is non-volatile, non-hazardous.

**For hazardous spills:**

- A. Cover liquid spills with spill kit absorbent and scoop into an appropriate disposal container. (As a rule of thumb, the container should be of the same type that the chemical came from. For example, if the spill is from a chemical that was stored in glass bottle, the disposal container should be made of glass).
- B. Wet mop or HEPA vacuum dry substances to avoid spreading hazardous dust, provided it is non-water reactive.
- C. Contact the Stockroom Supervisor for disposal instructions.

**If there are questions about proper spill response techniques, call the Chemical Hygiene Officer at x6678.**

## **5.2 Injury and Illness**

For non-emergency medical treatment, under current Colorado College policies and procedures, affected employees must seek care from a panel of approved providers. The approved provider list may be obtained by contacting the Office of Human Resources. For emergency treatment, go to the nearest facility and schedule a follow-up appointment with an approved provider.

All injuries and illnesses must be reported to your lab supervisor or human resources as soon as possible.

If you have any questions regarding injury and illness procedures, contact your laboratory supervisor or the Chemical Hygiene Officer at x6678.

## **5.3 Medical Consultations and Examinations**

All employees who work with hazardous chemicals shall be provided an opportunity to receive medical attention, including any follow-up examinations which the examining physician determines to be necessary, under the following circumstances:

- A. When 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 examination.

- B. 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.
- C. 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 consultations shall be for the purpose of determining the need for a medical examination.

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

#### **5.3.1 Information Provided to the Physician**

The following information shall be provided to the physician:

- A. The identity of the hazardous chemical(s) to which the employee may have been exposed.
- B. A description of the conditions under which the exposure occurred, including available quantitative exposure data.
- C. A description of the signs and symptoms of exposure that the employee is experiencing, if any.

#### **5.3.2 Physician's Written Opinion**

The College shall obtain a written opinion from the examining physician which shall include the following:

- A. Any recommendation for further medical follow-up.
- B. The results of the medical examination and any associated tests.
- C. Any medical condition which may be revealed in the course of the examination which may place the employee at increased risk as a result of exposure to a hazardous workplace.
- D. A statement that the employee has been informed by the physician of the results of the consultation or medical examination and any medical condition that may require further examination or treatment.
- E. The written opinion of the physician shall not reveal specific findings of diagnoses unrelated to occupational exposure.

## **6.0 STANDARD LABORATORY FACILITY REQUIREMENTS**

### **6.1 Signs and Information**

Labels and warning signs should alert employees to potentially hazardous materials and allow those unfamiliar with the laboratory surroundings to identify hazardous chemical use and storage areas, safety facilities, emergency equipment, exits and aid emergency response personnel.

#### **6.1.1 Safety Data Sheets (SDS's)**

A Safety Data Sheet (SDS) is a document containing chemical hazard identification and safe handling information and is prepared in accordance with the OSHA Hazard Communication Standard. Chemical manufacturers and importers must provide the purchasers of hazardous chemicals an appropriate SDS for each hazardous chemical/product purchased. The ordering department shall maintain copies of all SDS's received. If a chemical is received without a SDS, the ordering department will follow-up with a request to the vendor. If you wish to review a SDS, contact your laboratory supervisor or stockroom supervisor. If information from a SDS is needed in case of an emergency, call the Chemical Hygiene Officer at x6678.

#### **6.1.2 Restricted Access and Designated Areas**

Facilities containing certain hazards must have warning signs posted at the designated area of the laboratory where the hazard exists, and at the entranceway to the laboratory. Any areas placarded as such are restricted access, designated areas and have certain standards regarding training and use by employees. Such hazards include:

- A. Particularly Hazardous Substances
- B. Biological agents that require Biosafety Level 2 or higher\*
- C. Radioisotopes\*

\*Currently, Colorado College does not have radioisotopes in use but will reserve this section for use in the future if the need arises.

Other chemical hazards will be dealt with on a case-by-case basis, with consultation from the Chemical Hygiene Officer.

#### **6.1.3 Storage Areas**

Chemicals should be stored according to compatibility, as designated by hazard classes. When ordering chemicals that are unfamiliar, review the SDS before



purchase so that use and storage guidelines are understood. Assure that the following areas are labeled and chemicals are stored appropriately:

- A. Particularly Hazardous Substances
- B. Corrosives
- C. Flammable/Combustible Liquids
- D. Flammable Solids
- E. Oxidizers
- F. Perchloric Acid
- G. Biosafety Level 2 or higher

## 6.2 CONTROL MEASURES

Control measures must be implemented to reduce employee exposure to hazardous chemicals. The three types of control measures are:

- A. Administrative Controls: methods of controlling employee exposures to contaminants by job rotation, work assignment or time periods away from contaminant.
- B. Engineering Controls: methods of controlling employee exposures by modifying the source or reducing the quantity of contaminants released into the work environment.
- C. Personal Protective Equipment: personal safety equipment designed for secondary employee protection from hazardous chemicals.

**NOTE:** Engineering controls and administrative controls shall first be determined and implemented when feasible. When such controls are not feasible to achieve full compliance, personal protective equipment or any other protective measures shall be used to keep the exposure of employees within the limits prescribed in the rule.

Use the following primary methods for detecting exposures:

- A. Determine the source of exposure.
- B. Determine the path the contaminant follows to reach the employee.
- C. Determine the employee's work pattern and use of personal protective equipment.
- D. Change one or more of the above pathways to reduce or eliminate exposure.

The following general control measures are recommended for use in most situations requiring the use of hazardous chemicals:

- A. Use training and education as primary administrative controls for reducing exposures.
- B. Substitute less harmful chemicals for more harmful chemicals whenever possible.
- C. Change or alter processes to minimize exposure.
- D. Practice good housekeeping procedures to reduce unnecessary exposures.

- E. Isolate or enclose a process or work operation to reduce the number of employees exposed (for example, use of a fume hood).
- F. Use wet methods to reduce the generation of dust.
- G. Use local exhaust ventilation (hoods) at point of generation or dispersion of contaminants and use dilution (general) ventilation to reduce air contaminants.
- H. Use special control methods such as shielding and continuous monitoring devices to control exposures in special situations.

### **6.2.1 Safety Equipment**

#### **6.2.1.1 Safety Showers**

Safety showers provide an immediate water drench of an affected person. Colorado College accepts the following ANSI standards for location, design and maintenance of safety showers:

- A. Showers shall be located within 10 seconds where injurious corrosive materials are used.
- B. Showers must provide a 15 minute water supply at no less than 20 gallons per minute and must provide hands-free operation once activated.
- C. The location of the shower should be clearly marked, well lighted and free from obstacles, closed doorways or turns.

Stockroom personnel shall test safety showers at least monthly to flush the lines of corrosion and bacterial growth and to ensure proper function.

#### **6.2.1.2 Eye Wash Facilities**

Colorado College accepts the following ANSI standards for location, design and maintenance of emergency eyewash facilities:

- A. An eyewash shall be located within 10 seconds where injurious corrosive materials are used.
- B. Eye wash facilities must provide the minimum of a 15 minute water supply at no less than 0.4 gallons per minute and must provide hands-free operation once activated.
- C. The location of the eyewash should be clearly marked, well lighted and free from obstacles, closed doorways or turns.

Stockroom personnel shall test eyewashes at least monthly. A test consists of activating the eyewash for 1 minute to flush the lines of corrosion and bacterial growth and permit observation of proper pressurization levels and water temperature.

### 6.2.1.3 Ventilation Controls

Ventilation controls are those controls intended to minimize employee exposure to hazardous chemicals by removing air contaminants from the work site. There are two main types of ventilation controls:

- A. General (Dilution) Exhaust: a room or building-wide system, which brings in air from outside and ventilates within. Laboratory air must be continually replaced, preventing the increase of air concentration of toxic substances during the workday. General exhaust systems are not recommended for the use of most hazardous chemicals.
- B. Local Exhaust: a ventilated, enclosed workspace intended to capture, contain and exhaust harmful or dangerous fumes, vapors and particulate matter generated by procedures conducted with hazardous chemicals. Cold rooms and warm rooms have contained recirculated atmospheres. Precautions must be taken to prevent the release of toxic substances into these rooms.

#### 6.2.1.3.1 Provisions for Local Ventilation

To determine ventilation requirements, assess the SDS. Some SDS terminology, as listed below, may indicate a need for special ventilation considerations beyond general exhaust ventilation:

- A. *use with adequate ventilation*
- B. *avoid vapor inhalation*
- C. *use in a fume hood*
- D. *provide local exhaust ventilation*

#### Proper Use of Local Ventilation Systems:

Once a local ventilation system is installed in a work area, it must be used properly to be effective. For use of hazardous chemicals warranting local ventilation controls, the following guidelines should be observed:

- A. Make certain that the hood you are using is appropriate for your work (e.g. – Biosafety cabinets are different than fume hoods: they may be vented into the room and are not designed for chemical use).
- B. Conduct all operations which may generate air contaminants at or above the appropriate PEL inside a fume hood.
- C. Keep all apparatus at least 6 inches back from the face of the hood and keep the slots in the hood baffle free of obstruction by apparatus or containers. Large equipment should be elevated at

least two inches off the base of the fume hood to allow for the passage of air underneath the apparatus.

- D. Do not use the hood as a waste disposal mechanism.
- E. Keep extraneous chemicals or apparatus out of the hood as they will create air flow disturbances. Only materials being used in an ongoing experiment should be kept in the fume hood.
- F. Keep paper and other light materials that might be drawn into the vent duct or fan out of the hood.
- G. Keep the hood sash completely closed at all times except when the hood is in use.
- H. Minimize foot traffic and other forms of potential air disturbances past the face of the hood.
- I. Do not have sources of ignition inside the hood when flammable liquids or gases are present.
- J. Use sash as a safety shield when boiling liquids or conducting an experiment with reactive chemicals.
- K. Make contingency plans in case of power failure or mechanical failure of the hood.
- L. Periodically check the airflow in the hood using a continuous monitoring device or another source of visible airflow indicator. If airflow has changed, contact the Chemical Hygiene Officer to schedule an inspection or Facilities Services for repair.

The system must be checked prior to each use to assure it is operating. **Never work with hazardous chemicals if the required ventilation system is not working.**

#### **6.2.1.3.2 Fume Hood Testing and Repair**

The college performs fume hood certifications annually. After an inspection, hoods are passed or failed for use based on the following criteria:

- A. The face velocity of air being drawn into the hood at optimal sash height is measured quantitatively in feet per minute (fpm) by an anemometer. One measurement is taken per square foot of face space and averaged. Hoods must have an average face velocity of 80-120 fpm, depending on their design, with 100 fpm being the ideal average face velocity.
- B. If the exhaust system does not pass the face velocity test it will be posted as "failed" by the inspector. The laboratory supervisor must contact Facilities Services to have the system repaired before hazardous chemicals can be used in the hood.

- C. If the exhaust system does pass, the inspector will post the date of inspection and will mark the hood to indicate proper sash position for optimum hood performance. The hood sash should be set at this point for procedures which could generate toxic aerosols, gases or vapors. In general, the sash height should be set at a level where the operator is shielded to some degree from any explosions or violent reactions which could occur and where optimum air flow dynamics are achieved. If a fume hood has no markings regarding sash height or inspection dates, please contact the chemical hygiene officer to arrange an inspection.

## **6.2.2 Personal Protective Equipment**

The SDS will provide some information on the personal protective equipment recommended for a given chemical, though the SDS may not provide sufficient information concerning the specific type of safety equipment required (for example, it may say "use gloves" but not list the best glove to use).

### **6.2.2.1 Eye Protection**

Eye protection must be made available to all employees or visitors to laboratories where chemicals are used and stored. The minimum acceptable requirements are for hardened glass or plastic safety spectacles. The laboratory supervisor should establish the level of eye protection needed per laboratory activity. American National Standards Institute (ANSI) recommends the following types of eye protection for use in the laboratory: All eye protective devices must be stamped with "Z87" by the manufacturer if they meet ANSI standards. If the eye protection is not marked, it may not be the most effective protection available.

- A. Safety glasses with side shields offer minimal protection against flying fragments, chips, particles, sand and dirt. Safety glasses should only be used only when working with solid materials. When a splash hazard exists, other protective eye equipment should be worn.
- B. Safety goggles (impact goggles) offer adequate protection against flying particles. These should be worn when working with glassware under reduced or elevated pressure or other similar conditions.
- C. Chemical splash goggles (acid goggles) have indirect venting for splash proof sides, which provide adequate protection against splashes. Chemical splash goggles offer the best eye protection from chemical splashes. Impact goggles should not be worn when danger of a splash exists.
- D. Face shields protect the face and neck from flying particles and splashes. Always wear additional appropriate eye protection under face shields.

Ultra-violet light face shields or ultra-violet light goggles should be worn when working over UV light sources.

### **6.2.2.2 Protection of Skin and Body**

Skin and body protection involves the use of protective clothing to protect individuals from chemical exposure. Use the SDS to determine clothing needed for the chemical being used, as protective garments are not equally effective for every hazardous chemical. Some chemicals will permeate a garment in a very short time, whereas others will not.

The basic and most effective forms of protection are gloves and lab coats. Avoid wearing open-toed shoes, sandals, shorts, etc. when working with hazardous chemicals. Even when there is minimal danger of skin contact with a particularly hazardous substance, lab coats, coveralls, aprons, or protective suits should be utilized. These garments should not leave the work site. Lab coats are sent out for laundering three times a year – once each semester and once over the summer.

### **6.2.2.3 Respirators**

Use of respirators in laboratories is strongly discouraged. Respirator use is only allowed where engineering controls are not feasible or where they are being installed and respirators can only be used after a medical consultation and a proper fit test, etc.

Where the use of respirators is necessary to maintain exposure below permissible exposure limits, please contact the Chemical Hygiene Officer.

## **7.0 GLOSSARY**

**ACGIH** -- The American Conference of Governmental Industrial Hygienists is a voluntary membership organization of professional industrial hygiene personnel in governmental or educational institutions. The ACGIH develops and publishes recommended occupational exposure limits each year called Threshold Limit Values (TLV's) for hundreds of chemicals, physical agents, and includes Biological Exposure Indices (BEI).

**Action Level** -- A concentration designated in 29 CFR part 1910 for a specific substance, calculated as an eight hour time-weighted average, which initiates certain required activities such as exposure monitoring and medical surveillance. The action level is usually half the PEL.

**ANSI** -- The American National Standards Institute is a voluntary membership organization (run with private funding) that develops national consensus standards for a wide variety of devices and procedures. OSHA regulations may "incorporate by reference" an ANSI standard, giving it the force of law which changes as the standard is updated.

**Bonding** -- A safety practice where the electrical potential between two containers is equalized by interconnecting the containers with clamps and wire to prevent sparks from a static discharge that can ignite flammable materials being transferred between containers.

**(C) or Ceiling** -- A description usually seen in connection with a published exposure limit. It refers to the concentration that should not be exceeded, even for an instant. It may be written as TLV-C or Threshold Limit Value--Ceiling (See also THRESHOLD LIMIT VALUE).

**Chemical Hygiene Officer (CHO)** -- An employee who is designated by the employer and who is qualified by training and 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 (CHP)** -- A written program developed and implemented by the employer which sets forth procedures, equipment, personal protective equipment and work practices that are capable of protecting employees from the health hazards presented by the hazardous chemicals used in that particular workplace.

**Code of Federal Regulations (CFR)** -- A collection of the regulations established by law. Title 29 of the CFR, Part 1910.1450 (cited as 29 CFR 1910.1450) is the rule governing "Occupational Exposures to Chemical Substances in Laboratories," better known as the "Laboratory Standard."

**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. This area may be the entire laboratory or an area under a device such as a laboratory hood.

**DOT** -- The United States Department of Transportation is the Federal agency that regulates the labeling and transportation of hazardous materials.

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

**EPA** -- The Environmental Protection Agency is the governmental agency responsible for administration of laws to control and/or reduce pollution of air, water, and land systems.

**Flash Point** -- The minimum temperature at which a liquid gives off a vapor in sufficient concentration to form an ignitable mixture with air.

**Hazard Communication Standard** – 29 CFR 1910.1200: Regulation applying to the use of hazardous materials in the workplace, other than laboratories. Cited in the Laboratory Standard as a source of record for definitions of hazardous materials.

**Hepatotoxins** -- chemicals which produce liver damage

**High Efficiency Particulate Air (HEPA) filter** -- Highly effective for the removal of sub-micron size particles. National Sanitation Foundation Standard performance test requires that penetration of dioctylphthalate particles of 0.3 micrometers diameter shall not exceed 0.01 percent.

**International Agency for Research on Cancer (IARC)** -- division of World Health Organization, Geneva, Switzerland. One of three sources that OSHA refers to for data on a material's carcinogenicity.

**Lethal Concentration<sub>50</sub>** -- The concentration of an air contaminant (LC<sub>50</sub>) that will kill 50 percent of the test animals in a group during a single exposure.

**Lethal Dose<sub>50</sub>** -- The dose of a substance or chemical (LD<sub>50</sub>) that will kill 50 percent of the test animals in a group within the first 30 days following exposure.

**Lower Explosive Limit (LEL)** (Also known as Lower Flammable Limit-LFL) -- The lowest concentration of a gas that will produce a fire or flash when an ignition source (flame, spark, etc.) is present. It is expressed in percent of vapor or gas in the air by volume. Below the LEL or LFL, the air/contaminant mixture is theoretically too "lean" to burn (See also UEL).

**Nephrotoxins** -- chemicals which produce kidney damage

**Neurotoxins** -- chemicals which produce toxic effects on the nervous system

**NFPA** -- The National Fire Protection Association is a voluntary membership organization whose aims are to promote and improve fire protection and prevention. NFPA has published 16 volumes of codes known as the National Fire Codes. Within these codes is Standard No. 704, "Identification of the Fire Hazards of Materials." This is a system that rates the hazard of a material during a fire. These hazards are divided into health, flammability, and reactivity hazards and appear in a well-known diamond system using from zero through four to indicate severity of the hazard. Zero indicates no special hazard and four indicates severe hazard. Many NFPA standards are incorporated into law by reference.

**NIOSH** -- The National Institute for Occupational Safety and Health is a Federal agency that among its various responsibilities trains occupational health and safety professionals, conducts research on health and safety concerns, and tests and certifies respirators for workplace use.



**National Toxicology Program (NTP)** -- A federal program overseen by the Department of Health and Human Services with resources from the National Institutes of Health, the Food and Drug Administration, and the Center for Disease Control. One of three sources that OSHA refers to for data on a material's carcinogenicity.

**Occupational Safety and Health Administration (OSHA)** -- A Federal agency under the Department of Labor that publishes and enforces safety and health regulations for most businesses and industries in the United States.

**Permissible Exposure Limit (PEL)** -- An exposure limit that is published and enforced by OSHA as a legal standard. PEL may be either a time-weighted-average (TWA) exposure limit (8 hour), a 15-minute short term exposure limit (STEL), or a ceiling (C). The PELs are found in Tables Z-1, Z-2, or Z-3 of OSHA regulations 1910.1000. (See also TLV).

**Personal Protective Equipment (PPE)** -- Any devices or clothing worn by the worker to protect against hazards in the environment. Examples are respirators, gloves, and chemical splash goggles.

**Recommended Exposure Limit** -- The highest allowable airborne concentration that is not expected to injure a worker, as determined by NIOSH. It may be expressed as a ceiling limit or as a time-weighted average, usually for 10-hour shifts.

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

**Safety Data Sheet (SDS)** -- As part of OSHA's Hazard Communication Standard (29 CFR 1910.1200) better known as worker right-to-know law, manufacturers and distributors are required to provide these data sheets which communicate to the end user the hazards a material presents.

**Short Term Exposure Limit** -- Represented as STEL or TLV-STEL, this is the maximum concentration to which workers can be exposed for a short period of time (15 minutes) for only four times throughout the day with at least one hour between exposures. Also, the daily TLV-TWA must not be exceeded.

**"Skin"** -- This designation sometimes appears alongside a TLV or PEL. It refers to the possibility of absorption of the particular chemical through the skin and eyes. Thus, protection of large surface areas of skin should be considered to prevent skin absorption so that the TLV is not invalidated.

**Teratogen** -- An agent or substance that may cause physical defects in the developing embryo or fetus when a pregnant female is exposed to that substance.

**Threshold Limit Value** -- Airborne concentrations of substances devised by the ACGIH that represents conditions under which it is believed that nearly all workers may be exposed day after day with no adverse effect. TLV's are advisory exposure guidelines, not legal standards, which are based on evidence from industrial experience, animal studies, or human studies when they exist. There are three different types of TLV's: Time Weighted Average (TLV-TWA), Short Term Exposure Limit (TLV-STEL) and Ceiling (TLV-C). (See also PEL).

**Time Weighted Average** -- The average time, over a given work period (e.g. 8-hour workday) of a person's exposure to a chemical or an agent. The average is determined by sampling for the contaminant throughout the time period. Represented as TLV-TWA.

**Upper Explosive Limit** -- Also known as Upper Flammable Limit, is the highest concentration (expressed in percent of vapor or gas in the air by volume) of a substance that will burn or explode when an ignition source is present. Theoretically, above this limit the mixture is said to be too "rich" to support combustion. The difference between the LEL and the UEL constitutes the flammable range or explosive range of a substance. That is, if the LEL is 1ppm and the UEL is 5ppm, then the explosive range of the chemical is 1ppm to 5ppm. (See also LEL).

## Appendix A

### Guidelines for Use of Peroxide Forming Chemicals

Many laboratory chemicals are prone to the formation of explosive peroxides under normal usage. Opinions vary regarding the level at which peroxide formation poses a risk: while a maximum concentration of 100 ppm is widely accepted among industrial hygienists, OSHA has no published guidelines for the storage, use, and disposal of peroxidizable chemicals. To ensure the safety of Colorado College employees, the following guidelines have been established with regards to peroxide forming chemicals.

#### Purchase

Peroxidizable compounds should be purchased in quantities which can be exhausted within the time indicated in Table A. Container sizes should be selected according to use requirements so that exposure to air is minimized through reduced container openings.

**Table A: Safe Storage for Peroxide Forming Chemicals**

<b>Description</b>	<b>Safe Storage Period</b>
Unopened Chemicals from Manufacturer	18 months
Opened Containers:	
Chemicals in List A	3 months
Chemicals in List B and D	12 months
Uninhibited Chemicals in List C	24 hours
Inhibited Chemicals in List C	12 months

#### Labeling

All peroxidizable materials in Lists A—D must have a label containing the date received from the manufacturer and the date opened. Additionally, labels must state, "PEROXIDIZABLE COMPOUND: DISCARD OR TEST WITHIN XX MONTHS AFTER OPENING," where XX is the safe storage period from Table A. Labels should be in red print on a white background.

#### Storage

All peroxidizable compounds should be stored away from heat and light. All containers must have tight closures to prevent air exposure, evaporation and concentration of peroxides.

## Safe Handling

Test for peroxides before distilling or evaporating any List A or B material. Before distilling any List C material, a suitable polymerization inhibitor must be added. During distillation, addition of a high molecular weight inerting solvent, such as mineral oil or a phthalate ester will dilute residual peroxides when distillation is complete. Should such a diluent be undesirable, distill to not less than 10%. NEVER distill to a dry residue. Safety glasses and a face shield should be used when evaporating or distilling mixtures that contain peroxidizable compounds.

## Disposal

All peroxidizable compounds from Lists A—D will be tested for peroxide levels and removed from the inventory if necessary when the safe storage period expires. This includes unopened chemicals after 18 months of storage. All peroxidizable compounds suspected of having high peroxide levels, because of visual observation of unusual viscosity or crystal formation, or because of age, should be considered extremely dangerous. DO NOT attempt to open these containers as peroxide crystals around the container cap could detonate. Contact the Environmental Health & Safety Office at 389-6678 for assistance.

## References

1. Recognition and Handling of Peroxidizable Compounds; Data Sheet 655; National Safety Council: Chicago, IL, 1987
2. Kelly, Richard J., Review of Safety Guidelines for Peroxidizable Organic Chemicals, Chemical Health & Safety, American Chemical Society, Sept/Oct. 1996.
3. Furr, Keith, Handbook of Lab Safety, 4th ed., CRC Press, 1995.

## Classes of Peroxidizable Chemicals

List A: Chemicals that form explosive peroxides without concentration

Butadiene (liquid monomer)	Isopropyl ether
Chloroprene (liquid monomer)	Tetrafluoroethylene (liquid monomer)
Divinylacetylene	Vinylidene chloride

List B: Chemicals that form explosive peroxides on concentration

Acetal	2-Hexanol
Acetaldehyde	Methylacetylene
Benzyl alcohol	3-methyl-1-butanol
2-Butanol	Methylcyclopentane
Cumene	Methyl isobutyl ketone
Cyclohexanol	4-methyl-2-pentanol
2-Cyclohexen-1-ol	2-Penten-1-ol
Cyclohexene	4-Penten-1-ol
Decahydronaphthalene	1-Phenylethanol
Diacetylene	2-Phenylethanol
Dicyclopentadiene	Tetrahydrofuran
Diethyl ether	Tetrahydronaphthalene
Diethylene glycol dimethyl ether (diglyme)	Vinyl ethers
Dioxanes	Other Secondary Alcohols
Ethylene glycol dimethyl ether (glyme)	
4-Heptanol	

List C: Chemicals that may autopolymerize as a result of peroxide accumulation

Acrylic acid <sup>1</sup>	Tetrafluoroethylene
Acrylonitrile <sup>1</sup>	Vinyl acetate
Butadiene	Vinylacetylene
Chloroprene	Vinyl chloride
Chlorotrifluoroethylene	Vinylpyridine
Methyl methacrylate <sup>1</sup>	Vinylidene chloride
Styrene	

1 - Although these chemicals form peroxides, there are no reported explosions.

List D: Chemicals that may form peroxides but cannot clearly be placed in List A—C

Acrolein	1,2-Epoxy-3-isopropoxypropane <sup>2</sup>
Allyl ether <sup>2</sup>	1,2-Epoxy-3-phenoxypropane
Allyl ethyl ether	Ethoxyacetophenone
Allyl phenyl ether	1-(2-Ethoxyethoxy)ethyl acetate
p-(n-Amyloxy)benzoyl chloride	2-Ethoxyethyl acetate
n-Amyl ether	(2-ethoxyethyl)-o-benzoylbenzoate

Benzyl n-butyl ether	1-Ethoxynaphthalene
Benzyl ether	Ethoxyphenyl isocyanate
Benzyl ethyl ether	1-ethoxy-2-propyne
Benzyl methyl ether	3-ethoxypropionitrile
Benzyl 1-naphthyl ether <sup>2</sup>	2-ethylacrylaldehyde oxime
1,2-Bis(2-chloroethoxy)ethane	2-ethylbutanol
Bis(2-ethoxyethyl) ether	Ethyl ethoxypropionate
Bis(2-methoxyethoxy)ethyl) ether	2-ethyl hexanal
Bis(2-chloroethyl) ether	Ethyl vinyl ether
Bis(2-ethoxyethyl) adipate	Furan p-phenylphenetone
Bis(2-ethoxyethyl) phthalate	2,5-hexadiyn-1-ol
Bis(2-methoxyethyl) carbonate	4,5-hexadien-2-yn-1-ol
Bis(2-methoxyethyl) ether	n-hexyl ether
Bis(2-methoxyethyl) phthalate	Iodophenetole
Bis(2-methoxymethyl) adipate	Isoamyl ether <sup>2</sup>
Bis(2-n-butoxyethyl) phthalate	Isobutyl vinyl ether
Bis(2-phenoxyethyl) ether	Isophorone <sup>2</sup>
Bis(4-chlorobutyl) ether	p-isopropoxypropionitrile <sup>2</sup>
Bis(chloromethyl) ether	Isopropyl 2,4,5-trichlorophenoxyacetate
2-bromomethyl ethyl ether	Limonene
Bromophenetole	1,5-p-methadiene
3-bromopropyl phenyl ether	Methyl p-(n-amyloxy)benzoate
1,3-butadiyne	4-methyl-2-pentanone
Buten-3-yne	n-methylphenetole
Tert-butyl ethyl ether	2-methyltetrahydrofuran
Tert-butyl methyl ether	3-methoxy-1-butyl acetate
n-butyl phenyl ether	2-methoxyethanol
n-butyl vinyl ether	3-methoxyethyl acetate
Chloroacetaldehyde diethylacetal <sup>2</sup>	2-methoxyethyl vinyl ether
2-chlorobutadiene	Methoxy-1,3,5,7-cyclooctatetraene
1-(2-chloroethoxy)-2-phenoxyethane	Methoxypropionitrile
Chloroethylene	m-Nitrophenentole
Chloromethyl methyl ether	1-Octene
Chlorophenetole	Oxybis(2-ethyl acetate)
Cyclooctene <sup>2</sup>	Oxybis(2-ethyl benzoate)
Cylcopropyl methyl ether	Oxydipropionitrile
Diallyl ether <sup>2</sup>	1-Pentene
p-Di-n-butoxybenzene	Phenoxyacetyl chloride
1,2-dibenzyloxyethane <sup>2</sup>	Phenoxypropionyl chloride
p-Dibenzyloxybenze <sup>2</sup>	Phenyl o-propyl ether
1,2-dichloroethyl ethyl ether	n-propyl ether
2,4-dichlorophenetole	n-propyl isopropyl ether

Diethoxymethane <sup>2</sup>	Sodium 8,11,14-eicosatetraenoate
2,2-Diethoxypropane	Sodium ethoxyacetylide
Diethylethoxymethylenemalonate	Tetrahydropyran
Diethyl fumarate	Triethylene glycol diacetate
Diethyl acetal <sup>2</sup>	Triethylene glycol dipropionate
Diethylketene	1,3,3-trimethoxypropene <sup>2</sup>
Diethoxybenzene	1,1,2,3-tetrachloro-1,3-butadiene
1,2-Diethoxyethane	4-vinyl cyclohexene
Dimethoxymethane <sup>2</sup>	Vinylencarbonate
1,1-Dimethoxyethane <sup>2</sup>	Vinylidene chloride <sup>2</sup>
Dimethylketene	
3,3-Dimethoxypropene	
2,4-Dinitrophenetole	
1,3-Dioxepane <sup>2</sup>	
Di(1-propynyl) ether	
Di(2-propynyl) ether	
Di-n-propoxymethane <sup>2</sup>	

2 - These chemicals easily form peroxides and should probably be considered under List B