# CHEMICAL HYGIENE PLAN
# AND HAZARDOUS MATERIALS SAFETY MANUAL
# CENTER FOR HEALTH SCIENCES AT LOWRY

COMMUNITY COLLEGE OF DENVER

**Created on:**

**October 1, 2014**

**This is the Chemical Hygiene Plan specific to the following areas:**

Buildings: 1070 Alton Way, Building 849
1062 Akron Way, Building 753

Dean/Director: Stephanie Harrison, Dean, Health Sciences
Dr. Michelle Kohler, Chair/Director Dental Hygiene

Department: Center for Health Sciences

**Telephone Numbers**

- 911 ................................Emergency (Dial directly from any Lowry campus phone.)
- 303-419-5557................Lowry Campus Security Office
- 303-556-5000................Auraria Campus Police Department
- 720-913-3473................Denver Fire Department
- 303-326-8999……………Aurora Fire Department
- 303-352-3053................Community College of Denver Facilities Director (Office)
- 720-235-2844................Community College of Denver Facilities Director (Mobile)

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## Chapter 1
## Introduction

Laboratory safety is an integral part of laboratory work and is essential to ensure that Community College of Denver's (College or CCD) compliance with all applicable environmental, health and safety laws, regulations and requirements are met. The risks associated with laboratory work (workplace injuries, environmental incidents, and property losses or damage) are greatly reduced or eliminated when proper precautions and practices are observed in the laboratory. To better manage and mitigate these risks, the College has developed the Chemical Hygiene Plan (CHP), which is intended to be the cornerstone of your laboratory safety program and is designed to aid faculty, staff, and students in maintaining a safe environment in which to teach and conduct labs. Each laboratory using hazardous materials is required to have a copy of the CHP readily available to all laboratory personnel. Each laboratory worker must be familiar with the contents of the CHP and the procedures for obtaining additional safety information needed to perform their duties safely.

### 1.1 Purpose

The College is committed to providing a healthy and safe work environment for the campus community. The College's CHP establishes a formal written program for protecting laboratory personnel against health and safety hazards associated with exposure to hazardous chemicals and must be made available to all employees working with hazardous chemicals in a laboratory setting. The CHP describes the proper use and handling procedures to be followed by faculty, staff, and all other personnel working with hazardous chemicals in laboratory settings.

### 1.2 Scope

The CHP applies to all laboratories that use, store, or handle hazardous chemicals and all personnel who work in these facilities. The information presented in the CHP represents best practices and provides a broad overview of the information necessary for the safe operation of laboratories that utilize hazardous chemicals. Laboratory use of hazardous chemicals is defined as handling or use of such chemicals in which all of the following conditions are met:

- Chemical manipulations are carried out on a laboratory scale;
- Multiple chemical procedures or chemicals are used;
- The procedures involved are not part of a production process, nor in any way simulate a production process; and,

- Protective laboratory practices and equipment are made available and in common use to minimize the potential for employee exposure to hazardous chemicals.

The CHP was prepared in accordance with the requirements of the Occupational Safety and Health Administration (OSHA) Occupational Exposure to Hazardous Chemicals in Laboratories Standard (Lab Standard) found in 29 CFR 1910.1450, and is based on best practices identified in, among other sources, the “Global Harmonized System of Classification and Labeling of Chemicals”; “Prudent Practices for Handling Hazardous Chemicals in Laboratories”, published by the National Research Council, the American Chemistry Society Task Force on Laboratory Chemical and Waste Management’s “Laboratory Waste Management, A Guidebook”; the Princeton University “Laboratory Safety Manual”; and the University of California – Los Angeles “Chemical Hygiene Plan”.

### 1.3 CHP Use Instructions

The information presented in the CHP represents best practices and provides a broad overview of the information necessary for the safe operation of laboratories that utilize hazardous chemicals. It is not intended to be all inclusive. Departments engaged in work with hazardous chemicals or hazardous operations that are not sufficiently covered by the CHP must customize this document by adding appropriate sections, in the form of standard operating procedures (SOPs), hazard assessments, and any other written lab-specific operating procedures that address the hazards and how to mitigate risks.

### 1.4 Employee Rights and Responsibilities

As part of the OSHA Laboratory Standard, employees and other personnel who work in laboratories have the right to be informed about the potential hazards of the chemicals in their work areas and to be properly trained to work safely with these substances. This includes custodial and maintenance personnel (support staff) who work to maintain laboratories. All personnel, including principal investigators, laboratory supervisors, laboratory technicians, student workers, and support staff have a responsibility to maintain a safe work environment. All personnel working with chemicals are responsible for staying informed on the chemicals in their work areas, safe work practices and SOPs, and proper personal protective equipment (PPE) required for the safe performance of their laboratory work.

#### 1.4.1 Laboratory Supervisor Responsibilities

The Laboratory Supervisor is the individual that is ultimately responsible for the overall laboratory operation, including the lab safety program and ensuring that the requirements of the CHP are followed by all staff members that work in the lab. The Laboratory Supervisor may delegate some safety duties to a qualified individual, but ultimately remains responsible for the safety of all personnel working in the laboratory. Specifically, the Laboratory Supervisor must:

- Understand applicable environmental health and safety rules, including the contents of the CHP;
- Identify hazardous conditions or operations in the laboratory and establish SOPs and hazard assessments to effectively control or reduce hazards;
- Ensure that all laboratory personnel that work with hazardous chemicals receive appropriate training;
- Maintain written records of laboratory-specific training (e.g., PPE training);
- Ensure that appropriate PPE (e.g., laboratory coats, gloves, eye protection, etc.,) and engineering control equipment (e.g., chemical fume hood) are made available, in good working order, and being used properly;
- Conduct periodic lab inspections and immediately take steps to abate hazards that may pose a risk to life or safety upon discovery of such hazards; and,
- Actively enforce all applicable safety procedures and ensure that the CHP is followed by lab staff and all visitors, including having a progressive disciplinary process for lab staff members that do not comply with safety rules.

Laboratory Supervisors must ensure that employees receive CHP training and information before any work with hazardous materials occurs. Laboratory Supervisors must also ensure that all employees receive annual CHP refresher training. The Laboratory Supervisor can provide the training or delegate this task to a qualified individual (e.g., Laboratory Safety Officer, senior lab employee). The CHP training must be documented. Failure to follow the requirements of the CHP could possibly result in injuries, fines from regulatory agencies such as OSHA, and/or disciplinary action.

#### 1.4.2 Laboratory Employee Responsibilities

All employees (e.g., lab technicians, students, faculty and staff) in laboratories that use, handle, or store hazardous chemicals must:

- Review and follow the requirements of the CHP;
- Follow all verbal and written laboratory safety rules, regulations, and SOPs required for the tasks assigned;
- Develop and practice good personal chemical hygiene habits such keeping work areas clean and uncluttered;

- Plan, review, and understand the hazards of materials and processes in the laboratory prior to conducting work;
- Utilize appropriate measures to control hazards, including consistent and proper use of engineering controls, administrative controls, and PPE;
- Understand the capabilities and limitations of PPE;
- Immediately report all accidents, near misses, and unsafe conditions to the laboratory supervisor;
- Complete all required safety training and provide written documentation to the laboratory supervisor; and,
- Inform the Laboratory Supervisor of any work modifications ordered by a physician as a result of medical surveillance, occupational injury, or chemical exposure.

### 1.4.3 Non-Laboratory Personnel/ Support Staff Responsibilities

Custodians and maintenance staff (support staff) often must enter laboratories to perform routine tasks such as cleaning and equipment maintenance. Support staff members are expected to follow the posted safety rules of each laboratory. There may be PPE requirements for support staff working in a laboratory, such as safety glasses, long pants, and closed-toe shoes. If additional PPE is required or if other unique safety requirements must be followed, it is the lab personnel's responsibility to notify support staff.

### 1.4.4 Chemical Hygiene Officer Responsibilities

The Chemical Hygiene Officer has the primary responsibility for ensuring the implementation of all components of the CHP. The Chemical Hygiene Officer must:

- Inform Laboratory Supervisors of all health and safety requirements and assist with the selection of appropriate safety controls (engineering controls, administrative controls, and PPE);
- Ensure that Laboratory Supervisors have the necessary resources to maintain compliance with the CHP and that all lab staff receive appropriate training;
- Act as the liaison between the laboratory personnel and the Auraria Laboratory Safety Committee;
- Conduct periodic lab inspections and immediately take steps to abate hazards that may pose a risk to life or safety upon discovery of such hazards;
- Ensure that SOPs and hazard assessments are being prepared;
- Maintain employee exposure-monitoring records, when applicable;

- Help to develop and implement appropriate environmental health and safety policies and procedures;
- Review and evaluate the effectiveness of the CHP program at least annually and update it as appropriate; and,
- Actively enforce all applicable safety procedures and ensure the contents of the CHP are followed; take appropriate actions when safety procedures are not followed.

### 1.5 Chemical and Laboratory Safety Committee

The Lowry Campus will establish a Laboratory Safety Committee (LSC) with the responsibility to promote safe and proper chemical management. Chemical management includes, but is not limited to, the procurement and the safe handling, use, storage, and disposal of chemicals. The LSC reviews lab safety programs and makes recommendations as appropriate. The LSC consists of lab coordinators and other pertinent lab personnel who handle or use chemicals.

## Chapter 2
## Chemical Classification Systems

Chemical classification systems are designed to communicate hazards. The three (3) most widely used classification systems are the OSHA Globally Harmonized System (GHS) for Classifying and Labeling Chemicals (recently adopted and implemented under the OSHA Hazard Communication Standard), the National Fire Protection Association (NFPA) system of classifying the severity of hazards, and the Department of Transportation (DOT) hazard classes. These classification systems are used by chemical manufacturers when creating safety data sheets and chemical labels, therefore it is important that CCD lab employees understand the basic elements of each classification system.

### 2.1 Globally Harmonized System for Classifying Chemicals

The GHS is a world-wide system adopted by OSHA for standardizing and harmonizing the classification and labeling of chemicals. The objectives of the GHS are to:

- Define health, physical, and environmental hazards of chemicals;
- Create classification processes that use available data on chemicals for comparison with the defined hazard criteria (numerical hazard classification is based on a 1 – 5 scale, 1 being the most hazardous and 5 being the least hazardous); and,
- Communicate hazard information, as well as protective measures, on labels and Safety Data Sheet (SDS), formerly known as Material Safety Data Sheets (MSDS).

#### 2.1.1 Safety Data Sheets

The SDS provides comprehensive information that is imperative for the safe handling of hazardous chemicals. Laboratory personnel should use the SDS as a resource to obtain information about hazards and safety precautions. SDSs cannot provide information for hazards in all circumstances. However, the SDS information enables the employer to develop an active program of worker protection measures such as training on hazard mitigation. Chemical manufacturers are required to use a standard format when developing SDSs. The SDS will contain 16 headings which are illustrated in Figure 2.1.

| **Figure 2.1- GHS Required Sections of a Safety Data Sheet** | | | |
|---|---|---|---|
| 1 | Identification of the substance or mixture and of supplier | 9 | Physical and chemical properties |
| 2 | | 10 | Stability and reactivity |

| Figure 2.1- GHS Required Sections of a Safety Data Sheet | | | |
|---|---|---|---|
| 3 | Composition/information on ingredients | 11 | Toxicological information |
| 4 | Frist aid measures | 12 | Ecological information |
| 5 | Firefighting measures | 13 | Disposal considerations |
| 6 | Accidental release measures | 14 | Transport considerations |
| 7 | Handling and storage | 15 | Regulatory information |
| 8 | Exposure controls/personal protection | 16 | Other information |

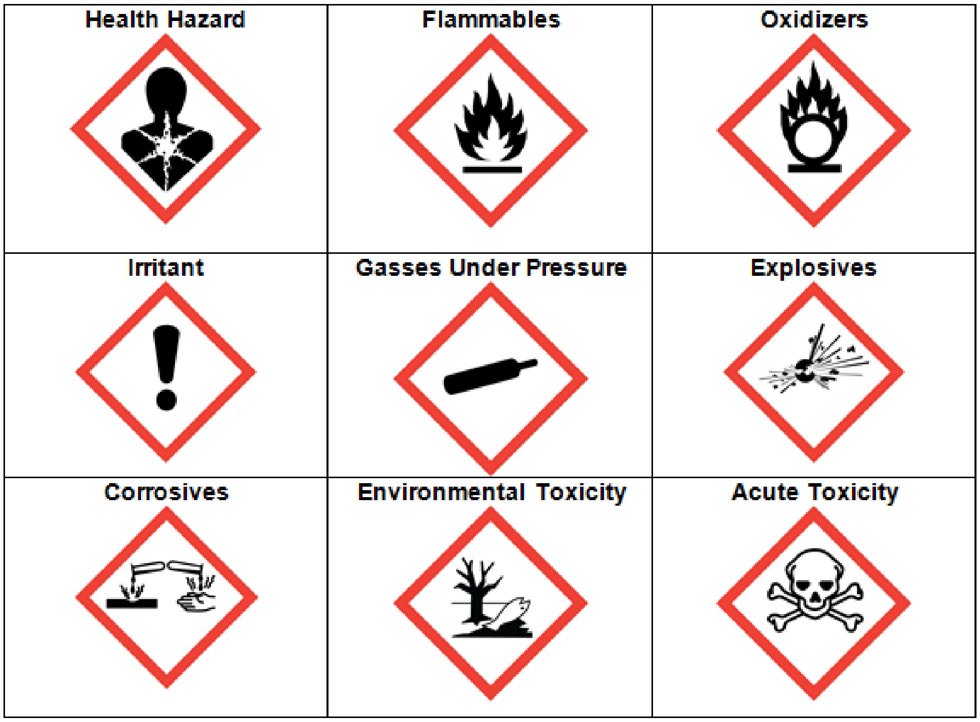
### 2.1.2 Chemical Labeling

The GHS standardized label elements, which are not subject to variation and must appear on the chemical label, contain the following elements:

- Symbols (hazard pictograms) are used to convey health, physical and environmental hazard information, assigned to a GHS hazard class and category;
- Signal Words such as “Danger" (for more severe hazards) or "Warning" (for less severe hazards), are used to emphasize hazards and indicate the relative level of severity of the hazard assigned to a GHS hazard class and category;
- Hazard statements (e.g., “Danger! Extremely Flammable Liquid and Vapor”) are standard phrases assigned to a hazard class and category that describe the nature of the hazard; and,
- Precautionary statements are recommended measures that should be taken to minimize or prevent adverse effects resulting from exposure to the hazardous chemical.

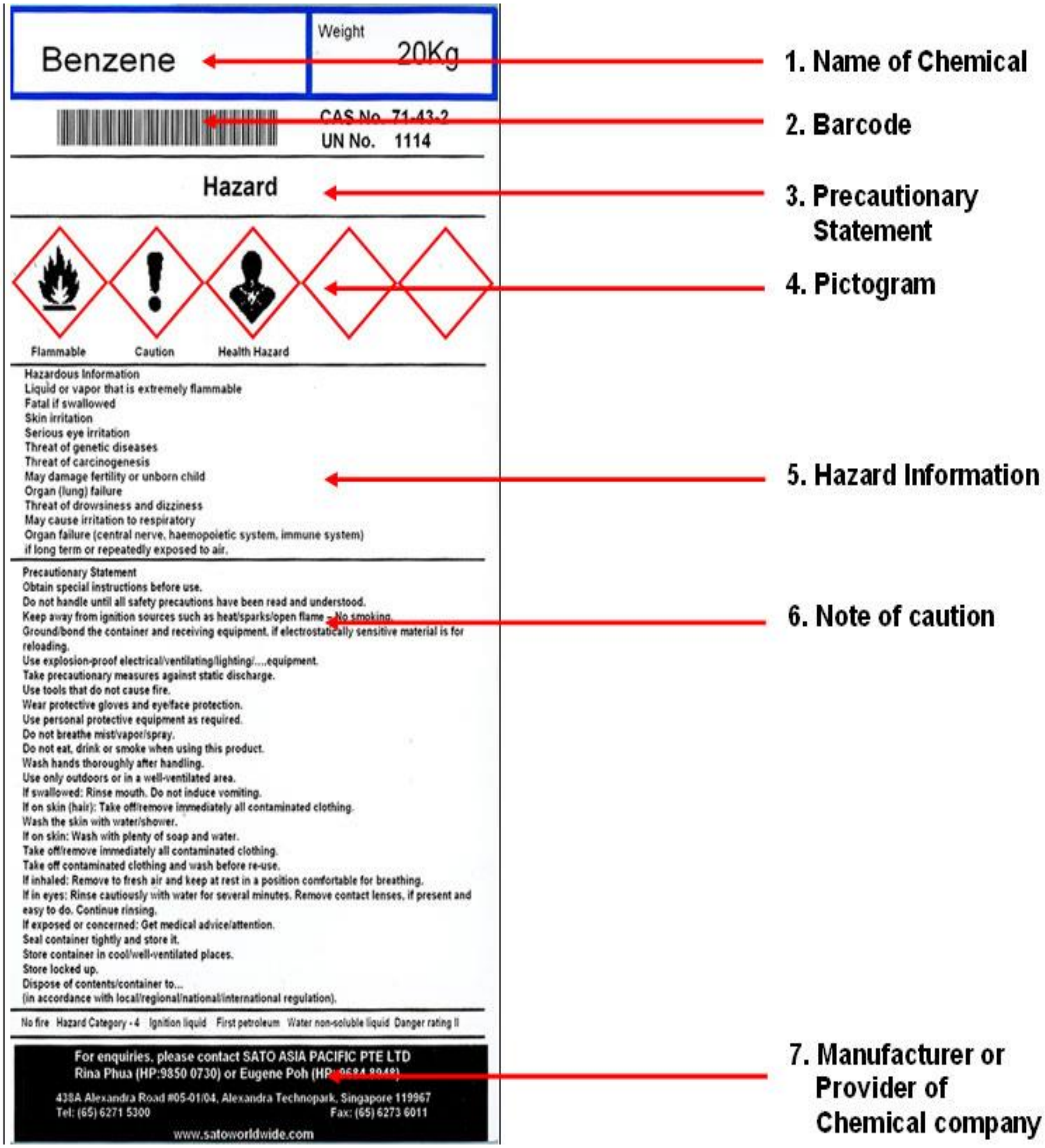
**GHS also standardizes the hazard pictograms that are to be used on all hazard labels and SDSs. There are nine (9) pictograms that represent several defined hazards, and include the harmonized hazard symbols which are intended to convey specific information about each hazard. Figure 2.2 illustrates these GHS hazard pictograms.**

**Figure 2.2 – GHS Hazard Pictograms**




GHS labeling requirements are only applicable to chemical manufacturers, distributors, and shippers of chemicals. GHS labeling requirements are not required for chemicals being stored in a laboratory. However, since most chemicals stored in the laboratory have been purchased from a chemical manufacturer, the GHS labeling and pictogram requirements are very relevant and must be understood by laboratory employees. Figure 2.3 illustrates the GHS label format showing the required elements.

**Figure 2.3 – GHS Label Format**

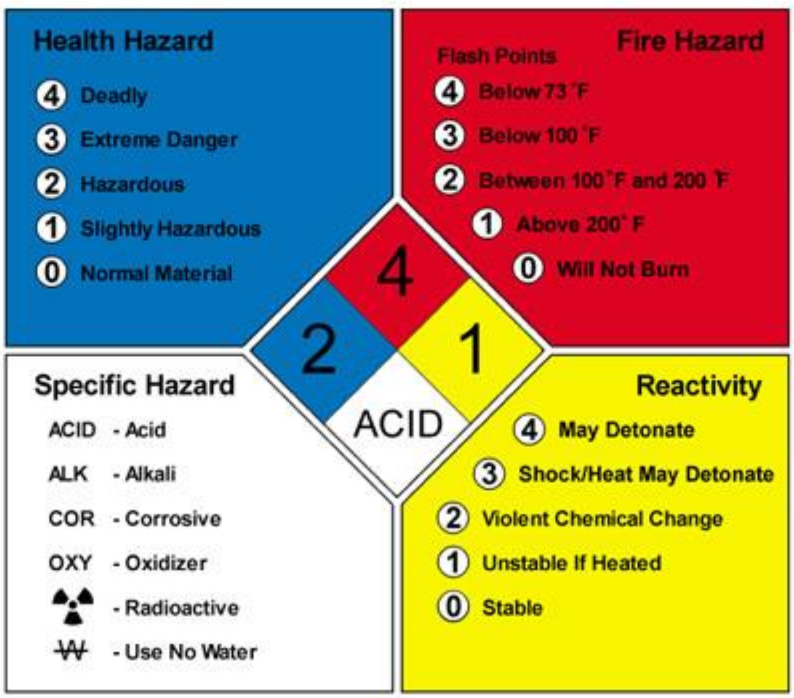



As mentioned earlier, one of the objectives of GHS was to create a quantitative hazard classification system (numerical hazard classification is based on a 1 – 5 scale, 1 being the most hazardous and 5 being the least hazardous) based on physical characteristics such as flash point, boiling point, lethal dose of 50% of a population (LD50), reactivity, etc.  More detailed information on GHS can be found on the OSHA website (https://www.osha.gov/dsg/hazcom/ghs.html).

## 2.2 National Fire Protection Association Rating System

The NFPA system uses a diamond-shaped diagram of symbols and numbers to indicate the degree of hazard associated with a particular chemical. This system was created to easily and quickly communicate hazards to first responders in the event of an emergency situation. These diamond-shaped symbols are placed on chemical containers to identify the degree of hazard associated with the specific chemical or chemical mixture. The NFPA system is a common way to identify chemical hazards and should be understood by laboratory employees. The NFPA 704 numerical rating system is based on a 0 – 4 system; 0 meaning no hazard and 4 meaning the most hazardous (note: this in contrast to the GHS system where 1 is the most hazardous and 4 is the least hazardous). Figure 2.4 illustrates the NFPA hazard rating system and identifies both the hazard categories and hazard rating system.

**Figure 2.4- NFPA Hazard Rating System**



## Chapter 3
## Classes of Hazardous Chemicals

Chemicals can be divided into several different hazard classes. The hazard class provides information to help determine how a chemical can be safely stored and handled. Each chemical container, whether supplied by a chemical manufacturer or produced in the laboratory, must have a label that clearly identifies the chemical constituents. In addition to a specific chemical label, more comprehensive hazard information can be found by referencing the SDS for that chemical. The OSHA Laboratory Standard defines a hazardous chemical as any element, chemical compound, or mixture of elements and/or compounds which is a physical or health hazard. This definition of a hazardous chemical and the GHS primary classes of chemicals are briefly discussed below.

### 3.1 Physical Hazards

A chemical is a physical hazard if there is scientifically valid evidence that it is flammable, combustible, compressed gas, explosive, organic peroxide, oxidizer, pyrophoric, self-heating, self-reactive, or water-reactive. Each physical hazard is briefly defined below.

- **Explosives:** A liquid or solid which is in itself capable by chemical reaction of producing gas at such a temperature and pressure and at such a speed as to cause damage to the surroundings.
- **Flammable Liquids:** Materials which under standard conditions can generate sufficient vapor to cause a fire in the presence of an ignition source and have a flash point no greater than 93 °C (200 °F).
- **Flammable Solid:** A solid which is readily combustible, or may cause or contribute to a fire through friction.
- **Gases under Pressure:** Gases which are contained in a receptacle at a pressure not less than 280 kPA at 20 °C or as a refrigerated liquid.
- **Organic Peroxide:** A liquid or solid which contains the bivalent -0-0- structure and may be considered a derivative of hydrogen peroxide, where one or both of the hydrogen atoms have been replaced by organic radicals.
- **Oxidizer:** A liquid or solid, while in itself is not necessarily combustible, may generally by yielding oxygen, cause or contribute to the combustion of other material.
- **Pyrophoric Substance (also called Spontaneously Combustible):** A liquid or solid that even in small quantities and without an external ignition source can ignite after coming in contact with the air.
- **Self-Heating Substance:** A liquid or solid, other than a pyrophoric substance, which, by reaction with air and without energy supply, is liable to self-heat.

- **Self-Reactive Substance:** A liquid or solid that is liable to undergo strong exothermic thermal decomposition even without participation of oxygen (air).
- **Water-Reactive Substance:** A liquid or solid that reacts violently with water to produce a flammable or toxic gas, or other hazardous conditions.

### 3.2 Health Hazards

A chemical is a health hazard if there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. Each health hazard is briefly defined below.

- **Carcinogens:** Substances that cause cancer. Generally they are chronically toxic substances; that is, they cause damage after repeated or long-duration exposure, and their effects may only become evident after a long latency period. Carcinogens are separated into two classes: select carcinogens and regulated carcinogens.
- **Corrosives:** Substances that cause destruction of living tissue by chemical corrosion at the site of contact and can be either acidic or caustic/basic.
- **Hazardous Substances with Toxic Effects on Specific Organs:** Substances that pose adverse health effects to specific organs such as the liver, kidneys, lungs, etc.
- **High Acute Toxicity Substances:** Substances that may be fatal or cause damage to target organs as the result of a single exposure or exposures of short duration. Acute toxins are quantified by a substance's lethal dose-50 (LD50) or lethal concentration-50 (LC50), which is the lethal dose of a compound to 50% of a laboratory tested animal population (e.g., rats, rabbits) over a specified time period.
- **Irritant:** Substances that cause reversible inflammatory effects on living tissue by chemical action at the site of contact.
- **Reproductive Toxins:** Substances that may affect the reproductive capabilities, including chromosomal damage (mutations) and effects on fetuses (teratogens).
- **Sensitizer (also called allergen):** A substance that causes exposed individuals to develop an allergic reaction in normal tissue after repeated exposure to the substance.

# Chapter 4
# Laboratory Safety Controls

Laboratory safety controls include engineering controls, administrative controls, and PPE. Elements of these three categories should be used in a layered approach to minimize employee exposure to hazardous chemicals. The hierarchy of controls prioritizes hazard mitigation strategies on the premise that the best way to control a hazard is to systematically eliminate it from the workplace or substitute a less hazardous technique, process, or material. If elimination or substitutions are not feasible options, administrative controls, engineering controls, and PPE must be used to provide the necessary protection. The laboratory employee's responsibility is to follow administrative controls, use engineering controls, and wear PPE correctly and effectively.

## 4.1 Routes of Exposure

There are four (4) primary routes of exposure in which hazardous substances can enter the body: inhalation, absorption, ingestion, and injection. Of these, the most likely routes of exposure in the laboratory are by inhalation and/or skin absorption. Many hazardous chemicals may affect people through more than one of these exposure modes, so it is critical that protective measures are in place for each of these exposure routes.

## 4.2 Engineering Controls and Safety Equipment

Exposure to hazardous materials must be controlled to the greatest extent feasible by use of engineering controls. Engineering controls to reduce or eliminate exposures to hazardous chemicals include:

- Substitution with less hazardous equipment, chemicals, or processes (e.g., safety cans for glass bottles);
- Isolation of the operator or the process (e.g., use of a glove box when handling air- or water-sensitive chemicals); and,
- Use of forced ventilation systems (e.g., chemical fume hood, biological safety cabinet).

### 4.2.1 Chemical Fume Hoods

A chemical fume hood is a type of local ventilation installation that is designed to limit exposure to hazardous or toxic fumes, vapors, or dusts. To determine if a chemical is required to be used inside of a chemical fume hood, first check the SDS for that chemical. Statements found in Section 2 on a SDS such as "do not breathe dust, fumes, or vapors" or "toxic by inhalation" indicate the need for ventilation. As a best practice, always use a chemical fume hood for all work involving the handling of open chemicals (e.g., preparing solutions) whenever possible. If a chemical fume hood is required or recommended to be used, the following guidelines must be followed at all times:

- Chemical fume hoods must be marked to indicate the proper sash position for optimum hood performance as illustrated in Figure 4.1.
- The chemical fume hood sash should be positioned at this height whenever working with hazardous chemicals that 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 splashes, explosions, or other violent reactions which could occur and where optimum air flow dynamics are achieved.
- Most chemical fume hoods are not intended to be used with the sash fully open. The sash should only be fully opened to add or remove equipment from the chemical fume hood.
- Chemical fume hoods must be equipped with a continuous reading monitoring device to indicate adequacy of flow. All lab employees must know how to read and interpret this gauge and check that the chemical fume hood is operating properly before using hazardous chemicals in the fume hood.
- Only apparatus and chemicals essential to the specific procedure or process should be placed in the chemical fume hood. Extraneous materials from previous experiments should be removed and stored in a safe location outside the chemical fume hood.
- Chemical fume hoods used for laboratory work should not be used for chemical or material storage. Chemical fume hoods used for chemical storage should be dedicated to chemical storage. No laboratory work should be conducted in storage chemical fume hoods.
- All chemical containers used in chemical fume hoods, including secondary containers (e.g., beakers, flasks, reaction vessels, vials, etc.) must be labeled. Reaction vessels in chemical fume hoods must be labeled as well.
- Do not allow the vents or air flow baffles to be blocked.
- Never put your head inside of an operating chemical fume hood.

Figure 4.1- Chemical Fume Hood Sash Approved Working Height


### 4.2.2 Safety Showers and Eyewash Stations

All laboratories using hazardous chemicals must have immediate access to safety showers and eye wash stations. Safety showers must have a minimum clearance of 24 inches from the centerline of the spray pattern in all directions at all times. Identify the safety station with a highly visible sign and maintain an unobstructed path to it. All lab personnel must be aware of the location and know how to properly use the safety shower and eyewash stations. If lab personnel are exposed to a hazardous chemical, they should dial 911 from a campus phone (or someone else in the lab that is not exposed should dial 911 from a campus phone) or dial 303-556-5000 from a mobile phone and use the safety shower and/or eye wash unit for 15 minutes or until emergency response have personnel arrive and begin treatment. If an uninjured individual is present, this person should assist with the decontamination of the affected individual.

All eyewash stations should be flushed by laboratory personnel on a monthly basis to ensure proper working order. This will keep the system free of sediment and prevent bacterial growth from reducing performance. Lowry performs annual inspections of all campus safety shower and eyewash stations. This inspection evaluates the basic mechanical functionality of each station. If the safety shower or eye wash unit becomes inoperable, notify your facilities maintenance immediately.

#### 4.2.3 Fire Extinguishers

All fire extinguishers should be mounted on a wall in an area free of clutter. Each fire extinguisher on campus is inspected on an annual basis by the Lowry personnel. All laboratory personnel should be familiar with the location, use, and classification of the extinguishers in their laboratory. Ensure that the fire extinguisher being used is appropriate for the type of material on fire before attempting to extinguish any fire. Laboratory personnel are not required to extinguish fires that occur in their work areas and should not attempt to do so unless:

- It is a small, contained fire that can be quickly and safely extinguished (e.g., small trash can sized fire);
- Appropriate training has been received and the individual feels the fire can be safely extinguished; and,
- It is necessary to extinguish a fire in order to exit an area (e.g., fire is blocking an exit).

If a fire occurs in the laboratory and is extinguished by lab personnel, Campus Security (303-419-5557) and the Lowry Director of Facilities (720-858-2723) must be contacted immediately.

### 4.3 Administrative Controls

Administrative controls are procedural measures which can be taken to reduce or eliminate hazards associated with the use of hazardous materials. Administrative controls include the following:

- Ensuring that employees are provided adequate documented training for safe work with hazardous materials.
- Careful planning of experiments and procedures with safety in mind. Planning includes the development of written SOPs and hazard assessments for safe performance of the work.
- Restricting access to areas where hazardous materials are used.
- Using safety signs or placards to identify hazardous areas (designated areas).
- Labeling all chemicals.
- Substitution of toxic materials with less toxic materials, when possible.
- Good housekeeping and good personal hygiene such as routine hand washing and regular decontamination of areas that are possibly chemically contaminated such as bench-tops and fume hoods.
- Prohibiting eating and drinking where chemicals are used or stored.

# Chapter 5
# Laboratory Management Plan

An effective laboratory management plan is essential to operating a safe lab environment. Requirements on topics such as lab housekeeping, chemical inventories, proper handling, storage, segregation, and labeling of chemicals, and equipment safety must be established and known by all laboratory personnel.

## 5.1 Laboratory Safety Guidelines

All laboratory employees must have a good understanding of the hazards associated with the chemicals being used and stored in the lab. Basic factors such as the physical state (gas, liquid, or solid) of the chemical and the type of facilities and equipment involved with the procedure should be considered before any work with hazardous materials occurs.

### 5.1.1 Laboratory Safety Questions

Many factors are involved is laboratory safety. Asking and answering the following questions will help address many of the factors that should be considered when it comes to laboratory safety.

- Is the material flammable, explosive, corrosive, or reactive?
- Is the material toxic, and if so, how can I be exposed to the material (e.g., inhalation, skin or eye contact, accidental ingestion, accidental puncture)?
- What kind of ventilation do I need to protect myself?
- What kind of PPE (e.g., chemical-resistant gloves, lab coats, and goggles) do I need to protect myself?
- Will the process generate other toxic compounds, or could it result in a fire, explosion, or other violent chemical reaction?
- What are the proper procedures for disposal of the chemicals?
- Do I have the proper training to handle the chemicals and carry out the process?
- Are my storage facilities appropriate for the type of materials I will be using?
- Can I properly segregate incompatible chemicals?
- What possible accidents can occur and what steps can I take to minimize the likelihood and impact of an accident? What is the worst incident that could result from my work?

### 5.1.2 General Laboratory Safety Rules

It is extremely important that all laboratory safety rules are known and followed by lab personnel. Not only is it important that the rules are understood and followed, it is also important that the Laboratory Supervisor enforce all lab safety rules. A culture of safety must be adopted by all employees before a lab safety program can be successful. The following general laboratory safety rules should be followed at all times:

- Prior to beginning work in the lab, be prepared for hazardous materials emergencies and know what actions to take in the event of an emergency. Plan for the worst-case scenario. Be sure that necessary supplies and equipment are available for handling small spills of hazardous chemicals. Know the location of safety equipment such as the nearest safety shower and eyewash station, fire extinguisher, spill kit, and fire alarm pull station.
- Do not work alone in the laboratory if you are working with high hazard materials (e.g., acutely toxics, reactives, or processes that involve handling a large volume of flammable materials, > 1 liter).
- If working with a high-hazard chemical, ensure that others around you know what you are working with and understand the potential hazards.
- Limit access to areas where chemicals are used or stored by posting signs and/or locking doors when areas are unattended.
- Purchase the minimum amount of hazardous materials necessary to efficiently operate the laboratory.
- Ensure that adequate storage facilities (e.g., chemical storage rooms, flammable safety cabinets) and containers are provided for hazardous materials. Ensure that hazardous materials are properly segregated by chemical compatibility.
- Ensure that ventilation is adequate for the chemicals being used. Understand how chemical fume hoods function and be able to determine if the hood is not functioning properly.
- Use good personal hygiene practices. Keep your hands and face clean; wash thoroughly with soap and water after handling any chemical.
- Smoking, drinking, eating, and the application of cosmetics are forbidden in areas where hazardous chemicals are in use. Confine long hair and loose clothing.
- Never smell or taste a hazardous chemical. Never use mouth suction to fill a pipette.
- When using equipment that creates potential hazards (e.g., centrifuge), ensure that the equipment is being used following the manufacturer's guidelines and instructions. If

equipment requires routine maintenance (e.g., HEPA filters need to be changed), ensure the maintenance is performed by a qualified individual.

### 5.2 Housekeeping

Housekeeping is an important element to a laboratory safety program. A clean, well-maintained lab improves safety by preventing accidents and can enhance the overall efficiency of the work being performed. The following laboratory housekeeping guidelines should be followed:

- All doorways and hallways must be free of obstructions to allow clear visibility and exit. The laboratory should be uncluttered without excessive storage of materials that could cause or support a fire (e.g., paper, cardboard, flammable liquids, etc.).
- Fire protection sprinklers must be unobstructed; a minimum of 18 inches of clearance is required below the sprinkler head. If the laboratory does not have fire protection sprinklers, there must be a minimum of 24 inches of clearance below the ceiling.
- Do not store items that block fire extinguishers or eyewash and safety shower stations.
- Do not store items in front of electrical boxes/panels in the lab.
- A routine cleaning schedule should be established. All work surfaces should be kept as clean as possible. All potentially chemically contaminated work area surfaces (e.g., chemical fume hood deck, countertops) should be cleaned routinely (e.g. daily, weekly).
- For operations where spills and contamination are likely (e.g., agarose gel electrophoresis/ethidium bromide applications), cover work spaces with a bench paper or liner. The soiled bench paper should be changed on a routine basis or as needed.
- All chemical spills must be cleaned up immediately.
- Do not allow materials to accumulate in laboratory hoods and remove used tissues, foil, gloves, or other unnecessary objects immediately after use. The safety of the workspace and the hood ventilation may be compromised when excessive chemicals and equipment are kept in hoods.
- Ensure that all waste (e.g., trash, chemically contaminated waste, etc.) is placed in the appropriate containers. Do not overfill waste containers.
- All equipment should be cleaned and returned to storage after each use.
- Equipment should be stored in a safe and orderly manner that prevents it from falling.
- Chemical containers must be clean, properly labeled, and returned to storage upon completion or usage. Avoid storing liquids above eye level.
- Do not store heavy or frequently used items on top shelves. Locate items used daily close to the work area.

## 5.3 Chemical Inventories

The OSHA Laboratory Standard does not require chemical inventories; however, it is prudent to adopt this practice. Lowry campus manually inventories all chemicals on campus, including their location.

## 5.4 Safety Data Sheets (SDSs)

A Safety Data Sheet (SDS), formerly known as a Material Safety Data Sheet (MSDS), is a document containing chemical hazard and safe handling information prepared in accordance with the OSHA Hazard Communication Standard. Chemical manufacturers and distributors must provide an SDS the first time a hazardous chemical/product is shipped to a facility. SDSs must be retained and made available to laboratory workers. You can request an SDS for any laboratory chemical from the manufacturer or distributor. If you want to review an SDS, contact your lab manager or instructor. If you need an SDS for your work area file, contact the chemical supplier.

## 5.5 Chemical Labeling Requirements

Every chemical container present in the laboratory, whether hazardous or not, must be properly labeled. All secondary chemical containers (e.g., wash bottles, beakers, flasks, sample vials, etc.) must also be properly labeled. Avoid using abbreviations, chemical formulae, or structure unless there is a complete and up-to-date legend (e.g., MeOH = Methanol) prominently posted in the lab. Most chemicals come with a manufacturer label that contains all of the necessary information, so care should be taken to not damage or remove these labels. It is recommended that each bottle also be dated when received and when opened to assist in determining which chemicals are expired and require proper disposal.

## 5.6 Chemical Segregation

All chemicals must be stored according to chemical compatibility. Once segregated by chemical compatibility, they can then be stored alphabetically. Information regarding chemical compatibility can be found in the SDS, primarily in Section 7, “Handling and Storage” and Section 10, “Stability and Reactivity”. If unsure of proper segregation procedures, contact the Laboratory Supervisor for assistance. Chemical segregation can be achieved by either isolation (e.g., organic solvents stored in a flammable cabinet), physical distance (e.g., acids and bases are stored on opposite sides of a chemical storage room), or secondary containment. In the most general terms, proper segregation can be achieved by:

- Storing acids away from bases and toxics;
- Storing oxidizers away from organic chemicals; and,

- Storing reactive and acutely toxic materials away from all other chemicals.

## 5.7 Chemical Storage Requirements

Proper storage of chemicals is an essential component to a laboratory safety program. Improper chemical storage practices can cause undesired chemical reactions, which may form hazardous products that can lead to employee exposure or possibly fires and property damage. All lab employees should carefully read each chemical's SDS and container label before deciding how to store a chemical, as these will often indicate any special storage requirements that may be necessary. The following subsections describe chemical storage requirements in more detail.

### 5.7.1 General Chemical Storage

The following general chemical storage guidelines must be followed in all laboratories:

- Each chemical in the laboratory must be stored in a specific location and returned there after each use. Acceptable chemical storage locations may include flammable cabinets, corrosive cabinets, laboratory shelves, or appropriate laboratory refrigerators or freezers.
- Chemical containers must be in good condition and appropriate for the chemical that they contain and be free from exterior contamination.
- Fume hoods should not be used as permanent chemical storage areas, unless designated as such. Not only does this create potentially unsafe conditions by having extraneous chemicals stored near chemical reactions and processes, excess chemical bottles in the hood may also seriously impair the ventilating capacity of the hood.
- Only chemicals being used in the process or experiment being conducted in the hood are allowed to be stored in the hood and should be removed when the process or experiment is complete.
- Chemicals should not be permanently stored on bench tops. Avoid storing any chemical containers on the floor. Under no circumstance should chemical containers, or anything else, be stored in aisle ways, corridors, or in front of doors.
- Hazardous liquids should not be stored on shelves above eye-level unless there is a SOP detailing safe handling procedures.
- Chemicals should be stored at an appropriate temperature and humidity level and never be stored in direct sunlight.
- Periodic cleanouts of expired or unneeded chemicals should be conducted to minimize the volume of hazardous chemicals stored in the laboratory.
- Always follow the chemical manufacturer's storage instructions, if provided.

### 5.7.2 Flammable Liquids Storage

Flammable liquids include any liquid with a flash point no greater than 93 °C (200 °F). The following guidelines for storing flammable liquids must be followed in all laboratories:

- Flammable and combustible liquids should be stored in flammable storage cabinets whenever possible. No more than 10 gallons of flammable liquid is permitted to be stored outside of a flammable storage cabinet.
- Domestic refrigerators or freezers must never be used to store flammable liquids. Flammable liquids can only be stored in refrigerators or freezers that are designed for flammable materials (most refrigerators are not intended for flammable storage).
- Flammable liquids must be stored in well-ventilated areas free from ignition sources.
- Some organic solvents (e.g., diethyl ether) have a shelf-life and can form organic peroxides over time while in storage. These "peroxide formers" must be dated when received from the chemical manufacturer and disposed of once expired. If any time-sensitive chemicals are found to be past the manufacturer's expiration date, they must be submitted for hazardous waste disposal immediately.

### 5.7.3 Corrosive Materials Storage

Corrosive materials are defined as substances that cause destruction of living tissue by chemical corrosion at the site of contact and can be either acidic or basic (caustic). The best storage method for corrosive materials is inside of a corrosive storage cabinet or lab cabinet where acids and bases are segregated at all times. Acids must also be segregated from chemicals where a toxic gas would be generated upon contact with an acid (e.g., reactive cyanide compounds). Organic acids (e.g., acetic acid, formic acid) must be stored away from oxidizing acids (e.g., nitric acid, perchloric acid), as these types of acids are incompatible with each other. Segregation can be achieved either by physical distance or by secondary containment.

### 5.7.4 Oxidizers and Organic Peroxide Storage

Oxidizing materials are defined as substances which, while in itself are not necessarily combustible, may generally by yielding oxygen, cause, or contribute to the combustion of other material. An organic peroxide is an organic substance which contains the bivalent -O- O- structure and may be considered a derivative of hydrogen peroxide, where one or both of the hydrogen atoms have been replaced by organic radicals. The following guidelines for storing oxidizers and organic peroxides must be followed in all laboratories:

- Oxidizers (e.g., hydrogen peroxide, sodium nitrate) and organic peroxides (e.g., methyl ethyl ketone peroxide, benzoyl peroxide) must be stored in a cool, dry location and kept away from combustible materials such as wood, pressboard, paper, and organic chemicals (e.g., organic solvents and organic acids).
- If possible, store all strong oxidizing agents in a chemical cabinet dedicated only for oxidizers.
- The amount of oxidizers and organic peroxides stored in the lab should be kept at a minimum.
- All material must be clearly labeled; the original manufacturer's label with the chemical name, hazard labels, and pictograms should not be defaced or covered.

#### 5.7.5 Refrigerators and Freezers Chemical Storage

A number of general precautions need to be taken when storing chemicals in refrigerators and/or freezers in the laboratory. When working with freezers or refrigerators, the following procedures must be followed:

- Domestic refrigerators or freezers must never be used to store flammable liquids. Flammable liquids are only allowed to be stored in refrigerators or freezers that are designed for flammable materials (most refrigerators are not intended for flammable storage).
- Lab refrigerators or freezers must never be used to store food or beverages for consumption. Lab refrigerators/freezers should be posted with a sign that states "No Food or Drink".
- All chemicals stored in a refrigerator or freezer must be labeled.
- Ensure that the chemicals stored in a refrigerator or freezer are compatible with each other. For example, do not store an oxidizer such as hydrogen peroxide in a refrigerator with organic chemicals.
- There must not be any open chemicals in a refrigerator or freezer. All containers must be completely sealed or capped and safely stored.
- Chemicals should be allowed to warm to room temperature before sealing to prevent pressure buildup.

- Shelves in refrigerators or freezers should all have suitable plastic trays for secondary containment in the refrigerator and freezer compartments. If plastic trays are not available, liquid chemicals should be placed in secondary containers to contain spills.
- Remember that power outages and technology failures can cause internal temperatures to rise, which can impact chemical contents. Be aware of unusual odors, vapors, etc., when opening the refrigerator or freezer.
- An inventory should be posted on the refrigerator door.
- Chemical refrigerator or freezers should be located away from laboratory exits.
- Refrigerators and freezers should be cleaned-out and manually defrosted as necessary.

## 5.8 Sharps Handling Safety

Sharps are defined as items capable of puncturing, cutting, or abrading the skin such as glass or plastic pipettes, broken glass, test tubes, petri dishes, razor blades, needles, and syringes with needles. Sharps are often contaminated with hazardous chemicals and/or infectious agents, so multiple hazards are often encountered. Employees that routinely work with sharps must be aware of the risk of being punctured or lacerated. It is important for these employees to take precautions and properly handle sharps in order to prevent injury and potential disease transmission. These employees should use appropriate PPE (e.g., puncture-resistant gloves), tools, barrier protection, sharps waste containers, and engineering controls to protect themselves.

## 5.9 Equipment, Apparatus, and Instrument Safety

### 5.9.1 Centrifuges

The following safety guidelines should be followed when operating centrifuges:

<u>Before centrifugation</u>:

- Centrifuges must be properly installed and operated only by trained personnel. Centrifuges cannot be placed in the hallway of a building; they must remain inside of the laboratory.
- Train each operator on proper operating procedures and/or review the user manual.
- Use only rotors compatible with the centrifuge. Check the expiration date for ultracentrifuge rotors.
- Check tubes, bottles, and rotors for cracks and deformities before each use.
- Make sure that the rotor, tubes, and spindle are dry and clean.

- Examine O-rings and replace if worn, cracked, or missing.
- Never overfill centrifuge tubes (don't exceed ¾ full).
- Always cap tubes before centrifugation.
- Always balance buckets, tubes, and rotors properly.
- Check that the rotor is seated on the drive correctly, close the lid on the centrifuge, and secure it.
- When using swinging bucket rotors, make sure that all buckets are hooked correctly and move freely.

<u>During centrifugation</u>:

- Close lids at all times during operation. Never open a centrifuge until the rotor has stopped.
- Do not exceed safe rotor speed.
- The operator should not leave the centrifuge until full operating speed is attained and the machine appears to be running safely without vibration.
- Stop the centrifuge immediately if an unusual condition (noise or vibration) begins and check load balances.

<u>After centrifugation</u>:

- Allow the centrifuge to come to a complete stop before opening.
- Wear a new pair of outer gloves to remove rotor and samples.
- Check inside of centrifuge for possible spills and leaks, clean centrifuge and rotor thoroughly if necessary.
- Wash hands after removing gloves.

### 5.9.2 Stirring and Mixing Equipment

Stirring and mixing devices commonly found in laboratories include stirring motors, magnetic stirrers, and shakers. These devices are typically used in lab operations that are performed in a chemical fume hood, and it is important that they be operated in a way that prevents the generation of electrical sparks. Only spark-free induction motors should be used in power stirring and mixing devices or any other rotating equipment used for laboratory operations. Because stirring and mixing devices, especially stirring motors and magnetic stirrers, are often operated for fairly long periods without constant attention, the consequences of stirrer failure, electrical overload or blockage of the motion of the stirring impeller should be considered.

### 5.9.3 Heating Devices

Laboratories commonly use heating devices such as ovens, hot plates, incubators, oil baths, salt baths, sand baths, air baths, hot-tube furnaces, hot-air guns, and microwave ovens. Steam heated devices are generally preferred whenever temperatures of 100 °C or less are required because they do not present shock or spark risks and can be left unattended with assurance that their temperature will never exceed 100 °C. Ensure the supply of water for steam generation is sufficient prior to leaving the reaction for any extended period of time.

A number of general precautions need to be taken when working with heating devices in the laboratory. When working with heating devices, consider the following:

- The actual heating element in any laboratory heating device should be enclosed in such a fashion as to prevent a laboratory worker or any metallic conductor from accidentally touching the wire carrying the electric current.
- If a heating device becomes so worn or damaged that its heating element is exposed, the device should be either discarded or repaired before it is used again.
- The external cases of all variable autotransformers have perforations for cooling by ventilation and, therefore, should be located where water and other chemicals cannot be spilled onto them and where they will not be exposed to flammable liquids or vapors.
- Fail-safe devices can prevent fires or explosions that may arise if the temperature of a reaction increases significantly because of a change in line voltage, the accidental loss of reaction solvent, or loss of cooling. Some devices will turn off the electric power if the temperature of the heating device exceeds some preset limit or if the flow of cooling water through a condenser is stopped owing to the loss of water pressure or loosening of the water supply hose to a condenser.

### 5.9.4 Laboratory Glassware

Broken laboratory glassware is dangerous. Glassware-related injuries ranging from small cuts to multiple stitches and eye damage are common to lab workers. In order to reduce the risk of accidents, the following guidelines should be followed:

- Temperature changes can shatter any laboratory glassware. Never flash-cool glassware with cold water, especially after autoclaving or exposure to any high temperatures.

- Only round-bottomed or thick-walled (e.g., Pyrex) evacuated reaction vessels specifically designed for operations at reduced pressure should be used.
- Inspect glassware for any small imperfections before using. Sometimes a hairline crack may be present. Tap the glassware with a pen and listen to the tone to tell if there is a defect. A ringing tone indicates the glassware is fine, while a dull “thud” indicates there is a flaw present.
- Don’t keep cracked glassware. If the bottom of a graduated cylinder is chipped or broken, properly dispose of it.
- Always wear appropriate PPE when working with glassware and varying temperatures. Always wear safety glasses.

### 5.10 Transporting Hazardous Chemicals

Chemicals will not be distributed to other persons or other areas of the College without the prior approval of the chemical hygiene officer or the laboratory supervisor. Chemicals should not be transferred to another location without the applicable safety data sheet(s), nor should they be transferred without the receiver having had appropriate training in their use, storage, and disposal.

### 5.11 Laboratory Security

All laboratory personnel have a responsibility to protect College property from misuse and theft of hazardous materials, particularly those that could threaten human health. At a minimum, the following security measures should be employed in all campus laboratories:

- The laboratory door should remain locked when not occupied.
- Always feel free to question anyone that enters the lab that you do not know and ask to see identification if necessary.
- If you see anything suspicious or someone displays suspicious behavior, immediately report it to the Lowry Campus Security by dialing 303-419-5557.
- Any sensitive information or particularly hazardous chemicals should not be stored out in the open where anyone can readily have access to them. These types of materials should be stored in a secure location and lab personnel should always be present when these materials are in use.

# Chapter 6
# Laboratory Personal Protective Equipment Policy

## 6.1 Purpose

The purpose of this Laboratory Personal Protective Equipment (PPE) Policy is to ensure that all College lab employees are aware of the PPE requirements and procedures to adequately protect themselves against chemical, radiological, biological, or mechanical hazards. This policy has been prepared in accordance with the requirements of the OSHA PPE regulations (29 CFR 1910.132 - 29 CFR 1910.140, 29 CFR 1910.95). As briefly discussed in Chapter 4, PPE should never be used in place of engineering and administrative controls.

## 6.2 Scope

This Laboratory PPE Policy applies to all personnel that work with or around hazardous chemicals or other safety and health hazards. This Laboratory PPE Policy does not cover all potential hazards (e.g., confined space entry, welding operations, and high voltage) in all operations or settings.

## 6.3 Hazard Assessment (IN DEVELOPMENT)

The hazard assessment is a process of identifying the hazards associated with a defined task, and prescribing PPE along with other relevant protection measures that must be employed to minimize the risk from the hazards. Hazard assessments are performed by completing a certification of hazard assessment, which is a written document detailing the hazard assessment process for defined tasks. The Laboratory Supervisor is responsible for ensuring that hazard assessments are performed and the certification(s) is written, signed, dated, and readily available or posted in each location. The Laboratory Supervisor is also responsible for ensuring that all lab personnel receive documented training on applicable hazard assessments. The certification of hazard assessment should be reviewed at least annually and updated any time a process is modified or when a new task which presents a hazard is introduced into the lab. Hazard assessments can be organized using three formats: by individual task (e.g., pipetting hazardous liquids), by location (e.g., Chemistry Laboratory Room 3090), or by job title (e.g., Chemistry Lab Technician). Any of these formats is acceptable and often will be used in conjunction with each other to provide the safest laboratory work environment possible for employees. The following subsections describe each hazard assessment format in more detail.

#### 6.3.1 Task Evaluation Hazard Assessment

Task evaluation hazard assessments should be conducted for specific tasks, such as preparing dilute hydrochloric acid solutions or conducting an analysis on an unknown solution. These types of hazard assessments should be written in a very detailed manner. The following describes the steps that should be taken to perform a task evaluation hazard assessment:

- Describe the task.
- List hazards associated with each body part.
- Determine PPE requirements for each hazard.
- List other control measures required such as engineering and administrative controls.

#### 6.3.2 Location Evaluation Hazard Assessment

Location evaluation hazard assessments should be conducted for specific areas/laboratories. These types of hazard assessments should be written in a comprehensive manner that includes the majority of hazards present in a specific location (e.g., flammable and corrosive liquids). This type of hazard assessment is the most commonly used in laboratories and should be posted in a location within the lab where it is easily accessed by personnel (e.g., posted near the front door of the lab). If employees perform specific tasks not covered by the laboratory hazard assessment, then it will be necessary to perform another type of hazard assessment such as the task evaluation assessment that does address the specific hazards of that task. The following describes the steps that should be taken to perform a task evaluation hazard assessment:

- Identify the hazards.
- List each task where hazard is present.
- Determine PPE requirements for each task.
- List other control measures required engineering and administrative controls.

#### 6.3.3 Job Title Evaluation Hazard Assessment

Job title evaluation hazard assessments should be conducted for specific positions. These types of hazard assessments should be written in a comprehensive manner that includes the majority of hazards that a specific job position (e.g., Laboratory Assistant) routinely encounters during the normal course of work. This type of hazard assessment is commonly used for positions where the hazards encountered do not frequently change. If the employee encounters a hazard that is not covered by the job title evaluation hazard assessment, then it will be necessary to perform another type of hazard assessment such as the task evaluation hazard assessment that does address the specific hazards of that task. The following describes the steps that should be taken to perform a task evaluation hazard assessment:

- Identify hazards that the position title may encounter while performing normal duties.
- List each task where hazard is present.
- Determine PPE requirements for each task.
- List other control measures required.

## 6.4 Minimum PPE Requirements for Laboratories

This section details the minimum PPE requirements for all laboratories using hazardous chemicals. These requirements do not apply to labs that involve solely mechanical, computer, laser or other non-ionizing radiation, or electrical operations. The requirements listed do not cover all operations in all laboratories. Some operations and procedures may warrant further PPE, as indicated by the SDS, the SOP for the chemical(s) being used, facility policies, or regulatory requirements.

### 6.4.1 Head Protection

If there is a serious risk of chemical splash to the head, a chemical-resistant hoodie must be worn. Each affected employee must wear protective helmets when working in areas where there is a potential for injury to the head from falling objects or “bump” hazards.

### 6.4.2 Hearing Protection

Hearing protection is not typically required in laboratory settings. However, if the lab seems excessively noisy (e.g., operating equipment that is loud, air handling unit is loud) and it is difficult to communicate with co-workers while in the lab, contact the CCD office of Facility Services (303-352-3053) for a noise level evaluation.

### 6.4.3 Respiratory Protection

The use of respirators in the laboratory setting is not typically necessary since all work involving hazardous materials must be conducted in a chemical fume hood whenever possible. When ventilation is not adequate to provide protection against an inhalation hazard, respiratory protective equipment may be necessary. Respirator selection is based on the chemical and process hazard, and the protection factors required.

### 6.4.4 Eye and Face Protection

Each affected employee must use appropriate eye and face protection equipment when exposed to hazards from chemical splash, flying debris, or other exposures that may occur in the laboratory. Splash proof safety goggles must be worn by all individuals working with anything that may damage the eyes and/or face in the laboratory area. All eye protection equipment must be American National Standards Institute (ANSI) approved and appropriate for the work being done. Eye and face protection may not be required in the lab if the employee is sitting at a workstation or desk that is away from chemical processes (e.g., working at a desktop computer, having a lab meeting at a table away from hazardous operations).

### 6.4.5 Hand Protection

Each affected employee must wear appropriate hand protection when the hands may be exposed to skin contact of hazardous chemicals, cuts, abrasions, punctures, or harmful temperature extremes. Chemical-resistant gloves must be worn while handling any hazardous chemical container; regardless of whether the container is open or closed (it should be assumed that all chemical containers are contaminated). When selecting appropriate gloves, it is important to evaluate the effectiveness of the glove type to the specific hazardous chemical being handled. Some gloves are more suitable for certain hazardous chemicals than others. The SDS for the specific chemical being handled and the glove manufacturer's glove chart should be consulted to select the most appropriate glove. Do not purchase gloves from a manufacturer that does not provide an adequate glove chart. It is recommended that each lab purchase a general purpose disposable nitrile glove (nitrile gloves are typically more versatile and provide resistance to a wider range of chemicals than latex gloves do) with a minimum of a 4 mil thickness that is suitable for general chemical handling. When handling chemicals with harmful temperature extremes such as liquid nitrogen or autoclaves, appropriate protection such as cryogenic gloves or heat-resistant gloves must be worn.

The volume of hazardous chemical being handled should be considered as well. For example, if working with a small volume of a sodium hydroxide solution, disposable chemical-resistant gloves provide adequate protection. But if working with a large volume of sodium hydroxide as with a base bath for instance, a more durable glove such as a butyl rubber should be selected to provide adequate protection.

Chemical-resistant gloves must not be worn outside of the laboratory (e.g., hallways, elevators, offices) to avoid contamination of public areas. Gloves should also be removed prior to handling any equipment that could likely result in cross-contamination (e.g., water fountains, telephones, computer work stations). Disposable gloves must never be reused.

#### 6.4.6 Body Protection

Each affected employee must wear protective clothing to protect the body from recognized hazards. All unprotected skin surfaces that are at risk of injury should be covered. Full length pants or full-length skirt must be worn at all times by all individuals that are occupying the laboratory area; shorts are not permitted. Lab coats, coveralls, aprons, or protective suits are required to be worn while working on, or adjacent to, all procedures using hazardous chemicals (e.g., chemical bottle is open and the chemical is being poured, transferred, pipetted, etc.). Laboratory coats must be appropriately sized for the individual and be fastened (snap buttons are recommended) to their full length. Laboratory coat sleeves must be of a sufficient length to prevent skin exposure while wearing gloves. Flame resistant laboratory coats must be worn when working with pyrophoric materials or flammable liquids greater than 1 liter in volume. It is recommended that 100% cotton (or other non-synthetic material) clothing be worn during these procedures to minimize injury in the case of a fire emergency.

Laboratory coats should not be worn outside of a laboratory unless the individual is traveling directly to an adjacent laboratory work area. Laboratory coats should not be worn in common areas such as break rooms, offices, or restrooms. Each department is responsible for providing laundry services as needed to maintain the hygiene of laboratory coats. They may not be cleaned by staff members at private residences or public laundry facilities. Alternatives to laundering lab coats include routinely purchasing new lab coats for employees to replace contaminated lab coats, or using disposable lab coats.

#### 6.4.7 Foot Protection

Closed toe shoes must be worn at all times when in the laboratory; open toe shoes and/or sandals are not permitted in any circumstance. Each affected employee must wear protective footwear when working in areas where there is a high-risk of objects falling on or rolling across the foot, piercing the sole, and where the feet are exposed to electrical or chemical hazards. If there is a high risk of chemical contamination to the foot (e.g., cleaning up a chemical spill on the floor), then chemical-resistant booties may need to worn as well.

## 6.5 Minimum PPE Requirements for Support Staff and Visitors

Support staff (e.g., custodians, maintenance workers) and visitors often must enter laboratories to perform routine tasks such as maintenance or take a tour of the lab. These individuals are present in the laboratory, but are not performing work with or directly adjacent to any work with hazardous chemicals. To be present in the laboratory, the minimum PPE requirements include safety glasses, long pants, and closed-toe shoe. If additional PPE is required or if other unique safety requirements must be followed, it is the lab personnel's responsibility to notify support staff and/or visitors of the additional requirements.

## 6.6 Injuries, Illnesses, and Medical Examinations

Employees must notify their Laboratory Supervisor of all injuries and illnesses regardless of the magnitude. The laboratory supervisor must ensure that an Incident/Injury form is completed. Employees should report to an approved occupational medical provider if medical attention is required. If the injury is serious and presents an emergency situation, dial 911 and emergency responders will respond and transport the patient to a local hospital emergency room.

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

- Whenever an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory;
- Where exposure monitoring reveals an exposure level routinely above the action level (or in the absence of an action level, the permissible exposure limit) 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; and,
- 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 examination. All medical examinations must be performed by or under the direct supervision of a licensed medical care provider and must be provided without cost to the employee.

## Chapter 7
## Hazardous Waste Management

### 7.1 Introduction

Hazardous waste is generally defined as waste that is dangerous or potentially harmful to human health or the environment. Hazardous waste regulations are strictly enforced by the Environmental Protection Agency (EPA). The laboratory supervisor is responsible for managing the hazardous waste program in a safe and compliant manner. No chemical waste should be poured down the drain or discarded in the trash unless it is certain that doing so does not violate hazardous waste regulations or the requirements of Denver Wastewater Management.

Hazardous wastes can be liquid, solid, gas, or sludge. They can be discarded chemicals or mixtures generated from research and teaching operations, commercial products (e.g., cleaning fluids or pesticides), or by-products of manufacturing processes. All hazardous waste falls into one of the following categories:

- Characteristic Wastes: includes wastes that are ignitable, corrosive, reactive, or toxic (D-listed).
- Listed Wastes: includes wastes from common manufacturing and industrial processes (F-listed), wastes from specific industries (K-listed), and wastes from commercial chemical products (U- and P-listed).
- Universal Waste: includes certain batteries (primarily rechargeable batteries such lithium, nickel-cadmium, nickel metal hydride, and mercury oxide), mercury-containing equipment (e.g., thermometers, thermostats), and certain lamps (e.g., fluorescent bulbs). Note: alkaline batteries and incandescent bulbs are not considered Universal Wastes and can be legally disposed of as trash.
- Mixed Waste: hazardous waste mixed with radioactive waste.

EPA-regulated hazardous waste should not be mistaken for biological or radiological wastes.

### 7.2 Waste Identification and Labeling

All chemical constituents in a hazardous waste container must be identified by knowledgeable laboratory personnel. Not only is this required by the EPA, it also ensures that waste can be properly characterized and disposed of by using a licensed and registered waste disposal contractor. If there is uncertainty about the composition of a waste stream resulting from an experimental process, laboratory employees must consult the laboratory supervisor for assistance. In most cases, careful documentation and review of all chemical products used in the experimental protocol will result in accurate waste stream characterization. Containers must be labeled and clearly marked with words that describe the contents of the waste and the words "Hazardous Waste". Hazardous waste should be listed completely on the label in a percentage format. Listing accurate percentages is not as important (+ 5% is acceptable and constituents less than 1% can be listed as “trace”) as listing all of the chemicals that makeup the waste. If a chemical is found in the laboratory and the composition is unknown, it should be assumed to be hazardous and labeled as “Hazardous Waste – awaiting proper characterization”.

### 7.3 Waste Storage Requirements

Hazardous waste containers in Community College of Denver laboratories may be stored in a satellite accumulation area (SAA). SAAs are used to manage hazardous waste in laboratories and shops because doing so provides safe and effective means to accumulate hazardous waste before removal by a licensed and registered waste removal contractor. Additionally, SAAs provide the least restrictive regulatory option for the accumulation and storage of hazardous waste containers. The following SAA rules must be followed at all times when managing hazardous waste in a laboratory:

- All waste must be stored in containers.
- Containers must be in good condition and compatible with the waste they contain (no corrosive waste in metal containers).
- Containers must be kept closed at all times except when adding or removing waste.
- Containers must be labeled or clearly marked with words that describe the contents of the waste (e.g., liquid chromatography waste) and the words "Hazardous Waste".
- Containers must be stored at or near the point of generation and under the control of the generator of the waste (wastes should remain in the same room they were generated in). A central waste collection room should not be established.
- The waste storage volume should never exceed 55 gallons per SAA.
- Containers should be segregated by chemical compatibility during storage (e.g., acids away from bases, secondary containment can be used as a means of segregation).
- Avoid mixing incompatible waste streams in the same container (e.g., acids with bases, oxidizers with organic solvents) that will potentially create an exothermic reaction in the waste container. If mixing waste streams does create heat, allow the container to vent and cool in a chemical fume hood before sealing to avoid over pressurization of the container.
- Collect all highly toxic, reactive, mercury and any exotic wastes (e.g., dioxin compounds, PCBs, controlled substances) separately even if they are chemically compatible with other waste streams. Failing to do so can result in costly disposal fees (e.g., mixing mercury with an organic solvent waste means that the entire waste stream must be treated as mercury waste).

- All spills and leaks should be cleaned up immediately.
- Identification of SAAs is not required by the EPA, but it is recommended as a good practice.

### 7.4 Waste Containers

The College's Facilities Director will assist the Lowry campus in obtaining waste containers. Usually the original container of the main component of the waste can be used (e.g., 4-liter glass jar, 5-gallon green metal solvent can).

Please remember that some chemical residues have the potential to mix with other incompatible residues in the dumpster or compactor causing a reaction or fire. In addition, sealed containers may become pressurized during compaction, which may result in residues spraying onto workers. Please keep the following procedures and information in mind when disposing of empty containers:

- Triple rinse empty containers with a solvent capable of removing the original material.
- Identify triple-rinsed, dry, odorless, and empty containers by placing a "Safe for Disposal" label on the container. Remove any cap that may cause the container to become pressurized when compacting.
- Arrange removal of these containers with the College's Facilities Director.

### 7.5 Sink and Trash Disposal

No chemical waste should be poured down the drain or discarded in the trash unless it is certain that doing so does not violate hazardous waste regulations or the Denver water treatment plant's discharge requirements.

### 7.6 Sharps Waste

Sharps are items capable of puncturing, cutting, or abrading the skin such as glass or plastic pipettes, broken glass, test tubes, petri dishes, razor blades, needles, and syringes with needles. Sharps waste contaminated with hazardous chemicals must be placed into puncture resistant containers (e.g., sharps container, plastic or metal container with lid) and properly labeled.

Clean uncontaminated broken glassware and plastic sharps should be placed in a corrugated cardboard box or other strong disposable container. Do not exceed 20 pounds. When ready for disposal, the box should be taped shut and prominently labeled as "Sharp Objects/Glass – Discard" or similar wording.

# Chapter 8
# Chemical Spills

Chemical spills in the laboratory can pose a significant risk to human health and the environment. All lab personnel must be trained on how to properly respond to chemical spills in order to minimize risk. In general, chemical spills can be placed into one of two categories: non-emergency chemical spills, or emergency chemical spills.

## 8.1 Non-Emergency Chemical Spill Procedures

Non-emergency chemical spills are generally defined as less than 1 liter, do not involve a highly toxic or reactive material, do not present a significant fire or environmental hazard, and are not in a public area such as a hallway. These spills can be cleaned up by properly trained lab personnel using conventional lab PPE (e.g., safety glasses/goggles, lab coat, gloves) and the lab spill kit. In general, when a non-emergency spill occurs in the lab the area around the spill should be isolated, everyone in the lab should be made aware of the spill, and the spilled material should be absorbed and collected using either pads or some other absorbent material such as oil dry or kitty litter. Decontamination of the spill area should be conducted using an appropriate solvent (soap and water is often the most effective). Proper PPE should be worn at all times and only trained personnel should conduct the cleanup. Additionally, review the SDS(s) (specifically Section 6, “Accidental Release Measures”) to obtain chemical-specific cleanup information.

## 8.2 Emergency Chemical Spill Procedures

Emergency chemical spills are generally defined as greater than 1 liter, involve a highly toxic or reactive compound, present an immediate fire or environmental hazard, or require additional PPE (e.g., respirator) and specialized training to properly cleanup. The following procedures should be followed in the event of an emergency chemical spill:

- Cease all activities and immediately evacuate the affected area (make sure that all personnel in the area are aware of the spill and also evacuate).
- If chemical exposure has occurred to the skin or eyes, the affected personnel should be taken to the nearest safety shower and eyewash station.
- Dial 911 (from campus phone) or 303-419-5557 (from cell phone), which will initiate both the Lowry Campus Security, Denver Fire Department or Aurora Fire Department response, if the situation is, or could become an emergency (e.g., chemical exposure has occurred, a fire or explosion has occurred).

- The fire alarm should be pulled, which will initiate building evacuation, if any of the following occurs:
  - A fire and/or explosion has occurred (or there is a threat of fire and/or explosion).
  - The large spill (which is either highly toxic or presents an immediate fire or environmental hazard) is in a public area such as a hallway.
  - Toxic vapors are leaving the area where the spill has occurred, such as seeping from the laboratory into the hallway or neighboring rooms.
  - You are unsure of the hazards and feel that the spill could be harmful to building occupants.
  - Ensure that no one else is allowed to enter the area until the spill has been properly cleaned up by appropriate personnel (Lowry facilities management, Denver Fire, etc.).

### 8.3 Chemical Spill Kits

Each laboratory should have a spill response kit available for use. Lab spill kits can either be purchased from a vendor or created by lab personnel, but each spill kit should be equipped to handle small spills of the most common hazards in the laboratory. The kit should be equipped with response and cleanup materials such as:

- Absorbent materials such as pads, booms, oil dry or kitty litter, booms, or pillows.
- Neutralizing agents (e.g., sodium bicarbonate) for acids and/or bases if high volume of acids and/or bases are stored in the laboratory.
- Containers such as drums, buckets, and/or bags to containerize spilled material and contaminate debris generated during the cleanup process.
- PPE such as gloves, safety glasses and/or goggles, lab coat or apron, chemical-resistant booties.
- Caution tape or some other means to warn people of the spill.

## Appendix A
## OSHA Hazard Class Definitions

### A. Physical Hazards

**Explosives** – An explosive substance (or mixture) is a solid or liquid substance (or mixture of substances) which is in itself capable by chemical reaction of producing gas at such a temperature and pressure and at such a speed that can cause damage to the surroundings. Pyrotechnic substances are included even when they do not evolve gases. A pyrotechnic substance (or mixture) is designed to produce an effect by heat, light, sound, gas or smoke or a combination of these as the result of non-detonative, self-sustaining, exothermic chemical reactions. An explosive compound that is sometimes found in a laboratory setting is picric acid (2,4,6-trinitrophenol).

**Flammable Liquids** – Flammable hazards are materials which under standard conditions can generate sufficient vapor to cause a fire in the presence of an ignition source. Flammable liquids (e.g., hexane, ethyl acetate, xylene) are more hazardous at elevated temperatures due to more rapid vaporization. The following definitions are important to understand when evaluating the hazards of flammable liquids:

- **Flammable liquid** is a liquid having a flash point no greater than 93 °C (200 °F).
- **Flash point** is the minimum temperature at which the application of an ignition source causes the vapors of a liquid to ignite under specified test conditions.
- **Boiling point** is the temperature at which the vapor pressure of a liquid equals the atmospheric pressure and the liquid changes into a vapor.
- **Auto ignition temperature** is the minimum temperature at which self-sustained combustion will occur in the absence of an ignition source.
- **Lower explosive limit (LEL)** is the lowest concentration (percentage) of a gas or a vapor in air capable of producing a flash of fire in presence of an ignition source (arc, flame, heat).
- **Upper explosive limit (UEL)** is the highest concentration (percentage) of a gas or a vapor in air capable of producing a flash of fire in presence of an ignition source (arc, flame, heat).

**Flammable Solids** – A flammable solid is a solid which is readily combustible, or may cause or contribute to a fire through friction. Readily combustible solids are powdered, granular, or pasty substances which are dangerous if they can be easily ignited by brief contact with an ignition source. Flammable solids are more hazardous when widely dispersed in a confined space (e.g., finely divided metal powders).

**Gases under Pressure** – Gases under pressure are gases which are contained in a receptacle at a pressure not less than 280 kPA at 20 °C or as a refrigerated liquid. Gases under pressure include the following:

- **Compressed gas** is a gas which when packaged under pressure is entirely gaseous at -50 °C; including all gases with a critical temperature ≤ -50 °C.
- **Liquefied gas** is a gas which when packaged under pressure is partially liquid at temperatures above -50 °C.
- **Refrigerated liquefied gas** is a gas which when packaged is made partially liquid because of its low temperature.
- **Dissolved gas** is a gas which when packaged under pressure is dissolved in a liquid phase solvent.

All compressed gases are hazardous due to the fact they are stored in compressed cylinders, which can explode and act as a projectile if ruptured. Compressed gases also carry the hazards of the chemicals they contain such as asphyxiation (carbon dioxide), toxicity (nitric oxide), flammable (propane), and corrosive (hydrogen chloride).

**Oxidizers** – An oxidizing solid/liquid is a solid/liquid which, while in itself is not necessarily combustible, may generally by yielding oxygen, cause or contribute to the combustion of other material. Hydrogen peroxide, nitric acid, and nitrate solutions are examples of oxidizing liquids commonly found in a laboratory. Sodium nitrate, Sodium perchlorate, and Potassium permanganate are examples of oxidizing solids commonly found in a laboratory.

**Pyrophoric, Self-Heating, and Self-Reactive Materials**

- **Pyrophoric material** (also called "spontaneously combustible") is a liquid or solid that even in small quantities and without an external ignition source can ignite after coming in contact with the air.

- **Self-heating material** is a solid or liquid, other than a pyrophoric substance, which, by reaction with air and without energy supply, is liable to self-heat. This endpoint differs from a pyrophoric substance in that it will ignite only when in large amounts (kilograms) and after long periods of time (hours or days).

- **Self-reactive material** is a thermally unstable liquid or solid liable to undergo a strongly exothermic thermal decomposition even without participation of oxygen (air).

**Water-Reactive Materials** – A water-reactive material is a liquid or solid that reacts violently with water to produce a flammable or toxic gas, or other hazardous conditions. Alkali metals (e.g., sodium, potassium) and metal hydrides (e.g., calcium hydride) are common water-reactive materials found in laboratories.

**2. Health Hazards**

**Corrosives** – Corrosive substances cause destruction of living tissue by chemical corrosion at the site of contact and can be either acidic or caustic (basic). Major classes of corrosive substances include:

- Strong acids such as sulfuric, nitric, hydrochloric and hydrofluoric acids.
- Strong bases such as sodium hydroxide, potassium hydroxide, and ammonium hydroxide.
- Dehydrating agents such sulfuric acid, sodium hydroxide, phosphorus pentoxide and calcium oxide.
- Oxidizing agents such as hydrogen peroxide, chlorine, and bromine.

**Hazardous Substances with Toxic Effects on Specific Organs**

- Substances with toxic effects on specific organs include:
- Hepatotoxins, which are substances that produce liver damage, such as nitrosamines and carbon tetrachloride.
- Nephrotoxins, which are substances that cause damage to the kidneys, such as certain halogenated hydrocarbons.
- Neurotoxins, which are substances that produce toxic effects on the nervous system, such as mercury, acrylamide, and carbon disulfide.
- Substances that act on the hematopoietic system (e.g., carbon monoxide and cyanides), which decrease hemoglobin function and deprive the body tissues of oxygen.
- Substances that damage lung tissue such as asbestos and silica.

**Irritants** – Irritants are defined as chemicals that cause reversible inflammatory effects on living tissue by chemical action at the site of contact. A wide variety of organic and inorganic compounds, including many chemicals that are in a powder or crystalline form, are irritants. Symptoms of exposure can include reddening or discomfort of the skin and irritation to respiratory systems.

**Particularly Hazardous Substances** – Substances that pose such significant threats to human health are classified as "particularly hazardous substances" (PHSs). The OSHA Laboratory Standard requires that special provisions be established to prevent the harmful exposure of researchers to PHSs, including the establishment of designated areas for their use. Particularly hazardous substances are divided into three primary types:

- **Carcinogens** – Carcinogens are chemical or physical agents that cause cancer. Generally they are chronically toxic substances; that is, they cause damage after repeated or long-duration exposure, and their effects may only become evident after a long latency period. Chronic toxins are particularly insidious because they may have no immediately apparent harmful effects. These materials are separated into two classes:

- **Select Carcinogens:** Select carcinogens are materials which have met certain criteria established by the National Toxicology Program or the International Agency for Research on Cancer regarding the risk of cancer via certain exposure routes. It is important to recognize that some substances involved in research laboratories are new compounds and have not been subjected to testing for carcinogenicity.

- **Regulated Carcinogens:** Regulated carcinogens are more hazardous and have extensive additional requirements associated with them. The use of these agents may require personal exposure sampling based on usage. When working with Regulated Carcinogens, it is particularly important to review and effectively apply engineering and administrative safety controls as the regulatory requirements for laboratories that may exceed long term (8 hour) or short term (15 minutes) threshold values for these chemicals are very extensive.

**Reproductive Toxins** – Reproductive toxins include any chemical that may affect the reproductive capabilities, including chromosomal damage (mutations) and effects on fetuses (teratogens). Reproductive toxins can affect the reproductive health of both men and women if proper procedures and controls are not used. For women, exposure to reproductive toxins during pregnancy can cause adverse effects on the fetus; these effects include embryolethality (death of the fertilized egg, embryo or fetus), malformations (teratogenic effects), and postnatal functional defects. For men, exposure can lead to sterility. Examples of embryotoxins include thalidomide and certain antibiotics such as tetracycline. Women of childbearing potential should note that embryotoxins have the greatest impact during the first trimester of pregnancy. Because a woman often does not know that she is pregnant during this period of high susceptibility, special caution is advised when working with all chemicals, especially those rapidly absorbed through the skin (e.g., formamide).

**Substances with a High Acute Toxicity** – Substances that have a high degree of acute toxicity are materials that may be fatal or cause damage to target organs as the result of a single exposure or exposures of short duration. Acute toxins are quantified by a substance's lethal dose-50 (LD50) or lethal concentration-50 (LC50), which is the lethal dose of a compound to 50% of a laboratory tested animal population (e.g., rats, rabbits) over a specified time period. High acute toxicity includes any chemical that falls within any of the following OSHA-defined categories:

- A chemical with a median lethal dose (LD50) of 50 mg or less per kg of body weight when administered orally to certain test populations.
- A chemical with an LD50 of 200 mg less per kg of body weight when administered by continuous contact for 24 hours to certain test populations.
- A chemical with a median lethal concentration (LC50) in air of 200 parts per million (ppm) by volume or less of gas or vapor, or 2 mg per liter or less of mist, fume, or dust, when administered to certain test populations by continuous inhalation for one hour, provided such concentration and/or condition are likely to be encountered by humans when the chemical is used in any reasonably foreseeable manner.

**Sensitizers** – A sensitizer (allergen) is a substance that causes exposed individuals to develop an allergic reaction in normal tissue after repeated exposure to the substance.  Examples of sensitizers include diazomethane, chromium, nickel, formaldehyde, isocyanates, arylhydrazines, benzylic and allylic halides, and many phenol derivatives.  Sensitizer exposure can lead to all of the symptoms associated with allergic reactions, or can increase an individual's existing allergies.