



Chemical Hygiene Plan (CHP)

JANUARY 2025





Chemical Hygiene Plan Certification Form

The Occupational Safety and Health Administration (OSHA) requires that faculty, staff, student workers and research students that work in laboratories or art studios be made aware of the Chemical Hygiene Plan at their place of employment (**29 CFR 1910.1450**).

After reading the Benedictine University Chemical Hygiene Plan, complete and return a copy of this form to the Chemical Hygiene Officer at: rrakers@ben.edu.

By signing below, you acknowledge and will abide by the Benedictine University Chemical Hygiene Plan and the policies and procedures applicable to the OSHA standard. The Benedictine University Chemical Hygiene Plan will be reviewed annually. You will be required to complete a Chemical Hygiene Plan Certification Form and quiz on an annual basis.

Please type or print legibly:

Name:

Email:

Department:

Phone:

Signature:

Date:

Completed Chemical Hygiene Plan Certification Forms and quizzes will be maintained by the Emergency Preparedness Manager and/or the Chemical Hygiene Officer. Chemical Hygiene Plan Certification Form records will be kept for a period of three (3) years from date of signature.

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Section 1 Introduction

1.1 Purpose

The "Occupational Exposure to Hazardous Chemicals in Laboratories" (OSHA Laboratory Standard, **29 CFR 1910.1450**), outlines safety responsibilities and training requirements to ensure individual and institutional compliance with relevant environmental health and safety laws, regulations, policies, and guidelines in laboratories that use hazardous chemicals. The Benedictine University Chemical Hygiene Plan (CHP) includes recommendations for good laboratory practices to serve as a useful resource and to assist laboratory supervisors in designing their own Standard Operating Procedures (SOP) to meet these requirements. These SOPs must go through an approval process.

Most laboratories at Benedictine University using chemicals are subject to the requirements of the OSHA Laboratory Standard. In addition to employees who ordinarily work full-time within a laboratory space, other employees (such as office, custodial, maintenance and repair personnel) who regularly spend a significant amount of their time within a laboratory environment as part of their duties, also may fall under the requirements of the OSHA Laboratory Standard. OSHA considers research students who get paid for working in a lab as employees and are subject to the requirements of the Laboratory Standard.

The OSHA Laboratory Standard requires employers to develop a CHP, designate a Chemical Hygiene Officer (CHO), and ensure laboratory employees are provided with the proper information and training, including knowing the location of the CHP, and how to work safely in their labs. The main goals of the OSHA Laboratory Standard and the requirement to develop a CHP are to protect employees from physical and health hazards associated with use of hazardous chemicals in the laboratory, and keep exposures below the permissible exposure limits as specified in **29 CFR Part 1910, subpart Z – Toxic and Hazardous Substances** and other resources such as **NIOSH** and **ACGIH**. In addition to other requirements, the OSHA Laboratory Standard specifies the CHP to include "criteria the employer will use to determine and implement control measures to reduce employee exposure to hazardous chemicals including engineering controls, the use of personal protective equipment and hygiene practices; particular attention shall be given to the selection of control measures for chemicals that are known to be extremely hazardous."

1.2 Scope

The CHP applies to all University functions involving hazardous chemicals found in laboratories and art studios. All students, teaching assistants, faculty, staff, and visitors are covered under the CHP. In all other areas that use chemicals, but do not fall under the OSHA definition of a "laboratory", the OSHA regulation **29 CFR 1910.1200 – "Hazard Communication Standard"** applies.

1.3 Definitions

Absorption - such as direct exposure to the skin by touching a chemical substance without any protection such as wearing gloves.

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

Biosafety Level 1 (BSL-1) - The lowest of the four biosafety levels, biosafety level 1 (BSL-1) applies to laboratory settings in which personnel work with low-risk microbes that pose little to no threat of infection in healthy adults — for example, a BSL-1 laboratory might work with a nonpathogenic strain of E.coli. BSL-1 labs typically conduct research on benches, do not use special contaminant equipment, and do not need to be isolated from surrounding facilities. BSL-1 labs also require immediate decontamination

after spills. Infectious materials should also be decontaminated prior to disposal, generally through the use of an autoclave.

Biosafety Level 2 (BSL-2) - Biosafety level 2 (BSL-2) covers all laboratories that work with agents associated with human diseases — that is, pathogenic or infectious organisms — that pose a moderate health hazard. Common examples of agents found in a BSL-2 lab include equine encephalitis viruses, HIV, and staphylococcus aureus (staph infections).

BSL-2 labs are required to maintain the same standard microbial practices as BSL-1 labs, as well as enhanced measures due to the potential risk the aforementioned microbes pose. Personnel working in biosafety level 2 laboratories are expected to take even greater care to prevent injuries, such as cuts and other breakage to the skin, as well as ingestion and mucous membrane exposures. Access to a biosafety level 2 lab is far more restrictive than to a biosafety level 1 lab. Outside personnel, or those with an increased risk of contamination, are often restricted from entering the area while work is underway.

Carcinogen (see select carcinogen)

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

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

Class 9 Miscellaneous - Class 9 is for miscellaneous dangerous items. The class does not have any subdivisions but comprises any substance that may pose a danger during air transport that isn't covered by the other classes. This includes items with anesthetic properties, solid dry ice, asbestos, life rafts and chain saws.

Combustible Dust: Finely divided solid particulates of a substance or mixture that pose a flash-fire hazard or explosion hazard when dispersed in air or other oxidizing media.

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

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

Exposure or exposed: An employee is subjected in the course of employment to a hazardous chemical and includes potential (e.g., accidental or possible) exposure. "Subjected" in terms of health hazards includes any route of entry (e.g., inhalation, ingestion, skin contact or adsorption).

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

Hazardous Chemical – means a chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. The term “health hazard” includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic systems and agents which damage the lungs, skins, eyes, or mucous membranes. **Appendix A** and **Appendix B** of the Hazard Communication standard (**29 CFR 1910.1200**) provide further guidance in defining the scope of health hazards and determining whether or not a chemical is to be considered hazardous for the purposes of this standard.

Health Hazard – means a chemical that is classified as posing one of the following hazardous effects: Acute toxicity (any route of exposure); skin corrosion or irritation; serious eye damage or eye irritation; respiratory or skin sensitization; germ cell mutagenicity; carcinogenicity; reproductive toxicity; specific target organ toxicity (single or repeated exposure); aspiration hazard. The criteria for determining whether a chemical is classified as a health hazard are detailed in appendix A of the Hazard Communication Standard (1910.1200) and (1910.1200(c) (definition of “simple asphyxiant”).

Ingestion - that is when toxins are accidentally swallowed

Inhalation - that is breathing in toxic vapors or small chemical particles

Injection - that is when a sharp contaminated object or needle accidentally penetrates a worker’s body (such as hand or foot)

Laboratory – means a facility where the “laboratory use of hazardous chemicals” occurs. It is a workplace where relatively small quantities of hazardous chemicals are used on a non-production basis. Some examples of spaces that also meet this definition are the instrumentation lab, and Art Studios.

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

Laboratory Use of Hazardous Chemicals – means handling or use of such chemicals in which all of the following conditions are met:

- i. Chemical manipulations are carried out on a “laboratory scale;”
- ii. Multiple chemical procedures or chemicals are used;
- iii. The procedures involved are not part of a production process, nor in any way simulate a production process; and
- iv. “Protective laboratory practices and equipment” are available and in common use to minimize the potential for employee exposure to hazardous chemicals.

Liquid: a substance or mixture which at 122°F (50°C) has a vapor pressure of not more than 43.51 PSI (300 kPa (3 bar)), which is not completely gaseous at 68°F (20°C) and at a standard pressure of 14.69 PSI (101.3 kPa), and which has a melting point or initial melting point of 68 °F (20°C) or less at a standard pressure of 14.69 PSI (101.3 kPa). Either ASTM D 4359-90 (2019) (Standard Test Method for Determining Whether a Material Is a Liquid or a Solid) (incorporated by reference; see §1910.6); or the test for determining fluidity (penetrometer test) prescribed in the European Agreement Concerning the International Carriage of Dangerous Goods by Road (ADR), section 2.3.4 of Annex A (2019) (incorporated by reference; see §1910.6) can establish whether a viscous substance or mixture is a liquid if a specific melting point cannot be determined

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

Mutagen – means chemicals that cause permanent changes in the amount or structure of the genetic material in a cell. Chemicals classified as mutagens in accordance with the Hazard Communication Standard shall be considered mutagens for purposes of this section.

Non-Hazardous Laboratory – means a space which is labeled as a laboratory but does not have hazardous chemicals found inside the space. Some examples of non-hazardous laboratory spaces are computer labs, Nutrition lab, Physics lab, and Nursing lab.

Permissible Exposure Limits (PEL) – means the employer shall assure that laboratory employees' exposures to such substances do not exceed the limits specified in 29 CFR 1910, subpart Z.

Physical Hazard – means a chemical that is classified as posing one of the following hazardous effects: Explosive; flammable (gases, liquids, or solids); aerosols; oxidizer (liquid, solid, or gas); self-reactive; pyrophoric (gas, liquid, or solid); self-heating; organic peroxide; corrosive to metal; gas under pressure; in contact with water emits flammable gas; or desensitized explosive. The criteria for determining whether a chemical is classified as a physical hazard are in appendix B of the Hazard Communication Standard (1910.1200) and (1910.1200(c)) (definitions of "combustible dust").

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

Reproductive Toxins – means chemicals that affect the reproductive capabilities including adverse effects on sexual function and fertility in adult males and females, as well as adverse effects on the development of the offspring. Chemicals classified as reproductive toxins in accordance with the Hazard Communication Standard (1910.1200) shall be considered reproductive toxins for purposes of this section.

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

- i. It is regulated by OSHA as a carcinogen; or
- ii. It is listed under the category, "known to be carcinogens," in the Annual Report on Carcinogens published by the National Toxicology Program (NTP) (latest edition); or
- iii. It is listed under Group 1 ("carcinogenic to humans") by the International Agency for Research on Cancer Monographs (IARC) (latest editions); or
- iv. It is listed in either Group 2A or 2B by IARC or under the category, "reasonably anticipated to be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:
 - a. After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m³;
 - b. After repeated skin application of less than 300 (mg/kg of body weight) per week; or
 - c. After oral dosages of less than 50 mg/kg of body weight per day.

Solid: A substance or mixture which does not meet the definitions of liquid or gas.

Workplace Label – a workplace label may only be used by employers who use chemicals they have purchased. Workplace labels are secondary labels that are placed on secondary containers of hazardous

chemicals used by employees in the workplace. Workplace labels must meet one of the following two options:

1. Meet the requirements of supplier labels with the exception that the name, address, and phone number of the chemical manufacturer, importer, or distributor is not required, or
2. Include a product identifier and words, pictures, symbols, or combination thereof, which provided at least general information regarding the hazards of the chemicals and provides specific information regarding the physical and health hazards.

1.4 Recordkeeping

Records of environmental monitoring or hazard assessment will be maintained by the Emergency Preparedness Manager/Safety Specialist.

Records of personnel monitoring and medical consultations or examinations must be made available to the affected employee and/or their representative.

Records of any maintenance or repairs to facilities or equipment that affect chemical hygiene are maintained by Facilities.

Records of any maintenance or repairs contracted by outside vendors should be maintained by that department for no fewer than three years.

Records of all relevant training that employees or students receive before, or during their time at the University will be maintained by the Emergency Preparedness Manager/Safety Specialist for the length of employment plus 30 years.

1.5 Plan Availability, Review and Update

The OSHA Laboratory Standard requires the CHP to be readily available to employees, employee representatives and, upon request, to the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee. This means laboratory employees working with hazardous chemicals in a laboratory must know the location of the CHP, be familiar with the contents, and be able to produce the CHP for any state or federal regulatory inspectors upon request. While it is recommended that a hard copy be kept in the laboratory, electronic access is acceptable and encouraged. The Chemical Hygiene Plan can be found on the University "S" drive at S:\University Info\General Information\Emergency Information\Safety.

At least annually, the plan is evaluated with input from the Safety Committee and other appropriate personnel to determine its continued effectiveness and identify any areas where updates or improvements are needed to the plan, the associated training, or other aspects of the CHP.

Section 2 Roles and Responsibilities

The ultimate responsibility for health and safety within laboratories lies with each individual who works in the laboratory; however, it is the responsibility of the faculty to ensure that employees and students have received all appropriate training, and have been provided with all the necessary information to work safely in laboratories under their control. Faculty have numerous resources at their disposal for helping to ensure a safe and healthy laboratory that is compliant with state and federal regulations.

2.1 University Administration

The University administration has overall responsibility for instituting policies and programs, establishing systems, and providing resources to help ensure that research and teaching activities involving laboratory chemicals are conducted in a responsible manner and in accordance with all applicable requirements.

2.2 Deans and Department Chairs

The Deans, Directors, and Department Chairpersons are responsible for laboratory safety within their department(s) and must know and understand the guidelines and requirements of the CHP. In addition to the responsibilities outlined within the CHP, the laboratory safety responsibilities of Deans, Directors, and Department Chairpersons - which can be delegated to other authorized personnel within the department must:

- Be familiar with and implement the CHP within their departments under their control or designate a person in the department with the authority to carry out these requirements.
- Communicate and implement the CHP and its requirements to faculty, staff (including temporary employees), visiting scholars, volunteers, and students working in laboratories within their departments.
- Assist the CHO with implementation of the CHP.
- Ensure laboratory personnel develop and adhere to proper health and safety protocols.
- Direct individuals under their supervision, including but not limited to - Faculty, supervisors, regular and temporary employees, and students employees - to obtain any required safety and health training before working with hazardous chemicals, biohazardous agents, radiation, and/or other physical/mechanical hazards found within their working or learning environments.
- Determine and ensure that safety needs and equipment for departments are met (e.g., engineering controls, training, protective equipment) and ensure corrective measures for noncompliance items identified in safety audits are corrected promptly.
- Keep the CHO informed of plans for renovations or new laboratory construction projects.
- Ensure departmental procedures are established and communicated to identify and respond to potential accidents and emergency situations.
- Notify the CHO before a faculty member retires or leaves the University so proper laboratory decommissioning occurs.
- Establish departmental priorities, objectives, and targets for laboratory safety and health performance.
- Lead by example by modeling appropriate behavior and demonstrate a culture of safety.

2.3 Chemical Hygiene Officer (CHO)

The role of the CHO is to facilitate the implementation of the CHP and to serve as a technical resource to the University.

The major duties of the CHO are:

- Comply with all University health and safety practices and programs.
- Request and coordinate assistance from the Emergency Preparedness Manager/Safety Specialist and other organizations that can provide guidance, training, and other services to assist laboratory personnel.
- Assist directors, unit heads, department chairpersons, supervisors, and individuals within the areas they represent to establish departmental or facility-wide safety programs, priorities, objectives and targets for safety, health, and environmental performance.
- Assist directors, department heads, department chairpersons, supervisors, and individuals to identify if the safety needs for the areas they represent are met (e.g., training, protective equipment, acquisition of safety equipment, and corrective measures including noncompliance items identified in safety inspections).
- Collaborate with the University Emergency Preparedness Manager/Safety Specialist on emergency planning efforts, response, and implementation.
- Endeavor to stay knowledgeable about safety, health, and environmental services available, the University health and safety policies and procedures that apply to, and the health and safety issues that occur within the areas they represent.
- Communicate to individuals working within the areas they represent about health and safety policies and procedures, including this CHP, and the safety, health, and environmental services available to them.
- Conduct and/or facilitate routine inspections of work/lab spaces. Facilitate corrective actions for any issues identified with the support and participation of the University, including bringing issues of noncompliance to the attention of directors and department chairpersons.
- Promote safety, health, and environmental training program and workshops throughout the areas they represent. Inform individuals working in areas they represent about the requirements to obtain necessary training.
- Serve as a "conduit for information exchange" through facilitation and dissemination of safety, health and environmental information to all personnel, including visiting faculty and researchers, and student employees, within the areas they represent.
- Communicate with supervisors that all incidents and near misses should be reported and that a written Injury/Illness Report is completed.
- Work with University stakeholders to evaluate, implement, review annually, and make updates as needed to the CHP.
- Provide technical expertise to the laboratory community in the area of laboratory safety and health, and serve as a point of contact to direct inquiries to other appropriate resources.
- Ensure that guidelines are in place and communicated for particularly hazardous substances regarding proper labeling, handling, use, and storage, selection of proper personal protective equipment, and facilitating the development of standard operating procedures for laboratories using these substances.
- Serve as a resource to review academic research protocols and standard operating procedures developed by faculty and department personnel for the use, disposal, spill cleanup, and decontamination of hazardous chemicals, and the proper selection and use of personal protective equipment.
- Coordinate the acquisition, testing and maintenance of fume hoods and emergency safety showers and eyewashes in all laboratories where hazardous chemicals are used.
- Conduct laboratory safety training sessions for laboratory personnel and upon request, assist laboratory supervisors in developing and conducting hands-on training sessions with employees.

- Review reports for laboratory incidents, accidents, chemical spills, and near misses and recommend follow up actions where appropriate.
- Stay informed of plans for renovations or new laboratory construction projects and serve as a resource in providing code citations and internal standards to assist with the design and construction process.
- Keep the senior administration informed on the progress of continued implementation of the CHP and bring college-wide issues affecting laboratory safety to their attention.
- Serve on the Safety Committee

2.4 Environmental Health & Safety

Inspections by state and federal regulatory agencies can occur at any time and can result in citations and significant fines for the University. The best way to be prepared for these inspections is to understand what regulations apply to your area and what you need to do to comply with those regulations. You can obtain this information from resources such as this CHP and by conducting your own self inspections.

If a state or federal inspector shows up in your work area unescorted, ask them to please wait and contact the Emergency Preparedness Manager/Safety Specialist immediately at 630-829-6364.

2.5 Principal Investigators (PI)

Research and teaching faculty are responsible for laboratory safety in their research or teaching laboratories. The laboratory safety duties of research and teaching faculty (which can also be delegated to other authorized personnel within the laboratory) are:

- Implement and communicate all University safety practices and programs, including the guidelines and procedures found within the CHP, in laboratories under your supervision or control.
- Establish laboratory priorities, objectives and targets for laboratory safety, health and environmental performance.
- Communicate roles and responsibilities of individuals within the laboratory relative to environmental, health, and safety according to this CHP.
- Conduct hazard evaluations for procedures conducted in the laboratory and maintain a file of standard operating procedures documenting those hazards.
- Ensure that specific operating procedures for handling and disposing of hazardous substances used in their laboratories are written, communicated, and followed and ensure laboratory personnel have been trained in these operating procedures and use proper control measures.
- Attend required health and safety training.
- Require all staff members and students under their direction to obtain and maintain required health and safety training commensurate with their duties and/or department requirements.
- Ensure that all appropriate engineering controls including chemical fume hoods and safety equipment are available and in good working order in their laboratories. This includes notifying the CHO when significant changes in chemical use may require a re-evaluation of the laboratory ventilation.
- Ensure procedures are established and communicated to identify the potential for, and the appropriate response to accidents and emergency situations.
- Ensure that all incidents and near misses occurring in their laboratories are reported to their Department Chairperson and the Emergency Preparedness Manager/Safety Specialist. A written Injury/Illness Report must be filed for each incident.
- Ensure laboratory personnel under your supervision know and follow the guidelines and requirements contained within the CHP.
- Follow the guidelines identified within this manual as research and teaching faculty responsibilities.

2.6 Laboratory Workers (Staff and Students)

Laboratory employees are those personnel who conduct their work in a laboratory and are at risk of possible exposure to hazardous chemicals on a regular or periodic basis. These personnel include laboratory technicians, instructors, researchers, visiting researchers, administrative assistants, student employees, and part time and temporary employees.

The laboratory safety duties of laboratory workers are:

- Comply with all health and safety practices and programs by maintaining class, work, and laboratory areas safe and free from hazards.
- Know the location of the CHP and how to access safety data sheets (SDS).
- Attend health and safety training as designated by your supervisor.
- Inform your supervisor or instructor of any safety hazards in the workplace, classroom, or laboratory, including reporting any unsafe working conditions, faulty fume hoods, or other emergency safety equipment to the principal investigator.
- Ensure an SDS is present for all new chemicals you purchase (either sent with the original shipment or available online). Review the SDSs for chemicals you are working with and check with your laboratory supervisor or principal investigator if you ever have any questions.
- Conduct hazard evaluations with your supervisor for procedures conducted in the laboratory and maintain a file of standard operating procedures documenting those hazards.
- Be familiar with what to do in the event of an emergency situation.
- Follow the standard operating procedures for your laboratory and incorporate the guidelines and requirements outlined in this CHP into everyday practice.
- Report all accidents, injuries, close-call and near misses.

2.7 Laboratory Visitors

Visitors and contractors who enter laboratory spaces on campus are responsible for meeting the minimum requirements for entry (e.g., no eating/drinking, proper laboratory attire, etc.) and observing all warning signs and other instructions. Visitors and contractors must immediately report any incident that occurs in the laboratory, and should never attempt to conduct tasks that they are not trained and authorized to perform.

Section 3 Hazard Assessment, Identification, Communication, Evaluation and Control

3.1 Globally Harmonized System (GHS)

The Globally Harmonized System of Classification and Labeling of Chemicals (GHS) is an international system for standardizing and harmonizing the classification and labeling of chemicals. It is a logical and comprehensive approach to:

- Defining health, physical and environmental hazards of chemicals;
- Creating classification processes that use available data on chemicals for comparison with the defined hazard criteria; and
- Communicating hazard information, as well as protective measures, on labels and Safety Data Sheets (SDS).

GHS standardized the hazardous symbols and labeling to include nine pictograms.

Health Hazard  • Carcinogen • Mutagenicity • Reproductive Toxicity • Respiratory Sensitizer • Target Organ Toxicity • Aspiration Toxicity	Flame  • Flammables • Pyrophorics • Self-Heating • Emits Flammable Gas • Self-Reactives • Organic Peroxides • Desensitized Explosives	Exclamation Mark  • Irritant (skin and eye) • Skin Sensitizer • Acute Toxicity (harmful) • Narcotic Effects • Respiratory Tract Irritant • Hazard Not Otherwise Classified (non-mandatory) • Hazardous to Ozone Layer (non-mandatory)
Gas Cylinder  • Gases Under Pressure • Chemicals Under Pressure	Corrosion  • Skin Corrosion/Burns • Eye Damage • Corrosive to Metals	Exploding Bomb  • Explosives • Self-Reactives • Organic Peroxides
Flame Over Circle  • Oxidizers	Environment (non-mandatory)  • Aquatic Toxicity	Skull and Crossbones  • Acute Toxicity (fatal or toxic)

3.2 Hazard Identification

3.2.1 Health Hazards

Hazard Class	Associated Hazard Category
Acute toxicity	Categories 1-4 (with 1 being the most dangerous)
Skin corrosion	Categories 1A, 1B, 1C, and 2
Skin irritation	Categories 1A, 1B, 1C, and 2
Eye Effects	Categories 1, 2A, and 2B
Sensitization (Skin or Eye)	Category 1A and 1B
Germ cell mutagenicity	Categories 1A, 1B, and 2
Carcinogenicity	Categories 1A, 1B, and 2
Reproductive toxicity	Categories 1A, 1B, 2, and additional category for effects on or via lactation
Target organ systemic toxicity: single and repeated exposure	Single: Categories 1-3
	Repeated: Categories 1 and 2
Aspiration toxicity	Category 1 and 2

3.2.2 Physical Hazards

Hazard Class	Associated Hazard Category
Explosives	Divisions 1.1-1.6 (with 1.1 being the most hazardous, 1.6 the least hazardous)
Desensitized Explosives	Categories 1 - 4
Flammable Gases	Category 1A (Flammable gas (specific properties), pyrophoric gas, chemically unstable gas (A & B)); Category 1B (Flammable gas (specific properties)); Category 2 (Flammable gas (specific properties))
Flammable aerosols	Categories 1 - 3
Chemicals under pressure	Categories 1 - 3
Oxidizing gases	Category 1
Gases under pressure	4 Groups include: Compressed gas, Liquefied gas, Dissolved gas, and Refrigerated liquefied gas
Flammable liquids	Categories 1 - 4
Flammable solids	Division 4.1 – 4.3
Self-reactive substances	Types A-G
Pyrophoric solids	Category 1
Pyrophoric liquids	Category 1
Self-heating substances	Categories 1 and 2
Substances which in contact with water emit flammable gases	Categories 1 - 3
Oxidizing liquids	Categories 1 - 3
Oxidizing solids	Categories 1 - 3
Organic peroxides	Types A-G
Substances corrosive to metal	Category 1

See **Appendix A** for Chemical Hazard Categories.

3.2.2.1 Radiation and Laser Hazards

[The Illinois Emergency Management Agency](#) outlines regulations governing the use of radiation and lasers.

Benedictine University does not currently have any regulated material or equipment that produces ionizing radiation, therefore there are no radiation hazards on campus. The University has appointed a Radiation/Laser Safety Officer in cooperation with the Safety Committee who will be responsible for evaluating any requests to bring radiation sources on campus. If radiation sources are brought to campus, the Radiation/Laser Safety Officer, in cooperation with the Safety Committee, is responsible for developing policies and procedures for safe handling, use, and disposal of radioactive materials.

ANSI Z136.1-2000 recommends that all class 3b and 4 laser users must have laser safety training including topics such as laser hazards, laser classifications, signage/labeling, medical monitoring, safety guidelines, and what to do in case of an exposure incident.

Benedictine University recently acquired a Class 4 laser which can also be used as a Class 1.

It is the responsibility of the faculty member with class 3b or 4 LASERs in laboratories under their supervision to ensure the class 3b or 4 LASERs are registered with the Radiation/Laser Safety Officer and employees and students using these LASERs have received the appropriate training. It is the responsibility of the faculty member to establish guidelines to protect students and employees from the potential hazards associated with laser devices.

3.3 Hazard Control

Controlling exposures to hazards in the workplace is vital to protecting workers. The hierarchy of controls is a way of determining which actions will best control exposures. The hierarchy of controls has five levels of actions to reduce or remove hazards. The preferred order of action based on general effectiveness is: elimination, substitution, engineering controls, administrative controls and personal protective equipment (PPE).

3.3.1 Elimination

Elimination removes the hazard at the source. This could include changing the work process to stop using a toxic chemical, heavy object, or sharp tool. It is the preferred solution to protect workers because no exposure can occur.

3.3.2 Substitution

Substitution is using a safer alternative to the source of the hazard. An example is using plant-based printing inks as a substitute for solvent-based inks.

When considering a substitute, pay attention to the potential for new risks. An effective substitute reduces the potential for harmful effects and do not create new risks.

3.3.3 Engineering Controls

Engineering controls are the third line of defense in the laboratory for the reduction or elimination of the potential exposure to hazardous chemicals. Examples of engineering controls used in laboratories at Benedictine University include dilution ventilation, local exhaust ventilation, chemical fume hoods, glove boxes and other containment enclosures, as well as ventilated storage cabinets. If the HVAC system is malfunctioning in the building, the laboratory **SHALL NOT** be used until the ventilation has been restored.

The **OSHA Laboratory Standard** requires that "fume hoods and other protective equipment function properly and that specific measures are taken to ensure proper and adequate performance of such equipment." General laboratory room ventilation is not adequate to provide proper protection against bench top use of hazardous chemicals. Laboratory personnel need to consider available engineering controls to protect themselves against chemical exposures before beginning any new experiment(s) involving the use of hazardous chemicals.

The proper functioning and maintenance of fume hoods and other protective equipment used in the laboratory is the responsibility of the University, but it is the responsibility of both Facilities and the CHO to facilitate or conduct periodic inspections of equipment such as fire extinguishers, emergency eyewash and showers, and mechanical ventilation to ensure proper functioning and adequate performance of these important pieces of protective equipment.

It is the responsibility of laboratory personnel to immediately report malfunctioning protective equipment, such as fume hoods, or mechanical problems to the CHO as soon as any malfunctions are discovered.

3.3.4 Administrative Controls

Administrative controls include policies and procedures that result in providing proper guidance for safe laboratory work practices and set the standard for behavior within the laboratory. Once developed, administrative controls must be implemented and adhered to by all personnel working in the laboratory.

CHO is responsible for developing policies and written guidelines to ensure laboratory workers are protected against exposure to hazardous chemicals as outlined in the OSHA Laboratory Standard and physical hazards that may be present, including the development of a written CHP.

It is the responsibility of the teaching and research faculty to ensure that personnel working in laboratories under their supervision are informed and follow laboratory specific, departmental, and campus wide policies and procedures related to laboratory safety – such as the guidelines and requirements covered in this CHP.

In addition to meeting regulatory requirements identified within this CHP, departments shall incorporate the recommendations and guidelines identified within this Plan. While this CHP provides the minimum requirements and recommendations to meet the intent of the OSHA Laboratory Standard, faculty have the authority to implement more stringent policies within laboratories under their supervision and are encouraged to do so.

3.3.5 Personal Protective Equipment (PPE)

Personal Protective Equipment (PPE) should be used in conjunction with engineering and administrative controls for the protection of laboratory personnel against chemical hazards. PPE is not a substitute for good engineering, or administrative controls, or good work practices. These control measures help to ensure the safety and health of University employees and students.

The OSHA Personal Protective Equipment standard, **29 CFR 1910.132** has the following requirements: The employer shall assess the workplace to determine if hazards are present, or are likely to be present, which necessitate the use of PPE. If such hazards are present, or likely to be present, the employer shall:

- Conduct hazard assessment and equipment selection
- Employee training
- Record keeping requirements
- Guidelines for selecting PPE
- Hazard assessment certification

Faculty and laboratory personnel need to conduct hazard assessments of specific operations occurring in their laboratories to determine what PPE is necessary to safely carry out the operations. PPE must be worn to reduce exposures to hazardous chemicals in the lab. Proper PPE includes items such as gloves, eye protection, lab coats, face shields, aprons, boots, hearing protection, etc.

When deciding on the appropriate PPE to wear when performing any experiments or operations, a number of factors must be taken into consideration such as:

- The chemicals being used, including concentration and quantity;
- The hazards the chemicals pose;
- The routes of exposure for the chemicals;
- The material the PPE is constructed of;
- The permeation and degradation rates specific chemicals will have on the material; and
- The length of time the PPE will be in contact with the chemicals.

Careful consideration should be given to the comfort and fit of PPE to ensure that it will be used by laboratory personnel. In addition, the temperature in the room could impact the comfort and ability to wear certain PPE.

All PPE and clothing must be maintained in a sanitary and reliable condition. Only those items that meet the National Institute of Occupational Safety and Health (NIOSH) or American National Standards Institute (ANSI) should be accepted for use.

Eye Protection

Eye protection is one of the most important and easiest forms of PPE to wear. All laboratory employees, students, and visitors must use eye protection while in laboratories where chemicals are being handled or stored, at all times, even when not working directly with chemicals. Eye protection is used to protect individuals from many chemical and physical hazards found in laboratories including flying particles, broken glass, molten metal, acids or caustic liquids, chemical liquids, chemical gases or vapors, or potentially injurious light radiation. [105 ILCS 115](#), "Eye Protection in School Act" requires every student, teacher and visitor to wear an industrial quality eye protective device.

The OSHA Health and Safety Topics Page (www.osha.gov/SLTC/eyefaceprotection/index.htmlfor eye and face protection) provides guidance for choosing eye and face protection.

Eye Protection Selection

All protective eye and face devices **MUST COMPLY** with ANSI Z87.1-2003, "American National Standard Practice for Occupational and Educational Eye and Face Protection" and be marked to identify the manufacturer. When choosing proper eye protection, be aware there are a number of different styles of eyewear that serve different functions.

Prescription Safety Eyewear

OSHA regulations require that employees who wear prescription lenses while engaged in operations that involve eye hazards shall wear eye protection that incorporates the prescription in its design, or must wear eye protection that can be worn over the prescription lenses (goggles, face shields, etc.) without disturbing the proper position of the prescription lenses or the protective lenses. Any prescription eyewear purchase must comply with ANSI Z87.1-1989.

Note: Contact lenses are not recommended in chemistry laboratories since they may absorb certain solvents. In addition, contact lenses represent a special hazard in the event of chemical splash to the eyes because they tend to concentrate hazardous chemical materials against the cornea and prevent tears from washing away the hazardous chemical. Contact lenses by themselves are not considered as protective eyewear.

Safety Glasses

Safety glasses provide eye protection from moderate impact and particles associated with grinding, sawing, scaling, broken glass, and minor chemical splashes, etc. Side protectors are required when there is a hazard from flying objects. Safety glasses do not provide adequate protection for processes that involve heavy chemical use such as stirring, pouring, or mixing. In these instances, splash goggles should be used.

Splash Goggles

Splash goggles provide adequate eye protection from many hazards, including potential chemical splash hazards, use of concentrated corrosive material, and bulk chemical transfer. Goggles are available with clear or tinted lenses, fog proofing, and vented or non-vented frames. Be aware that goggles designed for woodworking or viruses are not appropriate for working with chemicals. These types of goggles can be identified by the numerous small holes throughout the facepiece. In the event of a splash, chemicals could enter into the small holes, and result in a chemical exposure to the face. Ensure the goggles you choose are rated for use with chemicals.

Impact Goggles

Equipped with a tough, polycarbonate lens and soft, pliable shroud, these safety goggles help protect against certain particles and liquids while providing a comfortable fit that conforms to your face. The large size also accommodates some personal eyewear. Strategic vents help ensure protection from liquids while allowing airflow. The stretchy, adjustable strap provides a secure, personalized fit.

Face Shields

Face shields provide additional protection to the eyes and face when used in combination with safety glasses or splash goggles. Face shields consist of an adjustable headgear and face shield of tinted or clear lenses or a mesh wire screen. They should be used in

operations when the entire face needs protection and should be worn to protect the eyes and face from flying particles, metal sparks, and chemical/biological splashes. Face shields with a mesh wire screen are not appropriate for use with chemicals. Face shields must **not** be used alone and are **not** a substitute for appropriate eyewear. Face shields should always be worn in conjunction with a primary form of eye protection such as safety glasses or goggles.

LASER Eye Protection

A single pair of safety glasses is not available for protection from all LASER outputs. The type of eye protection required is dependent on the spectral frequency or specific wavelength of the laser source. Faculty using lasers should consult the user's manual to ensure that the proper eye protection is selected.

Hand Protection

Most accidents involving hands and arms can be classified under four main hazard categories: chemicals, abrasions, cuts, and heat/cold. Gloves must be worn whenever significant potential hazards from chemicals, cuts, lacerations, abrasions, punctures, burns, biologicals, or harmful temperature extremes are present. The proper use of hand protection can help protect from potential chemical and physical hazards. Gloves must be worn when using chemicals that are easily absorbed through the skin and/or particularly hazardous substances (such as "select carcinogens", reproductive toxins, and substances with a high degree of acute toxicity).

There is not one type of glove that offers the best protection against all chemicals or one glove that totally resists degradation and permeation to all chemicals. All gloves must be replaced periodically, depending on the type and concentration of the chemical, performance characteristics of the gloves, conditions and duration of use, hazards present, and the length of time a chemical has been in contact with the glove.

All glove materials are eventually permeated by chemicals; however, they can be used safely for limited time periods if specific use and other characteristics (i.e., thickness, permeation rate, and time) are known.

Gloves shall be removed before touching public objects such as telephones, elevator buttons, or door handles to avoid contamination.

Selecting the Proper Gloves

Before working with any chemical, always read manufacturer instructions and warnings on chemical container labels and SDSs. Recommended glove types are sometimes listed in the PPE section of the SDS. If the recommended glove type is not listed on the SDS, then laboratory personnel should consult with the manufacturers' glove selection charts. These charts typically include commonly used chemicals that have been tested for the manufacturers' different glove types. Different manufacturers use different formulations so check the glove chart of the specific manufacturer for the glove you plan to use.

If the manufacturers' glove chart does not list the specific chemical you will be using, then call the manufacturer directly and speak with their technical representatives to determine which glove is best suited for your particular application.

It is important to know that not all chemicals or mixtures have been tested by glove manufacturers. It is especially important in these situations to contact the glove manufacturer directly.

Some general guidelines for glove use include:

- Wear appropriate gloves when the potential for contact with hazardous materials exists. Laboratory personnel should inspect gloves for holes, cracks, or contamination before each use. Any gloves found to be questionable should be discarded immediately.
- Gloves should be replaced periodically, depending on the frequency of use and permeability to the substance(s) handled. Reusable gloves should be rinsed with soap and water and then carefully removed after use. Discard disposable gloves after each use and whenever they become contaminated.
- ***Due to potential chemical contamination, which may not always be visible, gloves must be removed before leaving the laboratory.***

Gloves shall be removed before touching public objects such as telephones, elevator buttons, or door handles to avoid contamination.

Double Gloving

A common practice to use with disposable gloves is “double-gloving”. This is accomplished when two pairs of gloves are worn over each other to provide a double layer of protection. If the outer glove becomes contaminated, starts to degrade, or tears open, the inner glove continues to offer protection until the gloves are removed and replaced. The best practice is to check outer gloves frequently, watching for signs of degradation (change of color, change of texture, tears, etc.). At the first sign of degradation or contamination, always remove and dispose of the contaminated disposable gloves immediately and double-glove with a new set of gloves. If the inner glove appears to have any contamination or degradation, remove both pairs of gloves, wash hands, and double glove with a new pair.

Another approach to double gloving is to wear a thin disposable glove (4 mil Nitrile) under a heavier glove (8 mil Nitrile). The outer glove is the primary protective barrier while the under glove retains dexterity and acts as a secondary barrier in the event of degradation or permeation of the chemical through the outer glove. Alternately, you could wear a heavier (and usually more expensive and durable) 8 mil Nitrile glove as an under glove and wear thinner, disposable 4 mil Nitrile glove as the outer glove (which can help improve dexterity). However, remember to change the thinner outer gloves frequently.

When working with mixtures of chemicals, it may be advisable to double glove with two sets of gloves made from different materials. This method can offer protection in case the outer glove material becomes permeated by one chemical in the mixture, while allowing for enough protection until both gloves can be removed. The type of glove materials selected for this type of application will be based on the specific chemicals used as part of the mixture. Check chemical manufacturers glove selection charts first before choosing which type of glove to use.

To properly remove disposable gloves, grab the cuff of the left glove with the gloved right hand and remove the left glove. While holding the removed left glove in the palm of the gloved right hand, insert a finger under the cuff of the right glove and gently invert the right glove over the glove in the palm of your hand and dispose of them properly. Be sure to wash your hands thoroughly with soap and water after the gloves have been removed.

Types of Gloves

As with protective eyewear, there are a number of different types of gloves that are available for laboratory personnel that serve different functions:

Fabric Gloves

Fabric gloves are made of cotton or fabric blends and are generally used to improve grip when handling slippery objects. They also help insulate hands from mild heat or cold. These gloves are not appropriate for use with chemicals because the fabric can absorb and hold the chemical against a user's hands, resulting in a chemical exposure.

Leather Gloves

Leather gloves are used to guard against injuries from sparks, scraping against rough surfaces, or cuts from sharp objects like broken glass. They are also used in combination with an insulated liner when working with electricity. These gloves are not appropriate for use with chemicals because the leather can absorb and hold the chemical against a user's hands, resulting in a chemical exposure.

Heat Resistant Gloves

Heat resistant gloves are used to protect hands while handling hot objects. Care must be taken to ensure that they are properly insulated if handling objects that are both hot and wet. They are most commonly used when working with glassware that is being heated or when removing objects from an autoclave or heating oven.

Cryogenic Gloves

Cryogenic gloves are used to protect hands from extremely cold temperatures. These gloves should be used when handling dry ice and when dispensing or working with liquid nitrogen and other cryogenic liquids.

Chemically Resistant Gloves

Chemically resistant gloves come in a wide variety of materials. The recommendations given below for the specific glove materials are based on incidental contact. Once the chemical makes contact with the gloved hand, the gloves should be removed and replaced as soon as practical. Often a glove specified for incidental contact is not suitable for extended contact, such as when the gloved hand can become covered or immersed in the chemical in use. Before selecting chemical resistant gloves, consult the glove manufacturers' recommendations or their glove selection charts.

Some general guidelines for different glove materials include:

- **Butyl Gloves** - are made of a synthetic rubber and protect against many chemicals, such as peroxide, rocket fuels, highly corrosive acids and strong bases. These gloves also resist oxidation and abrasion, and stay flexible at low temperatures.
- **Natural Rubber Latex***** - Resistant to ketones, alcohols, caustics, and organic acids. See note below.
- **Neoprene** - Resistant to mineral acids, organic acids, caustics, alcohols, and petroleum solvents.
- **Nitrile** - Resistant to alcohols, caustics, organic acids, and some ketones.
- **Norfoil** - Rated for chemicals considered highly toxic and chemicals that are easily absorbed through the skin. These gloves are chemically resistant to a wide

range of materials that readily attack other glove materials. These gloves are not recommended for use with Chloroform. Common brand names include: Silver Shield by North Hand Protection, 4H by Safety4, or New Barrier by Ansell Edmont.

- Polyvinyl chloride (PVC) - Resistant to mineral acids, caustics, organic acids, and alcohols.
- Polyvinyl alcohol (PVA) - Resistant to chlorinated solvents, petroleum solvents, and aromatics.

*** A note about latex gloves

The use of latex gloves, especially thin, disposable exam gloves, for chemical handling is **discouraged** because latex offers little protection from commonly used chemicals. Latex gloves can degrade severely in minutes or seconds, when used with common lab and shop chemicals. Latex gloves also can cause an allergic reaction in a percentage of the population due to several proteins found in latex. Symptoms can include nasal, eye, or sinus irritation, hives, shortness of breath, coughing, wheezing, or unexplained shock. If any of these symptoms become apparent in personnel wearing latex gloves, discontinue using the gloves and seek medical attention immediately.

The use of latex gloves is only appropriate for:

- Most biological materials.
- Nonhazardous chemicals.
- Clean room requirements.
- Medical or veterinary applications.
- Very dilute, aqueous solutions containing <1% for most hazardous chemicals or less than 0.1% of a known or suspected human carcinogen.

Staff required to wear latex gloves should receive training on the potential health effects related to latex. Hypoallergenic, non-powdered gloves should be used whenever possible. If a good substitute glove material is available, then use nonlatex gloves. A general-purpose substitute for disposable latex gloves is disposable Nitrile gloves. Benedictine University has made the decision to no longer use latex gloves. Please refer to the Latex Allergy Policy found at S:\University Info\Policies and Procedures\Emergency Information.

Lab Coats and Other Protective Clothing

Hazards exist in every University workplace and can take many different forms: sharp edges, falling objects, flying sparks, chemicals, noise, and a myriad of other potentially dangerous situations. Controlling a hazard at its source is the best way to protect students, employees and guests. The preferred solution is to use engineering or administrative controls to manage or eliminate the hazard to the greatest extent possible. When these controls are not feasible PPE must be used. The University requires a laboratory coat to be worn for admittance into any laboratory areas in which work with hazardous material, flammable and corrosive materials, radioactive materials and biological agents is conducted.

Lab coats are an important part of PPE that serve to:

- Provide protection of skin and personal clothing from incidental contact
- Prevent the spread of contamination outside the lab (provided they are not worn outside the lab)
- Provide a removable barrier in the event of an incident involving a spill or splash of hazardous substances

In general, lab coats and other protective clothing should not be used as a substitute for engineering controls such as a fume hood, a glove box, process enclosure, etc., or as a substitute for good work practices and personal hygiene. Conversely, use of engineering controls such as fume hoods do not preclude the need for wearing the proper PPE, including lab coats.

The following information and Do's and Don'ts should be considered when wearing a lab coat:

- The specific hazard(s) and the degree of protection required, including the potential exposure to chemicals, radiation, biological materials, and physical hazards such as heat.
- The type of material the clothing is made of and its resistance to the specific hazard(s) that will be encountered.
- The comfort of the protective clothing, which impacts the acceptance and ease of use by laboratory personnel.
- DO wear a lab coat when hazards to the body are present or likely to be present. A good rule of thumb is to wear a lab coat at all times when working in a lab.
- DO wear a lab coat of appropriate size.
- DO wear lab coats that hit just above the knees and have full-length sleeves, preferably tight sleeves than the loose ones.
- DO keep lab coats completely "buttoned" up. Snap closures are preferred over buttons or slippers to keep the body covered and allow quick removal in an emergency.
- DO immediately remove a lab coat if on fire or there is obvious hazardous contamination.
- DO consider the addition of a rubber apron when there is a significant chance of exposure to corrosive materials.
- DON'T wear lab coats unbuttoned. An open lab coat is an invitation for hazardous exposures.
- DON'T roll up the sleeves on lab coats for comfort or ventilation.
- DON'T wear lab coats outside the lab. Lab coats and other protective wear used in a lab should be kept in the work area to minimize the possibility of spreading chemicals to public spaces including eating or office areas.
- DON'T remove the lab coats from a BSL2 laboratory. The University will supply and launder the lab coats for those laboratories.

Hearing Protection

Hearing protection devices includes earplugs, earmuffs, or similar devices designed to protect your hearing. If occupational noise exposures exceed permissible levels and cannot be reduced through engineering or other controls, then hearing protection devices must be worn. Occupational Noise Exposure as defined by OSHA General Industry Standard "**Occupational Exposure to Noise" Part 1910.95** and the Hearing Conservation Amendment.

Additional information can be obtained from the OSHA Health and Safety Topics:
www.osha.gov/SLTC/noisehearingconservation/index.html

Foot Protection

Laboratory personnel (and other personnel) must wear foot protection at all times in laboratories, laboratory support areas, and other areas with chemical, biological and physical hazards are present. Laboratory personnel must not wear sandals or similar types of perforated or open-toed shoes whenever working with or around hazardous

chemicals or physical hazards. This is due to the potential exposure to toxic chemicals and the potential associated with physical hazards such as dropping pieces of equipment or broken glass being present. Shoes which are not inherently stable (high, narrow heels) pose a slip hazard. Shoes without backs (such as clogs) pose a slip hazard. In general, shoes should be comfortable, and leather shoes are preferable to cloth shoes due to the better chemical resistance of leather compared to cloth. Leather shoes also tend to absorb fewer chemicals than cloth shoes. However, leather shoes are not designed for long term exposure to direct contact with chemicals. In such instances, chemically resistant rubber boots are necessary.

3.4 Safe Work Practices

Procedural controls incorporate best management practices for working in a laboratory. These practices serve not only to protect the health and safety of personnel, but are a common-sense way of increasing productivity in a laboratory. Through implementation of good practices, laboratories can expect an increase in the efficient use of valuable lab space, in the reliability of experiments due to less potential contamination, and an increase in the awareness of health and safety issues by laboratory personnel. Following the practices outlined in this CHP should also result in a decrease in the number of accidents, injuries, and spills. This will result in a decrease in the overall liability for faculty, laboratory supervisor, and the University. Procedural controls are fundamental to instilling safe work behaviors and helping to create a culture of safety within the laboratory environment.

Housekeeping refers to the general condition and appearance of a laboratory and includes:

- Keeping all areas of the lab free of clutter, trash, extraneous equipment, and unused chemical containers. Areas within the lab that should be addressed include benches, hoods, refrigerators, cabinets, chemical storage cabinets, sinks, trash cans, etc.
- Keep all containers of chemicals closed when not in use.
- Cleaning up all chemical spills immediately, regardless if the chemical is hazardous or not. When cleaning up a chemical spill, look for any splashes that may have resulted on nearby equipment, cabinets, doors, and counter tops. For more information on cleaning up spills, see the Chemical Spill Procedures section.
- Keeping areas around emergency equipment and devices clean and free of clutter. This includes items such as eyewash/emergency showers, drench hoses, electric power panels, fire extinguishers, and spill cleanup supplies.
- Keeping a minimum of three feet of clearance (as required by fire codes) between benches and equipment. Exits must be clear of obstacles and tripping hazards such as bottles, boxes, equipment, electric cords, etc. Combustible materials may not be stored in exits (including corridors and stairways), exit enclosures, boiler rooms, mechanical rooms, or electrical equipment rooms.
- When storing non-chemical items overhead, keep heavier and bulkier items closer to the floor.
- Never store chemicals on shelves/cabinets that are above shoulder height.
- Always use a stepladder when reaching for overhead items, do not stand on chairs or countertops.

Maintaining a neat and orderly laboratory is essential to the safety of those who work and learn in the laboratory. Poor housekeeping is found to be the cause or contributing factor in many laboratory accidents. General practices for maintaining good housekeeping in the laboratory include:

- Maintain clear access ways to exits and emergency equipment at all times;
- Keep floors clean, dry and free of clutter;
- Wipe down lab benches frequently;
- Maintain individual work spaces and clean regularly;

- Store chemical containers in the appropriate locations;
- Keep chemical containers capped and away from the edge of the lab tables; and
- Properly store compressed gas cylinders.

In summary, good housekeeping has obvious health and safety benefits and can have a positive mental effect on laboratory personnel who work in a clean environment, which can lead to increased productivity. Also keep in mind that during an inspection by a state or federal regulatory agency, the general condition of the laboratory observed in the first few minutes of the inspection (the housekeeping of the lab) can have a significant impact (positive or negative) on the rest of the inspection process.

It is the responsibility of faculty to ensure laboratories under their supervision are maintained in a clean and orderly manner and personnel working in the lab practice good housekeeping.

3.5 Labeling

The faculty members, supervisors and/or designated department safety representative in departments storing hazardous chemicals are responsible for ensuring that all hazardous chemicals in their area are properly labeled and that the labels are updated as necessary.

1. Effective labeling may consist of affixed labels, securely attached tags, or highly visible signs posted immediately adjacent to a tank or vessel.
2. Labels on shipped or movable containers and bulk tanks and vessels must show the product identifier, signal word, hazard statement, pictogram (see following page), precautionary statement(s) and the name, address and telephone number of the chemical manufacturer, importer or other responsible party. For unclassified hazards, the label shall include the name of the chemical, the name, address and telephone number of the manufacturer, importer, or other responsible party, and, provide as supplementary information, a description of the unclassified hazard and appropriate precautionary measures to ensure the safe handling and use of the chemical.
3. Workplace labeling is required where transfers of chemicals are made from a large labeled container to a smaller container. Workplace labels must meet one of the following two options:
 - a. Meet the requirements of supplier labels with the exception that the name, address, and phone number of the chemical manufacturer, importer or distributor is not required, or
 - b. Include a product identifier and signal words, pictograms, symbols or combination thereof, which provide at least general information regarding the hazards of the chemical, and which, in conjunction with the other information immediately available to employees under the Hazard Communication program, will provide employees with the specific information regarding the physical and health hazards of the hazardous chemical.
4. Workplace labels shall be legible, in English and prominently displayed on the container, tank or vessel, or readily available in the work area.
5. No label is required for portable containers into which hazardous chemicals are transferred from labeled containers and which are intended only for immediate use of the employee who performs the transfer.
6. A label is required on the portable container if a different employee is working with the chemical and not the employee who performed the transfer. This label must consist of the product identifier and signal word, pictograms, symbols or combination thereof.

Labels shall not be defaced or removed on any containers, tanks or vessels of hazardous materials.

3.6 Maintenance and Inspections

Facilities will handle all maintenance issues and requests. Equipment that is out of service shall be labeled as such and if necessary "locked out." Out of service equipment will be repaired as quickly as possible. Equipment with safety/health implications should receive priority.

Formal laboratory inspections should be held quarterly but not less frequently than semiannually by the CHO and/or Emergency Preparedness Manager/Safety Specialist. Informal inspections should be carried out by teaching and research faculty continually in order to correct any deficiencies as quickly as possible. Eyewash and shower units shall be inspected weekly by Facilities staff and annually by a plumber. Drench hoses shall be inspected weekly by the PI of the lab and annually by a plumber. Fire extinguishers shall be inspected monthly by Facilities.

Section 4 Chemical Inventory, Procurement, Distribution, Waste Removal and Transportation/Shipping

4.1 Chemical Inventory

The Verteré Chemical Inventory system is used to inventory, track, share, and account for the thousands of chemicals used on campus. Upon initial receipt, chemicals are logged and entered into the departments' inventory system by the CHO. The inventory system includes:

- The name, amount and date the chemical was received;
- Location where the chemical is stored; and
- Amounts used should be recorded as the chemical is being used.

All departments may perform searches of chemicals in order to track their location and current use. Faculty can choose whether to make their chemicals available for sharing or not. This functionality is encouraged as a way to reduce waste and use our chemical inventory most efficiently.

Chemicals may NEVER be ordered using an individual credit card. Prior to ordering, the CHO must be made aware of all chemicals ordered, the PI responsible, and where the chemical(s) will be stored. For the sciences, only the CHO and Lab Manager may order/purchase chemicals. Chemicals purchased for the Mesa campus will be delivered to Gillett Hall. When a chemical is moved from one room to another, science and fine arts faculty should email the CHO with the chemical name and barcode so the appropriate change may be made in the inventory system. All laboratories with chemicals will be audited throughout the year to maintain our current inventory.

The frequency of chemical use and specific inventory procedures vary by department:

- **Chemistry** – The Chemistry department has the largest volume of chemicals and most frequent use of the Verteré system. Initial inventory of the stockroom and all labs/classrooms has been completed. When the chemical(s) arrive, it must come to the stockroom to be inventoried prior to distribution for the Lisle campus.
 - All new chemical deliveries go through the CHO.
 - When chemicals become out of date or depleted, faculty shall bring the empty container to the chemical stockroom with the chemical name/barcodes so the appropriate change can be made in the inventory system. Do not clean or deface the container.
- **Biology** – The Biology department follows similar procedures to the Chemistry department. An initial inventory of Biology research and teaching labs has been completed. When the chemical(s) arrive, it must come to the stockroom to be inventoried prior to distribution for the Lisle campus.
 - New, never used hazardous chemical should be ordered through the CHO. If reordering already existing hazardous chemicals, the lab managers can place the order and let the CHO know for inventory.
 - When chemicals become out of date or depleted, faculty shall bring the empty container to the chemical stockroom with the chemical name/barcodes so the appropriate change can be made in the inventory system. Do not clean or deface the container.
- **Fine Arts** – The Fine Arts department uses chemicals for two primary artistic mediums: printmaking and oil painting. Chemicals are safely stored in the rooms pertaining to the courses that use the chemicals. This includes
 - Designated Fine Arts fulltime faculty would be in charge of ordering the chemicals for the courses.
 - Chemical waste is stored in containers designated and labeled for its purpose.
 - The Designated Fine Arts fulltime faculty should contact CHO for inclusion of new chemicals in the inventory system or removal of old chemicals.

Chemicals used in Facilities, Art and in Athletics will be inventoried in Verteré. Facilities and Athletics do not fall within the CHP but are covered under the Hazard Communication Standard.

PI's that create a secondary container of a chemical must have a workplace label which includes the following:

- Full name of chemical
- Signal word
- GHS pictogram
- Date created for peroxide formers and other chemicals with limited shelf-life

4.2 Chemical Procurement

Before ordering new chemicals, search your existing inventories and use those chemicals currently in stock. An accurate and up-to-date chemical inventory can help to minimize purchase of chemicals already on hand and can facilitate acquisition of Safety Data Sheets (SDS).

If it is necessary to purchase new chemicals, laboratory personnel should request the smallest size necessary to carry out the experiment. Avoid ordering extra quantities because the chemical "might be needed in the future". Try to take advantage of chemical vendors "Just-In-Time" delivery rather than stockpiling chemicals in your lab.

Procurement of new chemicals that are hazardous requires prior approval from the CHO to ensure adequate safety provisions are in place to control risks to laboratory workers and/or the University community, as well as to comply with any additional regulatory requirements. This includes:

- Procurements of particularly hazardous substances (carcinogens, reproductive toxins, highly acute toxins); and
- Procurements of highly reactive or flammable chemicals that present a physical safety hazard to the user or other laboratory/building occupants.

4.3 Chemical Distribution

Chemicals should be received in the chemical stockroom only for the Lisle campus to ensure the input into the inventory, which is properly equipped (e.g. spill kit) to handle shipments of chemical substances. For the Mesa campus, chemicals should be received in Gillett Hall. The CHO or designee shall be authorized to receive shipments. Basic guidance on chemical distribution includes:

- Personal vehicles should never be used to move hazardous materials.
- Chemicals distributed from the stockroom should be moved on designated carts.
- Chemicals should be distributed using break-resistant secondary containers made of materials that are compatible with the chemicals, particularly for corrosives and solvents.
- Secondary containers must have adequate volume to contain primary container volume.
- Compressed gas cylinders must be properly secured and strapped to the cart during distribution.
- Compressed gas cylinders must be transported using hand-trucks or other appropriate means.
- Cylinders should be transported upright whenever possible.
- Elevators can be a confined space. Due to the potential for exposure to unsafe conditions in the event of a significant leak or catastrophic release, it is recommended that individuals do not ride in an elevator with compressed gas or pressurized cryogenic cylinders (nitrogen only). A sign will be placed on the cylinder in the elevator stating "Do not travel in elevator with compressed gases and pressurized cryogenic liquids."

4.4 Chemical Storage

While chemical storage requirements will vary depending on the nature of the laboratory work and the chemicals being stored, basic practices for safe chemical storage include:

1. Store chemicals only in compatible containers.

2. Segregate chemicals base on compatibility (see Appendix B).
 - a. Storing chemicals alphabetically, without regard to compatibility, can increase the risk of a hazardous reaction, especially in the event of container breakage.
 - b. Use common sense when setting up chemical storage. Segregation that disrupts normal workflow can increase the potential for spills.
 - c. In general, dry reagents, liquids and compressed gases should be stored separately, then by hazard class, then by any additional incompatibilities (and then alphabetically if desired).
3. Provide a specific storage location for each type of chemical, and return the chemicals to those locations after each use.
 - a. Arrange for the storage of highly reactive chemicals before procurement.
 - b. Avoid storing chemicals in the workspace within a laboratory hood or on lab bench tops, except for those chemicals currently in use.
 - c. If a chemical does not require a flammable storage cabinet or ventilated cabinet, store it inside a closable cabinet or on a shelf that has a lip to prevent containers from sliding off in the event of an accident or fire.
4. Ensure cabinets for chemical storage are of a solid, sturdy construction, preferable hardwood or metal. Be sure that the weight of the chemicals does not exceed the load capacity of the shelf or cabinet.
5. Avoid storing materials and equipment on top of cabinets. If you must place things there, maintain a clearance of at least 18 inches from the sprinkler heads or (if no sprinkler heads are present) 24 inches from the ceiling.
6. No chemicals shall be stored above shoulder height. Use corrosion resistant storage trays or secondary containers to collect materials if the primary container breaks or leaks.
7. Do not store flammable liquids in a refrigerator unless it is approved for such storage. Such refrigerators are designed with non-sparking components to avoid an explosion. Distinguish between refrigerators used for chemical storage and refrigerators used for food storage. Each refrigerator should be labeled "No Food" or "Food Only."
8. Do not store chemicals near direct sunlight or heat sources.
9. Avoid storing chemicals near exits, passageways, or emergency equipment.
10. For Compressed Gas Cylinder storage:
 - a. Ensure cylinders are secured with a strap or chain.
 - b. Store cylinders away from sources of heat and flame.
 - c. When cylinders are no longer in use, ensure that the valve is shut, pressure relieved from regulators, regulators removed, and the cylinder is capped.
 - d. Ensure cylinders are segregated flammables vs. oxidizers/non-reactives.
11. Hazardous chemicals may not be stored in a location near a drain unless there is sufficient secondary containment for quantity of chemical.
12. Keep laboratory doors locked at all times when not in use.

4.5 Chemical/Biological Waste Removal

Hazardous waste, as defined by the Environmental Protection Agency (EPA), is waste with properties that make it dangerous or capable of having a harmful effect on human health or the environment. Hazardous waste is generated from several sources, ranging from laboratory experiment waste (chemical or biological hazardous waste) to biomedical waste from Student Health, Campus Safety, Athletics or Exercise Physiology. All hazardous waste is disposed of at least two times during the year, typically at the end of the spring and fall semesters.

Glassware that is broken, cracked or chipped shall not be used. Pipettes shall not protrude from bottles, flasks, or beakers. When stoppers are stuck on gas tubing, do not attempt to force removal but instead cut them off. Glassware shall be decontaminated after exposure to potentially harmful substances such as infectious or chemical agents. Dispose of broken glass in a labeled puncture-proof container.

Sharps shall be disposed of in designated containers. The containers shall be labeled or color-coded, leak-proof containers that are closable and easily accessible to the user. Sharps containers shall not be allowed to over-fill. Sharps containers shall be disposed of in an appropriate manner after they become three-fourths full.

The hazardous waste inventory is compiled by the CHO and sent to the Emergency Preparedness Manager/Safety Specialist for a request for quote. This list has waste from chemistry, biology, art and other departments with hazardous waste.

The Emergency Preparedness Manager/Safety Specialist and the CHO must be notified of any accidents, spills, or any other potentially dangerous incidents involving hazardous materials. The Emergency Preparedness Manager/Safety Specialist will coordinate the clean-up and disposal of any chemical, biological or biomedical waste.

It is illegal to pour hazardous chemical waste down drains. It is also illegal to evaporate chemicals as a method of disposal. Make sure all chemical waste is placed in the waste containers located in each lab. Chemicals cannot be neutralized in order to dispose unless part of the experimental standard operating procedures. All chemical hazardous waste must be brought to the CHO for proper inventory and disposal.

All waste should be segregated according to hazard. Hazard should be indicated on the waste container. A waste log should be kept indicating the full name (not abbreviated) of each component added, how much was added (either volume or percentage of total volume), and the date it was added to the waste container. When the waste container is full, the PI should bring it to the stockroom for processing. The PI must notify the CHO that the waste is there with the waste log attached.

4.6 Transportation/Shipping

Transporting chemicals can be a risky process, because at no other time is accidental release and exposure more likely. However, by using the same care and caution before and during transportation that one would for any experimental procedure, danger to oneself, others, and the environment can be minimized. The purpose is to ensure that safe and efficient transport between collaborators at Benedictine University and other nearby universities and research facilities of hazardous materials and samples that qualify for the Department of Transportation (DOT) material of trade (MOT) exception. MOTs are hazardous materials, other than hazardous waste, that are carried using a motor vehicle.

This section covers only non-commercial transport on public roads of DOT hazardous materials meeting MOT requirements. (**The MOT exception does not apply to transport of hazardous materials by air or waterway.**) Materials subject to this procedure are limited to samples (synthesized or purchased) transported by those conducting the research and to MOT materials as defined by the DOT (49 CFR 173.6) in the quantities listed in Table 4.6 below. This procedure does not cover transport of hazardous, radioactive, or mixed waste or transport on-site.

The MOT exception does not apply to hazardous material that is self-reactive, poisonous by inhalation, or a hazardous waste. The total for any load must not exceed 200 kg (440 lbs.).

Table 4.6

Hazard Class or Division	Packing Group	Maximum amount of material in each individual package
2.1 Flammable compressed gases	Not applicable	Each cylinder may not weigh more than 100 kg (220 lbs.) gross
2.2 Non-flammable, non-toxic gases		
3 Flammable & combustible liquid	PG I	Solids: 0.5 kg (1 lb.)
4.1 Flammable solid		Liquids: 0.5 L (1 pint)
5.1 Oxidizer		
5.2 Organic peroxide		
6.1 Poisons		
8 Corrosive		
9 Class 9 (Miscellaneous)		
Consumer commodities (ORM-D)		
3 Flammable & combustible liquid	PG II and III, or ORM-D	Solids: 30 kg (66 lbs.)
4.1 Flammable solid		Liquids: 30 L (8 gal.)
5.1 Oxidizer		
5.2 Organic peroxide		
6.1 Poisons		
8 Corrosive		
9 Class 9 (Miscellaneous)		
ORM-D		

4.3 Dangerous When Wet	Only PG II and III materials are allowed	30 ml (1 ounce)
6.2 Infectious or biological substance (non-medical waste) excludes Cat. A infectious substances	Not applicable	One or more inner packaging, each no more than 0.5 kg (1 lb.) or 0.5 L (17 ounces), totaling no more than 4 kg (8.8 lbs.) or 4 L (1 gal.) Or A single inner packaging containing not more than 16 kg (35.2 lbs.) or 16 L (4.2 gal.) in a single outer package
Diluted mixtures of Class 9 materials (not exceeding 2% concentration)	Not applicable	May be transported in a tank having a capacity of up to 1500 L (400 gal.)

Incoming materials to Benedictine University from an outside source must be shipped to and inventoried by the CHO. Safety data sheets (SDS), if applicable, must be on file.

Outgoing materials must be communicated to the CHO. The material being transported must meet the definition of MOT and transport must meet 49 CFR 173.6. This includes those transporting the material having a general knowledge of MOT regulations, quantity limitations, and packaging, marking, and labeling requirements. Contact with the receiving institution is encouraged so that they can expect and prepare for receiving the hazardous materials.

4.6.1 MOT Requirements

A hazardous materials shipment must meet all of the following conditions to qualify as MOT:

- Must meet the maximum quantity limits in Table 4.6 for packages for hazard classes and divisions,
- With the exception of tanks containing diluted mixtures of Class 9 materials, no more than a combined gross weight of 200 kg (440 lbs.) of MOT may be transported on any one vehicle, and
- Transporter must be informed of the presence of hazardous materials and have general knowledge of MOT regulations.

If a shipment qualifies as MOT and is being driven by the researcher/collaborator that synthesized the material, the following applies:

- No shipping papers are required,
- No additional emergency response information is required,
- No placarding is required,
- No formal training or retention of training records is required,
- Hazardous material must not be transported in the passenger compartment of the vehicle. Must be kept in the trunk of a passenger vehicle or the bed of a truck (this means that hatchback vehicles and van with no trunks must not be used for transporting hazardous materials), and
- Any passengers must be informed of the presence of hazardous materials.

If a shipment qualifies as MOT and is being shipped using commercial modes of transportation (UPS, FedEx, USPS):

- Must create an SDS for synthesized materials,
- Must have proper labels and marks on outside packaging; and
- Must have proper packaging for type of material being shipped.

4.6.2 Packaging and Marking Requirements

MOTs have packaging and marking requirements. The packaging must be the manufacturers original packaging or a package of equal or greater strength and integrity. The packaging must be marked with a common name (such as "gas" or "spray paint") or a proper shipping name from the Hazardous Materials Regulations (HMR) (such as "Isopropyl Alcohol.") Additionally, the following other requirements apply:

- Packaging must be leak tight for liquids and gases, and sift proof for solids,
- Packages must be securely closed, secured against movement, and protected against damage,
- Outer packaging is not required for receptacles (such as cans or bottles) that are secured against movement in cages, bins, boxes, or compartments,
- Gasoline must be transported in a metal or plastic container meeting DOT or OSHA requirements (Section 173.6 (b) (4) and Section 173.202 in the HMR),
- Cylinders and pressure vessels must conform to the HMR except that outer packaging is not required. These cylinders must be marked with the proper shipping name and identification number and have a hazard class warning label,
- If the package contains a reportable quantity of a hazardous substance, it must be marked "RQ". Reportable quantities are found in Appendix A of Section 172.101 of the HMR, and
- A tank containing a diluted mixture (not more than 2% concentration) of a Class 9 material must be marked on two opposing sides with the identification number.

Section 5 Laboratory Work Requirements

5.1 Prior Approval Requirements

Access to University laboratories are restricted to Benedictine University faculty, staff, students, or other persons on official business.

All laboratory doors shall be closed and secured when the laboratory is unoccupied. Students shall only enter the lab by the PI or faculty designee. Designee cannot be office assistants and Campus Safety. Any glass viewing panel on a laboratory door shall be free of any obstruction (e.g., blinds, paper) to allow complete view into the laboratory for emergency response purposes, with the exception of laser laboratories and the anatomy lab.

It is the responsibility of the Department Chairperson, faculty, and laboratory supervisors to restrict access of visitors, children and volunteers to areas under their supervision when potential health and physical hazards exist.

Research or other activities involving the use of laboratory space, materials, or equipment without the knowledge and approval of the responsible PI or Department Chair is strictly prohibited. Violation of this prohibition may result in disciplinary action including employee termination or student suspension or expulsion. For non-Benedictine employees and students, refer to section 5.8.

5.2 Fume Hoods

Fume hoods and other capture devices are used to contain the release of toxic chemical vapors, fumes, and dusts. Bench top use of chemicals that present an inhalation hazard is strongly discouraged. Fume hoods are to be used when conducting new experiments with unknown consequences from reactions and when a potential hazard exists.

To achieve optimum performance, the greatest personal protection, and reduced energy usage when using a fume hood:

- Ensure the fume hood is working by checking the air monitoring device on the hood. DO NOT use an improperly working fume hood.
- Keeping the hood sash lowered improves the performance of the fume hood by maintaining the internal vortex and containment. It also helps to conserve energy.
- Keep the fume hood sash closed all of the way whenever the fume hood is not being used. Shut the Sash!
- Do not use fume hoods to evaporate hazardous waste. Evaporating hazardous waste is illegal.
- For work involving particularly hazardous substances or chemicals that can form toxic vapors, fumes, or dusts, the hood or equipment within the hood may need to be fitted with condensers, traps, or scrubbers in order to prevent the vapors, fumes, and dusts from being released into the environment.
- As with any work involving chemicals, always practice good housekeeping and clean up all chemical spills immediately. Be sure to wash both the working surface and hood sash frequently and always maintain a clean and dry work surface that is free of clutter.
- If the fume hood is not working properly, then let other people in the lab know by hanging up a "Do Not Use" sign on the hood.

It is the responsibility of faculty or laboratory supervisors to ensure that all personnel working under their supervision understand proper hood procedures.

The University has the responsibility for the annual testing and inspection of fume hoods on campus. After each inspection, an inspection sticker is affixed to the fume hood. If a fume hood does not have an inspection sticker or if the existing inspection sticker on your fume hood indicates a year or more has passed since the hood was last inspected it should not be used.

Fume hood testing and inspection consists of the following:

- The face velocity will be tested for compliance with American National Standards Institute (ANSI) and American Industrial Hygiene Association (AIHA) standard Z9.5-2012.
- Hoods will be classified as acceptable or unacceptable based on the average face velocity measurement and result of the annual certification.
- If a hood is found to be unacceptable, a warning sign indicating the hood did not pass inspection and does not provide optimum protection will be attached in a conspicuous location. This information will be provided to Facilities who will follow through with the repair arrangements and the Department Chair will assist with identifying other laboratories for the use of a different hood.

5.3 Safety Cabinets

Other engineering controls for proper ventilation include biosafety cabinets, glove boxes, downdraft vented gurneys, compressed gas cabinets, vented storage cabinets, kiln exhaust, and canopy hoods. These pieces of equipment are designed to capture hazardous chemical vapors, fumes, and dusts at the source of potential contamination.

When other laboratory apparatus (such as vacuum pumps and storage cabinets) are vented into the face or side of a fume hood, disruptions can occur in the design flow of the hood and result in lower capture efficiency. When such venting occurs, the connection should be further along the exhaust ducts of the hood system rather than into the face of the hood. Per ANSI 49, All biosafety cabinets, Class I, II, and III cabinets must be tested and certified at the time of installation, and at least annually thereafter, whenever HEPA filters are changed, maintenance repairs are made or when changes to the surrounding environment are made, such as moving the cabinets or making changes to the rooms exhaust system are made that could effect changes in the cabinet's performance.

Glove boxes are sealed enclosures with an inert environment designed to protect the user, the process or both. They are usually equipped with at least one pair of gloves attached to the enclosure. The user manipulates the materials inside using the gloves. Typically, a glove box has an antechamber that is used to take materials in and out of the box.

Regular maintenance and inspection are essential to ensure that a glove box is adequately protecting the user, the environment and/or the product/process. Routine maintenance procedures and the frequency of inspection (or certification) should follow the manufacturers and regulatory recommendations and should address the pressure, ventilation, and integrity of the gloves. A log sheet will be kept documenting maintenance and inspections.

5.4 Attire and Personal Hygiene

Good chemical hygiene practices include the use of personal protective equipment (PPE) and good personal hygiene habits. Although PPE can offer a barrier of protection against chemicals and biological materials, good personal hygiene habits are essential to prevent chemical exposure, even when using PPE. There are four ways exposure to chemicals can occur. They are ingestion, inhalation, injection and absorption. The following guidelines will help ensure that a potential exposure will be avoided.

Some general guidelines to be followed include:

- Always confine long hair, loose clothing (including dragging sleeves and head scarves), and jewelry.
- Wear a lab coat when working with hazardous materials. See section 3.3.3.
- Wear closed-toed shoes that completely cover the foot and heel and are well secured on the foot.
- Wear long pants, slacks, jeans, skirts or trousers that extend from the waist to the top of the shoe.
- Remove laboratory coats, gloves, and other PPE immediately when chemical contamination occurs. Failure to do so could result in chemical exposure.
- After removing contaminated PPE, be sure to wash any affected skin areas with soap and water for at least 15 minutes.
- Remove lab coats, gloves, and other PPE before leaving the lab. Do not wear lab coats or other PPE (especially gloves) in areas outside the lab, particularly not in areas where food and drink are served, or other public areas.
- Always wash hands with soap and water after removing gloves and before leaving the lab or using items such as the phone, turning doorknobs, or using an elevator.
- Always wash lab coats separately from personal clothing.
- Do not eat, drink, chew gum, or apply cosmetics in a lab or other area where chemicals are used.
- Do not store food or drink in refrigerators that are used to store chemicals.
- Do not ever try starting a siphon or pipette by mouth, doing so can result in ingestion of chemicals or inhalation of chemical vapors. Always use a pipette aid or suction bulb to start a siphon.
- Do not wear sandals, flip-flops, shoes with cut-outs, vents, or other shoes that do not completely cover your feet. Sandals with socks is not considered appropriate attire.
- Do not wear leggings/yoga pants or similar tight-fitting pants.
- Do not wear ripped jeans, shorts, capris or skirts or any other lower-body coverings that leave skin exposed or unprotected.
- Keep cell phone in your pocket or bookbag. Do not use a cell phone in the laboratory or place it on the bench.
- Take out ear buds and remove head phones in the laboratory.
- Smoking and vaping are prohibited on campus and inside any building.
- Acrylic nails are not allowed in laboratories where there is a potential for a fire hazard.

Violation of these guidelines may result in disciplinary action including employee termination or student suspension or expulsion.

Chemical exposure can occur through ingestion of food or drink contaminated with chemicals. This type of contamination can occur when food or drinks are brought into a lab or when food or drinks are stored in refrigerators, freezers, or cabinets with chemicals. When this occurs, it is possible for the food or drink to absorb chemical vapors and thus lead to a chemical exposure when the food or drinks are consumed. Eating or drinking in areas exposed to toxic materials is prohibited by the **OSHA Sanitation Standard, 29 CFR 1910.141(g)(2)**.

A similar principle of potential chemical exposure holds true with regard to the application of cosmetics (make-up, hand lotion, etc.) in a laboratory setting when hazardous chemicals are being used. In this instance, the cosmetics have the ability of absorbing chemical vapors, dusts, and mists from the air and when applied to the skin and result in skin exposure to chemicals.

To prevent exposure to hazardous chemicals through ingestion, do not eat, drink, chew gum, or apply cosmetics in areas where hazardous chemicals are used.

Wash your hands thoroughly after using any chemicals or other laboratory materials, even if you were wearing gloves, and especially before eating or drinking.

To help promote awareness, refrigerators and freezers should be properly labeled. Refrigerators for the storage of food should be labeled, "Food Only, No Chemicals" or "No Chemicals or Samples". Refrigerators used for the storage of chemicals should be labeled "Chemicals Only, No Food".

Keep in mind that some chemical exposure can result in immediate effects (acute exposure) while other effects may not be seen for some time despite repeated exposure (chronic exposure). Consuming food or drink or applying cosmetics in the lab can result in both types of exposure.

5.5 Respiratory Protection

Respiratory protection includes disposable respirators (such as N95 filtering facepieces, commonly referred to as "dust masks"), air purifying, and atmosphere supplying respirators. Respirators are generally not recommended for laboratory workers. Engineering controls, such as dilution ventilation, fume hoods, and other devices, which capture and remove vapors, fumes, and gases from the breathing zone of the user are preferred over the use of respirators in most laboratory environments. There are certain exceptions to this general rule, such as the changing out of cylinders of toxic gases and emergency response to chemical spills. Personnel wearing respirators must be fit-tested and trained at the expense of the University and must agree to comply with requirements (i.e. no facial hair) if such protection is appropriate for their job description. Refer to the Benedictine University Respiratory Protection Plan at S:\University Info\Policies and Procedures\Emergency Information. Additional information can be obtained from: www.osha.gov/SLTC/respiratoryprotection/guidance.html.

5.6 Unattended Experiments

While unattended experiments should be avoided, laboratory operations involving hazardous substances are sometimes carried out continuously or overnight with no one present. It is the responsibility of the PI to design these experiments to prevent the release of hazardous substances in the event of interruptions in utility services such as electricity, cooling water, and inert gas. General provisions for unattended experiments include:

- The PI must carefully examine how chemicals and apparatus are stored, considering the possibility for fire, explosion or unintended reactions.
- Fume Hood lights should be left on, and signs should be posted identifying the nature of the experiment and the hazardous substances in use.
- If appropriate, arrangements should be made for other workers to periodically inspect the operation.
- Contact information for the responsible individual should be posted by the experiment and on the door sign in the event of an emergency.
- Contact Campus Safety at 630-829-6122 to alert them to any unattended experiments so frequent passes can be made.

5.7 Working Alone

Whenever possible, faculty and staff should avoid working alone (a person is "alone" at work when they are on their own; when they cannot be seen or heard by another person) when in the laboratory, especially when experiments involve hazardous substances and procedures. No student shall be permitted to work in a lab alone when working with hazardous materials. The PI must be in the building and be able to check on their safety. The PI can designate an alternate PI to check in on the student if they are unavailable.

5.8 Visiting Scholars in Labs

Where visiting scholars will be conducting work in a laboratory, the "host" PI must remain with the visiting scholar at all times. The PI is responsible for ensuring that the visiting scholar has the appropriate training, is oriented to relevant University and laboratory-specific CHP requirements and emergency procedures, and that the laboratory operation to be conducted does not present an increased risk to the University and laboratory/building occupants. Each "host" PI is required to contact the CHO in advance of a visiting scholar's arrival on campus to ensure that all CHP requirements are met and that safety procedures are adequate for the planned laboratory activities. The "host" PI is required to get permission from the Department Chair prior to the visiting scholar's arrival.

5.9 Minors in Labs

Due to the potential hazards and liability issues, other persons, in particular children under the age of 16 are not permitted in hazardous work areas, with the exception of University-sanctioned activity, e.g., tours, open houses, or other University related business as authorized by the PI or laboratory supervisor. In these instances, all children under the age of 16 must be under careful and continuous supervision.

Any minors allowed in the laboratory at the discretion of the PI must be accompanied and supervised at all times. Minors should not be present in the laboratory while hazardous operations are in process. Refer to the Protection of Minors Policy found at [S:\University Info\General Information\Emergency Information\Safety](#).

5.10 Animals in Labs

Animals are prohibited in laboratories, except for those animals that are specifically exempted by this policy. If allowed, animals must be attended and restrained at all times and care must be taken to minimize risks from chemical hazards.

Exempted animals – Research subjects and service animals

Section 6 Training and Information

6.1 New Employee Orientation

Training can be in person, on-line, written, or a combination of all three methods.

The keys to any training programs are:

- The instructor providing the training is technically qualified to provide training on the particular subject.
- The training program(s) address the hazards present in the laboratory and describe ways employees can protect themselves.
- The training program and attendance must be documented in a way which is readily available and accessible upon request.

Training sessions do not have to be hours or half-day sessions, they can be short, 15 minutes, half hour, or however long it takes to achieve the training objectives.

Please note that one training class is usually not comprehensive enough to cover all of the hazards found within a laboratory. Faculty and laboratory supervisors may find that it is necessary to use a combination of the options below to ensure their employees are properly trained.

Training Manuals and Booklets

Training manuals, booklets, webpage downloads, etc., may be utilized as part of an ongoing training program by simply having laboratory staff review the material, be given an opportunity to ask any questions, and sign off that they read and understood the material.

Training Videos

Training videos may be used to supplement training of their employees. As with any training, it is important to document the training took place by using a sign-in sheet. When videos are used, the training sign-in sheet should have the date, time, location, and name and running time of the video, in addition to signatures of those people who watched the video.

Web-Based Training

Web-based trainings and quizzes may be used as part or all of a training program.

6.2 Safety Training

OSHA requires safety training to occur annually covering topics such as personal protective equipment, laboratory safety and proper disposal of chemical waste. Our training will take place every January unless completed in the previous fall semester. New student workers and research students will take the training upon hire with subsequent retraining within the year.

Personal Protective Equipment (PPE)

Laboratory personnel must be trained in the selection, proper use, limitations, care, and maintenance of PPE. Training requirements can be met in a variety of ways including videos, group training sessions, and handouts. Examples of topics to be covered during the training include but not limited to:

- When PPE must be worn.
- What PPE is necessary to carry out a procedure or experiment.
- How to properly put on, take off, adjust, and wear PPE.
- The proper cleaning, care, maintenance, useful life, limitations, and disposal of the PPE.

As with any training sessions, PPE training must be documented, including a description of the information covered during the training session and a copy of the sign-in sheet. Training records must be kept of the names of the persons trained, the type of training provided, and the dates when training occurred. The CHO and/or the Emergency Preparedness Manager and Safety Specialist will maintain records of employees and students.

Information on the specific PPE required to carry out procedures within the laboratory using hazardous chemicals must also be included in the laboratory's Standard Operating Procedures.

It is the responsibility of the faculty to ensure laboratory personnel have received the appropriate training on the selection and use of proper PPE and that laboratory personnel use proper PPE when working in laboratories under their supervision.

Laboratory Safety and Hazard Communication

The OSHA Laboratory Standard requires employers to provide employees with information and training to ensure they are apprised of the hazards of chemicals present in their work area. The OSHA Laboratory Standard goes on to state that such information shall be provided at the time of an employee's initial assignment to a work area where hazardous chemicals are present and prior to assignments involving new exposure situations.

The OSHA Laboratory Standard mandates that information must be provided to employees including:

- The contents of the **Laboratory Standard**
https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10106
- and its appendices **Appendix A**
https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10107
- and **Appendix B**
https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10108) shall be made available to employees.
- The contents, requirements, location and availability of the employer's Chemical Hygiene Plan.
- The **permissible exposure limits** for OSHA regulated substances or recommended exposure limits for other hazardous chemicals where there is no applicable OSHA standard.
- Signs and symptoms associated with exposures to hazardous chemicals used in the laboratory.
- The location and availability of identified reference materials listing the hazards, safe handling, storage and disposal of hazardous chemicals found in the laboratory including, but not limited to, SDSs received from the chemical supplier.

The OSHA Laboratory Standard goes on to state this training shall include:

- Methods and observations that may be used to detect the presence or release of a hazardous chemical.
- The physical and health hazards of chemicals in the work area.
- The measures employees can take to protect themselves from these hazards, including specific procedures the employer has implemented to protect employees from exposure to hazardous chemicals, such as appropriate work practices, emergency procedures, and PPE to be used.

While the OSHA Laboratory Standard is specific to working with hazardous chemicals, laboratory employees must also be provided with the proper training and information related to the other health and physical hazards that can be found in their work environment, including the hazards described within this CHP.

It is the responsibility of faculty to ensure personnel working in laboratories under their supervision have been provided with the proper training, have received information about the hazards in the laboratory they may encounter, and have been informed about ways they can protect themselves.

6.3 Laboratory Specific Standard Operating Procedures (SOP)

The OSHA Laboratory Standard requires that Chemical Hygiene Plans include specific elements and measures to ensure employee protection in the laboratory. One such requirement is the SOP “relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals” (1910.1450(e)(3)(i)).

SOPs can be stand-alone documents or supplemental information often found in research notebooks, experiment documentation, or research proposals.

At a minimum, SOPs should include details such as:

- The chemicals involved and their hazards.
- Special hazards and circumstances.
- Use of engineering controls (such as fume hoods).
- Required PPE.
- Spill response measures.
- Waste disposal procedures.
- Decontamination procedures.
- Description of how to perform the experiment or operation.

While the OSHA Laboratory Standard specifies the requirement for SOPs for work involving hazardous chemicals, laboratories should also develop SOPs for use with any piece of equipment or operation that may pose any physical hazards. Examples include but not limited to:

- Safe use and considerations of LASERSs.
- Use of cryogenic liquids and fill procedures.
- Connecting regulators to gas cylinders and cylinder change outs.
- Use of equipment with high voltage.
- Use of acids in etching.

SOPs do not need to be lengthy dissertations, and it is perfectly acceptable to point laboratory personnel to other sources of information. Some examples of what to include as part of SOPs are:

“The chemical and physical hazards of this chemical can be found in the SDS – located in the SDS file cabinet. Read the SDS before using this chemical.” “When using chemical X, wear safety goggles, nitrile gloves, and a lab coat.” See Appendix E: Standard Operating Procedures (SOP).

All instructors, research and upper level students who work with specific equipment with a written SOP must sign off they need it and will abide by it.

It is the responsibility of each laboratory, department and college to ensure that SOPs are developed and the practices and procedures are adequate to protect lab workers. It is the responsibility of teaching and research faculty to ensure that work is not completed unless the PPE and engineering controls are adequate to prevent overexposure to hazardous chemicals.

Section 7 Medical Consultation and Examinations

An opportunity for employee medical consultation, with evaluation, treatment and follow-up as warranted, must be provided 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.
- Whenever exposure monitoring indicates an exposure level that routinely meets or exceeds the OSHA action level (or PEL when no action level exists) for regulated substances for which there are exposure monitoring and medical requirements.
- 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.
- For all employees required to wear a respirator.
- For all emergency response team members.

All medical examinations and consultations shall be provided by or under the direct supervision of a licensed physician and shall be provided at no cost to the employee.

A consulting/treating physician must be provided with the following information as applicable:

- A description of the signs and symptoms of exposure.
- A description of the conditions under which the exposure occurred (e.g. chemical mixtures, amounts, fume hood use, etc.)
- The identity of the hazardous chemical(s) to which the exposure occurred, including any known byproducts of chemical mixtures that may have occurred. SDS sheets should be provided to the physician.

Section 8 Spill Response, Decontamination and Exposure

8.1 Emergency Procedures for Injury and Exposure

IN CASE OF AN EMERGENCY: CALL 911
or dial 630-829-6122 to reach Benedictine University Campus Safety

If a minor injury has occurred, call Campus Safety at 630-829-6122. Campus Safety will determine if 911 should be called or if the injured person should be escorted to Student Health (not open during the evenings or summer).

Render first aid by flushing the area with tepid water for 15 minutes as the paramedics and/or Campus Safety are responding.

Complete the Accident-Incident Report Form which is found on the University Share drive: S:\University Info\Forms\Emergency Information. Print and Sign the form. Print a copy of the SDS for the chemical in question and attach it to the form. The form and the SDS sheet will be forwarded to the Emergency Preparedness Manager/Safety Specialist in the Parking Garage, room 132. If the paramedics are called, they will also need a copy of the SDS. The SDS can be found in two locations:

- File cabinet on the third-floor north end of Birck Hall; or
- <https://ben.edu/emergency-preparedness/> and click on the SDS Search VelocityEHS website link.

8.2 Emergency Procedures for Spills

When a chemical spill occurs, it is necessary to take prompt and appropriate action. The type of response to a spill will depend on the quantity of the chemical spilled and the severity of the hazards associated with the chemical. The first action to take is to alert others in your lab or work area that a spill has occurred. A hazardous material accident is defined as requiring more than the person who caused the spill to clean or wipe it up immediately.

If, in the judgment of the CHO and/or faculty member responsible for such materials, the spill presents any danger to themselves or the other building occupants, the following steps should be taken:

- Evacuate the area where the spill occurred.
- Call 911. Then call Campus Safety at 630-829-6122 when appropriate.
- For Mesa campus, call 911. Then call Campus Safety at 602-888-5516 when appropriate.
- Appropriately trained personnel should confine or stop the spill using appropriate absorbent materials on hand, avoiding contact with skin, eyes and clothing and/or by shutting the doors of the room.
- Do not walk through or stand in any spill areas.

In the event that a building is evacuated, proceed to the Evacuation Assembly Area. Stay in the designated area until a head count can be taken and/or an "All clear" is given to re-enter the building.

In the event of a spill, a vendor specializing in chemical spill emergency responses will be contacted by the Emergency Preparedness Manager.

8.3 Emergency Procedures for Fire and Explosion

All fires must be reported to Campus Safety, including those that have been extinguished. Do not hesitate to activate the fire alarm if you discover smoke or fire.

- Alert people in the immediate area of the fire and evacuate the room.
- Confine the fire by closing doors as you leave the room.
- Activate a fire alarm by pulling on an alarm box.
- Call 911 immediately. Once in a safe location, notify Campus Safety of the location and size of the fire by calling 630-829-6122.
- For the Mesa campus, call 911 immediately. Once in a safe location notify Campus Safety of the location and size of the fire by call 602-888-5516.
- Evacuate the building using the Emergency Evacuation Procedure. Do not use elevators to evacuate unless directed to do so by emergency responders.
- Notify emergency responders of the location, nature and size of the fire once you are outside.

If you have been trained and it is safe to do so, you may attempt to extinguish the fire with a portable fire extinguisher. Attempt to extinguish only small fires and make sure you have a clear escape path. If you have not been trained to use a fire extinguisher you must evacuate the area.

If clothing is on fire:

- Stop - Drop to the ground or floor and Roll to smother flames.
- Drench with water from a safety shower or other source.
- Seek medical attention for all burns and injuries.

8.4 Emergency Procedures for Decontamination

All laboratories using hazardous chemicals, particularly corrosive chemicals, must have access to an eyewash and/or an emergency shower as per the OSHA **standard 29 CFR 1910.151 – Medical Services and First Aid**. The ANSI Standard Z358.1-2009 - Emergency Eyewash and Shower Equipment provides additional guidance by stating that emergency eyewash and/or emergency showers be readily accessible, free of obstructions and within 10 seconds from the hazard. The ANSI standard also outlines specific requirements related to flow requirements, use of tempered water, inspection and testing frequencies, and training of laboratory personnel in the proper use of this important piece of emergency equipment.

Due to the flow requirements outlined in the ANSI standard, hand held bottles do not qualify as approved eyewashes.

The ANSI Standard provides guidance by stating that plumbed emergency eyewash and safety showers should be activated weekly to verify proper operation and inspected annually. Regular activation (weekly flushing) ensures the units are operating properly, helps to keep the units free of clutter, and helps prevent the growth of bacteria within the plumbing lines, which can cause eye infections. It is recommended to allow the water to run for at least 3 minutes.

Any malfunctioning eyewashes and emergency showers should be reported to Facilities to be repaired. If either the emergency shower or eyewash is not working properly, post a Do Not Use sign on the unit to alert others.

8.5 Safety Data Sheets (SDS)

All chemical manufacturers or distributors are required to conduct a hazard evaluation of their products and include the information on a safety data sheet (SDS). The manufacturer or distributor is required to provide an SDS with the initial shipment of their products. Any SDS's received by the laboratory must be maintained in a central location in the laboratory or the department. If the SDS cannot be found, contact the manufacturer or distributor at the number listed on the container label and request an SDS.

All SDS's are housed in several locations on campus. In addition to physical locations around campus we also utilize an electronic filing cabinet for all SDS's on campus. VelocityEHS is also available to all students, faculty and staff. Go to <https://ben.edu/emergency-preparedness/> and click on the SDS Search VelocityEHS website link. Scroll down the page to locate the link.

Birck Hall - There are two four-drawer filing cabinets in Birck Hall.

- (i) First cabinet is located in the vestibule of Birck Hall on the east side. This locked cabinet is for the fire department.
- (ii) Second cabinet is located on the third floor of Birck Hall, north end. This cabinet is available for students, faculty, staff and visitors to access a hard copy of an SDS.

Scholl Hall – SDS binders located in room 121.

Power House – SDS binders located in the Power House.

Rice Center – SDS binders are located in the Athletic Training Room.

Mesa Campus – SDS binders are located in the Art space and in Gillett Hall.

All SDS's received by the manufacturer or distributor must have 16 sections. Those sections include the following:

1. Identification of the substance or mixture and of the supplier
2. Hazards identification
3. Composition/information on ingredients
4. First aid measure
5. Fire-fighting measures
6. Accidental release measures
7. Handling and storage
8. Exposure controls/personal protection
9. Physical and chemical properties
10. Stability and reactivity
11. Toxicological information
12. Ecological information (non-mandatory)
13. Disposal considerations (non-mandatory)
14. Transport information (non-mandatory)
15. Regulatory information (non-mandatory)
16. Other information, including date of preparation or last revision

Note: If a chemical substance is produced in the laboratory for another user outside of the laboratory or outside of Benedictine University, then the requirements of the OSHA Hazard Communication Standard (29 CFR 1910.1200) must be met including the requirements for preparation of the SDS and labeling.

8.6 Emergency Laboratory Evacuation Procedures

Evacuation of laboratories during an emergency requires special attention. While the following list is by no means complete, but it provides some simple steps to ensure a safe lab shutdown.

- Close fume hood sashes.
- Be certain that the caps are on all bottles of chemicals.
- Turn off all non-essential electrical devices. Leave refrigerators and freezers on and make sure the doors are closed.
- Turn off all gas cylinders at the tank valves. Note: If a low flow of an inert gas is being used to "blanket" a reactive compound or mixture, then the lab worker may want to leave the flow of gas on. This should be part of a pre-approved, written, posted standard operating procedure for this material or process.
- Check all cryogenic vacuum traps (Nitrogen, Carbon dioxide, and solvent). The evaporation of trapped materials may cause dangerous conditions. Check all containers of cryogenic liquids to ensure that they are vented to prevent the buildup of internal pressure.
- Check all pressure, temperature, air, or moisture sensitive materials and equipment. This includes vacuum work, distillations, glove boxes used for airless/moisture less reactions, and all reactions in progress. Terminate all reactions that are in progress, based on the known scope of the emergency.
- If experimental animals are in use, special precautions may need to be taken to secure those areas such as emergency power, alternative ventilation, etc.
- It is important to remember that some equipment does not shut down automatically. Be sure to check any special operating procedures for your equipment before an emergency occurs.

Section 9 Additional Resources

Appendix A: Chemical Hazard Categories

Appendix B: Guidance for Storage of Incompatible Chemicals

Appendix C: Guidance on Storage of Flammable and Combustible Liquids

Appendix D: Working with Compressed Gases and Cryogenic Liquids

Appendix E: Standard Operating Procedures (SOP)

Appendix A: Chemical Hazard Categories

Health Hazard Class	Hazard Category			
Acute Toxicity	1	2	3	4
Skin Corrosion/Irritation	1A	1B	1C	2
Serious Eye Damage/Eye Irritation	1	2A	2B	
Respiratory or Skin Sensitization	1	1A	1B	
Germ Cell Mutagenicity	1	1A	1B	2
Carcinogenicity	1	1A	1B	2
Reproductive Toxicity	1	1A	1B	2
Specific Target Organ Toxicity (STOT) – Single Exposure	1	2		
Specific Target Organ Toxicity (STOT) – Repeated Exposure	1	2		
Aspiration	1			

Acute Toxicity – Those adverse effects occurring following oral or dermal administration of a single dose of a substance, or multiple doses given within 24 hours, or an inhalation exposure of 4 hours. The lethal dose (LD50 & LC50) values are broken into the following 5 ranges:

Exposure Route	Categories				
	1	2	3	4	5
Oral (mg/kg bodyweight)	≤ 5	>5 ≤50	>50 ≤300	>300 ≤2000	>2000 <5000
Dermal (mg/kg bodyweight)	≤ 5	>50 ≤200	>200 ≤1000	>1000 ≤2000	>2000 <5000
Inhalation – Gases (ppmV)	≤ 100	>100 ≤500	>500 ≤2500	>2500 ≤20,000	>20,000
Inhalation – Vapors (mg/l)	≤ 0.5	>0.5 ≤2.0	>2.0 ≤10.0	>10.0 ≤20.0	>20.0
Inhalation – Dusts & Mists (mg/l)	≤0.05	>0.05 ≤0.5	>0.5 ≤1.0	>1.0 ≤5.0	>5.0

Pictogram					No symbol
Signal Word	Danger	Danger	Danger	Warning	Warning
Hazard Statement	Fatal if swallowed	Fatal if swallowed	Toxic if swallowed	Harmful if swallowed	May be harmful if swallowed

The above classification does not take into consideration chronic toxicity. **Chronic toxicity** is the development of adverse effects as the result of long-term exposure to a toxicant or other stressor.

Skin corrosion/irritation – Is the production of irreversible damage to the skin, namely, visible necrosis through the epidermis and into the dermis, following the application of a substance for up to 4 hours.

Category	Corrosive sub-categories	Corrosive in ≥ 1 or 3 animals	
Corrosive	(only applies to some authorities)	Exposure	Observation
Sub-Categories	1A	≤ 3 min.	≤ 1 h
	1B	> 3 min ≤ 1 h	≤ 14 days
	1C	> 1 h ≤ 4 h	≤ 14 days
Irritant	2	Mean value of $\geq 2.3 \leq 4.0$ for erythema/eschar or for edema in at least 2 of 3 tested animals from gradings at 24, 48 and 72 hours after patch removal, or it reactions are delayed, from grades on 3 consecutive days after onset of skin reactions, or Inflammation that persists to the end of the observation period normally 14 days in at least 2 animals, particularly taking into account alopecia (limited area), hyperkeratosis, hyperplasia, and scaling; or In some cases where there is pronounced variability of response among animals, with very definite positive effects related to chemical exposure in a single animal but less than the criteria above.	
Pictogram	Sub-Categories 1(A, B, C)	Category 2	
			
Signal Word	Danger	Warning	
Hazard Statement	Causes severe skin burns and eye damage	Causes skin irritation	

Serious eye damage/eye irritation – is the production of tissue damage to the eye, or serious physical decay of vision, or changes in the eye, following application of a substance to the anterior surface of the eye, which is not fully reversible with 21 days of application.

Category	Description		
Category 1	A substance is classified as Serious Eye Damage Category 1 (irreversible effects on the eye) when it produces: (a) at least in one tested animal, effects on the cornea, iris or conjunctiva that are not expected to reverse or have not fully reversed within an observation period of normally 21 days; and/or (b) at least in 2 of 3 tested animals, a positive response of: (i) corneal opacity ≥ 3 ; and/or (ii) iritis > 1.5 ; calculated as the mean scores following grading at 24, 48 and 72 hours after instillation of the substance.		
Category 2A	A substance is classified as Eye Irritant Category 2A (irritating to eyes) when it produces in at least in 2 of 3 tested animals a positive response of: (i) corneal opacity ≥ 1 ; and/or (ii) iritis ≥ 1 ; and/or (iii) conjunctival redness ≥ 2 ; and/or (iv) conjunctival edema (chemosis) ≥ 2 calculated as the mean scores following grading at 24, 48 and 72 hours after instillation of the substance, and which fully reverses within an observation period of normally 21 days.		
Category 2B	An eye irritant is considered mildly irritating to eyes (Category 2B) when the effects listed for Category 2A above are fully reversible within 7 days of observation.		
Pictogram	Category 1 	Category 2A 	Category 2B No pictogram
Signal Word	Danger	Warning	Warning
Hazard Statement	Causes serious eye damage	Causes serious eye irritation	Causes eye irritation

Respiratory sensitization – is a product that may cause allergy or asthma symptoms or breathing difficulties if inhaled.

Category 1	Respiratory sensitizer
	A substance is classified as a respiratory sensitizer: - If there is evidence in humans that the substance can lead to specific respiratory hypersensitivity and/or - If there are positive results from an appropriate animal test.
Sub-category 1A	Substances showing a high frequency of occurrence in humans; or a probability of occurrence of a high sensitization rate in humans based on animal or other tests. Severity of reaction may also be considered.
Sub-category 1B	Substances showing a low to moderate frequency of occurrence in humans; or a probability of occurrence of a low to moderate sensitization rate in humans based on animal or other tests. Severity of reaction may also be considered.
Pictogram	Category 1, 1A and 1B 
Signal Word	Danger
Hazard Statement	May cause allergy or asthma symptoms or breathing difficulties if inhaled

Skin sensitization – means a substance that will induce an allergic response following skin contact.

Category 1	Skin sensitizer
	A substance is classified as a skin sensitizer: - If there is evidence in humans that the substance can lead to sensitization by skin contact in a substantial number of persons, or - If there are positive results from an appropriate animal test.
Sub-category 1A	Substances showing a high frequency of occurrence in humans and/or a high potency in animals can be presumed to have the potential to produce significant sensitization in humans. Severity of reaction may also be considered.
Sub-category 1B	Substances showing a low to moderate frequency of occurrence in humans and/or a low to moderate potency in animals can be presumed to have the

	potential to produce sensitization in humans. Severity of reaction may also be considered.
Pictogram	Category 1, 1A and 1B 
Signal Word	Warning
Hazard Statement	May cause an allergic skin reaction

Germ Cell Mutagenicity – is defined as a permanent change to the amount or structure of the genetic material in a cell or an increased occurrence of mutations in populations of cells and/or organisms.

Category	Germ Cell Mutagenicity	
Category 1	Substances known to induce heritable mutations or to be regarded as if they induce heritable mutations in the germ cells of humans	
Sub-category 1A	Substances known to induce heritable mutations in germ cells of humans. Positive evidence from epidemiological studies.	
Sub-category 1B	Substances which should be regarded as if they induce heritable mutations in the germ cells of humans. a. Positive result(s) from in vivo heritable germ cell mutagenicity tests in mammals; or b. Positive result(s) from in vivo somatic cell mutagenicity tests in mammals, in combination with some evidence that the substance has potential to cause mutations to germ cells; or c. Positive results from tests showing mutagenic effects in the germ cells of humans, without demonstration of transmission to progeny.	
Category 2	Substances which cause concern for humans owing to the possibility that they may induce heritable mutations in the germ cells of humans. Positive evidence obtained from experiments in mammals and/or in some cases from in vitro experiments, obtained from: a. Somatic cell mutagenicity tests in vivo, in mammals; or b. Other in vivo somatic cell genotoxicity tests which are supported by positive results from in vitro mutagenicity assays.	
Pictogram	Category 1A and 1B 	Category 2 
Signal Word	Danger	Warning
Hazard Statement	May cause genetic defects	Suspected of causing genetic defects

Carcinogenicity – A carcinogen is a chemical substance or a mixture of chemical substances which induce cancer or increase its incidence. Chemicals which have induced tumors in animal studies are considered to be presumed or suspected human carcinogens unless there is evidence that the study is not relevant for humans.

Category	Carcinogenicity	
Category 1	Known or presumed human carcinogens. The classification of a substance as a Category 1 carcinogen is done on the basis of epidemiological and/or animal data. This classification is further distinguished on the basis of whether the evidence for classification is largely from human data (Category 1A) or from animal data (Category 1B)	
Sub-category 1A	Known to have carcinogenic potential for humans. Classification in this category is largely based on human evidence.	
Sub-category 1B	Presumed to have carcinogenic potential for humans. Classification in this category is largely based on animal evidence.	
Category 2	Suspected human carcinogens. The classification of a substance in Category 2 is done on the basis of evidence obtained from human and/or animal studies, but which is not sufficiently convincing to place the substance in Category 1A or B.	
Pictogram	Category 1A and 1B 	Category 2 
Signal Word	Danger	Warning
Hazard Statement	May cause cancer	Suspected of causing cancer

Reproductive toxicity – Includes adverse effects on sexual function and fertility in adult males and females, as well as adverse effect on development of the offspring. Adverse effects include, but not limited to, alternations to the female and male reproductive system, adverse effects on onset of puberty, gamete production and transport, reproductive cycle normality, sexual behavior, fertility, parturition, pregnancy outcomes, premature reproductive senescence, or modifications in other functions that are depended on the integrity of the reproduce systems.

Category	Reproductive Toxicity	
Category 1	Known or presumed human reproductive toxicant. Substance shall be classified in Category 1 for reproductive toxicity when they are known to have produced an adverse effect on sexual function and fertility or on development in humans or when there is evidence from animal studies, possibly supplemented with other information, to provide a strong presumption that the substance has the capacity to interfere with reproduction in humans. The classification of a substance is further distinguished on the basis of whether the evidence for classification is primarily for human data (Category 1A) or from animal data (Category 1B).	
Sub-category 1A	Known human reproductive toxicant. The classification of a substance in this category is largely based on evidence from humans.	
Sub-category 1B	Presumed human reproductive toxicant. The classification of a substance in this category is largely based on evidence from experimental animals. Data from animal studies shall provide sufficient evidence of an adverse effect on sexual function and fertility or on development in the absence of other toxic effects, or it occurring together with other toxic effects the adverse effect on reproduction is considered not to be a secondary non-specific consequence of other toxic effects. However, when there is mechanistic information that raises doubt about the relevance of the effect for humans, classification in Category 2 may be more appropriate.	
Category 2	Suspected human reproductive toxicant. Substance shall be classified in Category 2 for reproductive toxicity when there is some evidence from humans or experimental animals, possibly supplemented with other information, of an adverse effect on sexual function and fertility, or on development, in the absence of other toxic effects, or if occurring together with other toxic effects the adverse effect on reproduction is considered not be a secondary non-specific consequence of the other toxic effects, and where the evidence is not sufficiently convincing to place the substance in Category 1.	
Pictogram	Category 1A and 1B	Category 2

		
Signal Word	Danger	Warning
Hazard Statement	May damage fertility or the unborn child	Suspected of damaging fertility of the unborn child

Specific Target Organ Toxicity (STOT) (Single Exposure) – Means specific, non-lethal target organ toxicity arising from a single exposure to a chemical. This category includes all significant health effects that can impair function, both reversible and irreversible, immediate and/or delayed.

Human data is the primary source of evidence for this hazard class.

Category	STOT Single Exposure	
Pictogram	Category 1 	Category 2 
Signal Word	Danger	Warning
Hazard Statement	Causes damage to organs	May cause damage to organs

Specific Target Organ Toxicity (STOT) (Repeated Exposure) – Means specific target organ toxicity arising from repeated exposure to a substance or mixture. All significant health effects that can impair function, both reversible and irreversible, immediate and/or delayed.

Human data is the primary source of evidence for this hazard class.

Category	STOT Repeated Exposure	
Pictogram	Category 1 	Category 2 
Signal Word	Danger	Warning
Hazard Statement	Causes damage to organs through prolonged or repeated exposure	May cause damage to organs through prolonged or repeated exposure

Aspiration hazard – Means the entry of a liquid or solid chemical directly through the oral or nasal cavity, or indirectly from vomiting, into the trachea and lower respiratory system.

Category	Aspiration hazard
1	Chemicals known to cause human aspiration toxicity hazards or to be regarded as if they cause human aspiration toxicity hazard. A substance shall be classified in Category 1: a. If reliable and good quality human evidence indicates that it causes aspiration toxicity; or b. If it is a hydrocarbon and has a kinematic viscosity $\leq 20.5 \text{ mm}^2/\text{s}$, measured at 40 °C.
Pictogram	Category 1 
Signal Word	Danger
Hazard Statement	May be fatal if swallowed and enters airways

Physical Hazard Class	Hazard Category						
	Unstable Explosives	Div. 1.1	Div. 1.2	Div. 1.3	Div. 1.4	Div. 1.5	Div. 1.6
Explosives							
Desensitized Explosives	1	2	3	4			
Flammable Gases	1A	1B	2				
Flammable Aerosols	1	2	3				
Chemicals under pressure	1	2	3				
Oxidizing Gases	1						
Gases under pressure	1						
Compressed Gases							
Liquefied Gases							
Refrigerated Liquefied Gases							
Dissolved Gases							
Flammable Liquids	1	2	3	4			
Flammable Solids	1	2					
Self-Reactive Chemicals	Type A	Type B	Type C	Type D	Type E	Type F	Type G
Pyrophoric Liquids	1						
Pyrophoric Solid	1						
Self-Heating Chemicals	1	2					
Chemicals, which in contact with water emit flammable gases	1	2	3				
Oxidizing Liquids	1	2	3				
Oxidizing Solids	1	2	3				

Organic Peroxides	Type A	Type B	Type C	Type D	Type E	Type F	Type G
Corrosive to Metals	1						
Combustible Dusts	Single Category						

Explosives – An explosive chemical is a solid or liquid chemical 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. Pyrotechnic chemicals are included even when they do not evolve gases.

Division 1.1 – Chemicals and items which have a mass explosion hazard (a mass explosion is one which affects almost the entire quantity present virtually instantaneously).

Pictogram:



Signal Word: Danger

Hazard Statement: Explosive; mass explosion hazard

Division 1.2 – Chemicals and items which have a projection hazard but not a mass explosion hazard.

Pictogram:



Signal Word: Danger

Hazard Statement: Explosive; severe projection hazard

Division 1.3 – Chemicals and items which have a fire hazard and either a minor blast hazard or a minor projection hazard or both, but not a mass explosion hazard:

- Combustion of which give rise to considerable radiant heat or
- Which burn one after another, producing minor blast or projection effects or both.

Pictogram:



Signal Word: Danger

Hazard Statement: Explosive; fire, blast or projection hazard

Division 1.4 – Chemical and items which present no significant hazard: chemicals and items which present only a small hazard in the event of ignition or initiation. The effects are largely confined to the package and no projection of fragments of appreciable size or range is to be expected. An external fire shall not cause virtually instantaneous explosion of almost the entire contents of the package.

Pictogram:



Signal Word: Warning

Hazard Statement: Fire or projection hazard

Division 1.5 – Very insensitive chemicals which have a mass explosion hazard: chemicals which have a mass explosion hazard but are so insensitive that there is very little probability of initiation or of transition from burning to detonation under normal conditions.

Pictogram:



Signal Word: Danger

Hazard Statement: May mass explode in fire

Division 1.6 – Extremely insensitive items which do not have a mass explosion hazard: items which contain only extremely insensitive detonating chemicals and which demonstrate a negligible probability of accidental initiation or propagation.

Pictogram:



Signal Word: None

Hazard Statement: None

Flammable Gases – A gas having a flammable range with air at 20°C (68°F) and a standard pressure of 101.3 kPa (14.7 psi).

Category		Criteria
1A	Flammable gas	Gases, which at 20°C (68°F) and a standard pressure of 101.3 kPa (14.7 psi): a) Are ignitable when in a mixture of 13% or less by volume in air; or b) Have a flammable range with air of at least 12 percentage points regardless of the lower flammable limit. Unless data show they meet the criteria for Category 1B
	Pyrophoric gas	Flammable gases that ignite spontaneously in air at a temperature of 54°C (130°F) or below
	Chemically unstable gas	A Flammable gases which are chemically unstable at 20°C (68°F) and a standard pressure of 101.3 kPa (14.7 PSI)
		B Flammable gases which are chemically unstable at a temperature greater than 20°C (68°F) and/or a pressure greater than 101.3 kPa (14.7 PSI)
1B	Flammable gas	Gases which meet the flammability criteria for Category 1A, but which are pyrophoric, nor chemically unstable, and which have at least either: a) A lower flammability limit of more than 6% by volume in air; or A fundamental burning velocity of less than 10 cm/s
2	Flammable gas	Gases, other than those of Category 1, which, at 20°C (68°F) and a standard pressure of 101.3 kPa (14.7 psi), have a flammable range while mixed in air.
Pictogram		Category 1A Category 1B Category 2

	Signal Word	Danger	Danger	Warning
	Hazard Statement	Extremely flammable gas	Extremely flammable gas	Flammable

Desensitized Explosives – A desensitized explosive is a solid or liquid explosive that has been treated to reduce its explosive properties. This treatment can involve wetting, dissolving, or diluting the explosive with water, alcohol, or other substances.

Category	Criteria			
1	Desensitized explosives with a corrected burning rate (Ac) equal to or greater than 300 kb/min but not more than 1200 kg/min			
2	Desensitized explosives with a corrected burning rate (Ac) equal to or greater than 140 kb/min but not more than 300 kg/min			
3	Desensitized explosives with a corrected burning rate (Ac) equal to or greater than 60 kb/min but not more than 140 kg/min			
4	Desensitized explosives with a corrected burning rate (Ac) less than 60 kg/min			
Pictogram	Category 1 	Category 2 	Category 3 	Category 4 
Signal Word	Danger	Danger	Warning	Warning
Hazard Statement	Fire, blast or projection hazard	Fire projection hazard	Fire or projection hazard	Fire hazard

Flammable Aerosols – Means any non-refillable receptacle containing a gas compressed, liquefied or dissolved under pressure, and fitted with a release device allowing the contents to be ejected as particles in suspension in a gas, or as a foam, paste, powder, liquid or gas.

Category	Criteria		
1	Contains $\geq 85\%$ flammable components and the chemical heat of combustion is ≥ 30 kJ/g; or (a) For spray aerosols, in the ignition distance test, ignition occurs at a distance ≥ 75 cm (29.5 in), or (b) For foam aerosols, in the aerosol foam flammability test (i) The flame height is ≥ 20 cm (7.87 in) and the flame duration ≥ 2 s; or (ii) The flame height is ≥ 4 cm (1.57 in) and the flame duration ≥ 7 s.		
2	Contains $> 1\%$ flammable components, or the heat of combustion is ≥ 20 kJ/g; and (a) for spray aerosols, in the ignition distance test, ignition occurs at a distance ≥ 15 cm (5.9 in), or in the enclosed space ignition test, the (i) Time equivalent is ≤ 300 s/m ³ ; or (ii) Deflagration density is ≤ 300 g/m ³ (b) For foam aerosols, in the aerosol foam flammability test, the flame height is ≥ 4 cm and the flame duration is ≥ 2 s and it does not meet the criteria for Category 1		
3	Liquids having flashpoints at or above 73.4°F (23°C) and at or below 140°F (60°C)		
Pictogram	Category 1 	Category 2 	Category 3 No pictogram
Signal Word	Danger	Warning	Warning
Hazard Statement	Extremely flammable aerosol; pressurized container: may burst if heated.	Flammable aerosol; pressurized container: may burst if heated.	Pressurized container; may burst if heated

Chemicals Under Pressure – Liquids or solids in a receptacle (other than an aerosol dispenser) pressurized with a gas at a gauge pressure of greater than or equal to 200 kPa (29 PSI) at 20°C (68°F).

Category	Criteria		
1	Any chemical under pressure that: a) Contains greater than or equal to 85% flammable components (by mass); and b) Has a heat of combustion of greater than or equal to 20 kJ/g		
2	Any chemical under pressure that: a) Contains greater than 1% flammable components (by mass); and b) Has a heat of combustion less than 20 kJ/g		
3	Any chemical under pressure that: a) Contains less than or equal to 1% flammable components (by mass); and b) Has a heat of combustion of less than 20 kJ/g		
Pictogram	Category 1  	Category 2  	Category 3 
Signal Word	Danger	Warning	Warning
Hazard Statement	Extremely flammable chemical under pressure: may burst if heated.	Flammable chemical under pressure: may burst if heated.	Pressurized container; may burst if heated

Oxidizing Gases – Means any gas which may, generally by providing oxygen, cause or contribute to the combustion of other material more than air does.

Category	Criteria
1	Any gas which may, generally by providing oxygen, cause or contribute to the combustion of other material more than air does.
Pictogram	
Signal Word	Danger
Hazard Statement	May cause or intensify fire; oxidizer

Gases under Pressure: Gases which are contained in a receptacle at a pressure of 200 kPa (29 psi) (gauge) or more, or which are liquefied or liquefied and refrigerated. They comprise of compressed gases, liquefied gases, dissolved gases and refrigerated gases.

Group	Criteria
Compressed gas	A gas which when under pressure is entirely gaseous at -50°C (-58°F), including all gases with a critical temperature ¹ ≤ 50°C (-58°F).
Liquefied gas	A gas which when under pressure is partially liquid at temperatures above -50°C (-58°F). A distinction is made between: (a) High pressure liquefied gas: a gas with a critical temperature ¹ between -50°C (-58°F) and +65°C (149°F); and (b) Low pressure liquefied gas: a gas with a critical temperature ¹ above +65°C (149°F).
Refrigerated liquefied gas	A gas which is made partially liquid because of its low temperature.
Dissolved gas	A gas which when under pressure is dissolved in a liquid phase solvent.
Pictogram	
Signal Word	Warning
Hazard Statement	Compressed gas – Contains gas under pressure; may explode if heated Liquefied gas – Contains gas under pressure; may explode if heated Refrigerated liquefied gas – Contains refrigerated gas; may cause cryogenic burns or injury Dissolved gas – Contains gas under pressure; may explode if heated

Flammable Liquids – A liquid having a flash point of not more than 93°C (199.4°F). Flash point means the minimum temperature at which a liquid gives off vapor in sufficient concentration to form an ignitable mixture with air near the surface of the liquid.

Category	Criteria	
1	Flash point < 23°C (73.4°F) and initial boiling point ≤ 35°C (95°F)	
2	Flash point < 23°C (73.4°F) and initial boiling point > 35°C (95°F)	
3	Flash point ≥ 23°C (73.4°F) and ≤ 60°C (140°F)	
4	Flash point > 60°C (140°F) and ≤ 93°C (199.4°F)	
Pictogram	Category 1 and 2 	Category 3 and 4 
Signal Word	Danger	Warning
Hazard Statement	Category 1 – Extremely flammable liquid and vapor Category 2 – Highly flammable liquid and vapor	Category 3 – Flammable liquid and vapor Category 4 – Combustible liquid

Flammable Solids – A solid which is a readily combustible solid, or which may cause or contribute to fire through friction. Readily combustible solids are powdered, granular, or pasty chemicals which are dangerous if they can be easily ignited by brief contact with an ignition source, such as a burning match, and if the flame spreads rapidly.

Category	Criteria	
1	Burning rate test: Chemicals other than metal powders: (a) wetted zone does not stop fire; and (b) burning time <45 s or burning rate >2.2 mm/s Metal powders: burning time ≤5 min	
2	Burning rate test: Chemicals other than metal powders: (a) wetted zone stops the fire for at least 4 min; and (b) burning time <45 s or burning rate >2.2 mm/s Metal powders: burning time >5 min and ≤10 min	
Pictogram	Category 1 	Category 2 
Signal Word	Danger	Warning
Hazard Statement	Flammable solid	Flammable solid

Self-Reactive Chemicals – Are thermally unstable liquid or solid chemicals liable to undergo a strongly exothermic decomposition even without participation of oxygen (air). This definition excludes chemicals classified under this section as explosives, organic peroxides, oxidizing liquids or oxidizing solids. A self-reactive chemical is regarded as possessing explosive properties when in laboratory testing the formulation is liable to detonate, to deflagrate rapidly or to show a violent effect when heated under confinement.

Type A - Any self-reactive chemical which can detonate or deflagrate rapidly, as packaged;

Pictogram: 

Signal Word: Danger

Hazard Statement: Heating may cause an explosion

Type B - Any self-reactive chemical possessing explosive properties and which, as packaged, neither detonates nor deflagrates rapidly, but is liable to undergo a thermal explosion in that package;



Signal Word: Danger

Hazard Statement: Heating may cause a fire or explosion

Type C - Any self-reactive chemical possessing explosive properties when the chemical as packaged cannot detonate or deflagrate rapidly or undergo a thermal explosion;



Signal Word: Danger

Hazard Statement: Heating may cause a fire

Type D - Any self-reactive chemical which in laboratory testing meets the criteria in (d)(i), (ii), or (iii):

(i) Detonates partially, does not deflagrate rapidly and shows no violent effect when heated under confinement; or

(ii) Does not detonate at all, deflagrates slowly and shows no violent effect when heated under confinement; or

(iii) Does not detonate or deflagrate at all and shows a medium effect when heated under confinement;



Signal Word: Danger

Hazard Statement: Heating may cause a fire

Type E - Any self-reactive chemical which, in laboratory testing, neither detonates nor deflagrates at all and shows low or no effect when heated under confinement;



Signal Word: Warning

Hazard Statement: Heating may cause a fire

Type F - Any self-reactive chemical which, in laboratory testing, neither detonates in the cavitated state nor deflagrates at all and shows only a low or no effect when heated under confinement as well as low or no explosive power;



Signal Word: Warning

Hazard Statement: Heating may cause a fire

Type G - Any self-reactive chemical which, in laboratory testing, neither detonates in the cavitated state nor deflagrates at all and shows no effect when heated under confinement nor any explosive power, provided that it is thermally stable (self-accelerating decomposition temperature is 60°C (140°F) to 75°C (167°F) for a 50 kg (110 lb.) package), and, for liquid mixtures, a diluent having a boiling point greater than or equal to 150°C (302°F) is used for desensitization. If the mixture is not thermally stable or a diluent having a boiling point less than 150°C (302°F) is used for desensitization, the mixture shall be defined as self-reactive chemical TYPE F.



Signal Word: None

Hazard Statement: None

Pyrophoric Liquids – A liquid which, even in small quantities, is liable to ignite within five minutes after coming into contact with air.

Category	Criteria
1	The liquid ignites within 5 min when added to an inert carrier and exposed to air, or it ignites or chars a filter paper on contact with air within 5 min.
Pictogram	
Signal Word	Danger
Hazard Statement	Catches fire spontaneously if exposed to air

Pyrophoric Solids – A solid which, even in small quantities, is liable to ignite within five minutes after coming into contact with air.

Category	Criteria
1	The solid ignites within 5 min of coming into contact with air.
Pictogram	
Signal Word	Danger
Hazard Statement	Catches fire spontaneously if exposed to air

Self-Heating Chemicals – A solid or liquid chemical, other than a pyrophoric liquid or solid, which, by reaction with air and without energy supply, is liable to self-heat; this chemical differs from a pyrophoric liquid or solid in that it will ignite only when in large amounts (kilograms) and after long periods of time (hours or days).

Category	Criteria	
1	A positive result is obtained in a test using a 25 mm sample cube at 140°C (284°F)	
2	A negative result is obtained in a test using a 25 mm cube sample at 140°C (284°F), a positive result is obtained in a test using a 100 mm sample cube at 140°C (284°F), and: (a) The unit volume of the chemical is more than 3 m ³ ; or (b) A positive result is obtained in a test using a 100 mm cube sample at 120°C (248°F) and the unit volume of the chemical is more than 450 liters; or (c) A positive result is obtained in a test using a 100 mm cube sample at 100°C (212°F).	
Pictogram	Category 1 	Category 2 
Signal Word	Danger	Warning
Hazard Statement	Self-heating; may catch fire	Self-heating in large quantities; may catch fire

Chemicals, which in contact with water, emit flammable gases – Are solid or liquid chemicals which, by interaction with water, are liable to become spontaneously flammable or to give off flammable gases in dangerous quantities.

Category	Criteria		
1	Any chemical which reacts vigorously with water at ambient temperatures and demonstrates generally a tendency for the gas produced to ignite spontaneously, or which reacts readily with water at ambient temperatures such that the rate of evolution of flammable gas is equal to or greater than 10 liters per kilogram of chemical over any one minute.		
2	Any chemical which reacts readily with water at ambient temperatures such that the maximum rate of evolution of flammable gas is equal to or greater than 20 liters per kilogram of chemical per hour, and which does not meet the criteria for Category 1.		
3	Any chemical which reacts slowly with water at ambient temperatures such that the maximum rate of evolution of flammable gas is equal to or greater than 1 liter per kilogram of chemical per hour, and which does not meet the criteria for Categories 1 and 2.		
Pictogram	Category 1 	Category 2 	Category 3 
Signal Word	Danger	Danger	Warning
Hazard Statement	In contact with water releases flammable gases, which may ignite spontaneously	In contact with water released flammable gas	In contact with water releases flammable gas

Oxidizing Liquids – A liquid which, while in itself not necessarily combustible, may, generally by yielding oxygen, cause, or contribute to, the combustion of other materials.

Category	Criteria		
1	Any chemical which, in the 1:1 mixture, by mass, of chemical and cellulose tested, spontaneously ignites; or the mean pressure rise time of a 1:1 mixture, by mass, of chemical and cellulose is less than that of a 1:1 mixture, by mass, of 50% perchloric acid and cellulose;		
2	Any chemical which, in the 1:1 mixture, by mass, of chemical and cellulose tested, exhibits a mean pressure rise time less than or equal to the mean pressure rise time of a 1:1 mixture, by mass, of 40% aqueous sodium chlorate solution and cellulose; and the criteria for Category 1 are not met;		
3	Any chemical which, in the 1:1 mixture, by mass, of chemical and cellulose tested, exhibits a mean pressure rise time less than or equal to the mean pressure rise time of a 1:1 mixture, by mass, of 65% aqueous nitric acid and cellulose; and the criteria for Categories 1 and 2 are not met.		
Pictogram	Category 1 	Category 2 	Category 3 
Signal Word	Danger	Danger	Warning
Hazard Statement	May cause fire or explosion; strong oxidizer	May intensify fire; oxidizer	May intensify fire; oxidizer

Oxidizing Solids – A solid which, while in itself is not necessarily combustible, may, generally by yielding oxygen, cause, or contribute to, the combustion of other materials.

Category	Criteria		
1	Any chemical which, in the 4:1 or 1:1 sample-to-cellulose ratio (by mass) tested, exhibits a mean burning time less than the mean burning time of a 3:2 mixture, by mass, of potassium bromate and cellulose.		
2	Any chemical which, in the 4:1 or 1:1 sample-to-cellulose ratio (by mass) tested, exhibits a mean burning time equal to or less than the mean burning time of a 2:3 mixture (by mass) of potassium bromate and cellulose and the criteria for Category 1 are not met.		
3	Any chemical which, in the 4:1 or 1:1 sample-to-cellulose ratio (by mass) tested, exhibits a mean burning time equal to or less than the mean burning time of a 3:7 mixture (by mass) of potassium bromate and cellulose and the criteria for Categories 1 and 2 are not met.		
Pictogram	Category 1 	Category 2 	Category 3 
Signal Word	Danger	Danger	Warning
Hazard Statement	May cause fire or explosion; strong oxidizer	May intensify fire; oxidizer	May intensify fire; oxidizer

Organic Peroxides – A liquid or solid organic chemical which contains the bivalent -O-O- structure and as such is considered a derivative of hydrogen peroxide, where one or both of the hydrogen atoms have been replaced by organic radicals. The term organic peroxide includes organic peroxide mixtures containing at least one organic peroxide. Organic peroxides are thermally unstable chemicals, which may undergo exothermic self-accelerating decomposition. In addition, they may have one or more of the following properties:

- a) Be liable to explosive decomposition;
- b) Burn rapidly;
- c) Be sensitive to impact or friction;
- d) React dangerously with other substances.

Type A - Any organic peroxide which, as packaged, can detonate or deflagrate rapidly;



Signal Word: Danger

Hazard Statement: Heating may cause an explosion

Type B - Any organic peroxide possessing explosive properties and which, as packaged, neither detonates nor deflagrates rapidly, but is liable to undergo a thermal explosion;



Signal Word: Danger

Hazard Statement: Heating may cause a fire or explosion

Type C - Any organic peroxide possessing explosive properties when the chemical as packaged cannot detonate or deflagrate rapidly or undergo a thermal explosion;



Signal Word: Danger

Hazard Statement: Heating may cause a fire

Type D - Any organic peroxide which in laboratory testing meets the criteria in (d)(i), (ii), or (iii):

- (iii) detonates partially, does not deflagrate rapidly and shows no violent effect when heated under confinement; or
- (iv) (ii) does not detonate at all, deflagrates slowly and shows no violent effect when heated under confinement; or
- (v) (iii) does not detonate or deflagrate at all and shows a medium effect when heated under confinement;



Signal Word: Danger

Hazard Statement: Heating may cause a fire

Type E - Any organic peroxide which, in laboratory testing, neither detonates nor deflagrates at all and shows low or no effect when heated under confinement;



Signal Word: Warning

Hazard Statement: Heating may cause a fire

Type F - Any organic peroxide which, in laboratory testing, neither detonates in the cavitated state nor deflagrates at all and shows only a low or no effect when heated under confinement as well as low or no explosive power;

Pictogram:



Signal Word: Warning

Hazard Statement: Heating may cause a fire

Type G - Any organic peroxide which, in laboratory testing, neither detonates in the cavitated state nor deflagrates at all and shows no effect when heated under confinement nor any explosive power, provided that it is thermally stable (self-accelerating decomposition temperature is 60°C (140°F) or higher for a 50 kg (110 lb.) package), and, for liquid mixtures, a diluent having a boiling point of not less than 150°C (302°F) is used for desensitization. If the organic peroxide is not thermally stable or a diluent having a boiling point less than 150°C (302°F) is used for desensitization, it shall be defined as organic peroxide TYPE F.

Pictogram:



Signal Word: None

Hazard Statement: None

Corrosive to Metals – A chemical which by chemical action will materially damage, or even destroy, metals.

Category	Criteria
1	Corrosion rate on either steel or aluminum surfaces exceeding 6.25 mm per year at a test temperature of 55°C (131°F) when tested on both materials.
Pictogram	
Signal Word	Warning
Hazard Statement	May be corrosive to metals

Appendix B - Guidance for Storage of Incompatible Chemicals

The below list is provided to illustrate incompatibilities for common chemicals used in laboratories. This is not a complete list; always consult the SDS for the chemical or other chemical hazards. The material on the left should be stored and handled so that it does NOT come in contact with the incompatible chemical(s) on the right.

	Chemical Compound	Should Be Kept Out of Contact With
A	Acetic Acid	Acetaldehyde, ammonium nitrate, chromic acid, nitric acid, hydroxyl compounds, ethylene glycol, perchloric acid, peroxides, permanganates
	Acetaldehyde	Acetic acid, acetic anhydride, ammonia(anhydrous)
	Acetylene	Chlorine, bromine, copper, fluorine, silver, mercury
	Alkali and Alkaline Earth (e.g. Powdered Aluminum or Magnesium, Calcium, Lithium, Sodium, Potassium)	Water, carbon tetrachloride or other chlorinated metals hydrocarbons, carbon dioxide, halogens
	Aluminum	Ammonium nitrate, bromates, chlorates, iodates, bromine vapor, carbon disulphide vapor
	Ammonia (Anhydrous)	Mercury, chlorine, calcium hypochlorite, iodine, bromine, hydrofluoric acid (anhydrous)
	Ammonium Nitrate	Acids, powdered metals, flammable liquids, chlorates, nitrates, sulfur, finely divided organic or combustible materials
	Aniline	Nitric acid, hydrogen peroxide
	Arsenic	Any bromate, chlorate, or iodate
	Azides	Acids
B	Bromine	See chlorine
	Barium	Carbon tetrachloride
C	Calcium Oxide	Water
	Carbon (Activated)	Calcium hyperchlorite, all oxidizing agents
	Carbon tetrachloride	Sodium

	Chlorates	Ammonium salts, acids, powdered metals, sulfur, finely divided organic or combustible materials, sulphides
	Chromic acid	Acetic acid, naphthalene, camphor, glycerin, turpentine, alcohol
	Chlorine	Ammonia, acetylene, butadiene, butane, methane, propane (or other petroleum gases), hydrogen, sodium carbide, benzene, finely divided metals, turpentine
	Chlorine dioxide	Ammonia, methane, phosphine, hydrogen sulfide
	Copper	Acetylene, hydrogen peroxide
	Cumene hydroperoxide	Acids (organic or inorganic)
	Cyanides	Acids
F	Flammable Liquids	Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens
	Fluorine	Isolate from everything
H	Hydrocarbons (e.g. Butane, benzene)	Fluorine, chlorine, bromine, chromic acid, sodium peroxide
	Hydrocyanic acid	Nitric acid, alkali
	Hydrofluoric acid (anhydrous)	Ammonia (aqueous or anhydrous)
	Hydrogen peroxide	Copper, chromium, iron, most metals or their salts, alcohols, acetone, ferrous sulphide, lead IV oxide, lead II oxide, lead sulphide, organic materials, aniline, nitromethane, combustible materials, flammable liquids, oxidizing gases
	Hydrogen sulphide	Fuming nitric acid, oxidizing gases
	Hypochlorite	Acids, activated carbon
I	Iodine	Acetylene, ammonia (aqueous or anhydrous), hydrogen
M	Maleic Anhydride	Magnesium hydroxide, lithium metal
	Magnesium metal	Mercury II oxide, nitric acid
	Mercury	Acetylene, fulminic acid, ammonia
	Methanol	Lead perchlorate, mercury II nitrate

N	Nitrates	Sulfuric acid
	Nitric acid	Acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen sulphide, flammable liquids, flammable gases, powdered magnesium metal, phosphorus, phthalic acid
	Nitroparaffins	Inorganic bases, amines
O	Oxalic Acid	Silver, mercury
	Oxygen	Oils, grease, hydrogen, flammable liquids, solids
P	Perchloric acid	Acetic anhydride, aluminum, Bakelite, bismuth and its alloys, alcohol, paper, wood, plastics, nylon (polyamide), modacrylic ester (35-85% acrylonitrile), polyester, Lucite, cellulose-based lacquers, metals, copper and copper alloys, high nickel alloys, cotton, wool, glycerin-lead oxide, grease, oils
	Peroxides, Organic	Acids (organic or mineral), avoid friction, store cold
	Phosphorus (White)	Air, oxygen, alkalis, reducing agents
	Phosphorus Pentoxide	Water
	Potassium	Carbon tetrachloride, carbon dioxide, water
	Potassium chlorate	Sulfuric and other acids
	Potassium perchlorate (see chlorates)	Sulfuric and other acids
	Potassium permanganate	Glycerol, ethylene glycol, benzaldehyde, sulfuric acid
S	Silver	Acetylene, oxalic acid, tartaric acid, ammonium compounds
	Selenides	Reducing agents
	Sodium	Carbon tetrachloride, carbon dioxide, water
	Sodium nitrate	Ammonium nitrate and other ammonium salts
	Sodium peroxide	Ethanol, methanol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerin, ethylene glycol, ethyl acetate, methyl acetate, furfural
	Sulfides	Acids

	Sulfuric acid	Potassium chlorate, potassium perchlorate, potassium permanganate (or similar compounds of light metals, such as sodium, lithium)
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Special Segregation of Incompatible Chemicals

In addition to the segregation notes above, dangerously incompatible substances, even in small quantities, should not be stored next to each other on shelves or in such a position that accidental rupture of containers may allow mixing. For example:

Chemical	Keep out of contact with:
Chlorine	Acetylene
Chromic acid	Ethyl alcohol
Oxygen (compressed, liquefied)	Propane
Sodium	Chloroform and aqueous solutions
Nitrocellulose (wet, dry)	Phosphorous
Potassium permanganate	Sulfuric acid
Perchloric acid	Acetic acid
Sodium chlorate	Sulfur in bulk

Oxidizing agents are incompatible with reducing agents.

Oxidizing Agents	Reducing Agents
Chlorates	Ammonia
Chromates	Carbon
Dichromates	Metals
Chromium trioxide	Metal hydrides
Halogens	Nitrates
Halogenating agents	Organic compounds
Hydrogen peroxide	Phosphorus
Nitric acid	Silicon
Nitrates	Sulfur

Appendix C - Guidance on Storage of Flammable and Combustible Liquids

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

General considerations for storage of flammable and combustible liquids include:

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

Safety Cans and Closed Containers

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

Flammable Liquid Storage Cabinets

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

Refrigerators

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

Appendix D: Working with Compressed Gases and Cryogenic Liquids

Safe work practices for compressed gases include:

1. Keep all cylinders secured in place using chains, cages, straps, or special devices.
2. Keep compressed gas container valves closed at all times except when in use. Keep removable caps and plugs on compressed gas cylinders at all times except when connected to dispensing equipment.
3. Always assume a cylinder is pressurized – handle it carefully and avoid bumping and dropping.
4. Ensure that the contents of any compressed gas cylinder can be clearly identified and know the identity of the gas in a cylinder. If a cylinder is unlabeled, return it to the vendor. Know the properties and potential of the gas to be used, and the procedures for using it.
5. Carefully inspect fittings, regulators, and apparatus for damage before using. Do not use damaged equipment.
6. Use only regulators, gauges, and connections with matching threads and which are designed for use with the gas and cylinders involved. Never lubricate, modify, force, or tamper with a cylinder valve.
7. When opening cylinder valves, do not hold the regulator. Open valve slowly, directed away from the face. Do not force threads that do not fit. Make sure that threads on regulator connections match those on the container valve outlet.
8. Use only those tools approved by the cylinder vendor. Do not modify or alter cylinders or their attachments. Use cylinders and manifold systems only with their appropriate pressure regulators. Be careful not to exceed the design pressure of the apparatus.
9. Do not place cylinders in any area where they:
 - a. Are subject to contact with a flame or temperatures above 125°F (51.7°C)
 - b. Are subject to low temperatures (unless approved by the supplier)
 - c. May become part of an electrical circuit.
10. Do not attempt to transfer compressed gases from one container to another. This must only be performed by the supplier or manufacturer.
11. When empty, tag empty cylinders appropriately for return to designated storage.
12. Do not drag compressed gas cylinders. Use a cart or manufacturer approved dolly with a restraining strap to move cylinders.
13. In storage, group cylinders by type of gas and the groups further segregated as to compatibility. Store full and empty cylinder separately within the storage area. Ensure cylinders are properly secured by straps, chains, or other suitable devices.
14. Elevators can be a confined space. Due to the potential for exposure to unsafe conditions in the event of a significant leak or catastrophic release, it is recommended that individuals do not ride in an elevator with compressed gas cylinders. A sign will be placed on the cylinder in the elevator stating "Do not travel in elevator with compressed gases and pressurized cryogenic liquids."

Safe work practices for cryogenic liquids include:

1. The contents of cryogenic dewars and tanks must be clearly labeled to indicate contents.
2. Always wear appropriate personal protective equipment to prevent skin and eye contact. Heavy, loose-fitting gloves (special cryogenic gloves are available), safety glasses and face shield, and lab apron are recommended.
3. Handle objects that are in contact with cryogenic liquids with tongs or proper gloves.
4. Only work with cryogenic liquids in well-ventilated areas to avoid localized depletion or buildup of flammable or toxic gas.
 - a. Refrigerated rooms generally recycle room air and dangerous atmospheres can result from use of cryogenic liquids or dry ice in these rooms.
 - b. Rooms containing cryogenic liquids in quantities sufficient to reduce atmospheric oxygen levels below 20% through leaks or catastrophic release should have a continuous oxygen monitor with alarm that will notify personnel inside and outside of the room of low oxygen levels.
5. Transfers or pouring of cryogenic liquids should be done carefully to avoid splashing.
6. Cryogenic liquid/dry ice baths should be open to the atmosphere to avoid pressure build up.
7. Containers and systems containing cryogenic liquids should have pressure relief mechanisms.
8. Cryogenic liquid cylinders and other containers (such as Dewar flasks) should be filled no more than 80% of capacity to protect against thermal expansion.
9. Shield or affix fiber tape around glass Dewars to minimize flying glass and fragments should an implosion occur.
10. Elevators can be a confined space. Due to the potential for exposure to unsafe conditions in the event of a significant leak or catastrophic release, it is recommended that individuals do not ride in an elevator with pressurized cryogenic cylinders. A sign will be placed on the cylinder in the elevator stating "Do not travel in elevator with compressed gases and pressurized cryogenic liquids."

Appendix E – Standard Operating Procedures (SOP)

Standard Operating Procedures (SOPs) are step-by-step protocols to implement certain techniques. SOPs are integral for the safety and correct execution of procedures in the laboratory. Techniques and procedures carried out in the lab are defined by the PI or Supervisor and a corresponding SOP is constructed. All personnel must review the SOP and sign off that the SOP has been read, understood, and will be carried out as such. If a PI or Supervisor adds a new technique or procedure to a laboratory, communication with and approval from the Safety Committee is required to add the SOP to the SOP collection.

The SOPs corresponding to each lab space will be kept as a hard copy, with signatures of all personnel, in a clearly labeled binder in the lab.

An archive of every SOP, according to the PI, can be found on the University's share drive:

<S:\University Info\General Information\Emergency Information\Standard Operating Procedures>