DALHOUSIE UNIVERSITY

Chemical Laboratory Safety Manual

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Overview

The Chemical Laboratory Safety Manual (CLSM) is the minimum standard which must be practiced in laboratories and other locations where chemicals are stored, handled, or used at Dalhousie University. The CLSM aims to be a clear and concise document for chemical users so that chemicals or hazardous products are handled, stored and disposed in a consistent and safe manner. Individual departments, units, or laboratories may require additional and specific safety procedures based on the processes and type of hazards involved. These specific procedures must be developed by the chairperson, head, or supervisor who oversees the personnel working in those areas and ensures those areas follow those safety procedures.

It Is important to recognize that this manual does not cover all the risks and hazards in every laboratory. There are a wide variety of chemicals and hazardous products handles in laboratories at Dalhousie. Faculty and researchers know the most about the unique hazards in their laboratory. It is expected that persons of authority (e.g., principal investigators, laboratory supervisors, etc.) will append any supplementary safety information to this manual pertinent to their specific laboratory.

Responsibility and Accountability

People who are aware of their responsibilities and who discharge them carefully are critical to a successful safety effort. The implementation of the procedures outlined in the CLSM is a shared responsibility at the university.

Dalhousie University

- There is a shared responsibility of the university acting through senior administration, deans, directors, heads of departments and other administrative units to provide:
    - A safe and healthy working environment.
    - Support for implementation of this manual.

Department Chairperson, Director, or Head of an Administrative Unit

- Establish and maintain programs which comply with the Occupational Health and Safety (OHS) regulations in providing a safe and healthy work environment in their laboratories or work areas.
- Ensure that WHMIS and other safety related programs are implemented in the department.

Principal Investigators, Laboratory Supervisors and Managers

- Ensure that safe work procedures are established, reviewed periodically, followed, and are in compliance with current OHS regulations and the current version of the CLSM.
- Ensure that staff and students receive training on WHMIS and laboratory safety, as well as on specific hazards and safety procedures and practices specific to the laboratory and/or department.
- Document and maintain training records for laboratory personnel (staff and students).

- Perform routine laboratory safety inspections and maintain records of these inspections.
- Record and correct any unsafe conditions or work procedures promptly.
- Maintain a current chemical inventory and ensure that it is readily available to staff and emergency personnel.
- Ensure that all necessary personal protective equipment (PPE) is made available and worn by lab personnel.

Department, laboratory or unit personnel (staff and students)

- Follow established safety procedures and practices and participate in required training.
- Conduct themselves in a manner that does not endanger themselves or others.
- Wear appropriate personal protective equipment in order to maximize protection
- Report any unsafe or potentially unsafe conditions to the principal investigator, supervisor, or EHS Office.

Environmental Health and Safety Office

- Ensure adequate programs are provided, for compliance with safety and health regulations and for the protection of the health and safety of students, faculty, staff and the surrounding community.
- Facilitate WHMIS program training to the university community.
- Provide advice, guidance and technical support to departments, laboratories, and units in safety matters which includes occupational safety, fire safety, life safety, laboratory safety (chemical, biological and radiation), and hazardous waste disposal.
- Ensure fume hoods are inspected on a regular schedule by qualified personnel
- Ensure that periodic audits and inspections of the labs or work spaces are conducted to identify hazards and recommendations for abatement to ensure compliance with this manual and relevant regulations and guidelines such as WHMIS, Canadian Nuclear Safety Commission (CNSC), Health Canada, Fire and Building Codes, Provincial and Federal Environment laws and municipal bylaws.

Health and Safety Hazards

Principal investigators, supervisors and laboratory personnel must be aware of the hazards that exist in their work environment so that they can develop appropriate preventative and protective measures to address their health and safety needs.

A hazard is something that has the potential to cause damage, harm or adverse health effects. Hazards can be subdivided in to health hazards and physical hazards. A health hazard is any hazard that can cause adverse health effects to a person exposed to that hazard, such as exposure to a hazardous substance; the effects may be acute (immediate) or latent (delayed) from chronic or repeated exposure. A physical hazard is a hazard that can cause an immediate injury, such as fire, hot/cold and flying objects.

Chemicals can be broken down into hazard classes and exhibit both physical and health hazards. Several factors can influence how a chemical will behave and the hazards the chemical presents, including the severity of the response:

- Concentration of the chemical.
- Physical state of the chemical (solid, liquid, gas).
- Physical processes while using the chemical (cutting, grinding, heating, cooling, etc.).
- Chemical processes involved in using the chemical (mixing with other chemicals, purification, distillation, etc.).
- Improper storage, addition of moisture, storage in sunlight, refrigeration, etc.

Hazards in the laboratory can be assessed and identified by examining work environments, processes, activities and equipment (hazard assessment) and through routine laboratory and worksite inspections.

Hierarchy of Hazard Control

Identified hazards should be prioritized based on risk. Risk is the chance, or probability, that the hazard will actually cause somebody harm. Minimizing or eliminating risks of exposure to hazards is key to a safe lab environment. Highest risks must be managed immediately.

The hierarchy of hazard control presents methods in order of effectiveness to address a hazard:

1. Elimination – Removal of a hazard from the workplace. This is the most effective method of hazard control.
2. Substitution – Replace the hazard with a less hazardous alternative
3. Engineering Controls – Isolate the hazard from the individual (e.g., fume hoods)
4. Administrative Controls – modify the way how people work (e.g., training, policies, etc.)
5. Personal Protective Equipment (PPE) – protect worker against injury with PPE. This is the least effective hazard control method.

PPE is generally considered the last line of defense to protect an individual from a hazard. For this reason, it is imperative that the appropriate PPE be selected and worn when working in the laboratory.

Laboratory personnel should consider the acronym RAMP to stay safe while working:

- Recognize the hazard
- Assess the risk of the hazard
- Minimize the risk associated with the hazard
- Prepare for emergencies

Health and Safety Hazards in the Laboratory

There are a variety of common hazards that are routinely encountered in a laboratory. Laboratory personnel should be familiar with these common hazards, as well as other hazards specific to their laboratory environment.

Physical Hazards of Chemicals	**Health Hazards of Chemicals**
– Flammable and combustible substances – Corrosive substances – Oxidizing substances – Water reactive material – Self-reactive substances – Pyrophorics – Organic peroxides – Gases under pressure – Cryogens	– Sensitivities – Irritation or damage – Asphyxiants – Toxicity – Mutagens – Reproductive toxins – Carcinogens
Hazards of Laboratory Equipment – Cuts, punctures, bruises – Burns – Sharps (syringes, scalpels, etc.) – Electrical hazards – Mechanical hazards – Vacuum systems – High pressure systems	**Hazards of the Workplace** – Slips, trips and falls – Ergonomics – Hot/cold environments

Management of Chemicals

Acquisition of Chemicals

Prior to ordering chemicals or other hazardous products, users must evaluate the potential hazards and ensure that proper control measures are in place in order to minimize risk. Chemicals must be procured in the minimum quantities required to meet the immediate requirements of the experiment or process. Avoid stockpiling chemicals. Proper planning of experiments ensures that safety considerations are reviewed, bulk ordering is avoided and products with limited shelf-life are consumed and used appropriately.

Receiving Chemicals

Prior to receiving chemicals, information on the safe handling, storage, and disposal must be known to those individuals involved. This information can be obtained from the Safety Data Sheet (SDS) or other safety resource.

Once received, packages containing chemicals must be inspected to see if the integrity of the packaging or container has been compromised. Leaking packages must not be accepted and should be returned. Otherwise, spill containment procedures should be initiated to deal with the spilled chemical.

Chemical Inventories

A current and continuously updated chemical inventory must be maintained by the principal investigator or laboratory supervisor for chemicals used in their area. This includes laboratories, stockrooms and workshops. Proper chemical inventory management is a regulatory requirement under provincial and federal regulations. The electronic inventory should be readily available on request of staff, the EHS Office, and emergency response personnel.

A chemical inventory must include the following information:

- chemical name
- CAS number
- supplier
- container size
- date received
- location (e.g., room, shelf, cabinet, etc.)

Based on the requirements of the laboratory, other information on the chemicals in the area may be included.

Chemical Waste Management

It is the responsibility of the Principal Investigator and laboratory supervisor, and all individuals generating chemical waste to properly manage chemical waste to ensure its safe and environmentally responsible disposal in accordance with federal, provincial, and municipal regulations as well as university guidelines. Chemical waste must not be released to the environment nor dumped down the drain in the sink or fume hood or in the trash.

University faculty, staff, and students must be aware of the environmental impact of chemical waste, as well as the financial impact. All parties should actively seek to minimize the volume of chemical waste that is generated. Principal investigators and laboratory supervisors should consider chemical waste as part of the laboratory setup and operating procedures.

The university's "Chemical Waste Disposal Manual" must be followed for proper procedures and should be reviewed by all laboratory personnel working with chemicals. This can be found on the EHS Office webpage.

Workplace Hazardous Materials Information System (WHMIS)

WHMIS is a Canada-wide system that addresses the right to know about the safety and health hazards of hazardous products and chemicals in the workplace. The purpose of WHMIS is to help keep a worker safe by providing them with the necessary information to identify potential hazards that they may be exposed to in the workplace. All individuals who will be using, storing, handling or working in proximity to hazardous products and chemicals must be trained in WHMIS.

The EHS Office offers free online WHMIS training to university personnel through the College of Continuing Education.

Labelling

All containers of chemicals must have proper labels in compliance with WHMIS. Original containers must have supplier labels, while products decanted into other containers must have workplace labels to comply with WHMIS. Storage cabinets containing chemicals should be labeled appropriately and with the corresponding WHMIS pictogram.

Transportation of Chemicals

Off Campus

Individuals who package, receive and/or complete shippers declarations for the transportation of dangerous goods (TDG) on or off campus must have received training and hold a valid training certificate.

On Campus

Individuals transporting chemicals must be familiar with the hazards of the products and know what to do in the event of a spill or release. Spill procedures and PPE should be on hand while transporting. All substances being transported to or between laboratories must be placed in secondary containment (i.e., rubber pail, carriers, chemical-resistant trays) that can contain all the product in the event it is dropped or the primary container leaks for any reason. Incompatible chemicals must not be transported in the same secondary containment or in any way that might allow the chemicals to mix or react.

A push cart must be used for transporting multiple, or large containers. The cart must be sturdy with guards/rails on the side to prevent containers from sliding off the cart during transport. The weight and balance of the load on the cart must also be considered. Carts with large and wide wheels are recommended.

Transportation through public areas should be avoided. If it is necessary to pass through public space, restrict transportation to low traffic time periods (e.g., early morning or late in the afternoon). Freight elevators should be used when available to move chemicals between floors. If a passenger elevator must be used, it is best to not allow other passengers on until the chemicals have been delivered.

Personal modes of transportation are not to be used to transport chemicals on campus. If the amount of chemicals warrants vehicle transport, contact the EHS Office for guidance. If chemicals are to be transported outside of building, an emergency response plan must be in place in the event of a spill.

Compressed Gas Cylinders and Cryogens

Compressed gas cylinders must only be moved with the valve covers screwed on. The cylinder must be securely attached/restrained to a compressed gas cart. Cryogens must be transported in approved storage vessels such as Dewar flasks with pressure relief mechanisms. Individuals should not accompany compressed gas cylinders or cryogens in an elevator, since this represents a significant asphyxiation hazard should a spill or leak were to occur in the enclosed space of the elevator. It is strongly recommended that two persons are involved in the movement of gas cylinders between floors. One person to send the cylinder and one person to receive the cylinder. A sign should be posted to warn potential passengers that they cannot enter the elevator at this time.

Storage of Chemicals

Chemical storage areas include central stockrooms, storerooms, laboratory work areas, storage cabinets, refrigerators, and freezers. There are recognized legal requirements as well as recommended practices for proper storage of chemicals.

Quantities of chemicals stored in a laboratory should be kept at a minimum and must be segregated based on chemical compatibility. Chemicals must be stored in suitable locations such as in cabinets and on shelves; storage on the benchtop, floor, or in a fume hood is not appropriate. Storage cabinets and shelves must be of solid construction and should be corrosion resistant. Shelves and cabinets must not be overloaded with chemicals, and the load capacity must not be exceeded. In sprinklered rooms, all storage must be kept at least 18" below the level of the sprinkler head deflectors to ensure that fire sprinkler coverage is not impeded.

Principal investigators and laboratory supervisors must routinely inspect chemicals stored in their area. Labels that are illegible or in poor condition must be replaced in accordance with WHMIS requirements. Chemicals that are expired or unwanted must be disposed through the EHS Office's Chemical Waste Disposal Program. Information on this can be acquired through the EHS Office webpage.

The following guidelines should be followed for safe and proper storage of chemicals, which also includes waste chemicals:

- Flammable or combustible liquids, toxic chemicals, explosive chemicals, oxidizing agents, corrosive chemicals, water-reactive chemicals, and compressed gases should be segregated from each other.
- The manufacturer's storage recommendations listed in the SDS should be followed
- Containers must be kept sealed when not in use.
- Chemicals must be stored so that they will not mix with each other should a container leak or break.

Table 1: Laboratory Storage Guidelines

Chemical Hazard	Recommended Storage	Incompatible Materials
Flammable Liquids	In flammable storage cabinet	Acids, Bases, Oxidizers, Toxics
Flammable Solids	Store in a separate dry, cool area away from incompatible materials	Acids, Bases, Oxidizers, Toxics

Acids	Store in a separate storage cabinet away from incompatible materials	Flammable Liquids and Solids, Bases, Oxidizers, Toxics
Bases	Store in a separate storage cabinet away from incompatible materials	Flammable Liquids and Solids, Acids, Oxidizers, Toxics
Oxidizers	Store in a spill tray inside a non-combustible cabinet, separate from incompatible materials	Flammable and Combustible Liquids and Solids, Acids, Bases Toxics
Toxics	Store separately, in vented, cool, dry area in an unbreakable chemically resistant secondary container	Flammable Liquids and Solids, Acids, Bases, Oxidizers
Shock Sensitive Materials	Store in secure location away from all other chemicals	Flammable Liquids, Oxidizers, Acids, Bases, Toxics
Water Reactive Chemicals	Store in a dry, cool location and protect from water fire sprinklers	Aqueous solutions, Oxidizers
Compressed Gases – Flammable	Store away from incompatible materials	Oxidizers and Toxic Compressed Gases, Oxidizing Solids, Acids, Bases, Toxics
Compressed Gases – Oxidizing	Store in a cool, dry gas storage area away from incompatible materials	Flammable Gases
Compressed Gases – Poisonous	Store in a cool, dry toxic gas storage area away from incompatible materials	Flammable Liquids, Flammable and Oxidizing Gases, Oxidizers, Corrosives
General Chemicals	Store on general shelving..	Refer to SDS
Explosives	Special storage	

Flammable and Combustible Liquid Storage

Flammable chemicals must be stored in a flammable material storage cabinet and away from ignition sources. Allowable volumes of flammable materials, and types of storage cabinets is enforced by the National Fire Code of Canada.

Properties*	Laboratory Storage Maximums**
Flammable Liquids **Class 1A**: flash point below 22.8°C and a boiling point below 37.8°C **Class 1B:** flash point below 22.8°C and a boiling point at or above 37.8 °C **Class 1C**: flash point at or above 22.8°C and below 37.8°C	• Individual containers: 5 L • Safety containers: 25 L • Outside of a flammable storage cabinet (total): 50 L • Inside of a flammable storage cabinet: 250 L

Combustible Liquids **Class II:** flash point at or above 37.8°C and below 60°C **Class IIIA**: flash point at or above 60°C and below 93.3°C	• Outside of a flammable storage cabinet: 300 L total for all flammable and combustible liquids • Inside of a flammable storage cabinet: 500 L total for all flammable and combustible liquids

*Class I flammable liquid will have a flash point below 37.8°C. Any liquid with a flash point of 37.8°C or greater which is used or stored at or above its flash point shall be considered a Class I Flammable Liquid.
**Maximum storage quantities include any flammable or combustible waste that is being generated.

Flammable and combustible materials that require storage in refrigerators present a flammable and/or explosive hazard due to the in-built ignition sources in the refrigerators and the accumulated vapours of the chemicals. Domestic refrigerators do not address the special hazards of flammable materials due to the presence of ignition source and must not be used to store these materials. Flammable and combustible materials that require refrigeration must only be stored in approved flammable storage refrigerators or explosion proof refrigerators.

Dispensing of Flammable and Combustible Liquids

Flammable and combustible liquids must only be dispensed in areas free of ignition sources. Along with open flames, ignition sources include electrical equipment and static electricity. Static build up and discharge can be hazardous while dispensing flammable and combustible liquids due to the potential of a fire. Static charges are produced by the flow of liquid from one container to another. Metal storage containers dispensing flammable liquids must be properly bonded and grounded to disperse static electricity. Grounding involves electrically grounding the container using grounding straps or wires to a known ground. Bonding involves electrically connecting the storage container to the receiving container using a bonding strap or wire.

Dispensing must only be done with adequate ventilation, such as in a fume hood. Flammable and combustible liquids should be allowed to flow slowly to minimize the build up of static electricity.

Compressed Gas Cylinder Storage and Use

Compressed gas cylinders must be secure in place at its point of use or storage. Cylinders must be secured in an upright position by a cylinder stand, clamp, or chain at a point approximately 2/3 of the height of the cylinder, using one restraint per cylinder. The cylinder should be positioned so that the valve is easily accessible, and when not in use, the valve protection cap must be in place to protect the valve.

Compressed gas cylinders must be segregated by hazard class. The number of cylinders in a laboratory should be limited to no more than one back up cylinder for every cylinder in use. Oxidizing gases must be located at least 6 meters away from fuel gases and combustible materials or separated with an approved fire wall. Laboratory personnel must ensure that the pressure regulator is appropriate for the gas to be used. Gas flow should be shut off using the cylinder valve, rather than the regulator. Principal investigators and laboratory personnel should be familiar with special requirements and limitations to gas cylinder storage and use (e.g., gas detectors/monitors, volume limitations such as for flammable gases, and ventilation requirements).

Principal investigators and laboratory supervisors must ensure that individuals working with gas cylinders are properly trained. Proper regulators and fittings must be used for the particular gas in the cylinder. Specific regulators are designated for different gases and are accompanied with a Compressed Gas Association (CGA) number. Prior to each use, the cylinder, regulation and connections should be visually inspected for leaks, or damage.

Empty cylinders must be stored separately from full cylinders and be clearly marked as empty. Disposal of gas cylinder must be arranged with the gas supplier for empty or otherwise unneeded cylinders.

Cryogen Storage and Use

Cryogenic substances are materials with boiling points of less than −73 °C such as liquid nitrogen, helium, argon, and slush mixtures of dry ice with isopropyl alcohol. The main hazards associated with exposure to cryogenic substances are frostbite, asphyxiation, and pressure buildup. Principal investigators and laboratory supervisors must ensure that work with cryogenic liquids is performed in well-ventilated areas to avoid potential accumulation of gas that may generate an oxygen-deficient atmosphere leading to asphyxiation. If this is not possible, an oxygen meter must be installed.

A face shield over safety glasses or splash goggles must be worn during transfer and handling of cryogens. Gloves must be thermal insulated, and loose enough to be tossed off easily in case the cryogenic liquid becomes trapped close to the skin.

Cryogenic materials must be handled and stored only in containers and systems specifically designed for these materials. Cryogenic materials must be kept in containers with loose lids to permit intermittent venting to prevent an over-pressurization of the vessel.

Laboratory Maintenance Work

When repair and maintenance work is required within the laboratory, Principal investigators and laboratory supervisors must carry out the following before the work can begin:

- Remove/move and store hazardous materials away from planned work areas.
- Clean and decontaminate work surfaces and areas and/or equipment.
- Move/relocate equipment if required.
- Inform laboratory personnel of the work to be performed.
- Provide information on the hazards and safety precaution of the work area.

Modification of plumbing, electrical lines, structural components, ventilation, fume hood and associated ductwork must only be performed through Facilities Management.

Changes in Lab Occupancy

When a principal investigator, supervisor or department is vacating a university laboratory, the laboratory and associated research and teaching areas such as storage rooms, must be properly decommissioned. The laboratory must be left in a state that does not pose a health or safety risk to service staff or subsequent occupants. Decommissioning is the responsibility of the principal investigator or a lab supervisor. The removal of chemicals from laboratories must be coordinated through the EHS Office.

Laboratory Equipment

Engineering controls are considered the first line of defense in the laboratory. Engineering controls, such as fume hoods and other ventilation systems and shields, isolate, reduce or eliminate the potential exposure to hazardous chemicals. Laboratory personnel must familiarize themselves with the availability of engineering controls to protect themselves against exposure to chemicals prior to undertaking an experiment with hazardous products.

Fume hoods

A fume hood is one of the main safety devices in a laboratory. When properly installed and maintained, a fume hood offers a substantial degree of protection to the user. All work with chemicals or any operations which might result in release of toxic vapours, volatile compounds, odiferous materials, aerosols or dust must be conducted in a fume hood.

The EHS Office measures the face velocity of all hoods annually, notes any deficiencies, and refers them to Facilities Management for correction. Recommended face velocities are between 80-120 feet per minute (fpm) at a sash height of 12 inches. The Annual Fume Hood Inspection Policy can be obtained on the EHS Office website.

Laboratory personnel must follow the recommended work practices for fume hoods:

- Check the EHS Office inspection sticker on the hood to ensure it has been inspected within the past 12 months.
- Keep all chemicals and equipment 6 inches behind the sash to ensure vapours are captured effectively.
- Only chemicals that are being used in an ongoing experiment should be kept in a fume hood.
- Fume hoods must not be used as a storage space and obstructions within the hood should be avoided. When required, bulky pieces of equipment should be raised 1 ½ inches to minimize disruption to air flow.
- Fume hoods must not be used as a means of disposal for volatile chemicals by evaporation.
- Fume hood must not be altered in any fashion as it will affect the hood’s performance to contain hazardous vapours.
- The sash should be kept as low as possible while performing work in the fume hood and closed when the hood is unattended.

- An improperly working fume hood must not be used. If the EHS Office or Facilities Management has posted the fume hood as being out of service, it should not be used for any reason.
- Always practice good housekeeping and clean up all chemical spills immediately. Routinely wipe down the working surface and hood sash.

Perchloric acid hood

Heated perchloric acid must not be used in a conventional fume hood. The use of heated perchloric acid requires a specialized perchloric acid fume hood with a wash down function. The use of heated perchloric acid in a conventional fume hood can result in the deposition and accumulation of shock-sensitive perchlorate crystals that have been known to detonate on contact causing serious injury.

Other Laboratory Exhaust Systems

Local exhaust ventilation systems may be required to control contamination from processes or equipment that cannot be used in a fume hood, such as ovens, vacuums and gas chromatographs.

Elephant Trunks/Snorkels

An elephant trunk is a flexible duct or hose connected to an exhaust system. It can only capture contaminants that are very close to the inlet of the hose. They are ideal for capturing discharges from benchtop apparatuses such as gas chromatographs or heating processes.

Canopy Hoods

A canopy hood works in a similar fashion to range hoods seen in kitchens. They work well to exhaust heat and non-hazardous substances. They should not be used with hazardous substances due to their design where contaminated air passes through the individual's breathing zone.

Downdraft Tables

Downdraft hoods are specially systems with ventilation slots on the sides of the work area useful for chemicals with vapor densities heavier than air.

Ductless Fume Hoods

The use of ductless fume hoods is not recommended by the EHS Office. A ductless fume hood draws air from the laboratory into a chamber, through a filter, and back into the laboratory. It is difficult to assess if the filters are functioning properly or if they require changing. There is an increased risk of recirculating flammable vapours and toxic materials into the laboratory. A ducted fume hood is recommended for the majority of chemical work at the university. The EHS Office and Facilities Management must be consulted.

Emergency Eye Washes and Showers

Emergency eye washes and showers must be available where there may be a risk to the eyes from a corrosive or other harmful substance, or where there may be a risk of substantial contamination to the body from corrosive or other harmful substances. Emergency eye washes and showers must meet the requirements set out within the following standard, *ANSI Z358.1 Emergency Eyewash and Shower Equipment.* Laboratory personnel must be familiar with the location of their nearest emergency eye wash and shower and how to use it.

Emergency eye washes and showers must be tested regularly and must have a test sticker/certificate attached to them, as outlined in ANSI Z358.1. Laboratory personnel should also flush the eyewash unit weekly by allowing the water to run for a few minutes to remove debris that may have accumulated over time. If an emergency eye wash or shower is suspected to not be working, Facilities Management should be contacted.

Heating Devices

Heating devices routinely found in laboratories include hot plates, heating mantles, oil baths, and sand baths. Laboratory personnel should ensure that newer spark-proof hotplates are used; many older models are not spark-proof, and therefore unsafe for use with flammable materials. Laboratory personnel are encouraged to use temperature sensing devices as a control against overheating.

Laboratory personnel must ensure that oils selected for oil baths match the oil to the required heating temperature. The bath container as well as the reaction vessel must also be able to withstand this temperature. Saturated paraffin oil is appropriate for temperatures below 200 °C, and a silicone oil should be used for temperatures up to 300 °C.

Heat guns can be a source of ignition and should not be used around flammable materials. Ovens should only be used to dry glassware that is completely evaporated of solvent. Using an oven to dry glassware washed with solvent can result in an exposure to vapors since ovens do not typically have exhaust, and the possibility of an explosion.

Pressure and Vacuum Systems

Operations that require high pressures must only be performed in appropriate pressure vessels and protected with control and pressure-relief devices. Routine inspections of the equipment should be performed to ensure that pressure vessels can withstand the stresses encountered under the operation.

Working at reduced pressures, such as under vacuum, carries the dangers of flying glass and splashing chemicals as a potential result of an implosion. Systems under reduced pressure must be shielded, and controls be put in place to minimize implosion risk.

Glass flasks and reaction vessels should be wrapped with wire screening or taped to protect against explosion or implosion.

Glassware

Laboratory personnel should be familiar with the different types of glass and their purpose. Two of the most common types of glass found in laboratories is soft glass (soda lime) and hard glass (borosilicate). Borosilicate glass should be used for high temperatures or variations in pressure, not soda lime glass which is often used for graduated cylinders and stirring rods. Pyrex™ is a brand of borosilicate glass which is found in beakers and round bottom flasks.

Chipped or cracked glassware should be discarded. Glassware with chips, scratches, or cracks may result in structural failure.

Broken Glass

Broken glass must be disposed of appropriately to avoid punctures and injuries from lifting heavy boxes.

Centrifuges

Centrifuges are dependent on rotors intended for specific uses of a particular make and model. These rotors are designed to be used for maximum weights and speeds to take into account the applied forces from rotation speeds. As such, unsuitable balance and load can result in failure, or even the dislodging, of the rotors leading to potentially hazardous situations including flying shrapnel and vigorous, rattling movement.

Electrical Safety

Many common electrical hazards can be easily identified before a serious problem exists. Laboratory personnel must read and follow all equipment operating instructions for proper use. Electrical repairs may only be repaired or modified by Facilities Management. Extension cords or power bars are not substitutes for permanent wiring. They may only be used on a temporary basis only. If an additional power supply is required, Facilities Management should be contacted to have additional outlets installed.

Machine Guarding

The point of operation, as well as all parts of a machine that move while the machine is working, must be safeguarded. Common machine hazards occurring around moving parts include pinch points, wrap points, shear points and crush points. Guards must be put in place to protect users from these particular hazards and must remain in place and be functional.

Personal Protective Equipment

The use of personal protective equipment (PPE) is a basic and mandatory precaution that laboratory personnel must always follow when working with chemicals in Dalhousie laboratories. PPE is not a substitute for good engineering, or administrative controls, or good work practices, but should be used in combination with these controls to ensure the safety and health of staff and students. Whenever possible, engineering controls should be put in place to allow work to proceed safely. PPE does not reduce or eliminate the hazard and only protects the wearer. PPE is the last line of defence from the hazard.

The principal investigator and laboratory personnel must perform hazard assessments of the unique processes occurring in their research space to determine what PPE is required in order to safely carry out the operations. Personal protective equipment must be provided if it is required to perform the operation safely.

The need for and type of PPE required will depend on the particular hazards of the materials, equipment and procedures used. PPE includes items such as gloves, eye protection, lab coats, respiratory protection, aprons, boots, hearing protection, etc. Regardless of the type of PPE selected, individuals wearing the PPE must be familiar with its function, use and limitations.

When choosing the appropriate PPE to wear, the following must be considered:

- The chemicals being used, including concentration and quantity.
- The hazard presented by the chemicals.
- 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.
- The length of time in which the PPE will be in contact with the chemicals.

In addition to the safety features of the PPE, the comfort and fit must also be taken into consideration to ensure that it will be used by laboratory personnel.

PPE should be removed before leaving the laboratory or area where the work is being performed. PPE should be removed immediately upon significant contamination to avoid unintended contamination.

Eye Protection

Eye protection must be worn in the laboratory or in an area where eye hazards maybe found. The chemical and physical hazards found in laboratories can include chemical splashes, flying particles, dusts, or intense light sources. All laboratory employees and visitors should wear protective eyewear while in laboratories where chemicals are being handled or stored, at all times, even when not working directly with chemicals.

Prescription glasses are not a substitute for proper eye protection. Laboratory personnel who wear prescription lenses must wear eye protection that can be worn over the prescription lenses (e.g. goggles, face shields, etc.) or wear eye protection that incorporates the prescription in its design.

All eye protection must comply with Canadian Standards Association (CSA) standard *CSA Z94.3, "Industrial Eye and Face Protectors"*.

Safety Glasses
Safety glasses have lenses that are impact resistant and provide eye protection from moderate impact and minor chemical splashed, broken glass and particles. Safety glasses with side shields is the minimum requirement for eye protection that must be worn in the laboratory.

Chemical Safety Goggles
Chemical safety goggles offer additional eye protection against splashing from chemicals as they fully contour the eyes. Chemical safety goggles with indirect ventilation should be selected so that hazardous substances cannot drain into the eye area. Chemical safety goggles should be worn for processes that involve heavy chemical use such as stirring, pouring, or mixing.

Face Shields
Face shields provide additional protection to the eyes and face when used in combination with safety glasses or splash goggles. Face shields do not fully enclose the eyes and are to be used only in conjunction with primary eye protectors such as safety glasses or goggles.

Skin Protection
Protective clothing must be worn when there is the possibility of chemicals coming into contact with skin. Protective clothing protects against contamination, splashes, and potential exposures, and includes lab coats and gloves or other protective garments such as aprons, boots, Tyvek coveralls, and other items. Protective clothing must be resistant to the specific chemical and physical hazards that will be encountered. No single clothing material is impervious or provides total protection from all hazards. An evaluation of the hazards and determination of the risks of the work must be done to establish what protective clothing is required to protect the skin and body.

Principal investigators and laboratory supervisors should discourage the wearing of shorts and skirts in laboratories using chemicals by laboratory personnel, including visitors, working in or entering laboratories under their supervision.

Laboratory Coats
Laboratory coats must be worn when handling chemicals, or when hazardous laboratory operations are being performed. Laboratory coats must fit well and reach down to the knee to provide sufficient protection. They must also be worn properly (e.g., buttoned up, sleeves not rolled up, etc.). Laboratory coats must be removed when leaving the lab and put back on upon entering; they must not be worn in public areas or eating spaces, as the coats may be potentially contaminated. Due to potential contamination, lab coats should be laundered at work and not at home.

Flame-resistant (FR) lab coats must be worn when working with pyrophoric, spontaneously combustible, or extremely flammable chemicals.

Footwear

Closed-toed shoes must be worn in the laboratory as splashes and spills toward the floor can easily land on the legs and feet. Perforated shoes, sandals or cloth sneakers must not be worn in laboratories where chemical, biological, or physical hazards are present. This reasoning stems from the conceivable exposure to toxic chemicals and the potential associated with physical hazards such the presence of broken glass or dropping parts of equipment. Shoe materials, including soles and uppers, should be compatible with the laboratory environment, the materials handled, and the tasks being performed. Chemically resistant boots or shoe covers may be required when working with large quantities of chemicals and the potential exists for large spills to occur.

In some cases, the use of steel-toed shoes may be appropriate when heavy equipment or other items are involved. Protective footwear must comply with the latest version of CSA standard CSA Z195, "Protective Footwear".

Gloves

Gloves must be worn when handling chemicals, objects with sharp edges, and materials of extreme temperatures.

Gloves should be checked periodically for slits, small holes or signs of degradation, and should be replaced immediately if torn or contaminated. Gloves must not be worn outside of the laboratory, or when touching items in common areas that others may touch bare handed such as handles, door knobs, and keyboards to avoid contamination.

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. Remove gloves carefully, trying to avoid touching the outside of the gloves with bare skin. Hands should be washed thoroughly with soap and water after the gloves have been removed.

There is no single glove that provides universal protection for all purposes. Gloves are made from several materials, and in a variety of thickness and lengths. Gloves must be selected carefully to ensure that they are resistant to the chemicals in use. Choosing a glove that is not suitable for the chemical can result in serious consequences as the chemical penetrates the glove and contacts the skin. Information on glove selection can often be found in the SDS, in addition to glove manufacturers' chemical compatibility charts for their gloves. Glove selection is based on permeation rate, breakthrough time and degradation rating, as well as dexterity, thickness and length.

Glove Selection

There are a variety of types (fabric, leather, metal mesh, cryogenic, chemical resistant) of gloves available for laboratory personnel that serve different functions. For many applications, gloves made of nitrile provide good resistance to chemical penetration. The following list gives some qualitative information on the relative permeability's of some glove materials to a few common chemicals.

- Butyl - excellent resistance to gas and water vapour. Good resistance to a wide variety of chemicals (aldehydes, ketones, esters, alcohols, dioxane and most inorganic acids and bases)
- Natural rubber latex - Resistant to ketones, alcohols, caustics, and organic acids.
- Neoprene - Resistant to oils, alcohols, solvents and acids and bases.
- Nitrile - Resistant to alcohols, caustics, organic acids, and some ketones. Excellent puncture resistance.
- Norfoil – Highly chemical-resistant to many different classes of chemicals. Rated for chemicals considered highly toxic and chemicals that are easily absorbed through the skin. These gloves are not recommended for use with chloroform.
- Polyvinyl alcohol (PVA) - Resistant to chlorinated solvents, petroleum solvents, and aromatics. Coating is a water-soluble polymer.
- Polyvinyl chloride (PVC) - Resistant to mineral acids, caustics, organic acids, and alcohols.
- Viton® - Excellent resistance to chlorinated and aromatic solvents, but expensive synthetic elastomer.

Respiratory Protection

Respiratory protection includes disposable respirators, air purifying, and atmosphere supplying respirators. Respirators may only be used when engineering controls cannot control an exposure. The selection, use and maintenance of a respirator must comply with the latest version of CSA standard CSA Z94.4, "Selection, Use, and Care of Respirators". Respirators require specific training, a fit test, and medical evaluation prior to being used. The EHS Office offers respirator fit testing. Information on obtaining a respirator fit test is available through the EHS Office webpage.

Administrative Controls

Administrative controls consist of policies and procedures that result in providing proper guidance for safe laboratory work practices, in addition to establishing the benchmark for behavior within the laboratory. Principal investigators, supervisors and departments are responsible for ensuring that laboratory personnel working under their supervision are informed and abide by laboratory specific, departmental, and campus wide policies and procedures related to laboratory safety.

Standard Operating Procedures

Standard operating procedures (SOPs) can be stand-alone documents or supplemental information included as part of research notebooks, experiment documentation, or research proposals. The purpose of SOPs is to confirm that a process is in place to document and addresses relevant health and safety issues as part of every experiment.

The minimum details that SOPs should include are:

- The chemicals involved and their hazards.
- Special hazards and conditions.
- Use of engineering controls.
- Required PPE.
- Spill response methods.
- Waste disposal procedures.
- Decontamination practices.
- Outline of how to conduct the experiment or operation.

SOPs should also include the name(s) of who authored the procedure, who authorized the procedure, date active, and a method to track changes to the procedure, such as a revision table.

Principal investigators and laboratory supervisors must ensure that written SOPs incorporating health and safety considerations are developed for work involving the use of hazardous chemicals or processes in laboratories under their supervision and that PPE and engineering controls are adequate. In addition, principal investigators and laboratory supervisors must ensure that personnel working in laboratories under their supervision have been trained on those SOPs and that the SOPs are accessible for laboratory personnel to review.

Housekeeping

Poor housekeeping is one of the many contributing factors associated with accidents and fires. Areas of the lab should be free of clutter, trash, unnecessary equipment, and unused chemical containers. Chemicals and supplies must not be stored on the floor.

Exits must be clear of obstacles and tripping hazards. Areas around emergency equipment (e.g., fire extinguishers, emergency washing equipment, chemical spill kits, etc.) must be kept clean, free of clutter, in view and accessible.

General Laboratory Behaviour and Practices

Laboratory personnel must demonstrate prudent behavior within the laboratory, which includes following basic safety rules and policies, being aware of the hazards within the laboratory and exhibiting professionalism with other laboratory colleagues. Inappropriate behaviour can needlessly put people at risk. Laboratory personnel should also be aware of the work being performed nearby as well as the potential risks of that work.

Laboratory personnel must ensure their safety as well as the safety of their colleagues:

- Do not prepare, consume, or store food and drink in laboratories.
- Warn colleagues about any unusual dangers associated with their work.
- Be familiar with the location of emergency exits, alarms, available telephones and safety equipment (e.g. emergency washing equipment, spill kits, fire extinguishers, etc.).

- Understand safety rules and emergency procedures, and how to use safety equipment.
- Be alert to unsafe conditions and see that they are reported to the principal investigator or person responsible. Warn colleagues who are carrying out work in an incorrect or dangerous way.
- Confine long hair and loose clothing.

Laboratory Ergonomics

Laboratory personnel are often subjected to considerable amounts of awkward posturing and repetitive motion injuries through tasks such as pipetting, working in fume hoods, looking through microscopes, working with computers, and looking down at bench tasks for uninterrupted periods at a time. Back strain is often a common concern as a result of leaning and reaching due to the lack of leg room when sitting at benches or hoods. Granted that the required tasks likely cannot change, it is important to be aware of and to control such issues to reduce occupational injuries. An ergonomic self-assessment manual and educational video series can be found on the EHS Office webpage.

Working Alone

Whenever possible, laboratory personnel should avoid working alone when conducting research, especially when experiments involve hazardous substances and procedures. It is advisable that laboratories establish explicit guidelines and SOPs detailing when working alone is not allowed and develop notification procedures when working alone occurs. All work to be performed by someone working alone must be approved in advance by the principal investigator or laboratory supervisor.

Principal investigators or laboratory supervisors and the individual assigned to work alone must work together to identify hazards and risks associated with the specific task to be completed, the location where the work is to be completed, and conditions or situations that may arise while working alone.

Individuals are encouraged to use the DalSAFE app’s Work Alone feature when working alone at the university. This mobile app can be downloaded and installed on Android, Apple or Blackberry devices.

Phones in Labs

All labs are to have a means of communication in the event of an emergency, such as a landline phone or cell phone. If a phone is not available within the lab, then a notice must be displayed indicating where the nearest phone is located.

Unattended Operations

Some laboratory procedures must run for extended periods and laboratory personnel may not always be present throughout the procedure. Most do not present significant risk, but failure of a control (e.g., thermostat, flow regulator, etc.), the interruption of utilities (e.g., water, electricity, etc.) or a mechanical failure (e.g., stirrer, pump, etc.) could cause damage or injury. Laboratory personnel should carefully consider the possible implications of such failures when planning an unattended operation and develop a protocol that minimizes the likelihood and consequences of a failure. Whenever possible, laboratory activities should only be carried out while laboratory personnel are present in the laboratory or adjacent offices and are able to respond to accidents, service disruptions or emergencies.

A notice should be posted outside the laboratory door indicating that an unattended experiment is in progress, the nature of the experiment (i.e., chemicals and process) and the equipment involved, and the names and telephone numbers of people who should be contacted in an emergency.

Access to Laboratories

Access to Dalhousie University laboratories and other work areas housing chemicals is restricted to authorized Dalhousie faculty, staff, and students. Principal investigators and supervisors must ensure that authorized individuals receive site specific training.

Unless otherwise pre=arranged, visitors to laboratories and other work areas housing chemicals should be escorted by authorized individuals. Visitors must be informed of potential hazards in the area and be provided with required PPE prior to entering the space. Visitors include Facilities Management trades, security services, outside contractors, and other persons on official business.

Children should not be permitted in labs or work areas where chemicals are used or stored. Exceptions may be made to allow children to enter such hazardous areas in connection with university-sponsored events such as school tours or other outreach programs; however, they must be under direct supervision of authorized personnel and protected from potential hazards.

Laboratory Security

Laboratory personnel should take steps to secure their laboratories against theft of chemicals and valuable equipment. Suspicious activity should be reported immediately to Security Services and question the presence of unfamiliar individuals in laboratories. All laboratories must be locked when unattended or not in use. Any keys, or electronic access to laboratory space should only be provided to those who need to be in the lab and restrict off-hours access only to individuals authorized by the principal investigator or laboratory supervisor.

Emergency Preparedness

Prior to beginning an experiment, laboratory personnel must be familiar with emergency procedures, emergency equipment, spill kits, and emergency phone numbers to call for assistance. The label and SDS of a chemical must be reviewed prior to handling or storing a chemical to establish safety and emergency information. Furthermore, laboratory personnel must know the specific steps that must be taken in the event of an accidental release of any chemical prior to commencing work with it.

Security Services must be contacted for fires, suspicious odors, medical emergencies, spills, and other emergencies.

- Halifax Campus: 902-494-4109 or 4109
- Agriculture Campus: 902-893-4190 or 4190

All calls go directly to Security Services who will send the appropriate response and accompany outside emergency vehicles to the correct location.

Laboratory Fires

All laboratories that handle chemicals should have a fire extinguisher, commonly a class ABC fire extinguisher (carbon dioxide and dry chemical). Class D fire extinguishers are occasionally found in laboratories that have the risk of fires from combustible metals such as sodium, lithium or magnesium. Fire extinguishers must always be visible and accessible.

Laboratory personnel must be familiar with building evacuation procedures, and the location of the nearest fire extinguisher and fire alarm pull station. The first response for laboratory personnel in the case of a fire is to evacuate the area and sound the alarm. Upon hearing the fire alarm, all flames and gas sources should be turned off and personnel must exit the building via the stairway.

Fire extinguishers are inspected annually in coordination with Facilities Management.

The EHS Office offers online fire safety training which is available for all interested individuals.

Chemical Spills

Spills of chemicals differ based on the spill's size, and various levels of hazard(s) presented. If a spill were to occur, laboratory personnel must stop and assess the scene to determine the appropriate course of action. Laboratory personnel must notify others nearby the spill and must not leave the spill unattended nor allow unauthorized personnel to enter the contaminated area. Then proceed to carefully plan the cleanup of the spill. Chemical spill kits are located in proximity to laboratories where they can be easily accessed for minor spills. All personnel who work with chemicals must be familiar with appropriate spill clean up procedures for dealing with chemicals handled in their laboratory.

For more information about spill cleanup procedures, please review the "Chemical Spill Response Guidelines" available on the EHS Office website.

Chemical Exposures

Every laboratory should have a first aid kit available. Laboratory personnel must regularly inspect first aid kits and have them restocked as required. First aid kits and supplies are available through Facilities Management, Client Reception at (902) 494-3345.

The SDS for the chemical of concern should be reviewed to determine appropriate first aid response. The information on first aid in an SDS outlines basic procedures but cannot replace hands-on practice and training. When seeking medical attention, it is recommended to provide a copy of the SDS of the appropriate chemical to the attending medical personnel.

If any chemical exposure incident causes serious injuries or loss of consciousness, contact Security Services immediately. They will send the appropriate response and accompany outside emergency vehicles to the correct location.

Routes of Chemical Entry

The potential health effects that may ensue from exposure to chemicals depends on several components:

- Properties of the specific chemical – including toxicity
- Dose and concentration of the chemical
- Route of exposure
- Duration of exposure
- Individual susceptibility
- Further effects resulting from mixtures with other chemicals

It is important to first understand how chemicals can get into your body and do damage, and how chemical hazards can affect you. Exposure to chemicals in the laboratory occurs by several routes:

- Inhalation
- Ingestion
- Injection
- Contact with skin or eyes

Inhalation

Exposure to chemicals through inhalation can present the following symptoms: eye, nose, and throat irritation, coughing, difficulty in breathing, headache, dizziness, confusion, and collapse. If any of these symptoms are noted, leave the area immediately and get fresh air. Medical attention should be sought if symptoms persist.

Ingestion

Individuals who have ingested chemicals may encounter the following symptoms: metallic or other strange tastes in the mouth, stomach discomfort, vomiting, problems swallowing, and a general ill feeling. If a chemical is inadvertently ingested, medical attention should be sought immediately.

Injection

Exposure to toxic chemicals by injection can occur inadvertently through injury from sharp objects such as broken glass, pipettes or metal contaminated with chemicals, such as razor blades, or syringes used for handling chemicals. Cuts or injections from chemically contaminated items should be rinsed immediately under water trying to flush the wound to remove any chemical contamination. Medical attention should be sought out if necessary.

Eye and Skin Absorption

Many chemicals can be absorbed by the eyes and skin, resulting in a chemical exposure. Chemicals injure the skin directly by causing skin irritation and allergic skin reactions. Symptoms of skin exposure to chemicals include dry, whitened skin, redness, swelling, rashes, blisters, itching, chemical burns, cuts, and defatting. The eyes are made of very delicate tissue. Direct contact with many chemicals, particularly with corrosives, produces serious damage and even blindness. Symptoms of eye exposure can include itchy or burning sensations, blurred vision, discomfort, and blindness. If chemicals come in contact with the eyes or on the skin, the area must be washed immediately using emergency washing equipment. Flushing should occur for a minimum of 15 minutes, or as prescribed in the SDS.

Some chemicals, such as hydrofluoric acid, require use of a special antidote (e.g., calcium gluconate gel) and special emergency procedures, as outlined in the SDS.

Toxicity

Toxicity refers to the ability of a chemical to cause harmful effects to the body. There are a number of factors that influence the toxic effects of chemicals on the body:

- Quantity and concentration of the chemical (dose)
- Route of the exposure
- Length of time and the frequency of the exposure
- Whether it is a mixture of chemicals
- Characteristics of the exposed person, such as sex, age and lifestyle.

Toxic Effects

Toxic effects are generally classified as acute toxicity or chronic toxicity.

- Acute toxicity is generally thought of as a single, short-term exposure where effects appear immediately and are often reversible.
- Chronic toxicity is generally thought of as frequent exposures where effects may be delayed (even for years) and are generally irreversible.

Evaluation of Toxicity Data

It is the dose which distinguishes an exposure which is harmful from one that is not. Dose involves the quantity of chemical and the exposure route and pattern. It is generally considered that there is a dose below a threshold which there is no harmful effect. As the dose increases above this threshold, the chemical begins to exert an effect. At a high enough dose exposure can be fatal.

The dose-response relationship is a range of concentrations that result in a rated effect between the extremes of no effect and death for chemicals. It is well established that the magnitude of the risk increases with increasing dose.

SDSs and other chemical safety resources generally refer to the toxicity of a chemical numerically using the terms Lethal Dose 50 (LD_{50}) and Lethal Concentration 50 (LC_{50}).

- **LD_{50}** describes the amount of chemical ingested or absorbed by the skin in test animals that causes death in 50% of the animals.
- **LC_{50}** describes the amount of chemical (usually volatiles) inhaled by test animals that causes death in 50% of the animals.

As an example, an LD_{50} of less than 5 mg/kg would be considered extremely toxic, while an LD_{50} between 500mg/kg to 5 g/kg would be considered slightly toxic.

Incidents

Laboratory personnel involved in an incident, exposure, spill or near-miss incident while conducting work or engaged in activities at the university must follow the incident reporting process.

The individuals involved in the incident are responsible for:

- Seeking appropriate medical attention.
- Notifying their supervisor as soon as possible.
- Completing an incident report via the university's online incident reporting system. For assistance in completing an incident report, please contact the EHS Office.
- Participating and cooperating with their principal investigator or laboratory supervisor and EHS Office representatives on the review of the incident, and the determination and implementation of appropriate corrective and preventative measures to minimize a recurrence.

The individual`s principal investigator or laboratory supervisor is responsible to:

- Discuss the incident with the individual who reported the incident and perform an investigation to determine the cause of the incident, and corrective and preventative measures to minimize a recurrence.

The Accident/Incident Report Form and other related information can be found on the EHS Office webpage.

Laboratory Inspections

Conducting routine laboratory inspections is a proactive method to identify health and safety hazards, and to review work behavior and activities. Principal investigators or lab supervisors must conduct routine lab inspections to ensure that labs under their authority are in compliance with the requirements for the safe handling, storage and use of chemicals. Principal investigators or lab supervisors are required to complete the university's biannual self-inspection distributed by the EHS Office in May and November.

Inspections may be conducted by faculty, staff and students familiar with the laboratory and the activities of the laboratory, or by external departmental laboratory personnel. Principal investigators and laboratory supervisors should develop a regular inspection schedule and encourage laboratory personnel to participate in the inspection. Outside of the required EHS Office self-inspections, it is recommended that inspections be completed once a month.

Hazards and other related concerns that are identified should be addressed in consultation with the Principal investigator or lab supervisor and laboratory personnel, department administration and the EHS Office as required.

Records Management

Management and control of documents and records associated with the activities in the laboratory is necessary to assess health and safety, but also to provide evidence of due diligence if laboratory practices are questioned. Principal investigators and laboratory supervisors must manage and maintain records to provide evidence of compliance to regulatory requirements and university policies. Records must be easily identifiable, retained, made available as needed, and stored securely.

Principal investigators and laboratory supervisors must maintain the following types of records:

- Training records of laboratory personnel and visitors.
- Standard operating procedures and rules.
- Licences or permits issued by the university and/or regulatory bodies
- Laboratory inspections and audits
- Incident reports and steps taken to mitigate hazards in the laboratory.
- Maintenance, testing and repair records for equipment
- Chemical inventories, safety data sheets, and other technical information.