Chemical and Laboratory Safety Program

Foreword

The Occupational Health and Safety Act and *The Occupational Health and Safety Regulations* require employers to ensure that all chemicals are controlled, identified, labelled, handled, stored and disposed of in a prescribed manner. The safe use, storage, handling, waste and emergency management of chemicals, particularly in the laboratory is the subject of this reference manual. Chemicals are used, to one degree or another, in most university laboratories. The advent of WHMIS (Workplace Hazardous Materials Information System) in 1988 gave employees the legal right to know about the hazards of the materials used in the workplace and to receive the training necessary to use these materials safely. *The Occupational Health and Safety Regulations* require employers to provide worker training on all hazard information concerning a controlled product, including training in:

(a) The content required on a supplier label and workplace label for the controlled product and the purpose and significance of the information contained on those labels;

(b) The content required on a material safety data sheet for the controlled product and the purpose and significance of the information contained on the material safety data sheet;

(c) All necessary procedures for the safe use, storage, handling and disposal of the controlled product;

(d) All necessary procedures to be followed where fugitive emissions are present; and,

(e) All necessary procedures to be followed in case of an emergency involving a controlled product.

Details on specific types of chemical hazards as well as commonly used equipment and procedures are outlined on the following pages. The information is a starting point for the development of safe and best management practices for those who work, study, teach and conduct research in laboratories at the University of Regina.

Acknowledgement

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1. Program Administration

1.1 Purpose and Policy

The University of Regina, (U of R) is committed to providing a safe and healthy environment to all members of the University Community. As stated in the University's Safety Policy, it is the objective of the University to:

- Maintain, as a minimum standard, compliance with all relevant statutes, regulations and standards of regulatory authorities representing occupational health and safety
- Ensure that safety and accident prevention are an integral part of planning, operations and University activities and
- Promote safe working practices and awareness through training, education, and the implementation of general safety policies and workplace-specific procedures, including an Occupational Health and Safety Program

The purpose of the Chemical and Laboratory Safety Program is to meet the objectives of the University's Safety Policy in so far as they apply to chemicals and wet laboratory operations. [Wet laboratories are those in which chemicals or other hazardous materials are used or are present.]

The Program provides a comprehensive guide to University policies and procedures, regulatory requirements, mandatory standards and recommended best practices as they relate to chemical and wet laboratory operations. It is not, however, meant to be all inclusive. Since there is a wide range of hazards present in laboratories, laboratory-specific safe work procedures and arrangements will be required to supplement the information provided in this Program.

1.2 Related External Policies and Regulations

Laboratory activities must respond to a variety of regulations, policies, procedures and guidelines. The following is a list of the most important acts and regulations to which employees at the U of R must comply while conducting their various work and research tasks at the U of R, on or off-campus.

- *The Occupational Health and Safety Act*
- *The Occupational Health and Safety Regulations*
- *Transportation of Dangerous Goods Act*
- *Transportation of Dangerous Goods Regulations*
- *The Nuclear Safety and Control Act and Regulations*
- *The Radiation Health and Safety Act and Regulations*
- *Environment Management and Protection Act*
- *Environmental Spill Control Regulations*
- *Hazardous Substances and Waste Dangerous Goods Regulations*
- *Fire Prevention Act*
- *Saskatchewan Fire Code Regulations*
- *The National Fire Code of Canada*

1.3 University of Regina Policies

In addition to government regulations, U of R laboratory personnel are required to comply with U of R policies such as:

- Emergency Management Policy
- Hazardous Material Management Policy
- Respectful Workplace & Learning Environment Policy
- Radiation Safety Policy
- Safety Policy
- Violence Prevention Policy
- Travel & Fieldwork Safety Policy

These polices can be viewed at http://www.uregina.ca/presoff/vpadmin/policymanual/index.shtml

2. Responsibilities and Duties

Safety in the laboratory is the responsibility of every Laboratory User, each to the degree of his/her authority and control.

2.1 Administrators

In addition to the duties described in the Safety Policy, Administrators will:

- ensure that a Laboratory Manager is assigned for each laboratory within their unit.
- ensure compliance with regulatory requirements and with the U of R's policies and procedures described in this program.
- develop a plan which includes identification of essential staff required for on-going research projects and animal care.
- ensure emergency response personnel are identified, available and trained.

2.2 Laboratory Managers

The Laboratory Manager will:

- complete a Laboratory Hazard Control Plan (**Appendix 4** - Instructions and **Appendix 5** - Form).
- ensure students, staff or other persons working in the laboratory are aware of and comply with the lab safety rules and standards.
- implement the Monthly Laboratory Safety Checklist (see **Section 3.9** and **Appendix 1**). Inspect the lab monthly in accordance with the checklist and when circumstances warrant. Post the checklist.
- ensure that all chemicals brought into the laboratory have been entered in the chemical inventory.
- take action to rectify identified deficiencies in compliance with laboratory safety requirements and standards.
- report to the Local Safety Committee on follow-up actions taken to rectify any deficiencies noted in the Local Safety Committee's annual inspection.
- cooperate with HSE and the Local Safety Committee.
- ensure that all incidents occurring in the laboratory are reported and investigated in accordance with the University of Regina's incident reporting process (**Appendix 7**).
- provide and document work-site specific safety training and orientation.
- ensure proper disposal of chemicals and laboratory waste (**Section 9**).
- maintain the records and documents listed in **Appendix 8**.
- fulfill all other responsibilities as listed in **Appendix 9**.
- ensure that the Departing Laboratory User process is followed.

2.3 Laboratory Users

Laboratory Users will:

- comply with laboratory safety requirements and standards.
- comply with all University policies and procedures related to laboratory safety.
- inspect work areas daily to identify and correct any hazardous conditions.
- promptly report hazardous or unsafe equipment, conditions, procedures or behavior to the Laboratory Manager and make suggestions for their corrective action.
- promptly report all laboratory related incidents or injuries to the Laboratory Manager and to HSE (**Appendix 7** and **Appendix 8**), and obtain medical treatment if necessary without delay.
- follow proper disposal procedures (**Section 9**).

2.4 Local Safety Committees

The Local Safety Committee will:

- participate in the identification and control of health and safety hazards.
- cooperate with Health, Safety and Environment.
- maintain records with respect to duties of the committee.
- receive, consider and resolve matters respecting health and safety.
- participate in the annual inspection of each laboratory within its jurisdiction (**Appendix 3**).
- provide advice and make recommendations to ensure the health and safety of all laboratory users and compliance with the Chemical and Laboratory Safety Program.

2.5 Health, Safety and Environment, Human Resources Department (HSE)

Health, Safety and Environment will:

- develop and maintain effective incident prevention programs.
- provide the University community with basic WHMIS training and with generic laboratory safety training.
- assist the University in complying with health, safety and environmental legislation.
- enhance Faculty/Department/Unit services.
- develop, audit and update the Chemical and Laboratory Safety Program.
- maintain a central chemical inventory program.
- assist with providing access to Material Safety Data Sheets.
- manage the university's chemical disposals.
- investigate all matters respecting health, safety and environment.

3. Procedures

3.1 Laboratory Occupancy Approval Process

At the University of Regina, building space design is developed, reviewed, and completed according to the National Building Code of Canada, National Fire Code of Canada and other applicable codes and standards. Laboratory space can only be assigned by Facilities Management and no laboratory space may be occupied until Facilities Management and Health, Safety and Environment have commissioned both the proposed laboratory activities and the laboratory space.

The commissioning process is as follows:

- the researcher completes a Hazard Approval Checklist for Research Applicants, available from HSE, to determine whether or not the U of R can support the proposed research activity.
- once it has been determined that the support is available, the researcher applies for laboratory space through Facilities Management.
- when space has been allocated, the researcher completes a Laboratory Hazard Control Plan (**Appendix 5**) for the proposed activity, which includes the identification of the safety infrastructure requirements.
- when HSE has evaluated and approved the plan, it authorizes the use of the lab for the proposed activities and with the recommended hazard controls in place.
- Facilities Management and the researcher work together to ensure the laboratory and the hazard controls are completed.
- the Laboratory Manager (usually the researcher), HSE, Facilities Management and the Dean of the researcher's faculty sign the Laboratory Commissioning Checklist and Occupancy Approval Form (**Appendix 2**).

The researcher can now begin his/her research.

Note that changes in research activities must be preceded by a new Laboratory Hazard Control Plan.

3.2 Laboratory Safety Equipment

All wet laboratories at the University of Regina must be equipped with the following safety equipment that meets regulatory and University of Regina standards:

- Emergency Eyewash
- Emergency Shower
- Emergency Sprinkler
- Fire Alarm (ready access)
- Fire Extinguisher
- First Aid Kit
- Fume Hood
- Smoke Alarm
- Spill Kit
- Personal Protective Equipment

Exemption

Certain laboratories may be exempt from the mandatory safety equipment requirements by Health, Safety and Environment if in the opinion of HSE the activities carried out in the laboratory do not warrant the equipment.
See **Section 10** for a description of emergency equipment standards.

Each laboratory must also be equipped with additional equipment as required and that is identified by the Laboratory Hazard Control Plan.

3.3 Mandatory Postings

Facilities Management, in consultation with HSE and the Laboratory Manager, provides signs. The following information must be conspicuously and securely posted immediately outside the laboratory:

- The names and emergency contact numbers of the Laboratory Manager and other emergency contacts.
- Approved signage to indicate the presence inside the laboratory of:
  - Radioactive Material
  - Laser or X-Ray emitting equipment
  - Biohazardous Material
  - Compressed Gases
  - Flammable substances

The following documents must be available inside the laboratory:

- The last completed Monthly Laboratory Safety Checklist **(Appendix 1)**
- The last completed Annual Laboratory Safety Checklist **(Appendix 3)**
- The last completed Laboratory Hazard Control Plan **(Appendix 5)**
- Signage to indicate the location of First Aid Kit and Spill Kit

3.4 Laboratory Hazard Control Plan

A Hazard Control Plan must be completed by the Laboratory Manager:

- before a new laboratory is commissioned; and
- before new equipment, machinery or work involving high energy, special ventilation or special installation is used or started.

The Control Plan should be reviewed at least annually and whenever there is a change in laboratory operations or procedures or after an incident. A copy of the Control Plan must be provided to HSE.

The Laboratory Manager must use **Appendix 5** or a similar form (approved by HSE) to complete the hazard assessment. Prior to conducting the hazard assessment the Laboratory Manager must review the types of hazards and control measures discussed in this program and consult other laboratory users. **Appendix 4** provides instructions regarding the Hazard Control Plan.

3.5 Ordering and Receiving Hazardous Materials

Hazardous materials can only be ordered by authorized Academic Staff Members and employees, through the University purchasing departments (Science Stores, Facilities Management Stores and Supply Management Services). Students and visitors require written authorization from the Dean, Director, Department or Unit Head to order any hazardous materials. The unit ordering hazardous materials must be capable of handling the support functions needs as prescribed by legislation. All persons working with chemicals must have valid U of R WHMIS training.

Consideration must be given to substituting less harmful materials for those that are known to be hazardous at the time of acquisition. Hazardous materials must be purchased in quantities small enough that they do not have to be stored at the University of Regina over extended time periods.

Persons receiving or transporting dangerous goods must hold a valid Transportation of Dangerous Goods (TDG) certificate of training.

Academic Staff Members in research and teaching laboratories wishing to use Notifiable Chemical or Biological Substances are required to obtain written authorization from Advanced Employment, Education and Labour, Occupational Health and Safety Division. A "notifiable chemical or biological substance" means any of the substances listed in Table 19 of The Occupational Health and Safety Regulations. A copy of Table 19 is set out in **Appendix 20.** To initiate this authorization process, the Academic Staff Member must contact HSE for assistance in making the application and meeting legislated requirements. Approval of the Dean or Director is also required.

3.6 Using and Storing Chemicals

There are four basic principles to consider when working with chemicals in the lab:

- **Plan** - Identify the potential hazards associated with an experiment before beginning work. Always review the MSDS before using a new chemical
- **Minimize Exposure to Chemicals** - Avoid skin contact with all laboratory chemicals. Use laboratory fume hoods and other local ventilation to prevent exposure to airborne chemicals
- **Never Underestimate Risks** - Always assume a mixture of chemicals is more toxic than its most toxic component. Treat all unknown chemicals or substances of unknown toxicity as toxic substances
- **Be Prepared for Accidents** - Know what actions to take in the event of a spill or emergency, especially a spill on the body or in the eyes

These principles must be applied to **all** work involving chemicals in the laboratory.

Chemicals must be stored according to chemical compatibility so that incompatible materials do not come in contact with each other in the event of breakage or accidental spill. The usual approach is to separate chemicals into compatible groups, and segregate these groups from each other by physical barriers or distance. Generally, inorganic and organic chemicals are stored separately, and liquids are separated from solids. **NEVER** store chemicals solely alphabetically. This is acceptable within a hazard group, but this should never be the primary storage system.

The quantity of flammable and combustible materials stored in a laboratory is regulated by the National Fire Code.

Appendix 18 provides some basic chemical storage guidelines, and **Appendix 19** contains a list of some common chemical-specific incompatibilities. These appendices are general guidelines only. Always refer to the MSDS for specific information about the hazards associated with or possible incompatibilities of a chemical before storing or using chemicals. **Appendix 21** (Working with Specific Types of Chemicals) provides storage information about specific groups of chemicals.

In many cases, it is not practical to store all chemicals in physically separate locations. In such cases, segregate chemicals using a glass, porcelain or heavy gauge Nalgene© or similar plastic container that is compatible with the material being stored. The secondary container must be large enough in volume so as to contain any spills.

It is good laboratory practice to store liquids separately from solids to minimize the possibility of mixing. Liquids are inherently more dangerous because they are much more mobile and susceptible to mixing if a spill occurs.

Solids may be grouped together by compatibility on separate shelves or areas of shelves separated by taping off sections to designate where chemicals of one type are stored. Organic solvents, acids, and bases should be physically separated from each other by storage in separate areas or through the use of secondary containment as described above. Ideally, acids and bases should be stored in dedicated caustic storage cabinets, and flammables in an approved flammable storage cabinet.

General storage principles include:

- Do not store chemicals near exits.
- Ensure bottles are within easy reach of everyone in the lab, and no higher than eye level. In particular, large bottles and containers should be stored as close to the floor as is practical.
- Do not store chemicals directly on the floor unless they are in ULC approved safety cans, or if the chemicals are still in their shipping container.
- Shelves used to store chemicals should be chemical-resistant, secure and strong enough to support the weight, have a lip to prevent containers from falling off, and bolted to the wall to prevent tipping.
- Store chemicals according to instructions on the label or MSDS.
- Do not store chemicals under sinks. This will prevent corrosion of pipes, prevent any potential problems in the event of a leaking or burst pipe, and minimize chemical exposure of maintenance personnel working below the sink.
- Do not store chemical containers on top of flammable storage or acid storage cabinets.
- Ensure that lighting and ventilation is adequate in the storage area.
- Regularly inspect chemicals in storage to ensure there are no leaking or deteriorating containers. Some items to note:
    - Keep the outside of containers clean and free of spills
    - Check that caps and closures are secure and free of deformation. Use only screw caps on chemical containers in storage; foil, Parafilm™, corks or other plugs are not acceptable
    - Ensure that metal containers are free of rust, bulges or signs of pressure buildup
- Do not store chemicals in unsuitable containers or containers made of incompatible material (e.g., no hydrofluoric acid in glass containers).
- Do not store incompatible chemicals together (e.g. do not store acids with bases). Chemicals must be stored by hazard category and not alphabetically (except within a hazard group).
- Purchase solvents in containers with a plastic safety coating.
- Ensure that all gas cylinders are securely fastened and upright.
- All chemicals must be labelled as described in **Section 3.7**.

3.7 Labelling and Inventory

Maintaining an inventory of the chemicals used and stored in the lab is the first step in safe handling of chemicals. A current list of hazardous chemicals assists in implementing proper storage and safe work procedures and is a necessary component of proper emergency planning. Once an inventory has been established, it must be updated as new chemicals are received in the lab or as chemicals are used up or sent for waste disposal. Chemicals used in the laboratory are barcoded and added when they are received at Science Stores. When containers are emptied, they must be removed from the inventory by Stores or by the Laboratory Manager.

All chemicals should be labelled with the date of receipt. This helps track usage in the lab, as well as giving an indication of the "freshness" of the chemical. This is required when dealing with substances that deteriorate over time (e.g. peroxide formation in ethers, drying out of picric acid). It is also good practice to label chemicals with their storage location, to ensure they are returned to the proper place after use.

Chemicals that are produced, mixed or decanted, must be labelled to identify their contents. Failure to label the chemical containers can create unexpected hazards, and significantly increase the cost of disposal, which is the responsibility of the Faculty/Department/Unit.

Training on and access to the University of Regina web-based chemical inventory program is provided by HSE.

3.8 Transporting Chemicals

When transporting chemicals outside the laboratory:

- Carry glass containers in specially-designed bottle carriers or leak-resistant, unbreakable secondary containers.
- When transporting chemicals on a cart, use a cart that is suitable for the load and that has high edges or spill trays to contain leaks or spills
- When possible, transport chemicals on freight elevators or on passenger elevators when no other passengers are present. Using stairs while transporting chemicals is not recommended.
- Chemicals should be transported by hand for short distances only within buildings or between adjacent buildings.
- Transportation of compressed gas cylinders on elevators must only be done when no other passengers are present.
- Transportation of cryogenics (dry ice, liquid nitrogen or liquid helium in pressurized vessels) on elevators must be done using the "buddy" system – the materials must not be transported on elevators containing passengers.

Large quantities of chemicals may be moved from one laboratory to another laboratory (such as moving an entire lab) if the following conditions are met:

- Individuals moving chemicals are trained in the proper handling of chemicals and spill clean-up procedures and use the required personal protective equipment.
- Chemical bottles and containers are in good condition and are adequately labeled.
- Secondary containers used to move chemicals are in good condition and sturdy enough to handle the weight of the bottles of chemicals.
- Bottles of chemicals are segregated and packed into secondary containers by hazard class (in-compatible chemicals cannot be packed or moved in the same container).
- Glass bottles and bottles containing liquids are packed in containers with a buffer of vermiculite or other similar absorbent material.

- Each secondary container of chemicals is inventoried for contents (chemical name, number of bottles and quantity of each).
- During transport, compressed gas cylinders are secured on a cart or rack and the regulator removed and replaced with the gas cylinder cap.
- Adequate spill control materials are available and when the containers are being moved between buildings, the spill control material is available to the vehicle in use.
- HSE is notified of the movement of the chemicals prior to the start of and upon the completion of the move.

The chemical inventory for the originating lab (showing removal of the chemicals) and the receiving lab (showing the acquisition of the chemicals) is updated.

The Transportation of Dangerous Goods Act *and* Regulations govern transportation of chemicals off campus. For details, please refer to the regulations or contact HSE.

3.9 Laboratory Inspections

All laboratories in use at the University of Regina must be regularly inspected as follows:

- **Daily** - All employees or students working in a laboratory must inspect their work area prior to conducting any work, to identify and correct hazardous conditions, or report them to their supervisor.
- **Monthly Laboratory Manager's Inspection** - Each Laboratory Manager or his/her designate must conduct an inspection to identify hazardous conditions, using the Monthly Laboratory Safety Checklist contained in **Appendix 1**. The completed inspection checklist must be posted in the laboratory. Alterations to the checklist must be approved by HSE.
- **Annual Inspection** - The Local Safety Committee or designated members of that committee must conduct an annual inspection of each laboratory in their area. This committee must use the Annual Laboratory Safety Checklist contained in **Appendix 3**. A copy of the Local Safety Committee's report must be provided to the Laboratory Manager, the Unit Head/Dean and HSE.
- **Special Inspections** - The Laboratory Manager, or his/her designate, must conduct an inspection to identify hazardous conditions arising from changes in laboratory operations or facilities, introduction of new equipment or materials, after an incident, or before re-start of laboratory operations after a shut down. Special inspections may also be conducted by the Local Safety Committee or HSE.

Inspection Follow-up

The Laboratory Manager must ensure that all deficiencies noted in an inspection report are rectified as soon as reasonably possible. In the case of a deficiency noted in a monthly inspection, the Laboratory Manager is required to record the action taken to correct the deficiency and the date of the action.

In the case of a deficiency noted by an inspection report prepared by the Local Safety Committee or HSE, the Laboratory Manager must report the corrective action taken to HSE within fourteen days of the date of the inspection report or within such other date as HSE may designate.

3.10 Disposal of Hazardous Materials

Chemical Exchange

When chemicals have been identified as unwanted surplus within a laboratory, the Academic Staff Member, researcher, graduate student or other person responsible for the chemical should attempt

to locate other Academic Staff Members, researchers, graduate students or staff within the U of R community who may be able to use some or all of the chemicals.

In addition, researchers needing chemicals should contact other faculties to determine if they have surplus chemicals available for exchange, particularly when small quantities are required.

Disposal

If a new user cannot be found, the chemicals must be disposed of in accordance with the U of R's hazardous waste disposal procedures. An electronic disposal request form must be forwarded to HSE, who will arrange for a hazardous waste disposal contractor to pick up and dispose of identified chemicals in accordance with regulatory requirements. [Contact HSE for more information regarding this process.]

Each Unit is responsible for the cost of its chemical disposal. The cost can be significantly decreased when the CAS or UN number for the chemical is known, and when compatible chemicals are batched together. Contact HSE for information on batching chemicals.

Unidentified Chemicals

Chemicals of unknown identity cannot be disposed of, because their transport is prohibited by The Transportation of Dangerous Goods *Regulations*. Consequently, in order to dispose of chemicals, they must first be identified by the Unit which generated them. It is the responsibility of the Unit to safely store unidentified chemicals until such time as they are identified and disposed of.

Detailed information regarding hazardous waste management can be found in **Section 9**.

3.11 Decommissioning of Laboratory Activities

All Laboratory Users and Laboratory Managers who terminate or relocate their laboratory activities at the U of R must follow the outlined procedures and forward the appropriate documentation to HSE.

- When researchers conclude their work in a lab in which the research activity continues on (for example, when honours students complete their laboratory work) the Departing Laboratory User Checklist (**Appendix 6**) must be completed and submitted.
- When the Laboratory Managers close down their laboratory activities, the Laboratory Deactivation process must be followed. (Contact HSE for more information.)
- When a laboratory is completely shutdown, and turned over for another, unrelated activity, the Laboratory Decommissioning process is followed. (Contact HSE for more information)

The University's policy and procedures on concluding laboratory use can be found in the Hazardous Material Management Policy at: http://www.uregina.ca/presoff/vpadmin/policymanual/hr/index.html

3.12 Incidents and Emergencies

The University of Regina's Incident Report form must be completed for every incident, even if there were no injuries sustained. This includes all chemical spills. The University's Policy and Procedures on Incident Reporting and the Incident Report Form can be found at http://www.uregina.ca/hr, and a copy is found in **Appendix 7**.

File an Incident Report Form for all chemical spills.

4 Laboratory Safety

Exposure to hazardous materials can occur by **inhalation, ingestion**, **injection** and **absorption through mucous** membranes or **skin contact**. The following rules are designed to minimize contact with hazardous materials. They apply without exception to all laboratories and laboratory personnel.

4.1 Personal Health and Hygiene

While working in the laboratory:

- Do not pipette by mouth.
- Wash hands before and after work in a laboratory and after any spill clean up, even if gloves were worn. Avoid using organic solvents for washing. (Organic solvents remove natural protective oils from the skin which can cause skin irritation and inflammation, and their use may also increase the risk of toxic chemicals being absorbed through the skin).
- Tie back or otherwise restrain long hair.
- Avoid direct contact with any hazardous material.
- Avoid inhalation of chemicals. For example, transfer solvents in the fume hood
- Use required personal protective equipment.
- Avoid wearing contact lenses where water soluble gases, vapors, mists or dusts may be released into the atmosphere. Contact lenses must not be used in laboratories in which the following chemicals are used or stored:
  - Isopropyl alcohol
  - Ethyl alcohol
  - Acrylonitrile
  - Methylene chloride
  - 1,2-Dibromo-3-chloropropane
  - Ethylene oxide
  - Methylene dianiline
- If contact lenses must be worn, they may only be worn with the permission of the Laboratory Manager in conjunction with a risk assessment that may include increased use of personal protective equipment. Contact lenses are NOT a substitute for eye protection.
- Do not bring food or beverages into the laboratory.
- Do not store food or beverages in the laboratory refrigerator.
- Do not use laboratory glassware, containers and equipment to prepare or store food.
- Do not smoke in a laboratory.

4.2 Protection for Pregnant Workers

Workers who are pregnant should take steps to reduce their exposure to harmful chemicals. Laboratory Managers who have been notified that a Laboratory User is pregnant must take steps to minimize the worker's exposure.

4.3 Proper Laboratory Apparel

While working in the laboratory:

- Wear approved eye or face protection (ANSI/NIOSH or equivalent standard) when working with hazardous materials in the laboratory (**Appendix 11**).

- Wear gloves that will resist penetration by the chemical being handled. Check gloves for pinholes, tears, or rips (**Appendix 13**).
- Wear a full-length laboratory coat to protect skin and clothing from chemicals.
- Restrain loose clothing (e.g. sleeves, full cut blouses, neckties), long hair and dangling jewelry.
- Wear footwear that covers feet completely; no open-toe shoes or sandals are allowed.
- Wear clothing which does not leave large areas of skin exposed.
- Wear other appropriate Personal Protective Equipment, such as respiratory protection (**Appendix 12** provides information about fit testing respiratory protection).
- Do not wear lab coats outside the lab, except when necessary (e.g. getting chemicals from storerooms, walking to another lab) and never wear laboratory coats and aprons in eating areas, restrooms or offices.
- Remove gloves before leaving the lab and before handling objects used by others such as telephones, keyboards and pens, in order to prevent others from being exposed to hazardous material.

For further information on the standards for Personal Protective Equipment, refer to **Section 8.5**.

4.4 Housekeeping

Clutter in the laboratory is detrimental to efficient work and is a serious safety hazard. Always keep labs clean, tidy and free of unnecessary chemicals and apparatus. Make clean-up a part of your normal work routine by:

- storing equipment not in active use in a designated area, away from the work area.
- cleaning equipment and glassware as soon as possible.
- returning chemicals to storage after use (fume hoods are not storage cabinets).
- cleaning work surfaces regularly to prevent accumulation of dust and chemical spills.
- keeping all exits, aisles and walkways in the lab clean and unobstructed to allow safe movement throughout the lab and safe egress in the event of an emergency. A minimum aisle width of 28” must be maintained in the laboratory.
- not allowing electrical cords or tubing for gas or water flow to trail across aisles, out of fume hoods or from ceilings.
- cleaning up all spills immediately and properly.
- not blocking access to emergency equipment or utility controls.
- not storing boxes, excess equipment and personal belongings in the lab.
- disposing of broken glass properly (**Section 9**).
- promptly reporting leaking chemical containers to a supervisor or Laboratory Manager.
- identifying, containing and disposing of all waste in accordance with university policies and procedures.
- always leaving the lab in a safe condition.

4.5 Laboratory Security and Authorized Persons

To maintain laboratory security:

- labs must remain locked when not in use.
- keys must not be loaned out or shared.

- only Authorized Persons are permitted in University Laboratories. 'Authorized Persons' means:
  - Academic Staff Members, staff, teaching assistants, graduate students and students who hold current WHMIS and current Chemical and Laboratory Safety certification.
  - Academic Staff Members, staff, teaching assistants, graduate students and students working under the close and direct supervision of the Laboratory Manager or designate who hold current WHMIS and current Chemical and Laboratory Safety certification.
  - University staff who are present in the laboratory for a legitimate purpose connected to their job duties and who have been oriented to the hazards present in the laboratory.
  - Visitors who have been specifically authorized to enter by the Unit Head/Dean, and who have been oriented to the hazards present in the laboratory.
- Children of faculty, staff, teaching assistants, graduate students, volunteers or students are not allowed in restricted areas or in laboratories at any time. Children are only permitted in University labs as a part of University-sanctioned tours or visits authorized by a Faculty/Department/Unit. In these instances, the tour leader or other knowledgeable personnel must exercise careful, direct supervision at all times. Persons wishing to bring minors into their work areas require special permission from the Dean, Director, Department or Unit Head and must conduct a hazard assessment and implement appropriate corrective measures prior to bringing the children in.

4.6 Safe Work Procedures and Equipment

Laboratory Users are required to:

- perform all processes involving volatile, toxic or flammable materials, including solvents, in a fume hood.
- use covers or lids on processes to contain hazardous materials.
- vent any apparatus that may discharge chemical vapours.
- never take short cuts when handling, using, storing or disposing of hazardous substances.
- consult qualified personnel before handling an unlabelled or damaged container.
- comply with all Laboratory Safe Work Procedures developed for the specific laboratory or laboratory activity, as well as all other University Policies, Procedures and Standards.
- use required safety and personal protective equipment.
- order minimum quantities of controlled products.
- always substitute for a less hazardous material to the extent possible.

Laboratory Equipment:

- must meet, be used and maintained in accordance with recognized standards (ANSI, CSA and NIOSH).
- which contains moving belts and pulleys must have safety guards.

4.7 Working with Others

Laboratory Users must:

- always inform co-workers of plans to carry out hazardous work before beginning the work.
- ensure protective measures to protect the lab worker, lab partners and any persons working nearby are in place.

4.8 Working Alone/Working Off Hours

Working alone in certain circumstances, situations, or environments can be unsafe and requires special arrangements to minimize potential situations and hazards. Working Alone requirements are legislated by Occupational Health and Safety Regulations.

In each site-specific Working Alone situation, the Laboratory Manager must define the type of work and duties which may or may not be conducted while working alone and under which conditions working alone is permitted. Special arrangements must be made for laboratory work conducted after regular hours, because these situations pose an additional risk to life and property.
It is strongly recommended that handling of hazardous substances or performing hazardous activities be prohibited when the worker is working alone.

Laboratory Managers are required to ensure that they fulfill and document the following responsibilities:

- review all workplaces under their jurisdiction and identify Laboratory Users who are required to work alone.
- describe conditions where working alone is permitted and indicate which duties may be conducted and which are prohibited.
- identify risks to Laboratory Users in terms of the nature of their work, isolation, and conditions in the laboratory.
- identify and take any necessary steps to eliminate or reduce identified risks. The steps taken must include the establishment of an effective communication system (such as radio, telephone, or personal alarm devices) that provides effective communication commensurate with the risk.
- provide sufficient training and instruction for safe work practices and ensure minimum standards of competence are met.
- provide required personal protective equipment (PPE).

To assist in meeting the above noted requirements the Working Alone Procedure includes a working alone risk identification/limitation form.

Documentation of the above must be maintained and filed within each Faculty/ Department/Unit.
The policy and procedures must be communicated to all Laboratory Users who work alone.

4.9 Unattended Operations

Unattended operations pose a safety hazard if a problem occurs, especially outside of normal working hours. These operations should be kept to a minimum. Like working after hours, all unattended operations **require prior approval** of the Department Head or Laboratory Manager and **a written safe work procedure**. Emergency procedures must be posted.

For operations that **require continuous or overnight operation**, steps must be taken to prevent spills, floods and/or fires in the case of mechanical, power or water failure. Some typical precautions include:

- operations that involve cooling water must have the hoses firmly clamped and water flow adjusted to the minimum flow necessary. Tygon tubing is preferable to rubber tubing since it is less likely to deteriorate and break. The use of water pressure regulators on cooling water lines is strongly recommended.
- set up unattended operations in a fume hood, so that in the event of system failure, no hazardous materials will be released into the lab space. Ensure that all fume hoods will

remain on during the experiment by advising Facilities Management of the planned experiment.

- laboratory lights should be left on, and a sign posted with a description of the operation, the chemicals being used, and the name and phone number of a contact person. The sign should indicate when the operation was started, and when it is expected to be completed.
- if an operation is to be left running unattended during regular working hours, it should be visited periodically (as determined by the Laboratory Manager) to ensure there are no problems.
- Faculties/Departments/Units should develop additional policies to address costs associated with damage caused by unattended operations.

4.10 Utility Shutdowns

Work with chemicals must not be performed during water shutdowns. In the event of an accident or chemical spill during a shutdown, there is no water supply available for emergency showers and eyewashes. Laboratory work that does not involve the handling of chemicals, such as setting up apparatus or recording data, is permissible as long as the chance of chemical exposure is minimal.

If the building electrical supply is cut off, the ventilation system will also be shut down. In this instance, experimental work should be shut down in a safe way, and the room should be evacuated until ventilation has been restored and has refreshed the laboratory air supply.

5 Safety Training

Work in the laboratory requires safety training related to the activities being carried out. Formal classroom training must be supplemented by work-specific training provided by the Laboratory Manager.

All workers in the laboratory must successfully complete WHMIS and Chemical and Laboratory Safety training. Users of radioactive materials are required to complete the appropriate Radiation Safety training course. The receipt or shipping of chemicals requires that the individual completes Transportation of Dangerous Goods training. Contact HSE to arrange for safety training. All U of R laboratory safety training requires recertification every three years.

5.1 WHMIS

WHMIS stands for Workplace Hazardous Material Information System. It is a 'Right to Know' program designed to ensure employees are informed of the risks associated with controlled products found at the worksite.

Compliance with WHMIS is a legal requirement and University Policy. The legislation that supports WHMIS includes *Hazardous Products Act* (federal), *Hazardous Materials Information Review Act* (federal) and *The Occupational Health and Safety Act of Saskatchewan*. While the legislation is designed to protect the health and safety of employees, the University of Regina imposes WHMIS requirements on all persons within the University Community to ensure their health and safety.

The three key elements of the WHMIS system are requirements concerning:

- labels on containers containing hazardous material which alert individuals to the dangers of the products and basic safety precautions.
- availability of material safety data sheets (MSDS) which are technical reports providing detailed hazard and precautionary information on the product.
- education programs which provide instruction and safe work procedures.

WHMIS legislation imposes the following legal duties:

- Suppliers of hazardous products must provide certain information about their products through labels and MSDSs to the employers.
- Employers must ensure that;
  - all controlled products are identified and properly labelled.
  - MSDSs are readily available to employees.
  - employees using or in close proximity to controlled products are educated and trained in WHMIS to the extent necessary to ensure their health and safety.
- Employees must;
  - attend training and education sessions on controlled products.
  - follow safe work practices when using or handling controlled products or working within close proximity to these products.

In the case of the University these duties and rights are extended to all persons within the University Community who work with or in proximity to controlled products.

5.1.1 Training and WHMIS Certificates

It is the policy of the University of Regina that no person may work in a laboratory unsupervised unless that person is the holder of a current WHMIS certificate issued by HSE. WHMIS training is also required for other persons who work with controlled products.

WHMIS certificates expire every three years. To renew a certificate, individuals must again successfully pass the WHMIS examination set by HSE. Individuals must have their certification available when purchasing controlled products or during work conducted in a laboratory.

5.1.2 Controlled Products, Hazards, Symbols and Labelling

WHMIS controlled products are defined according to one of six hazard categories: (A) compressed gases, (B) flammable and combustible, (C) oxidizing, (D) poisonous and infectious material (3 classes), (E) corrosive, and (F) dangerously reactive material.

The symbols and hazards of each class of controlled product are shown here.

Hazard Symbols and Classes (Adapted from: Occupational Health and Safety Canada Volume 4, Number 5, page 54. Used with Permission.)		
This Symbol Represents...		It means the material...
	Class A Compressed Gas	• poses an explosion danger because contents are held under high pressure • may cause its container to explode if heated • may cause its container to explode if dropped
	Class B Combustible and flammable material	• may burn at relatively low temperatures • may burst into flame spontaneously in air or release a flammable gas on contact with water • may cause a fire when exposed to heat, sparks or flames or as a result of friction
	Class C Oxidizing material	• may cause a fire when it comes into contact with combustible materials such as wood • may react violently or cause an explosion when it comes into contact with combustible materials such as fuels
	Class D, Division 1 Poisonous and infectious material: immediate and serious toxic effects	• may be fatal or cause permanent damage if inhaled or if it enters the body through skin contact
	Class D, Division 2 Poisonous and infectious material: other toxic effects	• may cause death or permanent damage as a result of repeated exposure over time • may be a skin or eye irritant • may be a sensitizer, which produces a chemical allergy may cause cancer, birth defects or sterility
	Class D, Division 3 Poisonous and infectious material: biohazardous infectious material	• may cause serious disease resulting in illness or death
	Class E Corrosive material	• causes severe eye and skin irritation upon contact • causes severe tissue damage with prolonged exposure • may be harmful if inhaled
	Class F Dangerously reactive material	• is very unstable • may react with water to release a toxic or flammable gas • may explode as a result of shock, friction or increase in temperature • undergoes vigorous polymerization

Labels are designed to alert users to the hazards of the product and describe briefly the precautions to take. The two major categories of WHMIS labels are **supplier labels** and **workplace labels**.

Supplier Labels
Supplier labels are those that must be present on controlled products in their original (supplier) containers.

The Basic Supplier Label must include the following information:
- Product Identifier
- Supplier Name
- Hazard Symbols
- Risk Phrases
- Precautionary Measures
- First Aid Measures
- Reference to MSDS
- Hatched WHMIS Label

Small Container Labels for controlled products packaged in containers less than 100mL, an abbreviated label containing the following is permitted:
- Product Identifier
- Supplier Name
- Hazard Symbols
- Reference to MSDS
- Hatched WHMIS Label

Laboratory Supply House Labels for controlled products from a laboratory supply house, packaged in quantities of less than 10 kg and intended for laboratory use, must have the following on the label:
- Product Identifier
- Risk Phrases
- Supplier Name
- Precautionary Measures
- First Aid Measures
- Reference to MSDS

In all cases, the supplier label must be in both English and French.

Many laboratories have older chemicals on their shelves that pre-date the WHMIS regulations, or that have been imported into the country and not supplied with a label that meets Canadian regulations. In either case, the label must be updated to comply with WHMIS. In many cases, especially with older chemicals, the only change that is usually necessary is to include a reference to “See MSDS”.

If the original supplier label has been damaged or defaced, the label must be replaced, either with a new one obtained from the supplier or with a workplace label.

Laboratory Sample Label
This is for use on samples sent to an outside laboratory for analysis. Whenever possible, these samples should have a basic supplier label. In instances where there is not enough information about the composition of the sample to prepare a full supplier label, it should be labelled with the following information:

- Sample Identifier
- Identity of Known Ingredients
- Senders Name
- Statement of
  "Hazardous Laboratory Sample.
  For hazard information or in an emergency call _____ "
- An Emergency Telephone Number

Workplace Labels
Workplace labels are used on containers into which controlled products have been transferred from the original supplier container, controlled products produced for use on the worksite, or on supplier containers to replace missing or illegible supplier labels. The basic workplace label must include the following information:

- Product Identifier
- Information for Safe Handling
- Reference to MSDS

If a product will be used only in the lab in which it was decanted, AND is under the control of, and used exclusively by the worker who decanted it, AND is used up by the end of the shift, it only needs to have a **product identifier**. This can be:

- The name of the chemical, or
- Sample number, or
- Any other method that unequivocally identifies the substance

The same product identifier labelling applies to controlled products produced in the lab, reaction vessels, and mixtures undergoing testing or analysis. Note, however, that these simplified labels only apply as long as the controlled product is in the original lab. If a decanted product or lab produced controlled product is transferred elsewhere, then it should have a full workplace label.

Pipes and Vessels
Pipes and reaction vessels may be labelled in other ways such as color coding or placards. Lab users must be trained to recognize and interpret these markings.

5.1.3 Material Safety Data Sheet Requirements

A Material Safety Data Sheet (MSDS) is a document that provides detailed hazard, precautionary and emergency information on the product. It is meant to supplement the information contained in the supplier or workplace labels.

The following information is required on a MSDS:

- Hazardous Ingredients
- MSDS Preparation Information
- Product Information
- Physical Data
- Fire or Explosion Hazard
- Reactivity Data
- Toxicological Properties
- Preventive Measures
- First Aid Measures

Appendix 24 contains many of the terms found in a MSDS.

A MSDS must be available for each hazardous material regulated under WHMIS that is present in the laboratory, except in the following cases:

- Controlled products produced in the laboratory that will remain in the laboratory.
- Intermediate products in reaction vessels.

Consumer products that are used in the workplace are also partially exempt from the WHMIS legislation. However, at the University of Regina, MSDSs must be obtained for all hazardous products in the lab, even if purchased as a consumer product.

To ensure that the MSDS for each controlled product is present and readily available, the following practices must be employed:

- An inventory of all controlled products present in the lab must be maintained by the Laboratory Manager or designate (See **Section 3.7**).
- MSDSs which are less than three years old must be available for each controlled product, thus ensuring the availability of current hazard information.
- The inventories and MSDS must be updated whenever new products are brought into the laboratory or are no longer used.

5.2 Transportation of Dangerous Goods Training

TDG (Transportation of Dangerous Goods) training is required for anyone who ships or receives controlled products. Contact HSE to arrange for this training.

5.3 Radiation Safety

Radiation is energy in the form of waves or particles. Nuclear radiation originates from the decay of the nucleus of the atom, and some nuclear radiation causes ionization in the materials it strikes.

Types of Ionizing Radiation:

- Alpha particles – these particles have a large mass and typically low speed (for subatomic particles), and can only travel a short distance in air. They can be stopped by the outer layer

of skin, and as long as they stay outside the body, don't cause any harm. **Keep alpha emitting materials outside the body.**

- Beta particles – these particles have a small mass and typically high speed. They are stopped by a thin layer of plastic or aluminum. If lead is used to stop these particles, x-rays called Bremsstrahlung are created, so lead is not used for beta shielding. **Keep beta-emitting materials outside the body, and use low atomic number shields for high energy beta-emitters.**
- Gamma Rays or X-Rays – these waves are more penetrating than alpha or beta particles. They can pose a risk even when they are kept outside the body. To protect ourselves from gamma rays or x-rays, use:
  - **Time** – reduce the amount of time spent near the source.
  - **Distance** – the exposure to these sources is inversely proportional to the distance from them – doubling your distance from the sources reduces your exposure to one quarter. Keep the source as far away from the body as is reasonably practicable.
  - **Shielding** – we shield ourselves from gamma rays or x-rays using high molecular weight materials such as lead or steel.

Radioactive sources installed in equipment in the laboratory do not generally post a safety risk, as long as the source is not removed and the equipment is not tampered with.

Anyone who works with radioactive materials at the University of Regina must complete a radiation safety training course from HSE.

5.4 Other Laboratory Safety Training

Other laboratory safety training may be required, depending on the nature of the work conducted in the laboratory, and as identified by the Hazard Control Plan.

All Laboratory Managers, Academic Staff Members who teach or work in a lab and researchers should take fire extinguisher training. This training is recommended for all persons who work with flammable and combustible materials.

All workplace-specific training must be documented, and copied to HSE to be maintained on personnel files.

6 Safe Use of Laboratory Equipment

6.1 Electrical Equipment

Electrically powered equipment, such as hot plates, stirrers, vacuum pumps, electrophoresis apparatus, lasers, heating mantles, ultrasonicators, power supplies, and microwave ovens are essential elements of many laboratories. These devices can pose a significant hazard to Laboratory Users, particularly when mishandled or not maintained. Many laboratory electrical devices have high voltage or high power requirements, carrying even more risk.

The major hazards associated with electricity are electrical shock and fire. Electrical shock occurs when the body becomes part of the electric circuit, either when an individual comes in contact with both wires of an electrical circuit, one wire of an energized circuit and the ground, or a metallic part that has become energized by contact with an electrical conductor.

The severity and effects of an electrical shock depend on a number of factors, such as the pathway through the body, the amount of current, the length of time of the exposure, and whether the skin is wet or dry. Water is a great conductor of electricity, allowing current to flow more easily in wet conditions and through wet skin. The effect of the shock may range from a slight tingle to severe burns to cardiac arrest.

In addition to the electrical shock hazards, sparks from electrical equipment can serve as an ignition source for flammable or explosive vapours or combustible materials.

Loss of electrical power can create hazardous situations. Flammable or toxic vapours may be released as a chemical warms when a refrigerator or freezer fails. Fume hoods may cease to operate, allowing vapours to be released into the laboratory. If magnetic or mechanical stirrers fail to operate, safe mixing of reagents may be compromised.

Employ the following safe work practices to reduce the risk of injury or fire when working with electrical equipment:

- All laboratory receptacles and equipment should be equipped with 3-prong grounded plugs.
- When it is necessary to handle equipment that is plugged in, be sure hands are dry and, when possible, wear nonconductive gloves and shoes with insulated soles.
- Minimize the use of electrical equipment in cold rooms or other areas where condensation is likely. If equipment must be used in such areas, mount the equipment on a wall or vertical panel.
- If water or a chemical is spilled onto equipment, shut off power at the main switch or circuit breaker and unplug the equipment.
- If an individual comes in contact with a live electrical conductor, do not touch the equipment, cord or person. Disconnect the power source from the circuit breaker pull out the plug using a leather belt.
- Laboratory receptacles which are located near a fridge or emergency shower must be installed with ground-fault protection.
- Equipment should be located to minimize the possibility of chemical spills on or under it.
- Inspect cords on a regular basis for frayed and/or damaged connections. Remove and replace damaged cords.
- Devices equipped with motors used where there are flammable vapours present should be either non-sparking induction or air driven motors.

- On-off switches, rheostat type speed controllers, and similar devices can produce sparks every time they are adjusted. If electrical equipment is to be used in the fume hood, all controls should be outside the hood.
- Always unplug electrical equipment before making repairs or modifications.
- All electrical equipment must be CSA approved. Imported equipment that has not received CSA approval, and equipment designed and assembled in the lab must be approved in writing by the Director, Production, Facilities Management.
- Plug-ins near sinks or water sources must have a Ground Fault Circuit Interrupter.

Electrical devices such as stirrers and mixers are often operated over extended periods of time with the possibility of mechanical failure, electrical overload or blockage of stirrer. If they are to be left unattended, the associated equipment should be fitted with a suitable fuse or thermal protection device that will shut down the apparatus in the event of such problems.

6.2 Electrophoresis Equipment

Electrophoresis is a separation technique that involves the migration of charged molecules through fluid medium under the influence of an electrical field.

Lethal electric shock can result when operating at high voltages such as in DNA sequencing or low voltages such as in agarose gel electrophoresis. In addition, the use of chemicals such as ethidium bromide in these experiments adds the risk of chemical contamination.

For safe use of electrophoresis equipment:
- Turn the power off before connecting the electrical leads.
- Keep the apparatus away from sinks or other water sources.
- Do not over-ride safety devices.
- Do not run electrophoresis equipment unattended.
- If using ethidium bromide, have a hand-held UV light source available in the laboratory. Check working surfaces after each use.
- Provide spill containment by mixing gels on a plastic tray.
- Decontaminate surfaces with appropriate cleaning materials.
- The apparatus should be designed and maintained so that electrical current is shut off when the cover is opened.
- A label must warn workers of the electrical hazard.
- All high-voltage components must be guarded to prevent worker contact.
- Cracked or broken Plexiglas™ parts should be replaced.
- Always follow the manufacturer's operational instructions and safety guidelines.

6.3 Vacuum Pumps and Systems

Vacuum pumps are used in the lab to remove air and other vapours from a vessel or manifold. They are found on rotary evaporators, drying manifolds, centrifugal concentrators, acrylamide gel dryers, freeze dryers, vacuum ovens, tissue culture filter flask and aspirators, dessicators and filtration apparatus. Working at reduced pressure carries with it the risk of implosion and the subsequent dangers of flying glass, splashing chemicals and possibly fire. Any apparatus under reduced pressure should be shielded to minimize the risks from implosion.

To safely work with vacuum systems:

- Place cold traps between the apparatus and the vacuum source to minimize the amount of volatile material that enters the system.
- Choose the type of vacuum pump to match the application.
- Operate in accordance with instruction manuals.
- Vent rotary pumps to an air exhaust system, not directly into the laboratory.
- Conduct routine maintenance as recommended by manufacturer.
- Belt driven pumps must have protective guards, to prevent accidental entanglement.
- If using building-supplied vacuum, ensure a cold trap is used to keep contamination out of the vacuum system.

6.4 Heat Sources

Laboratory activities generally require the use of at least one type of heating device, such as ovens, hot plates, heating mantles, steam baths, oil baths, salt baths, sand baths, air baths, tube furnaces, hot air guns and microwave ovens. These devices carry with them the risks of burns, electrocution and of ignition of chemical fire.

In general, to work safely with heat sources:

- The heating element in any laboratory heating device should be enclosed in such a fashion as to prevent a laboratory worker or any metallic conductor from accidentally touching the wire carrying the electric current.
- Discard or repair heating devices which have exposed heating elements.
- Use variable autotransformers as required, but do not use the transformers in locations where water or other chemicals may be spilled on them.

Heating mantles

Heating mantles enclose a heating element in layers of fiberglass cloth, and are free of shock or fire hazard if used properly. Some precautions that should be taken when using mantles include:

- Do not use if the fiberglass cloth is worn or broken, exposing the heating element.
- Take care to avoid spilling water or other chemicals on the mantle, as this presents a serious shock hazard. Depending on the spilled chemical, it may also present a fire or explosion hazard.
- Always use with a variable transformer to control input voltage. Never plug directly into an electrical outlet. High voltage will cause the mantle to overheat, damaging the fibreglass insulation and exposing the bare heating element.

Hot Plates

Laboratory hot plates are normally used for heating solutions. Newly-purchased hot plates should be designed to avoid electrical sparks; however, older hot plates may pose an electrical spark hazard. As well, old and corroded bimetallic thermostats in these devices can eventually fuse shut and deliver full, continuous current to a hot plate. To safely use hot plates:

- Do not store volatile flammable materials near a hot plate.
- Limit use of older hot plates for flammable materials.
- Check for corrosion of thermostats, and arrange for repair if necessary.

Oil, Sand and Salt Baths

Electrically heated oil baths are commonly used in situations where a stable temperature is required, or a small or irregularly shaped vessel must be heated. Some precautions that should be taken when using oil baths include:

- Take care to avoid spilling water or volatile substances into the bath, which may result in splattering of hot oil or smoking/ignition of the bath.
- Saturated paraffin oil is suitable up to 200°C, and silicone oil should be used for temperatures up to 300°C.
- Always monitor the temperature of the bath to ensure it does not exceed the flash point of the oil.
- Mix well to prevent hot spots from forming.
- Support with a lab jack or similar apparatus so the bath can be lowered and raised easily without manually lifting the hot bath.

Molten salt baths can be treated similarly to oil baths, except that they have a higher operating range, up to 450°C. The bath container (and the reaction vessel being heated) must be able to withstand these temperatures. It is also imperative that the bath be kept dry, since hazardous sputtering and splattering may occur if the absorbed water vapour rises during heat-up.

Heat Guns

Laboratory heat guns use a motor-driven fan to blow air over an electrically-heated filament. They may be used to dry glassware or chromatography plates. The heating element in a heat gun may become red-hot during use and the on-off switches and motors are usually not spark-free. When using heat guns:

- Do not use a heat gun on or near flammable materials.
- Ensure they have ground-fault circuit interrupter protection to protect the user from electric shock.

Ovens

Electric ovens are frequently used in the laboratory to dry glassware or to remove water or solvents from chemical samples. They should be constructed so that their heating elements and their temperature controls are physically separated from their interiors. To safely use laboratory ovens:

- Connect the oven vent directly to an exhaust system to reduce the possibility of substances escaping into the lab or an explosive concentration developing within the oven.
- Do not use the oven to dry chemical samples which are toxic.
- Glassware which has been rinsed with an organic solvent must be rinsed with distilled water before being dried in an oven.
- Avoid using mercury thermometers in an oven – bimetallic strip thermometers are preferred.

Microwave Ovens

Microwave ovens are found in many laboratories, and when used with chemicals may pose hazards not found in the household. As with most electrical apparatus, there is the risk of generating sparks that can ignite flammable vapours. To minimize the risks in using microwave ovens in laboratories:

- Do not use metal containers and metal-containing objects in the microwave, as they can cause arcing.
- Do not heat sealed containers in the microwave – explosions may result.
- Do not microwave flammable or combustible materials.

Do not use laboratory ovens or microwaves for food preparation.

6.5 Glassware

Laboratory glassware may be made of several different types of glass, depending on the application. Select:

- Borosilicate glass (ex: Pyrex©, Kimax©, or similar) for situations involving thermal and mechanical shock use.
- Soft glass for applications in which the glassware is not exposed to these conditions, such as for reagent bottles, glass tubing, and measuring equipment.
- Round bottom or thick walled borosilicate glassware designed to withstand low pressures when doing vacuum work.

Before beginning any experimental work, check glassware for flaws such as chips, star cracks, scratches and etching marks, which may result in structural failure. Note also that repaired glassware is subject to thermal shock and subsequent failure, and should be used with caution. Choose glassware sizes that can properly accommodate the operation being performed. At a minimum, there should be at least 20% free space.

To prevent cuts from trying to force glass tubing into rubber/cork stoppers or tubing:

- Use appropriate hand protection and a soap solution, glycerine or other lubricant on the ends of glass rods or tubing before inserting into a stopper.
- Insert the rod or tubing into the stopper with a turning motion - never force it.
- Always aim the rod or tubing away from the palm of the hand which holds the stopper.
- Ensure that the stopper hole is large enough to accommodate the rod or tubing, and that the ends are fire-polished to remove sharp edges.

Glassware should only be disposed of in accordance with Section 9.

6.6 Refrigerators and Freezers

Refrigerators and freezers used in the lab must be carefully selected for specific chemical storage needs. Commercial refrigeration units are not designed to meet the special hazards presented by flammable materials. The interior of a commercial refrigerator contains a number of electrical contacts that can generate electrical sparks. Frost-free models often have a drain, which could allow vapours to reach the compressor, and electrical heaters used to defrost the refrigerator are also a spark hazard.

For these reasons, only specially-designed lab refrigerators or modified commercial units should be used for cold storage of flammable chemicals. Those rated for **flammable storage** have no internal switches or unprotected wires which can act as an ignition source. An **explosion-proof** unit has both interior and exterior switches and wires protected, and is suitable for use in environments where flammable vapours may reach explosion/ignition limits outside the refrigerator. For storage of flammable materials in most labs, a unit rated for flammable storage is sufficient. Commercial refrigerators and freezers are acceptable for storage of non-flammable materials, but must be prominently labelled as not suitable for flammable storage.

Fridges which do not meet this design criteria must be labelled “Refrigerator Not to be Used for Storage of Flammables”.

No food or drink may be stored in a lab refrigerator along with chemicals.

A major concern with chemical storage refrigerators is that as tightly sealed spaces, they can allow build-up of toxic and/or flammable vapours. Containers must be adequately sealed to minimize the likelihood of this happening. Beakers, flasks, and bottles covered with aluminium foil or plastic wrap are unacceptable for storage of volatile chemicals in the refrigerator. Likewise, corks and glass stoppers are also inadequate. Screw top caps with a seal inside are best suited for refrigerator storage. Refrigerators should also be regularly defrosted and cleaned to minimize accumulation of ice and hazardous vapours inside the unit. Chemicals no longer required must be disposed of as hazardous waste.

6.7 Decontamination of Laboratory Equipment

Any equipment that has been used in a lab that contains hazardous materials will become contaminated over time and must be decontaminated prior to removal. This applies whenever equipment is transferred to another lab, sent for repair or calibration, or disposed of as waste or surplus equipment.

Decontamination includes the removal of all hazardous products, containers, or other potentially contaminated items from equipment such as refrigerators, cabinets, etc. The equipment should then be visually inspected for stains, residues, or other evidence of chemical contamination, and this contamination removed by washing with soap and water, a decontaminating solution, or whatever other means necessary. If acid or alcoholic potassium hydroxide cleaning baths are used, care should be taken when disposing of the waste cleaning solution.

7 Control Of Specific Hazardous Processes And Materials

7.1 Control of Back Flow

Wherever there is a flow of gas or liquid into a system, there is danger of back flow of those fluids into the original container or system (e.g. gas cylinder or domestic water supply). This is easily prevented by the use of one-way valves.

7.2 Distillation

Reflux and distillation are processes which must be done with care. Ensure that all hoses are clamped down, and maintain temperatures carefully. Ensure that apparatus is vented (do not allow pressure to build up), and do not leave these experiments unattended.

7.3 Pressure and Vacuum Systems

High pressure operations should only be performed in appropriate pressure vessels, properly labelled and installed, and protected by pressure-relief and necessary control devices. The pressure vessels must be strong enough to withstand the stresses encountered at the intended operating temperatures and pressures. All pressure equipment must be inspected and tested at intervals determined by the severity of the equipment's usage, and must be operated only by qualified personnel.

Vacuum work can result in an implosion and the possible hazards of flying glass, splattering chemicals and fire. All potential risks must be evaluated before vacuum systems are set up and operated. To conduct vacuum work safely:

- Use appropriate PPE such as safety glasses, face shields and/or an explosion shield.
- Do not allow water, solvents and corrosive gases to be drawn into vacuum systems – protect pumps with cold traps and vent the pump exhausts into a fume hood.
- Assemble vacuum apparatus in a manner that avoids strain, particularly to the neck of the flask.
- Protect vacuum apparatus from being accidentally hit or bumped.
- Glass vacuum containers, such as desiccators and flasks, should be wrapped with tape to prevent glass from flying in the event of an implosion or explosion.
- When carrying out filtration or distillation procedures under reduced pressure, the heavy-walled glassware and tubing must be undamaged and able to withstand the conditions of reduced pressure.
- Rotoevaporation of solvents using a water aspirator is not appropriate where the vapor being removed is highly odorous or toxic unless a suitable cold trap is available to capture them. Alternative enclosed systems are recommended.

7.4 Bunsen Burners

Bunsen burners produce an open flame and burn at a high temperature. To use them safely in the laboratory:

- Use them away from any combustible materials or chemicals.
- Inspect the hose for defects, and ensure that the hose fits securely on the gas valve and the Bunsen burner. Replace defective hoses.

- Use a sparker/lighter with an extended nozzle to ignite the Bunsen burner – never use a match to ignite the burner.
- Do not leave open flames unattended.

Always shut off natural gas valves in labs when the gas is not in use.

7.5 Animals

No animals may be used or housed at the U of R without the written authorization of the President's Committee on Animal Care (PCAC). Canadian law requires that an animal utilization protocol be approved by the PCAC **BEFORE** research or teaching projects involving live animals are initiated. Additional information is provided by the PCAC website at http://www.uregina.ca/research.

7.6 Biosafety

Work with biohazardous material requires specialized training, procedures and infrastructure, in order to comply with provincial and federal regulations.

A biohazardous material is a pathogenic organism that, because of its known or believed ability to cause disease in humans, is classified in Risk Group 1, 2, 3, or 4 as defined by the Medical Research Council of Canada. The term 'biohazardous material' also includes anything contaminated with such an organism. Pathogens include bacteria, viruses, fungi, and other infectious agents. They are classified into risk groups based on factors such as:

- Severity of disease caused
- Route of infection
- Availability of effective treatment or immunization
- Possible effects on other species of plants or animals

As a rule of thumb, work with any biological materials which have the potential to cause illness in people are considered to be at the very least at Risk Group 2.

For information regarding safe work with biological materials, consult the Biosafety Program.

8 Hazard Control Measures

8.1 General Principles

Control of hazards in the laboratory is essential, especially those related to the use of chemicals. There are four methods of control for minimizing or eliminating hazards. In order of effectiveness they are:

- **Substituting something less hazardous** – Elimination of a hazardous product or substitution with a less hazardous product represents the best solution to hazard control.
- **Engineering controls** – These do not require continual monitoring, but do require regular maintenance and are more expensive to implement. Extra ventilation or the use of automation are examples of engineering controls.
- **Administrative controls** – These include written procedures, training, supervision and scheduling of activities.
- **Personal protective equipment** – This is the least effective type of hazard control. Its effectiveness is limited by the dependence on individuals wearing it, its discomfort, its fit and appropriateness. Work is slower when PPE is worn, and its selection and fit require extra supervision.

In laboratories where hazardous materials are used, engineering controls are preferred and usually comprise of fume hoods or local exhaust systems.

8.2 Hazard Control Plan for High Hazard Activities

Any activity that carries the potential risk for critical consequences requires a written safety control plan to address that risk. High hazard activities include the following:

- Potential exposure to radiation or chemicals at a level of exposure with critical consequences.
- Potential exposure to a blood-borne pathogen (all levels of exposure are treated as critical).
- Potential injury by equipment.

The plan must contain the following:

- Hazard identification and risk assessment (A hazard is any activity, situation or substance that can hurt someone, and risk is the chance of the hazard causing harm.)
- Assignment of responsibilities
- Safe work procedures (including required engineering controls, and PPE)
- Emergency response procedures including containment and decontamination procedures
- Education and training requirements
- Monitoring procedures, such as contamination levels, environment controls, compliance with safety plan and
- Documentation requirements

Safe work procedures are step-by-step descriptions of how specific high risk work-related activities are performed safely. Written safe work procedures should be developed for all work processes regardless of risk, where a fixed process is necessary for ensuring safety. Persons involved in the activity should know of the existence of the safe work procedures and have ready access to them. Written safe work procedures may include manufacturer's instructions, and equipment and process standards set out in this Program, in addition to the specific procedures that may be uniquely developed for a laboratory or laboratory process.

8.3 Fume Hoods

To maximize hood effectiveness and minimize personal exposure to toxic vapors or gases, use fume hoods in accordance with the operational guidelines described in **Appendix 14**.

8.4 Other Laboratory Ventilation

There are many types of laboratory equipment which generate vapours and gases but which cannot be used inside a traditional fume hood. Some examples of these are gas chromatographs, atomic absorption spectrometers and ovens. Always check and comply with the manufacturer's recommendations, and ensure that an exhaust system is provided to remove potentially hazardous or noxious fumes and vapours.

Ideally, a separate dedicated exhaust system should be used. If connected to an existing hood duct, the fan capacity must be increased and airflow must be properly balanced. Also note that each new exhaust hood requires provision of more make-up air supply to the lab. This must be approved by the Director, Planning, Design and Construction, Facilities Management.

The general laboratory ventilation system controls the quality and quantity of air supplied to the lab at such a rate that the air is continuously replaced to minimize the concentration of odoriferous or toxic substances. Labs are also designed so that they are at negative pressure to the rest of the building, to prevent movement of odoriferous or toxic substances to other parts of the building.

8.5 Personal Protective Equipment (PPE)

8.5.1 Eye and Face Protection

Eye protection must be worn in all labs when working with or around chemicals, and must meet the guidelines in the Canadian Standards Association standard CSA Z94.3-02 Industrial Eye and Face Protectors. For most situations, safety glasses with side shields are adequate. For more hazardous operations where there is potential for chemical splashing or explosion, safety goggles or a face shield which are rated for chemical splash protection should be used. This is especially important for work with corrosive chemicals. The Laboratory Manager must determine the level of eye protection required. (**Appendix 11**)

The type of eye protection required depends on the hazard.

Visitors to the lab are required to follow the same eye protection policy as everyone else in the lab. If they do not provide their own eye protection, it is the Laboratory Manager's responsibility to provide adequate protection for them or to deny them entry.

8.5.2 Footwear

Shoes must be worn in the laboratory; they must cover the entire foot and be made of a substantial material such as leather. Steel-toed safety shoes or boots may also be required in certain situations.

8.5.3 Gloves and Hand Protection

The right type of glove provides the much needed hand protection in the laboratory. It is recommended that appropriate gloves be used when handling hazardous chemicals, toxins and materials of unknown toxicity, corrosives, and hot/cold objects. Particular attention should be given to chemicals which have a "Skin" notation on the MSDS sheet.

When choosing a glove, consider the circumstances under which the glove will be used. The degree of protection required will depend on the hazards associated with the chemical in question, the type and scale of experimental work being performed, and individual work habits.

For routine lab work with small amounts of chemicals, disposable gloves of a suitable material are generally acceptable, as they offer the best combination of dexterity and tactile sensitivity, barrier protection and cost. Remove and replace gloves when they become contaminated. Since disposable gloves are not designed for situations where contamination or permeation are more likely (for example, immersion in cleaning baths, handling corrosives or chemical spill cleanup), reusable gloves of heavier construction and suitable material should be used for such applications. Reusable gloves should be inspected before each use, replaced whenever they become discoloured or show signs of damage, and be cleaned and/or decontaminated after each use.

Wearing the wrong type of glove when handling chemicals can be more hazardous than wearing none at all. If a chemical permeates the glove, it can be held in prolonged contact with the wearer's hand and potentially cause serious damage. Glove selection guides, such as found in **Appendix 13**, should be reviewed when choosing a suitable glove, and under some circumstances double gloves may be used when dealing with chemicals of high or multiple hazards to ensure maximum protection.

To protect the hands when handling hot or cold items in the lab, insulated gloves made of Kevlar©, Zetex© or a similar heat insulating material should be used instead of those containing asbestos. If there are asbestos-containing gloves in the lab, dispose of them as hazardous waste.

8.5.4 Lab Coats

Lab coats must be worn to absorb or deflect spills and prevent corrosive or toxic substances from reaching the skin or contaminating street clothes. For higher risk situations, use a chemical or flame resistant synthetic material such as Tyvek© or Nomex©. Plastic or rubber aprons should be used when handling large quantities of concentrated acids and other corrosives.

Lab jackets must not be worn in place of full-length lab coats.

8.5.5 Respiratory Protection

Respiratory protection is not normally required when working in the lab, due to the combination of engineering controls (such as fume hoods), safe work procedures, and the relatively small amounts of chemicals used in most labs. To determine the need for a respirator, the Laboratory Manager or other competent individual must perform a hazard assessment. If as a result of the hazard assessment it is determined that respiratory

protection is required, then those Laboratory Users requiring the protection must be trained and instructed in the proper selection, fit, use, care and maintenance of the respiratory equipment. **Appendix 12** provides detailed information regarding respiratory protection.

9 Laboratory Waste

9.1 Definition

Hazardous waste includes any solids, liquids or gases containing or contaminated with chemicals or substances designated under Provincial *Hazardous Substances and Waste Dangerous Goods Regulations* as:

- Corrosive (e.g. pH less than 2.0 or greater than 12.6, corrosive gas, or causes visible necrosis of skin)
- Ignitable (e.g. flammable or combustible liquids; ignitable compressed gas; solids capable of ignition under normal conditions)
- Oxidizing
- Reactive (e.g. oxidizers, reducing agents, cyanides, water-reactive pyrophoric, explosive or unstable material)
- Acute or chronic toxic material
- Any substance that has been demonstrated to pose a hazard to human health or the environment because of its chronic toxicity, bio-accumulative properties or persistence in the environment
- Any substance recognized as a human or animal positive or suspected carcinogen

Hazardous Waste includes needles, sharps and other items that are or may be contaminated with an infectious material or organism that can cause serious human disease.

The University of Regina also considers the following items to be hazardous waste:

- Waste oil
- Solvents
- Paints
- Photochemical wastes
- Dry cell batteries
- Glassware
- Needles and sharps

9.2 Minimizing Waste (Reduce, Reuse, Recycle)

Waste chemicals are generated as a result of reaction products or chemicals left over from experiments. Storing large quantities of leftover old chemicals is potentially hazardous to individuals in the lab and the environment. It is the responsibility of everyone in the lab to minimize the amount of chemicals used and subsequently, the amount of waste generated.

Practice the three principles of **R**educe, **R**euse, and **R**ecycle.

Reduce:

- Order only the amount of chemical required for the experiment.
- Use the smallest possible amount for the experiment.
- Use diluted solutions whenever possible.

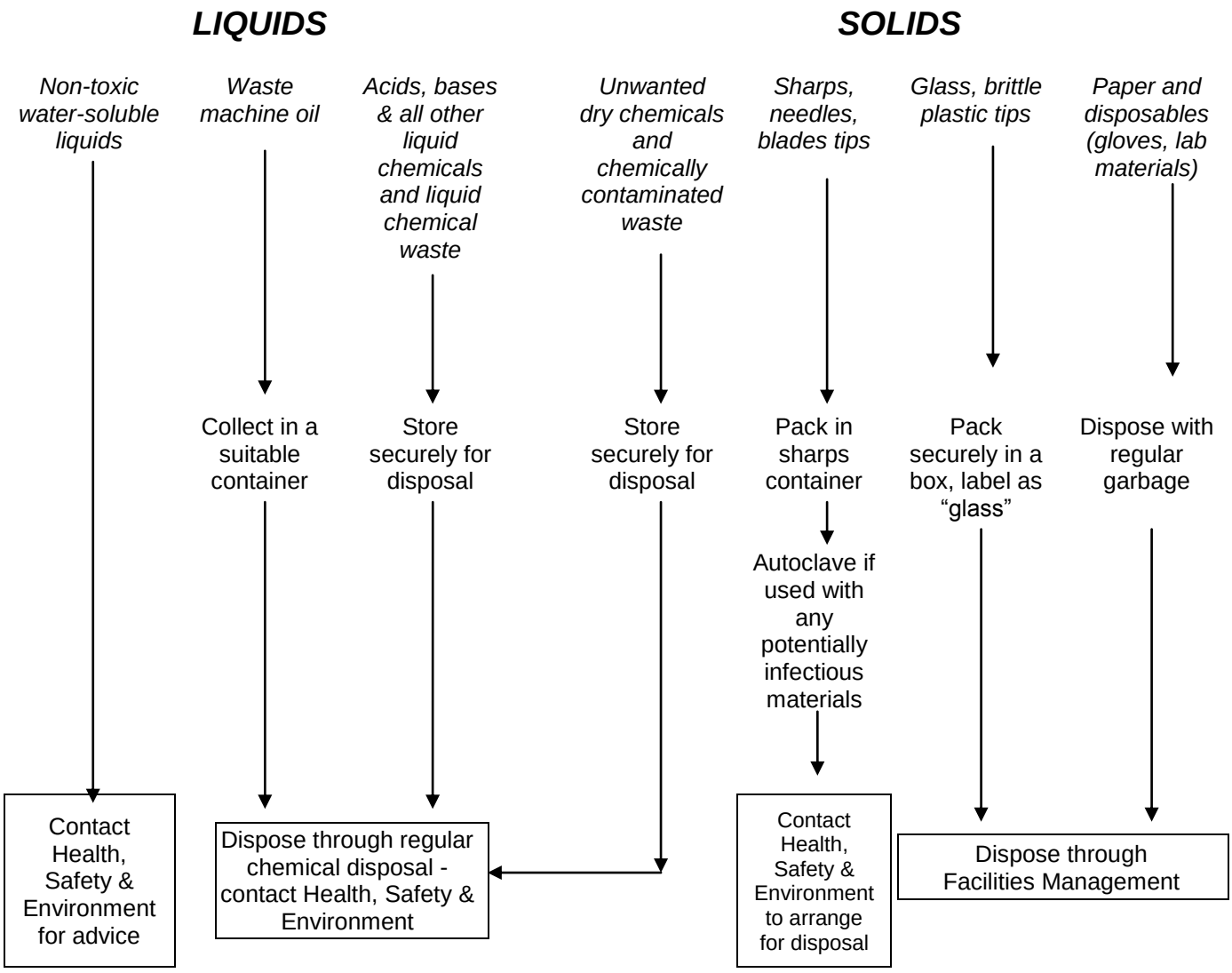
Reuse:

- Pass chemicals that you will not use to fellow researchers.
- Check with fellow researchers to determine if adequate amounts of chemical exist/are already available on campus.

Recycle:

- Look outside the Department to other Departments or faculties to obtain needed chemicals.

9.3 Waste Disposal Chart for Laboratories



9.4 Disposal of Chemical Waste

Chemical waste disposal is managed by HSE and is scheduled approximately three times a year. The University contracts this service to qualified companies who meet the legislated requirements. Waste chemicals are removed by the contractor and disposed of in an approved manner.

When a disposal has been arranged, a waste disposal request form must be completed by the waste generators and forwarded to HSE for processing. The generators of the waste pay the costs of the disposal.

Until the disposal is conducted, the waste chemicals must be securely stored in the labs in which they are produced, and must be properly labelled. Chemical Waste can be taken to Stores and stored in the waste room until the disposal, as long as the complete disposal request form is provided to Stores. HSE will provide labels as shown below. If waste chemicals are produced in the laboratory over a period of time, the label should be attached to the bottle and kept up-to-date as chemicals are added to the waste container. If the waste contains more than one chemical, the three or four most prevalent chemicals in the container must be listed.

CAUTION HAZARDOUS WASTE

Check all that apply

☐ ☐ ☐ ☐ ☐ ☐

Composition of Waste

Chemical Name	Concentration	CAS #

Laboratory Manager	Building and Room Number
Account Number	**- 6157**

Other waste chemical handling instructions:

- Separate organic and aqueous wastes as they are generated - it is less expensive to dispose of them separately.
- Separate chlorinated and non-chlorinated wastes.
- Do not dispose of solvents by allowing containers of them to dry out in fume hoods – this practice is dangerous and illegal.
- Do not fill liquid waste containers to more than 80% of their volume – allow room for expansion.

Rinse empty bottles or cans that have contained hazardous substances **three times** with a suitable solvent or appropriate detergent solution before discarding. **Remove or deface the container label** to make it illegible and discard the cap separately to prevent its re-use.

9.5 Disposal of Glassware

All laboratory glassware must be discarded in such a way that it cannot injure anyone who handles it or is exposed to it. This includes not only laboratory workers but also custodial staff and members of the general public. This policy applies to all glass, intact as well as broken, except for radioisotope-contaminated glass and biologically-contaminated glass, each of which requires special disposal.

Place all laboratory glassware, intact as well as broken, (except for clean chemical reagent containers) into a specially marked rigid container designed for this purpose. A properly labelled thick-walled, rigid cardboard container may be substituted. The container must be able to withstand penetration by any sharp edges, and must be lined with a leak-resistant liner (e.g. a polyethylene or polypropylene bag). Seal the container and clearly mark it 'BROKEN GLASS' to describe its contents, and contact custodial staff members to arrange for its disposal.

9.6 Disposal of Sharps

To dispose of biologically-contaminated sharps:

- Collect all sharps and needles in a sharps container, labelled 'Biohazard' and 'Sharps'.
- Chemically decontaminate all infectious items prior to disposal in the container, or autoclave the entire container once it is full.
- Securely close and snap lid in place.
- Contact HSE to arrange for disposal.

To dispose of other sharps:

- Collect all sharps and needles in a suitable container – a Biohazard Sharps container with the Biohazard label defaced is recommended.
- Securely close and snap lid in place when full.
- Contact HSE to arrange for disposal.

9.7 Disposal of Laboratory Equipment

Laboratory equipment which is no longer required must be decontaminated before removal from the laboratory. The equipment must not be re-used for non-laboratory purposes; this includes fridges, freezers and microwave ovens.

9.8 Unlawful and Lawful Disposals

The indiscriminate disposal of hazardous waste down the drain or with the regular lab trash is unacceptable. This activity is harmful to people and the environment, as well as being illegal. The University of Regina provides legal and safe hazardous waste disposal.

For disposal of other types of hazardous waste, consult HSE.

10 Emergency Equipment And Procedures

10.1 Emergency Planning

The University of Regina has developed a plan and set of procedures to respond to emergencies including fire, evacuation, and emergency closure. For further information see:

- Emergency Closure Procedures
- Emergency Management Policy and Plan
- Emergency Response Procedures Manual

Emergency procedures include arrangements for all persons to contact either 911 or Campus Security (585-4999) depending on the type of emergency.

In addition to these University-wide arrangements, each laboratory should have laboratory specific plans in place for hazards present in the laboratory. For example, each Laboratory Manager is responsible for ensuring that the appropriate spill kit is available and that Laboratory Users are trained in their use. In addition, in accordance with the Emergency Closure Procedures each Unit Head is required to prepare a contingency plan in the event of an emergency closure of the University that may disrupt on-going research or create a risk arising from unattended operations. (Faculty/Department/Unit Emergency Preparedness Plan)

10.2 Emergency Showers and Eyewashes

Accidental exposure to hazardous materials or chemicals can result in temporary or permanent irritation and damage to the skin and eyes. Appropriate training and supervision of staff and students who use hazardous materials, and controls that prevent hazardous exposures are critical in preventing or minimizing injuries. For example, personal eye protection is an essential requirement when working with any material or process which has the potential to cause eye injuries.

As a supplement to these measures and to comply with legislated requirements, all wet laboratories at the University of Regina are equipped with plumbed emergency showers and eyewashes.
Eyewash stations and emergency shower equipment must:

- meet the requirements of ANSI Z358.1-2004 standards as well as Occupational Health and Safety Regulations.
- be readily available near areas where hazardous materials are used.
- be supplied with lukewarm water.
- be maintained to approved standards.
- be routinely inspected to ensure that the equipment is in working order and meets applicable standards.

Appendix 15 provides more information regarding emergency showers and eyewashes.

10.3 First Aid

First Aid and CPR training is recommended for Laboratory Users and Laboratory Managers.

All U of R Laboratories must be supplied with a first aid kit. All first aid kits must be equipped with a first aid manual and a first aid register. It is the responsibility of the Laboratory Manager to ensure that the

location of the first aid kit and its contents are known to all Laboratory Users. More information regarding first aid kits can be found in **Appendix 10**.

10.4 Spill Response

Preventing Spills

The first step in chemical spill response is to prevent the spill from occurring in the first place. The worksite should be examined to identify measures that can be taken to minimize the risk of a chemical spill. These measures can be identified during regular worksite safety inspections.

Chemical spills occur during five types of activities; storage, transport, transfers, use and disposal.

To prevent spills during storage:

- comply with the Chemical Storage Guidelines in **Section 3.6**.

To prevent spills during transport:

- comply with the Chemical Transport Guidelines in **Section 3.8**.

While transferring chemicals between containers:

- Pay careful attention to the size of the receiving container, to prevent overfilling.
- Use pumps, siphons (not initiated by mouth) or other mechanical means to transfer liquids from large containers.
- Use spill containment trays to catch leaks and spills when transferring liquids.
- Ensure that both the drum and receptacle are grounded and bonded together to avoid an explosion initiated by a static electric spark when transferring flammable liquids from drums.

While handling and using chemicals, follow these procedures:

- In laboratories, work in a fume hood whenever possible.
- When setting up and working with laboratory apparatus:
  - Inspect laboratory glassware for cracks or defects before use.
  - Secure flasks and beakers to prevent them from tipping over.
  - Do not stage experiments below heavy objects which might fall on them. Ensure the work area is free of unnecessary clutter.
  - Select equipment that has a reduced potential for breakage (e.g. Pyrex).
- Replace mercury with alcohol thermometers or other alternate types of temperature measuring devices, as mercury spills are one of the most common lab spills.
- When planning experiments, anticipate possible accidents and provide controls to deal with problems that may occur.
- If you must work alone, ensure the working alone protocol addresses chemical spill response as part of the emergency procedures.
- Check gas cylinder valves and gas tubing for leakage before use.
- If possible, keep cylinders of highly toxic or corrosive gases in a fume hood or other ventilated enclosure.
- Ensure you have access to, and training on, a suitable chemical spill kit before you start working with chemicals.

While handling waste chemicals:

- Do not mix incompatible wastes together.
- Properly identify the contents of all waste containers to avoid inappropriate disposal.
- Leave at least 20% air space in bottles of liquid waste to allow for vapor expansion and to reduce the potential for spills due to overfilling.

- Keep waste containers securely closed or capped when not in use. Do not leave funnels in waste containers.
- Dispose of waste on a regular basis; do not allow excess waste to accumulate in the work area.

Spill Response Preparation
Each Laboratory User should have spill response training to respond in the event a spill occurs. The training should include, but is not limited to, a review of the spill response guidelines contained in this section, a review of department-specific chemical spill response plans, the location, contents and use of the laboratory spill response kit, and a review of hazards found in the work area (chemical, physical, biological) which may be of concern during a chemical spill response.

Information on the chemical hazards present at the worksite must be kept up-to-date and readily available. Sources of information include Material Safety Data Sheets, signs, container labels, posters, and reference books. The Laboratory Manager is responsible for ensuring that this information is readily available to Laboratory Users.

Each wet laboratory at the U of R must be equipped with spill response equipment. It is the responsibility of the Laboratory Manager to select and maintain spill response equipment that is adequate for the types and quantities of chemicals present in the laboratory. The equipment should include:
- First-aid equipment
- Personal protective equipment
- Spill cleanup supplies

Recommended contents for generic spill kits are provided in **Appendix 23**.

Spill kits should be customized to account for specific hazards and conditions in each department or laboratory.

Procedures
The procedures given in this section provide general guidance for responding to chemical spills and specific guidance for particular types of hazardous material.

In addition to these general procedures, chemical-specific procedures must also be available at worksites where hazardous chemicals are present or where large quantities of chemicals are stored. Site-specific procedures should include:
- information on the hazards of the chemical.
- the quantity and storage location of the hazardous chemical.
- the personal protective equipment and spill abatement equipment required and their location.
- the instructions for containing and cleaning up the spill.
- the first-aid measures and materials required to treat exposed individuals.
- the method of waste disposal.

Preparing for Spills
Make sure laboratory safety equipment (emergency shower and eyewash, fire extinguisher, emergency shutoffs) are always available, and that you know how to use them. Do not block the access to this equipment.

Responding to Spills

When you discover a hazardous material spill:

(1) Warn others in the area of the leak or spill.
(2) Move away from the area.
(3) Advise the Laboratory Manager.
(4) Identify the spilled material if it is safe to do so.
(5) Evacuate the room or area if necessary.
(6) If serious injuries have occurred, call 911. Direct them to the scene of the occurrence, and call Camus Security – 585-4999.
(7) Remain in the area to warn others and assist emergency personnel if they have been called, but do not put yourself at risk.
(8) Report the spill to Health, Safety and Environment as soon as possible.

Evaluate the Spill

Determine whether or not the spill is simple or complex. A simple spill is one that you can clean up yourself, a complex one requires outside assistance. A **simple spill** does not spread rapidly, endanger people or properly except by direct contact, or endanger the environment.

Factors to consider when evaluating a spill:

- What are the human health effects? Are there toxic vapours or dusts, can they enter the body? If you need a respiratory to clean up the spill, it's not a simple spill.
- Is significant damage to property possible, or potential for damage to the environment? Fire or explosion possible? Is the spilled material water or air reactive? Are ignition sources, oxidizers or large quantities of combustibles present? These all indicate a complex spill.
- Consider the quantities of spilled material, the training and experience of personnel, the availability and quantity of spill control materials, and the available PPE. Assess the layout of the spill location, the form of the material, and its volatility.
- As well, evaluate the possibility that spilled liquids could enter other areas, the presence of other, incompatible chemicals, the presence of the public nearby and the possibility that the spilled material could enter a sink or drain.

If the spill is complex, or if you do not feel comfortable cleaning it up with the training and facilities which have been provided to you, then you must:

- advise the Laboratory Manager.
- call the Spill Response Team.
- call Campus Security.
- call Health, Safety and Environment.
- stand by to assist.

If you determine that the spill is simple, AND you have sufficient clean-up materials, PPE, and assistance AND you feel comfortable cleaning up the spill, proceed using the following guidelines.

Responding to Spills

(1) Before you start a spill cleanup, ensure you have back-up – someone to assist you who will not be part of the actual cleanup.
(2) Put on your PPE – lab coat, safety glasses, appropriate gloves.
(3) Get the spill kit.
(4) Try to contain the spill – dike as necessary.

Cleaning Up Simple Spills

Prevent the spread of dusts and vapours:

- If the substance is volatile or can produce airborne dusts, close the laboratory door and increase ventilation (through fume hoods, for example) to prevent the spread of dusts and vapours to other areas.
- Spills of most liquid acids or bases, once neutralized with the appropriate Spill-X, can be mopped up and rinsed down the drain (to the sanitary sewer). However, be careful because the neutralization process is often vigorous, causing splashes and yielding large amounts of heat. Use pH paper to determine when acid or base spills have been neutralized.

Control the spread of the liquid:

- Contain the spill. Make a dike around the outside edges of the spill. Use absorbent materials such as vermiculite, cat litter, or spill pillows or sleeves.

Absorb the liquid:

- Add absorbents to the spill, working from the spill's outer edges toward the center. Absorbent materials, such as cat litter or vermiculite, are relatively inexpensive and work well, although they are messy. Spill pillows are not as messy as other absorbents, but they are more expensive.
- Special absorbents are required for chemicals such as hydrofluoric and concentrated sulfuric acids.

Collect and contain the cleanup residues – make sure to label them:

- The neutralized spill residue or the absorbent should be scooped, swept, or otherwise placed into a plastic bucket or other container.
- For dry powders or liquids absorbed to dryness, double bag the residue using plastic bags. Additional packaging may be required before the wastes can be transported from your laboratory.
- For spills of powders or solid materials, you may need to add a dust suppressant.
- Be sure to place descriptive labels on each container.

Dispose of the wastes:

- Keep cleanup materials separate from normal trash.
- Contact Health, Safety and Environment for guidance in packaging and labeling cleanup residues.
- Promptly place cleanup wastes in an appropriate hazardous waste receptacle (eg. pail with tight-fitting lid).

Decontaminate the area and affected equipment:

- Ventilating the spill area may be necessary – call Work Control Centre at 585-4039 to arrange for additional building ventilation.
- For most spills, conventional cleaning products, applied with a mop or sponge, will provide adequate decontamination.
- If you have any question about the suitability of a decontaminating agent or the atmosphere in the lab, call Health, Safety and Environment 585-4776.
- Decontaminate yourself – wash your hands after removing your gloves.

Special Spill Procedures

Low Hazard Material Spills:
- These materials have no substantial health hazard, and in general may be cleaned up by local personnel.
- Examples: Sodium chloride, calcium chloride, ethylene glycol, oils, paint.

Flammable Liquid Spill:
- Flash point below 37.8 degrees C, quickly get high vapour concentration.
- Examples: ethanol, methanol, hexane, diethyl ether, toluene.
- Large spills require Fire Department assistance if vapour concentration exceeds LEL.
- Remove ignition sources.
- DO NOT use paper towel for cleanup (this increases rate of evaporation and therefore vapour concentration in air).
- Use only spark-proof tools.
- After clean-up allow 1 hour for room air to be refreshed before re-entering lab.

Combustible and Other Non-Flammable Organic Liquid Spill:
- Flash point is between 37.8 and 93.3 degrees C – vapour ignition or explosion only a problem if heat sources are available.
- Protect yourself from vapour inhalation and skin absorption.
- Allow one hour for room air to be replenished before re-entering lab.

Acid Spill:
- Contain the spill.
- Neutralize it using an appropriate agent.
- Clean up, decontaminate the area.
- Solid acids can be swept up.
- Label waste and dispose in accordance with U of R policy.
- Hydrofluoric Acid, HF, requires a site-specific spill plan, as HF can penetrate deeply and damage underlying tissue.

Alkali or Base Spills:
- These materials are corrosive.
- Dike, neutralize, clean up starting from outside.
- Solid alkali or base spills can be swept up.
- Label waste and dispose in accordance with U of R policy.

Mercury Spills:
- Inhalation of mercury vapours is the main risk, as well as absorption through skin.
- A special mercury vacuum cleaner can be used.
- Establish procedures to reduce the chance for mercury spills.
- Label waste and dispose in accordance with U of R policy.

Oxidizer Spill:
- These materials can ignite organic solvents and combustible materials.
- Solid oxidizer – sweep up using non-sparking tools.
- Liquid oxidizer – absorb with a universal absorbent, then sweep up.
- Label waste and dispose in accordance with U of R policy.

Highly Toxic Materials:

- Substances with chronic toxic effects (carcinogens, reproductive or developmental toxins).
- Compounds that easily product toxic products (such as cyanide and sulfide salts).
- Require extreme care in their cleanup.
- Air and water reactive materials are particularly hazardous, since they will rapidly react with water and/or air to product toxic products.
- Some of these may be pyrophoric and spontaneously ignite in the presence of water or air.
- All spills of these materials are emergencies – call the spill coordinator immediately, and Campus Security and 911 as required.

Compressed Gas Leak:

- If the leak is in the equipment attached to the gas cylinder, shut off the gas cylinder if it is safe to do so.
- If the gas cylinder itself is leaking and can't be turned off, then,
- Evacuate the area if necessary (based on the nature of the gas).
- Leaks of oxygen, flammable gas or toxic gas are particularly dangerous.
- Call Campus Security 585-4999 or 911 as required.

Documentation

After the cleanup is done, complete the incident report form at http://www.uregina.ca/hr/assets/files/health_safety/forms/2009_Incident_Report_Form.pdf

10.5 Fire

Evacuation

In the event of fire, trained Laboratory Users may first attempt to extinguish the fire with a fire extinguisher available in the laboratory. If the fire cannot be readily extinguished, the Laboratory User must:

- **PULL** the fire alarm
- **CLOSE** the door to the area containing the fire if possible
- **WARN** others of the fire as you leave
- **EVACUATE** the building by the nearest exit (except elevators) and as soon as you can do so safely
- **CALL 911** or **499**9 to report the details of the emergency

The University has an emergency warden system in place, and these wardens are trained in building evacuation and crowd control. If you are the person who initially pulled the fire alarm, as soon as it is safe to do so, advise an emergency warden of the situation which caused you to sound the alarm.

When a fire alarm sounds, all persons in the building must evacuate the building. Persons on upper floors must evacuate using the stairs. During an evacuation elevators may not be used. When a fire alarm sounds, evacuation of the building by all persons other than emergency responders is MANDATORY.

Fire Extinguishers

All wet laboratories at the University are equipped with fire extinguishers. Fire extinguishers are designed for putting out small fires only.

To use a fire extinguisher:

P Pull safety pin from handle
A Aim (nozzle, cone, horn) at the base of the fire
S Squeeze the trigger handle
S Sweep from side to side (watch for re-flash)

Each Laboratory User must be made aware of the location and types of fire extinguishers available in the lab, as well as the limitations of those extinguishers. Generally fire extinguishers in most areas are Class ABC, and are located near the lab exit. However, Laboratory Managers and Laboratory Users may wish to have other types of extinguishers available based on the type of hazards or equipment in the lab. **Appendix 16** contains more information about fires and fire extinguishers. Training on how to use fire extinguishers is strongly recommended for Laboratory Managers.

10.6 Incident Reporting

The University of Regina's Incident Report form must be completed for every incident, even if there were no injuries sustained. This includes all chemical spills. The University's Policy and Procedures on Incident Reporting and the Incident Report Form can be found at http://www.uregina.ca/hr , in the Health, Safety & Environment pages and in **Appendix 7**.

University of Regina

Appendix 1

MONTHLY LABORATORY SAFETY CHECKLIST

Room & Building: _____ Year: _____

Lab Manager: _____ Designate (if appropriate): _____

Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1. Personal protective equipment available and used												
2. Good housekeeping; food and drink absent												
3. Aisles and exits clear and free of hazards												
4. Water hoses wired or clamped; gas cylinders clamped												
5. Fume hoods neat and functioning												
6. Minimal flammable solvents in open lab												
7. Peroxidizable compounds dated upon opening and tested as necessary												
8. Proper labelling of chemicals: labels clear and legible												
9. Compatible storage of chemicals												
10. Free of electrical hazards												
11. Sink traps, eye wash fountains flushed weekly												
12. Chemical waste handled appropriately												
13. Other												
Checked (√) by (initials)												

Laboratory Commissioning Checklist and Occupancy Approval

Building _____ **Laboratory Location** _____

Faculty _____ **Unit Head** _____

Laboratory Manager _____ **Date** _____

The following is present in the Laboratory:	Verified by:	On:
☐ Emergency Sprinkler	_____	_____
☐ Fire Extinguisher and Signage	_____	_____
☐ Smoke Alarm	_____	_____
☐ Laboratory Manager Name and Emergency Contact Posted on Laboratory Door	_____	_____
☐ Chemical-Resistant Flooring Installed	_____	_____
☐ Chemical-Resistant Benchtops Installed	_____	_____
☐ Chemical Storage Shelves with lips or doors	_____	_____
☐ Laboratory Ventilation – 8-12 room air changes per hour	_____	_____

The following equipment is present or readily accessible to the Laboratory:	Last tested on:	Verified by:
☐ Emergency Eyewash and Signage	_____	_____
☐ Emergency Shower and Signage	_____	_____
☐ Fume Hood	_____	_____

	Verified by:	On:
☐ Fire Alarm	_____	_____
☐ First Aid Kit and Location Signage	_____	_____
☐ Hand washing sink with soap and paper towels	_____	_____
☐ Spill Kit and Location Signage	_____	_____
☐ Safety Storage Cabinet for Flammables	_____	_____
☐ Safety Storage Cabinet for Acids	_____	_____
☐ Safety Storage Cabinet for Bases	_____	_____
☐ Material Safety Data Sheets	_____	_____

(All of the above items must be present unless an exemption by Health, Safety and Environment has been granted)

The Laboratory Manager has completed **Appendix 5** (Laboratory Hazard Control Plan) and agrees and undertakes as a condition of Tenancy to ensure the following will be present in or readily accessible to the laboratory and functional, before start up of any laboratory operations. (Check to indicate items selected)

The Laboratory Manager agrees as a condition of Tenancy that he or she shall:

☐ Complete and maintain the Laboratory Hazard Control Plan, with a copy provided to HSE

☐ Provide Emergency contact information (after hours contact name and phone) to Facilities Management

- (verified by _____ on _____)

☐ Provide HSE with a list of trained emergency response personnel (students, grad students, post docs) who are able to respond to emergencies specific to the activities of this laboratory

- (verified by _____ on _____)

☐ Describe any specialized alarms and provide emergency response procedures to HSE and contact information to Security

- (verified by _____ on _____)

☐ Ensure Laboratory Users or other persons working in the Laboratory are aware of and comply with Laboratory Safety Rules and Hazard Controls described in Appendix 5 (Laboratory Hazard Control Plan)

- (verified by _____ on _____)

☐ Implement the Monthly Laboratory Safety Checklist and inspect the lab in accordance with the checklist, monthly and on special occasions when circumstances warrant

- (verified by _____ on _____)

☐ Take action to rectify identified deficiencies in compliance with Lab Safety Rules, Standards or Hazard Controls.

☐ Ensure that worksite specific training is provided to all who work in the laboratory, and maintain a record of such training.

☐ Report to the Local Safety Committee on follow-up actions taken to rectify or answer any deficiencies noted in the Local Safety Committee's annual inspection.

☐ Ensure that all chemicals have been included in the chemical inventory.

☐ Cooperate with the Local Safety Committee and with Health, Safety and Environment.

☐ Complete all required safety training (WHMIS, Chemical and Laboratory Safety, Fume Hood Safety).

Name	Type of Training	Date Completed

The Laboratory Manager agrees with and undertakes to comply with the terms and conditions of occupancy.

_____	_____	_____
Print Name	Signature	Date

Reviewed by Health, Safety and Environment

_____	_____	_____
Print Name	Signature	Date

Approval of Occupancy is granted by Facilities Management, Planning Design and Construction.

_____	_____	_____
Print Name	Signature	Date

Approval of Occupancy is granted by Researcher's Dean or Designate.

_____	_____	_____
Print Name	Signature	Date

Annual Laboratory Safety Checklist

(To Be Completed By The Local Safety Committee)

Laboratory Manager: _____ **Room Number:** _____

Inspected By: _____ **Date:** _____

The following inspection report identifies deficiencies found by the inspection team.

ITEM	YES	NO	NA	COMMENTS
A. EMERGENCY and INFORMATION MATERIAL				
1. Emergency procedures posted and legible	☐	☐	☐	
• Fire, spills, injuries				
2. Chemical Safety Program Manual available	☐	☐	☐	
3. Monthly inspections posted and up-to-date	☐	☐	☐	
4. Shower available and accessible	☐	☐	☐	
5. Eyewash available and accessible	☐	☐	☐	
6. Eyewash tested weekly	☐	☐	☐	
7. Fire extinguisher present and accessible	☐	☐	☐	
8. Fire extinguisher seal intact; date tested	☐	☐	☐	
9. Spill kit available and stocked	☐	☐	☐	
B. FIRST AID				
10. First Aid Kit available and stocked	☐	☐	☐	
• Inventory list available	☐	☐	☐	
11. First Aid register available and used	☐	☐	☐	
12. First Aid Manual available	☐	☐	☐	
C. PERSONAL PROTECTION				
13. Safety glasses available and worn	☐	☐	☐	
14. Laboratory coats and gloves available and worn	☐	☐	☐	
15. No bare legs	☐	☐	☐	
16. Appropriate footwear worn	☐	☐	☐	
17. Face shield available and in good condition	☐	☐	☐	
18. Respiratory protection available	☐	☐	☐	
19. Respirator user(s) trained & fit-tested	☐	☐	☐	
D. HOUSEKEEPING				
20. Bench tops and sink areas tidy	☐	☐	☐	
21. Tripping hazards absent, passageways clear	☐	☐	☐	
22. Laboratory exits clear	☐	☐	☐	
23. Food and drink absent	☐	☐	☐	
24. Chipped or broken glassware not in use	☐	☐	☐	
25. Friable asbestos absent	☐	☐	☐	
26. Step-ladder available for out-of-reach items	☐	☐	☐	
E. WASTE CONTAINERS				
27. "Glass" refuse containers labelled	☐	☐	☐	
28. “Glass” segregated from general refuse	☐	☐	☐	
29. Needles and sharps in “Sharps” container	☐	☐	☐	
30. Bulk solvent-waste containers closed and labelled	☐	☐	☐	
• Clorinated and non-chlorinated segregated	☐	☐	☐	
• Bulk /waste solvents stored in flammables storage cabinet	☐	☐	☐	
31. Interim solvent waste containers closed and <1 litre	☐	☐	☐	
32. Ethidium bromide waste segregated	☐	☐	☐	
33. Photographic chemical waste procedures followed	☐	☐	☐	

ITEM	YES	NO	NA	COMMENTS
F. COMPRESSED GAS CYLINDERS				
34. Secured to wall or bench with belt or chain	☐	☐	☐	
35. Lecture bottles stored upright or slanted/secure	☐	☐	☐	
36. Only cylinders in use present in lab	☐	☐	☐	
G. FUME HOODS				
37. Sash at recommended height and air flow on	☐	☐	☐	
38. Area within and under hood tidy	☐	☐	☐	
H. ELECTRICAL APPARATUS				
39. Vacuum pumps stored safely and belts guarded	☐	☐	☐	
40. Refrigerator spark-proof (or "NO Flammables" sign posted & flammables are absent)	☐	☐	☐	
41. Frayed or cracked electrical cords absent	☐	☐	☐	
42. Make-shift wiring absent	☐	☐	☐	
I. RUBBER OR PLASTIC TUBING				
43. Cracked/brittle/pinched tubing absent	☐	☐	☐	
44. Water hoses wired at all connectors	☐	☐	☐	
45. Water pressure regulators in use	☐	☐	☐	
J. CHEMICAL LABORATORIES				
46. Solvent storage cabinet available and closed	☐	☐	☐	
47. Solvent containers closed and labelled	☐	☐	☐	
48. Minimal quantities of solvent outside safety cabinet	☐	☐	☐	
49. Solvent-still contents labelled	☐	☐	☐	
50. Reagent chemicals stored securely (lips on shelves or doors on cupboards)	☐	☐	☐	
51. Chemical containers intact	☐	☐	☐	
52. Ethers stored (& used) out of direct sunlight	☐	☐	☐	
53. Ether containers display opening date	☐	☐	☐	
54. Peroxide-forming chemicals (e.g. ethers) checked for peroxides (3 to 12 months)	☐	☐	☐	
55. Labels compliant with WHMIS	☐	☐	☐	
56. Chemical labels intact, legible, not overwritten	☐	☐	☐	
57. Cleaning baths labelled	☐	☐	☐	
58. Carcinogens/Corrosives/Flammables labelled	☐	☐	☐	
59. Incompatible materials separated	☐	☐	☐	
60. Perchloric acid absent/used in special wash-down fume hood	☐	☐	☐	

PLEASE ENSURE THAT CORRECTIONS ARE MADE BY*:*_____

Date

Supervisor: _____

(*Please sign after violations have been acted upon*)

Upon Correction of Violations, Please Return to Local Safety Committee
With a copy to Health, Safety & Environment

LABORATORY HAZARD CONTROL PLAN INSTRUCTIONS

A Hazard Control Plan must be conducted by the Laboratory Manager:
- at the start up of a new laboratory; and
- before any new equipment, machinery or work process is used or started

The Control Plan must be reviewed at least annually and whenever there is a change in laboratory operations or procedures or an accident/incident.

The Laboratory Manager is required to use **Appendix 5** or a similar form to complete the Control Plan. Prior to conducting the hazard assessment the Laboratory Manager shall review the types of hazards and control measures discussed in this program and consult other laboratory users.

The steps to completing a hazard/risk and control plan are:
Step 1 – Identify Potential Hazards
Step 2 – Assess the Risk associated with each Hazard
Step 3 – Select appropriate Hazard Controls
Step 4 – Implement the selected Controls
Step 5 – Assess the effectiveness of the selected Controls

1. Identify Potential Hazards

Hazards can be identified by such means as review of this program, inspection, interviews with persons who work in the laboratory or perform similar work and review of incidents in this or similar laboratories.

Common hazards in a laboratory include exposure to chemicals, biological agents, (bacteria, viruses, dust and mould), equipment in motion, high pressure, electricity, sharps, radiation, extreme temperatures, noise, vibration, and violence. Other hazards arise from work design (ergonomics), working alone, unattended processes, unplanned loss of air, power or water, animals, fire, spills and other emergencies.

When hazardous chemicals will be used, the following questions should be considered:
- What are the chemicals and in what quantities will they be purchased and used
- Is the experiment to be conducted once, or will the chemicals be used repeatedly
- Will the experiment be conducted in a fume hood or on the laboratory bench
- Will new or unknown substances be generated
- Are any of the workers pregnant, likely to become pregnant, or sensitive to specific chemicals
- Are any chemicals to be used toxic, corrosive, irritants or sensitizers
- Will any carcinogens or potential carcinogens be used
- Have flammability and environmental toxicity been considered
- Are any chemicals involved in the proposed experiment suspected to be reproductive or developmental toxins or neurotoxins
- What are the potential routes of exposure (inhalation, absorption, ingestion, injection)

2. Assess the Risks Associated with Each Hazard

Risk is assessed by considering the *probability* of an event in combination with the severity of harm the event would cause to the University community, the public and the environment if it occurred.

Probability factors are ranked in the following descending order of importance:
Frequent – Probable – Occasional – Remote – Improbable

Severity factors are ranked in the following descending order of importance:
Catastrophic – Critical – Marginal – Negligible

Some risks associated with each type of common hazard include:

- In the case of chemicals: spills; unintended contact with persons eyes, face, hands, skin or clothing; inhalation; combustion, explosion, and dangerous interaction with other chemicals. The severity of the risk ranges from negligible (no injury) to the catastrophic (death or severe destruction)
- In the case of biological hazards: infection, illness and death, ranging in risk from the marginal (minor injury) to the catastrophic
- In the case of laboratory equipment: unintended contact with moving or dangerous parts; electrical shock; electrical fire; emission of harmful airborne material during use or maintenance; spills and leaks; sharps and burns
- Animals pose a risk of physical injury and illness from improper restraint and hygiene controls
- In the case of work design: most commonly musculoskeletal injury from such factors as lifting, awkward or repetitive movement and vibration. There may also be a risk of hearing damage

3. Select Appropriate Hazard Controls

All hazards must be controlled either by removing the hazard or reducing its risk of harm to an acceptable safe level, both proactively (to prevent its occurrence) and reactively (to minimize its harmful affects in the event it does occur). Often more than one hazard control method must be implemented. For example, chemicals require a combination of proper storage, labeling, safe work procedures, the use of PPE and emergency response equipment, procedures and training.

In selecting appropriate hazard controls the following standards apply:

- The control must comply with legislated or regulatory requirements. Some of the legislation and regulations that specify standards for hazard control include:
  - *The Occupational Health and Safety Act and Regulations*
  - *Hazardous Products Act* (federal)
- The control must comply with University of Regina policies, procedures and rules
- Controls must be selected in the following order of priority:
  - **Eliminate hazards** at their source (e.g. redesign the work process, substitute a safer chemical for a hazardous chemical, use different equipment)
  - If it is not practical to eliminate hazards; **control the hazard** to reduce the risk to workers by using engineering controls (e.g. machine guards, noise enclosures, ventilation to dilute the concentration of a hazardous substance)
  - If it is not practical to control the hazard, **protect workers from the hazard** by using tools such as administrative controls, safe work procedures, effective safety training, proper supervision, or personal protective equipment
- Controls must be effective in reducing the risk of harm to staff, students, and the public, to an acceptable level

4. Implement Selected Controls (Formal Safety Control Plans required)

The Laboratory Manager is responsible to ensure that the hazard control measures selected to control the identified hazards are present, maintained and implemented.

Implementation includes the development of written safety control plans and/or safe work procedures, as discussed in this Program, and informing personnel of the procedures and ensuring proper procedures are followed.

5. Assess Effectiveness of Selected Controls

It is also the responsibility of the Laboratory Manager to evaluate the effectiveness of the hazard control selected, and to make improvements where deficiencies are identified. Laboratory Managers will assess effectiveness of controls through regular inspections, testing and monitoring, evaluations of complaints or concerns received and investigations into near misses or other incidents.

Common symptoms of ineffective controls include:

- Repeated non-compliance. Non-compliance may be a consequence of lack of training or consequence, or other problems in the control that cause persons to be reluctant to implement them, such as the creation of another hazard
- Failure to reduce risk. For example, testing may demonstrate that there has been no change in the measured risk after the control has been implemented. In other cases students/staff or others may have a continued complaint
- Near Miss/Injury. A near miss, a risk, or incident causing harm is proof positive that the control measures are ineffective in some way

A copy of the completed Hazard Control Plan must be provided to HSE.

Laboratory Hazard Control Plan

Building _____ **Laboratory Location** _____

Faculty _____ **Unit Head** _____

Laboratory Manager _____ **Date** _____

List of **Potential Hazardous Chemicals** Present or likely to be Present:				
Item	Quantity	(√) MSDS available	(√) MSDS reviewed	Selected Control Measures: (Storage / Labelling / Written procedures; PPE, emergency equipment)

Location and signage location of **MSDS:**	
Number and Type of **Chemical Storage Cabinets:**	
Separation of **Incompatible Chemicals:**	

List of **Potential Hazardous Equipment**: (e.g. glassware, sharps, centrifuges, high pressure, extreme temperature and high voltage equipment, ladders)	
Item	Selected Control Measures: (e.g. Safeguards, Written safe operation and maintenance procedures, PPE, emergency equipment; training or restricted use)

Other Potential Hazards: (e.g. Noise sources above 85 dBa Lex; Musculoskeletal Injury from lifting, awkward movement, repetitive motion, or vibration; Working Alone; Unattended Processes; Unplanned loss of air, power or water; Unplanned Leaks)	
Item	Selected Control Measures: (e.g. Safeguards, Written safe operation and maintenance procedures, PPE, emergency equipment, training)

Emergency Safety Equipment Available:		Location signage
Eyewash	Location:	☐
Emergency Shower	Location:	☐
Spill Kit:	Location: Type:	☐
First Aid Kit	Location: Type:	☐
Fire Extinguisher	Location: Type:	☐
Other:		☐

Personal Protective Equipment (PPE)		Location and Type:
☐	Eye Protection	
☐	Foot Protection	
☐	Hand Protection	
☐	Lab Coat/Apron	
☐	Hearing Protection	
☐	Respirator	
☐	Other:	

Hazardous Waste: Describe Type, Quantity and Disposal Methods Available:

Safe work/operating/emergency procedures		
Posted		Describe training and/or implementation measures
☐	Lab Safety Rules	
☐	Fume Hood Rules	
☐	Emergency Contact	
☐	Emergency Shut Down	
☐	Equipment Operation	
☐	Equipment Maintenance	
☐	Experiment Processes	
☐	Spill	
☐	Fire/Evacuation	
☐	Training Requirements	
☐	Decontamination	

Comments:

This Hazard Assessment has been completed by:

_____	_____	_____
Date	Laboratory Manager (please print)	Signature

Please submit completed form to Health, Safety & Environment

University of Regina

Departing Laboratory Researcher Checklist

The **Departing Laboratory User** must ensure that the Checklist is completed and signed. A copy must be sent to Health, Safety and Environment.

Hazardous Material/Procedure	Date Completed
Ensure all chemicals have WHMIS labels.	
Ensure all chemical containers are in good condition and have good lids.	
Laboratory-generated samples have been inventoried and a copy of the inventory has been provided to the Lab Manager.	
Ensure all chemicals are properly stored.	
Dispose of unwanted chemicals.	
Return gas cylinders.	
Clean/decontaminate laboratory surfaces such as benches, fume hoods and sinks.	
Clean/decontaminate equipment.	
Check all shared areas for hazardous materials.	
Shared storage units such as refrigerators, freezers, cold rooms have been properly surveyed in order to locate and appropriately dispose/designate remaining chemicals.	
Keys, research notebooks have been returned.	

Department Sign-Off

Researcher _____ Date _____
Signature

Unit Lab Inspector _____ Date _____
Signature

Department Head _____ Date _____
Signature

Health, Safety and Environment Sign-Off

HSE Consultant _____ Date _____
Signature

Send completed form to Health, Safety & Environment

INCIDENT REPORTING PROCEDURE

Health, Safety & Environment, Human Resources

Call 585-4999 immediately for all situations as outlined in the Emergency Response Procedures Manual.

Incident Reporting

Any incident that involves injury to a person or damage to property, or had the potential to do so, must be reported to Health, Safety & Environment, Human Resources, **within 24 hours of occurrence**. The University of Regina's Incident Report form must be completed for every incident, even if there were no injuries sustained. If the injured person is a student or visitor to Campus, the report form must still be completed. Injured employees must also notify their supervisor and if eligible complete a Workers' Compensation Board (WCB) form.

Purpose

The purpose of incident reporting and investigation is to prevent a recurrence of the hazardous condition causing the event. It also ensures that the University meets regulatory requirements.

Information for Employees/Supervisors/Managers

If an employee suffers an **injury** while at work:

1. **If immediate medical attention is required, call 911**. Do not transport injured persons to the hospital – call 911 for an ambulance. Otherwise, seek medical attention as required.
2. Employees must report the incident to their supervisor immediately or as soon as possible.
3. The supervisor must call Campus Security (585-4999) immediately.
4. Following a serious incident, no person may alter the scene without the approval of Health, Safety & Environment, Human Resources (585-5487 or 585-4776).
5. The supervisor and employee must complete an incident report form and when applicable a WCB form, including medical information. Fax (585-5232) or deliver forms to Human Resources within 24 hours. Where supervisors are unable to fully complete the forms within 24 hours, the forms, with as much information as is available at the time, should be submitted with the remaining information to follow later.
6. The supervisor and employee must review the recommendations of corrective action with a focus on prevention of recurrence.
7. The employee must report capabilities to their supervisor and continue to provide further written medical information to Pension & Benefits, Human Resources (337-3269). For privacy reasons, ***copies cannot be retained in units***.
8. During an absence from work, employees must report regularly to their supervisor regarding their return to work date and/or changes to work schedule. To ensure a safe return to work, an employee must provide medical evidence of capability to Pension & Benefits, Human Resources (337-3269).

NOTE: Effective July 1, 2005, WCB will impose a fine of $1,000 to the UofR for failure to report to WCB within 5 days of employer awareness of injury.

If **no injury** results and damage to equipment or property occurs:

1. Employee must report the incident to their supervisor.
2. The supervisor must call Campus Security (585-4999).
3. The supervisor and employee must complete an incident report form and fax (585-5232) or deliver to Health, Safety & Environment, Human Resources, within 24 hours. Where supervisors are unable to fully complete the form within 24 hours, the form, with as much information as is available at the time, should be sent to Health, Safety & Environment with the remaining information to follow later.
4. The supervisor and employee must review the recommendations of corrective action with a focus on prevention of recurrence.

All medical information must be forwarded to Human Resources and is kept on file only in HR as per Privacy Protection legislated requirements.

Information for Students

1. Seek medical attention or call 911 for emergencies.
2. Call Campus Security immediately (585-4999).
3. Report the incident to a faculty or staff member.
4. Complete an incident report form and submit to Financial Services and Campus Security **within 24 hours**. Include statements obtained from witnesses.

For more information, refer to the Student Accident Benefit Plan:
http://www.uregina.ca/presoff/vpadmin/policymanual/students/902040.html

Responsibilities:

Supervisors/Managers

1. Immediately call Campus Security - 585-4999 and Health, Safety & Environment - 585-4776 to report the incident.
2. Meet with employee to discuss the incident causes.
3. Participate in the investigation.
4. Implement effective and practical action to prevent a recurrence of the hazardous condition. Will require short-term corrective action measures to control immediate hazard, and long-term measures to effect change.
5. In consultation with the employee, complete the Incident Form, including the Supervisor/Manager section: http://www.uregina.ca/hr/assets/files/health_safety/forms/2009_Incident_Report_Form.pdf

   If injury sustained, complete the WCB Employer's Initial Report of Injury form for eligible employees (E1) - Section B (worker address only), Section C (all) and Section D (#13, 14 and 15): http://www.uregina.ca/hr/assets/files/hr_forms/WCB-E1.pdf
   (Return form and medical information to Health & Wellness Advisor, Human Resources.)

Employees

1. Immediately report your injury to your supervisor or designate.
2. Complete the incident report in consultation with your supervisor.
3. Cooperate in the investigation.
4. If you suffer an injury while at work, complete the WCB Worker's Initial Report of Injury form (W1) if you are one of the covered employee groups: http://www.uregina.ca/hr/assets/files/hr_forms/WCB-W1.pdf
   Include pertinent medical information.
5. Report regularly to your supervisor (see part 7 & 8 on page 1).

Occupational Health Committee

1. Participate in the investigation of all incidents that require an employee to be hospitalized for a period of 24 hours or more, and all dangerous occurrences.
2. Review and analyze incident report summaries and make recommendations.
3. Attend Accident Investigation training.

Health, Safety & Environment, Human Resources

1. Notify Saskatchewan Labour, Occupational Health and Safety Division of fatalities, accidents causing serious bodily injury and dangerous occurrences.
2. Receive all incident reports, review and analyze with the supervisor or manager and provide summary report to Occupational Health Committee. Follow up on the effectiveness of the remedial action.
3. Coordinate and provide the training required for supervisors, Occupational Health Committee members and employees in incident investigation.
4. Analyze statistical information on incidents and report to Occupational Health Committee.

Campus Security

1. Provide emergency response.
2. Conduct initial investigation.
3. Receive and distribute incident reports as required.

Questions? *For more information call Health, Safety& Environment, Human Resources (585-5487).*

INCIDENT REPORT FORM

If the situation is an emergency, call Campus Security immediately: 585-4999

Please complete this form and return to Health, Safety & Environment, Human Resources (AH 435)
WITHIN 24 HOURS OF OCCURRENCE

To be completed by individual(s) directly involved or injured in the incident.

Name: _____ Title/Occupation: _____

Regina Address: _____ Department/Faculty: _____

_____ Work Phone: _____

Permanent Address: _____ Home Phone: _____
(if different from above)

_____ Supervisor Name: _____

_____ Supervisor Phone: _____

Employment category: ☐ Employee ☐ Student* ☐ Faculty ☐ Visitor ☐ Contractor
*Students- refer to Student Accident Benefit Plan for information

Please select one of the following: ☐ Incident with medical attention ☐ Incident with no medical attention ☐ Spill-attach MSDS

Occurrence: Date (dd/mm/yy)**:** _____/_____/_____ **Time:** _____am/pm **Location** (Bldg, rm#)**:** _____

Details of injury/illness & treatment (e.g. body part involved, cut, strain, bruise, illness symptoms and date of onset, etc.)**:**

_____

Was medical treatment received? ☐ University Health Clinic ☐ Family physician ☐ Hospital ☐ Other ☐ No*
**Seek medical attention if symptoms arise or persist.*

Please complete a Workers' Compensation Report as required:
Employee complete W1 form: http://www.uregina.ca/hr/assets/files/hr_forms/WCB-Workers-Report-of-Injury.pdf
Supervisor complete E1 form: http://www.uregina.ca/hr/assets/files/hr_forms/WCB-Employers-Report-of-Injury.pdf

Was a Workers' Compensation Report filed? ☐ Yes ☐ No

Was there any property/equipment damage? ☐ Yes ☐ No If yes, identify property involved and description of damage:

_____

Was the correct equipment/tool/material available? ☐ Yes ☐ No

Was the correct equipment/tool/material used? ☐ Yes ☐ No If no, explain:

_____

What workplace conditions were contributing factors? (e.g. no training, no written procedures, slippery floors, noise, lighting, etc.)

Was Personal Protective Equipment (PPE) available? ☐ Yes ☐ No
What PPE was used?_____

Were emergency equipment/services available (i.e. first aid kit, spill kit, emergency shower/eye wash)**?** ☐ Yes ☐ No

If No, explain: _____

Previous safety training provided? ☐ Yes ☐ No
If Yes, list courses with dates:

_____

Were written procedures followed? ☐ Yes ☐ No
If No, explain:

_____

Describe how the incident occurred:
(use additional paper if required; witness statements should be attached – provide witness name, department & phone number)**:**
If a spill, list name of chemical, quantity, and attach MSDS.

_____

_____

_____

Causes of the incident – i.e. why did it happen and what conditions and/or actions contributed to the injury/accident? (Discuss with supervisor/manager)

Direct cause:

_____

_____

Indirect cause:

_____

_____

Employee's Signature _____ Date: _____
I certify that the information provided is correct.

Forward to supervisor immediately.

TO BE COMPLETED BY THE SUPERVISOR/MANAGER WITHIN 24 HOURS OF INCIDENT/ACCIDENT:

What preventative measures will be taken to avoid a reoccurrence of this incident? Include short-term and long-term measures where appropriate.

_____

_____

☐ Recommended medical attention: ☐ Yes ☐ No ☐ N/A

Action by: _____ Action will be completed by: _____
(Name) (Date)

Supervisor's Signature: _____ Date:_____
I certify that the information provided is correct.

Manager's Signature: _____ Date: _____
I certify that the information provided is correct.

REQUIRED RECORDS AND DOCUMENTS

The Laboratory Manager is responsible for maintaining the following records and documents. All records and documents must be kept for a minimum of seven years. HSE must be contacted before any documents are disposed.

Required records in labs where chemicals are used:

- Training Records for work-site specific training and orientation
- Hazard Control Plan, and Safe Work Procedures
- Spill response procedures
- Laboratory Start-up Checklist and Occupancy Approval
- Any completed Departing Laboratory Researcher Checklists
- First Aid Register
- Monthly and Annual Inspection Reports
- Waste Disposal forms

Required records in labs where Biological materials are used:

- Biological Safety Cabinet certification
- Safe Work Procedures
- Spill response procedures
- Decontamination procedures
- Inventory of biological materials

RESPONSIBILITIES OF LABORATORY MANAGERS

Laboratory Managers are responsible to:

- Ensure students, staff and others working in the lab are provided with training and are orientated to their work sites
- Ensure that departing researchers follow the departing researcher process described in **Appendix 6**
- Authorize access to laboratories only to qualified and trained persons
- Supervise the safety performance of personnel working in the laboratory
- Provide information and training required
- Arrange for supervision of laboratory activities during extended absences such as vacation or sabbatical

- Implement monthly inspections, utilizing the Monthly Laboratory Safety Checklist
- Take action to rectify identified deficiencies, and report follow-up to Local Safety Committee

- Ensure that laboratories are maintained in a tidy and safe fashion
- Ensure that all hazardous materials in the lab are properly labeled
- Provide adequate spill kits and spill training to lab personnel
- Ensure that laboratory safety equipment is available and working
- Ensure first aid kits and first aid registers are maintained
- Ensure that appropriate PPE is available, working and used
- Ensure an inventory of chemicals present in the lab is maintained and that current MSDS are readily available to all personnel working in the lab.
- Acquire the knowledge and information required to recognize and control hazards in the laboratory
- Ensure completion of Hazard Control Plan
- Regularly evaluate safety and health hazards with proposed procedures and the plan for handling any emergencies
- Ensure written work procedures are developed and followed for hazardous substances and procedures
- Obtain appropriate approvals from the Dean or HSE

- Ensure that all incidents are reported to HSE, as described in this program
- Arrange for immediate medical attention for injured personnel

FIRST AID KITS

First Aid and CPR training is required for Laboratory Managers and is recommended for Laboratory Users and lab instructors.

All U of R Laboratories must be supplied with a first aid kit. It is the responsibility of the Laboratory Manager to ensure the location of the first aid kit and that its contents are known to all Laboratory Users. In addition, the **First Aid Manual** and the **First Aid Register** must be kept and maintained with the first aid kit as required by legislation. Each first aid treatment and each case referred for medical attention must be recorded in the First Aid Register.

TABLE 10
Required Contents of First Aid Box

Amounts of quantities of the following supplies and equipment adequate for the expected emergencies, contained in a well-marked container:

Antiseptic, wound solution or antiseptic swabs
Bandage – adhesive strips and hypoallergenic adhesive tape
Bandage – triangular, 100-centimeter folded, and safety pins
Bandage – gauze roller, various sizes
Dressing – sterile and wrapped gauze pads and compresses, various sizes including abdominal pad size
Dressing – self-adherent roller, various sizes
Pad with shield or tape for eye
Soap
Disposable latex or vinyl gloves
Packet mask with disposable one-way rebreathe valves
Forceps – splinter
Scissors – bandage

From *The Occupational Health and Safety Regulations, 1996*

EYE AND FACE PROTECTION SELECTION GUIDE

Eye protection must be worn at all times in labs when working with or around chemicals, and must meet the guidelines in the Canadian Standards Association Standard CSA Z94.3-99 "Industrial Eye and Face Protectors." The type of eye protection required depends on the hazard. For most situations, safety glasses with side shields are adequate. For more hazardous operations where there is a potential for chemical splashing or explosion, safety goggles or a face shield which are rated for chemical splash protection should be used. This is especially important for work with corrosive chemicals.

Current evidence indicates that the use of contact lenses in the workplace, on the whole, does not place the wearer at additional risk of eye injury. Situations in which the use of contact lenses have minimized or prevented injury far exceed those in which they might have increased or exacerbated injury. This has been attributed to some obvious advantages related to the use of contact lenses, including increased visual acuity and better fit of protective eyewear than with eyeglasses. It is reasonable to allow the use of contact lenses in chemical work environments, if the hazard assessment conducted by the Laboratory Manager indicates that the practice is acceptable.

Contact lenses are not protective devices,
and must be used only in conjunction with appropriate protective eyewear.

Avoid wearing contact lenses where water soluble gases, vapors, mists or dusts may be released into the atmosphere. Contact lenses must not be used in laboratories in which the following chemicals are used or stored:

- Isopropyl alcohol
- Ethyl alcohol
- Acrylonitrile
- Methylene chloride
- 1,2-Dibromo-3-chloropropane
- Ethylene oxide
- Methylene dianiline

The Laboratory Manager must determine the level of eye protection required.

Visitors are required to follow the same eye protection policy as everyone else in the lab. If visitors do not provide their own eye protection, it is the Laboratory Manager's responsibility to provide adequate protection for them or to deny them access.

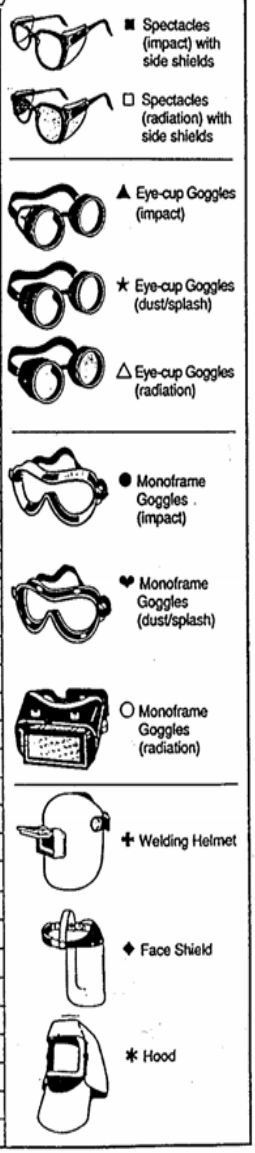
NOTE: Safety glasses and goggles are specifically designed to protect the eyes. Where the use of safety glasses and goggles is indicated, one may use either safety glasses or safety goggles. In contrast, face shields are designed primarily to protect the face and neck area, and only provide secondary protection to the eyes.

Face shields must be used in conjunction with safety glasses or goggles,
and not as a substitute for either of them.

PERSONAL PROTECTIVE EQUIPMENT

SELECTION OF EYE AND FACE PROTECTION

HAZARD	HAZARDOUS ACTIVITIES INVOLVED	RECOMMENDED PROTECTION						LEGEND
		Spectacles	Eye-Cup Goggles	Monoframe Goggles	Welding Helmet	Face Shield	Hood	Spectacles without side shields may be appropriate for certain work situations.
Group A Flying Objects	Chipping/Drilling/Scaling	■	▲	●		◆		
	Grinding/Polishing/Buffing	■	★	❤		◆		
	Rivetting/Punching/Shearing	■	▲	●				
	Hammer Mills/Crushing	■	▲	●				
	Heavy Sawing/ Planing		★	❤		◆		
	Wire & Strip Handling	■	▲	●				
	Hammering/Unpacking/Nailing	■	▲	●		◆		
	Punch Press/Lathe Work	■	▲	●		◆		
Group B Flying Particles Dusts/Wind	Woodworking/Sanding/Turning	■	★	❤		◆		
	Light Metal Working/Machining	■	★	❤		◆		
	Exposure to Wind/Dust	■	★	❤				
	Resistance Welding*	□	△	○		◆		
	Sand/Cement Handling		★	❤			*	
	Painting		★	❤		◆	*	
	Plastering/Concrete Work	■	★	❤		◆		
	Material Batching/Mixing	■	★	❤		◆		
Group C Heat/Glare/Sparks/ Splash from Molten Metal	Babbiting/Casting/Pouring/Molten Metal		★	❤		◆		
	Soldering/Brazing	□	△	○		◆		
	Spot/Stud Welding*		△	○		◆		
	Hot Dipping Operations		★	❤		◆		
Group D Chemical Splash	Acid/Alkali Handling		★	❤		◆	*	
	Pickling/Plating/Degreasing		★	❤		◆		
	Glass Breakage		▲	●		◆		
	Chemical Spraying		★	❤		◆	*	
	Liquid Bitumen Handling		★	❤		◆		
Group E Abrasive Blasting	Sandblasting		★	❤			*	
	Shot Blasting						*	
	Shotcreting						*	
Group F Glare/Stray Light	Reflection/Sunlight	□	△	○				
	Reflected Welding Flash	□	△	○				
	Metal Pouring/Furnace Work	□	△	○		◆		
	Spot/Stud Welding*		△	○		◆		
	Photographic Copying	□	△	○				
Group G Injurious Optical Radiation	Gas Cutting/Welding*		△	○		◆		
	Furnace Work	□	△	○		◆		
Group H Injurious Optical Radiation	Electric Arc Welding*	□			✚			
	Heavy Gas Cutting*	□			✚			
	Plasma Spraying/ Cutting*	□			✚			
	Inert Gas Shielded Are Welding*	□			✚			
	Atomic Hydrogen Welding*	□			✚			



This chart adapted from Canadian Standards Association (CSA) recommendations found in *Industrial Eye and Face Protectors Standards* Z94.3 1992
* For additional information on welding–eye and face protection refer to Safety Infogram D17.

RESPIRATORY PROTECTION

Respiratory protection is not normally required when working in the lab, due to the combination of engineering controls (such as fume hoods), safe work procedures, and the relatively small amounts of chemicals in use. To determine the need for a respirator, the Laboratory Manager or other competent individual must perform a hazard assessment. If as a result of the hazard assessment it is determined that respiratory protection is required, then those lab personnel requiring the protection must be trained and instructed in the proper selection, fit, use, care and maintenance of the respiratory equipment.

Respirator Selection
Respirators used at the University of Regina must provide effective protection against airborne contaminants that may be present. Use of respirators should be considered to control exposure **only** after engineering and administrative controls have been considered. These types of controls include ventilation (e.g. fume hoods), enclosing the process, substitution of less hazardous products, rescheduling of work procedures, etc.

Disposable dust masks may only be used for non-toxic or low concentrations of slightly toxic particulate materials; they must have two straps and a NIOSH-approval N or P – 95, 99 or 100 number on the mask or strap and be appropriate for the contaminant (i.e. oil or non-oil based).

The following procedure refers to the use of half-mask or full-face dual cartridge respirators. A cartridge type of respirator may only be used if the contaminant has adequate warning properties (taste, odour, irritation). It **must not be used** in situations that are **immediately dangerous to life and health (IDLH),** which includes*:*

- A low oxygen environment (<19.5%)
- High concentrations of contaminant
- Highly toxic contaminant (consult with HSE)

A full-face respirator is a minimum requirement where eye irritation is a known or a suspected characteristic of the contaminant.

Respirators may be required for the following situations:

- Working with hazardous fumes, dusts or vapors where engineering controls are not available or practical
- As an escape respirator in the event of a hazardous material release
- During spill clean-up operations
- During maintenance requiring rooftop entry where fume hoods or hazard control systems vent onto the roof

Cartridge Selection
The following cartridges are available for use with half-mask and full-face respirators. Select the appropriate cartridge according to the chart below.

Cartridge Type	Colour	Examples of Uses
Organic vapor and acid gas	Yellow	Rooftop entry/lab procedures/spills
Organic vapor only	Black	Solvents/paints
Dusts, particulates, and aerosols	Purple	Toxic dusts/ infectious aerosols/asbestos welding fumes
Ammonia/amines	Green	Ammonia spill
Acid gas	Grey	Acid gases/chlorine/ Sulphur dioxide
Acid/solvent/base	Olive	Spill Clean-up

Other types of cartridges that address additional classes or combinations of airborne hazardous materials are available. Contact HSE for more information.

Once opened, a cartridge must not be kept for more than 12 months.

Procedures for Respirator Use

To provide protection, respirators that are designed to fit the face must have an effective seal. The respirator user must be **clean-shaven** where the mask fits the face. Fit checks (1) and (2) must be performed by respirator users before every use. At the same time the integrity of the mask, especially the inhalation valves, must be checked prior to fitting on the face.

The wide part of the face piece is placed under the chin, with the narrow portion over the nose. The straps are placed over the back and top of the head, and then the neck strap is fastened and tightened until the mask feels secure.

1) Inhalation (negative pressure) check

Cover the inhalation openings (where cartridges are attached) and breathe in normally. The face piece should collapse against the face. Hold for ten seconds. If the face piece remains slightly collapsed and no leakage is felt around the mask, the respirator is probably sealed properly. When leakage no longer occurs, go on to the exhalation test.

2) Exhalation (positive pressure) check

Cover the exhalation valve (centre front) and exhale normally. Hold for ten seconds. If leakage occurs, adjust the mask until leakage does not occur. Do not use if mask continues to leak; try a different size or brand. Only after tests (1) and (2) have been passed should the chemical challenge fit test be performed. This test must be performed by a trained person, and must be repeated annually. Contact Health, Safety & Environment to arrange for this test.

Rules for Use of Respirators

- Corrective eye wear or other equipment must not interfere with the seal of the respirator
- No covering can be used which passes between the respirator face piece and the wearer's face
- Respirators will be inspected before and after each use, checking straps, valves, cartridges, etc., as well as general cleanliness
- The respirator user prior to each use will perform a positive/negative pressure fit check
- High contaminant levels and other factors such as high humidity, can affect the filter or cartridges
- When wearing a respirator, employees experiencing any of the following symptoms will leave the contaminated area:
  - Nausea
  - Dizziness
  - Eye irritation
  - Unusual odour or taste
  - Excessive fatigue
  - Difficult breathing
- Employees noting any of the above symptoms will leave the work area immediately and report to the supervisor. The respirator shall be checked and new cartridges installed followed by positive/negative pressure tests to ensure respirator is safe to use

Storage and Maintenance Procedures

Store respirators and cartridges in sealed plastic bags or containers, and keep in a cool, dry place away from contaminants.

Labelled zip lock bags work well for storing respirators.
Wash respirator after use:

- Disassemble respirator and wash in warm, mild detergent solution. (Do not wash the cartridges!)
- Disinfect mask after each short term use, after several short-term uses, or after a single long-term use.
- Rinse thoroughly in warm, clear water.
- Allow all parts to air-dry before assembly.
- Inspect and check after each cleaning to ensure respirator is in proper working order.

Defective respirators shall be tagged "out of service" and replaced or repaired.

Cartridge "Life"
Cartridge life is dependent on the type of cartridge, frequency and length of use, as well as the concentration of the airborne material. HEPA cartridges (purple) filter out particulate through a paper filter. Near the end of their useful life, the holes in the filter are plugged and air cannot be easily inhaled through them. Discard when breathing becomes difficult.
Basic rules for cartridge use are:

- Label, with the opening date, each cartridge after removal from the original packaging.
- A cartridge must not be kept for more than 12 months, once it has been opened.
- When used in potentially high contamination situations (e.g. spill response), replace cartridges immediately after use.

Breakthrough of chemical cartridges is indicated by odour, taste or irritation characteristics of the material. If any of these qualities are experienced while wearing a respirator, then leave the area immediately, check the fit of the mask and replace the cartridges if necessary. Breakthrough is not the recommended procedure for determining when cartridges need replacing. In order to make an assessment of when cartridges should be replaced, it is very important to label all new cartridges with the date-of-opening. It is also recommended to keep a log of the circumstances under which cartridges have been exposed (i.e. when; how long; and to what material).

From the opening date and log, a user can decide whether or not it would be appropriate to replace cartridges. For example, a set of cartridges could be worn several times for 3 short term (< 5 minutes) exposures.

GLOVE SELECTION GUIDE

The right type of glove provides much-needed hand protection in the laboratory. It is recommended that appropriate gloves be used when handling hazardous chemicals, toxins and materials of unknown toxicity, corrosives, and hot/cold objects. Particular attention should be given to chemicals which have a "skin" notation on the MSDS.

When choosing a glove, consider the circumstances under which the glove will be used. The degree of protection required will depend on the hazards associated with the chemical in question, the type and scale of experimental work being performed, and individual work habits.

For routine lab work with small amounts of chemicals, disposable gloves of a suitable material are generally acceptable. The gloves should be removed and replaced when they become contaminated. When gloves are required for immersion in cleaning baths or handling corrosive materials, reusable gloves of suitable material should be used. Reusable gloves should be inspected before each use, and decontaminated or replaced as necessary.

Wearing the wrong type of glove when handling chemicals can be more hazardous than wearing none at all. If a chemical permeates the glove, it can be held in prolonged contact with the wearer's hand and potentially cause serious damage. A selection guide should be used in choosing the type of glove required, and under some circumstances double gloves may be used when dealing with chemicals of high hazard.

When handling hot or cold items in the lab, insulated gloves made of Kevlar or a similar heat-insulating should be worn.

BASIC GLOVE SELECTION GUIDE

Compatibility Ratings
A — Very Good or Excellent
B — Good
C — Fair
D — Not recommended
— — No data available

Brand of glove	Microflex®				Ansell	Best™ N-DEX®	Safeskin®
	Diamond Grip™ Plus	NeoPro™	Nitron One®	Supreno™	Touch-N-Tuff™		
Glove material	Latex	Chloroprene	Nitrile	Nitrile	Nitrile	Nitrile	Nitrile
Chemical	**Compatibility rating**						
Acetic Acid	A	A	A	A	A	A	C
Acetone	A	B	D	D	D	A	C
Acetonitrile	—	A	—	—	C	A	C
Ammonium Hydroxide	A	A	A	A	B	A	A
Carbon Tetrachloride	D	C	B	B	—	C	C
Chloroform	D	B	D	D	—	D	D
Ethanol	A	A	A	A	C	A	B
Ethyl Ether	B	A	B	B	B	A	B
Formaldehyde	A	A	A	A	A	A	A
Hexane	D	C	B	B	A	A	A
Hydrochloric Acid	B	A	B	B	A	A	B
Isopropanol	A	A	A	A	A	—	A
Kerosene	C	—	A	A	A	A	A
Methanol	A	A	A	A	A	A	C
Nitric Acid	C	B	C	C	A	A	B
Phosphoric Acid	B	A	A	A	—	A	B
Potassium Hydroxide	A	A	A	A	—	A	A
Sodium Hydroxide	A	A	A	A	A	A	B
Sulfuric Acid	B	B	B	B	A	B	D

FUME HOODS AND LABORATORY VENTILATION

Guidelines for Fume Hood Use

To maximize fume hood effectiveness and minimize personal exposure to toxic vapours or gases, use fume hoods in accordance with these operational guidelines:

- Operate the hood at the proper sash height, as indicated by the red arrow located on the front of the hood. For variable air volume or bypass hoods, sash heights will not be posted.
- Reduce pedestrian traffic in front of hoods. Also minimize nearby disturbances, such as doors opening or closing, and any quick motion in order to prevent cross drafts.
- Do not position fans or air conditioners so as to direct airflow across the face of the hood. This can interfere with airflow and containment of hazardous chemicals.
- Do not block airfoil with equipment or absorbent paper; the airfoil provides airflow across the floor of the hood.
- Place bulky equipment away from sidewalls to allow airflow around the equipment.
- Place any bulky equipment towards the rear of the hood and raise it about 2 inches off the surface with blocks or bricks, but do not place this equipment against the rear of the hood, as it will block airflow to the rear baffles.
- Work as far inside the hood as possible, at least 4 to 6 inches from the front edge with the sash face between you and task at hand. All equipment should be a minimum of 9 to 12 inches away from the hood face.
- Keep sash face clean and clear. To encourage use of sash as added protection against splashes, sprays, etc. keep sash face clean. If sash face must be blocked with paper for certain experiments, please take it down after the experiment is complete.
- Do not use the hood as a storage cabinet for chemicals or equipment. Materials stored in fume hoods should be kept to a minimum and stored in a manner that will not interfere with airflow.
- Place any heat-generating equipment in the rear of the hood. Heating devices in the hood produce convection currents that can disrupt airflow.
- Do not use a hood for any function it was not designed for, such as perchloric acid, radioisotopes, etc. The generation of perchloric acid vapours requires specially-designed fume hoods with wash –down systems. Hoods used for perchloric acid must be approved by HSE. Hoods used for radioisotopes must be approved by the Radiation Safety Officer.
- ***Wear protective equipment!*** Fume hoods do not prevent accidents or chemical splashes
- Close sash when finished with hood work or when leaving experiments or chemicals unattended! This simple procedure has contained many fires and explosions within a hood.
- Fume hood maintenance is conducted annually. Face velocities are measured, adjusted if necessary and recorded then posted on the Fume Hood Maintenance label.
- If the Fume Hood alarm rings, close the sash and do not use the hood until Facilities Management has repaired the problem.
- Do not use the emergency purge button to vent off vapours as part of experimental procedure.

Conduct all operations which generate air-borne contaminants inside a fume hood.

Fume Hood Maintenance Procedures

Fume hood maintenance is a planned, annual procedure. Depending on the nature of the work involved there are standard procedures that must be performed by fume hood users prior to work being done by maintenance personnel.

The levels of fume hood maintenance differ with respect to the type of work or maintenance being done and consequently with respect to the activities to be assumed by the fume hood user. For all fume hood shutdowns the following is required:

- Containers capped; gas cylinders removed
- Heat sources closed
- Hood monitored for radioactivity and decontaminated as required
- No equipment venting into hood

Type of Work or Maintenance	User's Responsibilities
Work done outside hood, but within ductwork	All chemicals removed from hood
Work done within hood	Everything is removed from hood

U of R
Fume Hood Maintenance Label

_____ **Date of inspection**

_____ **Expiration Date**

_____ **Inspector**

_____ **Face velocity at sash height of 14 inches**

If Fume Hood Air Flow Stops:

- ❑ **Note pressure gauge reading, if one is provided.**
- ❑ **Shut off experiments, turn off heat, relieve pressures.**
- ❑ **Seal containers; remove compressed gas cylinders from the hood.**
- ❑ **Ensure no other lab equipment is vented into the hood.**
- ❑ **Place "Do Not Use; Hood Out of Order" sign on the fume hood.**
- ❑ **Where radioisotopes are used, contact Radiation Safety Officer at 3184.**
- ❑ **Advise departmental administrator – phone #** _____

Call Work Control 585-4039
(After hours /weekends call Central Heating Plant 585-4122)

Other Laboratory Ventilation

There are many types of laboratory equipment and apparatus that generate vapours and gases but cannot be used inside a traditional fume hood. Some examples include gas chromatographs, atomic absorption spectrometers and ovens. Always check and comply with the manufacturer's recommendations. Local exhaust ventilation should be used to contain and remove potentially hazardous or noxious fumes and vapours. Ideally, a separate dedicated exhaust system should be used. If connected to an existing hood duct, the fan capacity must be increased and airflow to both hoods properly balanced. Also note that each new exhaust hood requires provision of more make-up air supply to the lab.

The general laboratory ventilation system controls the quality and quantity of air supplied to the lab at such a rate that the air is continuously replaced to minimize the concentration of odoriferous or toxic substances. Labs are also designed so that they are at negative pressure to the rest of the building, to prevent movement of odoriferous or toxic substances to other parts of the building.

EMERGENCY SHOWERS AND EYEWASHES

Accidental exposure to hazardous materials or chemicals can result in temporary or permanent irritation and damage to the skin and eyes. Appropriate training and supervision of staff and students that use hazardous materials, and controls that prevent hazardous exposures are critical in preventing or minimizing injuries. For example, personal eye protection is an essential requirement when working with any material or process that has the potential to cause eye injuries.

As a supplement to these measures, and to comply with *The Occupational Health and Safety Regulations*, all wet laboratories at the University of Regina are equipment with plumbed emergency showers and eyewashes.

Eyewash stations and emergency shower equipment must:
- Meet ANSI (American National Standards Institute), CSA or other approved standards.
- Be readily available near areas where hazardous materials are used.
- Be maintained to approved standards in good condition.
- Be routinely inspected to ensure that the equipment is in working order and meets applicable standards.

Emergency Eyewash-Station Inspection:

Monthly inspections are required to verify the simple operational aspects and maintenance requirements of eyewash equipment. These inspections are the responsibility of the Laboratory Manager.

As part of the Laboratory Manager's monthly laboratory inspection, plumbed eyewash stations that are permanently affixed within a facility must have the following items verified:
- Eyewash signs that identify the eyewash equipment's location should be present and clearly visible from all directions within the shop or lab that the unit is intended to serve.
- There should be no hazards or obstructions impeding access to the operating area of the unit.
- All eyewash stations should be clean and free of debris and hazards. Nozzles should be protected from airborne contaminants by dust caps that do not require a separate independent motion by the operator to remove when activating the unit.
- The eyewash must provide an adequate supply (volume and pressure) of lukewarm water at a rate of at least 1.5 L/min, sustain 15-minutes of use and the water flow should meet at a midpoint between the nozzles. Lack of water supply to the station is a high priority concern and should be reported to Work Control for immediate repair.
- Mechanical parts should operate properly (e.g. activation bar is not stripped and activates water flow with minimal effort). Mechanical deficiencies should be reported to Work Control for immediate repair.

The Department/Faculty/Unit must correct deficiencies noted per the above inspection criteria immediately. Housekeeping hazards obstructing the eyewash are a departmental responsibility. Emergency repairs must be requested of Work Control, and any lab activities which could result in accidental exposure as described in this guideline must stop until such a time as the unit meets the inspection criteria. A record of the monthly eyewash inspection must be recorded on the laboratory's Monthly Laboratory Safety Checklist.

Weekly Eyewash Flushing
Plumbed eyewash stations must be flushed for three minutes each week. This is to reduce the levels of infectious organisms in the water, which have the potential to cause blindness in users of eyewash fountains.

Personal Eyewash Equipment
In working situations with identified eye-exposure hazards, where stationary emergency eyewash equipment is not located within 10 seconds (100 feet), portable personal eyewash equipment such as squeeze bottles are required. (Example: Custodial Services Carts) Personal eyewash equipment is intended to provide emergency support and at no time should be used to replace proper eyewash stations. Personal eyewash equipment must meet applicable standards and should be replaced or refreshed according to manufacturer's specifications. It is the responsibility of employees to whom this equipment is assigned, to notify their supervisor when a replacement bottle is required.

Emergency Shower Inspections
All wet laboratories at the University are equipped with a plumbed emergency drench shower. Departments that work with or store high hazard chemicals or hazardous materials must alert HSE if an emergency shower is not present or is improperly located. The following requirements must be met:

- Water must be delivered, as lukewarm water, with a flow rate of at least 113.6 L/min (30 gal/min), but at a velocity that is not injurious to workers, for 15 minutes.
- The on/off control must be easy to reach and start the water flowing within 1 second or less of being activated.
- The valve must remain open and the flow rate maintained without the use of the operator's hands, until intentionally shut off.
- The shower must be identified with a clearly visible sign.
- Emergency showers must be in accessible locations that require no more than 10 seconds to reach and should be within a travel distance no greater than 30.5 metres (100 feet) from the hazard.
- The path to the shower must be kept clear.
- The shower should be assembled according to manufacturer's instructions.

Facilities Management, Maintenance will schedule preventative maintenance inspections with appropriate maintenance personnel, annually or in accordance with manufacturer's instructions. Emergency showers should be inspected according to procedures set forth in applicable standards and manufacturer's recommendations. Although Facilities Management will conduct scheduled inspections and repair identified deficiencies, departmental staff who may become aware of deficiencies or required maintenance should report these to Work Control immediately.

Know the location of the eyewash and emergency shower closest to your work area.

Training
All employees/students who work with, or in close proximity to, hazardous materials, chemicals or other potential exposure hazards must be appropriately instructed with regard to the appropriate use of materials, potential hazards, proper controls of hazards and emergency response procedures including the use and location of emergency eyewash/drench shower units.

Department employees who are designated to inspect emergency eyewash and shower equipment shall be trained in the proper inspection procedures of the equipment. Laboratory Managers are responsible to provide, or arrange appropriate training for employees/students under their supervision.

Records
All records of inspections and/or maintenance repairs shall be maintained for all equipment for a period of 7 years.

All records of employee training should be forwarded to Human Resources for mandated retention periods.

FIRE EXTINGUISHERS

All wet laboratories at the University are equipped with fire extinguishers. Fire extinguishers must be inspected annually and tagged with an inspection date. Facilities management manages the installation and inspection of fire extinguishers.

Fire extinguishers are designed for putting out small fires only.

To use a fire extinguisher:

P Pull safety pin from handle
A Aim (nozzle, cone, horn) at base of the fire
S Squeeze the trigger handle
S Sweep from side to side (watch for re-flash)

Each lab worker should be aware of the location and types of fire extinguishers available in the lab, as well as the limitations of those extinguishers. Generally fire extinguishers in most areas are Class ABC as described below, and are located near the lab exit. However, Laboratory Managers and users may wish to have other types of extinguishers available based on the type of hazards or equipment in the lab.

There are four general classes of fires:

- Class A: Ordinary Combustibles
- Class B: Flammable Liquids
- Class C: Electrical Equipment
- Class D: Combustible Metals

Each class of fire has specific types of extinguishers that are most effective for extinguishing that fire. The following are the most common types of extinguishers:

- **Class A Type: Water-based extinguishers -** These should never be used in the lab, since they are not suitable for use on flammable liquid or electrical fires, two common fire types encountered in the lab.
- **Class ABC Multipurpose Dry Chemical -** Commonly found in many labs due to its versatility in fighting nearly all types of fires.
- **Class BC Carbon Dioxide -** Commonly found in labs that do not contain substantial amounts of Class A materials.

Class D fires are unresponsive to the regular classes of fire extinguishers listed above. Special extinguishing agents must be used, or the fire smothered with dry sand extinguisher.

If you notice a fire extinguisher which has been discharged or is only partially charged, with the safety pin pulled, obstructed from view, not hanging in the proper location or missing from its wall plate, please contact Work Control.

REQUIREMENTS FOR STORAGE OF FLAMMABLE AND COMBUSTIBLE LIQUIDS IN LABORATORIES

The maximum quantities of flammable and combustible liquids which are allowed in laboratories are based upon NFPA 45, Fire Protection for Laboratories Using Chemicals. The calculation for allowable quantities includes consideration of:

- The size of the laboratories
- The use of the laboratories (whether they are research or instructional)
- The presence of sprinklers
- The type of fire separation the labs have
- The presence of flammable storage cabinets

At the U of R, containers of flammable and combustible liquids in laboratories must be smaller than 5 litres, unless they are ULC-approved containers.

Definitions:

Combustible Liquid – Any liquid that has a flash point at or above 37.8 degrees Celsius.

- Class II Combustible – any liquid that has a flash point at or above 37.8 degrees and below 60 degrees Celsius
- Class IIIA Combustible liquid – any liquid that has a flash point at or above 60 degrees Celsius but below 93 degrees Celsius
- Class IIIB Liquid – any liquid that has a flash point at or above 93 degrees Celsius

Flammable Liquid – any liquid that has a flash point below 37.8 degrees Celsius

- Class IA Liquid – those liquids that have flash points below 22.8 degrees and boiling points below 37.8 degrees Celsius
- Class IB Liquids – those liquids that have flash points below 22.8 degrees and boiling points at or above 37.8 degrees
- Class IC – those liquids that have flash points at or above 22.8 degrees but below 37.8 degrees C

Storage cabinets:

- shall be labelled in conspicuous lettering to indicate that the cabinet contains flammable materials and that open flames must be kept away.
- shall conform to ULC-C1275 “Storage Cabinets for Flammable Liquid Containers”.
- shall have ventilation openings which are either sealed with materials providing a fire protection at least equivalent to that required for the construction of the cabinet or shall be vented outdoors.

CHEMICAL STORAGE GUIDELINES

The following categories should be used to plan storage of controlled products in the laboratory.

1. Compressed Gases

A) Flammable Gases
B) Non-flammable Gases

2. Water Reactives

Water reactives are materials that, when they come into contact with water, become spontaneously flammable, or release flammable or toxic gas. Water reactives are a special class of hazardous material because they require unique storing conditions, so as to prevent their contact with water during fire-fighting operations.

Store these away from oxidizers, flammables, corrosives, and any other materials containing water. Store these away from all plumbing fixtures and pipes.

Label the storage area for these, advising the presence of water reactive chemicals.

Examples: Sodium metal, lithium aluminum hydride, calcium oxides

3. Other Dangerous Reactives

These unstable materials react vigorously when they come into contact with air, or are under conditions of shock, temperature or pressure increases, or when certain inhibitors are absent.

Store in a cool dry well-ventilated area, away from heat and ignition sources including sparks, flames, hot pipes and direct sunlight.

Chemicals in this group may react with each other.

Each chemical's MSDS must be read and understood before attempting to store these chemicals.

Examples: Picric acid, boron, aluminum chloride

4. Oxidizers

These substances yield oxygen or another oxidizing substance, contributing to the combustion of another substance. Organic peroxides are included here. The hazard is the high potential to cause fires and explosions.

The main concern in storing these chemicals is to keep them separate from fuel, such as flammables. They also must be stored away from most other chemicals, including most compressed gases, water reactives, other dangerous reactives, strong reducing agents and organic substances.

Peroxides are examples of oxidizers which need to be stored especially carefully.

- **Organic peroxides** are unstable, they continuously decompose, potentially generating enough heat and flammable gas to explode. They are sensitive to heat, light, friction and impact. They are extremely flammable, and must be kept away from reducing agents and other strong oxidizers
- **Inorganic peroxides** are generally stable by themselves, but may form unstable organic peroxides and hydroperoxides on contact with organic materials. They may be extremely water reactive
- **Peroxide formers** are materials that react with oxygen or oxidizers to form peroxide compounds.

Examples: Sodium hypochlorite, compressed oxygen, hydrogen peroxide

5. Flammables and Combustibles

Flammables are substances that can catch fire at normal working temperatures (flash point below 38C) and combustibles are substances which can catch fire at temperatures above normal working temperatures (flash point above 38C and below 93C)

Examples: Acetone, benzene, gasoline

Flammables and combustibles must be separated from oxidizers, and must also be stored separately from corrosives, water-reactives, other dangerous reactives, toxins, and most compressed gases. Organic acids should also be stored with flammables and combustibles.

The maximum quantity of flammables and combustibles allowed in a lab is regulated by the National Fire Code.

6. Corrosives

Corrosives are materials that, on contact, chemically destroy body tissue, metals, and other materials.

Store each of these categories separately. Store acids in a dedicated acid cabinet, and store nitric acid separately from other acids, unless it is kept in a separate compartment of the acid cabinet.

Store corrosives away fro flammables, water reactives, other dangerous reactives, oxidizers, and organic material. Organic acids may be stored with organic flammables.

Corrosives should be stored on trays (secondary containers) made of corrosion-resistant materials, and should be large enough to contain the volume of the liquids in the containers in case the bottle breaks or spills.

A) Oxidizing and Inorganic Acids
Acids have a very low pH, generally less than 2.


Oxidizing acids are identified by both these WHMIS symbols

Examples: Nitric acid, sulphuric acid

B) Bases
Bases have high pH, generally above 11.5. They are called caustic or alkali.

Examples: Sodium hydroxide, ammonia

7. Toxins


Toxins are substances that can cause death or serious health effects if even small amounts are ingested, inhaled, or absorbed through the skin.

Toxins must be stored separately from flammables, oxidizers, water reactives or other dangerous reactives. Excellent ventilation is recommended. Consult the MSDS for specific storage requirements.

Examples: Cyanides, lead, DDT

8. General Chemicals (Non-hazardous)

This section is for chemicals that do not pose any major physical or chemical hazards.
Always check the MSDS before attempting to store a chemical. Separate organic chemicals from inorganic chemicals. Organic chemicals are incompatible with oxidizers and oxidizing acids. Alphabetic storage of these chemicals may be acceptable.

Examples: Sodium chloride, silica gel, iron oxide

COMMON CHEMICAL-SPECIFIC INCOMPATIBLES

The following list is a quick reference of incompatibilities of many chemicals commonly encountered in the laboratory. It is not a comprehensive list of all possible combinations and chemicals. For details on any chemical, check the MSDS.

Chemical	Incompatibilities for Chemical Storage
Acetic Acid	Aldehydes, bases, carbonates, chromic acid, ethylene glycol, hydroxides, metals, oxidizers, perchloric acid, peroxides, permanganates, phosphates, xylene
Acetic Anhydride	Acids, alcohols, bases, finely divided metals, oxidizers, reducing agents
Acetone	Inorganic acids, amines, hydrogen peroxide, oxidizers, plastics
Acetylene	Copper metal, halogens, mercury, potassium, silver, oxidizers
Alkalis	Acids, carbon dioxide, chlorinated hydrocarbons, chromium, flammable liquids, mercury, oxidizers, salt, sulphur, water
Ammonium Nitrate	Acids, alkalis, chlorates, fine organic powders, metals, nitrates, oxidizers, sulfur
Aniline	Inorganic acids, dibenzoyl peroxide, hydrogen peroxide, oxidizers
Azides	Acids, heavy metals, oxidizers
Bromine	Acetaldehyde, acetylene, alcohols, alkalis, amines, benzene, butadiene, butane and other petroleum gases, ethylene, fluorine, hydrogen, ketones, finely divided metals, sodium carbide, sulfur, turpentine
Calcium Oxide	Acids, ethanol, fluorine
Carbon (activated)	Alkalis, oxidizers, calcium hypochlorite, halogens
Carbon Tetrachloride	Benzoyl peroxides, ethylene, fluorine, oxygen, silanes
Chlorates	Acids, ammonium salts, carbon, metal powders, sulfur, finely divided combustibles and organics
Chromic Acid	Acetic acid, acetone, alcohols, alkalis, ammonia, bases, camphor, flammable liquids, glycerine, turpentine
Chlorine	Acetylene, ammonia, benzene, butadiene, ethylene and other petroleum gases, hydrazine, hydrogen, hydrogen peroxide, iodine, sodium hydroxide, turpentine, other petroleum components, finely divided metals
Chlorine Dioxide	Ammonia, hydrogen, hydrogen sulfide, mercury, methane, phosphine, phosphorous, potassium hydroxide
Copper	Acetylene, calcium, hydrogen peroxide, oxidizers
Cyanides	Acids, alkalis, strong bases
Flammable Liquids	Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens
Fluorine	Ammonia, halocarbons, halogens, ketones, metals, organic acids, hydrocarbons, other combustible material
Hydrazine	Inorganic acids, hydrogen peroxides, oxidizers
Hydrocarbons	Acids, bases, oxidizers
Hydrochloric Acid	Alkali metals, amines, bases, copper, copper alloys, aluminium, moisture
Hydrofluoric Acid	Ammonia, glass, organics, sodium
Hydrogen Peroxide	Acetylaldehyde, acetic acid, acetone, alcohols, aniline, carboxylic acids, flammable liquids and combustible material, metals and their salts, nitric acid, nitromethane, organics, phosphorous, sodium, sulfuric acid

Chemical	Incompatibilities for Chemical Storage
Hydrogen Sulfide	Acetylaldehyde, oxidizers, sodium
Hypochlorites	Acids, activated carbon
Iodine	Acetylaldehyde, acetylene, ammonia, hydrogen, sodium
Mercury	Acetylene, aluminium, amines, ammonia, calcium, fulminic acid, lithium, oxidizers
Nitrates	Sulfuric acid, other acids, nitrites
Nitric Acid (Conc.)	Acetic acid, acetonitrile, amines, ammonia, aniline, bases, benzene, brass, chromic acid, copper, cumene, flammable liquids and gases, formic acid, heavy metals, hydrogen sulfide, ketones, organic substances, sodium, toluene
Nitrites	Acids, nitrates
Nitroparaffins	Amines, inorganic bases
Oxalic Acid	Mercury, oxidizers, silver, sodium chlorite
Oxygen	Acetylaldehyde, alkalis, ammonia, carbon monoxide, ethers, flammable gases, liquids & solids, hydrocarbons, phosphorous
Perchloric Acid	Acetic acid, acetic anhydride, alcohols, aniline, bismuth and bismuth alloys, combustible materials, dehydrating agents, ethyl benzene, hydroiodic acid, hydrochloic acid, grease, iodides, ketones, other organic materials, oxidizers, pyridine
Peroxides, Organic	Acids (inorganic, organic)
Phosphorous	Air, alkalis, oxygen, reducing agents
Potassium	Acetylene, acids, alcohols, carbon dioxide, carbon tetrachloride, halogens, hydrazine, mercury, oxidizers, selenium, sulfur
Potassium Chlorate	Acids, ammonia, combustible materials, fluorine, hydrocarbons, metals, organic substances, sugars
Potassium Perchlorate	Acids, alcohols, combustible material, fluorine, hydrazine, metals, organic materials, reducing agents
Potassium Permanganate	Benzaldehyde, ethylene glycol, glycerol, sulfuric acid
Selenides	Reducing agents
Silver	Acetylene, ammonia, ammonium compounds, fulminic acid, oxalic acid, oxidizers, ozonides, peroxyformic acid
Sodium	Acids, carbon tetrachloride, carbon monoxide, hydrazines, metals, oxidizers, water
Sodium Nitrate	Acetc anhydride, acids, metals, organic matter, peroxyformic acid, reducing agents
Sodium Nitrite	Ammonium nitrate and ammonium salts
Sodium peroxide	Acetic acid, acetic anhydride, benzene, benzaldehyde, carbon disulfide, ethyl acetate, furfural, gylcerin, hydrogen sulfide, metals, methyl acetate, peroxyformic acid, phosphorous
Sulfides	Acids
Sulfuric Acid	Flammable and combustible liquids, potassium chlorate, potassium perchlorate, potassium permanganate, like compounds of sodium and lithium
Tellurides	Reducing agents

NOTIFIABLE CHEMICAL AND BIOLOGICAL SUBSTANCES

Excerpt from *The Occupational Health and Safety Regulations, 1996*

TABLE 19

[*Sections 305 and 311*]

A. Any of the following chemical substances or any mixture containing more than 1% of any of them:

CAS Number	Chemical Substance
92-67-1	4-Aminobiphenyl
492-80-8	Auramine
92-87-5	Benzidine
542-88-1	bis(Chloromethyl) ether
119-90-4	o-Dianisidine
91-94-1	3,3'-Dichlorobenzidine
107-30-2	Methyl chloromethyl ether
50-60-2	Mustard gas
91-59-8	2-Naphthylamine
92-93-3	4-Nitrobiphenyl
75-01-4	Vinyl chloride

B. Any of the following biological substances:

Genetically modified[1] microorganisms[2]

[1]"genetically modified" means genetic combinations not known to occur naturally.
[2]"microorganisms" means any organism or consortium of organisms of microscopic size, including bacteria, protozoa, fungi, algae and viruses.

The use of any of the above chemicals or biological substances requires authorization by the Saskatchewan Department of Labour.

Contact HSE for additional information.

WORKING WITH SPECIFIC TYPES OF CHEMICALS

Highly Toxic Chemicals

Highly toxic chemicals include those with high acute systemic toxicity, and substances with chronic toxic effects such as carcinogens, reproductive or developmental (embryotoxins, teratogens) toxins, and mutagens. Information on the potential carcinogenicity, mutagenicity, or reproductive toxicity is generally available on the MSDS. Chemicals with high acute toxicity may be identified using the criteria presented in the table below.

Criteria for Identifying Chemicals with High Acute Toxicity(1)

Oral LD_{50} (Rats, mg / kg)	< 50
Skin Contact LD_{50} (Rabbits, mg / kg)	< 200
Inhalation LC_{50} (Rats, ppm for 1 hour)	< 200
Inhalation LC_{50} (Rats, mg/m^3 for 1 hour)	< 2000

(1) Adapted from *US OSHA Standard 29 CFR 1910.1200AppA*

LC_{50} is the lethal concentration in air of a substance that produces death in 50 percent of the exposed test population within a specified time. LD_{50} is the dose required to produce death in 50 percent of the exposed test population within a specified time.

Before starting experiments with highly toxic chemicals, examine all stages of work including acquisition, storage and handling, experimental protocol, decontamination, disposal, and clean up of spills. Each experiment should be evaluated individually, as the circumstances and amounts of the toxic chemical used will affect the types of precautions required. Experimental work should be carried out in a designated area of the lab, preferably in a fume hood or glove box. Other lab work may be carried out in this area, provided all lab personnel are made aware of the nature of the toxic chemical(s) being used and the necessary precautions to take. Post warning signs to alert others in the area and clearly define boundaries.

In addition:

- Ensure fume hoods are working properly, and continue to monitor on a daily basis for the duration of the experiment. Alert Facilities Management of the nature of the work being conducted in the fume hood.
- Operate glove boxes under negative pressure to prevent escape of toxic vapours, dusts or aerosols.
- Use HEPA filters, chemical scrubbers and/or cold traps to prevent the release of toxic dusts, vapours or aerosols into the atmosphere or apparatus such as vacuum pumps and lines.
- Choose equipment that allows ease of decontamination. Equipment used should be labelled and isolated from the general lab equipment, and decontaminated before being removed from the designated work area.
- Wear long sleeved clothing and appropriate PPE, and take special care to select gloves that are impervious to the chemical(s) being handled. Wearing double gloves of different materials may be appropriate in many circumstances.

Never work alone with highly toxic materials!

Flammable and Combustible Liquids

Flammable (or Class I) liquids are defined in the ***National Fire Code*** as those liquids with a flashpoint below 37.8°C. Combustible (Class II or III) liquids are those with a flashpoint between 37.8°C and 93.3°C. The greatest danger associated with handling of these liquids in the lab is the potential for fire or explosion. Never heat flammable liquids with an open flame, and always handle them in an area free of ignition sources. This includes open flames, electrical equipment, static electricity and for some liquids with very low flash points such as diethyl ether and carbon disulfide, hot surfaces.

Use appropriate ventilation to prevent the formation of flammable or explosive gas mixtures in air. Carry out transfers in a fume hood or other areas with sufficient ventilation. Keep containers of flammable liquids closed except during transfer of contents.

Bond and ground metal lines and containers used to dispense flammable liquids to prevent the build-up of static electricity. This is especially important for nonconductive liquids. Liquids which are water soluble can conduct electricity well enough that static build-up is usually not a concern. Bonding is achieved by making an electrical connection from one metal container to the other by means of a bonding wire or strap attached to both containers. In a flammable liquid storage area, drums should also be grounded during dispensing. Drums are grounded by connecting the container to an already grounded object that will conduct electricity (e.g. metal water piping, grounded metal building framework). Ensure all grounding and bonding connections are made to bare metal.

Static electricity can also build up in plastic or other non-conductive containers. The splashing and turbulence of the liquid can cause a static charge to build up in the liquid. To minimize static build-up, use a slow pour rate and limit freefall when transferring flammable liquids.

Highly Reactive and Explosive Chemicals

Highly reactive and explosive chemicals are those that may be detonated by mechanical shock, elevated temperature, or chemical action to produce a violent release of energy and a large volume of gas, heat, and possibly toxic vapours. In many cases, it is not the total energy released that is a concern, but the extremely high rate of reaction. Even milligram quantities of some highly reactive substances can turn small fragments of glass or other material into potentially seriously injurious or lethal missiles. It is therefore very important to use only minimum amounts of these materials with adequate shielding and personal protective equipment.

Some examples of highly reactive and explosive chemicals encountered in the lab include:

- **Shock sensitive materials -** Examples include acetylides, azides, organic nitrates, nitro compounds, perchlorates and peroxides.
- **Peroxides** - Catalysis of the violent decomposition of hydrogen peroxide by metal ions. The instantaneous, heat induced decomposition of some peroxides. Many peroxides are highly explosive.
- **Highly Reactive or Unstable Chemicals -** Vigorous polymerization, decomposition, condensation or self reactivity of highly reactive chemicals.
- **Water Reactive Chemicals -** Active metals such as sodium, magnesium, lithium, and potassium are serious fire and explosion hazards due to reactivity with water and alcohols.
- **Oxidizers -** Violent reaction of oxidizing agents (halogens, oxyhalogens, permanganates, nitrates, chromates, persulfates, peroxides, perchloric acid, nitric acid, metal dust) with reducing materials, trace metals and ordinary combustibles.

Precautions to take when working with highly reactive or explosive materials:

- Plan experiments to minimize the need for handling of reagents and equipment while experiment is in progress.
- Assemble apparatus in such a way that if the reaction starts to run away, immediate removal of heat source, cooling or quenching of the reaction, cessation of reagent addition, and closing of the fume hood sash are possible.
- Use barriers such as shields, barricades and guards. These should completely surround the hazardous area. Note that a laboratory fume hood sash is designed to protect against chemical splash and minor explosions. Additional shielding will be necessary for higher hazard work.
- Use the smallest quantities of reactants necessary.
- Wear a face shield when working with explosive or highly reactive chemicals. Wear heavy gloves if necessary to reach behind a shielded area while a hazardous experiment is underway.
- All personnel in the lab should wear a lab coat and safety glasses or goggles.

Corrosives

Corrosive chemicals can be defined as those which result in an immediate, acute erosive effect on body tissue. Strong acids and bases of 1M or greater concentration, non-metal halides dehydrating agents, halogens, and oxidizing agents are all corrosive.

Precautions to take when working with corrosive chemicals include:

- Always add acid to water, not water to acid.
- Wear eye protection and gloves whenever working with any corrosive. In some instances, a face shield and acid resistant rubber apron will be warranted.
- Ensure that an eyewash and safety shower are available.

Compressed Gases

Compressed gases differ from other hazardous materials in the laboratory because of the additional physical hazard represented by the presence of a high-pressure vessel in the laboratory. A cylinder can easily become a lethal missile if mishandled.

Handling precautions:

- Transport cylinders using a suitable handcart equipped with a restraining strap.
- Never drag, roll or slide cylinders. The only exception is to roll a cylinder on its bottom edge ("milk churning") to move it a very short distance, such as from a hand cart to a wall strap.
- Ensure that the valve cap is in place during transport, and remove it only after the cylinder is securely strapped to a fixture or wall.
- Use only Compressed Gas Association (CGA) approved regulators. Regulators are gas specific and should be used only with the gases for which they were designed. Do not use an adapter or resort to cross threading to get a regulator to fit.
- Do not lubricate oxygen regulators, as the cylinder contents may oxidize the oil or grease and cause an explosion.
- When opening a gas cylinder valve, open it completely and then close it half a turn. If this is done, confusion regarding whether or not a cylinder is open or closed will be eliminated – a valve with "play" will be open, a valve without "play" is known to be closed.
- Use the cylinder valve, not the regulator, to shut off the gas.

Flammable gases should have a flash arrestor installed in the line to prevent flashback in the event of fire. All cylinders and gas lines and equipment used with flammable gases should be bonded and grounded to avoid the possibility of static ignition.

Check cylinders, connections, hoses and gas lines regularly for leaks. Use a commercial leak detector or leak-test solution, or a soapy water solution around all joints and watch for bubbles. Should a leak be detected, shut off the gas before attempting any repairs. If shutting off the cylinder valve does not stop the leak, treat the situation as an emergency uncontrolled release.

To prevent possibly dangerous flash back or back flow of air or other contaminants, cylinders should not be completely emptied. Discontinue use of a cylinder when the pressure drops to 172kPa (25psi). When removing a cylinder from use:

- Close the main valve.
- Bleed the system.
- Shut off and remove the regulator, and replace the valve cap.
- Mark the cylinder "empty" or "MT", and return to the appropriate storage area for pickup by the supplier.

Cryogenic Materials

Cryogenic materials (or cryogens) are defined as those liquids or solids with a boiling point less than -73^{o}C. In the laboratory, the most common cryogenics are liquid nitrogen, liquid helium, and dry ice, dry ice /organic solvent slush mixtures. Cryogens are normally gases at standard temperature and pressure. They all have two properties in common; they are extremely cold, and small amounts of liquid expand rapidly into very large amounts of gas. This rapid expansion to gas can result in pressure build-up in vessels containing cryogens, and also presents the danger of asphyxiation as oxygen is displaced in enclosed spaces or small rooms.

Wear full coverage clothing with no cuffs, pockets, etc. which could catch the liquid in the event of a spill. Jewellery such as rings and bracelets should not be worn because it may freeze to the skin. Use insulating gloves that are impervious to liquid but that are loose fitting so they can be thrown off quickly if any liquid spills in them. Always wear chemical splash goggles or a face shield if there is a chance the cryogenic liquids may splash and froth on contact with a warmer surface.

Handle these materials carefully, using appropriate personal protective equipment.

Many materials become brittle due to the extreme cold. Only materials designed for low temperatures should be used.

Store and transport cryogens only in Dewar flasks designed for that purpose. Always fill Dewar flasks slowly to reduce temperature shock effects and minimize splashing. Whenever possible, pre-cool the vessel. Similar precautions should be taken when cooling an object by immersion in a liquid cryogen. Cryogens should be kept covered to prevent condensation of atmospheric moisture, which can be especially dangerous if a plug forms in a narrow vessel neck, resulting in an over-pressurized vessel.

When using cold traps, ensure they do not become plugged with frozen material. When using liquid nitrogen or helium as the coolant, there is the added danger of oxygen condensing from the air. If this occurs, there is the danger of a serious explosion if any organic material is present as well. Be alert for the telltale blue, water-like appearance of liquid oxygen. If the presence of liquid oxygen is suspected, isolate the area and wait for the oxygen to vaporise and dissipate.

SPILL RESPONSE GUIDE

When a chemical spill occurs, personnel at the scene must take immediate action to reduce the consequences of the spill. The type and quantity of material spilled will determine the steps to be taken to reduce the risks associated with the spill.

The basic steps are:

- Stay clear and warn others
- Assist injured or contaminated persons
- Assess the situation – is this an emergency?
- Get help for all but minor spills
- Control and clean up the spill
- Report the spill

Type of chemical spilled	**Example of this type of chemical**	**Amount of spilled chemical which constitutes an emergency**
Low hazard material	Solids – sodium chloride, calcium chloride Liquids – ethylene glycol, paint	Normally not considered to be an emergency
Flammable liquids – materials which have flash points below 37.8 ^{o} C	ethanol, methanol, hexane, diethyl ether, toluene	500 ml or more
Combustible and other non-flammable organic liquids – materials which have flash points above 37.8 but below 93.3	Cyclohexanol, formic acid	1 litre or more
Acid – solid or liquid	Hydrochloric acid,	1 litre of liquid, 500 grams of solid
Alkali and Base compounds	Sodium hydroxide, potassium hydroxide	1 litre of concentrated liquid base or 500 g of solid base
Mercury		30 ml
Oxidizer	Hydrogen peroxide, permanganate compounds	1 litre of liquid or 500 g of solid
Highly toxic material	Carcinogens, mutagens, cyanide compounds	100 ml of liquid, 50 grams of solid
Air and Water Reactive	Alkali metals, sodium borohydride	Any amount

SPILL KITS

Spills kits can be assembled from individual parts or suitable spill kits may be purchased from most chemical or safety supply companies. If you do chose to purchase a commercial kit, however, ensure that it contains all the necessary items as listed below. In addition, note that most commercial spill kits and the lists below are generic; it is important that spill kits be tailored to meet the specific spill control needs of each lab, work area, or department.

Small Chemical Spill Kit
A small chemical spill kit should be available in each lab or work area that uses chemicals. It can be used for immediate response to most spills, and to clean up small, low hazard spills that may occur and do not require specialized personal protective equipment or spill control supplies. Although most small spill kit components are common items found throughout the lab, there must be a consolidated spill kit for emergency use.

Personal Protective Equipment for a small spill kit should include:
- Chemical Splash Goggles
- Lab Coat
- Heavy Nitrile or Neoprene Gloves

Spill clean up equipment should include:
- Plastic Dust Pan & Brush
- Heavy Plastic Bags (at least 3 mil thickness)
- Universal Spill Absorbent (1:1:1 mix of sodium carbonate: kitty litter: sand), Spill Pillows, or other suitable spill absorbent (enough to absorb a spill of the largest container in the work area)
- Other absorbents / neutralizers as required for the chemicals in the lab

Mercury Spill Kit
All areas that work with elemental mercury or mercury containing equipment (e.g. thermometers) should have a mercury spill kit available. The following list includes only those items specific to cleaning up a mercury spill, and must be used in conjunction with other items from a large/departmental spill kit.
Have available:
- Mercury clean-up supplies (ex: Merconwipes™, Merconvap™, amalgamating powder, etc)
- Mercury aspirator, disposable pipettes & bulbs, or similar equipment
- Razor blades or scrapers
- Plastic, zip-lock bags
- Flashlight
- Mercury Vapor Respirator Cartridges

MSDS DEFINITIONS

Acute Exposure - a short-term exposure usually occurring at high concentration.

Acute Health Effect - an effect that develops either immediately or a short time after exposure.

Autoignition Temperature - the minimum temperature required to initiate or cause self-sustained combustion, in the absence of a spark or flame.

Biohazardous Infectious Material - a material that contains organisms and the toxins produced by these organisms that have been shown to cause disease or are believed to cause disease in either humans or animals.

Boiling Point - the temperature at which a liquid changes from a liquid to a gas, at normal atmospheric pressure.

Carcinogens - agents/compounds that may induce cancer in humans.

CAS Registry Number - a number assigned to a material by the Chemical Abstracts Service (CAS) to provide a single unique identifier.

Chemical Formula - sometimes called the molecular formula, indicates the elements that make up a chemical.

Chemical Name - a proper scientific name for the active ingredient of a product.

Chronic Exposure - a long-term exposure, usually occurring at low concentrations.

Chronic Health Effects - an effect that appears a long time after exposure.

Coefficient of Oil/Water Distribution - the ratio of the solubility of the chemical in an oil to its solubility in water.

Combustible Liquid - a liquid which has a flash point above 37.8 C.

Compressed Gas - a material which is a gas at normal room temperature (20 C) and pressure but is packaged as a pressurized gas, dissolved gas or gas liquified by compression or refrigeration.

Condensation - the process of reducing from one form to another denser form such as steam to water.

Controlled Products - Under the Controlled Products Regulation, a controlled product is defined as a material, product or substance which is imported or sold in Canada and meets the criteria for one or more of the following classes: -

Class A - Compressed Gas
Class B - Flammable and Combustible Material
Class C - Oxidizing Material
Class D - Poisonous and Infectious Material
Class E - Corrosive Material
Class F - Dangerously Reactive Material

Corrosive Material - a material that can attack (corrode) metals or cause permanent damage to human tissues such as skin and eyes on contact.

Cryogenics - materials which exist at extremely low temperatures, such as liquid nitrogen.

Dangerously Reactive Materials - materials that may undergo vigorous condensation, decomposition or polymerization. They may react violently under conditions of shock or increase in pressure or temperature. They may also react vigorously with water or water vapour to release a toxic gas.

Decomposition - the breakdown of a substance, often due to heat, decay or other effect, with the release of other compounds such as vapours or gases that may be flammable or toxic.

Density - the weight of a material in a given volume. It is usually given in grams per millilitre (g/ml).

Dilution Ventilation - dilution of contaminated air with uncontaminated air in a general area, room or building for the purposes of health hazard or nuisance control, and/or for heating and cooling.

Dose - amount of the agent that has entered the body through the various routes of entry.

Evaporation Rate - the rate at which a liquid changes to vapour at normal room temperature.

Explosive (Flammable) Limits - the lower explosive (flammable) limit (LEL) is the lowest concentration of vapour in air which will burn or explode upon contact with a source of ignition. The upper explosive (flammable) limit (UEL) is the highest concentration of vapour in air which will burn or explode upon contact with a source of ignition.

Explosive (Flammable) Range - the range between the lower explosive limit (LEL) and the upper explosive limit (UEL).

Exposure Limits - established concentrations which, if not exceeded, will not generally cause adverse effects to the worker exposed. Exposure limits differ in name and meaning depending on origin

TWAEV Time-Weighted Average Exposure Value: The average airborne concentration of a biological or chemical agent to which a worker may be exposed in a work day or a work week.

STEV Short Term Exposure Value: - The maximum airborne concentration of a chemical or biological agent to which a worker may be exposed in any 15 minute period, provided the TWAEV is not exceeded.

CEV Ceiling Exposure Value: The maximum airborne concentration of a biological or chemical agent to which a worker may be exposed at any time.

SKIN: This notation indicates that direct or airborne contact with the product may result in significant absorption of the product through the skin, mucous membranes or eyes. Inclusion of this notation is intended to suggest that preventative action be taken against absorption of the agent through these routes of entry.

Threshold Limit Values (TLVs) are exposure guidelines developed by the American Conference of Governmental Industrial Hygienists (ACGIH). They have been adopted by several Canadian governments and others as their legal limits. They are expressed as follows:-

TLV-TWA Threshold Limit Value - Time-Weighted Average: The time-weighted average concentration for a normal 8 hour work day and a 40 hour work week, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect.

TLV-STEL Threshold Limit Value - Short Term Exposure Limit: a 15 minute time-weighted average exposure which should not be exceeded at any time during a work day even if the 8 hr TWA is within the TLV. Exposures at the STEL should not be repeated more than 4 times a day and there should be at least 60 minutes between successive exposures at the STEL.

TLV-C Threshold Limit Value - Ceiling: the concentration that should not be exceeded during any part of the working exposure.

Other exposure limits include the Permissible Exposure Limits (PEL) which are legal exposure limits in the United States.

Flammable Limits - "See Explosive Limits".

Flammable Substance - one that will readily catch fire and continue to burn in air if exposed to a source of ignition.

Flammable Aerosol - a material that is packaged in an aerosol container which can release a flammable material.

Flammable Gas - a gas which can readily catch fire and continue to burn.

Flammable Liquid - a material that gives off a vapour which can readily catch fire and continue to burn. A flammable liquid has a flashpoint below 37.8 C.

Flammable Solid - a material which can readily catch fire and continue to burn vigorously and persistently. This may occur from friction, absorbing moisture, from spontaneous chemical change, or by retaining heat from manufacturing or processing.

Reactive Flammable Material - a material which is a dangerous fire risk because it can react readily with air or water.

Flashback - this occurs when a trail of flammable material is ignited by a distant source of ignition. The flame then travels back along the trail of gas, vapour or aerosol to its source.

Flashpoint - the lowest temperature of a liquid at which it gives off enough vapour to form an ignitable mixture of vapour and air immediately above the liquid surface.

Freezing Point - the temperature at which a liquid becomes a solid, at normal atmospheric pressure.

Hazard- the potential for harmful effects.

Hazardous Combustion Products - chemicals which may be formed when a material burns. These chemicals may be flammable, toxic or have other hazards.

Hazardous Decomposition Products - formed when a material decomposes (breaks down) because it is unstable, or reacts with materials such as water or oxygen in air.

Hazardous Ingredient - Under the Hazardous Products Act, a chemical must be listed in the Hazardous Ingredients section of a MSDS if:

- it meets the criteria for a controlled product;
- it is on the Ingredient Disclosure List;
- there is no toxicological information available; or
- the supplier has reason to believe it might be hazardous.

Hazardous Polymerization - Polymerization is a process of forming a polymer by combining large numbers of chemical units or monomers into long chains (polyethylene from ethylene or polystyrene from styrene). Uncontrolled polymerization can be extremely hazardous. Some polymerization processes can release considerable heat or can be explosive.

Ingestion - means taking a material into the body by mouth (swallowing).

Inhalation - means taking a material into the body by breathing it in.

Irritant - some sort of aggravation of whatever tissue the material comes in contact with.

LC50 - the concentration of a material in air which causes death in 50% of a group of test animals. The material is inhaled over a set period of time, usually 4 hrs. LC stands for lethal concentration.

LD50 - the weight of material which causes the death in 50% of a group of test animals. It is usually expressed in weight of material per weight of test animal. LD stands for lethal dose.

LEL (Lower Explosive Limit) - See "Explosive Limits".

Local Exhaust Ventilation - involves the capture of pollutants at the source.

Material Causing Immediate and Serious Toxic Effects - classified under "Poisonous and Infectious Material" as toxic or very toxic based on information such as the LD50 or LC50.

Material Causing Other Toxic Effects - classified under "Poisonous and Infectious Material" as a material causing toxic effects such as skin or respiratory sensitization, carcinogenicity, mutagenicity, etc.

Melting Point - the temperature at which a solid material becomes a liquid.

Mutagen - an agent that affects the genes or cells of the exposed people in such a way that it may cause cancer in the exposed individual or an undesirable mutation to occur in some later generation.

NA Number - See "UN number".

Odour Threshold - the airborne concentration, usually in part per million, at which an odour becomes noticeable.

Oxidizing Material - gives up oxygen easily or can readily oxidize other materials.

Permissible Exposure Limits (PEL) - legal limits in the U.S.A. set by the Occupational Safety and Health Administration (OSHA).

pH - a measure of the acidity or basicity (alkalinity) of a material when dissolved in water.

Polymer - a natural or man-made material formed by combining units, called monomers, into long chains.

Polymerization - a process of forming a polymer by combining large numbers of chemical units or monomers into long chains.

Parts Per Million (ppm) - represents the concentration of gases or vapour in air. For example, 1 ppm of a gas means that 1 unit of the gas is present for every 1 million units of air.

Sensitization - the development, over time, of an allergic reaction to a chemical.

Solubility - the ability of a material to dissolve in water or another liquid.

Solvent - a material which is capable of dissolving another chemical.

Specific Gravity - the density of a liquid compared to the density of an equal amount of water.

Stability - the ability of a material to remain unchanged in the presence of heat, moisture or air.

Teratogen - agents or compounds that a pregnant woman takes into her body that generate defects in the fetus.

TLV - See "exposure Limits".

Toxicity - ability of a substance to cause harmful effects.

Trade Name - the name under which a product is commercially known.

TWA - See "Exposure Limits".

UEL (Upper Explosive Limits) - See "Explosive Limits".
UN Number - a four digit number assigned to a potentially hazardous material or class of materials. UN (United Nations) numbers are internationally recognized and are used by fire fighter and other emergency response personnel for identification of materials during transportation emergencies. NA (North American) numbers are assigned by Transport Canada and the US Department of Transport to materials they consider hazardous and to which a UN number has not been assigned.
Vapour - a gaseous form of a material which is normally solid or liquid at room temperature and pressure.
Vapour Density - the density of a vapour compared to the density of an equal amount of air.
Vapour Pressure - the pressure of a vapour in equilibrium with its liquid or solid form.
Ventilation - the movement of air.
Volatility - the ability of a material to evaporate.