UNIVERSITY OF THE FRASER VALLEY

Laboratory Safety Manual

Occupational Health and Safety Office

The purpose of this manual is to outline hazards and safety processes that are required to maintain a safe environment in UFV laboratories. This manual provides a set of minimum standards and practices for the safe and healthy operation of a laboratory and applicable workplaces on UFV campuses.

01/03/2013

EMERGENCY CONTACTS

Any disaster, unusual occurrence, utility malfunction, or equipment failure that presents imminent danger to human health or property is an emergency and is to be reported immediately by telephone.

General Contact Numbers

Fire/Police/Ambulance	9-1-1

First Aid

All Campuses	Local 7770 or 1-855-282-7770
Abbotsford Poison Control Centre	1-800-567-8911

Security

All Campuses	Local 7770 or 1-855-282-7770

Emergency Contact

All Campuses	Local 7770 or 1-855-282-7770

University of the Fraser Valley Facilities Dept Contacts

Occupational Health and Safety Office	604-854-4534
Biosafety Officer – Abbotsford Campus	Local 2837 or 604-792-0025
Radiation Safety Officer – Abbotsford Campus	604-504-7441 EXT 4307

Table of Contents

1 UNIVERSITY OF THE FRASER VALLEY HEALTH AND SAFETY

1.1 University Health and Safety Policy Statement

University of the Fraser Valley is committed to providing a safe, healthy and environmentally responsible workplace and learning environment for its employees and students. UFV believes that no task or activity is so important that it can't be done in a safe manner and in compliance with all applicable safety codes and standards.

University of the Fraser Valley, therefore, resolves to pursue any reasonable course of action to ensure achievement of these standards, including the enforcement of all applicable health, safety and environmental protection regulations, prompt actions to correct unsafe conditions, and continued safety and education for all concerned.

It is therefore the policy of UFV to:

1. Protect the safety of employees, students and visitors against accidents and occupational hazards.

2. Comply with all relevant regulations and standards relating to occupational health and safety.

3. Give priority to safe working conditions and job safety practices in the planning, budgeting, direction and implementation of UFV activities

Every UFV Senior Administrator, Dean, Director, Manager and Supervisor is accountable to maintain the standards that are required to meet this policy. Standards will apply to establishing annual accident prevention objectives and related action plans, maintaining facilities and equipment, ensuring that employees understand what is expected of them in accident prevention performance, and endorsing and supporting the OH&S Program.

Each instructional employee or supervisor within the Faculty/Division will ensure that the pertinent regulations and safe work procedures are followed by all employees or students, that adequate training is provided to the employee or student and that safe work procedures are implemented on the worksite.

All employees and students are responsible for knowing and observing pertinent regulations in the work area and for following safe work procedures. Each employee and student is expected to report unsafe conditions and unsafe behaviour to his/her Instructor or Supervisor.

Your cooperation in observing the proper health, safety and environmental protection regulations is vital to the success of this objective. It is the responsibility of all employees or students to follow safe

work procedures, to observe health and safety regulations and to constantly work towards improving health and safety standards at the University of the Fraser Valley.

1.2 Introduction of Laboratory Safety at UFV

The laboratory environment can be a hazardous place to work. In such environments, individuals are confronted with a wide array of chemicals, instrumentation, energy sources, and/or biological agents. It is important to understand and appreciate what these risks are, and how to work safely with them in a laboratory environment.

The purpose of this manual is to outline hazards and safety processes that are required to maintain a safe environment in UFV laboratories. This manual provides a set of minimum standards and practices for the safe and healthy operation of a laboratory at UFV. Following the requirements set out in this manual will help meet the requirements of the British Columbia – Occupational Health and Safety Act, WHMIS legislation in Canada, and UFV Policies.

This manual was developed to cover safety in all laboratories on all campuses. Faculty departments may have additional procedures applicable to its own situation and work. Revisions and updates may continue to be made to this manual as teaching programs evolve. Please contact the Associate Director, Occupational Health and Safety at UFV, with any comments or suggestions or updates you may have about the manual.

This manual is intended to:

- Define health and safety responsibilities within the UFV community;
- Explain basic emergency procedures;
- Provide information and standards for the healthy and safe operation of a laboratory;
- Outline any policies that are applicable to Biology, Chemistry, Geology, Physics, and Visual Arts.

This manual attempts to be all-encompassing for laboratory safety. However, it should be kept in mind that not every possible emergency scenario can be predicted or foreseen ahead of time. Laboratory safety requires constant due diligence and exercise of common sense by each individual working in such facilities.

2 RIGHTS AND RESPONSIBILITIES

All workplace parties have rights as well as duties under British Columbia Occupational Health and Safety Regulation (OHSR). According to this regulation, employers, supervisors and workers all have a role to play in ensuring a safe and healthy workplace.

2.1 General Duties of Employers

- Employer must:
    - Ensure the health and safety of;
        - all workers working for that employer;
        - any other workers present at a workplace at which that employer's work is being carried out; and
        - comply with OHSR and any applicable regulations.
- Without limiting the above, employer must also:
    - remedy any workplace conditions that are hazardous to the health or safety of the employer's workers;
    - ensure that the employer's workers;
        - are made aware of all known or reasonably foreseeable health or safety hazards to which they are likely to be exposed by their work,
        - comply with OHSR, the regulations and any applicable orders, and
        - are made aware of their rights and duties under OHSR and the regulations;
    - establish occupational health and safety policies and programs in accordance with the regulations;
    - provide and maintain in good condition protective equipment, devices and clothing as required by regulation and ensure that these are used by the employer's workers;
    - provide to the employer's workers the information, instruction, training and supervision necessary to ensure the health and safety of those workers in carrying out their work and to ensure the health and safety of other workers at the workplace;
    - make a copy of OHSR and the regulations readily available for review by the employer's workers and, at each workplace where workers of the employer are regularly employed, post and keep posted a notice advising where the copy is available for review;
    - consult and cooperate with the joint committees and worker health and safety representatives for workplaces of the employer; and
    - cooperate with the Board, officers of the Board and any other person carrying out a duty under OHSR or the regulations.

2.2 General Duties of Supervisors

- Supervisor must:
    - ensure the health and safety of all workers under the direct supervision of the supervisor;
    - be knowledgeable about OHSR and regulations applicable to the work being supervised; and
    - comply with OHSR, the regulations and all applicable safety policies.
- Without limiting the above, supervisor must also:
    - ensure that the workers under his or her direct supervision;
        - are made aware of all known or reasonably foreseeable health or safety hazards in the area where they work, and
        - comply with OHSR, the regulations and any applicable orders;
    - consult and cooperate with the joint committee or worker health and safety representative for the workplace; and
    - cooperate with the Board, officers of the Board and any other person carrying out a duty under OHSR or the regulations.

2.3 General Duties of Workers

- Worker must:
    - take reasonable care to protect the worker's health and safety and the health and safety of other persons who may be affected by the worker's acts or omissions at work; and
    - comply with OHSR, the regulations and any applicable orders.
- Without limiting the above, worker must also:
    - carry out his or her work in accordance with established safe work procedures as required by OHSR and the regulations;
    - use or wear protective equipment, devices and clothing as required by the regulations;
    - not engage in horseplay or similar conduct that may endanger the worker or any other person;
    - ensure that the worker's ability to work without risk to his or her health or safety, or to the health or safety of any other person, is not impaired by alcohol, drugs or other causes;
    - report to the supervisor or employer;

- any contravention of OHSR, the regulations or an applicable order of which the worker is aware, and
- the absence of or defect in any protective equipment, device or clothing, or the existence of any other hazard, that the worker considers is likely to endanger the worker or any other person,

- cooperate with the joint committee or worker health and safety representative for the workplace; and
- cooperate with the Board, officers of the Board and any other person carrying out a duty under OHSR or the regulations.

2.4 Rights of Workers

The OHSR gives workers in British Columbia three rights. They are:

- Right to know – about workplace hazards (e.g. WHMIS)
- Right to participate – in health and safety matters (e.g. Joint Occupational Health and Safety Committee)
- Right to refuse – work they deem to be unsafe

2.5 Students

Students also have a role to play in laboratory safety. They must:

- Follow all applicable safety procedures as outlined in the OHSR, this manual and by the supervisor.
- Attend and complete all applicable health and safety training courses as required by the supervisor and/or UFV policies.
- Wear any equipment, protective devices or clothing that the University requires.
- Immediately report any injuries and/or incidents to the supervisor.
- Report all unsafe acts and conditions to the supervisor.
- Not remove or alter any protective device.
- Not operate or use any equipment in such a manner as to endanger him/herself or someone else.
- Determine, in consultation with their supervisor, the potential hazards, appropriate safety precautions and proper waste disposal techniques before beginning any new project or experiment.
- Right to refuse-work they deem to be unsafe.

Note: All of the points listed above also apply to workers.

2.6 Work Refusal

The right to refuse unsafe work is a fundamental right held by workers and is an integral element in ensuring work is carried out safely. This right allows workers who reasonably believe work is unsafe to ensure their employer investigates and, where necessary, corrects the hazard. A flow-chart is included in APPENDIX 1 - OHSR FLOWCHARTAPPENDIX 1; however, it is recommended that the OHSR be referenced for greater detail.

3 GENERAL EMERGENCY PROCEDURES

All personnel and students in the laboratory must be familiar with the proper procedures and call 911 in the event of an emergency. Note that all serious incidents must be also be reported immediately by calling Campus Security at 7770. Additionally, all health and safety incidents involving staff, students, tenants, contractors, or visitors which occur on University owned or managed premised, or during the course of University organised activities must be reported using the Incident Report Form. This form and a copy of Incident Reporting Process are available online at:

www.ufv.ca/ohs/Incident_Reporting.htm

3.1 First Aid

Know how to handle emergency situations before they occur:

- Become familiar with the properties of the hazardous products used in your area.
- Familiarize yourself with the contents of the first aid kit and learn how to use them. Keep instructions readily available and easy to understand.
- Locate and know how to test and operate emergency equipment, such as showers and eyewashes, in your area.
- Learn first aid: Please contact OHSO for more information.

The emergency first aid procedures described below should be followed by a consultation with a physician for medical treatment.

3.1.1 Burns

In the laboratory, thermal burns may be caused by intense heat, flames, molten metal, steam, etc. Corrosive liquids or solids such as bases and acids can cause chemical burns; first aid treatment for chemical burns is described in Section 3.3 below. In electrical burns, electrical current passing through the body generates heat.

3.1.2 Burns to the skin

First aid treatment of skin burns encompasses the following:

- If the burn is electrical in origin, ascertain that the victim is not in contact with the power supply before touching him/her. If the victim remains in contact with a power source, unplug the device or shut off the main power switch at the electrical distribution panel.
- Dial 911 if the burn is serious. Seek immediate medical treatment for all electrical burns, even if they don't appear to be serious.
- Remove jewellery, including watches, from the burned area.
- Expose the burnt area, but avoid removing clothes that are stuck to the skin.
- If possible, immerse burnt surfaces in cold water for at least 10 minutes, or apply cold wet packs.
- Avoid applying lotions, ointments or disinfectants to a burn. First and second degree burns can be washed with soap and water after the cool down period.
- Cover first and second degree burns with a moist bandage; apply dry compresses to third degree burns and to entry and exit wounds of electrical burns.
- Do not burst blisters, as they form a natural barrier against infection.

3.1.3 Burns to the eyes

Burns to the eyes may be caused by chemical substances, heat (hot liquids, steam, open flames, molten metal, etc.), or radiation from welding procedures, laboratory lamps and lasers. Burns caused by ultraviolet, visible or near-infrared radiation may not produce symptoms until 6-8 hours after exposure. First aid procedures for chemical burns to the eyes are described in Section 3.3 below. General first aid procedures for thermal and radiation burns to the eyes are as follows:

- Prevent the victim from rubbing or touching the eyes.
- For heat burns, flush the eyes with cool water until the pain subsides.
- Cover the eyes with dry sterile gauze pads; apply a wet compress to the eyes if it is too painful to close them.
- Send the victim for medical care. If the burn is the result of exposure to a laser beam, advise emergency medical personnel of the characteristics of the laser and the distance between the victim and the laser.

3.2 Cuts

First aid treatment for minor scrapes, scratches, cuts, lacerations or puncture wounds include the following:

- Wash the wound and surrounding area with mild soap and running water.
- Remove any dirt around the wound.
- Cover with an adhesive dressing or gauze square taped on all sides with adhesive tape.

- Wounds caused by dirty, soiled or grimy objects should be examined by a physician, who will determine whether a tetanus immunization is needed.
- If the wound was caused by an object that has contacted human blood or body fluids, the victim must be seen by a physician immediately, as immunization or post-exposure prophylaxis may be required.
- If a wound is bleeding profusely, the first aider should attempt to stop the bleeding as quickly as possible:

    - Elevate the injured area above the level of the heart, if possible, in order to reduce the blood pressure to the area of the wound.
    - Apply direct pressure to the wound unless an object is protruding from it (in this situation, apply pressure around the injury). Direct pressure can be applied with the fingers of the hand, the palm of the hand or with a pressure dressing.
    - If bleeding cannot be controlled with direct pressure, apply pressure to the arteries supplying the injured area. This involves compressing the artery between the wound and the heart, against a bone.
    - Do not remove a dressing that has become soaked with blood, as this may interrupt the clotting process; apply an additional dressing on top of the first.
    - Avoid over-tightening of the dressing; i.e., do not cut off the blood circulation to limbs.
    - As a tourniquet completely stops the flow of blood to beyond the point of application, it should be applied only as a last resort, as in the case of a severed limb.

3.3 Chemical Splashes to the Skin or Eyes

For splashes to the skin:

- If the splash affects a large area of skin, go to the nearest shower and rinse thoroughly for at least 20 minutes; remove contaminated clothing while in the shower
- For splashes involving a small skin area, proceed to the nearest drench hose, remove contaminated clothing and jewellery and rinse for 15 minutes.

For splashes to the eyes:

- Go to the nearest eyewash and rinse for at least 20 minutes.
- If you are wearing contact lenses, remove them as quickly as possible, while continuing to flush.
- Hold your eyelids open with your fingers.
- Roll your eyeballs, so that water can flow over the entire surface of the eye.
- Lift your eyelids frequently to ensure complete flushing.
- Cover the injured eye with dry sterile gauze pads while waiting for medical attention.

3.4 Poisoning

As described in Section 8.1, toxic substances can enter and poison the body by inhalation, absorption through the skin, ingestion or injection. When assisting a victim of poisoning:

- Call for an ambulance (dial 911) for serious poisoning.
- Ensure that the area is safe to enter before attempting to aid the victim.
- Move the victim away from the contaminated area and provide first aid as required.
- Do not induce vomiting unless advised to do so by Abbotsford Poison Control Centre (1-800-567-8911).
- Provide emergency medical personnel with the MSDS for the poisonous product. If the victim was overcome by an unknown poison and has vomited, provide the ambulance technicians with a sample of the vomitus.
- Always ensure that the victim receives medical attention, even if the exposure seems minor.

3.5 Fires

The immediate response depends on the size of the fire. Laboratory personnel should attempt to extinguish a fire only if it is clearly safe to do so (Refer to Section 10).

3.5.1 Suspected fires

All members of the University should familiarize themselves with the locations of the fire alarms and evacuation routes in the areas that they occupy. Anyone discovering smoke, strong smell of burning or smell of an unusual nature, should immediately:

- Inform Security, (Local 7770).
- Alert the Floor Warden.

3.5.2 Known fires

- Shout "FIRE!" repeatedly to give the alert.
- Pull the fire alarm.
- Telephone the City Fire Department from a safe location by dialling 911.
- Evacuate the premises in a swift, orderly fashion using the stairways and/or fire escapes, but NOT the elevators, and following the instructions of Evacuation Monitors.
- Inform the Floor Warden of the location, magnitude and nature (e.g. electrical) of the fire, the open evacuation routes, individuals requiring assistance, and other pertinent details.
- Once outside the building, move away from the doors to enable others to exit.

3.5.3 Clothing fires

If your clothing should catch fire, it is important not to run, as this would provide additional air to support the flames. Remember the "Stop, Drop and Roll" rule:

Stop *where you are*
Drop *to the floor, and*
Roll *to smother the flames*

As soon as the flames are extinguished, go to the nearest emergency shower to cool burned areas with copious amounts of water. If someone else is on fire:

- Immediately immobilize the victim and force him/her to roll on the ground to extinguish the flames.
- Assist in smothering the flames, using whatever is immediately available, such as a fireproof blanket or clothing.
- Give appropriate first aid (refer to Section 3.1.1).

3.6 Hazardous Chemical Spills

In the event of a spill of a hazardous (volatile, toxic, corrosive, reactive or flammable) chemical, the following procedures should be followed:

- If there is fire, pull the nearest alarm. If you are unable to control or extinguish a fire, follow the fire evacuation procedures, as described by UFV's Emergency Procedures.
- If the spill is in a laboratory, shop or chemical storeroom:
    - Evacuate all personnel from the room
    - Be sure the hood/local exhaust is turned on
    - If flammable liquids are spilled, disconnect the electricity to sources of ignition if possible
    - Call the campus emergency telephone number (Local 7770) to request additional assistance if you cannot manage the clean-up yourself.
- If the spill is in a corridor or other public passageway:
    - Evacuate all people from the area and close off the area to keep others out.
    - Call the emergency telephone number (Local 7770), to have the air system in the area shut down (to prevent contamination of other areas) and to request additional assistance.

Note: For more detailed information on spill clean-up action, Refer to Section 8.6.3 and UFV Chemical Spill Response Guideline.

3.7 Natural Gas Leaks

Have the natural gas valves closed if you don't use gas. If you do use gas, and detect a natural gas smell:

- Check that all gas valves have been turned off.
- Call Local 7770 if the odour persists.
- Dial 911 if there is a confirmed gas leak.

4 GENERAL SAFETY PROCEDURES

There is a number of general health and safety principles that apply to working in any laboratory, which UFV employees and students should always keep in mind.

4.1 Preparing for Laboratory Work

Before starting to work in a laboratory, familiarize yourself with:

- The hazards of the materials in the lab, as well as appropriate safe handling, storage and emergency protocols. Read labels and material safety data sheets (MSDSs) before moving, handling or opening chemicals. Never use a product from an unlabelled container, and report missing labels.
- The agents, processes and equipment in the laboratory. If you are unsure of any aspect of a procedure, check with your supervisor before proceeding.
- The location and operation of safety and emergency equipment such as fire extinguishers, eye wash and shower, first aid and spill response kits, fire alarm pull stations, telephone and emergency exits.
- Emergency spill response procedures for the materials you will handle.
- Emergency reporting procedures and telephone numbers; and
- The designated and alternate escape routes.

4.2 During Laboratory Work

- Restrict laboratory access to authorized persons only. Children are not permitted in labs.
- Smoking; eating; drinking; storing food, beverages or tobacco; applying cosmetics or lip balm and handling contact lenses are not permitted in laboratories.
- Wear lab coats (knee length) and safety glasses in laboratories employing chemicals, biohazards or radioisotopes. Open shoes, such as sandals, should never be worn in the lab.
- Tie back or otherwise restrain long hair at all times when working in the laboratory.

- Keep work places clean and free of unwanted chemicals, biological specimens, radios, and idle equipment. Avoid leaving reagent bottles, empty or full, on the floor.
- Work only with materials once you know their flammability, reactivity, toxicity, safe handling and storage and emergency procedures.
- Consult material safety data sheets (MSDS) before working with hazardous chemicals or infectious material. Replace MSDS that are more than 3 years old.
- Prepare and maintain a chemical inventory for the lab.
- Never pipette by mouth; use mechanical transfer devices.
- Walk, do not run, in the lab.
- Keep exits and passageways clear at all times.
- Ensure that access to emergency equipment (eyewashes, safety showers and fire extinguishers) is not blocked.
- Report accidents and dangerous incidents ("near-misses") promptly
- Wash your hands thoroughly before leaving the laboratory.
- Conduct procedures involving the release of volatile toxic or flammable materials in a chemical fume hood (See Section 13).
- Perform procedures that liberate infectious bioaerosols in a biological safety cabinet.
- Handle all human blood and body fluids as if potentially infectious.

4.3 Cleaning Up Before Leaving

Perform a safety check at the end of each work session and before leaving the lab. Make sure to:

- Turn off gas, water, electricity, vacuum and compression lines and heating apparatus.
- Return unused materials, equipment and apparatus to their proper storage locations.
- Label, package and dispose of all waste material properly (Refer to Section 11).
- Remove defective or damaged equipment immediately, and arrange to have it repaired or replaced.
- Decontaminate any equipment or work areas that may have been in contact with hazardous materials.
- Leave behind protective clothing (lab coats, gloves, etc.) when leaving the laboratory.
- Close and lock the door to the laboratory if you are the last one to leave.

4.4 Evaluating Laboratory Hazards

There are many categories of hazards that might be encountered in a laboratory setting, and situations can change frequently. Even after you have identified and controlled all current risks, it is critical that you remain open to the possibility that new unexpected dangers can arise. Periodically verify that the laboratory safety information and other hazard warnings are current; advise OHSO whenever changes to the safety information are required.

Carry out weekly inspections on the condition of:

- Fire extinguishers
- Emergency wash devices such as eyewashes and drench hoses (run these for several minutes and update inspection tags)
- First aid kit contents
- Fume hood and other ventilation devices
- Tubing for circulating water, vacuum, gases
- Chemical storage compartments

Also, ensure that fire extinguishers and emergency showers are inspected, tested and tagged annually.

Among potential laboratory hazards, be alert for the following:

- Chemical products
    - flammable
    - toxic
    - oxidizing
    - reactive
    - corrosive
- Microbiological disease-producing agents and their toxins
    - viruses
    - bacteria
    - parasites
    - rickettsiae
    - fungi
- Physical or mechanical hazards
    - ionizing and non-ionizing radiation
    - electrical
    - poor equipment design or work organization (ergonomic hazards)
    - tripping hazards
    - excessive noise or heat
- Psychosocial conditions that can cause psychological stress and lead to accidents, incidents, and/or injury
    - perceived lack of psychological and physical safety support
    - negative or unhealthy culture and behaviours
    - unclear leadership and/or expectations

4.5 Working Alone Policy

Working alone is an unsafe practice at any time. However, if the nature of your work makes it unavoidable, take measures to ensure that others are aware of your location and have someone check in with you from time to time, either in person or by telephone.

Before conducting any work alone in a laboratory go through this checklist to determine if it is appropriate to proceed:

- Is your supervisor aware of your plans?
- Are there any hazardous experiments involved?

Examples:

  - High temperature
  - High vacuum
  - Extremely flammable materials (low flash point)
  - Poisonous materials
  - Scaling up i.e., higher quantities

- Have you reviewed your procedure with your supervisor?
- Do you have a written operating procedure?
- Are your apparatus and equipment in good working condition?
- Are you trained to carry out the work?
- Do you have a check-in/check-out procedure?
- Do you have an emergency contingency?
- Do you have access to a UFV telephone (rather than a cell) in case of an emergency?
- Does your door have a viewing window or other means of indicating someone is inside?
- Are you aware of the emergency evacuations procedure?
- Do you have access to a telephone in case of an emergency?
- Do you have access to a first aid kit?
- Do you have access to a spill kit?

5 WORKPLACE HAZARDOUS MATERIALS SAFETY INFORMATION SYSTEM (WHMIS)

The Workplace Hazardous Materials Information System (WHMIS) is a Canada-wide system for providing information on the safe use of hazardous materials, referred to as controlled products, in the workplace. It is intended to protect the health and safety of workers by promoting access to information on hazardous materials; this information is provided by means of product labels, MSDS and education programs. Controlled products are products, materials, and substances that are regulated by WHMIS legislation, based on their hazardous properties and characteristics. The WHMIS legislation falls under the Canada Hazardous Products Act.

WHMIS is governed by federal and provincial laws and regulations and any person supplying or using controlled products must comply with its requirements. At UFV, WHMIS legislation applies to all employees who work in areas where controlled products are used. WHMIS divides hazardous materials into six main categories or classes based on their characteristics, refer to APPENDIX 2 - WHMIS CLASSIFICATION. The main objectives of WHMIS are hazard identification and product classification. WHMIS achieves this goal through three main components: Labelling, MSDS and Training. All employees and students that require information on WHMIS training should contact the OHSO.

5.1 Labelling

Labels alert users to the dangers of the chemical product and basic safety precautions. It is imperative that all containers in laboratories be clearly identified.

WHMIS legislation dictates what information is required on a workplace label. Any controlled products, whether in transit, storage, or use, must be labelled. A label may be a mark, sign, stamp, device, sticker, ticket, tag, or wrapper and must be attached to, imprinted, stencilled, or embossed on the container of the controlled product. There are 2 types of labels prescribed under WHMIS regulation: supplier labels and workplace labels.

5.1.1 Supplier's labels

Suppliers are responsible for labelling WHMIS-controlled products. A supplier label must contain the following information:

- product identifier (name of product);
- supplier identifier (name of company that sold it);
- hazard symbols (WHMIS classification symbols) ;
- risk phrases (words that describe the main hazards of the product);
- precautionary statements (how to work with the product safely);
- first aid measures (what to do in an emergency);

- reference to the MSDS;
- be written in both official languages.

5.1.2 Workplace labels

A workplace label must appear on all WHMIS-controlled products when:

- controlled products are produced, manufactured or prepared (e.g., stock solutions) in the laboratory;
- the controlled product is transferred from the original container into another container; and
- the original supplier label becomes illegible or damaged or when it is removed.

A workplace label must contain the following information:

- product identifier (product name);
- information for the safe handling of the product; and
- reference to the MSDS.

A workplace label may contain the following information:

- WHMIS hazard symbols or other pictographs.

5.1.3 Laboratory sample labels

Laboratory samples are samples intended solely to be tested in a laboratory or used for educational or demonstration purposes. Laboratory samples do not include WHMIS-controlled products that are used by the laboratory for testing other products, materials or substances (e.g., buffer solutions).

The requirements for laboratory samples that are intended to be used in a laboratory immediately (same day) and solely by that person who prepared them include the following:

- clear and unambiguous label on the sample;
- a description of sample's contents must be readily available (e.g., noted in a lab book); and
- MSDS for the sample must be readily available.

Laboratory samples to be transported outside of a laboratory (e.g., sent elsewhere for analysis), including within UFV Campus must have a label affixed to it that contains the following information:

- product identifier (product name)
- owner's name (name of Laboratory Technician who prepared the sample)
- lab number
- contact telephone number of owner or Laboratory Technician

5.2 Material Safety Data Sheets (MSDS)

Material Safety Data Sheets (MSDS) provide more details than labels. They are technical bulletins that provide chemical, physical, and toxicological information about each controlled product, as well as information on precautionary and emergency procedures.

All containers of controlled products should be labelled with WHMIS compliant labels and be classified under MSDS.

Each laboratory should have its own MSDS database for controlled products used in the laboratory. These MSDS should be easily accessible in the laboratory and the database should be reviewed annually for completeness. The Facilities department should also receive a copy of the current MSDS. Refer to the facility floor plan for each of the individual laboratories for the MSDS storage location.

5.2.1 Supplier's responsibilities

Suppliers of WHMIS-controlled products are required to make available MSDS to the purchaser. The MSDS must be available in both official languages. Should any new information arise about a product, the Supplier is required to revise the MSDS.

5.2.2 Laboratory's responsibilities

WHMIS legislation requires that a MSDS be readily accessible to anyone who works with, or who may be exposed to controlled products. Each laboratory is responsible for ensuring that their MSDS Collection:

- location is communicated to all employees working on site;
- contains the MSDS for all WHMIS-controlled products in the laboratory;
- contains MSDS that are all less than 3 years old;
- is updated when new information becomes available.

MSDS Collections may be stored in several ways: a filing cabinet, binders, on a personal computer, or by any other means of storage. At the very least, there must be a hard copy collection of all MSDS's and all employees must be informed and aware of its location, and have unrestricted access to the data sheets at any time.

In order to simplify MSDS management, multiple departments utilizing a common laboratory space, or which are in close proximity to each other (ie. in the same building), can share a central MSDS collection. All lab employees, must have 24/7 access to the MSDS Collection area. If the room is sometimes locked, all employees must have a key. Students are to have supervised, limited access to MSDS's.

5.3 WHMIS Training

WHMIS training is a major component of the WHMIS legislation and therefore is mandatory for all employees at UFV working with controlled products. UFV is required to provide initial WHMIS training and it is encouraged that employees take a refresher course every 2 years. For more information on WHMIS training at UFV contact the OHSO.

6 PERSONAL PROTECTIVE EQUIPMENT

Personal protective equipment (PPE) is designed to protect parts of the body. It should act as a primary barrier between the hazard and the worker. It does not reduce the hazard itself, but reduces chances of exposure to it. PPE must be chosen that is appropriate to the hazards that are present.
All UFV laboratories must be stocked with adequate supplies of PPE and UFV employees must understand what PPE to use for different types of hazards. It is the responsibility of UFV employees to ensure that students use PPE and use it properly.

6.1 Laboratory Coats

Appropriate protective clothing (e.g., lab coats, aprons, and coveralls) is required in all experimental areas where hazardous materials are handled.

Guidelines for selection and use of protective laboratory clothing are as follows:

- Select full sleeve, knee-length lab coats with button or snap closures and full sleeves.
- Wear a solid-front lab coat or gown with back closures and knitted cuffs when working with highly toxic or infectious agents.
- Wear protective aprons for special procedures such as transferring large volumes of corrosive material.
- Remove protective clothing when leaving the laboratory.
- Remove protective clothing in the event of visible or suspected contamination.
- Provide maximum coverage of skin with clothing in accordance with the risk of exposure. UFV employees must determine the specific requirements in each lab.
- Button up lab coats to ensure fullest coverage.
- Remove and hang up lab coats prior to leaving the lab.
- Keep lab coats clean and launder them separately from regular clothing.
- Wear rubber aprons when handling highly corrosive or reactive materials.

6.2 Hand Protection

In the laboratory, gloves are used for protection from radiation, chemical products, biohazardous material and physical hazards such as abrasion, tearing, puncture and exposure to temperature extremes.

6.2.1 Latex gloves and skin reactions

Natural latex is derived from the sap of the rubber tree and contains rubber polymers, carbohydrates, lipids, phospholipids and proteins. During the manufacturing process additional chemical agents are added to impart elasticity, flexibility and durability to the latex. Because of these properties, and because of their high tactile strength and low cost, latex gloves are used for many laboratory procedures. Unfortunately, for some people, wearing latex gloves can cause skin reactions; these can be either irritant or allergic in nature, and can be caused by:

- chronic irritation from sweating of hands inside gloves or from gloves rubbing against the skin
- sensitization to the chemical additives used in the manufacturing process
- reaction to naturally-occurring latex proteins

Frequent handwashing, as well as residues from scrubs, soaps, cleaning agents and disinfectants may further irritate the skin.

Using one of the following alternatives may reduce the risk of skin problems associated with the use of latex rubber gloves:

- non-latex gloves
- "hypo-allergenic", non-powdered or low-protein latex gloves
- polyethylene, PVC or cloth liners under latex gloves
- non-latex gloves under latex gloves

Occurrences of skin problems (e.g., rash, itching, peeling, red, blistering skin or dry flaking skin with cracks and sores) that seem to be associated with the wearing of latex gloves should be reported to a physician when symptoms first appear.

6.2.2 Glove selection guidelines

View Appendix 3 for Recommended Glove Materials for a Variety of Laboratory Hazards.

Base selection of glove material on:

- identification of the work procedures requiring hand protection
- flexibility and touch sensitivity required; a need for high tactile sensitivity, for example, would restrict glove thickness, and some protocols may require the use of gloves with non-slip or textured surfaces
- type and length of contact (e.g., occasional or splash vs. prolonged or immersion contact)

- whether disposable or reusable gloves are more appropriate

6.2.3 Chemical glove selection

No single glove material is resistant to all chemicals, nor will most gloves remain resistant to a specific chemical for longer than a few hours. Determine which gloves will provide an acceptable degree of resistance by consulting the MSDS for the product, contacting glove manufacturers or by referring to a compatibility chart or table for permeation data.

These resources may use the following terms:

- Permeation Rate- refers to how quickly the chemical seeps through the intact material: the higher the permeation rate the faster the chemical will permeate the material.
- Breakthrough Time- refers to how long it takes the chemical to seep through to the other side of the material.
- Degradation- is a measure of the physical deterioration (for example, glove material may actually dissolve or become harder, softer or weaker) following contact with the chemical.

6.2.4 Selection, use and care of protective gloves

Guidelines for glove use include the following:

- Choose a glove that provides adequate protection from the specific hazard(s).
- Be aware that some glove materials may cause adverse skin reactions in some individuals and investigate alternatives.
- Inspect gloves for leakage before using; test rubber and synthetic gloves by inflating them.
- Make sure that the gloves fit properly.
- Ensure that the gloves are long enough to cover the skin between the top of the glove and the sleeve of the lab coat.
- Discard worn or torn gloves.
- Discard disposable gloves that are, or may have become, contaminated.
- Avoid contaminating "clean" equipment: remove gloves and wash hands before carrying out tasks such as using the telephone.
- Always wash your hands after removing gloves, even if they appear not to be contaminated.
- Do not reuse disposable gloves.
- Follow the manufacturer's instructions for cleaning and maintenance of reusable gloves.
- Before using gloves, learn how to remove them without touching the contaminated outer surface with your hands.

6.3 Eye and Face Protection

All UFV employees, students and visitors must wear appropriate eye and/or facial protection in:

- All areas where hazardous materials, or substances of an unknown nature, are stored, used or handled;
- All areas where the possibility of splash, flying objects, moving particles and/or rupture exist;
- All areas where there are other eye hazards, e.g. UV or laser light
- Guidelines for selection and use of protective eyewear:
- Light-to-moderate work: CSA approved safety glasses with side shields are the minimum requirement for working in a laboratory.
- Goggles should be utilized when working under significant risk of splash of chemicals, or projectiles.
- A full face shield, plus goggles should be utilized when working under significant risk of splashing on the face, or possible explosion.
- If safety glasses with correction lenses are needed, first consult with an optometrist or ophthalmologist.
- All PPE eyewear should be inspected regularly as is appropriate, for proper functionality, cleanliness and contamination. Dirty or contaminated eyewear can be cleaned with standard eyeglass pump sprays and/or a water/bleach solution for decontamination.

Approved safety glasses with side shields are the minimum protection required in a laboratory. Goggles and face shields may also be required for certain procedures, as determined by the instructor.

6.4 Respiratory Protection

Under normal circumstances at UFV laboratories, the use of fume hoods should generally eliminate respiratory hazards, and the use of dust masks may also be adequate. Extreme equipment such as respirator masks and self-contained breathing (SCBA) regulators should not be required for laboratory situations. If such equipment is ever required, the selection should be based on the CSA Standard: Selection, Use and Care of Respirators CSA – Z94.4-93. It is essential the wearer be properly instructed for safe and fit use of a respirator.

6.5 Hearing Protection

Hearing protection is not likely required in UFV laboratories but in British Columbia, hearing protection is required for noise levels above 85 decibels. In the event that such noise levels are encountered, UFV must have hearing protection aids available for employees and students in the form of disposable sponge ear plugs.

6.6 Foot Protection

As a general rule, people must not be allowed to wear opened-toed shoes such as sandals when entering and working in a laboratory.

Safety footwear is designed to protect feet against a variety of injuries. Impact, compression, chemical splashes and puncture are the most common types of injuries. This hazard is not likely significant in UFV laboratories, however if safety footwear is required in the future, it should be chosen according to the hazard and should be properly rated. (Protective Footwear CSA-Z195-M92)

For PPE considerations for working with biohazardous materials, refer to UFV Biosafety Manual.

7 SAFETY TRAINING

- All UFV laboratory employees must undergo WHMIS Chemical Safety training and read and understand this laboratory safety manual.
- All UFV employees working in laboratories that handle biological agents should undergo Biosafety training. Refer to UFV Biosafety Manual.
- Radiation Safety Training
- UFV employees should take refresher training course for lab safety and/or biological safety every 2 years.
- UFV employees must ensure that there are formally written safety procedures, as applicable to students, in all student laboratory manuals that are handed out as course materials. Employees must ensure that students read and understand these procedures prior to engaging in the laboratory activities for the school term.

8 CONTROL OF CHEMICAL HAZARDS

8.1 Toxic chemicals and the four routes of entry

Chemicals can gain entry into the body by:

- ***Inhalation*** of gases, vapours and particulate material (e.g. mists, dusts, smoke, fumes)
- ***Absorption*** through skin of liquids, solids, gases and vapours
- ***Ingestion*** of chemicals directly or indirectly via contaminated foods and beverages and contact between mouth and contaminated hands (nail-biting, smoking)
- ***Injection*** of chemicals through needles and other contaminated laboratory sharps

8.2 Flammable Chemicals

Flammable and combustible liquids, solids or gases will ignite when exposed to heat, sparks or flame. Flammable materials burn readily at room temperature, while combustible materials must be heated before they will burn. Flammable liquids or their vapours are the most common fire hazards in laboratories. Refer to Section 10 for specific details on the safe handling of flammable chemicals in the laboratory

8.3 Oxidizing Chemicals

Oxidizers provide oxidizing elements such as oxygen or chlorine, and are capable of igniting flammable and combustible material even in an oxygen-deficient atmosphere (Refer to Section 10.1, "The Fire Triangle"). Oxidizing chemicals can increase the speed and intensity of a fire by adding to the oxygen supply, causing materials that would normally not burn to ignite and burn rapidly. Oxidizers can also:

- React with other chemicals, resulting in release of toxic gases
- Decompose and liberate toxic gases when heated
- Burn or irritate skin, eyes, breathing passages and other tissues

Precautions to follow when using and storing oxidizers in the laboratory include the following:

- Keep away from flammable and combustible materials
- Keep containers tightly closed unless otherwise indicated by the supplier
- Mix and dilute according to the supplier's instructions
- To prevent release of corrosive dusts, purchase in liquid instead of dry form
- Reduce reactivity of solutions by diluting with water
- Wear appropriate skin and eye protection
- Ensure that oxidizers are compatible with other oxidizers in the same storage area

8.4 Reactive Chemicals

- May be sensitive to jarring, compression, heat or light
- May react dangerously with water or air
- May burn, explode or yield flammable or toxic gases when mixed with incompatible materials
- Can vigorously decompose, polymerize or condense
- Can also be toxic, corrosive, oxidizing or flammable
- Some chemicals may not be dangerous when purchased but may develop hazardous properties over time (e.g. diethyl ether and solutions of picric acid).

Follow these precautions when working with dangerously reactive chemicals:

- Understand the hazards associated with these chemicals and use them under conditions which keep them stable
- Store and handle away from incompatible chemicals
- Keep water-reactive chemicals away from potential contact with water, such as plumbing, fire sprinkler heads and water baths
- Handle in a chemical fume hood
- Wear the appropriate skin and eye protection
- Work with small quantities
- Use up or dispose of these chemicals before they attain their expiry date

8.5 Corrosive Chemicals

Corrosives are materials, such as acids and bases (caustics, alkalis) which can damage body tissues as a result of splashing, inhalation or ingestion. Also:

- They may damage metals, releasing flammable hydrogen gas
- They may damage some plastics
- Some corrosives, such as sulphuric, nitric and perchloric acids, are also oxidizers; thus they are incompatible with flammable or combustible material
- They may release toxic or explosive products when reacted with other chemicals
- They may liberate heat when mixed with water

Precautions for handling corrosive materials include:

- Wear appropriate skin and eye protection
- Use in the weakest concentration possible
- Handle in a chemical fume hood
- Use secondary containers when transporting and storing corrosives
- Always dilute by adding acids to water
- Dilute and mix slowly

- Store acids separately from gases

8.6 Chemical Spill

8.6.1 Spill Response

Laboratory heads are responsible for predetermining procedures for response to the types of spill situations that may be anticipated for their operations. Individuals requiring assistance in preparing spill response plans should contact OHSO.

In instances where more extensive equipment or technical assistance is needed, backup can be provided by other internal resources. Communications are handled through the emergency telephone number (Local 7770).

8.6.2 Development of Spill Response Plans

8.6.2.1 Communications

All laboratories housing hazardous materials are required to provide means of reaching contact people who may be summoned in the event of emergencies involving their laboratory, especially for after-hours situations. This may involve posting the relevant telephone number(s) and/or providing them to the Security Services, who operate the emergency telephone number.

Building Directors are also required to provide to the Security Services telephone numbers where they, or alternate contact persons, may be reached during after-hours crises.

8.6.2.2 General guidelines

The following factors are to be considered when developing spill response procedures:

- Categories of chemicals (e.g. oxidizers, flammable solvents) and their chemical, physical and toxicological properties.
- The quantities that may be released.
- Possible locations of release (e.g. laboratory, corridor).
- PPE needed.
- Types and quantities of neutralizing or absorbing material needed.

These guidelines should be followed when initially responding to a spill situation:

- Determine appropriate clean up method by referring to the Material Safety Data Sheet (MSDS). If you are unsure how to proceed, or if you do not have the necessary protective equipment, do not attempt to clean up the spill.

- If the spill is minor and of known limited danger, clean up immediately.
- If the spill is of unknown composition, or potentially dangerous (explosive, toxic vapours), alert everyone present and evacuate the room.
- If the spill cannot be safely handled using the equipment and personnel present, call the emergency telephone number (Local 7770) to request assistance.

8.6.3 Guidelines for Specific Types of Spills

This section describes how to clean up some of the chemical spills that may occur in the laboratory. Refer to Section 12.1, for details on how to dispose of the absorbed chemical.

8.6.3.1 Flammable and toxic liquids

- If you can do so without putting yourself at risk, immediately shut off all potential ignition sources
- If fire occurs, alert everyone present and extinguish all flames. If the fire cannot be controlled immediately pull the nearest fire alarm.
- If no flames are evident, pour adsorbent around the perimeter of the spill and then cover the rest of the material. Wear an appropriate respirator if toxic vapours are involved.
- Wear gloves resistant to the chemical being handled. Using a plastic utensil (to avoid creating sparks), scoop up the absorbed spill, place it in a plastic bag, seal it, and place in a labeled container.

8.6.3.2 Corrosive liquids

- Alert everyone present. If vapours are being released, clear the area.
- Do not attempt to wipe up a corrosive liquid unless it is very dilute.
- Gloves, boots, apron and eye protection must be used when neutralizing an extensive corrosive spill. Respiratory protection is required if the liquid releases corrosive vapour or gas.
- Pour the required neutralizing or adsorbing material around the perimeter of the spill, then carefully add water and more neutralizing material to the contained area. Carefully agitate to promote neutralization.
- Use pH paper to verify that all contaminated areas are neutralized and safe to wipe up.
- If an adsorbent (eg. spill control pillows) is used instead of a neutralizer, scoop up the absorbed spill, place it in a plastic bag, seal it, and then place in a labeled box. If neutralized material contains no toxic heavy metals (e.g. chromium), flush down the drain with plenty of water.

8.6.3.3 Corrosive solids

Small spills can be cleaned up mechanically with a dustpan and brush. Larger spills should be cleaned up using a HEPA (high-efficiency articulate) filter vacuum. For spills containing fine dusts, an air-purifying respirator with dust filters is recommended, as are gloves, protective goggles, and a lab coat.

8.6.3.4 Toxic solids

Avoid disturbing such solids (e.g. asbestos) which may release toxic dusts. Wet the material thoroughly, then place it in a plastic bag and label it appropriately. If wet removal is not possible, a vacuum equipped with a HEPA (High Efficiency Particulate Air) filter is required.

8.6.3.5 Gases

In the event of the release of a corrosive gas (e.g. chlorine) or gases that are absorbed through the skin (e.g. hydrogen cyanide), a complete chemical resistant suit and a self-contained breathing apparatus are required. There is no practical means of absorbing or neutralizing a gas - the leak must be corrected at the source.

8.6.3.6 Mercury

If a small amount of mercury is spilled (e.g. broken thermometer), use an aspirator bulb or a mercury sponge to pick up droplets, place the mercury in a container, cover with water, seal it, and label the bottle appropriately. To clean up the residual micro-droplets that may have worked into cracks and other hard-to-clean areas, sprinkle sulphur powder or other commercially available product for mercury decontamination. Leave the material for several hours and sweep up solid into a plastic bag, seal it and label it appropriately.

Contact OHSO (4534)for monitoring of mercury air concentrations.

If a large spill of mercury is involved, the area should be closed off, and a mercury respirator worn during the clean-up. Contact OHSO (4534) for further information and support.

8.6.3.7 Special categories

It is not within the scope of this manual to list procedures for all possible categories of chemicals. For further information on responses to other categories consult the material safety data sheet or contact OHSO (4534)

9 INVENTORY MANAGEMENT IN LABORATORIES

Management of Inventory is an important aspect of safety in the research and teaching laboratory. Over time, a laboratory space can easily accumulate materials, supplies, and hazardous agents and become cluttered and over-crowded. Some of the chemical materials themselves can become a danger if left unchecked/unsupervised for long periods of time. The following points should be followed for inventory management in a laboratory:

- It is the responsibility of laboratory technicians to oversee and maintain laboratory inventory.
- All newly received containers of laboratory chemicals at UFV must be date-marked to indicate time of receipt.
- First in First out (FIFO) principle should be applied to all laboratory supplies. Stock should be rotated with the oldest stock always being used first.
- In the laboratory, all media and stock solutions should be clearly labeled as per WHMIS requirements outlined in Section 5.
- All drawer and cupboards should be clearly labeled. Inventory lists should be reviewed and updated regularly.
- Keep inventory records of chemicals, and update annually.

9.1 Chemical Storage Guidelines

The following guidelines are applicable to chemical storage in the laboratory and in storage bunker rooms at UFV.

- Ensure all containers of hazardous chemicals are properly labeled as per WHMIS requirements outlined in Section 5;
- Store hazardous chemicals in an area that is accessible only to authorized laboratory employees;
- Only daily-use quantities should be kept in the laboratory;
- Do not store chemicals in aisles, under sinks or on floors, desks or bench tops;
- Store chemicals away from sources of heat (e.g., ovens or steam pipes) and direct sunlight;
- Water-sensitive chemicals must be stored to prevent contact with water;
- Never stack bottles on top of each other;
- Do not store chemicals above eye level/shoulder height;
- Store larger containers on lower shelves;
- When applicable, store liquids inside chemically-resistant secondary containers (such as trays or tubs) that are large enough to hold spills;
- When applicable, store chemicals inside closable cabinets or on sturdy shelving that has edge guards to prevent containers from falling;
- Ensure that chemicals cannot fall off the rear of shelves;

- When applicable, store acids in a dedicated acid cabinet. Nitric acid may be stored there also but only if it is kept isolated from all other acids;
- Chemicals must be stored in tightly closed containers;
- Chemicals must not be dispensed within the chemical bunker;
- Store chemicals according to compatibility, do not store chemicals alphabetically except within a grouping of compatible chemicals (refer to APPENDIX 2 - WHMIS CLASSIFICATION for further guidance);
- When applicable, store highly toxic or controlled materials in a locked, dedicated poison cabinet;
- Designate specific storage areas for each class of chemical, and return reagents to those locations after each use;
- Store volatile toxic and odorous chemicals in a way that prevents release of vapours (e.g., inside closed secondary containers, ventilated cabinets, paraffin sealing);
- Store flammables requiring refrigeration in explosion-safe or lab-safe refrigerators;
- Label reactive or unstable chemicals (e.g., ethers and other peroxide-forming chemicals) with the date of receipt, the date opened and an expiry date, if applicable. Should also indicate date of peroxide testing and required frequency;
- Inspect chemicals weekly for signs of deterioration and for label integrity;
- Dispose of unwanted chemicals promptly according to Section 12.1;
- Compressed gas cylinders must be anchored securely; and
- Keep all stored chemicals, especially flammable liquids, away from heat and direct sunlight.

9.2 Flammable Liquid Storage Cabinets

Flammable chemicals should be stored inside flammable liquid storage cabinets. Only those flammables in use for the day should be outside the cabinet. Guidelines for cabinet use include:

- Use NFPA or UL approved flammable liquid storage cabinets;
- Keep cabinet doors closed and latched;
- Do not store other materials in these cabinets; and
- Cabinets must be ventilated, refer to Section 13.1 for further information.

9.3 Packing and Moving Chemicals

9.3.1 General Procedures

- Review chemical spill clean-up procedures before packing and moving;
- Do not allow third party moving companies or other non-laboratory employees with no experience in working with chemicals, to box or handle chemicals;
- Consider discarding chemicals which have not been used for a long period of time;
- Review inventory of chemicals for especially dangerous ones, i.e. peroxide formers like isopropyl ether, butadiene, potassium metal, sodium amide, etc. Handle with extra caution;

- Wear appropriate PPE (lab coat, gloves, and eyewear) and be familiar with chemical(s) MSDS's before beginning work;
- Segregate and box chemicals into the following groups: organics, inorganics, acids, bases, oxidizers, reducers, and flammables;
- Damaged bottles that are open and exposed should be treated as hazardous waste and properly disposed of;
- Separate glass bottles and jars in a box with cardboard or vermiculite to prevent breakage during transportation;
- Large 4L bottles of liquid chemicals/solvents should be transported in rubber carrying cases with handles. Cap gas cylinders and move using a cylinder truck;
- Ensure that all chemicals are accounted for and no chemicals are left behind;

9.3.2 Transportation between Laboratory and Shipping/Receiving

The receiving, storage and transport of chemicals and other hazardous materials to and from the Shipping and Receiving at UFV must be properly controlled to minimize chances of accidents, chemical spills, and exposure of personnel to hazardous agents.

A general principle that guides all safety aspects of transportation is ensuring that personnel are present to receive and inspect transported agents. Transported materials must never be dropped off without an intended recipient present to receive the materials. Based on this general principle, the following guidelines should be followed for shipping and receiving of hazardous materials at UFV:

- Received goods must always be inspected for packaging integrity and damage. Only undamaged goods should be accepted for receiving and transport within UFV.
- Goods received that have time, temperature or other storage sensitivity restrictions must be handled immediately as appropriate, by the receiver.
- Received goods must not be allowed to sit unattended for extended periods of time.
- Goods must be transported in a safe and appropriate manner to minimize chances of damage and breakage of packaging integrity.
- Large shipments on skids must be transported using a fork lift.
- Heavy boxes and containers must be transported using aids such as dolly's and carts.
- The labels on all received goods should be reviewed for any safety requirements/restrictions and instructions followed.
- Shipping & Receiving personnel should undergo training and refresher courses every two years in Transportation of Dangerous Goods.

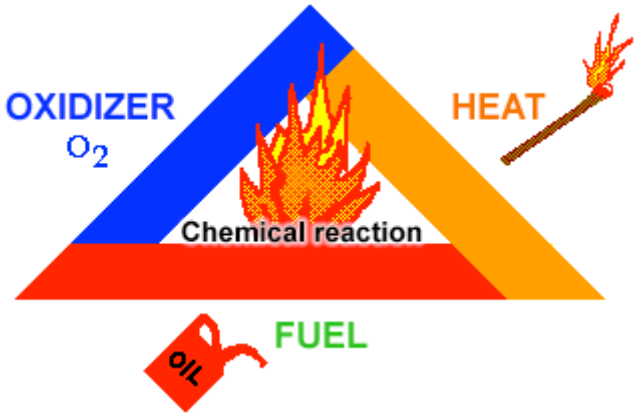
10 FIRE SAFETY

Laboratory fires can by caused by Bunsen burners, runaway chemical reactions, electrical heating units, failure of unattended or defective equipment, or overloaded electrical circuits. UFV employees must be aware of how and where these potential dangers exist in their laboratory rooms.

UFV employees must also familiarize themselves with the operation of the fire extinguishers, location of pull stations, fire blankets, emergency exits and evacuation routes. The evacuation procedure for UFV is outlined on signage placards located beside all building exit doors and elevators. In the event that the general alarm is sounded, use the evacuation routes established for your area and follow the instructions on the signage.

10.1 The Fire Triangle

Fire cannot occur without an ignition source, fuel and an oxidizing atmosphere (usually air). These three components comprise what is called the "fire triangle":



Fire will not be initiated if any one of these elements is absent, and will not be sustained if one of these elements is removed. This concept is useful in understanding prevention and control of fires. For example, the coexistence of flammable vapours and ignition sources should be avoided, but when flammable vapours cannot be controlled, elimination of ignition sources is essential.

UFV employees should have an understanding of the fire triangle and how best to work in the laboratory such that they are minimizing the potential of any or all of the three components of the triangle to be simultaneously present.

10.2 General Guidelines for Working Safely and Minimizing Chances of Fire

- Avoid using open flames if possible, otherwise, use an open flame only as long as necessary and extinguish it when done.
- Do not use an open flame to heat flammable or combustible materials.
- Remove all flammable and combustible materials from the work area before lighting a flame.
- Notify all others in the lab and note any procedure using flammable and combustible gases and liquids before lighting a flame.
- Store all flammable and combustible materials properly as specified in Section 9.
- Use non-spark generating equipment and have adequate ventilation if a flammable atmosphere may be present.
- In the event of fire, immediately locate and shut off the master supply valve for gas to the laboratory.
- Handle flammable and combustible chemicals inside of a fume hood.

10.3 Classes of fire

The National Fire Protection Association (NFPA) has defined four classes of fire, according to the type of fuel involved. These are:

> ***Class A*** *fires involve combustibles such as paper, wood, cloth, rubber and many plastics.*
> ***Class B*** *fires entail burning of liquid fuels like oil-based paints, greases, solvents, oil and gasoline.*
> ***Class C*** *fires are of electrical origin (fuse boxes, electric motors, wiring).*
> ***Class D*** *fires encompass combustible metals such as magnesium, sodium, potassium and phosphorus.*

UFV must have Fire Extinguishers on hand in each laboratory that is appropriate for the classes of fuels that are present. At present, Class ABC fire extinguishers are suitable for UFV's needs. These extinguishers must be inspected, serviced, and maintained on a regular basis by an outside contractor.

11 RADIATION SAFETY

Under the Radiation Protection Regulations of the Canadian Nuclear Safety Commission (CNSC), every licensee is required to implement a Radiation Safety Program that meets specified requirements. At UFV, the responsibility for establishing and continually reviewing the radiation safety program is delegated by the Geography Department. The Geography Department is responsible for implementing the radiation safety program on a daily basis. For more information contact Dr. Olav Lian at, extension 4307**.**

No work with radioactive material may be conducted until the individual has been trained in the safe handling of radioisotopes by Geography Department, and provided operational training by the supervisor. Any work with radioactive materials must be approved by Geography Department before work begins. Training must be in accordance with the requirements of the Canadian Nuclear Safety Commission (CNSC).

Below is a list of general safety precautions for handling radioactivity at UFV. The safety precautions listed below apply only to Stronium-90 radioisotope. If in the future, UFV is to handle higher energy isotopes, the safety precautions listed below may need to be reviewed and revised:

- All employees and students who work with radioactive materials must be conscientious of their activities and actions.
- All users of radioactive materials must be either an “authorized user” (persons with an extensive knowledge of radioactivity and safe working procedures) or work under the direction of an approved “authorized user”.
- All laboratories using radioactive materials must have a “Caution - Radioactive Materials” door sign.
- Use tongs or tweezers to handle individual plastic discs containing radioactive isotope.
- Perform procedures quickly, efficiently, and precisely.
- Store all radioactive materials within clearly labeled and shielded containers.

11.1 Physical Security of Radioactive Materials

- All laboratories using radioactive materials should have lockable doors. Laboratories without lockable doors may not be used for work or storage of radioactive materials.
- All laboratories using radioactive materials must be locked at all times when unoccupied.
- Laboratories where radioactive materials are stored may be unlocked if an authorized person is present at all times.
- Radioactive materials must be stored in an appropriately secured fashion to prevent unauthorized users to access the materials.

12 HAZARDOUS WASTE DISPOSAL

In general, hazardous waste is to be appropriately contained and labeled and placed in a designated Hazardous Waste Disposal Area. This waste is to be handled either by UFV or outside contractors. For information regarding general waste management at UFV, refer to UFV Policies on waste management.

12.1 Liquid and Solid Chemical Waste Disposal

Each laboratory facility at UFV has slightly different procedures for handling chemical waste. In general, solvent waste must be collected and stored in suitable containers (ie. capped 4L glass bottles or similar) which are stored in a well-ventilated fume hood. Halogenated and non-halogenated organic solvent waste must be collected and stored in separate bottles. Storage bottles should be capped shut while being stored in a fume hood. When they are full, they are transported to a pickup location and taken away for processing and disposal by an outside contractor company. At the discretion of knowledgeable laboratory employees, some liquid chemical waste can be discarded down the drain. Examples include but are not limited to aqueous buffers, dilute acids and bases.

In general, solid waste must be collected and stored in suitable containers (metal or plastic bottles or pails with sealable lid) and stored in a ventilated area (ie. chemical bunker). The containers must be labeled to indicate that they are being used to store solid chemical waste. Solid chemical waste may originate from a spill, in which case a dust pan and brush can be used to collect the waste, and transferred to the storage container. Knowledgeable laboratory employees must be wary of the compatibility or non- compatibility of combining certain classes of solid chemical waste together in the same container. When containers are ready for disposal, they are to be transported to a pickup location and taken away for processing and disposal by an outside contractor company.

12.2 Biohazardous waste

See Biosafety Laboratory Manual for details.

12.3 Radioisotope Disposal

See Radiation Safety Program Manual for details.

12.4 Regular Garbage

Regular garbage should not contain any hazardous waste. All regular-garbage bins are to be emptied daily (bags removed and replaced) by appropriate personnel.

12.5 Sharps and Needles

They are to be disposed of in designated and specially designed bins. When bins are ¾ full, they are to be transported to a pickup location appropriate for each laboratory, for disposal by an outside contractor. Individual departments are responsible for purchasing their own sharps containers.

12.6 Glass Waste and Broken Glass

This waste is to be disposed of in designated metal garbage cans with a foot lever operated closing lid and rigid plastic liner (no bag). When full, bins are to be transported to appropriate pick-up locations for UFV employees to pick up, process and dispose. Individual departments are responsible for purchasing their own glass waste cans.

Refer to further procedures that may be specific to each laboratory department.

13 LABORATORY VENTILATION AND FUMEHOODS

13.1 General Ventilation

General ventilation, also called dilution ventilation, involves dilution of inside air with fresh air. Its purpose is to:

- maintain comfortable environment of temperature, humidity and air movement for room occupants;
- dilute indoor air contaminants;
- balance out the removal of air by fume hoods and biological safety cabinets, from the general indoor atmosphere;

General ventilation systems comprise a balance of incoming air supply and outgoing air exhaust. The air may be supplied via a central HVAC (Heating, Ventilation and Air Conditioning) system. Laboratory air may be exhausted through either local exhaust devices or air returns connected to the HVAC system. UFV employees must be observant of any obvious deficiencies in air quality in the laboratory and report any problems to the Facilities department in UFV. The Facilities department or outside contractor should also routinely (recommend annually) inspect laboratory HVAC systems to ensure that they are functioning properly to maintain adequate ventilation and circulation of fresh air.

13.2 Chemical Fume Hoods

Chemical fume hoods are fire and chemical resistant enclosure units with a sliding sash for opening or closing the hood. They are able to capture and exhaust even heavy vapours by means of air being drawn into the front opening and up into an exhaust system at relatively high velocity. They are preferred for all laboratory procedures that require manual handling of hazardous chemical materials.

13.2.1 General Procedure for Fume Hood Use

1) Turn fume hood on; check for proper air movement.
2) Place work material at least 6” inside hood, behind the “plane” of the hood sash.
3) Lower glass shield to certification mark or lower.
4) Perform work slowly, entering “straight” into the hood; do not make large sweeping motions within the hood or upon exiting.
5) Remove materials from hood when work is completed; allow hood to run for 10-15 minutes before turning off.

When fume hoods are properly used and maintained, they will render substantial protection, provided the user is aware of its capabilities and limitations. Proper usage and maintenance encompasses the following:

1) Controls for the operation of a fume hood and its services must be located outside the fume hood and must be immediately accessible to the laboratory worker, except that water taps may be located inside the cabinet if the main shutoff valve is in a safe location outside the cabinet.
2) A fume hood must be connected to a local exhaust ventilation system which will provide minimum air velocities over the operational face area of the hood of:

    a. an average of 0.5 m/s (100 fpm) but not less than 0.4 m/s (80 fpm) at any point across the face, and
    b. an average of 0.75 m/s (150 fpm) but not less than 0.65 m/s (125 fpm) at any point across the face if the fume hood is used for carcinogenic substances.

3) A fume hood must be located to prevent cross drafts or other disruptive forces from lowering the air flow across the operational face to unacceptable levels.
4) A fume hood and its ductwork must be constructed from materials compatible with its use.
5) A fume hood must be clearly labeled with any applicable restrictions on its use.
6) A fume hood must not be used for storage of chemicals unless it is used exclusively for this purpose and is labeled with this limitation.
7) Air velocities over the operational face area of a fume hood must be measured and recorded at least annually and after any repair or maintenance which could affect the air flows.
8) Airflow in a fume hood used for very toxic or radioactive materials must be monitored continuously if there is risk to workers in the event of loss of airflow.
9) A fume hood with an adjustable sash must be marked to identify the maximum height the sash may be set at and still maintain the required air flows.
10) Fume hoods should be serviced and maintained on an annual basis through the Department at UFV who will use an outside contractor. The record of annual maintenance should include use of a sticker affixed to somewhere on the front face of the fume hood. The sticker would, at a minimum, outlined the name of the servicing entity, date/time of last maintenance inspection and name or initials of the service technician.

To ensure that fume hoods provide the highest degree of protection, observe the following guidelines:

- Only materials being used in an ongoing experiment should be kept in the fume hood. Cluttering the hood will create air flow disturbances.
- When it is necessary to keep a large apparatus inside a hood, it should be placed upon blocks or legs to allow air to flow underneath.
- Operate the hood with the sash as low as is practical. Keep in mind that reducing the open face size will also increase the face velocity, possibly to unsafe levels.
- Work as far into the hood as possible. At least six inches is recommended.
- Do not lean into the hood. This disturbs the air flow, and also places your head into the contaminated air inside the hood.

- Do not make quick motions into or out of the hood, or create cross drafts by walking rapidly past the hood. Opening doors or windows can sometimes cause strong air currents which will disturb the air flow into the hood.
- Heating devices should be placed at the rear of the hood.
- Power cords must not hang down in front of the fume hood workspace.
- Do not use a hood for any function it was not specifically designed for.
- Keep hood door closed when fume hood is not being used.
- Remember that sinks inside fume hoods are not designed for disposing of any and all chemical wastes. Consult with user's manual or fume hood manufacturer to determine what chemical waste is appropriate for disposal.
- If chemical fumes can be detected by sense of smell to be emanating from a fume hood, immediately discontinue fume hood use and make arrangements with the fume hood servicing and maintenance contractor (indicated on maintenance sticker on fume hood), and/or fume hood manufacturer, as necessary, for the fume hood to be inspected and repaired.

14 COMPRESSED GASES AND CRYOGENICS

By nature of being contained in a high pressure vessel, compressed gases have potential to be very dangerous if not handled properly. Similarly, cryogenic materials are at such low temperatures that they can cause damage and injury to humans, if not handled properly.

14.1 Hazards of Compressed Gases

All compressed gases have potential health and safety hazards related to the chemical properties of the gas, as well as pressure hazards. UFV employees must take precautions to protect employees and students from these potential hazards. The high pressure inside a gas cylinder can be extremely hazardous if disrupted. Knocking over an unsecured, uncapped cylinder of compressed gas can break the cylinder valve. The resulting rapid escape of high pressure gas can turn a cylinder into an uncontrolled projectile or pinwheel, causing serious injury and damage. Poorly controlled release of compressed gas in the laboratory can burst reaction vessels, cause leaks in equipment and hoses or result in runaway chemical reactions. Compressed gases may also have flammable, oxidizing, dangerously reactive, corrosive or toxic properties. Inert gases such as nitrogen, argon, helium and neon can displace air, reducing oxygen levels in poorly ventilated areas and causing asphyxiation.

14.1.1 Guidelines for Safe Handling, Storage and Transport of Compressed Gas Cylinders

- A sturdy cylinder cart should be used for transporting cylinders. Chain or strap the cylinder to the cart.
- When cylinders are not in use or are being transported, remove the regulator and attach the protective cap.
- All gas cylinders, full or empty, should be secured to a solid support such as a wall, using suitable racks, straps, chains or stands.
- Cylinders must be prevented from striking each other directly. This can be achieved by placing cylinders at a suitable distance from each other or by wrapping the upper part of cylinders with plastic webbing.
- Never bleed a cylinder completely empty; leave a residual pressure.
- Cylinders of flammable gases including hydrogen must be grounded; potential ignition sources such as open flames, sparks, and hot surfaces must be removed from the vicinity flammable gas cylinders.
- Toxic, odourless gases must be used with a venting system.
- Verify that the regulator is appropriate for the gas being used and the pressure being delivered. Do not rely upon the pressure gauge to indicate the maximum pressure ratings; check the regulator's specifications.

- Ensure the tubing and the apparatus downstream from the regulator are designed to withstand the pressures intended to be delivered. The tubing and other components should also be chemically resistant to the gas being used, tubing length should not be longer than is necessary and should be secured if necessary.
- Do not use adaptors or Teflon (PTFE) tape to attach regulators to gas cylinders. The recommendation of commercial gas suppliers is that regulator fittings in good condition do not require additional sealants.
- Do not lubricate an oxygen regulator.
- Compressed gas cylinders have a finite shelf life. Ensure cylinders are regularly inspected. Any cylinder that is corroded or has damaged valve components should be returned to the supplier. All cylinders older than five years should be returned to the manufacturer. Manufacturers of corrosive gases recommend that cylinders of corrosives be replaced every six months to guard against valve failure.
- Any cylinder that is found to be leaking must be returned to the vendor.
- Do not expose cylinders to temperatures extreme beyond the range of typical indoor and outdoor environmental temperatures.
- Always wear eye protection when working with compressed gases.
- Store incompatible classes of gases separately.

14.1.2 Guidelines for Safe Handling and Usage of Gas Cylinder Regulators

- Only qualified, experienced, WHMIS-trained individuals are allowed to be handling and manipulating gas regulators. At a minimum, PPE such as lab coats and safety glasses must be worn before working with gas regulators.
- Confirm that the properly rated regulator is being used for the specific gas cylinder. Regulators should be labeled to identify the specific gas that they are designed for.
- Only use non-adjustable wrenches (no pliers or adjustable wrenches) for loosening and tightening brass nuts on regulators. Thread the cylinder connection brass nut on the regulator onto a gas cylinder valve by hand until snug, then use wrench to tighten. Thread the brass nut of the regulator outlet to the hose or pipe of the gas recipient equipment by hand until snug, then use wrench to tighten.
- Never use lubricants or Teflon tape on a connection thread.
- When connections are tightened, slowly open the master cylinder valve until the cylinder pressure gauge value stabilizes.
- Slowly turn the pressure adjustment knob counter clockwise to open the regulator valve. Turn until the desired delivery pressure is indicated on the delivery pressure gauge.
- Open the outlet valve and readjust the delivery pressure if required.
- It is recommended to have on hand, a leak-test solution such as SNOOP® to detect leaks in connections. Leak-test solution should be sprayed or otherwise applied to regulator connections to confirm that there are no leaks.

14.2 Cryogenic Hazards

Cryogenics refers to very low temperature materials such as dry ice (solid CO_2) and liquefied air or gases like nitrogen and oxygen. The following potential hazards are associated with the use of cryogenics:

- Asphyxiation due to displacement of oxygen (does not apply to liquid air and oxygen);
- Materials becoming brittle and shattering from extreme cold;
- Extreme frostbite;
- Explosion due to pressure build up;
- Condensation of oxygen and fuel (e.g. hydrogen and hydrocarbons) resulting in explosive mixtures.

14.2.1 Precautions for Handling Cryogenic Materials and Vessels

When handling cryogenic materials:

- Always wear protection and insulated gloves to protect skin and eyes from contact;
- Use only low-pressure containers equipped with pressure-relief devices. Do not allow cryogenic preservation material to be stored in a sealed system;
- Use and store in well-ventilated areas;
- Keep away from sparks or flames, as appropriate;
- Minimize and control ice build-up;
- Use materials resistant to low temperature brittling and shattering (e.g. latex rubber tubing);
- Watches, rings, bracelets or other jewellery that could trap fluids against flesh should not be worn when handling cryogenic liquids;
- To prevent thermal expansion of contents and rupture of the vessel, do not fill containers to more than 80% of capacity;
- If cryogens must be transported by elevator, take adequate precautions to prevent possible injury. It is required to send cryogenic liquid tanks in elevators without any passengers and ensure that nobody gets on the elevator while the cryogen is being transported;
- Never use liquid nitrogen or liquid air as a cold trap to collect a flammable or combustible material mixed with air. Oxygen may condense from the air and lead to an explosion hazard;
- Dry ice/solvent cooling baths should be prepared carefully by the slow addition of small amounts of the solid dry ice to the solvent to avoid excessive frothing and overflow of the solvent;
- Never lower your head into a dry ice chest since a high level of CO_2 may accumulate there posing an asphyxiation hazard;

15 PHYSICAL HAZARDS AND ERGONOMICS

There are a number of common physical characteristics of laboratories that are of potential safety concern.

15.1 General Guidelines to Reduce Physical Hazards

- Do not block access to emergency safety equipment such as fire extinguishers, eyewashes, showers, first aid kits or utility controls such as breaker boxes or gas shut-off valves;
- Avoid blocking exits or normal paths of travel: keep hallways, walkways and stairs clear of chemicals, boxes, equipment and shelf projections;
- Ensure that the weight of stored material does not exceed the load-bearing capacity of shelves or cabinets;
- Ensure that wall-mounted shelving has heavy-duty brackets and supports and is attached to studs or solid blocking. Regularly inspect clamps, supports, shelf brackets and other shelving hardware;
- Arrange items so that they do not overhang or project beyond the edges of shelves or counter tops;
- Do not stack materials so high that stability is compromised;
- Leave a minimum of 18 inches (45.7 cm) of clearance between sprinkler heads and the top of storage;
- Use a safety step or stepladder to access higher items; never stand on a stool or a chair;
- Store frequently used items between knee and shoulder height;
- Store heavy objects on lower shelves;

15.2 Glassware

- Repair, replace or dispose of any damaged glassware. Follow proper disposal procedures for damaged glassware; refer to Section 12.6 for further details;
- Ensure that you are using gloves that provide adequate protection when working with glass tubing; at a minimum, latex gloves;
- Tape permanent vacuum glassware which presents an implosion risk with either electrical or duct tape or use appropriate shielding;
- Ensure that you are using gloves that provide adequate protection when picking up broken glass; at a minimum, latex gloves;
- When using and handling specialized glassware, ensure that you have had proper instruction and training on its safe and effective use;

- Specific procedures may apply for contaminated glassware. i.e. glassware contaminated with biohazardous materials must be handled differently than chemical contamination. Refer to UFV Biosafety Manual for details of handling glassware with biohazardous contamination.

15.3 Systems Under Pressure or Vacuum

Never heat or carry out a reaction in a closed vessel unless it is designed or tested to withstand the expected pressure of the reaction. Pressurized equipment must have an appropriate pressure release valve. Pressurized equipment must be shielded, guarded, or designed to protect the operator against potential explosions.

The corollary applies to systems under vacuum. Never create a vacuum in a closed vessel that is not designed or tested to withstand the expected vacuum pressure of a reaction or process. Vacuum-pressure rated equipment must have an appropriate vacuum-release valve. Vacuum-pressure rated equipment must have a label with a vacuum pressure specification rating indicating the range of pressure that it has been designed to be implosion-proof for.

Compressed air sources on laboratory benches must be carefully utilized. When utilizing compressed air through connecting rubber hoses, ensure that all hose connections are snug and tight before opening valve. Compressed air valve handles should be opened slowly to prevent sudden increases in pressure of an enclosed system. Compressed air should never be directed towards a person and personnel are recommended to wear eye goggle protection when working with compressed air.

15.4 Backflow Preventers

All gooseneck water faucets to which a hose is attached in a laboratory must be equipped with an appropriate backflow preventer. This prevents the contamination of the drinking water system.

15.5 Electrical Safety

Electrically powered equipment including but not limited to 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 workers, 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.

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.

15.5.1 Preventing Electrical Hazards

There are various ways of protecting people from the hazards caused by electricity, including insulation, guarding, grounding, and electrical protective devices. Laboratory workers can significantly reduce electrical hazards by following some basic precautions:

- Inspect wiring of equipment before each use. Replace damaged or frayed electrical cords immediately.
- Use safe work practices every time electrical equipment is used.
- Know the location and how to operate shut-off switches and/or circuit breaker panels. Use these devices to shut off equipment in the event of a fire or electrocution.
- Limit the use of extension cords. Use only for temporary operations and then only for short periods of time. In all other cases, request installation of a new electrical outlet.
- Multi-plug adapters must have circuit breakers or fuses.
- Place exposed electrical conductors (such as those sometimes used with electrophoresis devices) behind shields.
- Minimize the potential for water or chemical spills on or near electrical equipment.

15.5.2 Insulation

All electrical cords should have sufficient insulation to prevent direct contact with wires. In a laboratory, it is particularly important to check all cords before each use, since corrosive chemicals or solvents may erode the insulation.

Damaged cords should be repaired or taken out of service immediately, especially in wet environments such as cold rooms and near water baths.

15.5.3 Guarding

Live parts of electric equipment operating at 50 volts or more (i.e., electrophoresis devices) must be guarded against accidental contact. Plexiglas shields may be used to protect against exposed live parts.

15.5.4 Grounding

Only equipment with three-prong plugs should be used in the laboratory. The third prong provides a path to ground for internal electrical short circuits, thereby protecting the user from a potential electrical shock.

15.5.5 Circuit Protection Devices

Circuit protection devices are designed to automatically limit or shut off the flow of electricity in the event of a ground-fault, overload or short circuit in the wiring system. Ground-fault circuit interrupters, circuit breakers and fuses are three well-known examples of such devices.

Fuses and circuit breakers prevent over-heating of wires and components that might otherwise create fire hazards. They disconnect the circuit when it becomes overloaded. This overload protection is very useful for equipment that is left on for extended periods of time, such as stirrers, vacuum pumps, drying ovens, Variacs and other electrical equipment.

The ground-fault circuit interrupter, or GFCI, is designed to shutoff electric power if a ground fault is detected, protecting the user from a potential electrical shock. The GFCI is particularly useful near sinks and wet locations. Since GFCIs can cause equipment to shutdown unexpectedly, they may not be appropriate for certain apparatus. Portable GFCI adapters (available in most safety supply catalogues) may be used with a non-GFCI outlet.

15.5.6 Motors

In laboratories where volatile flammable materials are used, motor-driven electrical equipment should be equipped with non-sparking induction motors or air motors.

Avoid series-wound motors, such as those generally found in some vacuum pumps, rotary evaporators and stirrers. Series-wound motors are also usually found in household appliances such as blenders, mixers, vacuum cleaners and power drills. These appliances should not be used unless flammable vapours are adequately controlled.

Although some newer equipment has spark-free induction motors, the on-off switches and speed controls may be able to produce a spark when they are adjusted because they have exposed contacts. One solution is to remove any switches located on the device and insert a switch on the cord near the plug end.

15.5.7 Safe Work Practices

The following practices may reduce risk of injury or fire when working with electrical equipment:

- Avoid contact with energized electrical circuits.
- Use guarding around exposed circuits and sources of live electricity.
- Disconnect the power source before servicing or repairing electrical equipment.
- 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.
- If it is safe to do so, work with only one hand, keeping the other hand at your side or in your pocket, away from all conductive material. This precaution reduces the likelihood of accidents that result in current passing through the chest cavity.
- 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 or pull out the plug using a leather belt.
- All electrical installations must conform to the provisions of the BC electrical code ;
- All electrical equipment must be CSA approved ;
- Extension cords should not be used for permanent installations. Contact Facilities to install or relocate outlets in close proximity to the equipment;
- Use ground fault circuit interrupters where there is a risk of an operator coming in simultaneous contact with water and electrical equipment;
- Only trained, qualified employees may repair or modify electrical or electronic equipment;
- Power bars should not be located beneath work benches where chemicals are handled.

15.6 Ergonomics

Ergonomics is concerned with how the workplace "fits" the worker. Performing certain work tasks without regard for ergonomic principles can result in:

- Fatigue;
- Repetitive motion injuries;
- Strains, aches and injuries from biomechanical stresses;
- Eyestrain from video display terminals (VDTs);
- Decreased worker morale.

Factors that can increase the risk of musculoskeletal injury are:

- Awkward positions or movements;

- Repetitive movements;
- Application of force.

General guidelines for maximizing ergonomic comfort for UFV laboratory workers include:

- Maintaining suitable heights of laboratory workbenches for all employees;
- Laboratory chairs are on wheels or castors, are sturdy (5-legged), and are position-adjustable for seat height, angle, and backrest height;
- Computer monitor screens are positioned at or slightly below eye level, and are positioned so as to avoid glare from lights or windows;
- Computer keyboards and pointing devices are positioned so that wrists are kept in a neutral position and forearms are horizontal;
- Color, lettering size and contrast of images on the computer monitors should be optimized/customized by the operator through the operating system control panel and/or monitor adjustment knobs, for comfort and minimal eye strain;
- Work station design does not necessitate excessive bending, reaching, stretching or twisting;
- Vibration-producing equipment, such as vortex mixers and pump-type pipettors are not used for extended periods of time;
- Buttons and knobs on equipment are accessible and of a good size;
- Aids such as carts and dolly's are available for transport of heavy and/or bulky items;
- Employees are informed on proper techniques for lifting or moving heavy materials (ie. utilizing upper legs, and not the lower back to bear the weight);
- Indoor air quality parameters, such as temperature, humidity and air supply are maintained at comfortable set-points (suggested conditions: 21-23°C, 30-60% Relative Humidity , 4-12 air changes/hr);
- Floors are slip-resistant;
- Noise levels are not excessive and constant to the point of causing worker discomfort.

16 EQUIPMENT SAFETY

When procuring and purchasing new lab equipment at UFV, preference should be given to equipment that:

- Limits contact between the operator and hazardous material, and mechanical and electrical energy;
- Is corrosion-resistant, easy to decontaminate and impermeable to liquids; and
- Has no sharp edges or burrs.

All efforts should be made to prevent equipment from becoming contaminated and spreading contamination. To reduce the likelihood of equipment malfunction that could result in leakage, spill or unnecessary generation of aerosolized contaminants:

- Review the equipment manufacturer's documentation. Keep for future reference;
- Use and service equipment according to the manufacturer's instructions;
- Ensure that anyone who uses a specific instrument or piece of equipment is properly trained in setup, use and cleaning of the item;
- Ensure that equipment leaving the laboratory for servicing or disposal is appropriately decontaminated.

Some larger pieces of equipment that utilize electricity to operate also require down time for regular scheduled maintenance and/or repair. A specific UFV lockout procedure must be followed to ensure the safety of the maintenance/repair person. The procedure in brief includes:

- All locks/keys for the lock-out system will be supplied by UFV to employees. No other lock and keys are permitted.
- Every person must use their own lock and not work under another person’s lock.
- Facility Manager is to be notified of work to be done.
- Isolate equipment and lock-out by attaching your personal lock to the isolation point and place lock-out tag at that location.
- On electrical equipment, employees have the lock-out isolation checked by an electrician if there is any doubt that equipment is turned off.
- Do not work on equipment unless you are absolutely sure it is locked off with your lock and cannot be started.
- Upon completion of work, inspect to ensure equipment is safe to use before removing locks.

The following sections outline some of the precautions and procedures to be observed with some commonly used laboratory equipment.

16.1 Equipment Maintenance

Laboratory equipment, including autoclaves, fume hoods and biological safety cabinets, must be inspected and maintained by a competent person. The frequency of these inspections depends on the hazard(s) posed by the equipment, the manufacturer's instructions and as required by legislation. Maintenance records must be provided to the Manager so that they can be kept on file.

16.2 Biological Safety Cabinet (BSC)

Before a person is allowed to use the Biological Safety Cabinet (BSC), he/she will need to receive documented training as specified in the Laboratory Biosafety Manual. Please contact the Biosafety Officer or the Manager for more information.

16.3 Fume Hood

The fume hood is the primary protective device in most laboratories for protecting workers from exposure to hazardous chemicals. It is designed to contain, dilute and disperse gases, vapours and aerosols to the external environment. It is also an integral part of the building air handling system. It is imperative that the fume hood be functioning properly at all times.
Fume hoods that are in good condition, properly functioning and used as intended are vital to everyone's safety. The following list contains procedures that must be followed.

- Fume hoods must to be tested annually by a qualified individual and records of these inspections are to be kept on file by the Department or designate.
- Any work that involves hazardous or odorous chemicals should be completed in a fume hood.
- During experiments, equipment and chemicals should be kept a minimum of six inches away from the sash.
- When working with environmentally hazardous materials, it is imperative that the fume hood sink be protected with a barrier that will stop any spilled material from entering the sink drain. The use of a chemically compatible absorbent mat or sock should be used to protect the drain.
- Equipment and materials should not be stored in a fume hood for extended periods of time; the hood should not be considered a storage facility.
- Never place your head inside the fume hood when chemicals are present.
- Fume hoods must not be considered a substitute for PPE.

- Electrical devices should be connected outside the hood to avoid sparks and possible ignition.
- Equipment in the hood should be solidly positioned a few inches above the working surface to maximize air flow.
- Ideally, the fume hood will be situated away from heavily used walkways since foot traffic (air currents) can disrupt the proper operation of this device causing gases and vapours to escape.
- Keep the interior of the hood clean and tidy.
- Completely close the sash when the fume hood is on and left unattended.
- A label has been placed on fume hoods indicating optimal sash height. Do not raise sash higher than this marking when fume hood is in use.
- In emergency situations such as fires, gaseous emissions, or spills in a fume hood, always pull the sash down completely and assure hood fans are turned on.
- If you are unsure of the proper operation of the fume hood, contact your supervisor for directions.
- **Do not conduct work in a malfunctioning fume hood.**

In case of fume hood malfunction, do the following:

- Discontinue use of fume hood immediately.
- Inform your supervisor or Biology laboratory technologist.
- Inform any other affected person until fume hood is locked-out.

16.4 Autoclave

The autoclave, which uses saturated steam under pressure, is one of the most dependable methods available in the laboratory for the inactivation of all forms of microbial life. To ensure safety and quality control, all biohazardous materials and items contaminated with potentially infectious agents must be decontaminated before use or disposal. Such items include, but are not limited to: culture media, surgical instruments, laboratory equipment, glassware, and biomedical waste including sharps. Steam sterilization is not recommended for anhydrous substances, flammable materials, electrical equipment or any item that may be damaged in the autoclaving process.

The following is a list of general safety rules that must be adhered to:

- Only those who have received documented training from a competent person (e.g. Biology laboratory technologist) can use the autoclave.
- If steam is leaking around the door during the sterilization process, the door has not been sealed properly. Advise your supervisor immediately.

- All potentially infectious materials must be autoclaved before being washed, stored, or disposed as biohazardous waste.
- Never leave un-sterilized material inside the autoclave or sitting in the autoclave room overnight.
- Never autoclave materials that contain toxic agents or volatile chemicals.
- Do not stack or store combustible materials such as cardboard and plastic containers or flammable liquids next to the autoclave.
- All biohazardous waste that is to be autoclaved must first be placed in an approved and labelled autoclave bag.
- Do not double bag waste. Autoclave bags are designed to be permeable to steam but a double bag will hinder the flow of the steam through the bag.
- Do not overfill bags as this may interfere with the sterilization process due to poor steam circulation.
- Sharps such as needles and scalpel blades must be placed in an approved, labelled, and rigid sharps container before sterilizing.
- Do not place sharp pipettes or broken glass in bags.
- Be sure to loosen the caps on the vessels to allow for pressure build up during the process and to avoid the vessel exploding when being removed from the autoclave chamber.
- Efficacy monitoring of autoclaves used for decontamination with biological indicators must be done regularly (i.e., consider weekly, depending on the frequency of use of the autoclave), and the records of these results and cycle logs (i.e., time, temperature and pressure) must also be kept on file.

16.5 Centrifuges

Improperly used or maintained centrifuges can present significant hazards to users. Failed mechanical parts can result in release of flying objects, hazardous chemicals and biohazardous aerosols. The high speed spins generated by centrifuges can create large amounts of aerosol if a spill, leak or tube breakage occurs. To avoid contaminating your centrifuge:

- Check glass and plastic centrifuge tubes for stress lines, hairline cracks and chipped rims before use. Use unbreakable tubes whenever possible;
- Avoid filling tubes to the rim;
- Use caps or stoppers on centrifuge tubes. Avoid using lightweight materials such as aluminum foil as caps;
- Use sealed centrifuge buckets (safety cups) or rotors that can be loaded and unloaded in a biological safety cabinet. If necessary, clean and decontaminate the outside of the cups or buckets before and after centrifugation. Inspect o-rings regularly and replace if cracked or dry;
- Ensure that the centrifuge is properly balanced;
- Do not open the lid until the rotor head has come to a complete stop.

- Do not attempt to stop a spinning rotor by hand or with an object, or interfere with the interlock safety device;
- Decant supernatants carefully and avoid vigorous shaking when re-suspending;

When using high-speed or ultra centrifuges, additional practices should include:

- Connect the vacuum pump exhaust to a trap;
- Record each run in a logbook: keep a record of speed and run time for each rotor;
- Install a HEPA filter between the centrifuge and the vacuum pump when working with biohazardous material;
- Never exceed the specified speed limitations of the rotor.

16.6 Heated Water Baths/Circulating Baths, Ultrasonic baths

Heated water baths and circulating water baths keep immersed materials immersed at a constant temperature. They may be filled with a variety of materials, depending on the bath temperature required; they may contain water, mineral oil, glycerin, paraffin or silicone oils, with bath temperatures ranging up to 300^{o}C.

The following precautions are appropriate for heating baths:

- Set up baths on a stable surface, away from flammable and combustible materials including wood and paper;
- Relocate only after the liquid inside has cooled;
- Ensure baths are equipped with redundant heat controls or automatic cutoffs that will turn off the power if the temperature exceeds a preset limit;
- Use with the thermostat set well below the flash point of the heating liquid in use;
- Use a thermometer to allow a visual check of the bath temperature.

The most common heating bath and/or circulating bath used in laboratories are the water bath. When using a water bath:

- Do not overfill bath beyond design specifications;
- Clean regularly; a disinfectant, such as a phenolic detergent, can be added to the water;
- Avoid using sodium azide to prevent growth of microorganisms; sodium azide forms explosive compounds with some metals;
- Raise the temperature to 90^{o}C or higher, if applicable for 30 minutes once a week for decontamination purposes;
- Unplug the unit before filling or emptying, and have the continuity-to-ground checked regularly;

Ultrasonic baths present unique hazards to laboratory employees if not handled properly. The purpose such equipment is to expose the work-piece to vibratory energy of sufficient intensity to bring about a permanent physical change. The main hazard to the user is from accidental contact exposure to the

ultrasonic wave. However, many industrial and commercial uses of ultrasound also incidentally generate and propagate high sound-pressure levels in the air in the sonic and ultrasonic range. When this happens, a hazard may also arise from the ear's reception of the airborne ultrasound.

Contact exposure to high-power ultrasonic energy sources must be avoided at all times.

The following precautions are recommended to ensure the safe use of ultrasonic baths:

- Limited surrounding exposure -only operators familiar with the safe use of high-power ultrasonic bath equipment should be allowed within the boundaries of the controlled area while the equipment is operating. Exposure to others in the surrounding area is easily preventable.
- Use of PPE -Personnel using high-power ultrasonic baths should be knowledgeable about the possible harmful effects of ultrasonic energy and take preventative measure such as wearing protective hearing devices (disposable ear plugs) and gloves while operating equipment.
- Use of signage -a warning sign for ultrasonic energy sources in a laboratory is recommended for use, see below. Warning signs should be placed at or near the vicinity of the high power energy source. Accompanying each warning sign there should also be a statement indicating the precautionary measures to be taken while the ultrasound power is on (ie. Wear hearing protection). Labels should be placed on all ultrasonic cleaning tanks cautioning nearby personnel not to immerse hands or other parts of the body in the tank while it is operating.

16.7 Ovens and Hot Plates

Laboratory ovens are useful for baking or curing material, off-gassing, dehydrating samples and drying glassware.

- Ensure that oven design prevents contact between flammable vapours and heating elements or spark-producing components.
- Discontinue use of oven if the backup thermostat, pilot light or temperature controller has failed
- Avoid heating toxic materials in an oven unless it is vented outdoors (via a canopy hood, for example).
- Never use laboratory ovens for preparation of food for human consumption.
- Ensure that glassware placed in an oven is designed to handle the high temperatures.
- Glassware that has been rinsed with an organic solvent should be rinsed with distilled water before it is placed in a drying oven.

Hot plates in a laboratory setting also present potential hazards. Personnel using hot plates should be aware of the following:

- A typical hotplate will not appear to be obviously hot, especially shortly after it has been shut off. Personnel should have a sign and/or verbally communicate to other persons in the laboratory that a hot plate is in use.

- Glassware that is placed on a hotplate must be rated to withstand the temperature of a hotplate and must not be cracked. Otherwise, there is risk of shattering and spillage of contents.
- Never allow contents in glassware to heat to dryness on a hotplate as this may lead to cracking or breakage of glassware.
- Glassware and other containers place on a hotplate should be handled with appropriate gloves to prevent burning and scalding

16.8 Shakers, Blenders and Sonicators

When used with infectious biological agents, mixing equipment such as shakers, blenders, sonicators, grinders and homogenizers can release significant amounts of hazardous aerosols, and should be operated inside a biological safety cabinet whenever possible. Equipment such as blenders and stirrers can also produce large amounts of flammable vapours. The hazards associated with this type of equipment can be minimized by:

- Selecting and purchasing equipment with safety features that minimize leaking;
- Selecting and purchasing mixing apparatus with non-sparking motors;
- Checking integrity of gaskets, caps and bottles before using and replacing damaged components;
- Allowing for any potential aerosols to settle for at least one minute before opening containers;
- For blending of potentially biohazardous materials, cover the top of blenders with a disinfectant-soaked towel during operation and conduct blending operation in biosafety cabinet if possible;
- When using a sonicator, immersing the tip deeply enough into the solution to avoid creation of aerosols.

16.9 Microwave Ovens

Microwave ovens are potentially dangerous because of potential for exposure to microwave radiation. The following safety tips apply for operation and maintenance of microwave ovens in laboratories:

- Do not operate oven when empty.
- Exercise extreme caution if you have a pacemaker implant. Microwave radiation may cause pacemaker interference. Persons with pacemaker implants should not be near a microwave oven unless they are sure that it is in good operating condition and there is no leakage of microwave radiation.
- After each use, check to ensure that door seal and inside surfaces of door and oven cavity are clean.
- Do not put face close to door window when oven is operating.
- Ensure that the microwave is unplugged or disconnected from electrical power before reaching into any accessible openings or attempting any repairs.
- Ensure that the adjustment of applied voltages, replacement of the microwave power generating component, dismantling of the oven components, and refitting of waveguides are

undertaken only by qualified persons. The services of a qualified repairman should be sought when any malfunction is suspected.
- Do not bypass the door interlocks.
- Do not test a microwave power generating component without an appropriate load connected to its output. The power generated must never be allowed to radiate freely into occupied areas.

16.10 Ultraviolet Lamps

Exposure to ultraviolet light (UV) may result in serious and painful injury to the eyes or skin depending on the specific wavelength of the light to which the individual is exposed, the intensity of the light and the duration of exposure. That is why it is essential that the following safety precautions:

- Conspicuously label all UV light sources with the following warning (or equivalent) "Warning – this device produces potentially harmful UV light. Protect eyes and skin from exposure."
- Shield UV light sources.

Ensure that appropriate PPE is worn and is sufficient to protect the eyes and skin. PPE should include at least UV resistant face shield, gloves and lab coat.

16.11 Shielding

Appropriate shielding must be used whenever an operation involves working with chemicals that have the potential of exploding or severely splashing. Examples include:

- When a reaction is attempted for the first time.
- When a familiar reaction is carried out on a larger scale than usual.
- Whenever operations are carried out under non-ambient conditions.
- Whenever a severe splashing potential exists for corrosive materials.

Shielding or equivalent precautions are to be used when working with non-ionizing radiation sources, magnetic or other fields. Examples include:

- Lasers
- Infrared radiation
- Ultraviolet radiation
- Microwave radiation

Appropriate shielding is also required when using equipment with thermal hazards.

16.12 Safe use of Analytical Equipment

The following are general guidelines for safe use of analytical equipment:.

- Ensure that installation, modification and repairs of analytical equipment are carried out by authorized service employees;
- Read and understand the manufacturer's instructions before using this equipment;
- Make sure that preventive maintenance procedures are performed as required;
- Do not attempt to defeat safety interlocks;
- Wear safety glasses and lab coats (and other appropriate PPE as specified) for all procedures.

Refer to each UFV laboratory for specific analytical equipment.

16.13 Mass spectrometers (MS)

Mass spectrometry requires the handling of compressed gases and flammable and toxic chemicals. Consult MSDSs for products before using them. Specific precautions for working with the mass spectrometer include:

- Avoid contact with heated parts while the mass spectrometer is in operation.
- Verify gas, pump, exhaust and drain system tubing and connections before each use.
- Ensure that pumps are vented outside the laboratory, as pump exhaust may contain traces of the samples being analyzed, solvents and reagent gas.
- Used pump oil may also contain traces of analytes and should be handled as hazardous waste.

16.14 Gas chromatographs (GC)

Gas chromatography requires handling compressed gases (nitrogen, hydrogen, argon, helium), and flammable and toxic chemicals. Consult product MSDSs before using such hazardous products. Specific precautions for working with gas chromatographs include:

- Perform periodic visual inspections and pressure leak tests of the sampling system plumbing, fittings and valves.
- Follow the manufacturer's instructions when installing columns. Glass or fused capillary columns are fragile: handle them with care and wear safety glasses to protect eyes from flying particles while handling, cutting or installing capillary columns.
- Turn off and allow heated areas such as the oven, inlet and detector, as well as connected hardware, to cool down before touching them.

- Avoid electrical shock, and turn off the instrument and disconnect the power cord at its receptacle whenever the access panel is removed.
- Turn off the hydrogen gas supply at its source when changing columns or servicing the instrument.
- The use of hydrogen as fuel (flame ionization FID and nitrogen-phosphorus detectors NPD), ensure that a column or cap is connected to the inlet fitting whenever hydrogen is supplied to the instrument to avoid buildup of explosive hydrogen gas in the oven.
- Measure hydrogen gas and air separately when determining gas flow rates.
- Perform a radioactive leak test (wipe test) on electron capture detectors (ECDs) at least every 6 months for sources of 50MBq (1.35 mCi) or greater.
- Ensure that the exhaust from (ECDs) is vented to the outside.
- When performing split sampling, connect the split vent to an exhaust ventilation system or appropriate chemical trap if toxic materials are analyzed or hydrogen is used as the carrier gas.
- Use only helium or nitrogen gas, never hydrogen, to condition a chemical trap.

16.15 Nuclear magnetic resonance (NMR) equipment

The superconducting magnet of NMR equipment produces strong magnetic and electromagnetic fields that can interfere with the function of cardiac pacemakers. Users of pacemakers and other implanted ferromagnetic medical devices are advised to consult with their physician, the pacemaker's manual and pacemaker manufacturer before entering facilities which house NMR equipment. Precautions for work with NMR include the following:

- Post clearly visible warning signs in areas with strong magnetic fields.
- Measure stray fields with a gaussmeter, and restrict public access to areas of 5-gauss or higher.
- Keep all tools, equipment and personal items containing ferromagnetic material (e.g., steel, iron) at least 2 metres away from the magnet. The strong magnetic field can suddenly pull nearby unrestrained magnetic objects into the magnet with considerable force.
- Advise users that the magnetic field can erase magnetic media such as tapes and floppy disks, disable credit and automated teller machine (ATM) cards, and damage analog watches.
- Avoid skin contact with cryogenic (liquid) helium and nitrogen; wear a protective face mask and loose-fitting thermal gloves during dewar servicing and when handling frozen samples. Refer to Section 14, "Compressed Gases and Cryogenics".
- Ensure that ventilation is sufficient to remove the helium or nitrogen gas exhausted by the instrument.
- Avoid positioning your head over the helium and nitrogen exit tubes.
- NMR tubes are thin-walled; handle them carefully and reserve them for NMR use only.

16.16 High-pressure liquid chromatography (HPLC) equipment

HPLC procedures may require handling of compressed gas (helium) and flammable and toxic chemicals. Familiarize yourself with the hazardous properties of these products, as well as recommended precautionary measures, by referring to MSDSs.

- Inspect the drain system regularly; empty the waste container frequently when using organic solvents.
- Ensure that waste collection vessels are vented.
- Never use solvents with autoignition temperatures below 110oC.
- Be sure to use a heavy walled flask if you plan to use vacuum to degas the solvent.
- Never clean a flowcell by forcing solvents through a syringe: syringes under pressure can leak or rupture, resulting in sudden release of syringe contents.
- Switch off the electrical power and disconnect the line cord when performing routine maintenance of the pump. High voltage and internal moving parts are present in the pump. Shut down and allow the system to return to atmospheric pressure before carrying out maintenance procedures.

16.17 Liquid chromatography (LC/MS) equipment

LC/MS requires the handling of compressed nitrogen and flammable and toxic chemicals. Consult product MSDSs before using them. Specific precautions for working with LC/MS equipment include:

- Verify gas, pump exhaust and drain system tubing and connections before each use.
- Test the pressure switch for the exhaust line before each use.
- Ensure that pumps are vented outside the laboratory.

16.18 Glassware Safety

- Use a dustpan and brush, not your hands, to pick up broken glass;
- Discard broken glass in a rigid container separate from regular garbage and label it appropriately (refer to Section 12.6 for glass waste);
- Protect glass that is subject to high pressure or vacuum. Wrapping glass vessels with cloth tape will minimize the possibility of projectiles;
- Glass is weakened by everyday stresses such as heating and bumping. Handle used glassware with extra care;
- Discard or repair all damaged glassware, as chipped, cracked or star-cracked vessels cannot be expected to endure stress from normal use.

16.18.1 Handling Glass Rods or Tubes

- Fire polish the ends,
- Lubricate with water or glycerin when inserting through stopper,
- Ensure stopper holes are properly sized, and not too small,
- Insert carefully, with a slight twisting motion, keeping hands close together along the side, never over the end of the rod or tube, and
- Use gloves or a cloth towel to protect your hands

16.18.2 Glass Thermometers and Barometers Containing Mercury

- These instruments must be handled with care to avoid breakage and release of mercury droplets.
- Store instruments in a manner that minimizes chances of being accidentally smashed, dropped or otherwise broken.
- Wear gloves when handling instruments
- Do not expose instruments to temperature or pressure extremes, to avoid breakage.
- If these instruments are broken, carefully clean area of broken glass and dispose of as described in Section 12.6. For directions on cleanup and disposal of mercury waste, refer to Appendix XXXX.

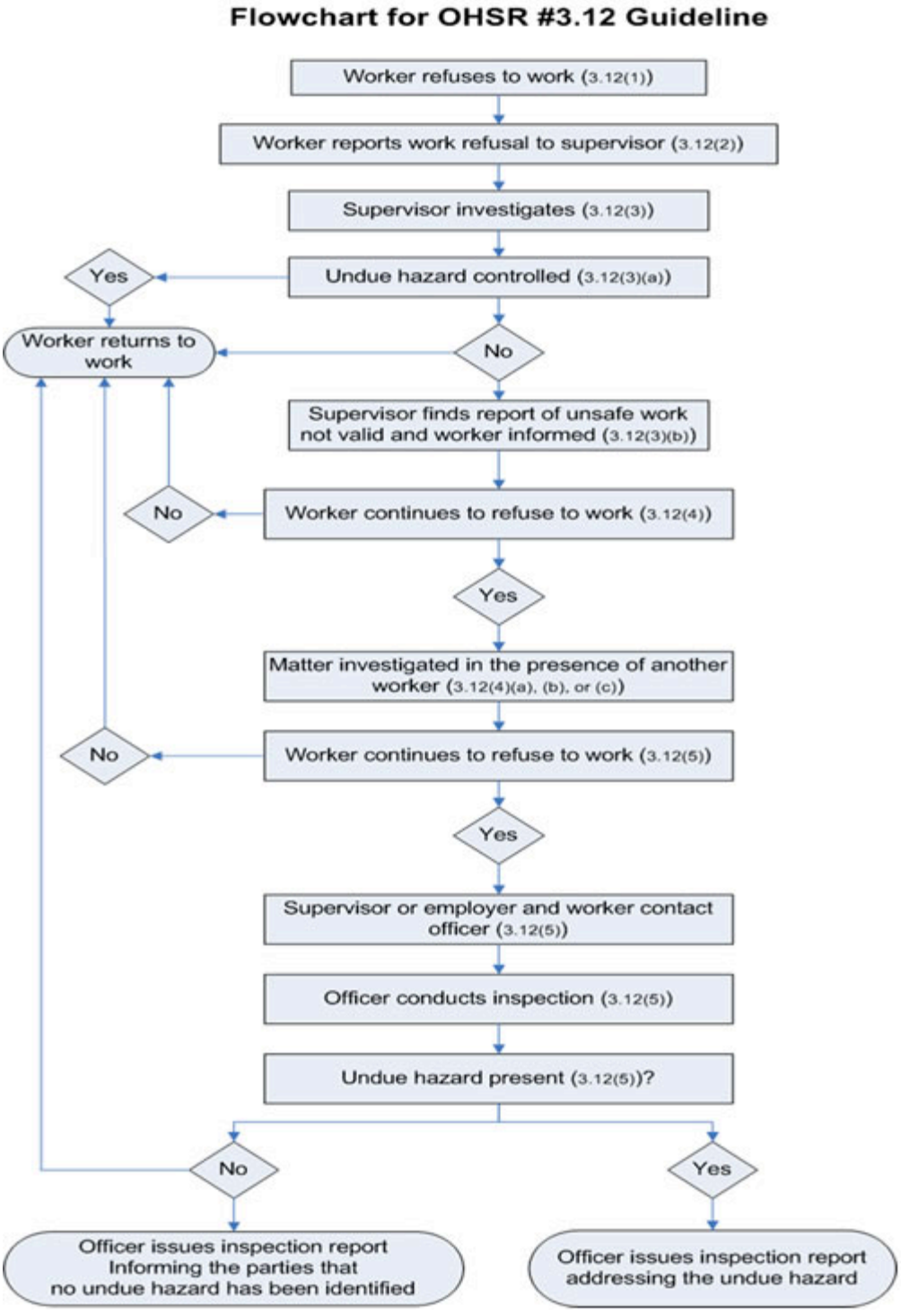
16.18.3 Types of Glass

Laboratory Glassware is made from many different variations and formulations. The following Table outlines brief definitions of some glass types and descriptions of their characteristics. This information is to be used as a guideline only—all materials should be tested under actual conditions before used in specific applications.

Glass type/Trade name	Characteristics and Properties
Corning® Pyrex® 7740	A borosilicate, low expansion Type I glass designed for use in all products requiring very high resistance to strong acids or alkalis and in products intended for use in heat applications such as autoclaves, hot plates, and open flame. Examples include Pyrex® beakers, burettes, centrifuge tubes, cylinders, desiccators, dishes, flasks, fritted ware, funnels, and jars.
Corning® Vycor® 7913	This material is formed as a borosilicate type glass. It is then subjected to a chemical treatment that removes most of the elements in the glass except silica (SiO_2). Glass is then reheated to eliminate the microscopic holes caused by the chemical treatment. Only quartz has higher silica content. It is designed for use in all products that must withstand very high temperatures or thermal shock. Since Corning is the only company that makes VYCOR® there are no federal or ASTM standards. Examples include evaporating dishes 34587-20 and -22.
Corning® PyrexPlus®	This laboratory glassware is Pyrex® brand borosilicate glass labware which has been coated with a tough, transparent plastic vinyl. The coating, which is applied to the outside of the vessel, helps prevent exterior surface abrasion. It also helps minimize

	the loss of contents and helps contain glass fragments if the glass vessel is broken. The recommended temperature range for PyrexPlus® labware is 10 deg C to 80 deg C.
Wheaton 180	An exceptionally clear borosilicate glass of high chemical durability which has been especially formulated for the lowest background count while still at a reasonable cost. Great care has been taken to select only those ingredients for the batch that would not cause unwanted background count or color. Potassium as a separate element has been excluded from the batch to minimize K40. Special controls ensure high quality and batch to batch uniformity.
Wheaton 200	Also referred to as Wheaton-33® low extractable borosilicate glass, is a borosilicate glass with exceptional thermal endurance that meets the requirements of Federal specification DD-G-541b, glass (laboratory), for both USP and ASTM Type I, borosilicate glass Class A. This glass meets all sterilization requirements. Examples include sample bottles 08913-15, -25, -45 and -55, and large sample vials 08918-22, -23 and -24.
Wheaton 400	Also known as No-Sol-Vit, is a borosilicate glass that falls well within the limits for USP Type I chemically resistant borosilicate glass, as specified in the XXIII revision of the U.S. Pharmacopoeia. Examples include safety-coated wide-mouth bottles 34501-20, -50 and -70.
Wheaton 800	a superior soda-lime flint glass that meets requirements for USP Type III soda-lime glass as specified in the XXIII Revision of the U.S. Pharmacopoeia. Examples include clear safety-coated bottles 08922-50 and -60.
Wheaton 900	Similar in formulation to Wheaton 800 glass except it is amber coloured which provides light sensitivity. Examples include amber safety-coated bottles 08922-55 and -65.

APPENDIX 1 - OHSR FLOWCHART



APPENDIX 2 - WHMIS CLASSIFICATION

Class and Symbol	Characteristics	Precautions
Class A Compressed Gas 	• Gas inside cylinder is under pressure • The cylinder may explode if heated or damaged • Sudden release of high pressure gas streams may puncture skin and cause fatal embolis	• Transport and handle with care • Make sure cylinders are properly secured • Store away from sources of heat or fire • Use proper regulator
Class B Flammable and Combustible Material 	• May burn or explode when exposed to heat, sparks or flames • Flammable: burns readily at room temperature • Combustible: burns when heated	• Store away from Class C (oxidizing materials) • Store away from sources of heat, sparks and flame • Do not smoke near these materials
Class C Oxidizing Material 	• Can cause other materials to burn or explode by providing oxygen • May burn skin and eyes on contact	• Store away from Class B (flammable and combustible) materials • Store away from sources of heat and ignition • Wear the recommended protective equipment and clothing
Class D Poisonous and Infectious Material  **Division 1:** Materials Causing Immediate and Serious Toxic Effects	• May cause immediate death or serious injury if inhaled, swallowed, or absorbed through the skin	• Avoid inhaling gas or vapors • Avoid skin and eye contact • Wear the recommended protective equipment and clothing • Do not eat, drink or smoke near these materials • Wash hands after handling
Class D Poisonous and Infectious Material 	• May cause death or permanent injury following repeated or long-term exposure • May irritate eyes, skin and breathing passages: may lead to chronic lung problems and skin sensitivity • May cause liver or kidney damage, cancer,	• Avoid inhaling gas or vapors • Avoid skin and eye contact • Wear the recommended protective equipment and clothing

Division 2: Materials Causing Other Toxic Effects	birth defects or sterility	• Do not eat, drink or smoke near these materials • Wash hands after handling
Class D Poisonous and Infectious Material  **Division 3:** Biohazardous Infectious Materials	• Contact with microbiological agents (e.g., bacteria, viruses, fungi and their toxins) may cause illness or death	• Wear the recommended protective equipment and clothing • Work with these materials in designated areas • Disinfect area after handling • Wash hands after handling
Class E Corrosive Material 	• Will burn eyes and skin on contact • Will burn tissues of respiratory tract if inhaled	• Store acids and bases in separate areas • Avoid inhaling these materials • Avoid contact with skin and eyes • Wear the recommended protective equipment and clothing
Class F Dangerously Reactive Material 	• May be unstable, reacting dangerously to jarring, compression, heat or exposure to light • May burn, explode or produce dangerous gases when mixed with incompatible materials	• Store away from heat • Avoid shock and friction • Wear the recommended protective equipment and clothing

APPENDIX 3 – RECOMMENDED GLOVE MATERIALS FOR A VARIETY OF LABORATORY HAZARDS

Trademark names were included because the reader is likely to encounter them in the literature: consult laboratory or safety equipment suppliers, or the manufacturer, for more information on brand name gloves. Gloves not listed here may also be suitable; refer to the MSDS, glove manufacturer or permeation chart. The section on electricity is included for information purposes only, as all electrical work must be done by licensed electricians.

Hazard	Degree of Hazard	Recommended Material
Abrasion	Severe	Reinforced heavy rubber, staple-reinforced leather
	Less severe	Rubber, plastic, leather, polyester, nylon, cotton
Sharp edges	Severe	Metal mesh, staple-reinforced heavy leather, Kevlar, aramid-steel
	Less severe	Leather, terry cloth (aramid fibre)
	Mild with delicate work	Lightweight leather, polyester, nylon, cotton
Chemicals and liquids	Varies depending on the concentration, contact time, etc. Consult MSDS, manufacturer or permeation chart	Choice depends on chemical. *Examples*: natural, nitrile or butyl rubber, neoprene, PTFE (polytetrafluoroethylene), polyvinyl chloride, polyvinyl alcohol, Teflon™, Viton™, Saranex™, 4H™, Chemrel™, Barricade™, Responder™
Cold	Leather, insulated plastic or rubber, wool, cotton	
Heat	Over 350°C	Asbestos Zetex™
	Up to 350°C	Neoprene-coated asbestos, heat-resistant leather with linings, Nomex, Kevlar™
	Up to 200°C	Heat-resistant leather, terry cloth (aramid fibre) Nomex, Kevlar™
	Up to 100°C	Chrome-tanned leather, terry cloth
Electricity	Rubber-insulated gloves tested to appropriate voltage (CSA Standard Z259.4-M1979) with leather outer glove	
General duty	Cotton, terry cloth, leather	
Product contamination	Thin-film plastic; lightweight leather, cotton, polyester, nylon	
Radiation	Low to moderate radiotoxicity	Any disposable rubber or plastic glove

APPENDIX 4 - DOCUMENT REVISION HISTORY

Revision	Reason	Date
00	New Document	