UNBC UNIVERSITY OF NORTHERN BRITISH COLUMBIA

CHEMICAL LABORATORY SAFETY AND METHODOLOGY MANUAL

January 2022

Emergency Numbers

UNBC Prince George Campus

Security/First Aid	3333
Security/First Aid External	250-960-7058

(Security will contact additional personnel as required)

Non-Emergency Numbers

UNBC Prince George Campus

Chemstores	2-6472
Chemical Safety	2-6472
Radiation Safety	2-6472
Biosafety	2-5279
Manager, Health & Safety	2-5530
Security	2-7058

FORWORD

This reference manual outlines the safe use, storage, handling, waste and emergency management of chemicals on the University of Northern British Columbia (UNBC) campuses and for its researchers in the field. This information supplements and reiterates information provided in the Workplace Hazardous Materials Information System (WHMIS) and the Occupational Health and Safety (OHS) Regulations. If there is a difference between this manual and current WHMIS and OHS policy, those government policies take precedence.

ACKNOWLEDGMENTS

The materials used to develop this program were provided by a variety of reliable sources. We gratefully acknowledge the contributions of other universities.

DISCLAIMER

If a discrepancy is found between the contents of this manual and UNBC policy or government act or regulation, the policy, act, or regulation takes precedence.

Chapter 1 INTRODUCTION

1.1 Definitions

Principal Investigator—is the person to whom the laboratory space is assigned. This person supervises all laboratory workers within the space.

Supervisor—is the faculty or staff member under whom laboratory work or teaching occurs. Supervisors include Senior Lab Instructors, coordinators, managers, and Principal Investigators.

Laboratory Worker—includes any person who has regular or unsupervised access to restricted laboratory spaces for research or learning purposes, including employees (e.g., faculty, staff, teaching assistants, research assistants), post-doctoral fellows, research students, volunteers, adjunct professors, research fellows, and visiting scholars.

1.2 Purpose and Policy

The University of Northern British Columbia, (UNBC) is committed to providing a safe and healthy environment to all members of the University community. As stated in the University's Occupational Health and Safety Policy, it is the objective of the University to:

- protect the safety of employees, students and visitors against accidents and occupational hazards;
- comply with all relevant statutes, regulations and standards of government agencies and other regulatory authorities relevant to occupational health and safety (which will be considered minimum requirements);
- give priority to safe working conditions and job safety practices in the planning, budgeting, direction and implementation of the University activities; and
- formulate and carry out continuing effective safety programs appropriate to University operations.

1.3 Governmental Policies and Regulations

In order to protect against accidents and occupational hazards, personnel at UNBC must comply with all relevant governmental regulations while conducting their various work and research tasks whether they are working on or off-campus. These regulations include, but are not limited to the following:

- The Occupational Health and Safety (OHS) Regulations
  http://www2.worksafebc.com/
- Transportation of Dangerous Goods Regulations
  http://www.tc.gc.ca/
- Workplace Hazardous Materials Information System
  http://www.hc-sc.gc.ca/
- The Nuclear Safety and Control Act and Regulations
  http://www.cnsc-ccsn.gc.ca/
- Canadian Environmental Protection Act and Regulations
  http://www.ec.gc.ca/
- British Columbia Environmental Management Act and Regulations
  http://www.bclaws.ca/

- The National Fire Code of Canada
  http://www.nationalcodes.ca/
- British Columbia Fire Code
  http://www.housing.gov.bc.ca/

1.4 Related UNBC Policies

In addition to government regulations, UNBC laboratory workers are required to comply with UNBC policies. Current policies are located at http://www.unbc.ca/safety/policy.html . Some applicable laboratory policies are:

- Occupational Health and Safety Policy
- Hazardous Waste Identification, Reporting, and Disposal Policy
- Radionuclides and Radiation Hazard Policy
- Protective Clothing and Equipment Policy
- Fire Safety Policy
- Fieldwork Safety Policy
- Respectful in the Workplace Policy

1.5 UNBC Safety Committees

Committees that are mandated to cover specific aspects of safety at UNBC are listed below. Additional information on these committees, including Chair and membership information, can be found at: http://www.unbc.ca/safety/committees.html

- UNBC Joint Health & Safety Committee
- Research Ethics Board
- Laboratory Safety Committee
- Field Safety Committee
- Radiation Safety Committee
- Green University Planning Committee
- Animal Care and Use Committee (ACUC)

Chapter 2 RESPONSIBILITIES AND DUTIES

Chemical safety requires several levels of responsibility. The BC Workers' Compensation Board Occupational Health and Safety Regulation (Section 3.4[a]) clearly defines the roles and responsibilities of the employer, employee and students at UNBC. The list below applies these regulations to the roles and responsibilities of groups at UNBC

2.1 Employer

An employer must:

- Take every reasonable precaution to ensure the workplace is safe
- Train employees about any potential hazards and in how to safely use, handle, store, and dispose of hazardous substances and how to handle emergencies
- Supply personal protective equipment and ensure workers know how to use the equipment safely and properly
- Immediately report all critical injuries to the government department responsible for Occupational Health and Safety

2.2 Supervisor or Principal Investigator

A Supervisor or Principal Investigator must:

- Ensure that laboratory workers use prescribed protective equipment and devices
- Train laboratory workers how to safely use, handle, store, and dispose of hazardous substances specific to duties
- Advise laboratory workers of potential and actual hazards
- Take every reasonable precaution in the circumstances for the protection of laboratory workers (practice due diligence)
- Immediately report all injuries to the appropriate Safety Officer and the Manager, Health & Safety
- Maintain and post up-to-date emergency procedures in a prominent location
- All supervisors in a shared space or location are responsible for all workers in the shared location

2.3 Laboratory Users

Laboratory users will:

- Use personal protective equipment and clothing as directed by the employer
- Report workplace hazards and dangers
- Work in a manner as required by the employer/Supervisor/Principal Investigator and use the prescribed safety equipment

2.4 Chemical Safety Officer

The Chemical Safety Officer is the individual assigned to manage chemical safety issues and is a member of the UNBC Laboratory Safety Committee:

- Identify laboratory hazards and potential hazards and take steps to mitigate these hazards.
- Take steps to mitigate hazards identified by laboratory users, supervisors, and principal investigators.
- Develop and implement emergency procedures for chemical incidents.

- Act as point of contact in case of chemical emergencies (accidental spills, personnel contamination).
- Train personnel on general laboratory and chemical safety practices and procedures.
- Inform and educate employees and laboratory workers regarding laboratory and chemical safety issues.
- Provide technical advice regarding safe handling, storage, and disposal of chemicals.
- Maintain UNBC's chemical inventory database.
- Enforce institutional regulations, under the jurisdiction of the UNBC Safety Committee and the UNBC Joint Health and Safety Committee.

2.5 Laboratory Safety Committee

As indicated in its mandate, the Laboratory Safety Committee will:

- Make recommendations through the UNBC Joint Occupational Health and Safety Committee for changes to university policies and procedures to be adopted in departments conducting investigations involving laboratory work.
- Establish strategies to ensure ongoing and adequate surveillance, hazard identification, and risk evaluation of laboratory activities.
- Advise and assist all members of the university who have a role in promoting and communicating laboratory safety awareness.
- Receive and review reports concerning services, activities, incidents, and interventions involving laboratory activities and/or field work and to recommend corrective strategies where appropriate.

Chapter 3 GENERAL CHEMICAL SAFETY

When working with any chemical consider possible exposure routes:

- Inhalation
  - Gases
  - Organic vapors
  - Fine particulates and aerosols
- Injection
  - Needles
  - Broken glassware
- Ingestion
  - Laboratory hygiene
- Direct contact
  - Skin contact
  - Eye contact
  - Mucus membrane contact

3.1 Work Habits

- Do not store food or beverages in the laboratory
- Do not eat, drink, or smoke in the laboratory
- Do not work in the laboratory under the influence of drugs or alcohol
- Restrain loose clothing, long hair, and dangling jewelry
- Contact lenses are not to be worn
- Headphones are not to be worn
- Wash hands before and after work in a science laboratory
- Do not pipette by mouth
- Laboratory doors must be kept closed at all times, as per the BC Fire Code
- All aisles and doorways must be kept free of obstructions
- All safety showers, eye washes, and fire extinguishers must be kept free of obstructions
- All laboratory benches and work areas should be kept clean and uncluttered

3.2 Personal Protective Equipment (PPE)

- ANSI (or equivalent standard) approved eye or face protection should be worn at all times when in the laboratory or while working with chemicals in the field
- Wear a laboratory coat (and apron as necessary) to protect skin and clothing from chemicals
  - Do not wear laboratory coats or gloves outside the laboratory
- Splash goggles, with sealed sides and top, must be worn when handling corrosive, toxic or irritating liquids
  - Safety glasses do not provide adequate splash protection
  - Shatterproof prescription eyeglasses do not provide adequate splash protection
- Face shields and explosion-proof shields must be used in addition to safety glasses where necessary
  - When there is a risk of explosion, splashing, or combustion with high or low temperature or pressure reactions or procedures
  - When manipulating or carrying chemical or dangerous substances above shoulder height

- Gloves resistant to the chemical being handled must be worn
  - Refer to compatibility charts for resistance to specific chemicals
  - Before use, check gloves for pin holes, tears, or rips
  - Remove gloves before handling public equipment (phones, etc.)
- Footwear should cover feet completely; no open-toe shoes
- Respirators should be worn as required, using the cartridge needed for a particular application (e.g., particulate, acid gases, organic vapors). Fit testing must be conducted before a person is authorized to use a respirator. Contact the Dispensing Chemist (6472) for further details

3.3 Safety Equipment

- Laboratories using chemicals must have a spill kit available to contain the chemicals being used; replace used or old spill kit materials as necessary
- Laboratories using chemicals should have an accessible safety shower and eyewash
- Laboratories using chemicals should have a fire blanket
- Fumehoods should be used for working with volatile solvents or any airborne contaminant
- Fumehoods and Biological Safety Cabinets (BSC) are not interchangeable; each has a different function
- Fumehood sashes should be below the maximum sash height indicated
- A fumehood must have a current certification sticker for it to be used
- Up-to-date emergency phone numbers must be clearly posted; stickers are available from the Dispensing Chemist and Manager Health & Safety

3.4 Chemical Information

- Always review the Safety Data Sheet before using a new chemical
- SDS used for reference cannot be more than 3 years old
- Safety Datasheets/Material Safety Data Sheets are available online from any campus computer at http://ccinfoweb.ccohs.ca/
- Chemicals transferred to bottles other than the original supplier's bottle should be labelled with the name of chemical and date of transfer. WHMIS labels should be affixed as required.

3.5 Chemical Storage

"Only the minimum necessary amounts of combustible, flammable, corrosive, toxic, biohazardous or highly reactive substances may be kept in the working area of the laboratory." (OHS Regulations 30.15)

Chemicals should be stored according to the following guidelines:

- All stored chemicals must be adequately labeled with WHMIS information
- Chemicals must be stored according to chemical compatibility, to prevent violent reactions between two or more incompatible chemicals (See Table 3.1)
  - Within a compatibility group, chemicals can be stored alphabetically
- Incompatible chemicals must be separated by either appropriate physical barriers or distance
- Within each laboratory, no more than 25 litres of flammable solvents may be present in the open laboratory at any one time
  - Excess must be stored in approved safety cans or flammable storage cabinets
- Ensure bottles are within easy reach of everyone in the lab, and no higher than eye level
- Shelves used to store chemicals should be chemical-resistant, secure and strong enough to support the weight, have a lip to contain spills, and bolted to the wall to prevent tipping

  - Do not store additional chemical containers on top of flammable storage cabinets
  - Do not store chemicals directly on the floor
- Use only screw caps on chemical containers in storage
  - Foil, Parafilm™, corks, or other such plugs are not acceptable closures

Storage Groups and Proper Storage

Storage Group	Examples	Proper Storage
Organic Acids	Propionic acid Acetic anhydride Acetyl bromide	Dedicated Acid Cabinet
Organic Bases	Hydroxylamine Triethylamine Phenylhydrazine	Dedicated Base Cabinet
Inorganic Acids	Hyrdobromic acid Chlorosulfonic acid Stannous chloride	Dedicated Acid Cabinet
Inorganic Bases	Hydrazine Sodium hydroxide Potassium hydroxide	Dedicated Base Cabinet
Oxidizers	Nitrates Chlorates Permanganate	Separate from Reducers, Flammable and Combustible Materials
Flammables	Acetone Ethyl acetate Heptane	Approved Flammable Cabinet or Explosion-Proof Fridge
Water Reactive	Alkali metals Lithium aluminum hydride Calcium hydride	Cabinet Away from Sinks
Air Reactive	Silane Silicon tetrachloride Yellow phosphorous	Under Nitrogen or Argon
Carcinogens	Benzene Chloroform Formaldehyde	Storage Cabinet
Peroxide Formers	Dioxane Tetrahydrofuran Ethyl ether	Approved Flammable Cabinet or Explosion-Proof Fridge

3.6 Chemical Inventory

A current list of chemicals is a necessary component of proper emergency planning. The chemical inventory for the campus is maintained by the Dispensing Chemist.

The chemical inventory contains the following information.

- Barcode Number
- Name of Chemical

- Quantity of Chemical
- Owner of Chemical
- Location of Chemical
- Date Received

Every laboratory user needs to do their part in order to keep the database information as up to date as possible. When a bottle is empty, the Dispensing Chemist should be notified with the name of the chemical and barcode number. If a chemical is being permanently moved to a new laboratory (Principal Investigator or location), the Dispensing Chemist should be notified of the transfer. Once received in the individual laboratory, all chemicals should be labeled with the date of receipt and purchaser's initials or department.

In the event of an emergency, the up-to-date chemical inventory is available to Security personnel to share with first responders.

The chemical inventory can be found online at http://chemstores/VIMEnt/login.aspx

3.7 Chemical Transportation

3.7.1 On-Campus

- Carry glass containers in specially-designed bottle carriers or leak-resistant, unbreakable secondary containers (e.g., 20L bucket for transporting 4L bottles)
- When transporting chemicals on a cart, use a cart that is suitable for the load and that has high edges or spill trays to contain leaks or spills
- Transport chemicals by elevator when no other passengers are present
  - do not use stairs while transporting corrosive, flammable, or toxic chemicals because many stairwells function as fire refuges
- Compressed gas cylinders
  - must be securely fastened to a cylinder cart during transport
  - Compressed gas cylinders must have the valve protection cap fastened during transport

3.7.2 Off-Campus

- The Transportation of Dangerous Goods Act and Regulations govern transportation of chemicals off campus. For details, please refer to the regulations. The Dispensing Chemist can provide advice regarding the regulations.

3.8 Chemical Labeling

The Workplace Hazardous Materials Information System (WHMIS) is a major response to the Canadian worker's right-to-know about the safety and health hazards of materials used in the workplace. WHMIS legislation provides employees, employers, and suppliers nationwide with specific vital information about hazardous materials (called "controlled products" in the legislation). Workers, students, and volunteers must be instructed in the information contained on labels and identifiers, including safe storage, handling, use, and disposal of all chemicals on campus. The Supervisor/Principal Investigator must take steps to ensure labels are not defaced and are easy to read at all times.

- Label all chemical containers accurately with date of preparation, names, and concentrations of chemicals and initials of the preparer

- Chemicals dispensed from bulk for storage purposes must have stickers with WHMIS symbols added
- If a label is damaged, the label or the container must be replaced immediately

3.9 Safety Data Sheets (SDS) Access

SDS are technical bulletins that provide detailed hazard, precautionary, and emergency information on a chemical. The data sheet is the second element of the WHMIS information system and supplements the alert information provided on labels. WHMIS provides minimum content requirements for data sheets. The SDS for any chemical is available from any computer on campus at http://ccinfoweb.ccohs.ca/. Note that SDS that are used for safety references cannot be more than three years old.

All data sheets must provide the following information:

- Product Information
- Hazardous Ingredients
- Physical Data
- Fire and Explosion Hazard
- Reactivity Data
- Toxicological Properties (Health Effects)
- Preventative Measures
- First Aid Measures
- Preparation and Contact Information
- Disposal information

Similar document are used to convey safety information for Biohazardous materials. Pathogen Safety Data Sheets (PSDS) are described in the Biological Safety Manual.

Chapter 4 Chemical Spills, Incidents, Accidents, and Preparation

Spills eventually occur in all wet laboratories. The majority of spills are of no or low hazard; however, hazardous spills occur, and preparation minimizes the damage, injury, and disruption these spills cause.

4.1 Responsibility for Spill Clean Up

Responsibility for spill cleanup is shared between several people, depending on the degree of hazard. The person of cause for the spill is always responsible for either

- the cleanup of the spill; or if not adequately trained to handle the degree of hazard of spill
- ensuring that someone with the necessary equipment and expertise has been informed of the spill

4.2 Types of Spills

At UNBC, there are three categories of spills: no hazard, low hazard, and hazardous. Each of these spills requires a different response.

Several factors determine the hazard posed by a spill

- Quantity and form
  - easily inhaled powder
  - liquids
- Chemical properties
  - pH
  - reactive (e.g., flammable, water reactive)
  - teratogen
  - carcinogen
  - volatile
- Location
  - proximity to drain, other chemicals, air intake, or people
- Type of materials required for clean-up
  - Spill X, mop and bucket, chemical-resistant footwear, respirator mask
- Number of people potentially affected
  - other laboratory users
  - people at other locations

4.2.1 No-Hazard Spills

No-hazard spills are spills that can be taken care of directly by a student or laboratory worker. There is little to no hazard to health, infrastructure, or the environment. These spills do not require the contents of a spill response kit and do not produce hazardous waste during clean up. Despite the no-hazard designation, these spills must be cleared promptly to avoid disruption due to unidentified substance concerns or reactions with other chemicals that create a hazard. These spills do not need to be reported unless specifically indicated by government regulation.

4.2.2 Low-hazard Spills

Spills that do not pose a substantial risk, and require the use of a spill kit, produce hazardous waste, or require support from Custodial Services for cleanup are defined as low-hazard spills. A Low-Hazard Spill Report form must be filled out for these spills. The form must be forwarded to the Chemical Safety Officer and the Manager, Health & Safety. These can still be cleaned by a laboratory worker of the worker has sufficient training in spill clean up

- If custodial assistance is required (greater than 1L), call Security at 250-960-7058

- If a spill kit has been accessed, the Supervisor must procure replacement materials

4.2.3 Hazardous Spills

Hazardous spills are spills that result in danger or exposure of personnel, infrastructure, or the environment or that require additional resources for containment and clean up. Security must be contacted. Security will then contact the Chemical Safety Officer and Manager, Health & Safety. All hazardous spills require a follow-up investigation by the Chemical Safety Officer and the Manager, Health & Safety.

- Contact the emergency Security number—3333 (250-960-3333)
    - Identify the nature of the hazard
    - Identify the chemical and quantity
    - Indicate any injuries associated with the spill
- Evacuate personnel as necessary
- Safely take steps to mitigate the spread of the spill, particularly into drains
- Print off a copy of the SDS sheet and meet the Chemical Safety Officer or first responders to provide additional information

4.2.4 Biohazardous Material or Biotoxin Spills

Refer to the UNBC Biological Safety Manual for procedures for addressing biohazardous material or biotoxin spills.

Examples of No-hazard, Low-Hazard, and Hazarodus Spills

Chemical	Challenges	Quantity	Chemical Hazard	Location	Spill Type
Potassium Phosphate buffer pH 6		0.5 litres	Minimal corrosive	Laboratory counter	No-hazard
Potassium Phosphate buffer pH 6		5 litres	Non-corrosive, slipping, equipment damage	Floor in low-traffic, secure area	Low-hazard
Phenol Solution	Volatile Organic Pipette to collect majority of liquid Remainder absorbed with solvent absorbent Contaminated items must be bagged and delivered to Dispensing Chemist Surface must be decontaminated after solvent absorbed	0.5 litres	Carcinogen Chemical burns Flammable	Fumehood, contained in work area No reactive chemicals nearby No inhalation hazard Low personnel exposure hazard if warning sign put in place	Low-hazard
Phenol Solution	Volatile Organic Pipette to collect majority of liquid Remainder absorbed with solvent absorbent Need respirator with organic vapor filter Contaminated items must be bagged and delivered to Dispensing Chemist Surface must be decontaminated after solvent absorbed	0.5 litres	Carcinogen Chemical burns Flammable Slipping hazard	Floor of lab Inhalation hazard, especially if aerosol formed High potential for spread of surface contamination and associated chemical burns Evacuation of room required Respirator needed	Hazardous

4.3 Spill Kits

All laboratory workers are expected to know the location of their laboratory spill kit. Supervisors (i.e., managers, senior laboratory instructors, and principal investigators) are responsible for ensuring that spill kits are complete and provide the appropriate spill response materials for the laboratory. In teaching laboratories, supervisors and TAs must be able to identify the location of spill kits and ensure that the inspection certificate is current.

4.4 Spill Kits Contents

Spill kits are available in every wet laboratory. They should contain, at minimum, the following:

- Safety goggles
- Nitrile gloves, thick
- Acid neutralizer shakers
- Base neutralizer shakers
- Solvent absorbent shakers
- Plastic scoop or dustpan
- Hazmat bags
- Ziploc bags
- pH paper
- Permanent marker
- Roll of lab tape
- Low-hazard spill kit forms

Biological spill kits have different contents. Refer to the Biological Safety Manual for more information.

4.5 Spill Kit Inspections

All spill kits must have a Spill Kit Inspection Form posted inside. Spill kits must be checked at least once a semester to ensure that they are fully stocked and that the components have not degraded. The person who checked the spill kit must fill and sign the Spill Kit Inventory form. A Spill Kit Inventory form is available in the appendix.

Supervisors in teaching laboratories must check the location and contents of the spill kit at the beginning of each semester or more regularly if there is reason to believe that the spill kit has been used or modified.

4.6 No-Hazard and Low-Hazard Spill Clean Up

- Classify the hazard posed by the spill
- If necessary, refer to the SDS for specific health and physical hazards and guidelines for disposal
- If safe, prevent the spill from spreading using compatible materials at hand (e.g., sand, paper towels)
- If it is likely that an aerosol was generated, evacuate the room for five minutes to let it dissipate
- Use necessary resources to clean spill (i.e., spill kit, custodial services)
- If using neutralizing shakers, add neutralizing absorbent slowly, working from the outside to the center
    - The neutralization reaction can generate substantial heat, creating a secondary hazard
    - If neutralization reaction is uncontrolled, sand can be added as an inert heat absorber

- Inform supervisor of spill, fill out Low-Hazard Spill Report form, and forward it to the Chemical Safety Officer and Manager, Health & Safety.

4.7 Ethidium Bromide Spills

Ethidium bromide spills represent a special case because it is commonly used in biochemistry and molecular biology laboratories. The following procedure should be followed.

- Before cleaning up the spill, make sure to don:
  - Laboratory coat
  - Safety glasses or goggles
  - Nitrile gloves (latex gloves should not be worn)
- Locate the extent of the spill using UV light.
- Collect excess liquid into a waste bottle if possible.
- Decontaminate the spill area by washing it with a paper towel soaked in the decontamination solution.
  - Repeat an additional 5 times (using a fresh paper towel each time).
- After cleaning up the area put all the used towels in the decontamination solution for 2 hours.
- Check the completeness of decontamination using ultraviolet light.

Ethidium Bromide Decontamination Solution

Lunn and Sansone Method	Armour Method
• 4.2 grams of sodium nitrite • 20 mL of hypophosphorous acid (50%) • 300 mL of water	• 100% Bleach

4.8 Injuries

4.8.1 Minor Injuries

In the event of a minor injury, where the injured is healthy enough to safely walk without risk of further injury, the injured person should be taken to Security for first aid treatment. This includes small cuts and abrasions.

4.8.2 Major Injuries

In the event of a major injury, follow the following steps.

- Ensure the accident scene is safe, so there is no further danger to the injured or yourself.
- Phone Security (3333) and report the exact location of the injured, the nature of their injuries, and any additional hazards.
- Do not move an injured person unless there is a high risk of further injury or death.
- If a chemical has affected the eyes in any way, use the safety eyewash by pushing lever forward to activate the flow of water. Flush for a minimum of 20 minutes for irritants. If the contamination is substantial or the contaminant is unknown or a penetrating corrosive (e.g., phenol, alkali, hydrofluoric acid), summon emergency medical help. For unknowns and penetrating corrosives, flush for a minimum of 60 minutes or until instructed otherwise by an emergency responder.

- If a chemical has affected a substantial portion of the body, use the safety shower by pulling the handle down to activate the flow of water; evacuate the laboratory and have injured remove contaminated clothing.
- Do not leave the injured unattended.
- Be prepared to assist if directed to do so by the first aid attendants.

4.9 Laboratory Incidents

Prior to major accidents and injuries, there are usually “close-call” incidents that were warning signs of a problem (e.g., wrong PPE, insufficient PPE, spills, poor methodologies, equipment failure, infrastructure failure). Laboratory workers are encouraged to report these close calls to the appropriate safety officer (Chemical, Biological, or Radiation) or the Manager, Health & Safety. The Low-hazard Spill Report forms also help the safety officers and the Manager, Health & Safety identify dangerous practices and potentially hazardous situations.

Chapter 5 Laboratory Safety Inspections

All laboratories in use at UNBC must be regularly inspected as follows:

- Daily
- Annually
- Special

5.1 Daily Inspections

All laboratory workers must inspect their work area prior to conducting any work, to identify and correct hazardous conditions. Hazardous conditions should be reported to supervisors/Principal Investigators or appropriate safety personnel if they cannot be remedied immediately

5.2 Semi-Annual Inspections

The principal investigator or Instructors must inspect their designated lab space once per semester. It is recommended that the inspection be documented with the Lab Inspection Checklist. The checklist is available from the Risk and Safety department or the UNBC Labs website.

5.3 Annual Inspections

The university safety officers will conduct an annual inspection of each laboratory on campus. This group should attempt to arrange a time when the Principal Investigator or laboratory supervisor is available, but may conduct an inspection at any time during the calendar year.

5.4 Special Inspections

Inspections will be conducted in a reasonable timeframe after an incident or after new equipment are introduced to the campus. After an incident, the safety officers will conduct a review of the laboratory in an effort to prevent similar incidents from occurring. The results of this review is be provided to the Principal Investigator or Supervisor.

When new pieces of equipment that could pose a safety threat are introduced to the campus (e.g., mercury analyzers, equipment that creates low oxygen atmospheres, radiation exposure devices), the safety officers will conduct a laboratory review. The results of this review will be provided to the Principal Investigator or laboratory supervisor. No work may be initiated on the new equipment until the review is complete and any concerns have been satisfactorily resolved

Chapter 6 Disposal of Laboratory and Research Materials

6.1 Disposal of Hazardous Materials

Proper disposal of hazardous materials is an important part of UNBC's role as a green institution. Improper disposal of wastes can result in environmental damage, health damage, and economic damage. For example, sending hazardous chemicals to a landfill can result in long-term environmental damage and health damage from leachates entering ground water. Likewise, unnecessarily entering non-hazardous wastes into energy and resource intensive waste streams can result in much larger carbon footprints and economic costs. Unlabelled materials pose the greatest potential for environmental, health, and economic damage.

6.2 Responsibility for Disposal

It is the responsibility of the person generating the waste or their authorized designate to ensure appropriate disposal of laboratory materials.

6.3 Chemical Exchange Program (Hazardous Waste Reduction)

When chemicals have been identified as unwanted surplus within a laboratory, the Principal Investigator or Laboratory Supervisor responsible for the chemicals should attempt to locate other Principal Investigators or Laboratory Supervisors within the UNBC community who may be able to use some or all of the chemicals. The Dispensing Chemist can provide assistance with finding new homes for old chemicals.

Similarly, researchers who need small quantities of a chemical should check the campus inventory prior to ordering the chemical to determine if it is available on campus already.

6.4 Disposal

Laboratory and Field Research Chemicals must be disposed of in accordance with UNBC's Hazardous Waste Identification, Reporting, and Disposal policy. A guide for determining if a waste is hazardous is included in the appendix.

HAZARDOUS WASTE FOR DISPOSAL

HALOGENATED ORGANIC

pH	≤2 3 4 5 6 7 8 9 10 11 ≥12
ADDITIONAL HAZARDS	
DATE STARTED	Jan 21, 2013
DATE FULL	Oct 21, 2013
PRINCIPAL INVESTIGATOR	Strom Lab

Composition

For all components, legibly list the full chemical name and percentage of mixture or volume/mass of each.
No Formulae or Abbreviations

FULL CHEMICAL NAME	VOL OR %
Acetone	20mL
Chloroform	2g
~~Bro~~ Dichloromethane	50mL
Trichloroethane	65mL
Dichloromethane Hexanes 2:1	275mL

6.4.1 Liquid Chemical Waste:

All hazardous liquid chemical waste (as defined in the UNBC Hazardous Waste Identification, Reporting, and Disposal policy) must be collected into designated waste containers. Generally, these waste containers will be glass bottles.

Liquid chemical waste must be segregated into four waste streams:

- Toxic Aqueous—Blue tags
  - Any toxic solution containing greater than 50% water
- Organic—Red tags
  - Any solution containing greater than 50% non-halogenated organic solvent
- Halogenated Organic—Green tags
  - Any solution containing greater than 5% halogenated organic solvent
- Oxidizers—Yellow tags
  - Any solution containing an oxidizer
  - Different oxidizers should not be mixed in the same container—each oxidizer should be in its own waste container

Waste labels must be completed for each waste bottle, and waste bottles must be swapped out every year. All chemicals must be labeled with full name—not abbreviations, acronyms, or formulae, and the concentrations and quantities of each substance must be indicated.

6.4.2 Solid Chemical Waste

All solid chemical waste must be collected into labeled containers that can be sealed (e.g., buckets, plastic bags). Solid chemical waste must be segregated by compatibility. However, chemicals within compatibility groups should not be mixed unnecessarily (unmixed solids may be used to treat other chemical wastes). All containers must be labeled with the full chemical name (not abbreviations, acronyms, or formulae), the date, and the Principal Investigator's or Supervisor's name.

6.4.3 Biological Waste:

Biological wastes are wastes of a biological origin that will not harm people or the environment. Examples include fresh plant materials or undiseased, uncorrupted animal carcasses. Depending on the quantity and the state of the waste, biological waste can often be disposed of through normal waste (landfill), composting, or drain disposal. Often biological wastes are disposed of as biohazardous waste due to the nuisance associated with the waste (i.e., smell, package leakage, flies). Biological wastes are

bagged, labeled, and boxed to avoid aesthetic impacts and to prevent unnecessary alarm if the garbage is accidently torn open during collection.

Disposal Guidelines for Biological Waste

Undiseased, Uncontaminated Biological Waste			Putrefying or Nuisance Biological Waste	
Less than 5kg	Less than 20kg	More than 20kg	Less than 20kg	More than 20kg
• Drain excess fluids • Place in sealed plastic bag • Write contents and source on bag with marker • Place in cardboard box • Tape box closed • Place in normal garbage	• Drain excess fluids • Place in sealed plastic bag • Write contents and source on bag with marker • Place in cardboard box • Tape box closed • Dispose of in compactor at loading dock	• Contact Dispensing Chemist to make arrangements	• Place in Red Biomedical Waste Bucket	• Contact Dispensing Chemist to make arrangements

6.4.4 Biohazardous Waste:

Biohazardous waste is any waste (e.g., micro-organism, parasite, primate body fluids, toxins, animal tissue/dander, cell cultures with infectious agents, or prions) that is capable of causing a disease in humans or animals or damage to the environment. Biohazardous waste must be disposed of in biomedical waste buckets. The total mass placed in a single bucket cannot exceed 35lbs. For more information regarding biohazards and biological safety, refer to the UNBC Biological Safety Manual.

6.4.5 Microbiological Waste:

Biohazardous microbiological wastes should be kept separate from non-hazardous microbiological wastes. Non-hazardous microbiological waste should be sterilized (e.g., autoclave, bleach, ethanol) and disposed of as a normal waste.

6.4.6 Ethidium Bromide Waste:

Whenever handling ethidium bromide, a laboratory coat, safety glasses, and nitrile gloves should be worn.

Electrophoresis gels containing ethidium bromide must be collected in buckets clearly labelled Ethidium Bromide Waste includes any disposable gloves, or other debris contaminated with ethidium bromide should be collected in sealable bags for incineration.

Ethidium bromide solution must be specially treated before disposal. The preferred method is to use activated charcoal destaining bags to absorb ethidium bromide out of solution. The used charcoal bag is then disposed of as solid ethidium bromide waste, while the clear solution no longer containing ethidium bromide can be disposed of in the appropriate waste stream, often down the drain.

**Note: Disposable latex gloves should not be worn when handling ethidium bromide solutions and gels. Pinhole leaks in latex gloves are generally difficult to detect until the liquid has passed into the glove. Latex gloves are also relatively permeable to liquids. Nitrile gloves are more chemical resistant and will tear completely if a pinhole is present, allowing early identification of the barrier failure.

6.4.7 Radioactive Waste:

Radioactive wastes (e.g., P-32, H-3) must be placed in dedicated waste bottles or waste bags, and wastes from different radioisotopes cannot be mixed without prior approval of the Radiation Safety Officer and the Dispensing Chemist. Radioactive wastes should be treated similarly to chemical wastes (i.e., separation, proper labeling) because the chemical properties will most likely be the primary hazard for the waste. The same waste labels are used for the liquid radioactive waste.

6.4.8 Sharps:

Sharps—any item that could reasonably pierce the container and cause a wound—must be disposed of in puncture-proof containers. Generally, these containers should be sharps disposal containers, which are distributed for free through Chemstores. Non-sharps items must not be unnecessarily placed in these containers.

6.4.9 Broken Glass:

Broken glass waste must be stored in a puncture-proof, dedicated waste receptacle, such as a broken glass box or 20L pail. The broken glass must be decontaminated prior to be added to the waste. If the glass fragments are contaminated and cannot safely be decontaminated, they should be kept separate from the rest of the glass waste by placing them in a sealable plastic bag inside of a cardboard box. The name of the contaminant must be indicated on the internal and external packaging and the package transferred to the Dispensing Chemist.

6.4.10 Empty Chemical Containers:

Most empty plastic chemical containers can generally be disposed of in the normal trash. Empty glass containers should be placed in dedicated glass waste receptacles. Generally, vessels can be cleaned by rinsing:

Water soluble chemicals	Organic chemicals
• Remove remaining chemical • Perform multiple rinses with small volumes of water (place rinsate in toxic aqueous waste if necessary) • Air dry • Deface label	• Remove remaining chemical • Rinse with multiple small volumes of acetone (or compatible solvent) • Discard rinsate in organic waste • Air dry container • Rinse with water • Air dry • Deface label

Containers that have held extremely toxic materials may need to be treated as hazardous waste. Check the SDS to determine if the container is also hazardous waste.

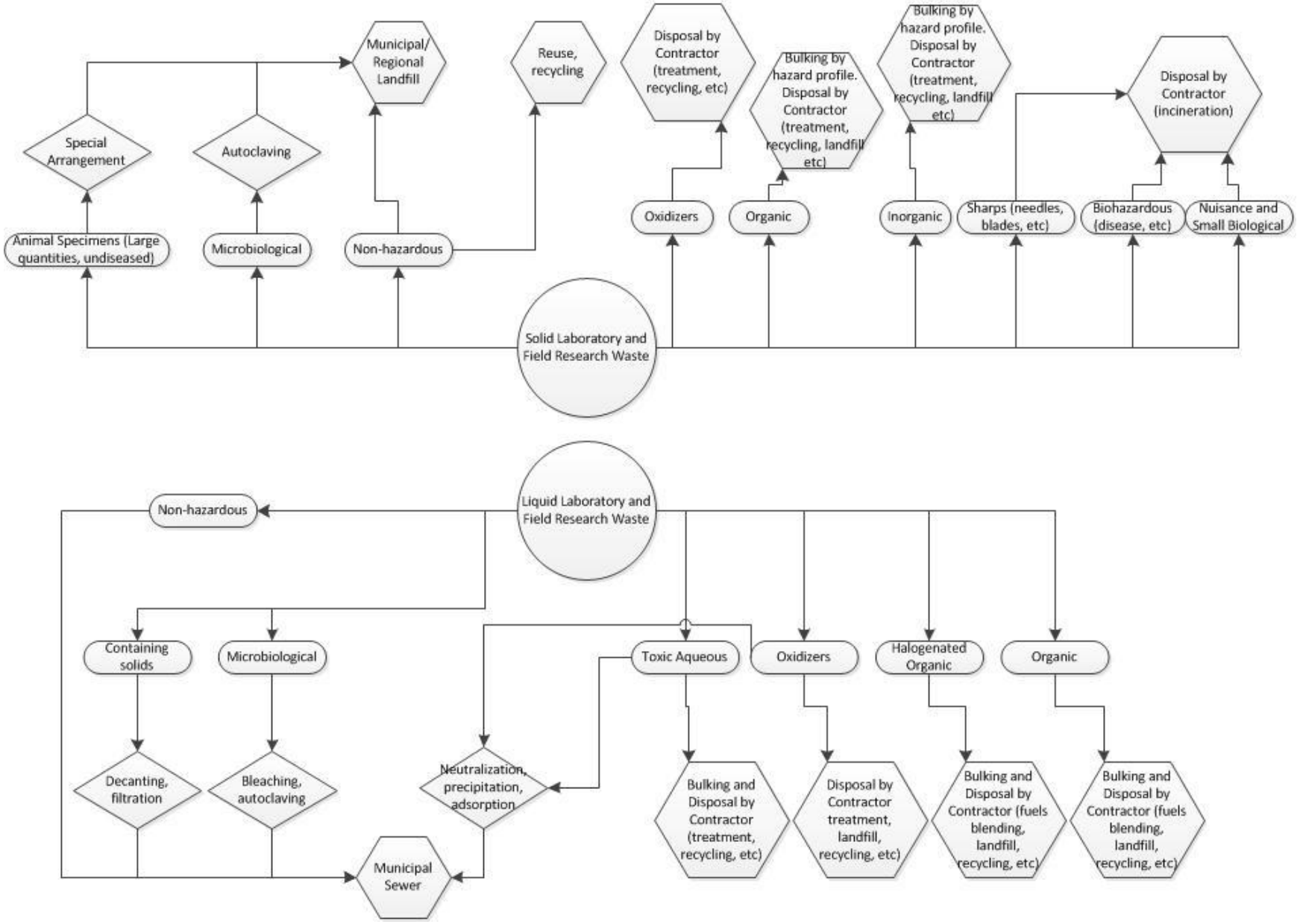
Empty glass, metal, and plastic chemical containers are often suitable for recycling, and labs are encouraged to recycle. A separate recycling waste collection area must to be set up to ensure that contaminated items are not placed in the recycling collection. A laboratory worker must take on the role of overseeing and monitoring the recycling collection and verify the cleanliness of the items when transferring for recycling. Large recycling items must be labeled with a marker as non-contaminated along with a contact phone number.

6.4.11 Disposable Nitrile Gloves

UNBC has implemented a disposable nitrile glove recycling program. For nitrile gloves that are not contaminated with chemical residues, place the used gloves into the purple glove recycling bins. The laboratory worker must make the determination if the gloves are suitable for recycling or if it is contaminated and counts as solid chemical waste.

Waste Stream Table

WASTE STREAM	DEFINITION	TREATMENT
Liquid Chemical Waste TOXIC AQUEOUS	Solution >50% water	Labeled Glass Bottle
Liquid Chemical Waste ORGANIC	Solution >50% organic solvent	Labeled Glass Bottle
Liquid Chemical Waste HALOGENATED ORGANIC	Solution >5% halogenated organic solvent	Labeled Glass Bottle
Liquid Chemical Waste OXIDIZER	Chemicals with High Oxidizing Potential	Labeled Compatible Container
Solid Chemical Waste	Chemicals and Contaminated Debris	Labeled Plastic Bag or Bucket
Biohazard Contaminated Waste NON-TISSUE	Debris Contaminated with Biohazardous or Nuisance Biological Material, but No Tissue	Yellow Biomedical Waste Bucket
Biohazardous Waste TISSUE	Biohazardous and Nuisance Biological Waste Associated Debris	Red Biomedical Waste Bucket
Ethidium Bromide Gels	Electrophoresis Gels Containing Ethidium Bromide	Waste Bucket dedicated to Ethidium Bromide
Ethidium Bromide Solution	Solutions Containing Ethidium Bromide	Treatment with Activated Carbon Destaining Bag
Radioactive ^{32}P Liquid	Solutions Containing 32P	Glass Waste Bottle with Trefoil Symbol
Radioactive ^{32}P Solid	Debris Containing 32P	Labeled Plastic Bag with Trefoil Symbol
Radioactive ^{3}H Liquid	Solutions Containing 3H	Plastic Waste Bottles
Radioactive ^{3}H Solid	Debris Containing 3H	Labeled Plastic Bag with Trefoil
Sharps	Needles, Razors, Scalpels, and Similar Debris	Puncture-proof Sharps Container
Broken Glass	Broken Laboratory Glassware	Puncture-proof Box or Bucket
Empty Chemical Containers (non-hazardous)	Waste container is uncontaminated	Deface for recycling or landfill
Empty Chemical Containers (hazardous)	Waste container is contaminated or otherwise unsafe	Transfer to Dispensing Chemist
Non-contaminated disposable nitrile gloves	Not contaminated with chemical residue	Place in purple glove recycling bin



Waste Stream Destination and Treatment

6.5 Green Tips for the Laboratory

- When using biomedical waste buckets, fill them completely before sealing them. To reduce issues with odors or microbial growth, seal individual waste components into Ziploc bags prior to adding.
- If large quantities of a specific waste will be produced, plan for an efficient manner of disposal. Examples of this may be:
    - Placing waste in a labeled dedicated bulk container
    - Identifying procedures for neutralizing the waste as it is produced or in batches
    - Identifying alternative uses for the wastes generated or ways wastes can be combined for neutralization
- Laboratory glassware can be recycled, but it must be clean of chemical or biological contamination to avoid alarming or injuring recycling center staff.
- Close containers in fume hoods when they are not in use. Actively evaporating chemicals in fume hood is referred to as atmospheric disposal and can be environmentally damaging and cause formation of reactive crystals in some solvents. If it does not result in a hazard, turn off fume hoods when they are they are not in use. Fume hoods use considerable quantities of energy when left running continuously.

Chapter 7 Specific Chemical Safety

This chapter is intended as an overview of several common laboratory safety concerns. It is framed as a review of WHMIS but includes information specific to UNBC. It is not intended to be all inclusive. For information about specific chemicals, please read their specific Safety Datasheet/Material Safety Data Sheet.

7.1 Compressed Gasses

Compressed gases present substantial stored energy and a physical danger that result from the sudden, out-of-control release of these materials from their containers. This release can occur with enough force to propel the cylinder through cinder block walls, and there are accounts of cylinders reaching an altitude of 140ft before falling back down, causing more damage on return. The release of the gas inside the cylinder can also create a low oxygen atmosphere by displacing the atmosphere from a room, resulting in an acute asphyxiation hazard.

- Compressed gas cylinders must be firmly strapped or chained to a wall or laboratory bench to prevent the cylinders from falling over
- Compressed gas cylinders should be transported using a cart specifically designed for this purpose
- Compresses gas cylinders must be capped when in transport or when not in use
- Dry ice block or flake makers must be properly ventilated to prevent asphyxiation
- When empty, compressed gas cylinders must be marked at “Empty” or “MT”
- Empty or unused cylinders should be returned to Chemstores promptly
- Tubing for routing of gases should be connected with non-leaking connections
- Tubing and fittings must be chemically and physically compatible with the gas being used. Pressure ratings for equipment must match
- If multiple types of gas are present in a lab space, each gas and its associated tubing should be labelled for easy identification in the event of a leak—this is particularly important for tubing that is routed along the ceiling. Flammable gases must be labelled (BC Fire Code 5.5.5.3).

7.2 Cryogenic Gases

Liquefied non-flammable gases, such as nitrogen, argon, or helium, present both an asphyxiation and explosion hazard.

- Liquefied gases must be stored in purpose-b uilt double walled metal containers Gloves designed for handling cryogenic liquids and a face shield should be used whenever transferring liquefied gases from one container to another
- Containers holding liquefied gases must be kept covered with a loose-fitting cap to prevent air or moisture from entering the container, and to allow built-up pressure to escape
- Liquefied gases must be properly ventilated to prevent asphyxiation

****Low Oxygen atmospheres pose a serious hazard. As few as two breaths (5-9 seconds of exposure) of a zero oxygen atmosphere can result in unconsciousness due to deoxgenation of blood passing through the lungs to the brain.**

7.3 Flammable Materials

Flammable materials are substances that form vapors that can burn or explode. In order for a fire to occur, three conditions must be present, oxygen, a fuel source, and an ignition source.

Examples of substances that are included in this classification are:

- Flammable gases
- Flammable liquids
- Flammable solids
- Spontaneously combustible substances
- Flammable aerosols
- Air reactive
- Water reactive

7.3.1 Flammable Liquids

Flammable liquids give off vapors that, in most cases, are heavier than air and can travel long distances until reaching a source of ignition such as an open flame, hot surfaces, static sparks, etc., at which time a fire or explosion could result. Flammable liquids pose many serious problems. The misuse of a small amount can have a disastrous effect. As liquids, they can flow and thus any spillage will increase the fire hazard by increasing the surface area exposed to oxygen and capable of burning. Burning flammable liquids will likewise flow and spread the fire.

- Proper grounding of containers is required to prevent static charge build-up when transferring flammable liquids from a source drum.
- Flammable solvent containers must be kept closed when not in use.
- In an open laboratory area, amounts of flammable liquids shall not exceed 25 litres. Excess amounts must be stored in an approved flammable materials cabinet.

7.4 Oxidizing Materials

Oxidizing materials are substances that readily yield oxygen or its equivalent to stimulate the combustion (oxidation) of organic matter. Oxidizers are incompatible with reducing agents (which usually contain hydrogen) and should be stored in separate cabinets.

7.5 Toxic Materials

A toxic chemical is any substance that may cause damage to structure or disturbance to function, when it is ingested, inhaled, absorbed, applied to, injected into, or developed within the body, in relatively small amounts. The severity and type of health effects are represented via three different pictograms:

The skull and crossbones pictogram indicates any material which is acutely toxic. These materials cause serious health effects by damaging critical body systems immediately upon exposure.

The health hazard pictogram indicates materials with severe long term effects. Examples include carcinogens, germ cell mutagenicity, and specific organ toxicity. These effects normally develop from chronic exposure to these substances.

The exclamation mark indicates irritants and sensitizers. The effects of these materials are generally reversible and of short duration if given proper medical treatment.

7.6 Corrosive Materials

Corrosive substances are those materials that, upon contact, cause visible destruction of, or irreversible alterations to, tissue or metal. The eyes are especially sensitive to permanent damage by corrosive substances. Acids and bases are corrosive substances, and corrosive ability is expressed as pH. Neutral non-corrosive compounds are pH 7. Acidic compounds are those below 7 on the pH scale, while basic compounds are those above 7. The further away from 7, the stronger the acid or base.

Considerations for specific corrosive materials are as follows:

7.6.1 Hydrofluoric acid

Both the gas and liquid form of hydrofluoric acid (HF) are highly toxic and able to penetrate deeply into the tissues and bone. Symptoms (pain) of contact with hydrogen fluoride solutions may be delayed with serious burns resulting. When skin is exposed to hydrogen fluoride solutions, flush with water for at least 15 minutes; apply calcium gluconate gel after washing with water; and in all cases of exposure, seek medical attention.

Hydrofluoric acid is a glass etching agent. Reactions with hydrofluoric acid should not be conducted in glass vessels.

7.6.2 Perchloric acid

Section 30.21 of the WCB Regulation specifically refers to the use of perchloric acid. Perchloric acid must be used in a special wash-down fume hood made of a non-combustible material (usually stainless steel). The use of the hood must be posted and no combustibles are permitted to be stored in the same hood.

No more than 6.4 kg of perchloric acid may be stored in a laboratory.

Stored perchloric acid must be inspected monthly, and if any discoloration is noted it must be disposed of immediately and in a safe manner. Anhydrous perchloric acid may only be used if freshly made; any unused portions must be disposed of safely at the end procedure and not kept for more than one day.

7.7 Dangerously Reactive Materials

Dangerously reactive materials are those substances that:

- undergo vigorous polymerization, decomposition, or condensation
- become self-reactive under conditions of shock, or increase in pressure or temperature
- react vigorously with water to release poisonous gas

WCB Regulation 30.20 states:
"(1) Quantities of explosive and highly reactive material available at the workbench or in the work area must be restricted to amounts immediately required for the work day.
(2) Storage facilities for explosive and highly reactive materials must be located and designed so as to prevent risk to workers.
(3) Explosive and highly reactive materials must be stored in a manner free from shock, vibration or other conditions which may compromise the stability of the material.
(4) If due to the nature of the laboratory work, explosions or implosions may result, the laboratory apparatus or equipment involved in such work must be adequately shielded and the operators must be provided with and must wear suitable personal protective devices, and wherever practicable the work must be safely isolated from workers by distance."

7.8 Specific Hazard: Organic Peroxides

Organic peroxides are a particular group of oxidizing materials that are often unstable in nature. They are low-power explosives which are sensitive, to varying degrees, to heat or shock. Often they are products of room temperature oxidation of a variety of common organic ethers, alkenes, certain alcohols, potassium, and other materials. All peroxidizable compounds should be stored away from heat and light (which catalyze the peroxidation reaction), and reducing agents as well as being protected from physical damage and ignition sources.

Peroxide-forming organic compounds must be labeled as such, using an adhesive label. In addition, the container must be tested regularly to determine if peroxide formation has made it unsafe, and the results must be recorded on the container:

Laboratory Responsible _____

Contact Number _____

Date Received _____ Date Opened _____

Test Date _____ Test Result _____

Test Date _____ Test Result _____

Testing can be performed using commercial peroxide detection strips which are able to detect peroxide concentrations up to 100ppm. These are available from Chemstores. Follow the directions on the package for the use of test strips.

There are no specific concentrations of peroxides for a given chemical which dictate if the material is unsafe. The level of hazard is dependent of intended usage of the chemical – for example, any material which is to be distilled or evaporated will have its hazard level magnified as the peroxides will be concentrated. Conversely, materials which will be diluted will pose minimal hazard. If peroxides are detected in a material please contact the Chemical Safety Officer for further risk analysis.

However, any ethers that show evidence of crystal formation in solution or around the cap, or of oil formation, should be treated as extremely hazardous and should not be handled. Treat as a bomb! Notify the Principal Investigator or supervisor and the Chemical Safety Officer immediately.

Chapter 8 Specific Equipment Safety

This chapter is intended as an overview of common laboratory equipment safety concerns. It is not intended to be all inclusive. For information about specific equipment, please read the owner's or user's manual.

8.1 Fume Hood Operation

Fume hoods should be used when working with volatile hazardous materials. Proper use can minimize the exposure of the user to these materials. Fume hoods at UNBC are analyzed and, if needed, calibrated on a yearly basis to performance standards. When working with a fume hood, keep these basic tips in mind:

- Is the fume hood functioning? Always check to see if there is air moving through the face of the hood before beginning work
- Are you working with the sash at the indicated working height? Fume hoods are set to operate with a certain airflow velocity with the sash at a specific set height.
- Position yourself so that your face is above the sash opening and avoid placing head in fumehood
- Try to work at least 6 inches behind the face of the fume hood. This minimizes the effects of airflow disturbances.
- Avoid overcrowding work areas. Excess materials in the fume hood could cause disturbances to airflow, limiting the protection the fume hood provides
- Try to avoid using lightweight materials that can be sucked up into the exhaust. This could result in damage to the fume hood
- Fumehoods are not storage spaces. Limit the amount of materials in the fumehood to the minimum amount needed for your work to limit risk such as fire or explosion hazards
- UNBC fume hoods do not operate when there is no power. Work must be discontinued when the power is out.
- Fume hoods operate between 80 and 120 fpm. If the fume hood is reading outside of these values after adjusting sash height, re-calibration might be necessary.

The fumehoods on campus are equipped with alarms. These alarms will sound when the air velocity has dropped below the minimum or rose above the maximum either due to malfunction, power loss/reset, or because the fan has been turned off. If you are using the fume hood, try resetting the fume hood and waiting for the airflow to stabilize. If the alarm is still sounding discontinue work and contact the Dispensing Chemist. If the fume hood is intentionally off, press the alarm silence button and pull the sash all the way down.

8.2 Reduced Pressure Operations

Glass vacuum containers, such as desiccators and flasks, should be wrapped with tape to prevent glass from flying in the event of an implosion or explosion. When carrying out filtration or distillation procedures under reduced pressure, the heavy-walled glassware and tubing must be undamaged and able to withstand the conditions of reduced pressure. Cold traps should be used to prevent leaking of

vapors from the experiment to the oil of the vacuum pump or the water passing through a water aspirator. Rotoevaporation of solvents using a water aspirator is not appropriate where the vapor being removed is highly odorous or toxic unless a suitable cold trap is available to capture them. Alternative enclosed systems are recommended.

8.3 Flammable, Toxic and Corrosive Gases

- For mixed gas occupancy of hazardous gases, there is maximum separation required between cylinders as defined by the BC Fire Code
- Regulators and gauges must be compatible with the gas used – for example, non-sparking equipment for flammable gases, corrosion resistant equipment for corrosive gases, compatible pressure ratings for equipment
- Highly toxic gases are kept and used in a continuously operating fume hood or in a specialized gas storage cabinet with an exhaust to the outside
- A sign is located on the outside door of any room and adjacent to equipment where a hazardous gas is being used, advising occupants of potential hazards and emergency procedures to follow if a leak or other incident occurs
- Gas detectors and alarm systems are installed where cylinders of compressed toxic gases are being used, or an equivalent means of managing an accidental release is implemented

Chapter 9 References

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Chapter 10 Appendices

Version notes (what changed and when)

Manual adopted August 22, 2013 Lab Safety Meeting

- Policies
- Cryogenic Liquids
- Peroxide Forming Compounds

Example Spill Kit Inspection Form (Template is Available from Chemical Safety Officer)

Spill Kit Inspection Form

Room:
PI/Supervisor Name:

Indicate if the item is present with a check mark. If the item is not functional or not present, replace it. When finished, date and sign to indicate the inspection was complete.

Item	**Dec 14, 12**									
Disposable nitrile gloves	2 pair									
Chemical resistant gloves	N/A									
Spill X-Acid	1 full									
Spill X-Caustic	1 half									
Spill X-Solvent	1 full									
Ziploc bags	4									
Indelible marker	1									
Bench broom	1									
Dustpan	1									
Safety glasses	1									
	John Hancock									

If items are missing, are broken, or need to be added to the inventory due to changes in room use, indicate this in the comments section:

Name	Date	Comment

Spill Kit Inspection Form

Room:

PI/Supervisor/Program Name:

Indicate if the item is present with a check mark. If the item is not functional or not present, replace it. When finished, date and sign to indicate the inspection was complete.

	Date									
Item										
Disposable nitrile gloves										
Chemical resistant gloves										
Spill X-Acid										
Spill X-Caustic										
Spill X-Solvent										
Ziploc bags										
Indelible marker										
Bench broom or scraper										
Dustpan										
Safety glasses										

If items are missing, are broken, or need to be added to the inventory due to changes in room use, indicate this in the comments section:

Name	Date	Comment

Low-Hazard Spill Report Form

Date:		**Time:**	
Type:	**□ Chemical**	**□ Biological**	**□ Radiological**
Location:		**Quantity:**	
Description of material spilled:			
Description of the incident (include a diagram if necessary):			
Corrective actions taken:			
Contact name:			
Phone:		**Email:**	
Supervisor's name:			
Phone:		**Email**	

Note:

- **Refer to the Chemical Safety and Methodology Manual for chemical spill response procedures**
- **Refer to the Biological Safety Manual for a Biohazardous spill response procedures**
- **If there are serious injuries or additional help is required for cleanup, call Security (x3333)**
- **Please attach a copy of the SDS with this form**
- **Forward the completed report form to the appropriate safety officer (Chemical Safety Officer, Biological Safety Officer, Radiation Safety Officer)**

Determining If a Substance Is a Hazardous Waste

At the Prince George campus, there are five relevant documents for determining if a waste is hazardous waste for disposal purposes.

BC Hazardous Waste Regulations:

Identifies specific hazardous wastes directly, sets limits on leachable toxin levels (Schedule 4, table 1) in solid waste sent to landfill, and sets limits on maximum concentration of specific substances in discharges to municipal sewers (Schedule 1.2). Directly identifies several hazardous wastes and waste exemptions.

Defines the Transportation of Dangerous Goods Regulations as one of the primary identifiers of hazardous waste.

Transportation of Dangerous Goods Regulations:

Identifies a variety of hazardous chemicals, materials, and mixtures directly by name.

Provides guidelines for categorizing new chemicals and mixtures of chemicals into the TDG classification scheme:

Flammable:

- Flammable Classification--2.18, 2.21
- Note: there are some exemptions for flammable materials. For example, solutions containing less than 24% ethanol by volume are exempt.

Toxic: Items with LD50s and an LC50 below the defined thresholds are classified as toxic (hazardous). However, these values are for the material in pure form, and waste is often diluted.

- Toxic Classification--Section 2.28
  - LD_{50} (Oral) is less than or equal to 300 mg/kg
  - LD_{50} (Dermal) is less than or equal to 1000 mg/kg
  - LC_{50} (Inhalation) for vapors is less than or equal to 5000 mL/m^3
  - LC_{50} (Inhalation) for dust or mist is less than or equal to 4 mg/L

- Determination of LD_{50} for a mixture of substances—2.31
  - If only one of the components of the mixture is classified as toxic in pure form, the LD_{50} (Mixture) =LD_{50} (toxic substance)/fraction of mass of toxic substance in mixture
  - If multiple components have LD_{50}s below the threshold, the contributing numbers (CN) for each component are used to generate a new LD_{50}

$$CN = \frac{LD_{50}\ of\ substance}{fraction\ by\ mass\ of\ subtance\ in\ mixture}$$

$$\frac{1}{LD_{50}}(mixture) = \frac{1}{CN\ (substance\ A)} + \frac{1}{CN\ (substance\ B)} + \cdots$$

If the final mixture LD_{50} is below the classification threshold, it is classified as toxic and must be treated as a hazardous waste.

Oxidizer:

- The majority of oxidizers are listed in the TDG by name
- Mixtures need to be tested for residual oxidizing power
- Some oxidizers are exempt at certain concentrations (e.g., hydrogen peroxide, aqueous solution with less with than 8% concentration)

Note: oxidizers can lose oxidizing power over time or when mixed with other substances, and there are several tests available to determine oxidizing power. In particular, a starch iodine test is available for hydrogen peroxide.

Safety Datasheet (SDS):

SDS provide the LD_{50} and LC_{50} for substances or the constituents of a mixture. These values can be used with the TDG guidelines to identify if a specific product or mixture is a hazardous waste.

Prince George Sanitary Sewer Bylaw 7897:

Sets limits on maximum concentrate of specific ions into the municipal sewer (Schedule A).

Sets the acceptable pH range for waste entering the municipal sewer at pH 5-9 (Section 4.2).

Indicates that foaming agents (Section 4.2), irritating smelling materials (Section 3.2), and high grit wastes cannot enter the municipal sewer.

States that dilution through increased use of process water cannot be used as substitute for treatment before entering the municipal sewer (Section 4.1)

Regional District of Fraser-Fort George By-law No. 1797

Defines controlled solid wastes, including animal carcasses and contaminated soils (Section One—Controlled Waste).

Defines prohibited wastes, including liquids (Section One—Prohibited Waste).

Strategies for Identifying if a Liquid Waste is Hazardous:

- Check the original container for WHMIS labels
- Compare the chemical composition to other non-hazardous or household products
- Look for evidence that the original hazard has been neutralized (e.g., hydrogen peroxide, aqueous solution with bacteria or mold growing inside)
- Check if the individual components are listed in the TDG or can be classified as toxic under the TDG.
    - Review SDS sheets of waste components for LD_{50} and LC_{50} values
        - Use the LD_{50} and LC_{50} values to determine if the components of the waste are toxic
        - If necessary generate mixture LD_{50}s and LC_{50} using TDG formulas
- Check the local sewer bylaw for additional criteria
- Check BC Hazardous Waste Regulation for additional criteria
- Test the pH—5-9 is non-hazardous

Strategies for Identifying if a Solid Waste is Hazardous:

- Check the original container for WHMIS labels
- Compare the chemical composition to other non-hazardous or household products
- Look for evidence that the original hazard has been neutralized (e.g., hydrogen peroxide, aqueous solution with bacteria or mold growing inside)
- Check if the individual components are listed in the TDG or can be classified as toxic under the TDG.
    - Review SDS sheets of waste components for LD_{50} and LC_{50} values
        - Use the LD_{50} and LC_{50} values to determine if the components of the waste are toxic
        - If necessary generate mixture LD_{50}s and LC_{50} using TDG formulas
- Check if the material is a leaching hazard as defined in BC Hazardous Waste Regulation
- Check the local solid waste bylaw for additional criteria