SAFETY PROCEDURES

In

Research & Teaching

An Introductory Handbook for the Faculty of Forestry

9.0 Edition, June 2020

Produced by the Safety Committee,
Faculty of Forestry
(revised by D. Hastings)

IMPORTANT PHONE NUMBERS

EMERGENCY CENTRE (Ambulance, Fire, Police) ..... DIAL 911
UBC CAMPUS FIRST AID 604 822-4444
BC DRUG & POISON INFORMATION CENTRE 1-800-567-8911
HAZARDOUS MATERIALS RESPONSE DIAL 911
UBC CAMPUS SECURITY 604 822-2222
UBC Hospital Urgent Care Department 604 822-7662

NON-EMERGENCY NUMBERS

Ambulance 604 872-5151
AMS SafeWalk 604 822-5355
Campus Security 604 822-2222
Campus Fire Department 604 665-6010
UBC Safety & Risk Services (General Inquiries) 604 822-2029
- Biological & Radiation Safety 604 822-4353
- Chemical Safety 604 827-3409
- Environmental Services Facility (Hazardous Waste Disposal) 604 822-9280
- Occupational Hygiene 604 822-6098
- Safety Programs 604 822-7052

RCMP – UBC Detachment 604 224-1322
Student Health Services (8:00 a.m. - 4:00 p.m. weekdays) 604 822-7011
UBC Building Operations - Trouble Calls 604 822-2173
UBC Waste Management 604 822-3827
WorkSafeBC 604 276-3100
- Long Distance - toll free within BC 1-888-621-7233

Volunteer Area First Aid Attendants (for minor injuries)

Forest Sciences Centre

1st Floor	Rolando Descalzo (FSC 3410)	822-0975
2nd Floor	Gayle Koch (FSC 2711)	827-4454
3rd Floor	Norm Hodges (FSC 3411)	822-3259
4th Floor	Diana Hastings (FSC 4642)	822-3209

Centre for Advanced Wood Processing

	Lief Erikson (CAWP 1942)	822-6122
High Head Labs	George Lee (CAWP 1902)	822-8137

Your Supervisor's number (work) _____ (home) _____

FACULTY OF FORESTRY SAFETY PERSONNEL

The Faculty of Forestry Safety Committee is comprised of Forestry Faculty, Staff, and Graduate Students. Visit the Faculty of Forestry Safety Committee and the Forestry Joint Occupational Health & Safety Committee (JOHSC) for contact information.

Other safety personnel include first aid attendants (listed at the front of this manual), Building Emergency Directors and Floor Wardens.

Specific procedures, floor plans, and responsibilities of floor wardens are detailed in the Forestry Building Emergency Response Plan.

In the event of other building emergencies (especially after hours, including fires), one of the following Building Emergency Directors should be alerted:

Dr. Greg Smith 604-822-0081
alternate ..... TBD

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FOREWARD

This handbook has been prepared by the Faculty of Forestry Safety Committee, comprised of Faculty, Staff, and Graduate Students. The information in this handbook has been collected from a number of general sources and contains supplementary details on UBC and Faculty of Forestry procedures. Its purpose is to bring this material together into one place for communication to students and staff. In an interdisciplinary field such as Forestry it is impossible to cover everything or to remain concise; therefore this handbook is neither complete nor particularly short

We ask that all faculty, staff and graduate students read Sections I through V, and those portions of Sections VI through XIII that are relevant to their particular situation. After doing so, please forward any comments to the Forestry JOHSC Committee. This will let us know that you have received this information as part of your safety training. Your comments will help us assess and improve the effectiveness of the manual.

Safety Procedures in Research and Teaching
was written and compiled by
the Faculty of Forestry Safety Committee

DISCLAIMER

The information in this handbook is intended for the use of The Faculty of Forestry personnel as a guide to working with hazardous materials in the Forest Sciences Centre and is by no means meant to replace information provided by UBC Safety & Risk Services (SRS), WorkSafeBC, BC Government Legislation.

Published: Edition 1, 1990; Edition 2, 1991; Edition 3, 1995; Edition 4, 1999; Edition 5, 2003; Edition 6, 2006; Edition 7, 2014; Edition 8, 2019, Edition 9, 2020

Edited by: Diana Hastings and members of the Faculty of Forestry Safety Committee

I. SAFETY - WHO'S RESPONSIBLE?

Everybody is. Safety is mostly common sense and common courtesy. For example, in your office space, minimize clutter, keep exits clear and avoid stacking boxes or material on the top of high cabinets. Don't overload extension cords or run cords across access routes. In the lab, equipment or experiments should not be run unattended unless they are fail-safe. Working alone should be avoided. Don't use laboratories or other facilities without permission. Don't smoke, eat or drink in laboratories. Food must not be stored in laboratory refrigerators and laboratory glassware must not be used to prepare food. Don't wash your hands with solvents. Don't block passageways, laboratory exits or access to safety equipment.

Keep your fellow worker in mind. In cases where special hazards are associated with one's work, warnings should be posted in the vicinity of the project to alert co-workers to the danger. These signs should be large and legible. Make sure these signs are not obstructed and remove them when the work is completed.

Plan your experiments carefully and consider potential hazards (*e.g.* what are the toxicity hazards? What will happen if the power fails? Are any incompatible chemicals involved?). During laboratory meetings, in lecture, or before laboratory demonstrations, students and teachers should discuss the health and safety aspects of any work that is planned. Inform the Safety Committee and Deans Office if your experiments are likely to alarm or affect other building occupants (i.e. produce obnoxious odors or loud noises).

Having said the above, there are certain responsibilities spelled out by WorkSafeBC, Workplace Hazardous Materials Information System (WHMIS) legislation (see Section IV) and UBC Safety & Risk Services (SRS) Policies[1].

The University aims to provide a safe, healthy and secure environment in which to carry on the University's affairs. All reasonable preventive measures are taken to prevent accidental injuries, occupational diseases and risks to personal security.

Compliance with the Workers' Compensation Act, WHMIS and related legislation is the full minimum standard acceptable. All students and members of faculty and staff are encouraged to strive to exceed this minimum standard.

The University

It is the responsibility of the University acting through administrative heads of unit to:

- provide a safe, healthy and secure working environment;
- ensure regular inspections are made and take action as required to improve unsafe conditions;
- ensure that health, safety, and personal security considerations form an integral part of the design, construction, purchase and maintenance of all buildings, equipment and work processes;
- provide first aid facilities where appropriate;
- support supervisors and safety committees in the implementation of an effective health, safety and security program;

[1] See UBC Policies for list

- ensure compliance with WORKSAFEBC and other applicable legislation;
- establish department or building safety committees;
- communicate with the university community or affected groups about events or situations when potentially harmful conditions arise or are discovered;
- ensure adequate resources are available to implement appropriate procedures

The Supervisor

It is the responsibility of supervisory staff to:

- formulate specific safety rules and safe work procedures for their area of supervision;
- ensure that all employees under their supervision are aware of safety practices and follow safety procedures;
- provide training in the safe operation of equipment;
- inspect regularly their areas for hazardous conditions;
- correct promptly unsafe work practices or hazardous conditions;
- be responsive to concerns expressed about personal security and investigate any accidents, incidents or personal security concerns which have occurred in their area of responsibility;
- report any accidents or incidents involving personal security to the appropriate University authority;
- participate, if requested, on department or building safety committees

Individual Students[2] and Members of Staff and Faculty

It is the responsibility of individual students and members of faculty and staff to:

- observe safety rules and procedures established by supervisory staff, administrative heads of unit and the University;
- be safety-conscious in all activities, be they work, study or recreation;
- report as soon as possible any accident, injury, unsafe condition, insecure condition or threats to personal security to a supervisor or administrative head of unit;
- use properly and care for adequately personal protective equipment provided by the University;
- participate, if elected or appointed, on departmental or building safety committees

Department Local Safety Committees monitor the safety programs within their areas and make recommendations to help meet the safety objectives of the University. The Faculty of Forestry Safety Committee meets and conducts inspections regularly. Our mission statement is:

"To develop, maintain and promote attitudes leading to a safe working environment, in the Faculty of Forestry, both on campus and in the field, through external and internal communication and liaison."

[2] Employees include graduate students who hold valid employee appointments (actually rendering a service at the University, e.g. GTA's, library assistants, etc.) and are on UBC Payroll. Graduate students who are not in an employment situation with UBC are not eligible for Workers' Compensation. Students may obtain insurance against personal injury while in the course of their academic pursuits by applying for student accident insurance by visiting the UBC Safety & Risk Services Insurance Programs website.

II. UBC EMERGENCY PROCEDURES

1. Major Accidents/Injuries[3]

i. DIAL **911**

Specify whether you need **Police**, **Ambulance** or **Fire**
Have the following information ready:

- Building name (Forest Sciences Centre or CAWP)
- Building address (2900-2424 Main Mall or 6247 Sopron Lane)
- Room number

ii. If emergency involves an unconscious/injured person

a. Ensure there is no danger to yourself or victim

b. **Do not move** the person unless their life is endangered by their situation, (*e.g.* fire, explosion, moving machinery);

c. If the person appears to have difficulty in breathing, check for tight neckbands, tongue, false teeth or other foreign body lodged in throat. Remedy situation without moving the person's head;

d. Remain with victim until help arrives;

iii. Inform supervisor and have them complete the online UBC Centralized Accident / Incident Reporting System (CAIRS) form.

iv. A WorkSafeBC Form 6A may also be required if medical attention is sought.

2. Minor Accidents or Illness

i. If a staff, faculty or student-staff member is injured call UBC Occupational First Aid Team 604 822-4444

ii. If a student is injured call 911

Student Health Services (Vancouver Hospital – UBC Site) is available for First Aid during the following hours:

Mon, Tues, Wed, Fri	08:00 – 16:00
Thurs	09:00 – 16:00

iii. Inform supervisor or department head. Complete the online UBC CAIRS form.

3. Incident/Accident Reporting - CAIRS

UBC Central Accident/Incident Report System (CAIRS) is an online reporting system which can be completed by the supervisor and individual. All incidents and accidents must be reported through CAIRS as soon as possible following the incident/accident.

[3] All accidents (including field accidents) must be reported through UBC CAIRS. For serious accidents, call 911 and UBC SRS (604 822-2029) and immediately seal the area. Do not begin clean-up as on-site evidence must be preserved.

4. Active Threat

RUN, HIDE, FIGHT

Active Shooter in the Building

If it is safe, **RUN (get out)!**

- Advise others NOT to enter the danger zone
- Call Police – 911 as soon as it is safe to do so

Evacuation Not Safe

Find a place to **HIDE**

- If the door does not lock, barricade the door with tables and chairs
- Silence your cell phone, including vibration mode
- Hide behind large objects if possible
- Stay low, below window level and be quiet
- Close curtains or blinds if possible
- Await instructions or escort from law enforcement

Last resort

- If you feel your life is in danger **FIGHT**
- Attempt to incapacitate the shooter
- Act with physical aggression
- Improvise weapons
- Once the shooter is incapacitated, call Police - 911

5. Bomb Threat

i. Remain calm; listen carefully to what the caller is saying and write it down. Keep the caller talking and obtain the following information if possible:

a. Where is the bomb?
b. When will it explode?
c. What does it look like?
d. What kind of bomb is it?
e. What will cause it to explode?
f. Did you place the bomb? Why?
g. What is your name?
h. Where are you calling from?

ii. Record the details such as time of call, whether caller was male or female, any distinctive voice characteristics (accent, manner, speech, whether voice was familiar), whether there were any background noises or reference to local issues

iii. If possible, get a co-worker to call or when the caller hangs up, call

a. RCMP: **911**
b. UBC Campus Security: 2-2222
c. Be prepared to give your name, phone number and exact location with details of the threat
d. Do not hang up until you are released by the authority talking to you

6. Earthquake

During an earthquake

If you are inside a building:

a. Remain calm and resist the urge to run. Do not immediately leave the building as there is danger from falling debris
b. Do not use elevators
c. Move away from glass windows, partitions and objects with the potential to fall
d. **DROP** to the ground. Take **COVER** under a sturdy desk or table. **HOLD ON** to the furniture
e. If there are no tables or desks, brace yourself against an inside wall and cover your head and neck with your arms.
f. If in a wheelchair and you are able, Drop, Cover and Hold seek shelter under a sturdy table or desk. Try to get into an inside corner of the room. Lock wheels and duck as low as possible. Use anything to protect your head and neck.
g. Wait for the shaking to stop. Count to 60 to allow debris to finish falling
h. Evacuate the building if there is major structural damage or fire hazard
i. Prepare for aftershocks

If you are outside:

a. Move away from buildings, trees and power lines
b. **DROP, COVER** and **HOLD** on
c. Do not enter buildings

If you are driving:

a. Pull over. Leave the road clear for emergency vehicles and stay in your vehicle
b. Do not stop on or under a bridge or overpass or under power lines

After an earthquake:

a. Stay safe. Stay calm. Assess your surroundings. Check for injuries, gas leaks and fires. Do not turn on the lights or light a match unless you are sure there are no gas leaks. Extinguish open flames
b. Be prepared for aftershocks. Move to a safe area in building interior or outside. Do not re-enter damaged buildings
c. Evacuate the building if there is major structural damage or fire hazard
d. Monitor battery-powered or car radio for directions
e. Do not use telephones except to report medical emergencies, fires, chemical spills, gas leaks or other hazards
f. Do not use elevators

7. Fire

i. Pull **FIRE ALARM;**
ii. Dial **911**
   a. state your name;
   b. give the ADDRESS where the fire is and the nearest intersection, and
   c. provide information about the fire (*i.e.* what floor, how fast the fire is spreading, people trapped, *etc.*);
iii. If possible and without placing yourself or others in danger, control the fire with the appropriate fire extinguisher;
iv. If the fire cannot be controlled, isolate by CLOSING THE DOORS. Do not lock the doors;
v. Leave by the nearest safe exit;
vi. Call Campus Security (604 822-2222)
vii. Meet the Fire Department to give details on the location of the fire;
viii. Do not re-enter building until permission is received from the Fire Department.

8. Hazardous Materials

i. Ensure own personal safety[4]
ii. Act quickly to stop, contain, minimize the effects of the spill and clean up the affected area;
iii. If the spill cannot be contained, ensure own personal safety and EVACUATE;
iv. Call **911**
   a. report location of the spill (building and room number);
   b. identify the material and the quantity spilled
   c. wait for emergency personnel outside the main entrance and provide information (e.g. SDS)
v. Call Campus Security: 604 822-2222
vi. Notify UBC Safety & Risk Services (604 822-2029) as soon as possible;
vii. Complete online UBC Spill Reporting Form and submit to UBC SRS
viii. Inform Supervisor and Department Safety Representative

9. Elevator[5] Incidents

If you are trapped in an elevator

a. Remain calm
b. Press the intercom button (telephone symbol). This directly contacts Campus Security 2-2222
c. Inform them of:
   - building name;

[4] See Section VI.8 for personal protection equipment requirements
[5] Refer to Section IX.1 for elevator transport of hazardous materials

- elevator location or number
- the floor

If there are exceptional circumstances (*i.e*. chemical spills or medical issues)

a. call **9-1-1** if you have a cell phone[6]
b. inform Campus Security operator via the intercom button
c. wait calmly for emergency personnel to arrive but stay in touch via intercom or cell phone if circumstances warrant

[6] Cell phones may not work in the elevator, basement or other parts of the Forest Sciences Centre

III. FIRST AID

UBC expanded its Occupational First Aid Program in 2019 to improve the level of care offered to employees in the workplace. All faculty, staff and student-staff on UBC Vancouver campus can call the UBC Occupational First Aid Team, 24 hours a day by calling:

604-822-4444 or 2-4444 (UBC landlines)

In the event of a medical emergency, all 9-1-1 first, then call the UBC Occupational First Aid Team.

Before starting any first aid, always ensure there is not further danger to the victim or yourself. Do not move the victim except in life-threatening situations. Do not leave the victim unattended – if you must leave to call for help, always place the victim in the recovery position. Call the UBC Occupational First Aid Team.

If immediate action is required, below are some things that may or may not be done while waiting for emergency personnel. Universal precautions (ie. wearing latex/nitrile gloves) should be followed whenever contact with blood or body fluids is likely to occur.

1. Automated External Defibrillators (AEDs)

AED's are installed in the Forest Sciences Centre – across from the Dean's Office 2005 and CAWP – across from the WS Reception 2900. For more information on AED's on campus, please see Safety & Risk Services website.

Report all injuries to your supervisor and complete the online UBC CAIRS form.

2. Burns

a) Classification

Burns are classified according to depth or degree of tissue damage:

- 1st Degree - hot object, scalding liquid - produces redness or discoloration, mild swelling, pain.
- 2nd Degree - more severe contact with hot object, flash burns (flammable liquids) - greater depth than 1st degree; red/mottled appearance, blisters; more pain than deeper burns because nerve endings are still intact.
- 3rd Degree - deep tissue damage; white or charred-look; complete loss of skin.

b) Treatment

- 1st Degree - submerge burn in cold water or apply water to area. This will ease the pain of minor burns and may promote healing.
- 2nd Degree - submerge in cold water until pain subsides (or apply clean cloths soaked in cold water); gently blot dry; apply sterile gauze or clean bandage. For arms/legs - raise above the body. Never break blisters or remove tissue. DO NOT apply antiseptics/ointments (surgeons treating the burn may have to remove any greases or salves applied, causing further damage).

3rd Degree - do not remove particles of charred clothing; cover burns with clean clothes; keep hands/legs elevated above the heart. For face burns, keep patient propped up. Do not submerge a large burned area in water (may increase shock). DO NOT apply ointments or greases. Transport to hospital immediately.

Chemical Burns - flush area immediately with large amounts of water (5-20 min.), remove contaminated clothing to facilitate irrigation. Apply dressing and transport to hospital.

3. Acid or Alkali Burns

Remove cause of the burn. Remove contaminated clothing or jewelry. Flush the affected area with cool running water for 15 minutes or more. Treat victim for shock if there is shallow, rapid breathing. Contact UBC Occupational First Aid Team.

4. Bleeding

Hold a pad of clean cloth directly on the wound and apply hand pressure. Do not apply a tourniquet. Prevent infection by applying a clean, sterile dressing. If necessary, contact UBC Occupational First Aid Team.

5. Cyanide[7] Inhalation

Remove victim from exposure. Keep warm and at rest. Oxygen should be administered but do not use mouth-to-mouth resuscitation. Contact UBC Occupational First Aid Team and contact BC Drug & Poison Control Information Centre[8]

6. Electric Shock

Remove the source of electrical shock as soon as possible (use a dry towel when moving "live" wires or equipment). If the victim is not breathing, perform CPR. Contact UBC Occupational First Aid Team.

7. Fractures

Do not move victim unless absolutely necessary. In the field, immobilize broken arms or legs (a broken foot or ankle should usually remain in its loosened boot). Contact UBC Occupational First Aid Team.

8. Not Breathing

Start artificial respiration as soon as possible.

9. Sprains

Rest the victim. Apply ice then a compression bandage. Elevate the sprain. Contact UBC Occupational First Aid Team.

[7] See Appendix C.8 for cyanide hazards

[8] BC Poison Information 24-hour line 1-800-567-8911

10. Swallowing Poison

Dilute strong acids and bases by quickly administering large amounts of water. For other poisons, follow instructions on the container label. Never give liquids to an unconscious person. Do not induce vomiting if the patient is unconscious, convulsing, or has swallowed a corrosive poison. Contact UBC Occupational First Aid Team and BC Drug & Poison Information Centre[8]

Additional Information:

First Aid – Safety Oriented Emergency Level, St. John Ambulance

IV. WHMIS

1. What's WHMIS?

WHMIS is the **W**orkplace **H**azardous **M**aterials **I**nformation **S**ystem. WHMIS is a Canada-wide program aimed at providing information on the safe use of hazardous materials. WHMIS was legislated in October 1988 and aligned with the Globally Harmonized System of Classification and Labelling of Chemicals (GHS) in 2015 to include 4 main components:

i. Hazardous identification and product classification
ii. Labeling
iii. Safety data sheets (SDS)
iv. Worker education and training

WHMIS 2015 divides hazardous products into two major hazard groups: physical hazards and health hazards. Each hazard group is further divided into hazard classes.

Online information on WHMIS is available from the following sources:

a) Health Canada

b) WorkSafeBC

c) Canadian Centre for Occupational Health & Safety (CCOHS)

d) UBC SRS WHMIS Training

2. WHMIS Labels

There are two main types of WHMIS labels: supplier labels (*e.g.* on containers from chemical suppliers) and workplace labels (*e.g.* on laboratory beakers, bottles, *etc.*).

Supplier labels must be bilingual and have the following pieces of information:

1. product identity;
2. Initial supplier identifier;
3. Pictograms;
4. signal word;
5. hazard statement;
6. precautionary statement;
7. supplemental label information.

The last three items are not required on containers of 100 ml or less. Containers of <100 ml is exempt from the precautionary statement. Containers <3 ml would be required to have a label that is durable and legible for transport and storage but may be removable during use. The WHMIS pictograms are illustrated in Appendix D.

Laboratory samples sent out for analysis must have the WHMIS border, "product" identifier, supplier identifier, and chemical composition. Also required, in both official languages, is the statement "Hazardous Laboratory Sample. For hazard information or in an emergency call (*supplier telephone number*)."

Workplace labels are required whenever a hazardous product is transferred or decanted into a new container or when the old supplier label is lost or damaged. They are also required on containers of materials produced for storage or use in the workplace, and on research equipment containing chemicals. They should be in the language of the majority in the workplace (English at UBC). At minimum, three pieces of information are required:

1. product identifier (name);
2. safe handling information (*e.g.* hazard symbols);
3. reference to the SDS.

Do not overwrite supplier labels. If you change the contents of a bottle, remove the old label and apply a new workplace label. In a laboratory site[9] only the chemical identity is required. This may simply be an abbreviation, symbol or color code (**as long as everyone working in the laboratory knows what it means and what precautions should be taken**).

3. Responsibilities under WHMIS

Under WHMIS, employees (faculty, staff and graduate students) are expected to:

- understand label information and procedures
- follow these procedures
- inform the supervisor when labeling is inadequate
- know where the SDS are and consult them as necessary

However, the employer or supervisor (PI) is ultimately responsible. He/she must:

- ensure all labeling requirements are met by suppliers and laboratory members
- provide access to and ensure maintenance of SDS
- ensure that the chemical inventory is maintained
- provide adequate training for workers (students, technicians)
- develop safe working procedures and spill clean-up procedures[10]

4. Safety Data Sheets (SDS)

Suppliers and importers of hazardous materials must provide safety data sheets (SDS) and are meant to be a quick and readily available source of information to workers at the work site. An SDS is not required to be in hard copy format. There are several web versions available. The University has access to the web version http://ccinfoweb.ccohs.ca/**,** however if this is going to be the sole method by which the SDS information is provided, the computer which accesses the SDS website must also be readily available to all workers at the laboratory site. Although a hard copy is not required, the worker must be able to generate a hard

[9] Laboratory site includes field sites, gardens or any other place devoted to experimental studies

[10] During WorkSafeBC inspections, workers may be asked where written procedures are located. This handbook may suffice in some situations

copy if necessary. The main purpose is to assist in risk assessment and planning of safe procedures for handling during an emergency response.

There are nine categories of information which must appear on the SDS. These include:

1. product identification,
2. hazardous identification,
3. composition,
4. first aid measures,
5. fire-fighting measures,
6. chemical and physical properties,
7. reactivity data,
8. toxicological properties,
9. preventative measures,
10. handling and storage
11. SDS preparation information.

SDS information is generic and must be considered in the context of the particular work situation.

Users are required to read the SDS prior to working with the hazardous product. An SDS is required for **every** hazardous chemical present in the laboratory, must accompany all chemical shipments (if not, request that one from the vendor or go online to print one up) and should be added to the laboratory SDS binder when received. SDS's are to be updated at least every three years and as soon as further information related to the hazardous product is available.

If SDS for chemicals already in stock are not available, an SDS from a different manufacturer may suffice. Chemicals ordered directly from foreign countries may not have SDS, in which case supervisors are required to compile their own SDS (or dispose of the chemical).

V. SAFETY INFORMATION

There are many sources of safety information on campus. The Faculty of Forestry Safety Committee has a bulletin board located on the 2nd floor of the Forest Sciences Centre near the Faculty Office. Other important sources of information, and regulations pertaining to them, are highlighted below.

1. UBC Safety & Risk Services Training

All new employees are required to complete **mandatory** courses to meet WorkSafeBC and UBC requirements. A worker at UBC includes: Senior Executives, Faculty, Staff and Student workers. See UBC Worker Mandatory Training for list of required courses.

It is **mandatory** for all faculty, staff and students working with hazardous chemicals to take one or more of the following chemical courses offered through UBC Safety & Risk Services:

Introduction to Laboratory Safety - this course covers WHMIS, knowledge about biohazards, hazardous chemicals, radioactive materials and safety in the UBC laboratories. The course is suitable for undergraduate students working, volunteering or studying in UBC laboratory under direct supervision of a senior lab member.

It is a requirement that all UBC students who may potentially be exposed to hazardous materials take this course which fulfills the safety requirements for UBC summer work students, co-op students and/or work study students that are ONLY working under direct supervision. Completion of this safety course does NOT certify individuals to work unsupervised in UBC laboratories. This course is offered online by UBC Safety & Risk Services.

Chemical Safety - this online course covers safe chemical use, storage, handling and disposal, laboratory inspections, emergency response and spill management. The course is **mandatory** for all personnel handling laboratory chemicals. Successful completion of the online course, practical session and exam is required for certification. The completion of this course meets the basic regulatory requirements.

Biological Safety - offered online, this course is **mandatory** for all faculty, staff and students prior to commencing work with Risk Group 1-3 biohazards. The UBC BioSafety Program oversees and evaluated the potential risks in biohazardous materials. All work with biological materials must be reviewed and approved by the UBC BioSafety Committee initiated through the RISe system.

Radiation and X-Ray Safety Training - this course meets the basic training requirements of the Canadian Nuclear Safety Commission and is **mandatory** for all faculty, staff and students prior to commencing work with radioactive materials. See SRS website or contact the Biological & Radiation Safety Advisor, 604 822-45-353 for further information.

2. UBC Safety & Risk Services Manuals and Handbooks

The UBC Safety & Risk Services website contains the most recent information and is an excellent reference tool. There are fact sheets, quarterly newsletters, Hazardous Waste Procedures, forms and the following publications: Chemical Lab Safety Manual, Biosafety Reference Manual, Radiation Reference Manual, Hazardous Waste Disposal Guide.

3. Field Safety

Forestry research often involves fieldwork. *Field Procedures and Safety Manual* is developed by the Faculty of Forestry Safety Committee for information on field safety. This manual is available from the Forest Resources Management and Forest Conservation Sciences department offices.

The staff at Malcolm Knapp Research Forest (MKRF) put on a Field Safety orientation session each spring at UBC and has also developed the *Malcolm Knapp Research Forest Emergency Procedures* handbook. Contact MKRF in Maple Ridge, 604-463-8148 for details. Researchers should also consult *Forestry Handbook for British Columbia*, pp. 738-751 in Watts and Tolland, 2005.

For information on procedures at Alex Fraser Research Forest (AFRF), contact the Williams Lake office at 250-392-2207

All accidents[11] occurring in the field must be reported online in CAIRS.

4. Respiratory Safety[12]

Every employee, who wears a respirator, must be fit tested and trained in the proper use of the respirator. UBC Safety & Risk Services provide training and fit-testing for respirator use for a fee. The purpose of this program is to ensure employees and students are protected from respiratory hazards encountered during normal working conditions, repairs and maintenance. Register for annual fit test at Safety & Risk Services Respiratory Safety or for more information contact the UBC Occupational Hygiene Advisor at 604-822-6098.

5. Woodshop Facilities and High Head Laboratories Access

Wood Science Woodshop

All individuals intending to use the Woodshop must first attend a safety training session with the Technical Operations Coordinator by contacting 604-822-3981.

High Head & Wood Drying Laboratories

All individuals working in the High Head & Wood Drying Laboratories for the first time should attend an orientation session where safety issues specific to the facilities will be discussed. Contact the Technical Operations Coordinator at 604-822-3981 for more information.

[11] Refer to Section II.3 for Incident/Accident reporting

[12] See Section VI.8 for fit-testing

CAWP High Head Machine Laboratory

All individuals working in the CAWP High Head Machine Laboratory must have proven operator proficiency and safety training before operating machinery. Contact the Technical Operations Coordinator at 604-822-3981 for more information.

6. Forest Sciences Centre Hazardous Material Facility[13]

The Hazardous Material (HazMat) Facility includes storage areas for hazardous materials, flammable materials and compressed gas cylinders. The Hazardous Waste Disposal area is also located within the HazMat Facility. Access is restricted to those who have successfully completed the UBC Chemical Safety Course and the Forestry Haz-Mat Facility Safety Quiz. For Haz-Mat Facility Safety training, contact the Safety Representative in your department.

See Section X for hazardous waste disposal guidelines.

7. Faculty of Forestry Chemical Inventory

To comply with WHMIS regulations, there is a full inventory of chemicals in the Faculty of Forestry which includes some 2500 chemicals. Each Department is responsible for maintaining a chemical inventory that should be reviewed annually. The chemical inventory should be maintained in Quartzy.

Procedures for the departments are as follows:

a) **Forest Conservation Sciences**: It is the responsibility of each professor to see that their own inventory is updated annually. Individual listings have been provided. New chemicals should be added to the end of each list as they are received and crossed off when spent or disposed of. A copy of the updated inventory from each laboratory is to be forwarded annually to the inventory coordinate in FSC 3410. These will be added to the main Faculty Inventory and new lists will be distributed.

b) **Wood Science**: It is the responsibility of each laboratory supervisor to ensure that the chemical inventory for their area is kept up-to-date. Quartzy, a web-based chemical inventory was adopted and used to maintain the chemical inventory. All new chemicals should be added to the inventory and spent chemicals should be removed from the inventory. For questions regarding the Wood Science chemical inventory, contact the Senior Technician at 604 822-3209.

All chemicals stored in the Hazardous Materials Storage Facility in the Forest Sciences Centre must be added in Quartzy. See Section VIII for details on storage of hazardous materials.

It is a requirement for all departments, that the principal investigator (PI)'s name, buyer's name and the date be written on the chemical container upon receipt. Before buying a new chemical, check the main inventory to see if the chemical on hand. This can save you time, money and help minimize unnecessary stocks.

[13] Restricted access – contact Department Safety Representative for more information

VI. SAFETY EQUIPMENT

1. First Aid Kits (FAK)

BC Basic First Aid Kits are located in all laboratories in the Forest Sciences Centre, Department offices and First Aid Attendant offices. These FAK contain adhesive dressings and tape, abdominal pads, compress bandages, gauze dressing, triangular bandage, antiseptic towels, hand cleaners, bandage scissors, splinter forceps and latex gloves. Some kits may also contain tensor bandages, cold packs, sting stop and a pocket mask. Adhesive strips (Band-aids) are always the first to go so check your supply. Due to the possibility of tampering, FAK do not contain any other type of oral medication.

First aid kits should contain a treatment record sheet and a checklist of contents. Contact your Department Safety Representative for replacements of supplies.

2. Fire Extinguishers

Fires are classified into four categories and fire extinguishers are rated with a letter which refers to the class of fire that the agent is best suited:

Class A
- ordinary combustibles (wood, paper, textiles, rubber)
- use water (to quench and to cool) or foam/multipurpose dry chemical extinguisher that is marked with an **A**

Class B
- flammable liquids (oils, gasoline, solvents)
- **do not apply water.** It may cause the fire to spread and will not effectively smother if the flammable liquid floats on top
- use CO_2, foam/multipurpose dry chemical extinguisher marked with a **B**

Class C
- electrically charged equipment
- **avoid water** or any other agent that can conduct electricity and create a shock hazard
- use CO_2 or a dry chemical extinguisher marked with a **C**

Class D
- combustible metals (*e.g.* Li, Mg, Na, and K)
- **do not apply water** (explosion hazard)
- smother with sodium carbonate, sodium chloride, sand, or use a fire extinguisher marked with a **D**

All persons should be aware of where the fire extinguishers are located (see Building Emergency Response Plan for FSC) and what type of fire the extinguishers are designed for. They must be clearly visible and easy to access. Fire extinguishers should be checked annually. If an extinguisher requires maintenance, replacement or if it has been discharged, contact Acme Fire and Safety Co. Ltd. at 604-437-8555

3. Emergency Showers and Eye Wash Stations

In accordance to WORKSAFEBC regulations, safety showers and/or eyewash stations are located in all wet laboratories in the Forest Sciences Centre. Access to the safety showers and eye wash stations are to be kept clear and these

stations are to be checked regularly. Water flow of the safety showers and eyewash stations must be sufficient to drench the subject rapidly and to accommodate more than one person, if need be.

Eye wash fountains should provide a gentle flow of clean, tepid, aerated water for a period of at least 15 minutes. When using an eye wash, forcibly hold the eye open to wash behind the eyelids and rotate your eyeball so that all surfaces are rinsed.

It is recommended to flush the eyewash stations regularly to clear any debris in the lines. For bottled eyewash solutions, check expiry dates and change when necessary.

4. Fume Hoods

The purpose of a fume hood is to capture and retain or vent atmospheric contaminants generated within the hood. Successful operation depends mainly on the velocity of the air moving through. Various factors such as cross currents, entrance shapes, and obstructions affect the face velocity and air movement within the hood. For general use, the minimum permissible operational face velocity is 0.5 m/s. For carcinogens and radioisotopes, 0.75 m/s is required. UBC Safety & Risk Services performs annual flow rate checks.

Cross currents, generated by open windows or doors or pedestrian traffic, can draw air out of a fume hood and impair its effectiveness. Even with adequate face velocity, a person standing in front of a hood can create eddies that may result in exposure to toxic materials. Use a horizontal sliding sash or shield in front of the person to prevent this.

The inside of a fume hood should be kept as clear as possible. A hood full of storage containers and equipment may impair air flow and circulation. Large items (*e.g.* an oven) should be raised on blocks. Shelving, if installed, should be located on the sides of the hood and not on the back wall. Storage of materials (waste, *etc.*) in a fume hood is discouraged.

The hood sash (window) is designed to be raised or lowered without affecting the hood efficiency. When working in the fume hood, the sash must be kept below the sash level indicated by the red or blue sash height sign. The sash should be down when the hood is not in use. On a daily basis and before using a hood, ensure the fan is operating - a streamer inside or attached to the bottom of the sash provides a quick visual check.

DO NOT USE any fume hood which has no airflow or has been LOCKED OUT. If the fume hood airflow stops, submit a service request by contacting UBC Building Operations Service Centre (Trouble Call) at 604-822-2173 and post a sign which reads:

DO NOT USE HOOD
OUT OF ORDER

5. Exhaust Hoods

Exhaust hoods are located in various laboratories in the Forest Sciences Centre. These exhaust hoods are positioned over benches or equipment to remove odors, small amounts of smoke, steam and/or other NON-TOXIC vapors. These are NOT fume hoods nor should they ever be used as fume hoods. These hoods do not provide adequate protection from toxic vapors.

To confirm proper functioning, a small 'tell-tale' strip of tissue paper should be taped near the hood opening to check that air is moving in the right direction. All exhaust hoods should have a sign taped to the edge of the hood stating:

NOT a fume hood – NO toxic chemicals or flammables

If the exhaust hood is not functioning properly or there is no air movement, submit a service request by contacting UBC Building Operations Service Centre (Trouble Call) at 604-822-2173.

6. Laminar Flow Hoods (LFH) and BioSafety Cabinets (BSC)[14]

Biological Safety Cabinets include Laminar Flow Hoods, Class II Cabinets and Class II type Cabinets. The concept behind BSC was developed in 1909. Pre-filtered air is drawn into the cabinet and the exhausted air is passed through filters to protect the environment from possible release of biohazards.

WORKSAFEBC requires that biological safety cabinets be certified annually. Laminar flow hoods are not required to be certified unless they are used to prepare products to be consumed or injected into humans. However, the HEPA filters should be checked and replaced when necessary. UBC Safety & Risk Services will certify biological safety cabinets and certify the performance of laminar flow hoods annually for a fee.

Working for a long period of time in a biosafety cabinet can result in an increased risk of musculoskeletal injury due to poor ergonomics. Contact UBC Workplace Health for help in setting up your workstation.

a) Laminar flow hoods: provide product protection only. While suitable for the preparation of media or products where a sterile work environment must be maintained, they must not be used when working with any form of biohazard or chemical hazard. The theory behind LFH is that they provide a sterile work environment by creating a laminar flow of air across the work surface that has passed through a High Efficiency Particulate Air (HEPA) filter. Therefore, any potentially infectious aerosol that is created will lead to exposure of the operator and the environment.

Certain precautions should be followed when using laminar flow hoods. LFH should be sprayed or wiped down with alcohol and the fan should be turned on 15 minutes prior to use. If open flame burners are used in LFH, keep alcohol at

[14] See for Safe Use of Biosafety Cabinets for guidelines

a safe distance from the flame and do not attempt to spray or wipe down the LFH when the flame is on. Allow cabinet fan to run for at least 5 minutes before shut-down. Always spray and wipe down the LFH with alcohol after use.

Some LFH have UV germicidal lights. Ensure safety shield/sash installed and do not use the unit with the UV light on.

b) Biological Safety Cabinets - Class I: provide personnel and environmental protection but lack in product protection, thereby of limited use.

c) Biological Safety Cabinets - Class II: provide personnel, product and environmental protection. There are 4 types of Class II cabinets, the functional differences being the amount of air that is recirculated within the cabinet and whether or not the plenum is under positive or negative pressure. The difference between Type A and Type B cabinets is that Type A cabinets are often exhausted back into the laboratory or they may be vented to the outside environment, whereas Type B cabinets must have a dedicated, sealed exhaust system with an external blower and alarm system.

Type A - cabinets are suitable for work with biohazardous agents in the absence of volatile toxic chemicals and volatile nuclionuclides.

Type B1- cabinets are suitable for work with agents treated with no more than a few micrograms of toxic chemicals or trace quantities of radionuclides.

Type B2 - cabinets may be used with biological agents treated with toxic chemicals and radionuclides.

Type B3 - (or A/B3) cabinets are suitable for work with biological agents treated with minute quantities of toxic chemicals and trace quantities of radionuclides. Referred to as convertible cabinets, it is a cross between a true Type A and a Type B cabinet, all biologically contaminated plenums and ducts are under negative pressure or are surrounded by negative pressure

7. Flammable Solvent[15] Safety Cans and Solvent Storage Cabinets

Approved portable safety cans for carrying, storing and dispensing flammable and combustible liquids are either made from metal construction or very low conductivity plastic. Safety cans generally have two distinctive features: (i) a spring-mounted self-closing cap and (ii) a flame arrestor in the pouring spout. The spring-closing cap automatically opens when the vapor pressure inside builds up allowing vapors to escape and prevent rupture or explosion in the event of a fire. This spring-mounted cap also causes the spout cap to close automatically when pouring is complete or if the can is dropped.

The flame arrestor consists of a double layer of wire mesh that prevents fire flash-back into the can by providing very rapid heat dissipation. These screens should never be removed and should be replaced if they become damaged.

[15] See Section VII.4 for hazards, Section VIII.2 for transportation and Section IX.5 for storage requirements of flammable materials

UBC solvent waste disposal safety containers generally have a wider opening than safety cans, which are intended for storing and dispensing. These containers must be capped when not in use.

Plastic cans are more resistant to corrosion or damage from rough handling and its non-conducting surface prevents the accumulation of sufficient static charge to cause ignition of flammable vapors. When pouring from one metal container to another, it is advisable to connect the two cans together with a wire to prevent generation of static spark.

Stainless steel flammable liquid safety cans conform to ULC-C30 and the capacity does not exceed five liters. Static electric sparks may result when transferring liquid from one metal container to another. When dispensing flammable liquid from one metal container to another, connect the two cans together with a wire.

Approved flammable liquid storage cabinets are constructed with an air space between double walls to provide some insulation in the event of a flash fire. This protection is only temporary. A small fire might be extinguished before internal cabinet temperatures rise to the ignition point[16]. In a major fire, the insulation could provide a few extra minutes for personnel to escape. Flammable liquid safety cabinets should be vented to a fume hood and also be equipped with a ground wire.

8. Personal Protection Equipment (PPE)[17]

The WorkSafeBC requires that "workers in laboratories shall be provided with and shall wear protective clothing and personal protective equipment..." The need for personal protection equipment will depend on the circumstance. When planning experiments, consider these needs in advance and consult the appropriate SDS.

Common personal protection equipment in the laboratory includes lab coats, aprons, gloves of various types, and goggles. On occasion, particle masks, respirators, face shields and steel-toed or rubber boots may be required. In the field, coveralls or a waterproof suit, high visibility headgear, caulked boots, and leg protection (*e.g.* when operating chain saws) may be required. Flares and other survival gear might also be appropriate.

a) Clothing

In a wet laboratory, a lab coat must be worn at all times when handling, working with or around hazardous materials. Sandals, open-toed shoes are not acceptable footwear when working with hazardous materials. Bare legs should be properly protected when working with/around hazardous materials, particularly corrosives or solvents.

Lab coats should not be washed at home due to risk of contaminating other clothing. The University has a contract with a company that provides lab coat cleaning service. Contact your Department Technician for details.

[16] See Appendix G for flammable liquid properties

[17] See Personal Protective Equipment (PPE) in SRS website

b) Eyewear

It is a requirement that properly fitted safety eyewear is worn if handling or exposed to materials are likely to injure or irritate the eyes. Safety eyewear must meet the requirement of CSA Standard CAN/CSA-Z94.3-92 or ANSI Standard Z87.1-1989. Choose the appropriate safety eyewear for the type of work and nature of the hazard. See Appendix F for selection of safety eyewear and face protection.

c) Respiratory Safety

Respirators should be used for protection from contaminants in the air only if other hazard controls are not practical or possible under the circumstances. Respirators should not be the first choice for respiratory protection when working in the laboratory. Respiratory protection may be required when working with hazardous materials outside a fume hood or when transferring flammable solvents in the Hazardous Materials Storage Facility. Respiratory protection may also be required when cleaning up hazardous spills depending on the material spilled.

All UBC employees required to wear a respirator are mandated by the BC Occupational Health & Safety Regulations to have a qualified person perform fit testing[18] of the respirator to the user's face. UBC Safety & Risk Services has a respiratory protection initiative which offers guidelines, training and respirator fit testing to all UBC community members.

Respirator Fit Testing

Respirators are designed to fit the face and have an effective seal to the face therefore the user must be ***clean-shaven*** where the mask fits the face. Check the integrity of the respirator prior to fit testing. Fit testing must be performed prior to every use.

Place the respirator over your mouth and nose, pull the harness over the crown of your head and fasten the bottom straps behind the neck. Adjust the top/bottom straps for a snug fit.

Perform negative and positive pressure tests:

i) Inhalation (negative pressure) Test

Cover the cartridge or filter retainer to restrict air flow. Inhale gently. If the face-piece collapse slightly and pulls closer to the face with no leaks between the face and face-piece, a proper fit has been obtained.

[18] See UBC Respiratory Safety

ii) Exhalation (positive pressure) Test

Cover the exhalation valve cover and exhale gently. If face-piece bulges slightly and no air leaks are detected between the face and the face-piece, a proper fit has been obtained.

Respirator Storage

Store respirators and cartridges in tightly sealed plastic bags when not in use. Keep in a dry cool place, away from contaminants. Depending on the manufacturer suggested cartridge life, replace when odors are detected when breathing through the respirator.

The two main types of respirators are air-purifying respirators (APR) and supplied-air respirators (SAR):

Air-purifying Respirators

APRs can remove contaminants in the air breathed by filtering out particulates (ie. dust, metal fumes, mists, etc.) and/or purifying air by adsorption of gases or vapors on a sorbent in a cartridge or canister. These are tight-fitting and available in various forms:

- Mouth bit – fits in the mouth and comes with nose clip to hold nostrils closed
- Quarter mask – covers the mouth and nose
- Half-face mask – covers the face from the nose to below the chin
- Full facepiece – covers the face from above the eyes to below the chin

Examples of air-purifying respirators (APR) include:

- Particulate respirators (formerly called dust, fume, mist masks)
- Chemical cartridge respirators that can have a combination of chemical cartridge and dust pre-filter
- Gas masks – contain more adsorbent than cartridge-type respirators and can provide a higher level of protection than chemical cartridge respirators

Supplied-air Respirators

SARs supply clean air through an air-line or from a compressed air tank. This air is not from the work room area, rather is supplied in tanks or from compressors which must meet certain standards of moisture and purity (CSA Standard Z180.1-00).

Examples of supplied-air respirators (SAR) include:

- Self-contained breathing apparatus (SCBA)
- Air-line supplied-air respirators
- Protective suits that totally encapsulate the wearer's body and incorporate a life-support system

For a guide to selection of respiratory protection, see WorkSafeBC Breathe Safer.

9. Chemical Spill[19] Clean-up Kits and Carts

Chemical Spill Clean-up Carts are located in various areas of the Forest Sciences Centre. All hazardous spills must be reported the Department Safety Representative, UBC Safety & Risk Services and the UBC Spill Reporting Form must be completed and submitted as soon as possible.

Report items used from the Chemical Spill Carts to the Department Safety Representative.

The chemical spill clean-up cart contains:

i. Protective clothing (coveralls, heavy rubber gloves, goggles, disposable respirators and polyethylene foot covers).
ii. Commercially available absorbent spill control pillows or neutralizing powders (*e.g.* Spill-X) for acids, caustics and solvents.
iii. Dustpan/scoop, broom.
iv. Mop and pail or sponge - to scrub down the area after the bulk of the spill has been removed.
v. Heavy plastic disposal bags and ties.
vi. pH paper

All laboratories using heating oils, vacuum oils, etc. should have kitty litter or vermiculite on hand to absorb any spilled oils.

[19] See Section II.8 for chemical spill reporting details

VII. HAZARDOUS MATERIALS AND REACTIONS

The major groups of hazardous chemicals, their reactions and recommendations regarding handling are highlighted below. Persons contemplating the use of particularly noxious or toxic chemicals (*e.g.* chloropicrin) should be able to produce written procedures upon request.

Chemicals should be stored in cool, dry and properly vented areas and not stored alphabetically, but rather according to their hazard class according to the six WHMIS categories. See Section VIII for storage and Section IX for transport guidelines.

1. Asbestos

Asbestos is a potential health hazard. It can be found in various forms such as transite in fume hoods, and as insulation around pipe elbows and tees. It was formerly very common in laboratories as a heat resistant insulating material and inert filler (i.e. as loose transite sheets for heating mantles).

If the asbestos containing material is in good intact condition, it is non-hazardous. However, if the material is ripped or friable in condition, it is extremely hazardous and should be dealt with carefully.

Do not handle damaged asbestos-containing material. Post a sign restricting the area which reads:

DANGER

DAMAGED ASBESTOS CONTAINING MATERIAL

DO NOT DISTURB ANYTHING INCLUDING DEBRIS

Contact the UBC Asbestos Management Group at 604 822-8772 to arrange for the disposal of the damaged material.

TLV[20] = 0.2 fibres/cc. Ensure there are no sources of friable asbestos in the laboratory (*e.g.* exposed unsealed edges of cut sheets (tremolite), old fireproof gloves, etc.)

2. Corrosives[21]

Corrosives are strong acids (*e.g.* sulfuric acid, nitric acid, hydrochloric acid, etc.) and caustics (*e.g.* ammonium hydroxide, sodium hydroxide, etc.). They are generally non-combustible (except perchloric acid) but may generate sufficient heat to cause a fire if in contact with combustible materials. Some corrosives react violently with water.

Always wear goggles and appropriate gloves when handling corrosives. If skin or eye contact occurs when handling caustic alkali (*e.g.* NaOH, KOH, NH_4OH), remove the solution from the area of contact immediately and flush with generous amounts of cold water (10 min.). Strong alkali causes more damage to the eye than strong acid.

[20] TLV = Threshold Limit Values reflect the level of exposure that a worker can experience without unreasonable risk of disease or injury. Note: TLV are guidelines, not standards.

[21] See Section IX.3 for transport guidelines

Acids can precipitate a protein barrier that will retard further movement into the tissue, but alkalis do not and may continue penetrating further. Flush eyes for an extended period of time to flush out all caustic (10-20 min.). Contact lens wearers may sustain more damage due to spasms of the eye lid causing difficulty in removing them for proper irrigation.

Acids and caustics should be stored in separate cabinets away from flammable or readily combustible materials. It is advisable to keep bottles in a corrosion resistant pan (plastic or glass) to facilitate clean-up in case of breakage.

Considerable heat may be generated when solutions of strong acids or bases are prepared. Heat-resistant containers (*e.g.* a Pyrex beaker, not a glass storage bottle) should be used for mixing with tongs or oven mitts on hand. **Always add acid to water (not the reverse)**. Add water to acid slowly, stirring constantly to prevent splattering. Wear face/eye protection and gloves when handling corrosives.

If a major corrosive spill[22] occurs contain the spill, ensuring personal safety. Use the appropriate absorbent for the type of corrosive (ie. Spill-X-A for acid and Spill-X-C for caustic). Slowly sprinkle small amounts of neutralizer on the spill from the perimeter inward. Mix the neutralizer into the spill and test with pH paper. If the pH is between 3 and 10, the neutralized spill can be swept up, contained and packaged appropriately for disposal. Decontaminate and wash the area with lots of water and soap. Caustic spills will make the floor very slippery.

It is not advisable to flush or wash a spill down the floor drain because a violent reaction could occur upon contact with water. DO NOT try to neutralize a strong acid spill with a strong base, or *vice versa*.

3. Cryogenics[23]

a) Dry Ice

Dry ice is solidified carbon dioxide (CO_2) and is particularly useful for freezing and keeping things frozen due to its extreme low temperature, -109°F (79°C). Unlike water ice, dry ice does not melt, instead changes from solid to gas (sublimate) at normal atmospheric conditions, releasing CO_2. Carbon dioxide gas is substantially heavier than air, thereby in a confined or poorly ventilated space, it can displace air. The sublimation rate is approximately 5-10 pounds/24hrs in a typical ice chest.

When handling dry ice, use special cold-resistant gloves and do not store in airtight containers or compartments. Avoid contact with eyes or skin. Brief contact to the skin is harmless but prolonged contact will cause severe frostbite[24] within seconds. Frostbite is an injury similar to a burn. Transport dry ice in highly insulated containers made of polyethylene, glass-fiber or polypropylene (Styrofoam). The thicker the insulation of the container, the slower the dry ice will sublimate. Do not store dry ice in airtight containers as the container can rupture or explode due to the pressure.

[22] See Section II.8 for major chemical spill procedures

[23] See Section IX.4 for transportation guidelines

[24] Treatment of frostbite is the same as for a regular burn

Do not store dry ice in confined or unventilated areas. Do not store dry ice in a refrigerator freezer as the extreme cold will cause the thermostat to turn off the freezer.

b) Liquid Nitrogen

Liquid nitrogen (LN_2) is colorless, inert, non-corrosive, nonflammable, odorless and extremely cold. Referred to as a 'cryogenic refrigerant, its boiling point is -320.5°F (-1968°C). This extremely low temperature liquid can cause severe burn-like damage to skin. The hazard level is comparable to that of boiling water. The low temperature vapor can cause damage to softer tissues such as eyes and lungs.

There is a potential for asphyxiation when handling inert cryogenic liquids. When cryogenic liquids form a gas, it is very cold and usually heavier than air. It does not disperse very well and can accumulate near the floor, displacing air. Small amounts of cryogenic liquid can evaporate into very large volumes of gas. One liter of LN_2 vaporizes into 695 liters of N_2 gas when warmed to room temperature. Use and store LN_2 in well ventilated areas and do not store in a confined space.

Liquid cylinders are pressurized containers specifically designed for cryogenic liquids. These containers have valves for filling/dispensing the cryogenic liquid and a pressure control valve with a burst disc.

Liquid dewar flasks[25] are non-pressurized, vacuum-jacketed vessels, like a 'Thermos' bottle. They have loose fitting caps or plugs that allow excess pressure to vent yet prevents air and moisture from entering. Dewar flasks used for transporting of cryogenic liquids must be protected against flying glass fragments during transfer from stock vessels.

Avoid skin contact with liquid nitrogen to avoid thermal burns. Eyes are the most sensitive to the extreme cold of liquid nitrogen and its vapors. Prolonged breathing of extremely cold vapors may damage the lungs. Personal protective equipment for handling cryogens include: full face shield over safety glasses, loose-fitting thermal insulated or leather gloves, long sleeve shirts, pants without cuffs and safety shoes. The insulated gloves should be loose-fitting so they can be quickly removed if cryogenic liquid is spilled on them. Insulated gloves only provide short-term protection from accidental contact with the cold liquid.

4. Flammable and Combustible Liquids[26]

Flammable and combustible liquids are liquids that can burn. They are classified by their flashpoints[27]. Flammable liquids will ignite and burn easily at normal working temperatures whereas combustible liquids will burn at temperatures above working temperature. According to WHMIS, flammable liquids have a flashpoint below 37.8°C (100°F) and combustible liquids have a flashpoint at or above 37.8°C (100°F) and below 93.9°C (200°F).

[25] See Section XII.3 for details of cryogenic and vacuum equipment

[26] See Section VIII.2 for storage and Section IX.5 for transport guidelines

[27] The flashpoint of a liquid is the lowest temperature at which the liquid gives off enough vapor to be ignited at the surface of the liquid.

Flammable liquids can give off enough vapors at normal room temperature to form burnable mixtures with air. Ignition can be caused when a source of heat is available and the concentration of vapor in the air is within a certain range of its flammable limit[28]. The source of heat may be a Bunsen burner, heating element, static spark or sparks from a motor brush or light switch. Thermostats may also spark and for this reason flammable and combustible liquids must be stored in explosion-proof refrigerators and NOT regular refrigerators. Similarly, flammable solvents should not be used in centrifuges or near motorized devices such as magnetic stirrers.

Flash points, ignition temperatures, specific gravities and vapor densities of some commonly used organic solvents are tabulated in Appendix G.

The vapor densities of all flammable and combustible liquids are greater than one (*i.e.* heavier than air). These vapors will flow across a bench, settle to the floor or travel down a stairwell, presenting dangers far removed from the source. If ignited, the fire can flash back to the source along the vapor trail. Vapors may also be toxic, usually at concentrations far below the limit of flammability. Therefore, always ensure that ventilation is adequate. Watch out for olfactory fatigue (*i.e.* it's there but you can't smell it anymore. Symptoms: headache; eye, nose, throat irritation; increased flow of mucous in lungs). All operations involving the dispensing of flammable liquids should be conducted in a fume hood with no possible source of ignition nearby. There is invariably some spillage that can be readily cleaned up and evaporated within the hood.

The specific gravity of many flammable and combustible liquids is less than one. These liquids are lighter than water and will float on top if not miscible. Such solvents should never be discarded down a sink since they may not be effectively flushed through the trap. Furthermore, if several sink drains are "ganged" in a chain with only one trap for the group, vapors may travel up through the other sinks.

Small volumes of flammable liquids that are miscible with water (*e.g.* ethanol) can be diluted with water and discarded down the drain. Some such solvents may have toxic properties (*e.g.* methanol, acetone) and it is probably best to dispose of them in hazardous waste disposal safety cans.

See Section X.7 for disposal procedures or check with your laboratory supervisor for specific laboratory details.

5. Oxidizers[29] and Peroxides[30]

Oxidizing materials are solids or liquids that react with other compounds and give off oxygen or other oxidizing substances (*e.g.* bromine, chlorine, etc.). They also include materials that react chemically to oxidize combustible materials. Oxidizing materials can be severe fire and explosion hazards.

Caution is required when working with or storing strong oxidizers as these compounds are capable of reacting with combustibles at room temperature. Rapid oxidations

[28] The range between the lower flammable limit/lower explosive limit (LFL/LEL) and upper flammable limit/upper explosive limit (UFL/UEL) gives the range between the lowest and highest concentrations of vapor in air that will burn or explode.

[29] See Section VIII.4 for storage guidelines

[30] See UBC SRS Working with Peroxide Forming Compounds

can be explosive and the mixing of an oxidant with an oxidizable substance is potentially very hazardous. Violent reactions can occur if oxidants are mixed or contaminated with combustible materials (wood, paper, powdered metals, varsol, organic solvents, *etc.*). Such mixtures are very sensitive to heat, friction and impact.

Oxidizing materials decompose rapidly to yield O_2 when heated, thus the hazards are greatly increased as temperatures rise, such as in a fire. Strong oxidants should be stored in a separate cabinet (preferably metal) away from combustibles and acids.

Typical oxidizers are listed in the table below:

Chemical Group	Chemical Formula
Peroxides	O_2^{-2}
Nitrates	NO_3^-
Nitrites	NO_2^-
Perchlorates	ClO_4^-
Chlorates	ClO_3^-
Chlorites	ClO_2^-
Hypochlorites	ClO^-
Dichromates	$Cr_2O_7^{-2}$
Permanganates	MnO_4^-
Persulfates	$S_2O_8^{-2}$

a) Organic Peroxides[31]

Organic Peroxides are unstable organic compounds characterized by an oxygen-oxygen bond linkage. Included are compounds such as benzoyl peroxide (BPO), methyl ethyl ketone (MEK), and diacetyl. Benzoyl peroxide is sometimes used in the laboratory as a bleaching agent during sample preparation for scintillation counting. Although relatively stable at room temperature, it can decompose instantaneously and explosively if heated above 70°C. Friction or impact can also detonate it. Benzoyl peroxide should never be re-packaged into a container having a screw top closure.

Quantities of organic peroxides should be kept to an absolute minimum with appropriate warnings attached to the container.

b) Peroxide Forming Compounds[32]

Peroxide forming compounds include diethyl ether, isopropyl ether, dioxane, tetrahydrofuran, *etc*. These and other alkyl ethers tend to absorb oxygen and form unstable peroxides that can detonate with extreme violence when concentrated by distillation or evaporation. The peroxides may also be deposited on the thread of old screw-capped bottles and can detonate from friction when opened.

[31] See Section VIII.7 for storage guidelines

[32] See UBC SRS Chemical Lab Safety Manual 2017, 2.3.4.iv

It is recommended to purchase only the quantity that is required for a month period.

There are 4 classes of peroxide-forming chemicals:

Class	Description	Max Storage (unopened)	Testing period (opened)
A	severe peroxide hazard	3 months	Every 3 months
B	concentration hazard	6 months	Every 3 months
C	shock and heat sensitive	6 months	Every 3 months
D	potential peroxide-forming chemical	1 year	Every 3 months

If test indicates > 80 ppm peroxide levels or manufacturer expiration date is reached or occurs first, dispose of safely

All peroxide forming compounds must display a label with the following information: date received, date opened, test dates and test results.

A sample label is shown below:

PEROXIDIZABLE COMPOUND

Date Rec'd: _____

Date Opened: _____

Discard or test within _____ months after opening

Test Dates: _____ _____ _____ _____

Test Results: _____ _____ _____ _____

Store all peroxide forming compounds in a tightly closed, properly labeled container. Peroxide forming compounds must be stored in a flammable storage cabinet away from flames, heat, light, sources of ignition, oxidizers and oxidizing agents.

Since peroxide formation increases with time, bottles should be dated and tested for peroxides so that they may be disposed of before they become an unacceptable risk.

See Appendix H for list of peroxide forming compounds and frequency of testing.

c) Ethers

Ethers must be tested for peroxide content before use. Peroxide test strips indicate the amount of peroxide contamination. The follow are guidelines for the degree of hazard associated with peroxide content:

< 3 ppm	reasonably safe for most laboratory procedures involving moderate quantities

3 – 5 ppm	Possible moderate hazard depending on type of use. Avoid concentration of the peroxides. Disposal recommended if the ether is not to be used
> 50 ppm	Unacceptable; may pose a serious hazard. Dispose of ether or remove peroxides by a suitable method.

Prior to distillation, test the compound for peroxide contamination. A simple test is to dip a starch iodide paper strip into the solvent. A purple color indicates peroxides. If peroxides are detected, the solvent should be treated to remove the peroxides prior to use.

The following guidelines will help reduce risks associated with peroxide forming compounds:

i. isopropyl ether and anhydrous ethyl ether - purchase small quantities and keep in metal cans (don't transfer to glass bottles).

ii. containers should be dated and disposed of after:
3 months for isopropyl, isoamyl, and anhydrous ethers
12 months for ethyl and other ethers

iii. perform all operations using ethers in a fume hood and behind a shield.

6. Other Explosive Reactions[33]

Under certain conditions, a number of common laboratory chemicals can cause or contribute to explosions. Below are some highly reactive compounds. For a complete list of potentially explosive materials see Appendix H.

a) Azides

Soluble azides in contact with heavy metals (*e.g.* copper, brass and lead around sinks and drains, *etc.*) can produce heavy metal azides, which are heat and shock sensitive. Azide solutions should not be dumped down the sink and should be neutralized and disposed of appropriately.

b) Cellulose Nitrate Centrifuge Tubes

These can ignite or explode if heated (*e.g.* in drying oven or autoclave). They deteriorate with time and should be discarded after 2 years (date all supplies) or if they turn **yellow**.

c) Diazomethane

This is often used to methylate acidic compounds for gas chromatography. It is unstable and explosive. Only small amounts (micromoles) should be prepared at one time and the glassware must be smooth (no ground glass joints or broken edges). Diazomethane can be prepared from nitrosoguanidine. Both substances should be regarded as carcinogenic.

[33] SRS Chemical Lab Safety Manual, Appendix E

d) Magnesium Perchlorate

Perchlorate salts are generally more stable than perchloric acid and the latent hazards of these compounds are often overlooked. Anhydrous Mg and Ba perchlorates are widely used as desiccants. However, serious accidents may result from using a vacuum desiccator containing a perchlorate with certain organic compounds. Mixtures of perchlorate and organic materials may be shock-sensitive and care must be taken even when stirring such a mixture with a spatula. **Don't let a perchlorate-organic mixture come in contact with a strong acid.**

Mg-perchlorate is often used to remove water vapor from an air stream in measurements of photosynthesis using a gas exchange system. This is quite safe but the spent material should be contained in a sealed container or in a plastic bag before disposal. Contact the UBC Environmental Services Facility for disposal procedures.

e) Perchloric Acid[34]

Perchloric acid is often used in sample preparations for chemical analysis. It is commonly available as a relatively stable 72% solution in water. Numerous explosions have occurred due to improper handling of this very hazardous substance. Most accidents are caused by contact with organic material or accidental formation of anhydrous perchloric acid.

The 72% solution is strongly acidic (corrosive) but may be safely stored for extended periods provided it does not contact oxidizable materials. At room temperature it is not an oxidizer, but, at higher temperatures, its ability to donate oxygen increases and at its boiling point (203°C) it will explosively react with organic matter. Thus, if samples are to be added to hot perchloric acid, it is advisable that they be pre-treated (*e.g.* with nitric acid) to reduce quantities of easily oxidizable materials. Many laboratory accidents have involved only small amounts of reactant (<1 g).

Unlike aqueous solutions of perchloric acid, the anhydrous acid is not stable. Anhydrous perchloric acid may be formed if a dehydrating agent such as acetic anhydride, sulfuric acid or phosphorous pentoxide is added to the solution. Care must be taken not to inadvertently form the anhydrous acid during a reaction. Anhydrous perchloric acid will explode on contact with wood, paper, lab coats, organic solvents, *etc*.

Perchloric acid digestions should be done in a fume hood designated for this purpose (usually of stainless steel construction with well-sealed joints and spray heads for washing down). Vapors may condense in the system and react with blower lubricants, sealing compounds, or deposits of organic materials previously vented through the hood.

Warning signs should be posted around perchloric acid operations. Fume hood systems used for perchloric acid work must be washed down after use before organics can be used again. The fume hood systems must be checked to ensure they are safe and must have warning signs posted:

[34] See UBC SRS Safe Work Procedure - Working with Perchloric Acid

PERCHLORIC ACID HOOD
KEEP COMBUSTIBLES OUT

A third hazard is that perchloric acid can form unstable perchlorates, even at room temperature. Bottles stored for extended periods after opening may contain perchlorate crystals. If formed around the cap, they may explode from friction upon opening. See below for handling recommendations.

Recommendations:

i. Keep only minimal amounts in storage (<500 ml)
ii. Do not store with combustible materials
iii. Transport in an acid carrier. Keep bottle in a second glass container large enough to contain contents in case of breakage
iv. Inspect bottles regularly (WORKSAFEBC requires monthly inspections). Any bottle containing crystals should be disposed of with great caution (contact UBC Environmental Services Facility to arrange removal by a commercial bomb disposal unit). Bottles showing discoloration should be disposed of by pouring into 10x volume of cold water in a glass beaker. After stirring, pour the diluted acid down the drain and flush with lots of cold water
v. Protect yourself! Use appropriate fume hood and shields for full body protection
vi. Keep digestion samples small (see above)
vii. Avoid dehydrating agents. Don't boil reaction dry. Don't heat with an open flame or an oil bath
viii. Clean spills up immediately with cold water. Any organic material (paper towels, wooden shelves, rubber stoppers, *etc.*) exposed to perchloric acid should be regarded as hazardous and disposed of as such. There have been cases where perchloric acid has been spilled on wood and cleaned up but, years later, burst into flames when a second spill (*e.g.* sulfuric acid) was spilled in the same area

All persons using perchloric acid should familiarize themselves with all the hazards involved. Refer to: Everett, K. 1967. Handling perchloric acid and perchlorates, *Handbook of Laboratory Safety*, Chemical Rubber Company. pp. 205-216.

f) Picric Acid[35] & Other Aromatic Nitro-compounds

Picric acid (trinitrophenol) and other aromatic nitro compounds can explode at high temperatures (300°C for picric acid). Nitrobenzene and nitric acid will form an explosive mixture in the absence of water.

[35] See UBC SRS Safe Work Procedure - Working with Picric Acid

Dry picric acid is extremely explosive. Commercial picric acid contains from 10% to 15% water. When the moisture content is less than 10%, it should be handled as though it were shock, spark, and heat sensitive. Picric acid that is known or assumed to contain less than 10% water, or contains picrate salts, should be destroyed as soon as possible (contact the UBC Environmental Services Facility for assistance). Picrate salts, either wet or dry, are friction and shock sensitive. Handle carefully. Avoid contact with metals, ammonia or ammonium compounds, or with acid-decomposable metal compounds (*e.g.* concrete, plaster).

Do not open a new bottle of picric acid until needed. Date the container when it was received and when it was first opened. Check the hydration of the picric acid at least every 6 months and add distilled water as necessary. Do not use metal spatulas to remove the material. Clean the bottleneck, cap and threads with a wet cloth before resealing. Do not store large amounts of picric acid and dispose of picric acid every 2 years from date of use.

7. Pesticides[36]

Persons using pesticides should understand their mode of action, know the hazards and risks involved, and know how to protect themselves and the environment. There are some 4000 pesticide formulations being used in Canada, but the actual number of active chemical ingredients registered for use is far fewer. Unregistered pesticides can only be used for research purposes and only under permit. For most types of pesticides, a use permit is required for application on public land (and private land if for forestry purposes).

Information on hazards and proper handling of pesticides is readily available. Two recommended publications are *WorkSafeBC Standard Practices for Pesticide Applicators* (WORKSAFEBC, 1985) and *Handbook for Pesticide Applicators and Dispensers* (Adams, 1987).

Wear eye protection and use a respirator when measuring, mixing or when sprays or dusts may contact the face. Stand upwind and cease operations if it is too windy (>8 km/hr). Clean up splashes or spills **IMMEDIATELY**. Guard against backflow into water lines or garden hoses by using an in-line vacuum breaker, backflow preventer or by maintaining an air gap between the supply line and the pesticide in the mixing tank.

No pesticides, no matter how benign, should be applied wearing the following personal protective equipment: a long-sleeved shirt, trousers, shoes and socks, gloves, eye protection and respirator. In general, no pesticide should be applied when the temperature is above 30°C because of the increased vapor hazard. Never try to clear a nozzle or spray line by blowing through it by mouth.

Always wash your hands after using pesticides and before eating or smoking. Pesticides formulated with organic solvents (*e.g.* kerosene) are flammable liquids and should be handled appropriately.

[36] See UBC SRS Integrated Pest Managment (IPM)

Do not transport pesticides in the passenger compartment of any vehicle. Do not transfer pesticides into improperly labeled containers and do not re-use pesticide containers for purposes for which they weren't intended.

8. Toxic Chemicals[37]

Practically all compounds can be toxic under certain conditions if the dosage is high enough. Zero risk is not technically possible. Acceptable risk, based on available information, is the aim. In evaluating the hazard associated with a particular chemical, one must consider the nature of the toxicity, potential routes of entry, quantity used, and exposure time. Exposure may be acute (*i.e.* a single short period of seconds, minutes, or hours) or chronic (repeated doses over long periods). The harmful effects of exposure may also be acute (*e.g.* the rapid consequences of a single dose of cyanide) or chronic (*e.g.* as with carcinogenic agents). See Appendix C for list of commonly used toxic chemicals and the precautions.

a) Definitions

i. *carcinogen* - promotes cancer.
ii. *teratogen* - causes birth defects.
iii. *TLV* - threshold limit value; concentration to which workers can be exposed for a normal 8 hr day, 40 hr work week.
iv. LD_{50} - 50% lethal dose; amount of substance (applied orally or dermally) required to kill 50% of test animals; the smaller the value, the greater the toxicity.
v. LC_{50} - 50% lethal concentration in the air (or water for aquatic organisms).
vi. *toxic* - having a LD_{50} of < 50 mg/kg by any route of entry (see below).
vii. *highly toxic* - LD_{50} < 5 mg/kg.

Note that LD_{50} and LC_{50} values are based on single dose or short exposure tests and do not indicate the cumulative effects of small doses.

b) Means of Entry

i. **Skin contact** - the skin may sustain damage itself and/or allow penetration of toxic agents into the bloodstream. Although usually an effective barrier to penetration, fatal poisoning by this route of entry is possible with high concentrations of extremely toxic substances (*e.g.* parathion and other organic phosphates, aniline, hydrocyanic acid). Dimethyl sulfoxide (DMSO) is significant because it can rapidly penetrate the skin and carry with it dissolved chemicals that might otherwise be excluded. Breaks in the skin (cuts, scrapes, blisters) will also facilitate entry. Wear appropriate personal protective equipment (*i.e*. gloves, lab coat or apron) to reduce possible exposure by skin contact.

ii. **Inhalation** - the most common means of entry for injurious substances. Entry can be in the gaseous state (*e.g.* solvents, iodine) or as particulates (*e.g.* silica dust, spray paint). Absorption and retention of vapors in the body will depend on the aqueous solubility of the gas, its concentration and rate of elimination. Small particles (<1 micron) remain suspended in the air longer and will

[37] Refer to UBC SRS Chemical Lab Safety Manual, 2017, Section 4.4.4.4

penetrate more deeply into the lungs. Reduce inhalation hazards by working in a well-ventilated area or fume hood. Wear appropriate respirator where warranted.

iii. **Ingestion** - the least common method of poisoning in the workplace. Highly toxic chemicals need not be ingested in large amounts to have a serious or fatal result. Do not eat or drink in the laboratory and always wash your hands before leaving the laboratory. Do not store food in refrigerators or anywhere else in the laboratory.

Another possible point of entry or contact is the eye. This should be of particular concern to people wearing soft contact lenses. Solvent fumes can penetrate these lenses and cause prolonged exposure of the eye long after the source of fumes has been removed. Contact lens wearers should wear safety goggles when working in laboratory.

c) Handling Toxic and/or Hazardous Chemicals

Workers should know as much as possible about the hazards involved with the chemicals they use before work begins. Various sources of information are available both online and in hard copy. Catalogues of chemical suppliers provide some details (*e.g.* Sigma-Aldrich), as do supplier labels (see Section IV). The SDS should be your primary source of concise up-to-date safety information on the chemicals you use. It is your responsibility to familiarize yourself with this information. Another useful source book to have in any laboratory is *The Merck Index*. Calbiochem has a free booklet entitled *Handling of Carcinogens and Hazardous Chemicals* that covers some of the more unusual products used in cell and molecular biology. All carcinogens should be labeled as such.

Due to an increasing variety of chemicals being used in laboratories and the lengths of time necessary to fully assess their effects, there is often incomplete information available on the possible hazards involved. It is therefore highly advisable to minimize all unnecessary exposure. Maintaining a clean working environment is the responsibility of all laboratory members. It is much more difficult to detect safety problems, chemical or otherwise, against a background of debris. Pay particular attention to common-use chemical areas such as around balances, centrifuges, pH meters, scintillation counters, *etc*. To assume that your fellow workers will know that the trace of white powder you spilled near the balance is sucrose and not cyanide is unfair. No matter what it is, **clean up after yourself**!

Special precautions should be taken when working with toxic or potentially toxic chemicals. It is advisable to work in a fume hood. Wear personal protective equipment[38] (*i.e*. lab coat, appropriate gloves, face shield, splash goggles, respirator, etc.) and ensure proper ventilation. When using highly toxic agents **post warning signs** on the bench or hood to alert fellow workers, visitors or custodial staff. Work should be confined to a tray lined with disposable lining material for containment should a spill occur.

[38] See Section VI.8 for details on personal protective equipment

Spills[39] must be cleaned up immediately. Absorb solutions with appropriate spill absorbance, contain and dispose of as hazardous waste. Use soap, water and paper towels to clean area. 'Wet mop' solids with an appropriate solvent (this is preferable to sweeping, which can spread dust). Glass stock bottles should be kept in a second container (plastic or metal) especially while being transported.

Carcinogens and other highly toxic compounds should be disposed of appropriately. Contact UBC Safety & Risk Services for advice. The Calbiochem booklet mentioned above also contains some tips on deactivation (*e.g.* by chemical digestion) and disposal of toxic compounds.

For additional disposal procedures see Section X.

[39] See Section II.8 for spill procedures

VIII. STORAGE OF HAZARDOUS MATERIALS

Chemicals should be stored according to their hazard potential and not simply arranged alphabetically on the shelves. Shelving for chemicals should be accessible and at/below eye level unless a stool is available. Segregation[40] prevents contact between incompatible chemicals (see Appendix L).

Contact UBC Safety & Risk Services for additional information and assistance regarding the safe storage of chemicals.

NOTE: Peroxide forming compounds must NOT be stored in the Hazardous Material Facility as frequent testing for peroxide formation is required.

The Hazardous Materials (HAZ-MAT) Facility in the Forest Sciences Centre is located on the main floor between the Centre for Advanced Wood Processing (CAWP) and the Forest Sciences Centre (FSC). Access to this area is restricted to authorized personnel only. Keys are accessible from ProxySafes to authorized users.

1. Compressed Gases[41]

WHMIS Hazard Class A - compressed gases are delivered to the Hazardous Materials Facility. The University preferred vendor for compressed gases is on campus daily so only order what you need. Cylinders should be chained in place and secured at all times. All compressed gas cylinders must be stored with the valve caps in place, even when empty. All valves should be closed when not in use.

Empty cylinders should be returned to the Hazardous Materials Facility, marked 'MT' and placed in the designated area for 'EMPTY' cylinders. Do not place cylinders near exit routes or block doorways.

Valve caps must be in place when transporting compressed gas cylinders. Compressed gas cylinders must not be used when on transport carts.

There are three rooms for the storage of compressed gases, each restricted to the gases in the categories listed below:

A. Flammable Gases

Category	Allowable Compressed Gases		
Flammable, non-corrosive, low toxicity	Acetylene Butane Deuterium Ethane	Hydrogen Isobutane Isobutylene	Methane Propane Propylene
Flammable, corrosive and/or toxic	Carbon monoxide Dichlorosilane Ethylene oxide	Hydrogen sulfide Trichlorosilane	

[40] See Appendix J for incompatibilities by hazard class

[41] See Section XII.2 for compressed gas cylinder hazards

B. Non-Flammable, Corrosive & Toxic Gases

Category	Allowable Compressed Gases		
Non-Flammable, non-corrosive, low toxicity	Air Argon Banana gas Carbon dioxide	Helium Krypton Neon Nitrogen	Oxygen Sulfur hexafluoride Xenon
Non-Flammable, corrosive and/or toxic	Ammonia Boron trichloride Boron trifluoride Chlorine	Hydrogen bromide Hydrogen chloride Sulfur dioxide Hydrogen fluoride	Nitrogen trifluoride Nitrous oxide Phosphorous pentafluoride Silicon tetrachloride

C. Poisonous Gases

Category	Allowable Compressed Gases		
Poisonous	Arsine Chlorine trifluoride Diborane	Hydrogen selenide Nitric oxide Nitrogen dioxide	Phosphine Tungsten hexafluoride

See Appendix K for storage guidelines for compressed gas cylinders.

2. Flammable & Combustible Materials[42]

WHMIS Hazard Class B - flammable materials should be stored in a dry, cool, well-ventilated area, preferably an area segregated for flammable reagents. Flammable liquids should be stored in one of the following: approved cabinet; approved fire safety can; explosion-proof refrigerator; approved room.

All containers for laboratory storage of flammable liquids must not exceed 5 L capacity. Containers must be labeled as to the type of flammable liquid contained and a warning that the liquid is flammable. The UBC Flammable Liquids Policy permits the following containers:

i. "Prepackaged" containers from chemical vendors (*e.g.* Sigma, *etc.*)
ii. Approved safety cans (contact UBC Safety & Risk Services for recommendations)
iii. Containers made from material appropriate to the liquid contained and having a capacity not exceeding 1 L. This category includes wash bottles, chromatograph reservoirs, and other dispensed volumes
iv. Stills not exceeding a 5 L capacity. It is permissible, where necessary, to store solvents in the still between distillations
v. Other containers acceptable to the UEL Fire Department (i.*e.* UBC organic waste solvent containers)

The maximum allowable total of all flammable liquids in the open (*i.e.* outside of a flammable liquid storage cabinet or an approved refrigerator) in a given laboratory cannot exceed 25 liters. Each laboratory is allowed one flammable liquid storage cabinet. Fire Department approval is required for installation of additional cabinets or for the installation of flammable liquid storage refrigerators.

[42] See Section VII.4 for properties of flammable and combustible materials

Where possible, return all flammable liquids to the storage cabinet at the end of each working day. Solvent waste containers should also be stored in a cabinet if available.

Refrigerators for the storage of flammable materials must be approved (ULC) for flammable liquids (explosion-proof).

3. Organic and Inorganic Chemicals

When storing large quantities of chemicals use the following groupings for a final segregation of chemical classes[43]:

	INORGANIC SEGREGATION
1.	Metals & metal hydrides[i]
2.	Acetates, halides, iodides, halogens, oleates, oxalates, phthalates, phosphates, sulfates, sulfites, thiosulfates
3.	Amides, azides, nitrates[ii] (except ammonium nitrate)[iii], nitrites*
4.	Carbon, carbonates, hydroxides, oxides, silicates
5.	Carbides, nitrides, phosphides, selenides, sulfides
6.	Bromates, chlorates, chlorites, iodates, hydrogen peroxide, hypochlorites, perchlorates, perchloric acid, peroxides
7.	Arsenates, cyanates, cyanides
8.	Borates, chromates, manganates, permanganates, molybdates, vanadates
9.	Acids (except nitric)[iii]
10.	Arsenic, phosphorous[ii], phosphorus pentoxide[ii], sulfur
11.	Misc inorganics

	ORGANIC SEGREGATION
1.	Acids, anhydrides, amino acids, peracids
2.	Alcohols, amines, amides, glycols, imides, imines, sugars
3.	Aldehydes, esters, hydrocarbons, oils
4.	Ethers[ii], ethylene oxide, halogenated hydrocarbons, ketenes, ketones
5.	Epoxy compounds, isocyanates
6.	Azides[ii], hydroperoxides, peroxides
7.	Nitriles, polysulfides, sulfides, sulfoxides
8.	Cresols, phenols
9.	Dyes, stains, indicators
10.	Misc organics

i store away from any water; store flammable solids in flammable cabinet

ii dangerously reactive

iii ISOLATE from all other substances

NOTE: Refrigerated storage of volatile materials must be stored in an explosion-proof refrigerator

[43] From Flinn Chemical Catalog Reference Manual

4. Oxidizing Materials[44]

Hazard Class C under WHMIS - store away from flammable/combustible materials and reducing agents.

5. Highly Toxic Materials[45]

Hazard Class D under WHMIS - store in a dry and well-ventilated area that is secure.

6. Corrosive Materials[46]

Hazard Class E under WHMIS - store away from dangerously reactive materials; oxidizers; highly toxic materials; flammable and combustible materials.

Separate concentrated acids and bases (caustics or alkalis; amines and anilines)

7. Dangerously Reactive Chemicals[47]

Hazard Class F under WHMIS - store away from flammable/combustible materials and as required according to the nature of their individual hazards.

8. Temperature Sensitive Chemicals

Refrigeration units must be approved (ULC) for the type of material stored (e.g. explosion-proof refrigerators for flammable liquids). Segregation of chemicals should follow the UBC Chemical Storage Guidelines listed in Appendix L.

Additional Information:

UBC Chemical Lab Safety Manual 2017

[44] See Section VII.5 for properties of oxidizing materials
[45] See Section VII.8 for properties of toxic chemicals
[46] See Section VII.2 for properties of corrosive materials
[47] See Appendix H for list of potentially explosive materials

IX. TRANSPORT OF HAZARDOUS MATERIALS

Transport of hazardous materials from any UBC site to an off-campus site is regulated by the Transportation of Dangerous Goods (TDG) Act. See Appendix M for Hazard Classifications under TDG. If you wish to transport dangerous chemicals off UBC Campus, consult UBC Safety & Risk Services (604 822-2029) and UBC Supply Management (604 822-2638).

When transporting hazardous materials, ensure they are correctly packaged for transport and held securely on the trolley, tray or carrying container. Small quantities can be transported (in the appropriate packaging) using the stairways.

1. Elevator Transport[48] of Hazardous Materials

If the elevator is used to transport any hazardous materials, use the elevator located in the Lab Block ONLY (east end of the Forest Sciences Centre, central corridor). Material should be properly and securely packaged, be placed unaccompanied in the elevator and must boldly display a precautionary sign:

DANGER

TRANSPORTING HAZARDOUS MATERIAL

DO NOT ENTER THE ELEVATOR AT THIS TIME

The elevator containing the material must be met at each floor between the points where the material was placed on-board until the destination floor. If the elevator has a chain hanging inside the doorway, latch this across the doorway.

2. Compressed Gases[49]

Always keep the valve protection cap on when moving or transporting a gas cylinder. Only remove the cap **AFTER** the cylinder has been securely fastened to a bench or wall. Always use a cylinder hand truck when transporting or moving a gas cylinder – never drag it.

3. Corrosives

When transporting 4L bottle of liquid corrosive materials use a bottle carrier (*e.g.* a rubber bucket) to reduce the possibility of smashing the bottle on an object while walking or to contain the liquid should there be a leak.

[48] See Section II.8 in case of an elevator incident

[49] See Section XII.2 for more information on gas cylinders

4. Cryogenics[50]

When transporting cryogenic materials, ensure they are correctly packaged for transport and held securely on the trolley, tray or carrying container. Small quantities can be transported (in the appropriate packaging) using the stairways. Follow instructions for transport of cryogenics in the elevator[51].

5. Flammable & Combustible Materials

When transporting a 4L bottle of flammable or combustible liquid use a bottle carrier (*e.g.* a rubber bucket) to contain the spill should a breakage occurs.

Additional Information:

UBC Chemical Lab Safety Manual 2017

[50] See Section VII.3 for cryogenic hazards
[51] See Section IX.1 for elevator transport

X. HAZARDOUS WASTE DISPOSAL[52]

UBC Hazardous Waste Management

Disposal and/or treatment of hazardous waste at UBC are carried out at the UBC Environmental Services Facility (ESF) located at south campus. Most hazardous waste can be dealt with there, however, no matter what the substance is, it must be labeled or it will not be accepted. Use the CAS (Chemical Abstract Service) number when identity is obscure. Any unidentified or mislabeled material will **not** be picked up. For hazardous waste not identified below, contact the UBC Environmental Services Facility (604 822-6306) for disposal procedures.

All waste generators are required to register online on the Hazardous Waste Inventory System (HWIS) for official hazardous waste generator status.

Approved waste generators will be assigned a waste generator number and barcodes stickers. All hazardous waste sent to the Environmental Services Facility must be accompanied by waste generator information.

Generator Tags[53] (or manifest tags) and barcode stickers are required for disposal of: biohazard waste, flammable liquids, radioactive waste, photographic waste, solvent recovery waste and oil. The tags are color-coded depending on the type of waste - ensure the correct color-coded tags are attached to the appropriate wastes. Waste Generator tags and barcodes can be ordered by sending an e-form UBC ESF.

See Hazardous Waste Disposal Procedures for details on disposal of hazardous waste. Further questions pertaining to the handling of hazardous waste at UBC should be directed to the UBC Environmental Services Facility. .

Forest Sciences Hazardous Waste Disposal

The Hazardous Waste Disposal area for the Forest Sciences Centre is located in the HAZ-MAT Facility. The HAZ-MAT Facility is located on the main floor between CAWP and the Forest Sciences Centre. Procedures developed for the disposal of hazardous materials in the Forest Sciences Centre can be found in the *FSC HazMat Facility & Hazardous Waste Disposal Reference Guide*. A copy can be found in the (yellow) HazMat Facility binder located in each departmental office.

See the UBC Hazardous Waste Information Sheet poster[54] posted at the Hazardous Waste Disposal Cage for details of hazardous wastes accepted by ESF.

All hazardous waste for pick-up by UBC Environmental Services Facility must be properly tagged, labeled and placed INSIDE designated Hazardous Waste Disposal cage in the HazMat Facility. Keys to the Hazardous Waste Disposal area can be signed out from the Department Offices. Only authorized personnel can sign out the keys to the HazMat Facility. Access is restricted to those who have successfully completed the UBC *Laboratory Chemical Safety* or the UBC *Introduction to Laboratory Safety* Course and the Forestry Haz-Mat Facility Safety Quiz.

[52] Contact UBC Safety & Risk Services for complete list of hazardous wastes and updated procedures

[53] See Appendix N

[54] See Appendix O

Scheduled pickup of hazardous waste in the Forest Sciences Centre is weekly. If you intend on disposing of large amounts of hazardous waste, please contact the UBC Environmental Services Facility (604 822-1285) for additional pickup.

Unknown chemicals are not to be placed or stored in this area.

1. Biohazardous Waste Disposal[55]

This applies to Risk Group 1 (RG1) Agents, Risk Group 2 (RG2) Agents and Pathological (Anatomical Animal) Waste. Risk Groups 1 & 2 may include: cultured animal cells; micro-organisms including bacteria, viruses, fungi, chlamydiae and rickettsiae; parasites; allergens; extracted tissues and dander from animals; plant viruses, bacteria and fungi; bacterial or plant toxins and pathological waste. This does not apply to biomedical waste and Risk Group 4 agents.

New disposal procedures for RG1 & RG2 were introduced in 2013. All RG1 and RG2 waste MUST be contained in CLEAR and UNLABELED autoclave bags. Risk Group 1 and Risk Group 2 waste must be sufficiently autoclaved (60 minutes at 121°C, 115 PSI) to render harmless. Double bag the autoclaved bag with another CLEAR plastic bag to prevent leaks and breakage during storage or transport. Each bag must not exceed 10kg total. Do not put glass or sharps in the RG1 or RG2 waste bags.

After autoclaving, the bag of waste must be tagged with the red Biological Waste Disposal tag, include waste generator barcode and check "Autoclaved Risk Group 1 or 2" on the tag. Place the tagged waste in the Hazardous Waste Disposal area.

2. Ethidium Bromide Waste[56]

Ethidium bromide is considers a mutagen and must be neutralized and/or disposed of properly.

a. Contaminated solid waste

Solid waste (including gels, gloves, paper towels, etc.) should be collected in a thick plastic garbage bag. Ensure bag contains no liquid and does not leak. Place filled bag in a cardboard box, affix yellow Non-Regulated Contaminated Solid Waste tag, include generator bar code and check appropriate box. Place tagged waste in the Hazardous Waste Disposal Area for pickup

b. Contaminated liquid waste

There are three methods for disposing of liquid ethidium bromide waste. This material is mutagenic and must be handled with care. It must be neutralized prior to proper disposal. .

Liquid waste contaminated with ethidium bromide **must not** be sent to ESF.

EtBr in aqueous solutions can be removed with activated charcoal, amberlite ion exchange resin or chemically deactivated:

a) Charcoal Filtration – relatively simple and effective method. Filtrate can be disposed of down the drain. This method should be used for ALL EtBr in

[55] See UBC Biosafety Reference Manual for more information

[56] See Appendix D.12 for ethidium bromide hazards

organic solvent solutions. For buffers containing ≤ 0.5 ug/mL EtBr or for cleaning accidental spills:

- for every 100 ml of waste buffer add 100 mg of powdered activated charcoal
- store solution for 1 hour at room temperature, shaking intermittently. Filter solution through Whatman No. 1 filter and dispose of the filtrate down the drain.
- dispose of activated charcoal and filter paper as non-regulated contaminated solid waste

b) Amberlite Ion Exchange – for solutions of EtBr ≤ 0.1 mg/mL

- for every 100 ml of EtBr solution add 3.0 g of Amberlite XAD-16 ion exchange resin
- stand and stir mixture for 20 hours
- dispose of the treated resin as non-regulated contaminated solid waste

c) Chemical Neutralization – NOT to be used for organic solvent solutions. Deactivation MUST be confirmed using UV light detection for fluorescence. For solutions containing ≤ 0.5 ug/mL EtBr

i) Lunn & Sansone Method

- for each 100ml, add 20ml of 5% hypophosphorous acid (H_3PO_2)and 12ml of 0.5M sodium nitrate ($NaNO_2$)
- Stir briefly, stand for 20 hours at room temperature
- use UV light to ensure all EtBr removed (absence of reddish-orange fluorescence)
- adjust pH to 5.5 – 10.5 with sodium bicarbonate ($NaHCO_3$) before discarding liquid down the drain with copious amounts of running water

ii) Armour Method

- for each 100ml, add 100ml of household bleach, sodium hypochlorite (NaOCl)
- stir for 4 hours at room temperature and let sit for 2-3 days (alternatively stir continuously for 20 hours using magnetic stirplate)
- use UV light to ensure all EtBr removed (absence of reddish-orange fluorescence)
- adjust pH to 5.5 – 10.5 with sodium bicarbonate ($NaHCO_3$) before discarding liquid down the drain with copious amounts of running water. Alternatively for large volumes of solution use 3% hydrogen peroxide (H_2O_2) or sodium thiosulphate ($Na_2S_2O_3$) to neutralize the bleach. DO NOT pour bleach solutions down the drain without neutralizing to pH 5.5-10.5

NOTE: the bleaching technique will likely be banned[57] in the near future due to possible residual mutagenicity.

[57] Check UBC Safety & Risk Services website for updates

3. Inorganic Chemical Waste

Inorganic wastes include solid waste, acids and bases, oxidizing and reducing agents, heavy metals, poisons, etc. All inorganic waste must be listed in the Hazardous Waste Inventory System.

The person disposing of inorganic waste must complete the Chemical Waste Inventory form including the full name of the chemical(s), the approximate quantity and any other pertinent information (*e.g*. poisonous, carcinogen, *etc*.). A code will be assigned to each chemical and the form will be emailed back to you. Separate the chemicals according to the code indicated and package separately.

Package all glass containers in sturdy cardboard boxes of a manageable size. Use packing material between the bottles and tape the box up to prevent accidental breakage during pick-up. Place a copy of the approved chemical disposal sheet in an envelope and tape the envelope to the top of each box. Write the code of the group of chemicals on top and sides of the box and place the package in the Hazardous Waste Disposal area.

4. Mercury Waste[58]

Fluorescent lamps/light bulbs containing mercury are recycled by contacting UBC Waste Management.

Mercury should be collected in a clean glass or plastic bottle, with a properly tightened cap and labeled "Mercury Waste for Disposal". Wear appropriate personnel protective equipment and sprinkle area of spill with Mercsorb. Collect contaminated mercury waste in the smallest volume possible and properly labeled as mercury waste. Keep mercury waste separate from other chemical waste.

Broken mercury thermometers should be collected (glass and all) in a sealed container. Complete online Hazardous Waste Inventory System form for approval. Once approval is received, attach a copy of the authorized form to the package and place the packaged mercury waste in the Hazardous Waste Disposal area.

5. Non-hazardous Chemical Waste[59]

Some chemicals can be safely disposed of in normal garbage collection or down the drain. Non-hazardous chemicals include certain salts (e.g. potassium chloride and sodium carbonate), many natural products (e.g. sugars and amino acids) and inert materials (e.g. non-contaminated chromatography resins and gels). If not contaminated, these materials can be disposed of safely and legally in the normal garbage stream.

Review the list of non-hazardous chemicals in Appendix P BEFORE requesting approval for chemical disposal.

6. Non-Regulated Contaminated Solid Waste

Non-regulated solid wastes are diverted from the landfill and applies to contaminated silica gel and solid waste contaminated with ethidium bromide. Silica gel may be

[58] See Appendix D.16 for mercury hazards

[59] See Safe-to-dispose-down-drain and Safe-for-garbage-disposal lists

contaminated with solvents, trace organic chemicals or heavy metals (e.g. moisture indicators).

Collect solid waste contaminated with ethidium bromide or silica gel in a thick plastic bag. Double bag to prevent leakage ensuring each bag does not exceed 10 kg. Package the bag in a sturdy cardboard box. Affix a yellow *Non-Regulated Contaminated Solid Waste* tag indicating type of waste. Take the box to the Hazardous Waste Disposal area for pickup.

7. Organic Solvent Waste Disposal

Waste solvents should be stored in *Solvent Waste Disposal* safety cans or in the red *UBC Solvent Waste Disposal* containers prior to disposal or treatment. Note that chlorinated and non-chlorinated solvents must be separated. Inorganic, acid and oil wastes must not be placed in these disposal cans. Solvent waste containers must be tagged with a Hazardous Waste Generator tag and barcode. Generators are required to complete the shaded area on the Waste Generator tag, indicating the contents of the waste container.

Use blue Waste Generator tags for disposal of solvent waste and include the barcode sticker. Take the container with organic solvent waste to the Hazardous Waste Disposal area. The Environmental Services Facility will routinely pick up the waste and return an empty container in its place.

For additional tags, barcodes and waste solvent containers, call the UBC Environmental Services Facility (604 822-1281).

8. Photochemical Waste Disposal/Treatment

Photochemical fixers, stabilizers and developers should be collected in the red *UBC Solvent Waste Disposal* containers for disposal. Photochemical wastes are segregated and neutralized for disposal after the silver has been recovered. Separate containers must be used for FIXER and DEVELOPER. Do not mix photochemical waste with organic solvent waste.

The procedures for disposal of photochemical waste are the same as those for Solvent waste. Use purple Waste generator tags for disposal/treatment of photochemical waste. Generators are required to complete the shaded area on the Waste Generator tag, indicating the contents of the waste container and affix their barcode sticker prior to placing the waste in the Hazardous Waste Disposal area.

9. Potentially Explosive Chemicals[60]

Do not handle potentially unstable or explosive chemicals. Place the containers of explosives in a cardboard box. Mark the box with 'EXPLOSIVES – CLASS F - DO NOT TOUCH' in clear lettering. Store securely.

ESF does not accept explosive materials. Cost for the removal and disposal of these chemicals will be charged to the generator. Contact the UBC Environmental Services Facility (604 822-6306) for list of approved contractors. Contact waste disposal contractors directly.

[60] See Appendix H for list of potentially explosive materials

10. Plastic Syringes (Disposable)

The Greater Vancouver Regional District (GVRD) waste transfer station considers syringes to be an infectious hazard. Therefore disposable syringes must be disposed of by incineration. Either the entire syringe and needle can be disposed of in an *APPROVED* "**SHARPS CONTAINER**" or if the needle is removable, the needle should be placed in the "**SHARPS CONTAINER**" and the plastic barrel can be disposed of as "PLASTIC WASTE FOR INCINERATION".

Contaminated or biohazardous syringes MUST be either autoclaved or chemically decontaminated prior to disposal. Syringe bodies (with the needles removed) can be collected in a clear plastic bag and disposed of as Risk Group 1 waste. Attach a red Waste Generator tag and barcode and check the appropriate box off identifying the type of waste prior to being taken to the Hazardous Waste Disposal area.

11. Sharps & Needle Waste

Sharps and needle waste include sharp metal cutting blades (*e.g.* razor blades, scalpels, etc.), disposable plastic syringes and needles. Sharps and needle waste must be collected in *APPROVED* containers made of a hard impervious plastic which are both autoclavable and acceptable for incineration. These containers must be easily identifiable by bold labels "**SHARPS CONTAINERS**".

DO NOT put sharps in plastic bags. **DO NOT** put these containers in the "**GLASS WASTE ONLY**" cans.

Collect all sharps and needles in "**SHARPS CONTAINERS**" and chemically decontaminate all infectious items prior to disposal. Once the container is full securely close and snap the lid in place. Autoclave the entire container once it is full. Attach a red Biological Waste tag, include the waste generator barcode and place into the Hazardous Waste Disposal area for waste disposal.

12. Waste Batteries[61]

Waste batteries include: car batteries, rechargeable batteries, all regular size (AAA, AA, A, 9V, D) batteries; nickel-cadmium (NiCad); lithium or cadmium batteries; calculator and watch batteries. There are basically two procedures for the disposal of batteries at UBC.

i) Waste batteries can be deposited at the Call2Recycle box located at the Forestry Dean's Office reception area

ii) Lead acid batteries heavier than 5 lbs are to be placed in a strong box. Mark box boldly with 'USED BATTERY FOR DISPOSAL'.

   Complete Hazardous Waste Inventory form including battery type and quantity in the Hazardous Waste Inventory System. When approval is emailed back to you, attach the approval and place the battery in the designated Hazardous Waste Disposal area. If the battery is wet or leaking, contain in a plastic bag for disposal.

   Package UPS batteries inside a strong cardboard box and secure the box with tape prior to pick up. Ensure the box is less than 10 kg.

[61] Non-rechargeable and rechargeable batteries can be recycled

For more information regarding battery recycling, contact UBC Environmental Services Facility at 604 827-5389.

13. Waste Oil

Disposal procedures for waste oil apply to non-hazardous material containing more than 3% by weight of oil. Types of waste oil include: automotive lubricating oil; cutting oil; fuel oil; gear oil; hydraulic oil; refined petroleum based oil; synthetic oil; vacuum pump oil. **Oil must not be contaminated with PCB's (Polychlorinated biphenyl), water, solvents or toxic materials.** Do not mix waste oil with other solvents and do not overfill the containers.

Waste oil can be collected in 3 ways:

a) in the original suppliers' container (providing it is in good condition)
b) in designated 5 liter or 20 liter red plastic oil cans
c) in 45 gallon (200 liter) metal or plastic drums

Do not use red solvent containers for disposal of waste oil.

Complete a blue Waste Generator tag and affix with barcode sticker. Mark the tag "**WASTE OIL", "WASTE OIL CONTAMINATED WITH LEAD**" or "**PETROLEUM OIL**" as applicable in the area designated [OTHER]. Place waste oil containers in the Hazardous Waste Disposal area.

Contact UBC Environmental Services Facility (604 822-6306) for empty oil containers, waste oil tags and barcode stickers.

14. Unknown Chemicals

UBC Environmental Services Facility does not accept unknown chemicals. In order to dispose of these chemicals economically, the hazard class needs to be determined. The disposal of unknown/unidentified chemicals is performed by an approved contractor and the service costs ~$100 per hour. Unidentified laboratory chemicals for disposal must be registered with UBC Environmental Services Facility at (604 822-6306). All unidentified chemicals are to be listed on the "UNIDENTIFIED CHEMICAL INVENTORY" form issued by the Environmental Services Facility. Copies can be made from Appendix Q.

Fax (604 872-5087) the completed form to UBC Environmental Services Facility. Give the name, department, and phone number of the contact person in charge of the waste. Assign numbers to the different containers of unknown chemicals. Put the containers in a cardboard box, include a copy of the completed form in the box and write "**UNIDENTIFIED CHEMICALS - DO NOT TOUCH**" in clear lettering on the outside of the box. Once a date has been set for removal of these items, the generator will be contacted by the Environmental Services Facility. The contractor performing the hazard class determinations will bill the researcher directly.

Additional Information:

RMS Hazardous Waste Management Manual
RMS Laboratory Chemical Safety Manual
FSC HazMat Facility & Hazardous Waste Disposal Reference Guide

XI. NON-HAZARDOUS WASTE DISPOSAL

Disposal of non-hazardous waste, which includes laboratory glass, plastic, metal, wood and soil waste, is handled by UBC Waste Management. For pick-up of non-hazardous waste not described below, contact UBC Waste Management (604 822-3827).

The designated area for the disposal of NON-HAZARDOUS WASTE for the Forest Science Centre is located near the rear entrance. Outside the loading (receiving) dock to the right of the "SMITHRITE" disposal bin a sign has been posted to indicate where to leave LABORATORY GLASS WASTE containers. Soil waste containers can also be wheeled to this area for pickup.

1. Laboratory Glass Waste

Laboratory glass waste include: glass bottles; pipettes; broken glassware; other laboratory glassware. Contaminated pipettes and laboratory glass waste must be decontaminated before disposal. Collect laboratory glass waste in APPROVED "GLASS WASTE ONLY" containers (lined with 6 mil clear plastic bags).

NOTE: laboratory glass cannot be recycled. DO NOT place laboratory glass in the regular glass recycle bins

APPROVED laboratory glass waste containers can either be 5 gallon grey metal cans or white plastic pails labeled "GLASS WASTE ONLY". Each container must be lined with a clear 6 mil plastic bag to contain the glass waste. These *APPROVED* containers have been distributed in all laboratories in the Forest Sciences Centre. Containers and plastic bags can be purchased from UBC Building Operations Stores (604 822-5272).

Do not dispose of regular garbage such as paper, food, metal, etc. into the "GLASS WASTE ONLY" containers and do not dispose of glass waste in other waste streams.

a) **Broken Glass Waste (includes uncontaminated Pasteur pipettes)**

If uncontaminated, deposit the broken glass into the "GLASS WASTE ONLY" container. If previously contaminated, decontaminate, neutralize or if contained RG1 or RG2, decontaminate using bleach or autoclaving prior to disposal in the 'GLASS WASTE ONLY' containers.

When the can is ¾ full, tie a knot in the top of the bag, ensuring no glass objects protrude past the top of the container and attach a tag indicating your name, telephone number and location (*i.e*. room number and building name). Take the entire container down to the designated area for non-hazardous waste disposal.

b) **Small Chemical/Reagent Bottles (less than 4L size)**

Remove and discard the cap, rinse the bottle out with cold water until the bottle is free of residue. Deface or remove all labels and hazard signs. If there is considerable residue, do not rinse the contents down the sink. Instead, treat the sludge as "Hazardous Waste" and follow waste disposal procedures for that particular chemical (see Section X). Place the rinsed bottle in the "GLASS WASTE ONLY" container. When the can is ¾ full, tie a knot in the top of the bag and

attach a tag indicating your name, telephone number and location (*i.e*. room number and building name). Take the entire container down to the designated area for non-hazardous waste disposal

c) **Solvent Bottles**

Remove cap and place the empty solvent bottle in the fume hood to allow trace amounts of vapor to evaporate. When the vapors have evaporated, (usually 1 day), rinse the bottle with soap and water. Do not replace the cap. Deface or remove all labels and hazard signs and place rinsed bottles either into the "GLASS WASTE ONLY" container or into sturdy plastic bags that are tagged indicating your name, room number and building name and taken it down to the designated area for disposal.

d) Acid/Corrosive Bottles

Remove and discard cap. Carefully rinse out the acid/corrosive bottle with cold water until there is no residue acid/corrosive remaining. Follow the same packaging procedures as for solvent bottles.

2. Laboratory Plastic Waste

Uncontaminated plastic chemical/reagent bottles may be considered for the Laboratory Plastic Recycling Program. Contact UBC Green Labs to register to be part of the program.

The three steps to recycling laboratory plastics are as follows:

1. Identify what plastics can be recycled
2. Empty, clean and dry the container
3. Place the plastic in a Lab Plastic Collection Bin.

Accepted plastics must be:

- Containers that previously contained non-hazardous materials,
- Empty, clean & dry containers, and
- Only plastic codes #1 (PET), 2 (HDPE), 4 (LDPE), 5 (PP), 6 (PS)

Non-accepted plastics include:

- Plastic #3 (PVC), 6 (Styrofoam), 7
- Pipette, pipette tips, vials, tubes, syringes
- Empty container previously containing or contaminated with hazardous materials (ie. any toxic, corrosive, flammable, reactive, radioactive, oxidizer substance or RG1 and RG2 (excluding recombinant DNA)

Empty containers previously containing hazardous materials should be defaced of the label, rinsed well with cold water before discarding in the regular garbage.

Contact green.labs@ubc.ca or 604 822-6045 for more information.

3. Metal Solvent Drums

Bulk solvents are sometimes purchased and the contents are dispensed into smaller bottles. These 20L drums should be treated much the same way as solvent bottles. The residue should be evaporated off either in a fume hood or in a well vented area.

Once the drum is completely residue-free, mark it EMPTY and place it in the designated area for non-hazardous waste disposal.

Occasionally empty 210 L solvent drums can be re-used by ESF. Call 604 822-1285 for details and pickup.

4. Wood Scraps and Wood Waste

For disposal of waste wood and wood scraps, call UBC Waste Management at 604 822-4118 to arrange for pick-up.

5. Uncontaminated Soil Waste[62]

Generators of soil waste are required to complete a 'Soil and Organic Matter Pick-up Clearance Form' and send or fax (604 822-5209) a copy to UBC Waste Management prior to use of the bins. Designated green **'SOIL ONLY'** waste bins are located in FSC 0712 and 1702.

Do not fill past the yellow 'fill line' marked on the exterior of each bin. The soil waste will be recycled and used in the gardens on UBC campus, so do not put contaminated soil, plastic waste, plant shards, tags, etc. in these bins. Once the user has finished using the soil bin (or if it is filled to the 'fill line'), roll the soil bin to the designated area for non-hazardous waste disposal. Once emptied, the user is required to return the empty bin to the room it came from.

Additional Information:

RMS Hazardous Waste Management Manual
FSC HazMat Facility & Hazardous Waste Disposal Reference Guide

[62] See Appendix R for Soil and Organic Matter Pick-up Clearance Form

XII. HAZARDOUS EQUIPMENT

1. Centrifuges

Centrifuges are one of the most dangerous pieces of laboratory equipment. Although bench top centrifuges are not likely to create serious problems, the inertia of high-speed and ultracentrifuge rotors can wreak considerable havoc. Centrifuges must not be operated with the cover open. Manual braking of clinical centrifuges is poor practice. Watch that bench top centrifuges do not work their way off the edge of the bench.

When placing a tube into a centrifuge, ensure that it is properly counter-balanced by a tube of equal mass placed on the opposite side of the rotor. This is of critical importance on high-speed and ultracentrifuges (use a trip balance).

Never use damaged or dirty rotors as its balance may be off. Don't use rotors or tubes at higher speeds or g-forces than they are rated to handle. If microprocessor-controlled, be certain that the rotor identity keyed in matches the rotor in use. Before operation, always double check that the rotor placement is properly positioned on the spindle and that the lid is well fastened with the o-ring in place.

Do not over-fill tubes and inspect a tube to ensure it is not cracked or damaged. Discard plastic centrifuge tubes after one cycle in an ultracentrifuge due to fatigue. Do not use *yellowed* or brittle nitrocellulose[63] tubes due to possible explosion. Clean up spilled liquids within centrifuges or rotors **IMMEDIATELY**, particularly if it is corrosive.

2. Compressed Gas Cylinders and Regulators[64]

Compressed gas cylinders come in a variety of different shapes and sizes. Most cylinders are color-coded to indicate their contents, but don't rely on this to identify the gas type - read the tag. Valve protection caps are also color-coded and are threaded such that they will only fit on the appropriate cylinder. Don't try to force a cap onto the wrong cylinder.

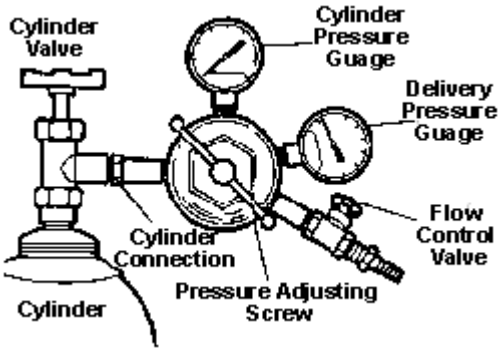
Cylinders must be chained or strapped to a wall, bench or post to prevent tipping or falling. If an unsecured tank falls over, its considerable weight could easily crush a foot or worse, the valve could break off and cause the tank to spin wildly about the lab. If the valve were to snap off, the tank could become a rocket capable of destroying whatever was in its path.

Always move gas cylinders using a cylinder hand-truck – never drag a gas cylinder. Keep the valve protection cap on when transporting and remove **AFTER** the cylinder has been securely fastened. **NEVER** try to remove a tight cap with a bar or wrench placed through the holes in the cap. You might end up snapping the cylinder valve off. Do not tamper with the packing nut on the cylinder valve or with the safety nut on the stem of the valve. The purpose of the safety nut is to rupture should tank pressure become excessive (*i.e.* during filling or in a fire).

[63] See Section VII.6.c for hazardous reaction

[64] See Section IX.2 for transport and Section VIII.1 and Appendix K for storage guidelines

Regulators



Regulator fittings are standardized to fit only those cylinders for which they are intended (*i.e*. a nitrogen regulator will not fit a hydrogen cylinder and vice versa, etc.). Generally, a different regulator will be needed for each gas you use. Before attaching a regulator, inspect the cylinder valve for damaged threads, dirt, dust, oil, grease or other flammable substances. Do not use if oil, grease or damage is present. Remove dust and dirt with a clean cloth. Attach the appropriate regulator to the cylinder and tighten securely with a wrench (making sure not to over-tighten it).

Before opening the cylinder valve, release the spring pressure on the pressure adjusting screw by turning it counter-clockwise until the handle turns freely. Stand to the side of the cylinder (away from the side the regulator is attached to) when opening the cylinder valve. Open the cylinder valve slowly - the cylinder pressure will register on the cylinder pressure gauge.

Note: Acetylene cylinder valves should not be opened more than one complete turn. All other cylinders should be fully opened. The pressure adjusting screw can now be turned clockwise to achieve the desired delivery pressure.

Keep the cylinder valve closed when not in use. When you are finished using the apparatus that the gas cylinder is attached to, close the cylinder valve. Allow all pressure to drain from the regulator then release the spring tension on the pressure adjusting screw. When the cylinder is empty, close the valve, replace the protective cap, mark the cylinder **EMPTY** and return the empty cylinder to the Hazardous Materials Storage area for return.

Rapid release of gas can generate static electricity and cause a spark. For this reason, it is advisable that all cylinders of flammable gases (acetylene, ethylene) be grounded before opening and during use.

3. Cryogenic[65] and Vacuum Equipment

Non-shielded vacuum flasks (*i.e.* Dewar) should be wrapped with electrician's tape to help contain glass fragments in the event of an implosion. The life of a vacuum flask can be extended by avoiding rapid temperature shocks (*e.g.* replacing boiling water directly with liquid nitrogen). Only use containers designed for storage and transport of liquid Nitrogen (LN_2) and dry ice. Thermos bottles are NOT adequate substitutes for Dewar flasks.

It is good practice to use a desiccator shield (a wire or plastic basket) when desiccators are placed under vacuum. Vacuum distillations should be performed in a fume hood or behind a polycarbonate shield where possible. It is advisable to wear goggles or a face shield if the apparatus is not behind a shield. Never apply a vacuum to flasks that are not designed for this purpose.

[65] See Section VII.3. for handling and Section IX.4 for transport guidelines of cryogenics

Ensure that vacuum pump belts on freeze dryers and other equipment are covered. On vacuum lines where an ion gauge is in use, all isolated conducting components should be grounded to prevent lethal voltages from developing.

4. Electrical Hazards

Electrical currents of surprisingly low amperage and voltage can, under certain circumstances, be fatal. The effects of increasing current on an adult human body are listed below:

Current (mA)			Effect
0	-	1	No sensation
1	-	3	Mild perception
3	-	10	Painful shock, muscular contraction
	>	10	Paralysis, inability to let go
	>	30	Asphyxiation, unconsciousness
80	-	240	Fibrillation
		4000	Heart paralysis
	>	5000	Burning

Some general tips about working with electricity:

- Don't use electric wires as supports.
- Don't pull on live wires. Prevent damage by pulling the plug, not the cord, when unplugging equipment.
- Don't use wiring that is frayed or worn or stretched across the floor. Inspect regularly. Whether you're working indoors or out, inspect cords and plugs regularly and replace damaged ones.
- Don't obstruct panel boards. Know where they are in case of an emergency.
- Don’t place portable heaters, hotplates, *etc.* next to combustible materials.
- Don't overload the circuit. Limit the equipment plugged into each outlet to prevent overheating which could damage the equipment or cause a fire. Don't exceed the recommended wattage when replacing light bulbs or the recommended amperage when replacing fuses.
- Extension cords should be for temporary use. If you must use an extension cord, make sure it is the right capacity for the tool or equipment with which it is used. Keep slack in flexible cords to prevent tension on electrical terminals. Use extension cords with polarized plugs. For outdoor use, select tools and equipment with heavier wiring, special insulation and a three-prong, grounded plug
- Only use appliances, tools, lights, extension cords which are CSA or Underwriters Laboratories Approved (ULA)
- Ensure all electrical equipment is adequately grounded (don't make 3-prong plugs into 2-prong plugs by removing the ground!). If the equipment does not have a 3-prong plug, ground it separately to a cold-water pipe.
- Water and electricity don't mix. Water and your body are excellent conductors of electricity. Be sure that outdoor outlets and outlets near wet areas (laboratory sinks, kitchen, lavatory, etc.) have ground fault circuit interrupters

(GFCI) to prevent serious shock injuries. If you're using equipment that sprays water, avoid spray contact with power lines and outlets. Never step into a flooded area if water is in contact with electrical outlets, equipment or power cords.

- Switch equipment off before connecting to power. Disconnect power before cleaning, adjusting, or repairing equipment. Lockout either the power or the power switch on equipment and pull fuses to prevent another person or a timer from starting equipment under repair.
- Ensure that all electrical outlets have cover plates.
- Replace safety guards over moving parts and belts before unlocking or re-fusing the power switch. Always follow the lockout, tag-out and grounding procedures appropriate for your work environment.

5. Electric and Hand Tools[66]

Ensure you have been properly trained to use power tools. Ignorance of how power tools work and of proper procedures can cause accidents. More importantly, overconfidence and carelessness can be just as lethal. **ALWAYS BE A LITTLE AFRAID OF POWER TOOLS**.

Read the operator's manual before using the tool and operate according to the manufacturer's instructions. Ensure the tools are properly grounded and CSA approved. If the tool is battery operated, only use the battery specified for that tool by the manufacturer. Remove the battery from the tool, ensure the tool is switched off and/or locked before making adjustments, changing parts or storing.

Many power tools, especially stationary ones, are equipped with safety devices such as guards or anti-kickback devices. All such safety devices should be well-maintained, not be removed from the equipment **AND USED**. With some tools, special guards are available for use under particular circumstances.

Safety glasses, safety goggles, hearing protection, dust masks, gloves and safety boots are all standard shop safety equipment. Safety glasses/goggles, hearing protection and dust masks should be worn whenever working with any shop tool. High-speed electric motors can generate high frequency noise that may damage hearing and the effects are cumulative. Check the filters of the dust mask are clean before use and replace as needed.

Don't wear gloves, neckties, floppy sleeves or other loose clothing (*e.g.* hanging shirttails) that might snag on a tool. Don't wear jewelry. Tie up or wear appropriate hair protection to prevent hair from getting caught in moving parts.

Return hand tools to their proper place when finished and clean up sawdust, *etc.*, after use. Don't allow litter and wood scraps to clutter the floor, which may cause slips or falls. Do not use power tools in damp or wet conditions. Always work in a well-lit environment.

[66] Refer to Woodshop Safety Operations Manual, April 1981

All persons intending to use the Wood Science Wood Shop Facility must first meet certain requirements as discussed in Section V.5

General Reminders when using electric powered tools:

- Switch the tool off and unplug it from the electrical source before changing parts and always check that the tool is in the OFF position before plugging in again
- Ensure that tools are appropriately grounded
- Don't work with dull tools
- Never leave a tool running and unattended. If you need to attend to another chore, turn the tool OFF
- Don't force a cut - something is likely to be wrong
- Feed material against the direction of rotation of the blade or cutter
- Don't work when you are tired, upset, or have consumed medications or alcohol
- Don't overreach and don't struggle with material that is too large. Get help or provide support for long pieces
- Don't work on a piece that is too small to be safely held. Use a larger piece and then cut off the part you need or use an aid specially designed to cut small pieces safely
- Don't let wood dust pile up around any tool. Vacuum and/or clean up before beginning

a) Band saw

Wear safety goggles and appropriate safety gloves while folding, unfolding or installing band saw blades (they can be very springy). In operation, keep fingers well away from the blade and try to work so that they are not directly on the cut line.

b) Belt Sanders and Bench Grinders

Metal grinding or sanding creates sparks that could ignite accumulated sawdust. Keep these areas clean and free of sawdust.

Check grinding wheels for cracks before mounting and never run a wheel faster than the speed it is rated for. Adjust tool rests so that they are within $^{1}/_{8}$" of the wheel to reduce the possibility of getting the work jammed. Do not perform heavy grinding on the side of a wheel unless it is designed for this purpose.

c) Drill press

Use the drill press column, a fence and clamps or vice to brace work against the twisting force exerted by the drill. Use the recommended speed for the type and size of cutter being used.

d) Jointer

Whenever possible, avoid passing your hands over the cutter head. It is located in the gap between the infeed and outfeed tables. Don't let work-piece or anything else jam in there! Don't try to surface thin material or to joint short or very narrow pieces. Always use the guard. Use a hold-down/pusher while surfacing to improve your work and increase safety.

e) Lathe

Be sure the work-piece is secure before starting to cut and check frequently as you go. Spin the work-piece by hand before turning the machine on. Be careful with speeds and work cautiously. Don't cut too fast or too deeply.

f) Radial arm saw

Anti-kickback fingers should be used on ripping operations to prevent the blade from forcing the work-piece back towards the operator.

g) Table saw

Table saws have removable inserts to minimize the opening around the blade. Make sure they are flush with the worktable. Check that the blade alignment is correct.

Use pusher to guide small pieces of wood through the saw. Homemade combination hold-down/pusher tools are available or can be easily constructed. These are used to keep the work flat and advance it past the blade so your fingers are kept at a safe distance. Always keep your hands away from the cutting area. The blade should not project too far above the height of the work. Set the projection to not more than the deepest gullet on the blade. Stand out of line with the saw blade. Don't remove the cutoff, especially if it's a short one, until the blade has stopped turning.

6. Overhead Crane

All crane operators must receive "operator safety training" from the laboratory supervisor before using a crane. The crane capacity of 5 tons must never be exceeded on a lift. Before making a lift, inspect crane emergency stop button, bottom block/hook, cables, lifting slings, chains and clevises for damage. Report damages to the laboratory supervisor and do not operate the crane. All lifts must be vertical, with no horizontal component. Suspend the load vertically first, then move the load horizontally (i.e. do not drag a load sideways). Protect slings from damage by padding sharp corners with saddles or wooden blocks. Never allow anyone to stand or walk under a suspended load. Never leave a load unattended while suspended.

Pay careful attention to lifting sling/chain capacity when used in the basket and choker modes. Sling capacity in the basket mode is double that for a single strand lift, but the maximum basket angle from the horizontal is 30 degrees with the capacity reduced by 50%. Choker capacity is 75% of the single strand rate capacity.

7. Pressure Bombs

One common use of compressed air in the Forest Sciences Centre is in conjunction with a pressure bomb for measuring "plant moisture stress" or water potential. Cylinders used for this purpose are generally small but hazards associated with the use of compressed gas cylinders[67] still hold. When observing the cut end of a branch or stem under pressure, wear safety goggles or a face shield. A large magnifying glass fixed at an angle above the pressure bomb will aid in observation as well as

[67] See Section XII.2 for Compressed Gas Cylinder hazards

shield the operator against projectiles. A stem propelled out of a bomb at 20-60 times atmospheric pressure can impact with considerable force.

8. UV Light[68]

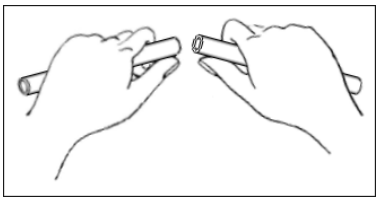
UV light at 254 nm is commonly found used in laminar flow hoods, biological cabinets, used to detect fluorescent compounds or for sterilizing equipment and bench tops. This light has little penetrating power and ordinary glass, most plastics, rubber and clothing will absorb most of the energy. For eyes, ordinary glasses should provide adequate protection against infrequent exposure. For routine work, safety glasses or goggles with solid side pieces are recommended. Plastics (either prescription lenses or face shields) should be tested to ensure zero transmission of 254 nm light. Acrylic plastic (Lucite, Plexiglas) shields may transmit germicidal radiation.

Arc welders are a powerful source of UV light. This light can sunburn the retina but pain may not be felt for several hours after the exposure. Avoid looking directly at the arc if in the vicinity of a welder in operation. If participating in the operation or standing nearby, wear full face protection (not just goggles) and gauntlets (any exposed skin can get a serious radiation burn).

9. Miscellaneous Laboratory Hazards

a) Glass Tubing[69]

When drilling a stopper, use a sharp borer one size smaller than the tube to be inserted and dip the borer tip in glycerol before drilling to aid in lubricating the bore tip. Soften the cork or stopper by rolling or kneading. The end of the glass to be inserted should be fire polished or filed smooth. Lubricate the glass tube with water or glycerol before insertion. Don't force glass tubing into rubber hose that is too small or through a stopper with too narrow a hole. Wear safety glasses, protect your hands with a cloth or gloves and hold the glass tube close to the end to minimize breakage. Gently but firmly insert the glass tubing into the stopper or hose with a slight twisting motion, avoiding too much pressure or torque.



To cut glass tubing, hold the tubing against a firm support and make a deep scratch with a sharp file in one clean stroke $^1/_3$ circumference in length. Wear safety glasses, cover the tubing with cloth and hold it on either side of the scratch, which should be facing away from you. Thumbs should be placed on the side opposite the scratch about 2.5 cm apart, pointing toward each other. Push out on the tubing with your thumbs... it should snap readily. If not, make a fresh scratch in the same place and try again.

c) Heating Baths & Elements

Heat chemicals in a fume hood or provide a vent. To prevent "bumping" in unstirred vessels use boiling stones (except when using test tubes, where it is

[68] Contact UBC Waste Management for disposal

[69] See Section XI.1 for disposal of lab glass

optional). If using a burner, distribute the heat with ceramic-centered wire gauze.

Oil and sand baths can be extremely hazardous because of spattering from spills, smoking of the hot oil or fire caused by over-heating of oil. Use the appropriate temperature-rated oils in the baths and do not leave such baths unattended without a high temperature shutoff. Silicone oil, which has a very high temperature range (*e.g.* Dow Corning 550) is appropriate for most heating needs.

d) Pipets

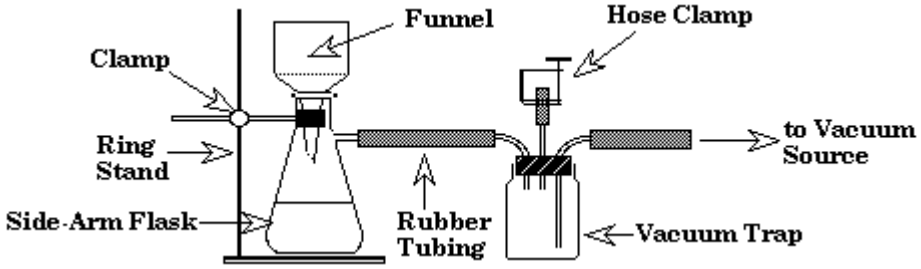
"Mouth pipetting", even if it is only water, is poor practice and not recommended. Use a pipette bulb or pump or a displacement pipettor at all times.

e) Vacuum Systems

Vacuum work can result in implosion, possible flying glass, splattering chemicals and fire hazards. Personal protective equipment such as safety glasses/goggles, face shield and/or polycarbonate shield should be used if the procedure is performed outside a fume hood.

When using a vacuum source, it is important to place a trap between the experimental apparatus and the vacuum source. Do not a allow water, solvents and corrosive gases to be drawn into the vacuum source. The vacuum trap not only protects the pump and piping from potential damage, it also prevents vapors and related odors from being emitted back into the laboratory and system exhaust.

Clamp the vacuum flask and trap to a stand or ring clamp to prevent movement of the glassware under pressure.



f) Water Faucets

Sinks with gooseneck faucets must be equipped with vacuum breaks to prevent "suck back" of contaminated water into the drinking supply. If hoses are attached to taps, they should be wired securely.

Additional Information:

Woodshop Safety Operations Manual, April 1981
UBC Laboratory Chemical Safety Manual (2017)

XIII. RADIOACTIVE MATERIALS

All faculty, students and staff intending to use radioactive materials in their research must complete the UBC Radiation Safety Course. The course consists of two lecture sections of three hour duration followed by a three hour laboratory practical session. The UBC Radiation Safety Course is available online or by contacting the UBC Biological & Radiation Safety Office at 604 822-4353 for further information.

The UBC Radionuclide Safety & Methodology Reference Manual should be consulted regarding safe working procedures, radioactive purchases, waste management and disposal, spills, etc.

The certification from the Radiation Safety Course confers an "authorized user" status which is *only valid for 5 years*. The radiation requalification course is offered online as an alternative to retaking the full length regular course in order to maintain an authorized user status.

A valid UBC Radioisotope License must be clearly posted at the work-site and is required in order to purchase radioactive materials. Any faculty member can apply for this license and it is not necessary to take the radiation protection course to obtain a license for a sealed source (*e.g.* an electron capture detector in a gas chromatograph).

Radiation Spill[70]

If you have not taken the radiation protection course and a sealed source breaks, evacuate all personnel from the area (they will need to be monitored), then notify your supervisor and the UBC Biological & Radiation Safety Office (604 822-7052) **IMMEDIATELY**. No person shall resume work at the site of an emergency until authorized to do so by the UBC Radiation Safety Advisor.

IMMEDIATELY notify the UBC Biological & Radiation Safety Office (604 822-4353) in the event of any accidental radioisotope release, spill of material or personal contamination.

If the volume of a spill is greater than 1L or if you are not able to handle the spill, call UBC Hazardous Materials Response: 9-1-1

Radiation Accidents Involving Injury[71]

In the event of serious injury to someone using radioactive materials, it is possible for untrained personnel to take action. The treatment of the injury must take precedence over all other considerations, regardless of radiation contamination. However, it may be possible to 'contain' any contamination by confining the injured person to a restricted area.

For minor injuries, treat immediately at or near the scene of the accident. Immediately notify the Supervisor or Licensee and the UBC Biological & Radiation Safety Office at 604 822-4353. For situations requiring basic first aid, contact the First Aid Attendant in your area or call UBC Campus First Aid at 822-4444. For serious bodily harm and/or radiation involvement, call 9-1-1. Pull the Fire Alarm if a phone is not available. Describe the injury, the isotope and amount involved, as well as the

[70] Refer to Radionuclide Safety and Methodology Reference Manual, Section 15
[71] Refer to Radionuclide Safety and Methodology Reference Manual, Section 17

physical and chemical form of the material. Immediately notify the Supervisor or Licensee and the UBC Biological & Radiation Safety Office at 604 822-4353.

All incidents/accidents must be reported in CAIRS within 24 hours of the incident/accident. Complete the UBC Spill Reporting Form online if a spill occurs.

REFERENCES

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_____. 2001. **Fallers' & Buckers' Handbook** - Practical Methods for Falling and Bucking Timber Safely., WorkSafeBC. 116 pp.

_____. 2001. **Industrial Health & Safety Regulations** , WorkSafe BC.

_____. 2009. **Standard Practices for Pesticide Applicators**. WorkSafeBC. 202 pp.

_____. 2003. **Safety in Academic Chemistry Laboratories**, 7th edition. American Chemical Society. 52 pp.

_____. 2013. **The Merck Index,** 15th edition. Merck & Co. 2708 pp.

2. Useful Internet Addresses and Websites

UBC Safety & Risk Services	https://srs.ubc.ca/
UBC Waste Management	http://www.recycle.ubc.ca
Workers' Compensation Board	http://www.worksafebc.com
UBC Emergency Preparedness	https://ready.ubc.ca/
UBC Policies	http://www.universitycounsel.ubc.ca

For Material Safety Data Sheets (SDS):

Fisher Scientific	Fisher Chemicals ACROS Chemicals	https://www.fishersci.ca/
VWR Scientific	BDH Chemicals JT Baker Chemicals	https://ca.vwr.com/
Sigma-Aldrich	Sigma Chemicals Aldrich Chemicals Fluka Chemicals Supelco Chemicals	http://www.sigma-aldrich.com
Canadian Centre for Occupational Health and Safety (CCOHS)	SDS plus Cheminfo RTECS OSHR	http://ccinfoweb.ccohs.ca

XIV. LIST OF APPENDICES

Appendix A

CLASSIFICATION OF DANGEROUS GOODS

(Note: The first number is the class and the second number is the division number)

Class 1 Explosives

- 1.1 A substance or article with a mass explosion hazard
- 1.2 A substance of article with a projection hazard, but not a mass explosion hazard
- 1.3 A substance or article that has a fire hazard along with either a minor blast hazard or a minor projection hazard or both, but not a mass explosion hazard
- 1.4 A substance or article that presents no significant hazard beyond the package in the event of ignition or initiation during transport
- 1.5 A very insensitive substance with a mass explosion hazard
- 1.6 Extremely insensitive article with no mass explosion hazard

Class 2 Gases

- 2.1 A flammable gas which is easily ignited and burns
- 2.2 A non-flammable, non-toxic, non-corrosive gas
- 2.3 A non-toxic gas

Class 3 Flammable and Combustible Liquids

- 3.1 A liquid with a closed-cup flask point of less than -18°C
- 3.2 A liquid with a closed-cup flash-point less than -18°C
- 3.3 A liquid with a closed-cup flash point not less than 23°C but less than 61°C

Class 4 Flammable Solids

- 4.1 A flammable solid which is readily combustible and may cause fire through friction or from heat retained from manufacturing
- 4.2 A spontaneous combustible substance that ignites when exposed to air
- 4.3 A water-reactive substance which emits flammable gas when it comes into contact with water

Class 5 Oxidizing Substances and Organic Peroxides

- 5.1 An oxidizing substance which may yield oxygen and contribute to the combustion of other materials
- 5.2 An organic peroxide which releases oxygen readily and may be liable to explosive decomposition, or sensitive to heat, shock or friction

Class 6 Toxic and Infectious Substances

- 6.1 A toxic substance that is liable to cause harm to human health
- 6.2 An infectious substance

Class 7 Radioactive Materials

Radioactive materials as defined in the Packaging and Transport of Nuclear Substance Regulations

Class 8 Corrosive Substances

Solids and liquids such as acids or alkalis materials that cause destruction of the skin or corrode metals

Class 9 A regulated substance that cannot be assigned to any other class. It includes genetically modified micro-organism, marine pollutants and substances transported at elevated temperatures

n

CANADIAN ENVIRONMENTAL PROTECTION ACT SCHEDULE 1
LIST OF TOXIC SUBSTANCES

- (4-Chlorophenyl)cyclopropylmethanone, O-[(4-nitrophenyl)methyl]oxime
- 1,1,1-Trichloroethane
- 1,2-Dichloroethane
- 1,3-Butadiene
- 2,4,6-tri-tert-butylphenol
- 2-(2-Methoxyethoxy) ethanol (DEGME)
- 2-Butanone
- 2-Butoxyethanol
- 2-Methoxy-1-propanol
- 2-Methoxyethanol
- 2-Methoxyethanol acetate (2-MEA)
- 2-Nitropropane
- 2-Nitrotoluene
- 3,3'-Dichlorobenzidine
- Acetaldehyde
- Acrolein
- Acrylamide
- Acrylonitrile
- Ammonia
- Asbestos
- Benzenamine, *N*-phenyl-, reaction products with Styrene and 2,4,4-Trimethylpentene (BNST)
- Benzene
- Benzidine and benzidine dihydrochloride
- Benzyl chloride
- Bis(2-ethylhexyl) phthalate
- Bis(chloromethyl) ether
- Bisphenol A
- Bromochlorodifluoromethane
- Bromochloromethane
- Bromofluorocarbons
- Bromotrifluoromethane
- Carbon dioxide
- Catechol
- Chlorobiphenyls
- Chlorofluocarbon
- Chlorinated Alkanes
- Chloromethyl methyl ether
- Cyclotetrasiloxane, octamethyl - D4
- Dibenzofuran
- Dibenzo-para-dioxin
- Dibrometetrafluoroethane
- Dichlorodiphenyltrichloroethane (DDT)
- Dichloromethane
- Diethyl sulfate
- Dimethyl sulfate
- Dodecachloropentacyclo [5.3.0.0^{2,6}.0^{3,9}.0^{4,8}] decane (Mirex)
- Epichlorohydrin
- Ethylene oxide
- Ethyloxirane
- Formaldehyde
- Hexabromocyclododecane (HBCD)
- Hexachlorobenzene
- Hexachlorobutadiene
- Hexavalent chromium compounds
- Hydrazine
- Hydrobromofluorocarbons
- Hydrochlorofluorocarbons
- Hydrofluorocarbons
- Hydroquinone
- Inorganic arsenic compounds
- Inorganic cadmium compounds
- Inorganic chloramines
- Inorganic fluorides
- Isoprene
- Lead
- Long-Chain (C9-C20) Perfluorocarboxylic Acids (PFCAs), their salts and their precursors
- MAPBAP Acetate
- Mercury
- Methane
- Methyl Bromide
- Methyl Eugenol
- Methyloxirane
- Michler's Ketone
- Naphthalene
- n-Butyl glycidyl ether (n-BGE)
- Nitric oxide

Appendix B

CANADIAN ENVIRONMENTAL PROTECTION ACT SCHEDULE 1
LIST OF TOXIC SUBSTANCES (cont'd)

- Nitrogen dioxide
- Nitrous oxide
- N-Nitrosodimethylamine
- Nonylphenol and its ethoxylates
- Oxidic, sulphidic, and soluble inorganic nickel compounds
- Ozone
- Pentachlorobenzene (QCB)
- Perfluorocarbons
- Perflurooctanoic Acid (PFOA), its Salts and its Precursors
- Perfluorooctane Sulfonate (PFOS), its Salts and Its Precursors
- Phenol, 2,6-bis(1,1-dimethylethyl)-4-(1-methylpropyl)- (DTBSBP)
- Pigment red 3
- Pigment red 104
- Pigment yellow 34
- Polybrominated Biphenyls
- Polybrominated Diphenyl Ethers (PBDEs)
- Polychlorinated dibenzodioxins
- Polychlorinated Dibenzofurans
- Polychlorinated Naphthalenes (PCNs)
- Polychlorinated Terphenyls
- Polycyclic aromatic hydrocarbons
- Potassium bromate
- Quinoline
- Sulphur dioxide
- Sulphur hexafluoride
- Tetrabutyltin
- Tetrachlorobenzenes (TeCBs)
- Tetrachloroethylene
- Tetrachloromethane, Carbon Tetrachloride
- TGOPE
- Thiourea
- Toluene diisocyanates
- Tributyltetradecylphosphonium chloride
- Tributyltins
- Trichloroethylene
- Tris(2-chloroethyl)phosphate (TCEP)
- Vanadium Pentoxide
- Vinyl Chloride

Appendix C

COMMONLY USED TOXIC CHEMICALS

1. **Acrylamide** [$H_2C=CHCONH_2$]: used in preparing gels for electrophoresis of proteins. It is a potent neurotoxin and suspected carcinogen. Avoid breathing dust, wear protective clothing and **use gloves** as acrylamide can be absorbed through unbroken skin.

   TLV (skin) = 0.3 mg/m^3. The polymerized gels, if free of the monomer, are probably not as serious a threat although caution is recommended.

   Mop up spills with plenty of water. Store the waste in sealed containers and follow disposal of chemical waste procedures.

2. **Aromatic amines:** members of this group (*e.g.* aniline, *m*-nitroaniline, and benzidine) can readily be absorbed through the skin and cause rapid systematic poisoning. Toxic amounts of solid amines may be absorbed as readily as liquid amines. The amines react in the blood to convert hemoglobin to methemoglobin, a form that cannot carry oxygen.

   TLV = 5 ppm for aniline; TLV = 3 mg/m^3 for nitroaniline. Poisoning can also occur by inhalation or ingestion. The odor of airborne aniline can be detected at concentrations of less than 1 ppm.

   Work in a fume hood whenever possible, use **butyl rubber gloves**, eye protection and lab coat when working with aromatic amines.

   Skin exposure requires prolonged washing with water, because most amines are only slightly soluble in water. Ventilate area well ($^1/_2$-face mask may be required).

   Small laboratory spills can be removed with absorbent paper. Larger spills[72] should be absorbed with sand, soil or a 1:1:1 mix of sodium (or calcium) carbonate + clay cat litter + sand. Package in a plastic container and contact the UBC Environmental Services Facility (604 822-6306) for disposal.

3. **Aromatic nitro compounds:** compounds such as nitrobenzene are similar to aromatic amines in that they are easily absorbed through the skin. They convert hemoglobin to methemoglobin.

   TLV = 1 ppm for nitrobenzene. Treatment of spills and skin exposure is similar to that for aromatic amines.

4. **Benzene** [C_6H_6], **toluene** [$C_6H_5CH_3$], **xylene** [$C_6H_4(CH_3)_2$]: aromatic organic solvents, the latter two are used in liquid scintillation cocktails. Benzene is a potent carcinogen!

   TLV (skin) = 10 ppm (30 mg/m^3). These solvents are highly flammable and toxic by inhalation and contact with skin. The dangers are of very serious irreversible effects. Handle all organic solvents in a **FUME HOOD ONLY**. Special cartridges for respirators are commercially available for benzene fumes. See Section X.7 for disposal procedures.

[72] See Section II.8 for spill procedures

5. **Benzoyl peroxide**[73] [$(C_6H_5CO)_2O_2$]: an organic peroxide and oxidizer, this compound has an extremely high risk of explosion by shock, friction, fire or other sources of ignition. Keep away from possible contact with acids, alcohols, ethers or other reducing agents. All precautions must be taken to guard against fire and explosion hazards. .

   TLV = 5 mg/m^3. It is also an irritant of the eyes, skin and respiratory system.

   For solid spills - moisten well with water and mix with plenty of wetted vermiculite, sand or a 1:1:1 mix of sodium (or calcium) carbonate + clay cat litter + sand. Contain liquid spills with sand or vermiculite. Transfer slurry into a plastic container and deactivate by adding slowly to 10x's its weight in 10% NaOH solution. Stir and add more water to thin. Package in a plastic container and call the UBC Environmental Services Facility (604 822-6306) for disposal. (Empty containers should be washed in 10% NaOH and discarded).

6. **Carbon tetrachloride, chloroform, other halogenated hydrocarbons:** used as organic solvents (*e.g.* lipid extraction), these compounds are extremely toxic by inhalation and contact with skin. Carcinogen and moderate teratogen. **HANDLE IN FUME HOOD ONLY!!** .

   TLV = 5 ppm for carbon tetrachloride; TLV = 10 ppm for chloroform. Avoid breathing vapor. Carbon tetrachloride causes liver damage

   If spilled[74] use respirator, eye protection, lab coat and nitrile rubber gloves. Absorb and contain spill with a 1:1:1 mix of sodium (or calcium) carbonate + clay cat litter + sand. Package in plastic container and call the UBC Environmental Services Facility (604 822-6306) for disposal. See Section X.7 for disposal procedures.

   Note: Methylene chloride can be collected for recovery, call 604 822-1285 for details

7. **Chromic acid cleaning solution:** used to clean glassware, this highly corrosive (contains concentrated sulfuric acid) material represents one of the greatest hazards in laboratories. Avoid inhaling dichromate dust as it irritates all parts of the respiratory system. A very powerful oxidant, reacts violently or explosively with acetic acid, acetic anhydride, potassium, selenium. Chromium compounds are suspected carcinogen.

   There are numerous known and postulated toxic effects of chromium to both humans and the environment. There are some excellent substitutes for chromic acid cleaning solutions that are equal, if not more effective. Most local scientific suppliers have a range of products to choose from (ie. Nochromix, Liqui-Nox, Citranox)

   If you must use chromic acid cleaning solution, do so in a fume hood and pre-wash all glassware and rinse with water before immersing in the acid solution. Although, data has suggested that problems of chromium release into the atmosphere are not detected, if a) solution kept cold (not heated) and b) solution not violently agitated, a serious problem involves the reaction of the solution with chloride to form chromyl chloride which is appreciably volatile at room temperature.

   Collect solution in a glass bottle for disposal. See Section X.3 for disposal procedures.

[73] See Section VII.5 for more information on peroxides
[74] See Section II.8 for spill procedures

8. **Cyanides and nitriles:** organic compounds combined with the -CN group are commonly called nitriles, although they may be called cyanides, as the inorganic compound are. A common organic cyanide CH_3CN is called acetonitrile or methyl cyanide. Cyanide compounds are powerful poisons that prevent respiration (the utilization of oxygen) by inhibition of cytochrome oxidase.

   Cyanide in the body can be converted to the much less toxic thiocyanate, SCN^-. Such conversion prevents any buildup of cyanide in the body, so poisoning from chronic, daily exposure to cyanide is less common than from acute exposures. Nitriles are less toxic than inorganic cyanides, but they do cause greater irritation of the nose and eyes. Wash cyanides and nitriles from the skin immediately.

   Spilled cyanides should be placed in a special container for disposal. Contact UBC Environmental Services Facility at 604 822-6306 for disposal.

9. **Dimethyl sulfate** [$(CH_3O)_2SO_2$]: used as methylating agent in organic synthesis, this compound is very toxic by inhalation and contact with skin with possible risks of irreversible effects.

   TLV (skin) = 0.1 ppm. Causes intense irritation to skin/mucous membranes several hours after even a short exposure. Often no odor or initial irritation detected. Causes kidney/liver damage. Highly toxic and suspected carcinogen.

   If a spill occurs, instruct others to keep at a safe distance, wear protective breathing apparatus, protective eyewear, clothing and nitrile rubber gloves. Absorb with sand or a 1:1:1 mix of sand + sodium (or calcium) carbonate + clay cat litter. Package sludge in plastic container and seal. Contact UBC Environmental Services Facility (604 822-6306) for disposal procedures. Wash spill site thoroughly with water and detergent.

10. **p-Dioxane** [$C_4H_8O_2$]: used in preparing liquid scintillation cocktail. Highly flammable; soluble in water, can form explosive peroxides on storage and may explode on distillation. It is toxic by inhalation and absorbed through skin.

    TLV = 25 ppm. Wear appropriate gloves and work in fume hood. Cancer suspect agent.

    If a spill occurs, instruct others to keep at a safe distance, wear protective breathing apparatus, protective eyewear, clothing and nitrile rubber gloves. Absorb with sand or a 1:1:1 mix of sand + sodium (or calcium) carbonate + clay cat litter. Package sludge in plastic container, seal and contact UBC Environmental Services Facility (604 822-6306) for disposal procedures. Wash spill site thoroughly with water and detergent. See Section X.6 for disposal information.

11. **Epoxy resins:** used for embedding samples for electron microscopy. Can cause contact dermatitis (hands, lower arms, face and neck). Responses vary from itchy hives to red swollen patches of skin.

    Process involves mixing resin + hardener + accelerator + plasticizer. Amine accelerators are most likely to cause dermatitis. Some other components are mutagens and suspected

carcinogens. Wear protective clothing (gloves) and work in fume hood. The cured resin is considered to be non-irritating and non-sensitizing.

12. **Ethidium bromide (EtBr):** used for staining DNA. A powerful mutagen and toxic compound. Avoid contact with eyes, skin and clothing as well as the creation of "EtBr dust". Wash thoroughly after handling.

    There are non-toxic **alternatives** to bromide that are available and should be considered. GelRed™, SYBR® Safe, GelGreen™ and EvaGreen® are some substitute that can be used in place of ethidium bromide.

    Ethidium bromide solutions should be diluted to contain less than 0.1mg/ml before disposal. To check for efficiency, add DNA (to 10mg/ml and check the fluorescence: excitation 540, fluorescence 590, limit of detection 0.5mg/ml).

    NOTE: Ethidium bromide is a chemical and should NOT be treated or labeled as a biohazard.

    Choose the most suitable method of treatment before disposal.

    A. Contaminated Solid Waste

    For any solid waste contaminated with ethidium bromide (electrophoresis gels, gloves, test tubes, paper towels, etc.) follow the procedures for disposal of non-regulated contaminated solid waste.

    B. Contaminated Liquid Waste

    Liquid waste contaminated with ethidium bromide **must not** be sent to UBC Environmental Services Facility. EtBr in aqueous solutions can be removed with activated charcoal, amberlite ion exchange resin or chemically deactivated. For updated procedures for the disposal of ethidium bromide contaminated liquid waste contact the UBC Environmental Services Facility (604 822-6306).

13. **Formic acid** [HCO_2H]: used as chromatography solvent. Colorless, fuming liquid, pungent/irritating odor. Causes severe burns and is very damaging to skin (outer skin usually peels off in a few days exposing very tender lower layers of skin). Wear appropriate gloves and work in fume hood.

    TLV = 5 ppm. Avoid breathing vapors. Vapor irritates all parts of the respiratory system.

    Do not store with strong acids such as nitric or perchloric (oxidizers). Regularly vent containers to prevent pressure build up.

    Collect in appropriate containers for disposal, label accordingly and contact the UBC Environmental Services Facility (604 822-6306) for disposal procedures.

14. **Hydrofluoric acid** (HF): used in sample digestion and glass etching. Extremely corrosive fuming liquid with pungent smell. Causes severe burns. Skin burns do not usually cause pain for several hours. If solution contacts skin, immediately flush area with large amounts of water. All splashes should be referred to the hospital after initial washing.

TLV = 3 ppm. Very toxic by inhalation and contact with skin. . The fume irritates severely all parts of the respiratory system. .

Labs continually handling HF should obtain a special fluoride safety kit containing a burn ointment and instructions that should be taken to the hospital with the patient. Wear appropriate gloves and use in fume hood.

Handle spills with extreme caution. Use protective breathing apparatus, protective eyewear, clothing and butyl rubber gloves. Cover spill with a 1:1:1 mix of sand + clay cat litter + calcium (or sodium) carbonate. Scoop sludge into plastic container, seal and contact the UBC Environmental Services Facility (604 822-6306) for disposal procedures.

15. **Mercaptoethanol** [$HSCH_2CH_2OH$]: used in protein preparations to prevent oxidation. Mercaptans are highly toxic and have an offensive odor causing nausea and headaches.

    TLV = 1 ppm. Use in fume hood.

    Absorb spills with paper towels or sand and neutralize with household bleach. Collect spill clean-up materials in plastic container, seal and contact the UBC Environmental Services Facility (604 822-6306) for disposal procedures. Scrub spill area with soap and water containing bleach.

16. **Mercury** (Hg)**:** Mercury (found in thermometers and barometers) and mercury derivatives (*e.g.* methyl mercury used in RNA analysis). Mercury is very toxic by inhalation. It interferes with enzyme systems in the body and prolonged exposures can lead to irreversible damage. Mercury is appreciably volatile at room temperature - the equilibrium concentration of Hg vapor at room temperature is 20 mg/m^3.

    TLV (skin) = .05 mg/m^3. For organic mercury, the limit is 0.01 mg/m^3.

    Although handling large quantities of metallic mercury in the laboratory is not common, it still represents a potential health hazard due to the difficulties in containing Hg, avoiding splashes and recovering small droplets. Any visible droplets should be collected with an aspirator connected to a Pasteur pipette. As mercury is not soluble in water, alkalis or dilute acids, scrubbing the spill area is not effective in removing the residual spill from the surface. There is a mercury spill kit in the Chemical Spill Cart, but these are very expensive and should be used sparingly. Any laboratory that routinely handles mercury should purchase a mercury spill kit.

    The volatility of residual mercury decreases after a spill due to the formation of an oxide/dust coating on the droplets that acts as a barrier to vaporization. The best approach is to try and avoid spills - work in containment trays within a fume hood.

    Any waste material contaminated with mercury or mercury derivative (*e.g.* gloves, paper towels, pipettes) should be stored in a sealed container (i.e. plastic bag or sealed jar) and placed in a well-vented area (i.e. fume hood) until disposed of. See Section X.4 for disposal procedures

17. **Methylene chloride (dichloromethane)** [CH_2Cl_2]: used to glue acrylic plastics and as a wood extractive. A volatile liquid, methylene chloride is harmful by inhalation and can cause skin dermatitis. Vapor irritates the eyes and respiratory system causing headache and nausea.

    TLV = 200 ppm. Wear appropriate gloves and use in fume hood. See Section X.6 for disposal procedures.

18. **Nitrosoguanidine** [CH_4ON_4]: used as mutagen and to prepare diazomethane. A very potent mutagenizing agent that may explode with shock, heat or flame.

    Store waste in sealed containers and contact UBC Environmental Services Facility (604 822-6306) for disposal procedures.

19. **Osmium tetroxide** [OsO_4]: used in sample preparation for electron microscopy. Very toxic by inhalation and contact with skin. Osmium tetroxide is volatile, so wear appropriate gloves, work in a fume hood and/or use a respirator.

    TLV = 0.0002 ppm. Vapor irritates all parts of the respiratory system. Continued exposure causes disturbances of the vision.

    In the event of a spill, wear a protective breathing apparatus, face shield or splash goggles, **nitrile** gloves and protective clothing. Collect in heavy plastic or glass container and seal. Store wastes separately from other chemicals and call the UBC Environmental Services Facility (604 822-6306) for disposal procedures.

20. **Phenol (carbolic acid)** [C_6H_5OH]: used as disinfectant and reagent for nucleic acid work. Highly toxic in contact with skin. Vapor irritates the respiratory system and eyes. Inhalation over a long period may cause digestive disturbances, nervous disorders, damage to the liver and kidney and dermatitis.

    TLV (skin) = 5 ppm. Rapidly absorbed through the skin will result in headache, dizziness, rapid and difficult breathing, weakness and collapse.

    Use in ventilated area and wear protective clothing. Although phenol is more soluble in ethanol than water, ethanol should **not** be used to remove skin contamination since it may aggravate the problem.

    For spills, wear a protective breathing apparatus, face shield or splash goggles, **nitrile** gloves and protective clothing. Eliminate all sources of ignition, sweep onto paper and package in plastic bag. Wash area thoroughly with water and detergent. Contact the UBC Environmental Services Facility (604 822-6306) for disposal. See Section X.6 for disposal procedures.

21. **Phenylhydrazine** [$C_6H_5NHNH_2$]: used in sugar determination. Toxic by inhalation and contact with skin. Cancer suspect agent and powerful allergen. Avoid inhalation of vapor or dust.

    TLV (skin) = 5 ppm. Absorption via inhalation, skin or ingestion may result in blood and liver damage. Dermatitis or hyper-sensitization may follow skin contact.

If a spill occurs, wear a protective breathing apparatus, face shield or splash goggles, **nitrile** gloves and protective clothing for clean-up. For disposal, dilute to <40% solution with water and neutralize with dilute sulfuric acid. Collect in glass bottle, label and call UBC Environmental Services Facility (604 822-6306) for disposal.

22. **Silica gel (silicic acid):** fine powder used to coat glass plates for thin layer chromatography. Dust is easily inhaled and causes lung damage. Work in fume hood or well-ventilated area.

    Another trade name for very finely divided silica is Carbosil (used in liquid scintillation counting to form a gel in the vial and allow measurement of particulate samples). Handle in fume hood or wear appropriate respirator.

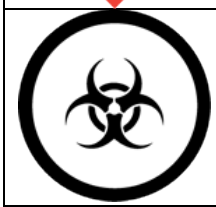
    Collect silica gel in sealed container (plastic bag or sealed jar) for disposal. Disposal of silica gel as non-regulated contaminated waste. See Section X.6 for disposal procedures.

23. **Trichloroacetic acid (TCA) [CCl_3CO_2H]:** used to precipitate proteins. Very corrosive, cause severe burns. Wear personal protective equipment and work in fume hood. If contacts skin, flush immediately with water. If penetrates into tissue, irrigate with sodium carbonate solution. Clean site of spill with plenty of water and dilute with running water down drain.

    TLV = 1 mg/m^3.

WHMIS PICTOGRAMS

	Exploding bomb (for explosion or reactivity hazards)
	Flame (for fire hazards)
	Flame over circle (for oxidizing hazards)
	Gas cylinder (for gases under pressure)
	Corrosion (for corrosive damage to metals as well as skin, eyes)

	Skull & Crossbones (can cause death or toxicity with short exposure to small amounts)
	Health hazard (may cause or suspected of causing serious health effects)
	Exclamation mark (may cause less serious health effects or damage the ozone layer*)
	Environment* (may cause damage to the aquatic environment)
	Biohazardous Infectious Materials (for organism or toxins that can cause diseases in people or animals)

* The environmental hazards group not adopted in WHMIS 2015 because this hazard group is in the Global Harmonized System of Classification & Labelling of Chemicals (GHS).

** The 'Biohazardous infectious materials' hazard symbol was included in WHMIS1988 but not part of the GHS

CHEMICAL INVENTORY FORM

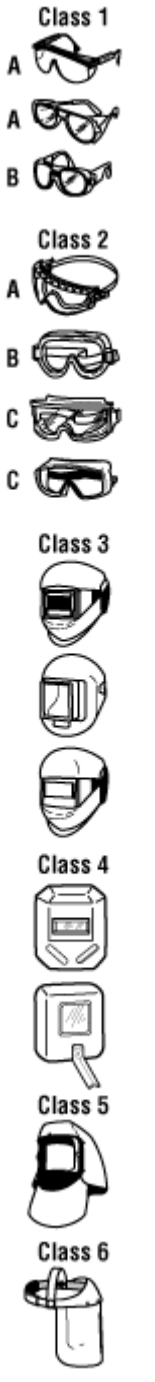
Fp(C)=Flash point : CAN=Cancer Agent (A) or Teratogen (T) or Mutagen (M) : COR=Corrosive (C) : EXP=Explosive when heated (E) or Peroxide-forming (P) : FL/CM=Flammable (F-L) Liquid or (F-S) Solid or Combustible (C-M) : HG/LC=Hygroscopic (H) or Lachrymator (L) : IRR=Irritant (I) : OX=Oxidizer (O) : POI=Poison (P) : SENS=Sensitive to Light (L) or Moisture (M) : TOX=Toxic (X) or Very Toxic (XX) : MISC=Misc - Stench (St)

State	State				Date	Location	HAZARDS											
Product Name	L, S	Qty	Supplier	Buyer	Recd	FSC	Fp (C)	CAN	COR	EXP	FL/CM	HY/LC	IRR	OX	POI	SENS	TOX	MISC

SELECTION OF EYE AND FACE PROTECTION

Note: This table cannot cover all possible hazards and combinations that may occur. Examine each situation carefully and select the appropriate protector or combination of protectors. *indicates recommended protection	Spectacles (Class 1)		Goggles (Class 2)			Welding Helmet (Class 3)	Welding Hand Shield (Class 4)	Non-Rigid Hoods (Class 5)				Face Shields (Class 6)		
	A	B	A	B	C			A	B	C	D	A	B	C
Flying Objects														
Chipping, drilling, scaling, grinding, polishing, buffing, riveting, punching, shearing, hammer mills, crushing, heavy sawing, planning, wire and strip handling, hammering, unpacking, nailing, punch press, lathe-work, etc.	*		*	*				*	*			*		
Flying particles, dust, wind, etc.														
Woodworking, sanding, light metal working and machining, exposure to dust and wind, resistance welding (no radiation exposure), sand, cement, aggregate handling, painting, concrete work, plastering, material batching and mixing	*		*	*				*	*			*		
Heat, sparks and splash from molten materials														
Babbiting, casting, pouring molten metal, brazing, soldering, spot welding, stud welding, hot dipping operations		*			*					*	*		*	*
Acid splash, chemical burns														
Acid and alkali handling, degreasing, pickling and plating operations, glass breakage, chemical spray, liquid bitumen handling				*					*			*		
Abrasive blasting materials														
Sand blasting, shot blasting, shotcreting				*					*			*		
Glare, stray light (for reduction of visible radiation)														
Reflecting, bright sun and lights, reflected welding flash, photographic copying	*		*	*				*	*			*		
Injurious optical radiation (moderate reduction of optical radiation)														
Torch cutting, welding, brazing, furnace work, metal pouring, spot welding, photographic copying		*			*					*			*	
Injurious optical radiation (large reduction of optical radiation)														
Electric arc welding, heavy gas cutting, plasma spraying and cutting, inert gas shielded arc welding, atomic hydrogen welding						*	*							

Examples



From: "Z94.3.1-09 Selection, use and care of protective eyewear" by Canadian Standards Association, 2009.

Appendix G

PROPERTIES OF FLAMMABLE LIQUIDS[75]

Solvent	Flash Point °C	Ignition Temp °C	Specific Gravity (water = 1.0)	Vapor Density (air = 1.0)
Acetone	-18	538	0.8	2.0
Benzene	-11	562	0.9	2.8
Carbon disulfide	-30	90	1.3	2.6
p-dioxane	12	180	1.0	3.0
Ethanol	13	423	0.8	1.6
Ethyl ether	-45	-	0.7	2.6
Ethylene glycol	111	413	1.1	-
Gasoline	-43	>260	0.8	3.4
Kerosene	38	230	<1	-
Petroleum ether	-54	-	0.6	2.5
Methanol	1	464	0.8	1.1
Toluene	4	536	0.9	3.1
Turpentine	35	253	<1	-
Xylene	17	-	0.9	3.7

[75] See UBC Safety & Risk Services Laboratory Chemical Safety for complete list of Flash Points of Flammable Liquids

POTENTIALLY EXPLOSIVE MATERIALS

Class A – Severe Peroxide Hazard

Some chemicals can spontaneously form explosive peroxides upon exposure to air due to concentration during storage. The following compounds should be tested for peroxide formation ***every 3 months*** after opening and before use:

- butadiene
- chloroprene
- divinyl acetylene
- isopropyl ether
- potassium amide
- potassium, metal
- sodium amide
- tetrafluoroethylene
- vinylidene chloride

Class B – Concentration Hazard

Some substances can produce explosive peroxide conditions upon concentration and distillation. Do not distill or evaporate the following compounds without first testing for peroxides and once opened, must be tested ***every 6 months:***

- acetal
- acetaldehyde
- benzyl alcohol
- 2-butanol
- cumene
- cyclohexanol
- 2-cyclohexen-1-ol
- cyclohexene
- decahydronaphthalene
- diacetylene
- dicyclopentadiene
- diethyl ether
- diethylene glycol dimethyl ether (diglyme)
- dioxane
- divinyl acetylene
- ethylene glycol dimethyl ether (glyme)
- 4-heptanol
- 2-hexanol
- methyl acetylene
- 3-methyl-1-butanol
- methylcyclopentane
- methyl isobutyl ketone
- 4-methyl-2-pentanol
- 2-pentanol
- 4-penten-1-ol
- 1-phenylethanol
- 2-phenylethanol
- 2-propanol
- tetrahydrofuran
- tetrahydronaphthalene
- vinyl ethers
- vinylchloride
- other secondary alcohols

Class C – Shock and Heat Sensitive

Some substances are highly reactive and can auto-polymerize as a result of internal peroxide accumulation. These peroxide forming compounds are extremely shock and heat sensitive and must be tested ***every 6 months*** once opened:

- acrylic acid
- acrylonitrile
- butadiene gas
- chloroprene
- chlorotrifluoroethylene
- methyl methacrylate
- styrene vinylpyridine
- tetrafluoroethylene gas
- vinyl acetate
- vinylacetylene gas
- vinyladiene chloride
- vinyl chloride gas

Class D – Potential Peroxide-forming

See UBC Safety & Risk Services Chemical Safety Manual 2017 for complete list of compounds that may form peroxides but cannot clearly be categorized in Class A, B or C.

INCOMPATIBLE CHEMICALS

Many explosions, fires and asphyxiation are caused by the accidental contact of chemicals due to breakage, spillage, or more seriously, from fire in a chemical store. Segregation of different materials in storage will minimize the effects of accidental contact.

*The lists below are only **partial**, for more information on the chemical you are dealing with, see the SDS.*

1. INCOMPATIBLE CHEMICALS - REACTIVE HAZARDS

Substances in the left column should not be stored or handled with corresponding substances in the right hand column.

Acetaldehyde	acetic anhydride, acetic acid, acetone, ethanol, sulfuric acid
Acetic acid	chromic acid, nitric acid, peroxides, hydroxyl compounds, ethylene glycol, perchloric acid and permanganates
Acetic anhydride	hydroxyl-containing compounds, ethylene glycol, perchloric acid
Acetone	conc. nitric and sulfuric acid mixtures
Acetylene	chlorine, bromine, copper, silver, fluorine and mercury
Alkali and alkaline earth metals (*e.g.* sodium, potassium, lithium, magnesium, calcium, powdered aluminum)	carbon dioxide, carbon tetrachloride and other chlorinated hydrocarbons. (Also prohibit water, foam and dry chemicals on fires involving these metals - dry sand should be used)
Ammonia (anhydrous)	mercury, chlorine, calcium hypochlorite, iodine, bromine and hydrogen fluoride
Ammonium nitrate	acids, metal powders, flammable liquids, chlorates, nitrites, sulfur, finely divided organics or combustibles
Aniline	nitric acid, chromic acid, hydrogen peroxide
Bromine	ammonia, acetylene, butadiene, butane and other petroleum gases, sodium carbide, turpentine, benzene and finely divided metals
Calcium oxide	water
Carbon, activated	calcium hypochlorite and other oxidants
Carbon tetrachloride	diborane, fluorine
Chlorates	ammonium salts, acids, metal powders, sulfur, finely divided organics or combustibles
Chlorine	ammonia, acetylene, butadiene, butane and other petroleum gases, hydrogen, sodium carbide, turpentine, benzene and finely divided metals
Chlorine dioxide	ammonia, methane, phosphine, and hydrogen sulfide
Chromic acid and chromium trioxide	acetic acid, naphthalene, camphor, glycerol, turpentine, alcohol and other flammable liquids
Copper	acetylene, hydrogen peroxide
Cumene hydroperoxide	acids (organic or inorganic)
Dimethyl sulfoxide	perchloric acid, silver fluoride, potassium permanganate, acetylchloride, benzene sulfonyl chloride
Flammable liquids	ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium pentoxide, halogens
Fluorine	isolate from everything
Hydrazine	hydrogen peroxide, nitric acid, any other oxidant

Cont'd on next page

INCOMPATIBLE CHEMICALS (cont'd)

1. INCOMPATIBLE CHEMICALS – REACTIVE HAZARDS (CONT'D)

Substances in the left column should not be stored or handled with corresponding substances in the right hand column.

Hydrocarbons (benzene, butane, propane, gasoline, turpentine, etc.)	fluorine, chlorine, bromine, chromic acid, peroxides
Hydrocyanic acid	nitric acid, alkalies
Hydrofluoric acid, anhyd.	ammonia, aqueous or anhydrous
Hydrogen peroxide	copper, chromium, iron, most metals or their salts, any flammable liquid, combustible materials, aniline, nitromethane
Hydrogen sulfide	fuming nitric acid, oxidizing gases
Iodine	acetylene, ammonia (anhyd or aqueous), hydrogen
Mercury	acetylene, fulminic acid*, ammonia, oxalic acid
Nitric acid, conc.	acetic acid, acetone, alcohol, aniline, chromic acid, hydrocyanic acid, hydrogen sulfide, flammable liquids, flammable gases and nitratable substances
Nitroparaffins	inorganic bases, amines
Oxalic acid	silver, mercury
Oxygen	oils, grease, hydrogen, flammable liquids, solids or gases
Perchloric acid	acetic anhydride, bismuth and its alloys, alcohol, paper, wood and other organic materials, grease and oils
Peroxides, organic	acids (organic or mineral), avoid friction, store cold
Phosphorus, white	air, oxygen, alkalis, reducing agents
Potassium	carbon tetrachloride, carbon dioxide (Also prohibit water, foam and dry chemicals on fires involving these metals - dry sand should be used)
Potassium chlorate and potassium perchlorate	acids (see chlorates and perchloric acid)
Potassium permanganate	glycerol, ethylene glycol, benzaldehyde, sulfuric acid
Silver	acetylene, oxalic acid, tartaric acid, fulminic acid*, ammonium compounds
Sodium	see alkali metals
Sodium nitrite	ammonium nitrate and other ammonium salts
Sodium peroxide	any oxidizable substance (*e.g.* ethanol, methanol, glacial acetic acid, acetic anhydride, benzaldehyde, acetate, methyl acetate and furfural)
Sulfuric acid	chlorates, perchlorates, permanganates and similar compounds of light metals (*e.g.* sodium, lithium, etc.)

** Produced in nitric acid-ethanol mixtures*

INCOMPATIBLE CHEMICALS (cont'd)

2. INCOMPATIBLE CHEMICALS – TOXIC HAZARDS

Substances in the left column should not be stored or handled with corresponding substances in the center column as toxic materials (right hand column) would be produced

Arsenical materials	Any reducing agent	Arsine
Azides	Acids	Hydrogen azide
Cyanides	Acids	Hydrogen cyanide
Hypochlorites	Acids	Chlorine or hypochlorous acid
Nitrates	Sulfuric acid	Nitrogen dioxide
Nitric acid	Copper, brass, any heavy metals	Nitrogen dioxide (nitrous fumes)
Nitrites	Acids	Nitrous fumes
Phosphorus	Caustic alkalies or reducing agents	Phosphine
Selenides	Reducing agents	Hydrogen selenide
Sulfides	Acids	Hydrogen sulfide
Tellurides	Reducing agents	Hydrogen telluride

** Arsine has been produced by putting an arsenical alloy into a wet galvanized bucket.*

CHEMICAL INCOMPATIBILITY BY HAZARD CLASS

	Acids, inorganic	Acids, organic	Acids, oxidizing	Alkalis (bases)	Organic solvents	Oxidizers	Poisons, inorganic	Poisons, organic	Water-reactives
Acids, inorganic		X		X	X		X	X	X
Acids, organic	X		X	X		X	X	X	X
Acids, oxidizing		X		X	X		X	X	X
Alkalis (bases)	X	X	X		X			X	X
Organic solvents	X		X	X		X	X		
Oxidizers		X			X			X	X
Poisons, inorganic	X	X	X		X			X	X
Poisons, organic	X	X	X	X		X	X		
Water-reactives	X	X	X	X		X	X		

X – Incompatible storage

STORAGE GUIDELINES FOR COMPRESSED GASES

From BC Fire Code, 2006 – Table 3.2.7.6

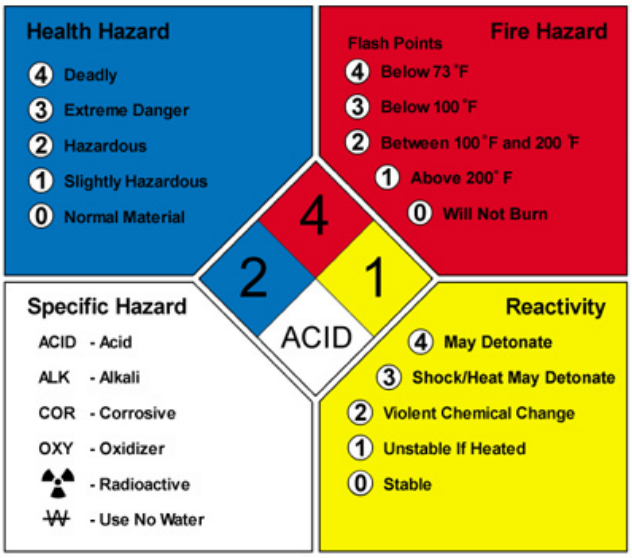
Separation Chart for Storage of Dangerous Goods					
Class	Flammable Gas	Non-flammable /Non-toxic Gas	Toxic/ Corrosive Gas	Oxidizers	Poison Gas
Flammable Gas	P	P	X	X	X
Non-flammable/ Non-toxic Gas	P	P	P	P	P
Toxic/ Corrosive Gas	X	P	P	A	DS
Oxidizers	X	P	A	P	A
Poison Gas	X	P	DS	A	P

P Permitted – items may be stored together
A Incompatible items – separate by minimum of 1 meter distance
X Incompatible items – do not store together in the same fire compartment
DS Defer to Material Safety Data Sheet

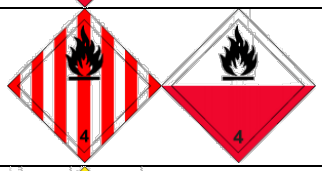
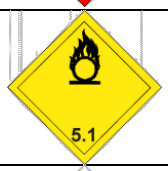
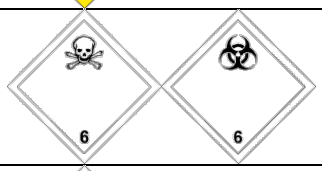
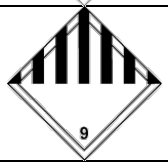
UBC CHEMICAL STORAGE GUIDELINES

WHMIS Class	NFPA Code	Comments
B. Flammable & Combustible Materials	RED	Store in area segregated for flammable reagents. Flammable liquids should be stored in one of the following: approved cabinet; approved fire safety can; approved room; explosion-proof refrigerator. **25 litres is the maximum total volume of all containers which may be in the open lab, not including liquids stored in an approved flammable liquid cabinet or safety cans** Other flammable and combustible materials include: *combustible liquids (flashpoint > 37.8℃* *flammable gases & aerosols* *flammable solids (organic solids)* *reactive flammables*
C. Oxidizing Material	YELLOW	Store away from flammable/combustible materials and reducing agents *e.g. sodium bisulfite, hydrogen sulfide, sulfur dioxide, metals, hydrogens, hydroxylamine*
D. Poisonous & Infectious Material	BLUE	Store in secure place. *e.g. antimony, arsenic, carcinogens, cyanide, other heavy metals and their compounds*
E. Corrosive Material	WHITE	Store away from red-, yellow-, blue-coded reagents. Separate concentrated acids and bases (caustics or alkalis; amines and anilines)
F. Dangerously Reactive Material	YELLOW	Store away from flammable/combustible materials and as required according to the nature of their individual hazards *e.g. metal hydrides, some hydrogenation catalysts, picric acid, dinitrophenol, trinitrotoluene*

NFPA Hazard Identification System

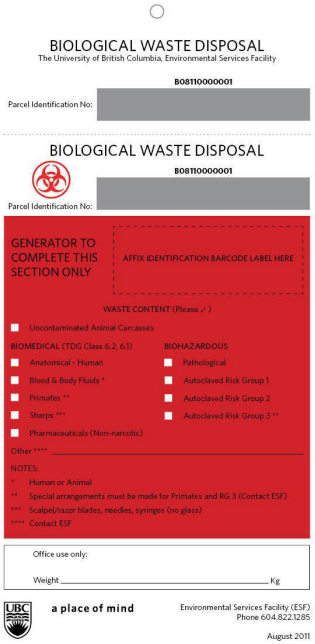


DANGEROUS GOODS HAZARD CATEGORIES

TDG Class	Placard	Comments
1. Explosives		
2. Compressed Gases		
3. Flammable Liquids		
4. Flammable Solids		Spontaneously combustibles and substances that on contact with water, emit flammable gases
5. Oxidizers		Oxidizing substances and organic peroxides
6. Toxic/Infectious		Poisonous (toxic) and infectious substances
7. Radioactive		
8. Corrosive		
9. Misc		Miscellaneous identified dangerous goods, dangerous wastes

UBC Environmental Services Waste Generator Tags

Biological Waste (red)



BIOLOGICAL WASTE DISPOSAL
The University of British Columbia, Environmental Services Facility

B08110000001

Parcel Identification No:

BIOLOGICAL WASTE DISPOSAL

B08110000001

Parcel Identification No:

GENERATOR TO COMPLETE THIS SECTION ONLY

AFFIX IDENTIFICATION BARCODE LABEL HERE

WASTE CONTENT (Please ✓)

- Uncontaminated Animal Carcasses

BIOMEDICAL (TDG Class 6.2, 6.1)

- Anatomical - Human
- Blood & Body Fluids *
- Primates **
- Sharps ***
- Pharmaceuticals (Non-narcotic)

BIOHAZARDOUS

- Pathological
- Autoclaved Risk Group 1
- Autoclaved Risk Group 2
- Autoclaved Risk Group 3 **

Other ****

NOTES:

* Human or Animal

** Special arrangements must be made for Primates and RG 3 (Contact ESF)

*** Scalpel/razor blades, needles, syringes (no glass)

**** Contact ESF

Office use only:

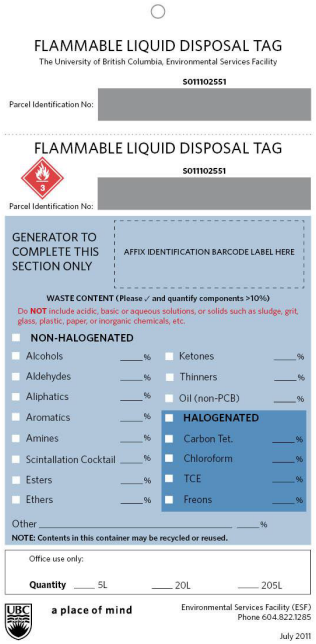
Weight _____ Kg

a place of mind

Environmental Services Facility (ESF)
Phone 604.822.1285

August 2011

Flammable Liquid Disposal (blue)



FLAMMABLE LIQUID DISPOSAL TAG
The University of British Columbia, Environmental Services Facility

S011102551

Parcel Identification No:

FLAMMABLE LIQUID DISPOSAL TAG

S011102551

Parcel Identification No:

GENERATOR TO COMPLETE THIS SECTION ONLY

AFFIX IDENTIFICATION BARCODE LABEL HERE

WASTE CONTENT (Please ✓ and quantify components >10%)

Do **NOT** include acidic, basic or aqueous solutions, or solids such as sludge, grit, glass, plastic, paper, or inorganic chemicals, etc.

NON-HALOGENATED

- Alcohols ____%
- Aldehydes ____%
- Aliphatics ____%
- Aromatics ____%
- Amines ____%
- Scintallation Cocktail ____%
- Esters ____%
- Ethers ____%
- Ketones ____%
- Thinners ____%
- Oil (non-PCB) ____%

HALOGENATED

- Carbon Tet. ____%
- Chloroform ____%
- TCE ____%
- Freons ____%

Other _____ ____%

NOTE: Contents in this container may be recycled or reused.

Office use only:

Quantity ____ 5L ____ 20L ____ 205L

a place of mind

Environmental Services Facility (ESF)
Phone 604.822.1285

July 2011

Photochemical Waste (purple)

PHOTOGRAPHIC WASTE—TREATMENT
The University of British Columbia, Environmental Services Facility

PW0811000001

Parcel Identification No:

PHOTOGRAPHIC WASTE—TREATMENT

PW0811000001

Parcel Identification No:

GENERATOR TO COMPLETE THIS SECTION ONLY

AFFIX IDENTIFICATION BARCODE LABEL HERE

WASTE CONTENT (Please ✓)

- Developer
- Silica Fixer
- Stop/Stabilizer

Other _____

Office use only:

Date Received: _____
mm/dd/yy

Date Treated: _____
mm/dd/yy

Volume: ☐ 5L ☐ 20L

a place of mind

Environmental Services Facility (ESF)
Phone 604.822.1285

August 2011

Non-regulated Contaminated Solid Waste (yellow)

NON-REGULATED CONTAMINATED SOLID WASTE
The University of British Columbia, Environmental Services Facility

NR08110000001

Parcel Identification No:

NON-REGULATED CONTAMINATED SOLID WASTE

NR08110000001

Parcel Identification No:

GENERATOR TO COMPLETE THIS SECTION ONLY

AFFIX IDENTIFICATION BARCODE LABEL HERE

WASTE CONTENT

- Soild waste contaminated with Ethidium Bromide
- Silica Gel

Other _____

Office use only:

Date Received: _____
MM/DD/YY

Weight: _____ Kg

a place of mind

Environmental Services Facility (ESF)
Phone 604.822.1285

August 2011

UBC HAZARDOUS WASTE DISPOSAL PROCEDURES POSTER

UBC Hazardous Waste Disposal Information Sheet
Environmental Services Facility (ESF), Safety & Risk Services

ESF Weekly Pick-up Schedule
Please have wastes ready before 9:30 a.m.

Monday	Tuesday	Wednesday	Thursday	Friday

- Take all hazardous wastes to **centralized storage location** in your building
- Please ensure wastes are **properly packaged** and **tagged** and do not exceed **10 kg**
- To ensure worker safety, ESF will **NOT** pickup waste that is not properly packaged, tagged or weighed

General Inquiries, Solvent, Photographic Waste Disposal
Bang Dang
604.822.1285 or 604.323.4420
bang.dang@ubc.ca

Chemical Waste Disposal
Valeriy Kichenko
604.822.6306 or 778-879.2863
valeriy.kichenko@ubc.ca

Biological Waste Disposal
Kenneth Cheng
604.827.5389 or 604.790.2444
kenneth.cheng@ubc.ca

Also visit:
http://srs.ubc.ca/environment/hazardous-waste-management/

Produced by: Safety & Risk Services
Revised: August 2019

Biological Waste Disposal

Autoclaved Risk Group 1
- Autoclave in **clear unlabeled** autoclave bags
- Double bag with clear bags and ensure no leaks
- Affix biological waste disposal tag (red)
- Indicate Risk Group 1 on tag
- Attach generator barcode sticker on tag

Autoclaved Risk Group 2
- Autoclave in **clear unlabeled** (*) autoclave bags
- Double bag with clear bags and ensure no leaks
- Affix biological waste disposal tag (red)
- Indicate Risk Group 2 on tag
- Attach generator barcode sticker on tag

(*) **Note**: Orange biohazard bags are only used by containment level 3 facilities, non-UBC waste generators and off-campus labs.

Sharps
- Collect in **red** or **yellow autoclavable** sharps containers and ensure lid is securely closed/locked. Do not overfill.
- Autoclave
- Affix biological waste disposal tag (red) with generator barcode

Human Anatomical/ Human Blood & Body Fluids
- Double bag in **red** bags; ensure no leaks
- Affix biological waste disposal tag (red) with generator barcode
- Store in freezer for pickup

Animal Carcasses
- Package in **black 6 mil** polypropylene **bags**
- Double bag to ensure no leaks; do not exceed **10 kg**
- Affix biological waste disposal tag (red)
- Attach generator barcode **sticker** on tag
- Store in freezer for pick-up

Chemical Waste Disposal

Surplus Chemicals & Experimental Byproducts
- Check if chemical is included on the "non-hazardous" list
- Access Chemical Waste Inventory System (**CWIS**) online
- Input your generator and chemical information
- Wait to obtain approval for disposal from ESF
- **Segregate** chemicals by hazard class
- Package chemicals safely with absorbent material in a **heavy duty cardboard box**
- Ensure **no leaks** from liquid chemicals & package bottles upright
- Ensure each package weighs less than 10kg
- Tape the box closed
- Affix the approval form to the box (in an envelope)
- Print **generator contact info** on the envelope
- Print **hazard class** and **authorization number** on box

Solvent/Oil Waste
- Collect in red jerry cans. **Segregate** halogenated & non-halogenated
- Ensure cap is tight and there are no leaks
- Affix flammable liquid tag (blue)
- Indicate **halogenated**, **non-halogenated** or **oil waste**
- Attach generator barcode sticker on tag

Non-Regulated Contaminated Solid Waste
- Double bag waste in thick clear garbage bags
- Ensure no liquid; do not exceed **10 kg**
- Affix non-regulated contaminated solid waste tag (yellow)
- Indicate waste type on tag
- Attach generator barcode sticker on tag

Photographic Waste
- Segregate fixer and developer
- Collect in **20 L** red jerry cans
- Affix photochemical tag (purple)
- Indicate waste type on tag
- Attach generator barcode sticker on tag

Note: ESF will NOT pick-up the following materials: 1) radioactive 2) potentially explosive 3) compressed gases 4) unknowns 5) controlled substances

Appendix P

NON-HAZARDOUS CHEMICALS FOR DISPOSAL

Safe to Dispose Down the Drain (with plenty of water)

- 2-[4-(2-hydroxyethyl)piperazin-1-yl]ethanesulfonic acid
- allura red AC
- alpha tocopherol acetate
- ampicillin sodium
- Aprotinin
- aureomycin
- bacitracin
- benzyl benzoate
- carbopol
- cefotaxime
- chloroquine
- deoxyribonuclease 1
- deuterium oxide
- dextrose solution
- dihydroxyfumaric acid hydrate
- di-potassium hydrogen orthophosphate 3-hydrate
- erada-stain
- ethoxyehtoxy ethanol
- ethylene glycol
- fungizone
- gluconic acid lactone
- glycerol
- glycerol polyglycidyl ether
- griseofulvin
- hyaluronidase
- liquid paraffin
- maltose hydrate
- mannide mono oleate
- methyl green
- N-nitro-L-arginine
- lanolin
- oleic acid
- pegylated interferon
- peroxidase
- poly(ethylene glycol) diglycidyl ether
- poly-lysine
- propylene carbonate protease peptone
- sodium chloride solution
- soybean oil
- squalane
- streptolysin O
- tetramethylene sulfone
- tocopherol
- triacetin
- triethylene glycol
- vasopressin
- vitamins
- yeast peptone dextrose (ypd) broth

Safe to Throw out with Normal Garbage

- 1,3-diphenylisobenzofuran
- 2,2-di(4-tert-octylphenyl)-1-picryl hydrazyl
- 2-carboxybenzaldehyde
- 3-quinolinecarboxylic acid
- acetylimidazole
- adenine hemisulfate salt
- adenosine
- adenosine 5'-triphosphate,disodium salt
- agar
- agar, bacteriological grade
- agarose
- albumin
- albumin human
- albumin, bovine
- alfa-lactose
- alspha-D(+) melibiose
- alpha-methyl-mannopyranoside
- alpha-naphthyl acetate
- alumina wool
- amberlyst 15
- amino-2-naphthol-4-sulfonic acid
- aminobutiric acid
- ammonium phosphate, monobasic
- ampicilline sodium salt

NON-HAZARDOUS CHEMICALS FOR DISPOSAL

Safe to Throw out with Normal Garbage (cont'd)

- aprotinin
- anthracenecarboxylic acid
- arginine hydrochloride
- aragonite
- ascorbic acid
- ascorbate oxidase
- atipamezole hydrochloride
- azelaic acid
- bacto agar
- bacto peptone
- bacto tryptone
- bacto-levulose
- bacto-peptamin
- bacto-peptone
- barium sulfate
- b-cyclodextrin
- beef extract
- b-nicotinamide adinine dinucleotide
- biotin
- borax (sodium tetraborate)
- boron carbide
- bromo phenol blue
- brucella agar
- buthionine sulfoximine
- butylated hydroxytoluene
- calcite, crystal
- calcium acetate
- calcium borogluconate
- calcium carbonate
- calcium d-gluconate
- calcium dihydrogenphosphate monohydrate,
- calcium lactate
- calcium sulfate dehydrate
- carbamazepine
- carbon powder
- casamino acids
- catalase
- cellobiose
- cellulose
- cetyl alcohol
- chitin
- chlortetracycline
- cholesterol
- choline chloride
- chlorophenylalanine
- chlorophyllin sodium salt
- cinnarizine
- collagen
- cyanuric acid
- deoxyribonucleic acid
- dexamethasone sodium phosphate
- dextran T 500
- dextrose
- diammonium phosphate
- diastase
- dibutyryladenosine AMP
- dichlorofluorescein
- diglycidyl ether of polypropylene glycol
- dihydroxyfumaric acid hydrate
- dimethylglyoxime
- di-sodim hydrogen phosphate anhydrous
- di-sodium hydrogen orthophosphate
- dl-octopamine HCL
- domperidone
- drierite
- elastase
- ethyleneaminotetraacetic acid
- ethylenedinitrilo-tetraacetic acid disodium salt dihydrate
- europium (III) chloride hexahydrate
- ferric citrate
- ferrozine
- ficoll
- fluorobenzamide
- fructose
- fructose 6 phosphate
- fucose
- gadolinium chloride
- gelatin
- glucose
- glucose-1-diphosphate
- glucose 1 phosphate
- glucose 6 phosphate dehydrogenase
- glucose-6-sulfate (potassium salt)

NON-HAZARDOUS CHEMICALS FOR DISPOSAL

Safe to Throw out with Normal Garbage (cont'd)

- glucuronic acid
- glutamine
- glycerol 2-phosphate disodium salt hydrate
- glycine
- glycogen
- glycylglycine
- gum mastic
- hektoen enteric agar
- hemocyanin
- heparin lithium salt
- hepes
- heptakis (2,6-di-o-methyl)-b-cyclodextrin
- hexamethylbenzene
- hyaluronic acid
- hydrocortisone
- hydroxyethylpiperazine-n'-2-ethanesulfonic acid (HEPES)
- hydroxypropyl-b-cyclodextrin
- hypoxanthine
- inulin
- invertase
- isopropyl b-d-thiogalacto-pyranoside
- L-ascorbic acid
- lab-lemco broth
- lactose
- lanthanum chloride
- lauroylsarcosine
- leucylglycine
- lincocin
- lincomycin hydrochloride
- lipopolysaccharide
- lithium benzoate
- lithium citrate
- lithium tetraborate
- L-lysine
- l-(-)sorbose
- lysine monohydrochloride
- lysozyme
- mac-conkey agar
- magnesium acetate
- magnesium carbonate
- magnesium chloride
- magnesium hydroxide
- magnesium oxide
- magnesium sulphate
- magnesium sulfate heptahydrate
- malt extract
- maltose
- mannitol
- melatonin
- methyline blue chloride
- methyl-d-glucamine
- methyl-d-glucopyranose
- minocycline
- m-9 minimal salts
- molecular sieve
- montmorillonite K10
- mueller hinton agar
- mueller hinton broth
- Myoglobin
- myo-Inositol
- nanoanoyl-n-methyl-glucamide
- nickel oxide + aluminum oxide
- nigrosin
- norethindrone
- n-propyl gallate
- octanediol
- ovalbumin
- paclitaxel
- palmitic acid
- p-amino benzoic acid
- paraffin
- pectin
- pectinase (fungal)
- pepsin
- pepstatin A
- pepton from meat pepsin-digested
- perylene
- phentolamine hydrochloride
- placebo drug (sugar pills)
- polybrene (= hexadimethrine bromide)
- poly-d-lysine hydrobromide
- poly (DL-lactide-co-glycolid)
- poly caprolactone

NON-HAZARDOUS CHEMICALS FOR DISPOSAL

Safe to Throw out with Normal Garbage (cont'd)

- poly ethylene vinyl acetate
- polygalacturonic acid
- poly l lactide
- Polymethylmethacrylate powder
- polystyrene (recycle plastic 6)
- polyethylene chips
- potassium chloride
- potassium citrate
- potassium di-hyrdogen phosphate
- potassium iodide
- potato dextrose agar
- prednisone
- propane-1,2-diol (propylene glycol)
- protein a sepharose
- propylene glycol
- protease
- protease E
- protein g-agarose
- pseudomonas agar base
- pseudomonas Isolation agar
- pumice stone powder
- quinidine sulfate salt
- raffinose
- RGP peptide
- ribose
- saccharin
- saccharin sodium
- saccharose (sucrose)
- salicylic acid
- sea sand
- sephadex
- sepharose
- silica gel
- silicon monoxide
- sodium acetate trihydrate
- sodium bicarbonate
- sodium dihydrogen orthophosphate
- sodium hydrogen carbonate
- sodium hydrogen orthophosphate (= sodium dihydrogen orthophosphate,)
- sodium phosphate
- sodium phosphate dibasic dodecahydrate
- sodium phosphate monobasic
- sodium phosphate monobasic dehydrate
- sodium sulfate
- sodium thiosulphate
- soluble starch
- staplococcus medium
- starch
- starch hydrolysed
- stearic acid
- sterile water
- succinic acid
- sucrose
- syringic acid
- tannic acid
- tartaric acid
- tetramethylmurexide
- tetrathionate broth base
- thioflavin T
- thymidine
- thymolphthalein
- trehalose
- trifluoromethane sulfonic anhydride
- triple sugar iron agar
- tris (hydroxymethyl) aminomethane hydrochloride,
- trisodium citrate
- tryptone
- tryptophan
- tryptose phosphate broth
- tungsten disulfide
- uracil
- uridine
- vanadium
- vermiculite
- vitabmin B12
- Vitamin D31
- xanthosine
- xylazine
- xylenecyanol FF
- xxt sodium salt
- yeast (and extract of yeast)
- ypd (yeast media)
- zirconium oxide

UNIDENTIFIED CHEMICAL INVENTORY

Faculty/Department: _____ Contact Person (Supervisor): _____

Building: _____ Telephone number: _____

Room Number/Location: _____ Date Submitted: _____

Item Number	Container Size/Type	Approx Amount	Physical State	Approx purity	Age	Possible Identity
Mark container with Room # and this Item #	*e.g.* 4L: glass 200ml: plastic 1L: metal	estimate ml, L, grams, etc.	Solid, liquid, crystal, dust, etc.	*e.g.* as purchased, homogeneous, mixture, etc	estimate	

NOTE: Unidentified/unknown chemicals for disposal must be registered with the ESF Manager. Complete this form and faxed to 604 872-5087. Number each unknown and place in a cardboard box, clearly marked "UNIDENTIFIED CHEMICALS – DO NOT TOUCH" and store safely. Further questions - contact 604 822-6306.

SOIL AND ORGANIC MATTER PICK-UP CLEARANCE FORM

Building:	Laboratory Supervisor:
Laboratory Room Number:	Contact Number(s):
Department:	

Clearance must be obtained prior to scheduled work being carried out by Land & Building Service workers.

Possible Hazards (Note: The laboratory supervisor/user must indicate if the soil or organic matter ***contains*** or has been ***exposed*** to these items in the lab). If any of these materials are present, UBC Waste Management may arrange for alternate arrangements to ensure of proper disposal:

- ☐ Lab Chemical (i.e. any foreign organic or inorganic compounds)
- ☐ Bio-Hazards
- ☐ Leachate
- ☐ Pesticides, fungicides, etc.
- ☐ Radioactive material (i.e. isotopes)
- ☐ Vermiculite or perlite
- ☐ Other: (please specify):

Prior to the soil pick up, Waste Management Personnel and Lab Supervisor must establish:
The experimental nature of the soil and/or organic matter. Please ensure that a new form is filled out, if the materials to be picked-up have changed in nature. **A new form must be submitted for soils having undergone different experiments prior to pick-up.**

The pick-up location for drivers is on the specified date. **Please note whether this is a one-time pick-up or a recurring pick-up of materials from the same experiment.**

Laboratory Supervisor must:

Done	N/A	
☐	☐	Ensure that the contents of the bin are not filled above the **'fill line'** marked on the outside of the soil bin
☐	☐	Ensure that contaminants such as chemicals, biohazards or pure sand are not present within the organic matter to be collected. If chemicals or biohazards have been used, contact HS&E for proper means of disposal
☐	☐	Ensure that UBC Waste Management has been notified of special safety precautions required to handle the materials in the green bin (i.e. gloves, masks required?). You may be referred to HS&E or scheduled for an alternate pick-up instead

The undersigned laboratory supervisor/user hereby verifies that the collected material is free of biohazardous, chemical or radiation contamination and that all other hazards are appropriately controlled.

Name	Position and **Contact Information** (phone, email)
Date	Signature

Plant Operations: Sign off the form below ***before*** the material has been collected

Name	Position and Contact Information	WO#
Date	Signature	

Please submit signed copy to UBC Waste Management office
Fax 604 822-5209 or 604 822-6969