Brock University

Laboratory Safety Manual

2022

Table of Contents

INTRODUCTION

Laboratory operations and its environment pose risks to the occupants derived from the wide range of hazardous materials present and the activities conducted in them. This manual addresses chemical and general lab hazards. Other manuals are available that address biohazards and radiation hazards.

This manual covers the general responsibilities and the practices and procedures that shall be followed by the occupants of science labs, whether for teaching or research, to minimize hazards-associated risks. Research experiments that are unique complex, and field-specific place primary responsibility on the principal investigator, who must identify and assess risks and implement practices or procedures beyond those covered in this manual.

Many laws, policies, and standards regulate the way in which safe laboratory operations must be conducted. In addition, there are guidelines and best practices that are applied in many organizations and have become standards of practice. Below are listed the most significant such items which this manual is based on.

Federal and Provincial Jurisdiction

- Occupational Health and Safety Act, R.S.O. 1990, c. O.1.
- Regulation for Industrial Establishments (O. Reg. 851).
- Control of Exposure to Biological or Chemical Agents (O. Reg. 833).
- Workplace Hazardous Materials Information System (O. Reg. 860).
- O. Reg. 490/09: Designated Substances.
- R.R.O. 1990, Reg. 861: X-Ray Safety.
- Environmental Protection Act, R.S.O. 1990, c. E.19.
- Hazardous Products Act (R.S.C., 1985, c. H-3).
- Hazardous Products Regulations (SOR/2015-17).
- Controlled Drugs and Substances Act (S.C. 1996, c. 19).
- Controlled Drugs and Substances Act (Police Enforcement) Regulations (SOR/97-234).
- Transportation of Dangerous Goods Act, 1992 (1992, c. 34).
- Transportation of Dangerous Goods Regulations (SOR/2001-286).

Brock University Jurisdiction

- Occupational Health and Safety Policy. (https://brocku.ca/policies/)
- Code of Conduct Policy.
- Respectful Work and Learning Environment.
- Workplace Violence Prevention.

Through these Policies, Brock University expresses its commitment to the health and safety of its community members and to taking every reasonable precaution to protect them from injury and

occupational illness. Likewise, the University is committed to providing a respectful work and learning environment and in complying with all applicable laws, policies, and procedures.

RELEVANT CONTACTS

Service/Department	Phone # Extension	Email Address	Web Address
Brock Board	905 688 5550		https://brocku.ca/directory
Campus Security Services (Emergencies)	x 3200		https://brocku.ca/campus-security/
Campus Security Service (General inquiries)	x 4300	security@brocku.ca	https://brocku.ca/campus-security/
Campus Security- campus - wide phone failure	905-688-6300		
Health, Safety and Wellness	x 7233	besafe@brocku.ca	https://brocku.ca/human-resources/health-safety-and-wellness/ https://brocku.sharepoint.com/human-resources/Pages/Health%20Safety%20and%20Wellness.aspx
Lab Safety Specialist	x 6179	lvistorte@brocku.ca	https://brocku.sharepoint.com/human-resources/Pages/Academic%20Safety.aspx
Lab safety coordinator	x 3284	cbucciarelli@brocku.ca	https://brocku.sharepoint.com/human-resources/Pages/Academic%20Safety.aspx
Custodial Services	x 3508	custodial@brocku.ca	https://brocku.ca/facilities-management/custodial-grounds/
Electronic Shop (equipment servicing)	x 3419	tommacd@brocku.ca	
Environmental Safety and Hazardous Waste	x 5390	etodd@brocku.ca	https://brocku.sharepoint.com/human-resources/Pages/Environmental%20Safety.aspx
Facilities Management (Maintenance and Operations)	x 3717	facmgmt@brocku.ca	https://brocku.ca/facilities-management/
Machine Shop (equipment servicing)	x 3420	srenda@brocku.ca	
Science Stores (Hazardous waste disposal & purchases)	x 3407	sciencestores@brocku.ca	https://brocku.ca/mathematics-science/services/science-stores/

Abbreviations

ACC	Animal Care Committee
AED	Automated External Defibrillator
ASC	Academic Safety Committee
BSC	Biosafety Cabinet
BSO	Biosafety Officer
BUSU	Brock University Students' Union
CAD	Council of Academic Deans
CCOHS	Canadian Centre for Occupational Health and Safety
CL	Containment Level
CNSC	Canadian Nuclear Safety Commission
CPR	Cardiopulmonary resuscitation
CRN	Cairns' Family Health and Bioscience Research Complex
CSS	Campus Security Services
CWC	Chemical Weapons Convention
CWCIA	Chemical Weapons Convention Implementation Act
DHHSI	Deaf, Hard of Hearing or Speech Impaired
DOCs	Discrete Organic Chemicals
EtBr	Ethidium bromide
FAS	First Aid Station
FIPPA	Freedom of Information and Protection of Privacy Act
FM	Facilities Management
HR	Human Resources
HSW	Health, Safety and Wellness

HVAC	Heating, Ventilation and Air Conditioning
IPA	Isopropanol
JHSC	Joint Health and Safety Committee
MC	Mackenzie Chown
MOE	Ministry of Environment
MSDS/SDS	(Material) Safety Data Sheet
OHSA	Occupational Health and Safety Act
PEG	Polyethylene glycol
PHAC	Public Health Agency of Canada
PPE	Personal protective equipment
RCR	Responsible Conduct of Research
RG	Risk Group
RSO	Radiation Safety Officer
RTW	Return to Work
SAC	Senior Administrative Contact
TDG	Transportation of Dangerous Goods
TLV	Threshold limit value
VP	Vice President
WHMIS	Workplace Hazardous Materials Information System
WSIB	Workplace Safety and Insurance Board

Niagara Region Important Numbers

- EMERGENCIES - Medical, Fire, Police 911

Members of the DHHSI (Deaf, hard of hearing or speech impaired) Community in Niagara Region can use the service of Text with 9-1-1 (T9-1-1) which enables communications between operators and the community member by text messaging when Police, Fire Department, Niagara EMS, or Niagara Parks Police response is required. You must be:

- Registered for T9-1-1 with the DHHSI subscriber's cell phone company in advance
- Capable of sending and receiving text (SMS) messages and have a service package that includes text messaging
- Connected to a cellular network
- Details here: https://www.textwith911.ca/en/home/

SECTION 1. EMERGENCIES RESPONSE AND ACCIDENTS

The main laboratory supervisor (eg. Principal Investigator /Professor /Instructor) must prepare their laboratory personnel for emergencies, such as injuries, fires or explosions, chemical spills, floods, and power failures. Preparation for emergencies shall include having a response plan for all lab personnel, obtain response kits and materials, and practice responses.

Fire Safety within the University delivers periodic drills and exercises, including "tabletop" discussions that lab personnel should participate in to keep knowledge current and be prepared.

ESSENTIAL FIRST AID KNOWLEDGE AND TRAINING

A basic knowledge of first aid procedures is essential for working anywhere where there is a significant risk of accidents, such as in laboratories and workshops. Recreation Services offer Standard First Aid/CPR training for a price. Various sessions are offered throughout the year. Visit their webpage for more information or to register for a session.

There are various First Aid Stations (FAS) across the campuses, listed below. Get familiar to the ones closer to your regular areas of work and study. Some stations are available during only office hours, i.e. 8:00 am- 4:30 pm on weekdays. Outside of these times call Campus Security at **x 3200.**

The stations where external automatic defibrillators are available are marked in the map available onsite with a red heart symbol (see map on pg. 19). When no AED is present at the physical location of the FAS there is wording indicating where is the closest one.

Table 1. Location of First Aid Stations and AED near labs areas. For updates click this *link*.

Building/Location/Area	First Aid Station	AED Location(s)
Central Utilities Building (CUB)	Lunchroom 107	Ground floor by 113
Robert S.K. Welch Hall	Instructional Resource Centre (IRC)	Basement Lobby WH 60
MacKenzie Chown Complex	D Block 202A F Block 237A	D Block 200 level by Pond Inlet
Thistle Complex	Audio Visual Services 235	
Schmon Tower	Library Staff Room 200 level	
Schmon Tower	CACF215 behind Campus Security sub office	
Scotia Bank Hall	Computer Commons Front Desk - Fish Bowl	North lobby wall beside Computer Commons
573 Glenridge A	Photocopy room 110	On brick wall in vestibule ground floor
573 Glenridge B - International Building	Staff Lounge room 203	North Entry Vestibule 101
Cairns Building	Child & Youth Studies Lunchroom	Level 2, Level 4, Level 5, and CL3 facility (level 5)

Building/Location/Area	First Aid Station	AED Location(s)
Cairns Building	West lounge level 400	Level 2, Level 4, Level 5, and CL3 facility (level 5)
Cairns Building	West lounge level 500	Level 2, Level 4, Level 5, and CL3 facility (level 5)
Plaza Building		Level 2 West hallway by the elevator, Level 3 Corridor West hallway by the elevator
Academic South	Faculty and Staff Lounge Room 358	
BRIC	Lunch Room 120	Level 100 entry vestibule
Marilyn I. Walker School	Campus Security room 161	Lobby outside Campus Security Office
Walker Complex	FIRST AID ROOM – ATHLETIC THERAPY ROOM 137	West wall near the men's change-room
Campus Security Vehicle	Trauma first aid bags in each campus security vehicle	CSS Vehicle #86 CSS Vehicle #89
Harrison Hall		Student Health Services Mobile Emergency Kit
BUSU		Student Alumni Centre
Student Health Services		Brock Pharmacy

GENERAL EMERGENCY PROCEDURE

- Call Campus Security at **ext. 3200**, 24 h/day, 365 days/year and 911. Where possible use a landline due to the ability for Campus Security to identify a caller's location. If the 911 call is made by a cell phone they cannot know the location of the call. A follow up call to campus security should be made.

- Even when you call 911 or other external responders ensure you call Campus Security and they will direct off-site responders to the exact location of the problem, assist, and also call Brock personnel as needed. Police, Fire, Ambulance are not always familiar with our campus, nor do they have access to spaces.

- Campus Security staff are all trained First Responders including the application of automated external defibrillators (AED). They will start first aid if emergency responders are delayed.

- Be prepared for what to do if you need to quickly evacuate your lab! Consult emergency procedures for specific events, described in this section.

MEDICAL EMERGENCY AND FIRST AID

In the event of an injury or a medical emergency:

- Call 911 and Campus Security at **ext. 3200** (or have someone who can call); in the meantime, proceed as follows.

The person best trained on first aid on a scene of an incident takes command of the emergency procedure. The safety of people is the priority. Quickly try to determine if there is risk of explosion or similar catastrophe. If that is the case, immediately evacuate everyone and yourself after.

If the quick assessment dictates that there is time for action, proceed as follows:

- If the injured is conscious, identify yourself and offer to assist.
- Assess the cause of the accident and how the situation may have occurred. If possible to safely do so, remove the cause danger and remove any injured person from the danger.
  EXCEPTION! If a neck or spinal injury is suspected, **do not move** the injured person until paramedics arrive.
- Instruct injured person to lie still (if conscious); offer reassurance, and support. Cover with a blanket if cold and use words that provide comfort and a sense of calm.
- Assess the following on the injured.
  - Level of consciousness.
  - Is the airway open? Is breathing present?
  - Is there severe bleeding? Do they have a pulse?
- Send for help -as needed- and have the helper return to the scene and report to you. Provide this information to the designated person:
  - Your identity.
  - Description of suspected accident circumstances.
  - Exact location of emergency.
  - Number of injured persons.
    - Type(s) of injury.
    - Condition of the injured.
  - Direct phone number where you can be reached, if applicable.
- If you are trained in First Aid, provide first aid assistance until first responders arrive.

Critical Injury and Fatality

- In the event of a Critical Injury (defined below), immediately contact Campus Security at **ext. 3200**. Indicate that there has been a critical injury or fatality.
- Describe the emergency and the location. Provide any necessary first aid within your capabilities. Follow the instructions described in prior section. Do not move injured person unless in immediate danger.
- Remain with injured the person until help arrives.
- Do not further alter the scene unless for:

  - saving life, relieving human suffering, maintaining essential public utility or transportation service, preventing unnecessary damage, or unless instructed by the authority having jurisdiction, i.e., Ministry of Labour Inspector.
- Await arrival of Campus Security staff and; remain available in a safe location in case further information is required.

An injury is defined as a Critical Injury when:

- Places life in jeopardy.
- Produces unconsciousness.
- Results in substantial loss of blood.
- Involves the fracture of a leg or arm but not a finger or toe.
- Involves the amputation of a leg, arm, hand, or foot, but not a finger or toe.
- Consists of burns to a major portion of the body.
- Causes the loss of sight in an eye.

Chemical Contact with Eyes

- Proceed to the closest emergency eyewash station immediately and activate (turn the handle).
- Hold eyelids apart and flush the eye(s) with copious amounts of running water for a minimum of 15 minutes. If a tap or hose is used, direct water flow on the bridge of the nose; water will run into the eyes.
- Seek medical attention and bring the Safety Data Sheet.

Figure 1. Eyewash station. Hold eyelids open!

Asphyxiation

- If safe to do so, remove the injured person from the area.
- Loosen tight-fitting clothing.
- A person trained in CPR should monitor the victim's airway and vital signs.
- Seek immediate medical attention, **call x 3200** or **911**.

Small Cuts and Animal Bites

- Wash abundantly with a mild soap.
  - Allow the wound to bleed freely.
- Apply a disinfecting solution and bandage the wound.
- Attend a medical facility based on the level of risk.

Significant Wounds

- If wound was caused by a contaminated object/animal, allow to bleed freely for a few seconds.

- Apply pressure to the wound with a sterile pressure dressing. When there is an object protruding from the wound, apply pressure around the wound.
- If bleeding can be stopped, cleanse and dress the wound and seek medical attention, based on the level of risk. If in doubt, seek medical help.
- Advise medical staff if there was a contaminant whether chemical or biological and bring SDS.

Special Category of Injury. Exposure to Hydrofluoric Acid Procedures

Hydrofluoric Acid exposure requires immediate and specialized first aid and medical treatment. First aid must be followed by treatment by a physician as soon as possible. In all cases, while the victim applies first aid, someone call 911 and Campus Security at ext. 3200. Prompt first aid is essential even in the absence of pain and of signs or symptoms. Initiate first aid even if contact with low concentration solutions is suspected.

Eye Contact

- Immediately flush for at least 15 minutes. Hold upper and lower eyelids open during irrigation.
- Do not apply calcium gluconate gel to the eye.
- Remove contact lenses, if possible. Continue flushing with an eyewash or apply ice water compresses during transport to medical facility.
- Avoid rubbing of the eyes.
- Attend an emergency medical facility immediately.

Skin Contact

- Immediately proceed to the nearest safety shower to wash the contaminated area with copious amounts of running water for a minimum of 5 minutes if calcium gluconate gel is available, otherwise run the shower for 15 min. Speed and thoroughness in washing off the acid is essential. Remove all contaminated clothing while rinsing. Any clothing that must be pulled over the head is to be cut off the body instead.
- After rinsing, wear protective gloves and apply calcium gluconate gel; massage the gel into the contact site and adjacent area. If assistance is required in applying the gel, the person assisting should wear gloves to avoid a secondary burn. Apply gel frequently (every 15 minutes) and continually massage into skin. Continue until at least 15 minutes after pain is relieved or until medical treatment is provided. Continue applying gel during transport to a medical facility. The gel will turn white upon reaction with the acid.
- Attend an emergency medical facility immediately.

Inhalation

- Remove victim to fresh air and call x 3200 Campus Security and 911.
- Keep victim warm, comfortable, and quiet.
- Oxygen should be administered by medical personnel as soon as possible.

Ingestion

- Have victim drink large amounts of room temperature water as quickly as possible to dilute the acid.
- Drink several glasses of milk or several ounces of Mylanta, Maalox or milk of magnesia, or antacid tablets (all contain calcium or magnesium which act as an antidote).
- Do not induce vomiting, do not give emetics or baking soda or any bicarbonates, the carbon dioxide by-product could further injure the victim.
- Do not give anything by mouth to an unconscious person.
- Attend an emergency medical facility immediately.

Phenol, Trizol, Chloroform Contamination

Inhalation

1. Remove victim to fresh air.
2. Get medical attention immediately. Bring SDS.

Skin Contact

1. Immediately flush skin with large amounts of soapy water or plain water under an emergency shower.
2. Remove contaminated clothing and shoes while under the shower.
3. As soon as possible, apply isopropanol (IPA) or polyethylene glycol (PEG) 300 or 400 to the affected area.
4. Get medical attention immediately*.

Eye Contact

1. Immediately flush eyes with water under an eyewash for 15 minutes.
2. Get medical attention immediately*.

Cyanide Contamination

Inhalation

1. Remove from contaminated zone and get immediate medical attention.

Skin contact

1. Immediately flush with copious amounts of water under an emergency shower.
2. Remove all clothing and shoes while under the shower.
3. Get medical attention immediately. Bring SDS.
4.

Eye Contact

1. Immediately flush eyes with water under an eyewash.
2. Get medical attention immediately. Bring SDS.

FIRE EMERGENCY PROCEDURES

Individuals are responsible for themselves and anyone they are supervising at the time the alarm sounds.

If You Discover a Fire

Shout

1. Activate the nearest Fire Alarm Pull Station to begin building evacuation.
2. Warn others immediately to leave the building at the nearest safe exit or fire stair.
3. Attempt fire suffocation with a cover or extinguisher ONLY if safe (small, contained fire & exit route clear) and able, up to 1 minute maximum, otherwise
4. Leave the fire area and close doors; **do not lock**!
5. Call Emergency Services – **911** - from a safe location to ensure response and then Brock Campus Security **x 3200** to advise of location/circumstance.

Whenever You Hear a Fire Alarm at Brock

Get Out

1. Close doors behind you – DO NOT LOCK - Leave building via closest safe Exit or Fire Stair.
2. NEVER use elevators.
3. If you encounter fire or smoke in the Fire stair, cross-over where possible to use an alternate Fire Stair/Exit.
4. Help mobility impaired individuals to exit or to a pre-planned safe area of refuge, preferably a fire stair landing or an enclosed, fire-rated space near the fire stairs and then advise an Emergency Warden, Campus Security member or Firefighter of their location.
5. Once evacuated, keep a safe distance, 30m, from exit or proceed into an unaffected building.

Stay Out

1. Do not re-enter building until so authorized by the Fire Department, Campus Security Services, the Building Warden Coordinator, or a Brock Emergency Warden (regardless of alarm bell status).

Persons Requiring Assistance Emergency Procedures

Whenever You Hear a Fire Alarm at Brock & You Are Unable to Evacuate

If there is no fire, smoke or unsafe conditions on the floor.

- Attend the AREA of REFUGE nearest to your work area, generally at an exit stairwell, and await further directions from the first responders or your Emergency Warden.
- Do not leave your floor area unless there is an unsafe condition or directed to do so.

If conditions worsen, you may use the RED Firefighters Phones located immediately outside the exit stair to report your location or conditions on the floor. These phones provide a direct connection to the main fire alarm panel located in the lobby CACF room during all alarm conditions.
To use these phones:

- Break or remove the glass insert, and life receiver off cradle.
- Approximately 10 – 20 second delay to connect (will hear what sounds like a "busy" signal).
- Advise the individual on the other end your condition and situation.

In addition to the Red Firefighter phones, some Areas of Refuge are instead fitted with a yellow Emergency Phone; these are 2-way voice communication call box that is a direct connect to Campus Security Services, 24x7.

- If conditions worsen, move inside the Exit Stair and use the Yellow Emergency Phone to report this, ensuring that the stairwell door remains closed.
- These 2-way voice communication Emergency Phones are a direct connect to Campus Security Services, 24x7, advise the individual on the other end your location and circumstance.

Faculty and staff are responsible for anyone they are supervising at the time of an emergency. They must help any person requiring assistance to evacuate or transition to an Area of Refuge. Any person, especially persons requiring assistance, should develop a plan in advance for evacuation routes and the employer should be provide information on plans in place to ensure their safety during emergency situations.

- Additional information about roles and responsibilities during an emergency can be found in the Fire Safety Manual.

PROCEDURES FOR ALARMS IN MC G200

The room MC G200 houses the liquid nitrogen generator and many cylinders of compressed substances, some of which are hazardous. Therefore, the room is suited with sensors to detect when leakage or spill occur. When elevated concentration of chlorine, carbon dioxide, nitric oxide, as well as a low concentration of oxygen are detected, sound and visible alarms will be activated. For details on the room set up refer to The Gases Monitoring System in MC G200.

Follow the procedures below if you are in MC G200 or its vicinity and see or hear an alarm in the room:

Stage 1 Alarm

The stage 1 alarm is evident from within the room only. It does not pose a risk to persons outside of the room.

1. ROOM USER: upon activation of the audible alarm and clear strobe light in the room all room users will:
    a) STOP any activity (except if liquid nitrogen spillage. See below)
    b) EVACUATE the room,

c) CALL Campus Security at 3200 to notify of any known or potential cause of the alarm from a safe location.
d) DO NOT leave the area and meet Campus Security Services at the H-Block fire alarm panel, or at a safe place agreed to by CSS.

2. CAMPUS SECURITY SERVICES: upon receipt of an alarm via pager or upon notification of an alarm within G200 CSS will:
   e) Attend the location and IF persons are still within the room as seen from the viewing window, advise them to immediately evacuate the room.
   f) Arrange a safe location to meet the room user and obtain details as to the cause (if known). When the alarm clears release the room user.

   NOTE: you will know that the alarm has cleared when the strobe inside the room can no longer be seen pulsing and the audible tone have stopped.
   g) For ALL G200 alarms notify Health Safety and Wellness at besafe@brocku.ca

NOTE: If you create a liquid nitrogen spill while dispensing liquid nitrogen, there may be an alarm generated in the room or outside the room.

(1) stop dispensing immediately by closing the valve,

(2) move away from the cloud that will be created until it dissipates, and the sound alarm stops,

(3) if there is a technical problem, call the machine shop during daytime hours at x3420 or campus security x3200 after hours,

(4) when the alarm stops, and the oxygen sensor registers a value between 20-21% you may resume dispensing.

Stage 2 Alarm

Stage 2 alarm is visible and audible from within and outside of MC G200.
DO NOT ENTER the room. Only the Fire Department may enter during an active S2 alarm in MC G200.

1. CAMPUS SECURITY SERVICES

   FOR ALL ALARMS: Upon receipt of a STAGE 2 alarm via pager or upon notification of an alarm within G200 CSS will
   a) Immediately contact 911 providing details of the alarm, and the type of gas released and any other relevant information on possible cause.
   b) Attend the scene and through the viewing window identify if there are any persons within the room.
   c) Remain at or near the room ensuring that no person enters the room.
   d) Call Health Safety and Wellness and email at besafe@brocku.ca and the Praxair emergency line at 1-800-645-4633.

e) In consultation with the Fire Department, determine if evacuation of adjoining blocks is necessary, ie. G-Block, F-Block and all or portions of H-Block.

NOTE: for ALL Stage 2 activations, responders will see a RED strobe light activated on the outside of the room and hear a loud sound as they approach.

FOR OXYGEN ALARM ONLY: In addition to the previous step,

f) CSS will look through the glass window for signs of liquid nitrogen spillage (a cloud or liquid on the floor around the nitrogen generator).
g) If you identify a liquid nitrogen spill, call Machine Shop personnel: daytime ext. 3420, or nighttime contacts.

2. HEALTH, SAFETY & WELLNESS
   a) Liaise with Campus Security Services and the Fire Department in determining the circumstances of the spill and notify the Spills Action Centre (MOE) by calling 1-800-268-6060.
   b) If the spill was caused by a defective or leaking cylinder, call Praxair (if CSS has not done so already) and coordinate the recovery of damaged cylinders and spill clean-up.
   c) Determine whether there has been a "critical injury"; if so determined:
      — Immediately notify the Ministry of Labor by phone 1-877-202-0008 or TTY: 1-855-653-9260 or Fax: 905-577-1316.
      — Notify the Joint Health and Safety Committee, and trade union representative when applicable
   d) Conduct an investigation on the cause of the spill and any propitiating or aggravation conditions, and implement actions based on the investigation results in order to prevent future spills.

1. EXHAUST FAN FAILURE ONLY. Upon receipt of an EXHAUST FAN FAILURE (MCG200 EF#1 Failure) message via pager in G200 CSS will ONLY:
   a) Notify the On-Call Facilities Tech.
   b) email Health Safety and Wellness at besafe@brocku.ca.

[Table of Contents]

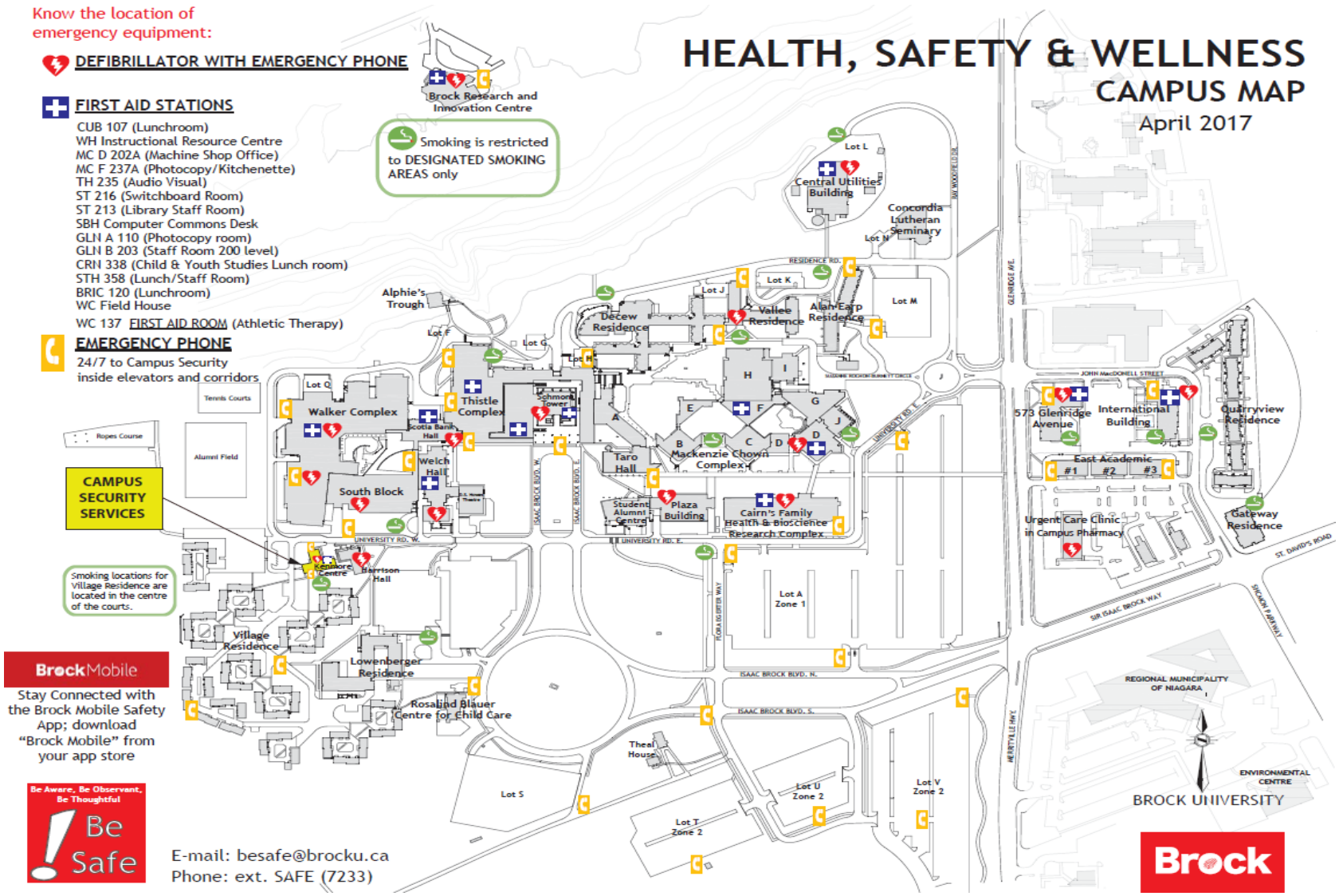


Table 2. Health & Safety and Emergency devices/services locations. For updates click here.

[Table of Contents]

GENERAL CHEMICAL SPILL PROCEDURES

ATTENTION! **If there is immediate risk to your health or safety or if this is not a simple spill evacuate the area, close the door, and call Campus Security ext. 3200. Do not attempt to stop or contain the spill.**

If this is a **simple lab spill**, proceed as indicated below.
Simple lab spill defined: (1) it poses a risk to the health and safety that can be controlled by wearing a lab coat, gloves, spill goggles, and/or respirator, (2) its spread can be controlled quickly or does not spread rapidly, (3) it does not endanger the environment. If the toxicity of the spilled chemical is unknown, then it is not considered a simple spill.

Chemical Spill on Body General Immediate Procedures

1. Use the nearest emergency shower and under running water remove contaminated clothing and shoes, and shower for 15 min. Any clothing that must be pulled over the head is to be cut off the body instead.
2. In the event of splash to the face/eyes, go the nearest eyewash station and flush for 15 min.

EXCEPTION! **Do not apply water to burns from any metals** such as sodium, potassium, calcium, magnesium, and aluminum, etc.

3. Evacuate non-essential personnel from spill area. Alert personnel in adjacent areas.
4. Get medical attention for injured personnel:
   - For major injuries, call Campus Security at x3200 for an ambulance.
   - For minor injuries of students, go to the Student Health Services (Harrison Hall) during office hours.
   - After office hours and for workers, go to the emergency room or family physician.
5. Attempt to stop any release of chemicals into the environment at floor drains by placing sufficient absorbent material on the spill.
6. Seek medical attention should a reaction to the spill develop or persist.
7. Notify the lab supervisor immediately.

General Chemical Clean-Up Procedure

ATTENTION! **When a flammable or oxidizing substance has been spilled, turn off all sources of heat and ignition. Turn on and open all fume hoods in the lab to speed up the air exchange in the room.**

1. **Wear the appropriate Personal Protective Equipment** (PPE), including gloves of resistant material, lab coat, spill goggles, and a respirator if the circumstance require ie. the spilled chemical releases hazardous fumes, vapors.
2. **Control:** Control the source of the spill, when possible and safe to do so, eg. a bottle which was knocked over may still contain some material, and then carefully place the container upright on an absorbent pad in a safe location and replace its lid.

- Attempt to stop any release of chemicals into the environment at floor drains or down sinks by placing sufficient absorbent material around the perimeter of the spill, between the drain and the spill or around the drain.
- Control the spread of the material by placing enough absorbent material around and on the spill.

NOTE: If material does enter the drain, once you have controlled the spill and minimized the amount that enters the drain contact Health, Safety & Wellness by calling **x 7233** or emailing besafe@brocku.ca. If the spill occurs after hours contact Campus Security **x 3200**.

3. **Absorb:** Apply enough quantity of absorbent pads/kitty litter/cellulose, as to soak up all the spill. Start on the outer edge, then move inwards in a circular fashion.

Clean the affected area with a mild soap and water, if the spilled material is not water reactive.

4. **Neutralize:** When the spilled material is a strong corrosive/caustic, neutralize residues after it has been absorbed and prior to the final clean up with soap and water.

***NOTE*:** for the case of some acids that are also flammable or oxidizers and can start a fire if in contact with organic matter and when such fire may produce irritating or poisonous gases, the Lab Supervisor must develop special spill procedures and stock appropriate spill kit materials.

Third Party Spill Response

Third party spill responders will be required in the event of a complex spill. This include but is not limited to:

a) there is a risk to the room occupants that cannot be mitigated by wearing personal protective equipment such as gloves, spill goggles, lab coat and respirator,
b) the spill spread cannot be contained,
c) the identity of the spilled chemical is unknown.

During regular office hours (8:00 am to 5:00 pm Monday to Friday) RPR Environmental Services will have staff available to offer emergency advice.

After these hours RPR Environmental has staff on call and will be able to provide 24-hour emergency spill response. They can respond to any type of spill but specialize in hazardous chemical spill response. They are currently covered under a contract as our hazardous waste disposal vendor.

Daytime emergency advice (8-5 Monday-Friday): 905-662-0062

24 Hours Emergency response: 905-521-4097

Spills that reach the drain are to be notified to the Ministry of Environment; vacuuming the drain may be required depending on the hazard posed to the environment by the chemical. When the spill reaches the drain, contact the Environmental Health and Safety Specialist at Brock University at ext. 5390.

Spill Kits

Spill kits can be found in every lab in Cairns and on the 2nd and 3rd floors of Mackenzie Chown D and H blocks. They contain Brock's Spill Procedures provided by HSW. However, each facility or department should make the determination of any specific spill response procedures or materials relating to the

hazards or conditions that could occur in each work area. Each spill kit should be checked regularly and restocked as needed by those who would use that area's kit as coordinated by the department and should be appropriate for the types of hazardous chemicals used in the area. Minimum contents may include:

- Chemical resistant gloves (neoprene, nitrile, etc.)
- Absorbent materials (spill pads, powders, etc.)
- Safety goggles and/or chemical resistant face shield
- Disposal bags
- Neutralizing agents (see below)
- Hand-held brush and plastic dustpan
- Disposable lab coat

Table 3. Neutralizing Agents

ACIDS Sodium Bicarbonate (Baking Soda), sodium carbonate, or calcium carbonate.	FORMALDEHYDE/FORMALIN Absorbent pads or commercially available formaldehyde spill neutralizer.
ACID CHLORIDES AVOID water and AVOID Sodium Bicarbonate Absorbent Pad.	HYDROFLUORIC ACID Neutralize with sodium bicarbonate or magnesium oxide (or absorb spill with special HF spill pillow, standard spill pads will not work). Absorb with inert absorbent material. Apply Calcium gluconate gel (2.5%) for skin contact.
ALKALI METALS (Li, Na, K, Mg) Class D fire extinguisher. AVOID contact with water. If possible, dispose of by slow addition of isopropanol.	MERCURY Mercury amalgamate powder, such as Merc-sorb.
BASES/CAUSTICS Sodium bisulfate.	OXIDIZERS Non-combustible absorbent pads.
BROMINE 5% solution sodium thiosulfate, inert absorbent material.	SOLVENTS (ORGANIC) Inert absorbent.
CHLOROFORM/PHENOL Isopropanol (IPA) or polyethylene glycol (PEG) 300 or 400 for skin contact.	THIOLS/MERCAPTANS The odor of thiols and mercaptans can be removed with activated charcoal.
FLAMMABLES Activated charcoal, sand or non-combustible absorbent pads.	WHITE OR YELLOW PHOSPHORUS Blanket with wet sand or wet absorbent.

5. **Remove broken glass.** Using tongs, a dustpan and a brush remove pieces of glass and place them in an appropriate container. DO NOT use hands to handle glass directly.
6. **Inspect.** Carefully check the entire affected area for spilled residue, hidden contamination or unsafe conditions and act accordingly.

7. **Package Spill Residues.** Place all spill residues and contaminated PPE in plastic bags. Seal the bags and place where you normally would the solid waste. Attach a properly completed yellow Chemical Hazardous Waste Label on the outside of the container. Register the waste with Sciences Stores for removal during next hazardous waste removal day, following established waste disposal procedures.
8. **Restock Spill Supplies**. Gather and restock supplies as needed from Sciences Stores.
9. **Report the spill** to the lab supervisor. Fill out an Injury/Incident Report Form. The supervisor completes the last page of the form and email it to besafe@brocku.ca within 24 hours of the spill occurring. If not possible, based on unresolved health and safety issues, report it as soon as possible. The laboratory supervisor shall take all steps to complete reporting as reasonably soon as possible.

SPECIAL SPILL PROCEDURES

Hydrofluoric Acid Spill

IMPORTANT: personnel contamination with HF is to be treated immediately following this procedure.

the procedure below deals with spills that do not involve personnel contamination.

Hydrofluoric Acid spills will be cleaned by the lab users if the amount is equal or below 100 ml. If above 100 ml, call Leila Vistorte at **ext. 6179** or Health, Safety and Wellness at **ext. 7233** during office hours. After 4:30 pm, call Campus Security at **ext. 3200**.

1. Alert supervisor and personnel in the immediate area and evacuate personnel that is not indispensable. Keep one other person in the room to assist in case of need. Post a signage on entry door(s): "DO NOT ENTER. Hydrofluoric Acid Spill Clean Up in Process".
2. Bring the spill kit. Wear face shield over safety goggles, HF gloves and lab coat and apron.
3. Contain and neutralize spill by carefully and slowly spreading HF neutralizing powder outside spill area, working inwards. DO NOT BREATH IN vapors or fumes that may be generated. Alternatively, slowly spray with liquid HF neutralizer starting around the edges working inwards.
4. Isolate spill area by delineating with caution tape and posting signage “Danger: Hydrofluoric acid spill”.
5. Allow sufficient contact time as recommended by the manufacturer. Verify that neutralization is complete by using pH strips or observing the color change called for the specific neutralizer used.
6. Repeat the neutralization treatment until all acid residues are neutralized.
7. If any liquid neutralizer was used, cover the treated spill with absorbing pads (grey pads as it does not react with HF, from Science Stores). Add sodium bicarbonate or magnesium oxide to any absorbent and place in a plastic container/bag for disposal.
8. Wash the spill site with a sodium bicarbonate solution.
9. Collect HF clean-up waste and all materials used in the cleanup in a sealed plastic container/bag. Label “HF clean-up waste” following university waste procedures. See the section on waste above.

10. Rinse off all PPE used during clean-up with copious amount of water. Immerse in a saturated solution of calcium carbonate for a while. Rinse again with clean water.
11. When the emergency has been resolved, report the spill to the lab supervisor. Fill out an Injury/Incident Report Form. The supervisor completes the last page of the form and email it to besafe@brocku.ca within 24 hours of the spill occurring. If not possible, based on unresolved health and safety issues, report it as soon as possible. The laboratory supervisor shall take all steps to complete reporting as reasonably soon as possible.

Mercury Spills

ATTENTION! Mercury is very toxic. Avoid getting in contact with mercury. If about a pound of mercury spilled or there is aerosolization of mercury, EVACUATE THE AREA, close the door, and call Campus Security ext. 3200. Do not attempt to stop or contain the spill.

When mercury spilled on a heated surface immediately:

- Shut off the room's ventilation system to prevent the spread of mercury vapor to the rest of the building.
- Turn down the thermostat to slow the release of mercury vapor into the air.

Mercury spills other than the situation described above shall be treated as follows:

1. Alert the supervisor and personnel, evacuate the room and post a signage on entry door(s): "DO NOT ENTER. Mercury Spill Clean Up in Process". Only personnel cleaning up are allowed in.
2. Wear protective clothing and gloves- nitrile, vinyl and natural rubber are appropriate.
3. Minimize spread of the spill to the extent possible. Quickly block or contain the size and spread of a spill by placing absorbing material, such as sand, vermiculite, inert absorbent, spill pillows, berms around the perimeter and around drains.
4. Use a mercury spill kit when available.
5. Clean up mercury beads immediately with an aspirator bulb, medicine dropper or a mercury sponge. Do not use vacuum cleaner.
6. Use forceps or tongs to handle broken materials and place them in a properly labelled sharps container.
7. If using an eyedropper or aspirator bulb, slowly and carefully squeeze mercury into in a zip locking bag or directly into a sealable container. Secure and dispose as hazardous waste.

NOTE: Mercury can move long distances on hard-flat surfaces, so be sure to inspect the entire area, including any cracks in the floor, when searching. In a darkened room hold a flashlight at a low angle close to the floor and look for additional glistening beads of mercury that may be sticking to the surface or in small cracked areas of the surface.

8. If mercury has broken up into too many smaller globules, or got into small crevices and cracks, sprinkle with sulphur powder or commercial product and leave for several hours before cleanup.
9. Dispose of all cleanup materials as hazardous waste. Waste must be properly packaged, sealed and labelled with hazardous waste label. Refer to Chemical Waste Disposal Procedures.

10. When the emergency has been resolved, report the spill to the lab supervisor. Fill out an Injury/Incident Report Form. The supervisor completes the last page of the form and email it to besafe@brocku.ca within 24 hours of the spill occurring. If not possible, based on unresolved health and safety issues, report it as soon as possible. The laboratory supervisor shall take all steps to complete reporting as reasonably soon as possible.

What **NEVER** to Do After a Mercury Spill

- **NEVER** use a vacuum cleaner to clean up mercury. The vacuum will put mercury into the air and increase exposure.
- **NEVER** use a broom to clean up mercury. It will break the mercury into smaller droplets and spread them. [Table of Contents]
- **NEVER** pour mercury down a drain. It may lodge in the plumbing and cause future problems during plumbing repairs. When discharged, it can cause pollution of the sewage treatment plant.
- **NEVER** walk around if your shoes might be contaminated with mercury. Contaminated clothing can also spread mercury around.

Cyanide Spills

ATTENTION! Cyanide is very toxic. Avoid getting in contact with cyanide.
DO NOT USE PLAIN WATER to clean up a cyanide spill. The reaction of water with cyanide compounds forms HIGHLY TOXIC hydrogen cyanide gas. If gas is released, EVACUATE THE AREA, close the door, and call Campus Security ext. 3200.
Do not attempt to stop or contain the spill/release if it occurs outside a fume hood.

Spill Outside Fume Hood

• Alert others and evacuate to a safe distance and prevent entry.
• Call Campus Security at ext.3200 and alert them of the cyanide spill.
• Remain in a safe location until HSW or other response personnel arrive.

Spill Inside Fume Hood (<500 ml)

- Contact Campus Security at ext. 3200
- If trained and confident, you may assist in the clean-up effort of small amounts, wearing appropriate PPE and using effective spill supplies. Clean up should be handled only under the direction of the supervisor.
- If a spill is contained in the fume hood and involve less than 1 gram of material, absorb liquid spills using inert material from a Spill Kit. Dry spills can be shoveled into a secure container for disposal. Do not allow spilled material to come into contact with your skin.
- Decontaminate the surface using pH 10 buffer solutions and rinse with diluted bleach.
- All contaminated debris and solutions should be collected as cyanide containing hazardous waste.
- Otherwise close the fume hood sash and await support.

Symptoms of Cyanide Exposure

Early Symptoms

Reddening of the eyes/skin	Nausea	Headache

Delayed Symptoms 4-6 hours

Irritation of the throat	Salivation	Giddiness
Weakness of the arms and legs	Difficulty breathing	Palpitations
Numbness	Convulsions	Collapse

If you experience any of these symptoms, call 911 and get medical assistance. Cyanide poisoning can also cause affects either through breathing in cyanide gas or dust or can be absorbed through the skin and can result in loss of consciousness and the inability to breathe.

[Table of Contents]

Pyrophoric Chemical Spills

- Shut off all ignition sources and allow spilled materials to react with atmospheric moisture.
- A container of powdered lime or sand should be kept within arm's length when working with a pyrophoric material and it should be used to completely smother and cover any spill that occurs.
- DO NOT use water to attempt to extinguish a pyrophoric material fire as it can actually enhance the combustion of some pyrophoric materials (e.g. metal compounds).
- Do not use combustible materials (paper towels) to clean up a spill, as these may increase the risk of igniting the pyrophoric compound.
- Know the location and function of all appropriate emergency equipment.
- Consider purchasing a fire blanket and keeping it in the working area to quickly extinguish flames on a person.
- If anyone is exposed, or on fire, wash body with copious amounts of water and try to remove contaminated clothing.
- Recurring incidents should be evaluated for process improvement and hazard mitigation.

Large Spills

- Exert extreme caution due to potential spontaneous combustion.
- Exert extreme caution due to potential ignition of flammable solvents or other materials.
- If anyone is exposed, or on fire, wash with copious amounts of water, ideally in the lab shower.
- Call x3200 for emergency assistance.
- Evacuate the spill area.
- Post someone or mark-off the hazardous area with tape and warning signs to keep other people from entering.
- Provide emergency personnel with technical advice on the chemicals involved.

Small Spills

- Exert extreme caution due to potential spontaneous combustion.
- Exert extreme caution due to potential ignition of flammable solvents or other materials.
- If anyone is exposed, or on fire, wash with copious amounts of water, ideally in the lab shower.
- Call for a co-worker to provide backup.
- Place a fire extinguisher nearby.
- Carefully remove nearby flammable materials.
- Powdered lime (calcium oxide, CaO) or dry sand should be used to completely smother and cover any spill that occurs.
- Carefully quench by slow addition of isopropanol.
- After complete quench, double bag spill residues for hazardous waste pickup.
- Call 911 for emergency assistance if necessary.
  [Table of Contents]

FLOODS

Floods in labs occur sporadically, usually due to a hose that pulls apart from its connecting line in chemistry experiment setups. A second reason is an activated fire sprinkler.

When a lab has a significant flood, this may pose an electric shock hazard if water reaches electric outlets.
Another significant concern is when water-reactive chemicals get in contact water. Their reaction may release gases that are deadly at low airborne concentrations.

Examples of such substances: s***odium or potassium phosphide*** release phosphine gas when they contact water. Alkali metal cyanide salts, such as ***sodium or potassium cyanide***, slowly release deadly hydrogen cyanide gas on contact with water. The cyanide salts of alkaline earth metals such as ***calcium or barium cyanide*** react at a faster rate with water to produce hydrogen cyanide gas. This can result in a life-threatening problem in confined spaces or poorly ventilated areas.

Large amounts of corrosive hydrogen chloride gas are rapidly released when water reacts with ***aluminum chloride, phosphorous trichloride, tin chloride*** and ***chlorosilane compounds***. When water contacts ***thionyl chloride or sulphuryl chloride***, they decompose rapidly giving off sulphur dioxide gas and hydrogen chloride gas.

Flooding Procedures

Significant flooding. A flooding is significant when one of the following is present: a large portion of the lab floor is covered by water, the level of water on floor rises about half a centimeter or more, or the water reaches under fume hoods, hazardous places, under workbench or a benchwork surface that contain material/ equipment/ devices that may be hazardous when in contact with water.

Danger! Possibility of electric shock in flooded areas!
Danger! Possibility of deadly gases when water contact water-reactive chemicals, in chemistry labs!

Follow these procedures:

1. **Call** Campus Security **x 3200** and alert of hazards present.
2. **Report.** Provide the following information:
    - Location (building and room number).
    - Nature and extent of emergency.
    - Source of water/flood, if known.
3. Your name and the number or location you are calling from.
4. **Arrange** to meet responders and discuss contents of affected area, safe entry procedures, and any hazardous or unknown conditions.
5. When the emergency has been resolved, **report it to the lab supervisor**. Fill out an Injury/Incident Report Form. The supervisor completes the last page of the form and email it to besafe@brocku.ca within 24 hours of the spill occurring. If not possible, based on unresolved health and safety issues, report it as soon as possible. The laboratory supervisor shall take all reasonable steps to complete reporting as soon as possible.

Minor flooding: a flooding is minor when dealing with the cleaning and drying tasks does not pose a hazard.

- Try to eliminate the cause of the flood, e.g. close the running tap. If not possible, call Facilities Management x 3707.
- **Call** Custodial Services at x 3508 during office hours to have the floors dried. Assist the custodians moving equipment off their way, etc. as needed. After office hours call Campus Security x 3200; they will contact custodial services.

POWER LOSS

Science buildings have emergency power generators that will take over a few seconds after the power outage. However, if emergency power were to fail, proceed as follows.

- **Turn off** hot or stir plates, heating mantles, centrifuges, and other equipment with potential for dangerous consequences upon unattended restart.
- **Close** all chemical containers and safely **stop work** with any material or on any experiment. **Do Not** keep using fume hoods or any other lab ventilation equipment.
- **Remove** material off lab aisles to prevent tripping during low light conditions.
- **Remove** contaminant from work surfaces.
- **Remove** gloves and wash hands before heading out.
- **Assemble** at the point of gathering pre-arranged by your lab supervisor.

INCIDENT REPORTING

Emergency situations, incidents, and injuries shall be reported immediately to the supervisor, then to HSW.

All Brock community members shall use the Injury/Incident Report Form available on the HSW webpage (https://brocku.ca/human-resources/wp-content/uploads/sites/81/Brock-Incident-Injury-Report-Form-01-25-18.pdf). The first page of the form contains the instructions to use it.

What are responsibilities of Employees and Supervisors when an injury occurs?

Employees who experience an injury are to:

- promptly receive any required, or appropriate medical treatment,
- notify immediate supervisor as soon as possible of any incident/injury, or related healthcare sought, or received,
- assist in the completion of the injury/incident report form,
- assist in the injury/incident investigation, including implementation of any corrective action and adhere to the legal requirements of the WSIB and
- participate in return to work (RTW) programs if modified work, or lost time is an outcome of a workplace injury.

Supervisors responsible for injured employees are to:

- ensure that the affected employee promptly receives appropriate medical treatment,
- arrange transportation for the affected person if necessary (e.g. ambulance for an emergency situation, providing transportation to the hospital or walk-in clinic for a serious matter),
- advise the affected employee that the department is able to offer accommodation in the form of modified duties.
- In completing the injury/incident report the supervisor is to advise the employee of the following:
    1. explain the notice at the bottom of the report to ensure that the employee is aware of the legal authorization under FIPPA and OHSA to collect and share the information with designated Brock staff and JHSC members to carry out their duties
    2. the purpose of collecting the information is to identify trends, mitigate risks and prevent recurrence.
- report the incident to the HSW department through the completion of the Injury/Incident report form (report forms are to be kept strictly confidential and only shared with the Health, Safety & Wellness department),
- investigate the incident as soon as possible and take corrective action to prevent additional incidents/injuries,
- inform the HSW department promptly should an employee:
    1. be diagnosed with an occupational illness/disease

2. intends to seek or has sought healthcare has lost time as a result of a workplace injury, or incident
3. experiences changes in their ability, or status in an active RTW program.

When to report HSW of the incident or injury?

The supervisor shall submit the Injury/Incident Report Form immediately after the emergency has been dealt with. As well, all incidents and accidents that cause personnel injury, property damage, or deployment of resources shall be reported, even when they do not constitute emergencies, with a few exceptions- see below.

Who fills out the Injury/Incident Report Form and when to submit to HSW?

The injured or person who handled the situation whether an emergency or not, must fill out the Incident Report Form and hand it to the lab/area supervisor. Then, the supervisor shall complete the last portion and submit it, preferably via email to besafe@brocku.ca or via interoffice mail to Health, Safety & Wellness within 24 hours of the occurrence. If not possible, based on unresolved health and safety issues, report it as soon as possible. The laboratory/area supervisor shall take all reasonable steps to complete reporting as soon as possible.

When the incident is minor, a report submission is not required. Minor incidents are those where no injury or damage occur or cannot evolve to cause injury AND can be handled and controlled by the lab supervisor only, e.g. a small cut with a non-contaminated sharp caused by lack of care during a procedure, or a minor burn upon brief contact with a hot plate caused by lack of care while doing a procedure.

The lab supervisor may choose to keep records of those small incidents to analyze tendencies and use for training design.

[Table of Contents]

SECTION 2. LAB SAFETY CULTURE, AUTHORITIES, DUTIES AND RESPONSIBILITIES

PERSONAL BEHAVIOUR

Personnel behaviour at the University is partly governed by a multitude of Policies, such as:

- Biosafety
- Code of Conduct
- Conflict of Interest
- Occupational Health and Safety
- Smoking and Vaping Policy
- Workplace Violence Prevention
- Respectful Work and Learning Environment
- Sexual Assault and Harassment
- Responsible Conduct of Research at Brock
- Student Code of Conduct

On another hand, we must consider that science labs are commonplace for a multitude of hazards. Therefore, for the protection of users of labs in any capacity, the following professional standards of personal behaviour are required to prevent injury or damage:

- Avoid distracting or startling other workers.
- Do not allow or partake in practical jokes and horseplay at any time. It is prohibited under OSHA.
- Use laboratory equipment only for its designated purpose.
- Do not allow visitors, including children and pets in laboratories where hazardous substances are stored or in use or hazardous activities are in progress.
- Underage individuals permitted in laboratories, for example, as part of an officially sanctioned educational or classroom activity, must be under the direct supervision of qualified adults.
- Make sure that before teaching materials and publicity photographs are taken no personnel is exposed to hazards and that personal protective equipment is worn appropriate to the hazards present.
- Such activities must receive the approval of the administrative area and are coordinated with the lab supervisor.

DRESS CODE SAFETY RULES

As you'd expect, laboratory dress codes set a clear policy for the clothing employees should avoid wearing in order to prevent accidents or injuries in the lab. For example, skirts and shorts are nice for enjoying the warm weather outside, but quickly become a liability in the lab where skin can be exposed to the danger of hazardous conditions and substances present in labs.

1. Always tie back hair that is chin-length or longer.
2. Make sure that loose clothing or dangling jewelry is secured or avoid wearing it in the first place.

3. Never wear sandals or other open-toed shoes in the lab. Footwear should always cover the foot completely.
4. Never wear shorts or skirts in the lab.
5. When working with Bunsen burners, lighted splints, matches, etc., acrylic nails are not allowed

LAB SAFETY CULTURE

While any lab safety program should include the goals of minimizing accidents and injuries, academic laboratories in particular have the unique responsibility of building the foundation for a life-long attitude of safety consciousness, risk assessment and prudent laboratory practice. Research labs also often deal with the rapid turnover of young people as well as discovering new knowledge through research programs with unpredictable hazards.

Inexperienced people may be introduced to numerous lab hazards and may be hesitant or unsure in a new environment. At the same time, teaching assistants may be the ones to oversee them and may be adapting to their first teaching experience. Because of this, the supervision and training of new teaching assistants should be a special departmental responsibility because the safe operation of undergraduate labs depends heavily on them. Commitment of the entire faculty to laboratory safety and the responsible disposal of chemicals sets a good example to initiating students into laboratory culture at every level.

Advanced training is safety is particularly important in education through research. Research often includes the production of new materials by unprecedented methods and may involve unknown hazards. This results in research labs sometimes placing many processes and products with young researchers with varied levels of experience. Safety planning before this point is placed on teachers and students; new researchers may be ill-prepared to face many real hazards in the lab. Because of this, the safest possible environment should be cultivated, and sufficient training, both lab-specific and faculty-offered, should be completed before beginning any work.

Safety training should be a continuing process and become an integral part of daily lab work. New protocols should be accompanied by the safest practices for performing them and collegial interactions should be pursued to exchange safety information, convey meaningful guidance and overall create a culture of workplace safety. While principal investigators and other supervisors are legally accountable for safety in the lab, this activity is distributable. A hierarchy based on experience is highly effective in transmitting the importance of safe, prudent laboratory operation. The university thrives under leadership that shows deep concern for safety.

THE ACADEMIC SAFETY COMMITTEE

The Academic Safety Committee (ASC) has the responsibility of, and authority for, establishing and enforcing the University's research and teaching safety programs. The Committee is composed of four subcommittees namely, the Biosafety Group, the Radiation Safety Group, the Chemical Safety Group, and the Fieldwork and Travel Safety Group. The goal is to promote a culture of safety and to develop and maintain said safety programs. The reporting structure is graphed below.

The ASC’s performance rest on its membership, who are “expert users” (researchers and teaching faculty and staff) and/or have the appropriate technical and legislative expertise in each of the four

areas of risk to ensure adequate coverage in all of the four areas of safety concern listed above, the ASC include working groups for Chemical Safety, Biosafety, Radiation Safety and Fieldwork & Travel Safety.

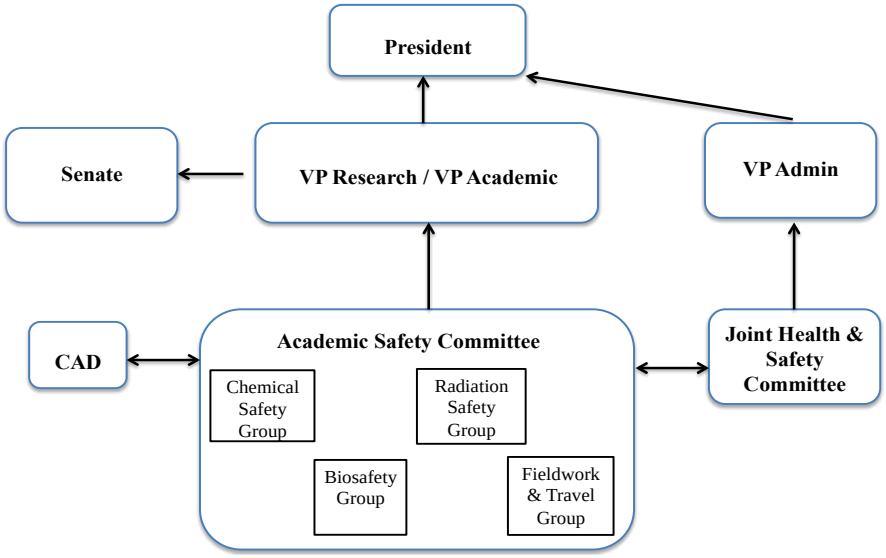


Figure 2. Organization of the Academic Safety Committee and its sub-committees. Arrows indicate directions for reporting. Communication flows in both directions in all cases.

The Terms of Reference of the ASC are available here.

ROLES AND RESPONSIBILITIES

Academic Safety Committee

- In partnership with HSW, develop and maintain or improve existing safety programs, policies, procedures, and guidelines based on legislative requirements or best practices, as applicable.
- Review and approve requests for the use of radioactive, biological and hazardous material within the institution by issuing, through the RSO or BSO user permits and/or hazard packages.
- Review safety programs as required, including reviewing the results of internal inspections of facilities, premises, equipment and work practices that assess whether radioactive, biological or hazardous materials are used safely.
- Receive reports from the RSO and BSO and recommend remedial action to correct any deficiencies.
- Review and adjust risk assessments and risk management protocols, as conditions warrant, and generate and share information about best practices and policies for travel and off-campus teaching, research and/or recreational activities.
- Seek advice, when needed, from different departmental and specialist safety officers and assistance from independent experts, local authorities, and or community members.

Health, Safety & Wellness

- Provide advice and counsel to stakeholders on the legislative items that regulate the health and safety operations of the University.
- Develop, implement, and monitor the University's safety programs as mandated by legislation or recommended as best practice in the areas of biosafety, radiation, chemical, travel & field trips, laser, and x-ray safety, in collaboration with the ASC members and the broader community, as appropriate.
- Communicate, educate, and train students, staff and faculty on applicable health and safety matters.
- Ensure that incidents investigation is carried out; make recommendations to involved parties and administrators as appropriate to mitigate risks and prevent reoccurrences or manage the implementation of corrective and preventative measures as appropriate; report such incidents to the ASC during meetings and provide a space for discussion.
- Consult and liaise with the Regulators, Research Ethics Board, Animal Care Committee, Joint Health and Safety Committee and any other institutional committees and stakeholders to ensure harmonization of policy and regulation.

Academic and Research Vice-Presidents

Vice-Presidents, Academic & Research are responsible for implementing the strategy for the administration of teaching and research activities and for allocating the appropriate resources to the lab's administrators. They are the ultimate authority that ensures teaching and research activities are conducted in compliance with applicable federal, provincial, municipal legislation and other applicable standards, policies and procedures internal or external.
VPs have also all the duties of an employer as outlined in the Occupational Health and Safety Act of Ontario.

Deans

Deans are responsible at the faculty level for overseeing compliance with legislation, policies, procedures and standards established by regulatory agencies, the University, and their faculty. They are also responsible for the allocation of resources to ensure the effective operation of their faculties including elements of safety, and for monitoring adherence to said policies, procedures and legislation. Deans are required to take corrective action, within the scope of their authority, as soon as they are made aware of a situation involving non-adherence to policy and procedures, or laws and bylaws. Situations requiring further assistance or intervention are to be reported to the appropriate University authority.
Deans have also all the duties of an employer as outlined in the Occupational Health and Safety Act of Ontario.

Department Chairs

Department chairs are responsible for monitoring compliance with all directives, procedures and standards established by the University, their faculty or by regulatory agencies at the individual department level. This includes supporting the implementation and maintenance of faculty directives and monitoring adherence to them at the department level. Department chairs must also initiate necessary preventive measures to control hazards associated with activities under their authority.

Department chairs are required to take corrective action, within the scope of their authority, as soon as they are made aware of a situation involving non-adherence to policy and procedures, or laws and bylaws. Situations requiring further assistance or intervention are to be reported to their Dean. Academic Chairs have also all the duties of a supervisor as outlined in the Occupational Health and Safety Act of Ontario.

Laboratory Supervisor

The Laboratory Supervisor is the individual with overall responsibility for the research or teaching laboratory, often a member of the University faculty and sometimes a staff. Supervisors are responsible for ensuring compliance with all policies, procedures, directives, and standards established by the authority having jurisdiction, the University, and their faculty and department. More specifically, their responsibilities are:

- Ensure that the procedures specified in this manual are carried out.
- Ensure laboratory workers and students attend the appropriate safety trainings provided by HSW in accordance with the activities they perform and stablished procedures.
- Provide training on specific hazardous materials, equipment, and procedures, as needed and ensure laboratory workers know how to work safely with them.
- Provide laboratory workers with appropriate engineering controls and personal protective equipment needed to work safely with the lab hazards. Ensure such equipment are used correctly.
- Conduct incident investigation and implement the derived remedial and preventive measures and report the incident to HSW.
- Take corrective action, within the scope of their authority, as soon as they are made aware of a situation involving non-adherence to policy and procedures, or laws and bylaws. Situations requiring further assistance or intervention are to be reported to their immediate supervisor for resolution and / or escalation.
- Has also any other duty of a supervisor as outlined in the Occupational Health and Safety Act of Ontario and that are also covered in a manual put together here by the office of HSW.

Lab Worker

- Workers are comprised of staff and students who work in the laboratory under the direction of the Laboratory Supervisor.
- Attend the required safety trainings provided by HSW and the lab supervisor.
- Conduct lab activities in accordance with the instructions of the supervisor, the provisions of this manual, and all policies, procedures, directives and standards established by the University, or their specific faculty and department. Also, everyone is responsible for conducting activities in a manner that will not endanger themselves or others. Individuals must exercise all reasonable care in activities that may pose a risk.
- Use the engineering controls and personal protective equipment required for the task at hand.
- All individuals are required to report all known hazards to their immediate supervisors.
- Report all incidents, accidents, potential chemical exposures and near miss situations to the lab supervisor.

- Fill out the Injury/Incident Report Form for any reportable incident following the procedure outlined in the Form and hand it to the Supervisor.
- All individuals shall assist and cooperate with University and regulatory authorities conducting inspections, audits, or investigations in accordance with specified policies and procedures.
- Have any other duty outlined in the Occupational Health and Safety Act of Ontario and also available in a manual put together here by the office of HSW.

Support Personnel

Support personnel are the custodians, technicians and trades University staff that provide cleaning and maintenance services to the facilities and equipment.

- Work in accordance with the procedures outlined by their department and follow the general duties of workers under the Occupational Health and Safety Act of Ontario.
- Attend the safety training provided by HSW.
- Use the protective equipment required for the task at hand.
- For complex or disruptive tasks, coordinate with the lab supervisor and schedule tasks so that interruptions of the lab activities are minimized as much as possible.
- Limit entry to the labs to performing the official business duties.

Visitors

Visitors could be visiting scholars, external contractors, governmental representatives or inspectors, affiliates, or other organizations rep on official business.

- Liaise with University representatives to acquaint themselves with protocols and requirements for accessing and working in labs.
- May work/enter labs only after completing the required safety trainings.
- Are subjected to the same rules and procedures that apply to lab users in a similar working category to theirs.
- Report any incident to the lab supervisor or university rep with whom they coordinated the work.

NON-COMPLIANCE MANAGEMENT

Safety and compliance violations will be discussed in meetings of the Academic Safety Committee.

Consequences of non-compliance

Safety violations that pose immediate or significant health or safety risk to an individual or a group of individuals may result in a direct work suspension depending on the level of risk associated and severity of the action or inaction, until the violation is resolved. In addition, the following steps may be taken, accordingly.

Research-related (funded) noncompliance for Faculty and Staff members

- For violations relating to health and safety legislation or policies, including but not limited to securing all required certifications (eg., biohazard permits, radiation safety permits) the case

will be forwarded to the Senior Administrative Contact (SAC) as established on the *Responsible Conduct of Research Policy at BrockU*, available here https://brocku.ca/research-at-brock/wp-content/uploads/sites/73/Brock-RCR-Policy.pdf

- Policy breaches shall be submitted using the form *RCR Allegation Submission Template* available at this URL https://brocku.ca/research-at-brock/wp-content/uploads/sites/73/RCR-Allegation-template.pdf

Graduate and undergraduate students' noncompliance

- Noncompliance of students will be referred to the SAC, in accordance with Appendix A: Administrative Flowchart for Allegations Regarding Students' Academic Work (Section 4) of the RCR Policy.

Non-research-related noncompliance and research-related (not funded) noncompliance

Depending on the severity of the violation or its impact on health and safety, the consequences may be:

(1) temporary suspension of a permit,
(2) revocation of a permit, or
(3) suspension of work,

Followed in all cases by notification of the Chair and/or Dean, or Program Director, as appropriate.

[Table of Contents]

SECTION 3. THE LABORATORY FACILITIES

LABORATORY DESIGN AND MINIMUM PROVISIONS

The ultimate goal of laboratory design is to foster innovation, support science and keep scientists and support staff safe. The nature of modern laboratory work requires distinct workspaces and a defined, but permeable barrier between them. Scientists working in these spaces need an area that allows for both focused concentration and easy engagement with colleagues. Incorporated adjacencies and visual connections allow for spontaneous interaction and collaboration between disciplines. Design should focus on workplaces that promote innovation, the transfer of knowledge, collaboration and effectiveness while still providing a pleasant environment which is desirable to occupy.

Lab design needs to incorporate the elements of safety that provide for the protection of health and safety of the university community and guests. It also encompasses protection from material losses or events that can negatively impact on the continued operation of the institution.

The aim in the lab design process is to make sure the safety components are “right-sized” i.e., able to meet the demands of the present and flexible enough to also do so in the future. On one hand, an under-designed lab can result in retrofits that can cost more than they would have if included in the original design, while on the other hand, an over-designed lab can include expensive safety features that are never used, thereby diverting valuable financial resources.

Compliance with health and safety legislation is a complex challenge, with jurisdictions at the municipal, provincial, national, and international levels. Research granting agencies also impose health and safety conditions as a part of the research granting process. Health and safety are a moving target, with new hazards emerging from new research, coupled with a steady stream of new regulatory requirements.

Meeting the compliance requirements of health and safety in the research lab may sometimes be viewed as a hurdle or a large expense; however, it is a necessity to effectively manage risks and avert situations which can impede progress. This is clearly visible when tallying the costs of a significant accident. It is expensive in (sometimes) human costs, material, and financial costs, and on added stress.

Some government agencies such as the Canadian Nuclear Safety Commission (CNSC) and the Public Health Agency of Canada (PHAC) require impermeable work surfaces and furniture in laboratories handling open sources of radioisotopes and biohazards.

General structural requirements are required for a CL2 lab as outlined by Canadian Biosafety Standards. These requirements will be summarized below, the source document can be found here

General Lab Ventilation

General ventilation, also called dilution ventilation, involves dilution of inside air with fresh outside air, and is used to:

- dilute indoor air contaminants,
- maintain comfortable temperature, humidity, and air movement for room occupants,
- replace air as it is exhausted to the outside via local ventilation devices such as fume hoods,

- provide a controlled environment for specialized areas such as surgery or computer rooms.

General ventilation systems comprise an air supply and an air exhaust. The air is be supplied via a central HVAC (Heating, Ventilation and Air Conditioning) system. Laboratory air may be exhausted through either local exhaust devices or air returns connected to the HVAC system.

Exhaust Stacks and Strobic Fans

Exhaust stacks and strobic fans are part of the fume hood system to release contaminants from the labs. The latter are also part of the general building exhaust.

- Mackenzie Chown's labs have exhaust stacks that allow for individual control of the face velocity of each fume hood in use.
    - Since each fume hood has its own exhaust on the roof, there is a risk of the wind carrying high concentrations of a gas down the exhaust of another lab. While there is not an elevated risk of a dangerous level of a hazardous gas re-entering another fume hood stack, extra precautions should still be taken when working with hazardous chemicals in fume hoods in Mackenzie Chown.
- Cairns and CCOVI use strobic fans which are powerful single systems that connect all the fume hoods in each of these locations and also provide building general exhaust.

Local ventilation devices

Local exhaust ventilation systems capture and discharge air contaminants (biological, chemical, radioactive) or heat from points of release. The best way to prevent exposure to airborne substances is to prevent their escape into the working atmosphere by use of hoods and other ventilation devices.

A laboratory hood with 2.5 linear feet of hood space per person should be provided for every 2 workers if they spend most of their time working with chemicals.

Common local exhaust ventilation devices found in laboratories include:

- chemical fume hoods
- laminar flow hoods
- biological safety cabinets
- direct connections (eg., ventilated flammable cabinet)

Ventilation Balancing and Containment

By regulation, more air must exhaust from a laboratory than is supplied to it, resulting in a net negative pressure (vacuum) in the laboratory. Negative pressure draws air into the laboratory from surrounding areas, and serves to prevent airborne hazardous chemicals, radiation, or infectious microorganisms from spreading outside the laboratory in the event of an accidental release inside the laboratory.

Balancing of laboratory ventilation must take into consideration the amount of air exhausted by local ventilation devices such as fume hoods. Modern laboratories do not have openable windows, as opening of windows tends to pressurize a room, pushing air from the laboratory into adjacent non-laboratory areas.
Details on the functioning of hoods are covered in the section Fume Hoods of this manual.

SECTION 4. HAZARDS COMMUNICATION – WHMIS

CONTAINER LABEL FOR HAZARDOUS PRODUCTS

WHMIS legislation in Canada requires that products used in the workplace that meet the criteria to be classified as hazardous products must be labelled. Labels will alert users about major hazards associated with that product and outline the basic precautions or safety steps that should be taken.

Who is responsible for labelling?

- In most cases, suppliers are responsible for labelling the hazardous products that they provide to customers.
  Note: Labels should be affixed to, printed or written on, or attached to the hazardous product or the container and remain legible. Providing a WHMIS 2015 label along with the shipping papers would not be considered to be in compliance.
- Any product to be used withing the university authority premises must have a proper label. It is the responsibility of the person who brings in the product making sure that hazardous products have a compliant label.
- When the product is prepared in-house (eg., disinfecting solutions, decanted products, diluted solutions, or new compounds from research activities), it is the responsibility of the lab supervisor to ensure that a workplace label is affixed to the container.

Supplier labels and workplace labels are two different types of WHMIS labels. If the hazardous product is always used in the container that the workplace label is on, a workplace label is not required. A workplace label is required when:

- A hazardous product is produced (made) at the workplace and used in that workplace,
- A hazardous product is decanted (e.g., transferred or poured) into another container, or
- A supplier label becomes lost or illegible (unreadable).

A workplace label is not necessary when:

- A hazardous product is poured in to a container AND is immediately used, or
- Is “under the control of the person who decanted it”. If a person pours a product into another container and will be the sole user and used during one shift, a full workplace label may not be required. The container, however, must still be identified with the product identifier (name).

If the product is not used right away or if more than one person will be in control of the product, a full workplace label is required.

In general, a workplace label will require the following information:

- Product name (matching the SDS product name).
- Safe handling precautions- may include pictograms or other supplier label information.
- A reference to the SDS (if available).

A workplace label has been created by HSW for use by the Brock community. The labels have a sticky back and is made of a write-on vinyl material. Two sizes are available to accommodate different containers sizes and can be obtained in Science Stores free of charge to the user.

Product Identifier	Must be identical to the name that appears in the SDS
Safe Handling Precautions	Precaution for safe handling, including PPE, hygiene, emergency measures
Read and understand the Safety Data Sheet (SDS) before use	

Figure 3. Workplace label available in Science Stores.

In this or any other workplace label that has been created, pictograms may be used to show the user of a hazardous product what type of hazard is present. Most pictograms have a distinctive red "square set on one of its points" border with a symbol inside that represents the potential hazard. Below shows hazard pictograms with the name in bold and the words in brackets to describe the hazard.

Figure 4. WHMIS 2015 Pictograms

Exploding bomb	· Explosives · Self-Reactives (exploding) · Organic peroxides	**Gas Cylinder**	Gas under pressure
Corrosion	· Corrosive to metals · Serious eye damage · Skin corrosion	**Skull and Crossbones**	Acute toxicity (severe)
Flame	· Flammables (gases, aerosols, liquids, solids) · Self- reactive substances and mixtures · Pyrophoric liquids, solids, and gases · Self-heating substances and mixtures · Substances and mixtures when in contact with water emit flammable gases · Organic peroxides	**Exclamation mark**	· Skin sensitization · Acute toxicity (harmful) · Hazardous to the ozone layer · Specific target organ toxicity – single exposure (Cat. 3) · Eye irritation · Skin irritation
Flame over circle	Oxidizing gases, Iiquids, solids	**Environment (not mandatory)**	Hazardous to the aquatic environment
Health hazard	· Carcinogenicity · Germ cell mutagenicity Respiratory sensitization · Reproductive toxicity · Specific target organ toxicity - repeated exposure · Specific target organ toxicity - single exposure (Cat. 1, 2) · Aspiration hazard	**Biohazardous Infectious Materials**	Biohazardous Infectious Materials

Supplier labels for hazardous products in small containers may carry less information. Containers with a capacity of 100 ml or less are not required to have hazard statements or precautionary statements on the label.

Labels on containers with a capacity of 3 ml or less can be designed to be removed at the workplace if the label interferes with the normal use of the product. The label must remain durable and legible while the product is stored and transported.

WHMIS 2015 classes and categories that do not require a pictogram are:

- Flammable gases – Category 2
- Flammable liquids – Category 4
- Self-reactive substances and mixtures – Type G
- Organic peroxides – Type G
- Combustible dusts – Category 1
- Simple Asphyxiants – Category 1
- Serious eye damage/eye irritation – Eye Irritation – Category 2B
- Reproductive toxicity – Effects on or via lactation

More information about these pictograms can be found at CCOHS.

SAFETY DATA SHEETS (SDS)

A product covered by the *Hazardous Products Act* and meets the criteria to be included in a hazard class or category is classified has a "hazardous product" under WHMIS and must have an SDS (formerly material safety data sheet, MSDS) in the workplace. An accurate SDS shall be provided by a supplier to their customer at the time of sale.

Brock University has a subscription with MSDSonline that has a database on the MSDSs of most chemicals used at Brock. A memorable link to this is: bit.ly/BrockMSDS.

Safety data sheets for every hazardous product being used in the lab must be readily accessible in case of emergency handling situations. HSW provides access to safety data sheets online through MSDSonline. This can be accessed here or through bit.ly/BrockMSDS.

As a lab user at Brock, one should always be familiar with the hazards of a product before it is used. Look at the MSDS, match the name on the product to what is on the MSDS, know the hazards, understand safe handling and storage instructions, and emergency precautions and procedures.

Four main purposes of an MSDS are to provide information on:

- Identification: for the product and supplier. (Found in Section 1 of the MSDS sheet)
- Hazards: physical (fire and reactivity) and health. (Found in Section 2)
    - Note: While Section 2 summarizes hazards and precautions of a product, it may not be specific about safe work procedures needed, such as what type of respirator is used and only that one is needed. Any concerns should be addressed with your supervisor.

- Prevention: steps you can take to work safely, reduce or prevent exposure, or in an emergency. (Found in Section 7)
- Response: appropriate responses in various situations (e.g., first-aid, fire, accidental release). (Found in Sections 4, 5 and 6)

A product should only be used as the manufacturer intended and if a product is not being used correctly the MSDS may not apply. Discuss with your supervisor or contact HSW if you have any concerns.

If a product is developed in the laboratory that meets the criteria for WHMIS hazard classes, the lab must classify the product hazards and provide a label and MSDS once it is analyzed and evaluated. It shall be treated as a laboratory sample until then.

A laboratory sample is defined as a sample of a hazardous product that:

- is packaged in a container that contains less than 10 kilograms of the hazardous product,
- is intended solely to be tested in a laboratory, and
- does not include a sample that is to be used by a laboratory for testing other products or for educational or demonstration purposes.

Examples: Samples for quality control testing, diagnostic specimens.

Hazardous products may also be designated as biohazardous infectious materials (BIMs). BIMs are micro-organisms (e.g., bacteria, viruses, fungi, and parasites), nucleic acids, or proteins that cause or probably cause infection in people or animals. BIMs require a full supplier label and a 16-section SDS with a 9-section appendix. More information about labelling requirements of BIMs can be found at CCOHS.

LAB DOORS SIGNAGE

Communicating the hazards present in laboratories is an important method of hazard communication so that anyone who enters can be aware of them and can act accordingly, whether using the laboratory or providing any type of support. This is accomplished by posting hazard signage at each entry door to laboratories where hazardous materials are present, including WHMIS 2015 pictograms with their name, primary laboratory contact names, contact office phone number, and requirements of PPE. For CL2, CL3 laboratories, the containment level and the pathogenic material that is present must be posted additionally. Emergency contact numbers are not published for privacy reasons but are available to Campus Security for use during emergency situations.

Doors signage is created and managed by HSW. Do notify HSW of any updates to emergency contacts, a change in hazards or PPE requirements so the signage can be appropriately updated. A template for this signage can be seen in the appendix A 7.A 7 This template has all WHMIS symbols included, as well as magnets, lasers, x-rays, and radiation, but the lab signage should only contain the hazards relevant to the lab.

[Table of Contents]

FUME HOOD WHITE BOARD

Fume hoods are used very frequently in laboratories and most often to handle hazardous materials. Reactions and experiments within the hoods can sometimes fail or errors made conduce to incidents, sometimes while the hood user is actively involved in the experimentation and other times when users are absent. When responding to a fire, explosion, or similar catastrophic incident, emergency services must be aware of the details of the reaction where the incident occurred to take appropriate precautions for their own safety and that of others around them or simply to respond appropriately. For example, knowing if the material is reactive to water or if a type D extinguisher is needed.

To enable any concerns about fume hood experiments or reaction-related issues to be addressed quickly and effectively, it has been determined that relevant information about the fume hoods at Brock be made available on white boards that shall be located at the end of the banks of fume hoods. The white boards should be populated with the supervisor's name (and designated supervisor's name in the supervisor's absence) and the primary user's name and contact information. The following template was created as a guide.

Please note that posting the information required on the hood sash should not be taken as an alternative, as fume hoods in the past have been partially destroyed or burned during incidents making the information unavailable.

Laboratory: Supervisor name: Designated supervisor name:		Supervisor emergency number: Designated supervisor number:	
Fume Hood number	Fume Hood number	Fume Hood number	Fume Hood number
Student Name	Student Name	Student Name	Student Name
Student Phone #	Student Phone #	Student Phone #	Student Phone #
Reaction and Type of Hazards	Reaction and Type of Hazards	Reaction and Type of Hazards	Reaction and Type of Hazards

CHEMICAL INVENTORY

Background

Knowing the chemicals and their quantities in each lab helps ensure compliance with the fire code and insurance, as well as able to supply information to first responders in case of incident. For these

reasons, amongst others, the University has implemented a system to issue all stock requests and allow for an procedure to update inventory of hazardous lab chemicals.

Removal of Empty Containers

Chemical containers in shelves at the time of the inventory implementation have not been barcoded but labelled with a generic label affixed to them. The label indicates that the item was inventoried and to contact science stores when it is empty or otherwise the lab supervisor wishes to get rid of it (eg., it's expired, not in use anymore).

Containers with generic labels, as well as barcoded containers (that were purchased after inventory implementation started) must be removed from the inventory when are used up, to maintain accuracy and value of the inventory system. Removal of non-barcoded item is done manually by science stores staff and is an integral part to keep the inventory up to date.

For this, the Empty Container Chemical Waste Form found at https://brocku.ca/mathematics-science/services/science-stores/#wastes should be filled out by lab personnel when a container that is part of the lab's chemical inventory is used up. Once submitted, Science Stores will remove the container from the chemical inventory in Workday.

It is the responsibility of the lab supervisor to ensure that Science Stores is informed of any empty chemical bottle/ containers or loss or movement of chemicals.

NOTE: If a container is to be reused in the lab for other purposes, eg., solvent drum will be used to store used solvents that will be later distilled for reuse, ensure that the drum is first removed from inventory. For this contact Science Stores. Then deface the barcode and place the container where it does not impede the passing of personnel or contribute to tripping. The result of not removing the container from the inventory in this case is that the lab will show a higher load of flammable liquids, if applicable, and will not help to maintain the accuracy of the inventory.

A list of chemicals that can be acquired through Science Stores can be found on their page and can be purchased through Workday.

CHEMICAL WEAPONS CONVENTION RELATED ACTIVITIES DECLARATION

In conformity with Section 11 of the *Chemical Weapons Convention Implementation Act* (*CWCIA*, hereafter "the *Act*"), the University must generate the Annual Declaration of Past Activities on a yearly basis, under the *Act*, to the Canadian National Authority (CNA) which is responsible for the collection and monitoring of data concerning the annual production, processing, consumption, import and export of chemicals covered by the Chemical Weapons Convention (CWC) in Canada to fulfill its obligations with the Organization for the Prohibition of Chemical Weapons (OPCW). This report is due at the beginning of the calendar year and reports on the previous years' activities.

The information required to be included in your declaration depends on the CWC Schedule to which a chemical belongs. Schedule 1 chemicals declarations must include information on annual production, acquisition, consumption, storage, transfer, import and export; Schedule 2 chemicals declarations must include information on production, processing, consumption, import and export; and Schedule 3 chemicals declarations must include information on production, import and export. A guidance

document is provided by the CNA each year of the chemicals within each Schedule. This list can be found on the Appendix A 11.

Principal investigators, professors and staff may receive in early January an email requesting the following information:

1. In the previous calendar year, were you involved in producing, processing, consuming, acquiring, transferring, or storing any amount of a chemical listed in **Schedule 1** (pgs. 2-4 of the Schedules) in any quantity and in any concentration?
2. In the previous calendar year, were you involved in producing, processing, or consuming any chemical listed in **Schedule 2** (pgs. 5, 6 of the Schedules) that meets or exceeds **both** of the below declaration thresholds?
   I. **Quantitative Thresholds for Schedule 2**
      - 100 grams of a chemical designated '*' in Schedule 2, Part A
      - 10 kg of any other chemical listed in Schedule 2, Part A
      - 100 kg of a chemical listed in Schedule 2, Part B

   II. **Concentration Thresholds for Schedule 2**
      - Mixtures containing 10% or more by weight of a schedule 2B chemical or 0.5% or more by weight of a schedule 2A/2A*chemical are subject to declaration.
3. In the previous calendar year, were you involved in the **import and/or export** of any of **Schedule 1**, **Schedule 2**, **Schedule 3** chemicals (Schedule 3 is on page 7 of the Schedules) on any quantity or concentration?
4. In the previous calendar year, did you produce any Discrete Organic Chemicals? For the definition of DOC, see pg. 8 of the Schedules sheet.

If you answer yes to any question, we will contact you to collect the information required for submission. The Declaration will be submitted on behalf of the entire University to the CNA.

[Table of Contents]

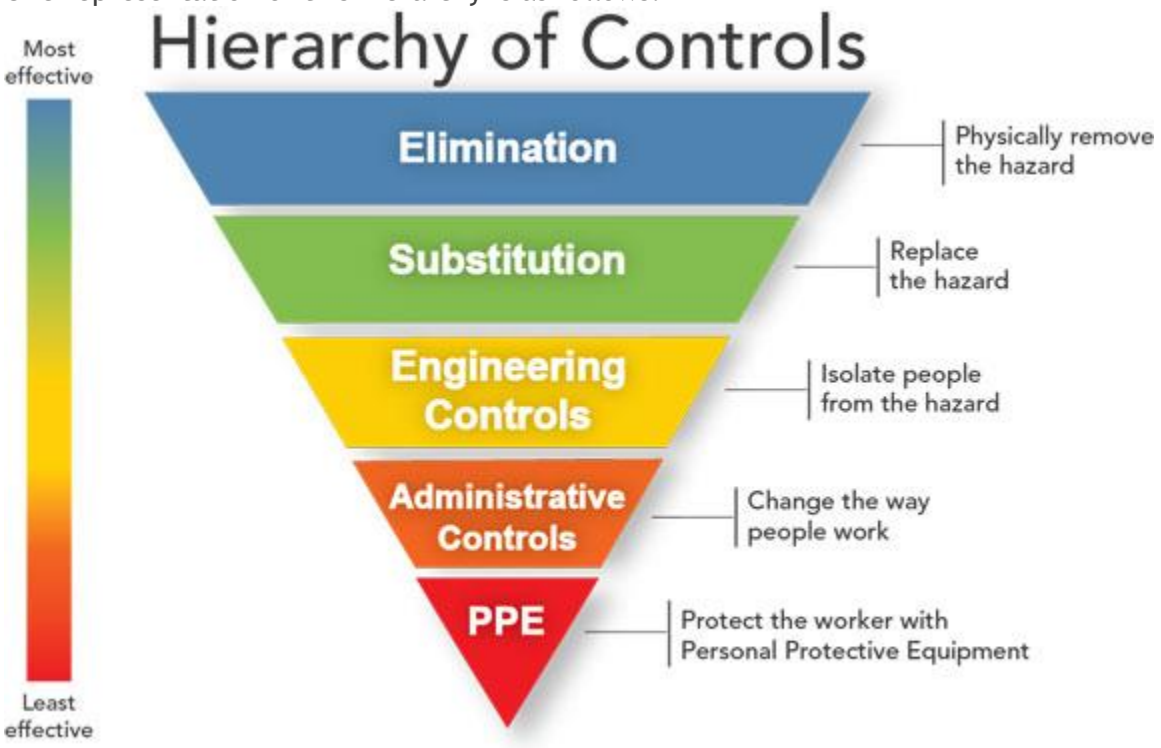
SECTION 5. HAZARDS CONTROL

HAZARDS CONTROL OVERVIEW

Controlling exposures to hazards in the workplace is the fundamental method of protecting lab personnel. Traditionally, a hierarchy of controls has been used as a means of determining how to implement feasible and effective control solutions. The main ways to control a hazard include:

- **Elimination (including substitution)**: remove the hazard from the workplace, or substitute (replace) hazardous materials or machines with less hazardous ones.
- **Engineering Controls**: includes designs or modifications to plants, equipment, ventilation systems, and processes that reduce the source of exposure.
- **Administrative Controls:** controls that alter the way the work is done, including timing of work, policies and other rules, and **work practices** such as standards and operating procedures (including training, housekeeping, and equipment maintenance, and personal hygiene practices).
- **Personal Protective Equipment**: equipment worn by individuals to reduce exposure such as contact with chemicals or exposure to noise.

One representation of this hierarchy is as follows:



The idea behind this hierarchy is that the control methods at the top of graphic are potentially more effective and protective than those at the bottom. Following this hierarchy normally leads to the implementation of inherently safer systems, where the risk of illness or injury has been substantially reduced.

[Table of Contents]

Elimination and Substitution

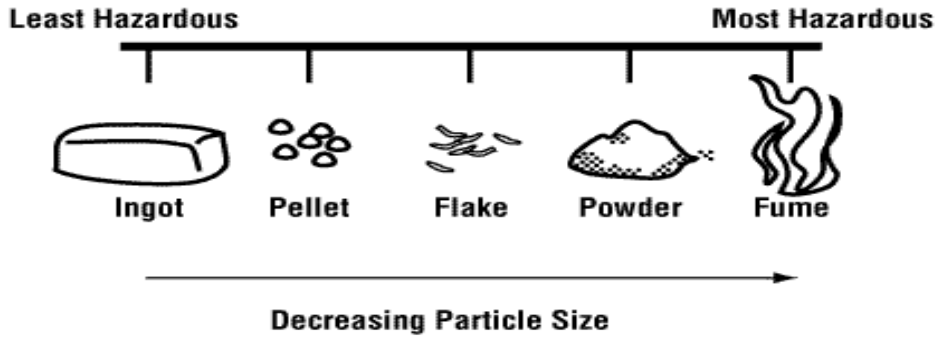
Substitution occurs when a new chemical or substance that is less hazardous is used instead of another chemical. It is sometimes grouped with elimination because, in effect, you are removing the first substance or hazard from the workplace. The goal, obviously, is to choose a new chemical that is less hazardous than the original.

Elimination and substitution, while most effective at reducing hazards, also tend to be the most difficult to implement in an existing process. If the process is still at the design or development stage, elimination and substitution of hazards may be inexpensive and simple to implement. For an existing process, major changes in equipment and procedures may be required to eliminate or substitute for a hazard.

The table below provides some examples of potential substitutions:

Instead Of:	**Consider:**
carbon tetrachloride (causes liver damage, cancer)	1,1,1-trichloroethane, dichloromethane
benzene (causes cancer)	toluene, cyclohexane, ketones
pesticides (causes various effects on body)	"natural" pesticides such as pyrethrins
organic solvents (causes various effects on body)	water-detergent solutions
leaded glazes, paints, pigments (causes various effects on body)	versions that do not contain lead
sandstone grinding wheels (causes severe respiratory illness due to silica)	synthetic grinding wheels such as aluminium oxide

Another type of substitution includes using the same chemical but to use it in a different form. For example, a dry, dusty powder may be a significant inhalation hazard but if this material can be purchased and used as pellets or crystals, there may be less dust in the air and therefore less exposure.



Remember!
When substituting, be very careful that one hazard is not being traded for another. Before deciding to replace a chemical/substance with another, consider all the implications and potential risks of the new material.

Researchers are highly encouraged to eliminate or substitute hazards whenever possible. In research activities, however, at times the purpose is to study the hazard itself or properties of the material very correlated to its hazardous characteristics therefore substitution or elimination is not possible in these instances.

Engineering Controls

Engineering controls are methods that are built into the design of a facility, equipment or process to minimize the hazard. The basic types of engineering controls are:

- Process control.
- Enclosure and/or isolation of emission source.
- Ventilation.

Engineering controls are favored over administrative and personal protective equipment (PPE) for controlling existing worker exposures in the workplace because they are designed to remove the hazard at the source before it comes in contact with the worker. Well-designed engineering controls can be highly effective in protecting workers and will typically be independent of worker interactions to provide this elevated level of protection.

Examples of engineering controls used in our labs are fume hoods, biosafety cabinets, and glove boxes which isolate or remove contaminants from the lab air, preventing lab users from getting exposed to them. Engineering controls are a reliable way to control exposures as long as the controls are designed, used and maintained properly, therefore it is paramount that lab users follow the guidance provided in this manual on the use of fume hoods.

ADMINISTRATIVE CONTROLS AND PPE

Administrative controls limit exposures by the implementation practices, procedures other "rules" proven to be or generally recognized safe. These control measures have many limitations because the hazard itself is not actually removed or reduced. Administrative controls can be difficult to implement, maintain and are not a reliable way to reduce exposure but at times they is no alternative method of exposure control. When necessary, methods of administrative control include:

- Restricting access to a work area.
- Restricting the task to only those competent or qualified to perform the work.
- Scheduling high exposure tasks for times when fewer people are present.
- Using job-rotation schedules that limit the amount of time an individual is exposed to a substance.

Work Practices

Work practices are also a form of administrative controls. In most workplaces, even if there are well designed and well-maintained engineering controls present, safe work practices are very important. Some elements of safe work practices include:

- Developing and implementing safe work procedures or standard operating procedures.
- Training and education of employees about the operating procedures as well as other necessary workplace training (including WHMIS).
- Establishing and maintaining good housekeeping.
- Keeping equipment well maintained.

- Preparing and training for emergency response for incidents such as spills, fire, or employee injury.

Personal protective equipment (PPE) includes items such as respirators, protective clothing such as gloves, face shields, eye protection, and footwear that serve to provide a barrier between the wearer and the chemical or material.
It is the final item on the list of hazards control methods for a very good reason. Personal protective equipment only protects the person wearing it and should not be the only method used to reduce exposure except under specific circumstances because PPE may fail (stop protecting) with little or no warning. For example: "breakthrough" can occur with gloves, clothing, and respirator cartridges. Therefore, when wearing PPE, the wearer must get familiar with the protection it affords, the time it provides protection (eg. breakthrough time for gloves), perform any necessary fit testing, maintenance to be provided, and use it as specified by the manufacturer.

The supervisor of a lab is responsible for making sure that all people under their supervision are wearing PPE that is appropriate to he hazards being handled.
Lab coats can be acquired at the campus store; they can also be ordered through Science Stores as well as gloves.

Contact cbucciarelli@brocku.ca for any further questions about acquiring PPE.

PERSONAL PROTECTION SAFETY RULES

Personal protective equipment (PPE) is legislatively required by the O. Regulation 851 when workers are exposed to the following hazards:

- Hazard of head injury- s. 80
- Hazard of eye injury- s. 81
- Hazard of foot injury- s. 82
- Hazard of injury from contact with the skin- s. 84
- Hazard of falling more than 3 meters - s. 85
- Hazard of entanglement- s. 83

Unlike laboratory dress code policies, rules for personal protection cover what employees should be wearing in the lab in order to protect themselves from various hazards, as well as basic hygiene rules to follow to avoid any sort of contamination.

- When working with equipment, hazardous materials, glassware, heat, and/or chemicals, always wear face shields or safety glasses.
- When handling any toxic or hazardous agent, always wear the appropriate gloves.
- When performing laboratory experiments, you should always wear a smock or lab coat.
- Before leaving the lab or eating, always wash your hands.
- After performing an experiment, you should always wash your hands with soap and water.

- When using lab equipment and chemicals, be sure to keep your hands away from your body, mouth, eyes, and face.

Chemical protective clothing should not be considered as a replacement for engineering control methods. However, there are often few alternatives available or an emergency, eg. a spill, which require their use.

NOTE – personal protective equipment does not remove the hazard itself; it is considered as the last line of defence against a hazard, therefore care must be taken to ensure it provides the protection expected.

PPE Types, Use, Care and Maintenance

Personal protective equipment must be appropriate in the circumstances and the user shall be instructed and trained in its care and use before wearing or using the equipment or device. It is the supervisor's responsibility to conduct a hazard assessment and determine if additional, or in rare cases less, personal protective is required.

There are many different types of protective equipment for different types of hazards. For example, protective eyewear protecting from impact will not provide enough protection for splashes. It is therefore important for the supervisor to identify the type of protection required, ensure access to and the use of them. This identification is the done through a assessing the hazards present or that arise when conducting specific experiments/ activities and then consulting the literature to select the matching protective clothing for the specific hazards. Many times, this knowledge is readily available due to the frequency of the hazard but when faced with less common hazards specialized information may be needed.

In the absence of a hazard assessment conducted by the lab supervisor identifying the required personal protective equipment, the minimum requirements for laboratory work are listed next. Information on PPE for specific hazards is covered further down.

- Long pants: shorts and capri pants are not appropriate for laboratory work,
- Proper footwear- closed heel and toe,
- Lab coat, knee-length with snaps rather than buttons,
- Appropriate protective eyewear, as needed- impact glasses, splash goggles, and/or face shield,
- Appropriate gloves, as needed- nitrile, latex, vinyl, leather, or other.

It is the user's responsibility to maintain any personal protective equipment assigned to them in good and useable condition. The lab supervisor is responsible to maintain, in good and useable condition, any generic stock of personal protective equipment for the lab. In any event, if the condition of the protective equipment is in doubt, users must inform their supervisor and not use the equipment.

Leave reusable protective equipment inside lab when leaving the work area. Lab coats should be placed by the point of entry to the lab on a hanger and prevent contact between the inside and outside of adjacent coats or the same coat to avoid contamination of the skin when the coat is next used. PPE should always be segregated from other personal belongings to prevent bringing

contaminants outside of the lab. For smaller PPE such as goggles, a storage area like a drawer or a dedicated portion of a shelf provides a hygienic location.

Lab coats and gloves may not be worn outside the labs as they can spread the contaminants that are on them. Wash hands and forearms with soap and water before leaving the work area, even if you were using gloves. When removing your personal protective equipment do so with care as to avoid contact of your skin with the contaminated side of the protective equipment.

Skin absorption protection

- Appropriate PPE shall be worn by personnel when performing procedures that use chemicals that can irritate or be absorbed by the skin (hazardous by skin contact). This includes gloves and aprons resistant to the chemical.
- Be aware of what the manufacturer specifies as the breakthrough time for the specific glove and chemical.
- Lab coats can prevent contact with minor chemical splashes and spills. If the lab coat doesn't significantly resist penetration by organic liquids, it shall be removed immediately when becoming contaminated.
- Lab coats must be worn in the immediate areas where hazardous chemicals are handles or used. Ideally, these coats must stay in the lab. They are never to be work in other areas outside the lab such as offices, cafeterias, or libraries.

Gloves

Gloves are the most used type of PPE. Without them lab users would be exposed to the chemical hazards that are handled during long hours of experimentation, daily. However, for your protection you must be aware that not all gloves are appropriate for all circumstances. There are multiple types of gloves material available to protect against the wide variety of hazards posed by chemical substances. But, because the permeability and breakthrough time of gloves of the same or similar material vary from one manufacturer to another, no specific recommendations will be provided here. Appendix A 8 lists the chemical resistances of some common glove materials from one manufacturer (also available at this link), to assist in the search but other manufacturers may offer a solution as well. Also available in Appendix A 10 is a shorter compatibility chart. Other manufacturers also offer their own compatibility chart. It is important to review the compatibility data from the manufacturer whose PPE is being used.

Be aware that no glove offers unlimited protection and that hazardous materials will eventually diffuse through when the breakthrough time is reached, therefore you must get familiar with this concept and its implication and monitor the time the glove is in use. Discard the glove once it is nearing its breakthrough time. To account for a glove's time of use, each period the glove is in contact with the substance must be added; therefore, if you want to increase the life of the glove, you should wash it when it is not in use with the appropriate decontaminant.

NOTE: The phrase commonly found on the Safety Data Sheet "Wear impervious (or impermeable) gloves" has very limited value. It is technically inaccurate. No glove material will remain impervious to a specific chemical forever. No one glove material is resistant to all chemicals. Some chemicals will travel through or permeate the glove in a few seconds, while other chemicals may take days or weeks. Information specifying the best type of chemical protective material is what should be on the SDS

(e.g., neoprene, butyl rubber). If this information is missing, contact the supplier or manufacturer of the product. Manufacturers of chemical protective gloves and clothing may also assist their customers in making the appropriate choices or refer to this table for additional information.

There are some other safety practices to using gloves, see below:

- When reusing gloves, always check them for cracks, rips, or erosion prior to wearing them and discard any showing signs of a compromised integrity. Note that aged gloves can deteriorate over time even when they have not been used.
- Do not wear gloves in public areas. Remove gloves before leaving the work area, also before handling lab equipment such as telephones, doorknobs, writing instruments, and laboratory notebooks.
- Gloves shall be reused, cleaned, or discarded, consistent with their use and contamination.
- Gloves are an important part of personal protection. Hazards will be assessed, and the appropriate gloves will be provided. Your instructor will assess the risks of hazards and will require the use of gloves when appropriate and provide the proper type of gloves.
- Gloves should be removed before handling things like cell phones, calculators, laptops, doorknobs, writing instruments, laboratory notebooks, and textbooks.
- Wash your hands when leaving the laboratory, even if you have worn gloves.
- A variety of gloves and materials are available: neoprene, butyl rubber, and many other materials. Different lengths are also available; they can reach the entire arm, the forearm or are only wrist-length.
- Individuals who are latex-sensitive should not wear gloves made of latex.
- Although cloth or leather gloves may protect against hot or cold objects, do not rely on them for protection against hazardous chemicals.
- Disposable gloves and gloves that have been permeated by a chemical should not be reused because the chemical cannot be totally removed.
- Contaminated gloves may be considered hazardous waste, but this is not always the case. In all instances, dispose of your used gloves in the designated hazardous waste container or as directed by your instructor the chemicals being used.
- Always check your gloves before each use to ensure the absence of cracks and small holes.

Eye protection

Eye protection is legislatively required upon exposure to a hazard of eye injury, eg., in the presence of corrosive, flammable or toxic materials. Safety glasses must comply with CSA Standard Z94.3.1-09. Eye protection shall be provided and worn when participating in or observing any other following functions:

- Chemical, physical, or combined chemical-physical operations involving caustic, toxic, irritant or explosive materials, hot liquids or solids, injurious radiation, or any dispensing of hazardous chemicals.
- Goggles or safety glasses that protect the sides of the eye must be worn around procedures using liquid hazardous corrosive chemicals or have a health hazard rating of 3 or 4.

Depending on the protection required during a specific procedure, regular safety glasses, impact-resistant goggles, chemical safety goggles aka spill goggles or a full-face shield may be necessary. The supervisor is responsible for identifying the proper type of protective eyewear. Consult with your supervisor for additional lab-specific information.

More information on recognizing safety eye wear and selection the right type can be found at the Canadian Centre for Occupational Health and Safety. See also Figure 5 showing different types of eye protection.

The Department of Chemistry has enacted a policy that makes it mandatory wearing impact-resistant eyewear upon entering a chemistry lab due to the ever-present risk in these labs. Refer to the document Personal Protective Equipment in the Department of Chemistry for more information.

Supervisors of other labs where the same type of hazards are present must ensure eye protection for their supervisees. Areas such as near high pressure, activities with vacuum equipment or when

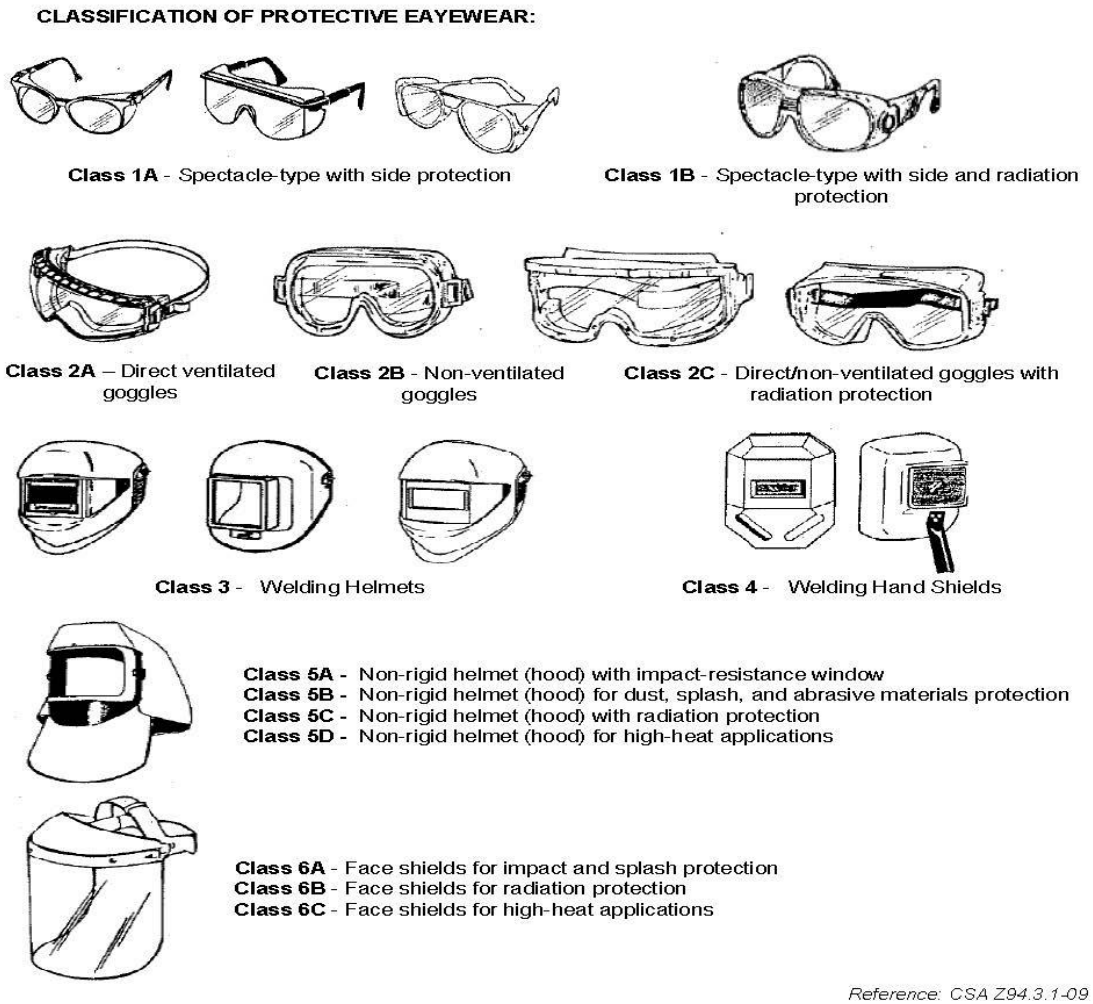


Figure 5. Types of eye protection.

carrying out work that may generate dusts, sprays, or other projectiles, are highly impacted by

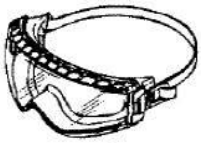
hazards to the eyes, therefore proper eyewear must be secured for and used by the affected employee/student

The wearing of contact lenses in a laboratory is strongly discouraged unless while wearing chemical splash safety goggles. Vapours can readily enter the space between the lenses of impact safety glasses and the eyes. This can make the lenses difficult to remove and further increase the risk of permanent eye damage. Handling lenses in the lab is not permitted. If you need to do so, wash your hands, leave the lab, and manipulate your lenses in a clean area.

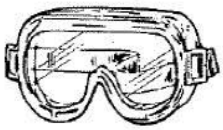
CLASSIFICATION OF PROTECTIVE EAYEWEAR:

Class 1A - Spectacle-type with side protection

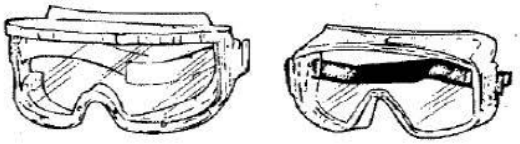
Class 1B - Spectacle-type with side and radiation protection



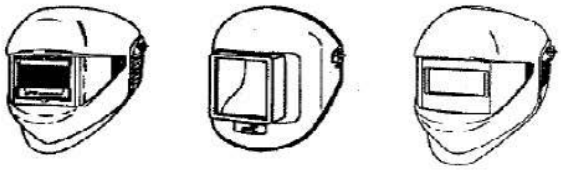
Class 2A – Direct ventilated goggles



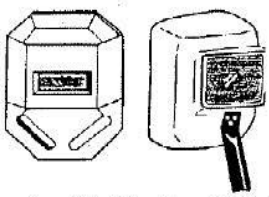
Class 2B - Non-ventilated goggles



Class 2C - Direct/non-ventilated goggles with radiation protection



Class 3 - Welding Helmets



Class 4 - Welding Hand Shields

Class 5A - Non-rigid helmet (hood) with impact-resistance window
Class 5B - Non-rigid helmet (hood) for dust, splash, and abrasive materials protection
Class 5C - Non-rigid helmet (hood) with radiation protection
Class 5D - Non-rigid helmet (hood) for high-heat applications

Class 6A - Face shields for impact and splash protection
Class 6B - Face shields for radiation protection
Class 6C - Face shields for high-heat applications

Reference: CSA Z94.3.1-09

Protective Clothing

Be aware that there are hazards associated with materials commonly used in clothing both street clothing and protective lab attire. For example, cotton is highly permeable and easily degradable by acids. Nylon, polyester, and spandex are easily melted. Spandex clothing will saturate and hold spilled chemicals close to the skin. Evaluate the potential hazards of your activities and wear clothing appropriate for the circumstances of your work. When searching for a lab coat consideration to the type of hazards present is a must.

Lab coats are offered in a variety of fabric and blend and are not suitable for all activities. Select one made of a material that offers proper protection against that specific hazard. Anyone working in a chemistry lab or with bloodborne pathogens should consider wearing a lab coat with knit cuffs. Flame-resistant lab coats are also available and should be worn when there is a risk of flash fires, electric arc or other dangerous conditions. Lab coats are laboratory environment specific and could also be experiment specific, eg. for work with pyrophoric materials.

Here is a break down of the most used materials in lab coats and what its is best used for:

- Synthetic/Cotton Blends: 100% Polyester, 80/20, 65/35 and 60/40 polyester/cotton blend lab coats are the most common lab coats and are good for clinical settings and labs handling biological materials. They are the most combustible and are not considered appropriate for working with flammables should never be used while working with pyrophoric materials. 100% polyester and 80/20 blend lab coats are NOT recommended for chemical laboratories; however, 65/35 and 40/60 polyester/cotton lab coats are generally suitable for chemical research laboratories.
- 100% Cotton: comfortable, superior to synthetic blends for fire-resistance, and are a good affordable compromise for chemical safety than the more expensive Fire-Resistant lab coats. However, these are less resistant than blends and are degraded by acids. 100% cotton is the standard undergraduate lab coat.
- Flame Resistant treated lab coats: These more costly lab coats are better for labs with significant fire hazard, with an understanding of the limitations for flame resistance. Generally, will not lose flame resistance with laundering over typical use life, specific manufacturer recommendations must be followed.
- Dupont Nomex/ aramid fiber: These flame-resistant lab coats are more expensive, but good for lab environments where there is a risk of arc flash or flash fire and recommended for working with pyrophoric materials.

Knee length lab coats are always recommended in laboratories when work involves hazardous chemicals, biohazards, or radioisotopes. All lab coats must have snap fasteners rather than buttons so that they can be quickly removed in the event of an emergency. It is basic principle of protection to not mix contaminated and non-contaminated clothing, therefore when doing laundry choose between segregating them or decontaminating prior to mixing them.

RESPIRATORY PROTECTION

Respiratory protection may be necessary when exposure to certain chemicals and particulates cannot be achieved through other means. There are two types of respiratory protection: respirators and surgical masks.

The decision whether workers need to use either respirators or masks must be based upon a hazard analysis of the specific work environment and the protective properties of each type of personal protective equipment.

Respirators are designed to help reduce the wearer's respiratory exposure to airborne contaminants such as particles, gases, or vapours. Respirators and filters must be selected based on the hazards present. They come in various sizes and styles and should be individually selected to fit the wearer's face and to provide a tight seal. A proper seal between the user's face and the respirator forces inhaled air to be pulled through the respirator's filter material, thereby providing protection.

Surgical masks are designed to help prevent contamination of the work environment or a sterile field from large particles generated by the wearer/worker, eg. to prevent the spread of the wearer's spit or mucus. Surgical masks may also be used to help reduce the risk of splashes or sprays of material from reaching the wearer's mouth and nose. The CSA Standard Z94.4-11 is the reference document to be used for the selection, use, and care of respirators. CCOHS guidelines for respirators can be found here.

The use of hazardous chemical substances abounds in labs. Many volatile substances will quickly emanate gases even only if its container is open. In other instances, experimentation or handling of chemicals will cause mists, vapors to develop. Laboratory air contamination with chemical substances can be controlled most of the time by handling chemicals and performing experiments in a fume in good working order and following the working practices outlined in the Fume Hoods section.

There are instances in which using a fume hood is not sufficient to control the lab user to exposure to hazardous concentrations of chemicals. This may be the case when working with designated substances, when there is chemical sensitivity, and when spills occur.

Each laboratory where substances that are hazardous by inhalation are handled (eg., solvents) must be ready to respond to spills of such substances in a safe manner. This includes having the right type respirators with filter ready and personnel fit tested to wear the respirators. The office of HSW can support by coordinating the fit testing. At this time, external fit testers will be contacted as there is no internal qualified fit tester for the sciences. Laboratory supervisors will be charged for the service.

Contact besafe@brocku.ca if you require respiratory protection for support.

[Table of Contents]

SECTION 6. HOUSEKEEPING, LABORATORY INSPECTIONS, RISK ASSESSMENTS

A principal cause of laboratory accidents is poor housekeeping. *A clean work area is much safer than a cluttered or dirty one, and all laboratory personnel must strive to maintain an orderly and safe laboratory setting as it impacts not only their safety but the potential safety of others who work/visit the lab.*

Cleanliness and tidiness of laboratories is a shared responsibility between lab users and custodians, with the bulk of it weighing on lab users. Due to the multitude of chemical, biological, or radioactive hazards in labs which pose a high risk to not highly skilled personnel if they were to handle/clean them, custodians only clean floors and remove general garbage and clean glass waste from labs. It is the responsibility of the lab's users to keep bench tops, sinks and any other surfaces free from contaminants after each day of work, at a minimum.

GENERAL HOUSEKEEPING PRACTICES

- Access to emergency equipment, showers, eyewash stations, and exits must never be blocked.
- Keep all work areas, and especially work benches, clear of clutter and obstructions. Properly store items when not in use.
- Do not place chemicals within two inches of the edge of a lab bench (to avoid accidental knocking off of bench).
- Chemicals must be stored properly (e.g., incompatibles are separated), and must not be stored in/on fume hoods, desks, or lab benches.
- Keep all aisles, hallways, and stairs clear of all chemicals and other obstructions; *never store or place chemicals on the floor*.
- Never stack chemicals in the laboratory; containers must be stored upright.
- Coats, bags, and other personnel items must be stored in the proper area, not on the bench tops, or near chemicals or equipment that is in use.
- All work surfaces and floors should be cleaned regularly.
- Keep all floors and work surfaces dry.
- Promptly clean up all spills, including water spills and ice, and properly dispose of all spilled chemicals.
- Clean up work areas at the end of the operation or day.
- Keep drawers and cabinets closed to avoid accidents.
- To avoid the presence of noxious fumes arising from the sewer lines, each Laboratory Supervisor should ensure that a liter of water is poured down each laboratory drain at least monthly to ensure that the drain trap is functional.
- Hallway doors of all laboratories must remain closed to maintain the proper negative airflow from the hallways into the labs.
- Promptly dispose/recycle packing materials and empty cartons.
- Inspect faucets to see that they work properly and do not drip.

- Make sure that hose/tubing connections on faucets and other items are secure, and that hose/tubing is not brittle. Immediately replace any old or degraded hose/tubing.

Glassware and Sharps (e.g., needles and blades)

- See also the section on Sharps waste for specific procedures.
- Make sure that disposal containers for broken glass and sharps are well labeled and placed in low-traffic areas.
- Properly dispose of broken glassware and sharps. If these items are contaminated with a hazardous substance, they need to be treated as hazardous waste and disposed in the appropriate waste container.
- Never use cracked or chipped glassware; promptly discard these items in the broken glass container.
- Do not stack beakers, flasks, etc.
- If glassware is stored on open shelving, then use the black storage bins, or some other type of guard, to keep the glassware from falling off the shelf.
- Wear appropriate gloves to clean glassware; do not pile up dirty or clean glassware.
- Wash glassware carefully (dirty water can hide glass fragments).

Electrical Equipment

- Electrical equipment should be maintained by trained individuals only.
- Never overload circuits; use surge protection power strips and Ground Fault Circuit Interrupters as needed.
- Properly ground all electrical equipment.
- Be sure that all cords are well placed, in good shape, and away from water. Keep cords out of aisles.
- Immediately report any electrical failure or suspicious heating of equipment to the stockroom manager.
- Refer to chapter 7 of “Prudent Practices” [1] for guidelines for handling assorted electrical laboratory equipment.

Lab supervisors are to ensure that inspections of the lab are performed regularly to detect any deficiency in facilities, equipment, etc. that may compromise the safety of its occupants. These deficiencies should be reported to facilities management or the department chair as appropriate for solution in a timely manner.

Much of what lab inspections reveal are issues with tidiness and excess of unused materials which must be solved by the laboratory users themselves, while following the University’s guidelines for decontamination, local risk assessments, and other safety programs.

A Lab Safety Self Inspection Checklist should be filled out prior to starting any new work in the lab and reviewed regularly. It contains aspects of health and safety that should be considered such as PPE,

safety equipment, handling and storage of volatile substances and waste disposal practices. This can be found in the Appendix A 3.

A Laboratory Emergency Preparedness Checklist is available and contains recommended steps to take prior to an event that may result in an interruption of laboratory operations. This form can be found in the Appendix A 4.

A Laboratory Risk Assessment should be completed when new lab-based research will be performed at Brock University. This is used to identify hazards at each step of research and to provide essential information for enhancing safety practices, establishing proper procedures, and ensuring all lab members are properly trained. This template can be used to help with gathering all relevant information. It is available in the Appendix A 6.

[Table of Contents]

SECTION 7. SAFETY EMERGENCY EQUIPMENT AND DEVICES

EYEWASH STATION AND EMERGENCY SHOWERS

Accidental chemical or biological exposures can occur even with good engineering controls and safety precautions. As a result, it is essential to look beyond the use of personal protective equipment. **The first 10 to 15 seconds after exposure to a hazardous substance, especially a corrosive substance, are critical. Delaying treatment, even for a few seconds, may cause serious injury.** Emergency showers and eyewash stations minimize the effects of accident exposure to chemicals by providing on-the-spot decontamination. They allow workers to flush away hazardous substances that can cause injury. Emergency showers can also be used effectively in extinguishing clothing fires or for flushing contaminants off clothing.

Brock University is committed to the prevention of illness and injury through the provision and maintenance of healthy and safe conditions throughout its premises and activities. The University endeavors to provide a hazard-free environment and minimize risks by adherence to all relevant legislation and, where appropriate, through the development and implementation of additional internal standards, programs, and procedures.

The Ontario Occupational Health & Safety Act Regulation 851 Part III establishes that “Where a worker is exposed to a potential hazard of injury to the eye due to contact with a biological or chemical substance, an eyewash fountain shall be provided. Where a worker is exposed to a potential hazard of injury to the skin due to contact with a substance, a quick-acting deluge shower shall be provided”. Therefore, in harmony with Brock University Occupational Health and Safety Policy, and in adherence to the afore-mentioned legal provisions the program for Emergency Eyewash Stations and Safety Showers has been developed by Health, Safety & Wellness in collaboration with Facilities Management.

Installation / Location Requirements

- Currently, there is no Canadian standard for the design or placement of eyewash stations or emergency showers. As a result, the American National Standards Institute (ANSI) Standard Z358.1-2009 "Emergency Eyewash and Shower Equipment" is generally used as a guide [**Error! Reference source not found.**].
- Where a worker/student is exposed to a potential hazard of injury to the eye and the skin due to a contact with a biological or chemical substance, a job hazard analysis (JHA) shall be conducted to determine if potential for an injury exists. **The hazard analysis shall be conducted by the supervisor of the area where the substance is used.** Assistance from the department of HR/HSW may be requested at besafe@brocku.ca.
- Only equipment that is certified by the manufacturer as meeting specifications in ANSI Z358.1 may be placed in new facilities. HR/HSW can assist to provide recommendations on the appropriate unit required. Refer to “Quick compliance Guide to ANSI Z358.1-2009” (a supplement distributed with this document) for specific requirements.
- Existing university facilities must be equipped as necessary to include emergency drenching and/or flushing equipment that is readily accessible and can be reached within 10 seconds from the area(s) where there is a potential for injury due to spills or splash of hazardous material.

- Off-site/remote locations must have drenching/flushing equipment available whenever work involves the use of hazardous materials and where there is a reasonable potential for injury due to contact. Plumbed units that are maintained by the owner/controller of an off-site facility may be used or self- contained units can be purchased. A water hose supplying potable water and equipped with a proper face and body wash nozzle can be used at off-site locations where the possibility of exposure to injurious hazardous materials is very low and when proper personal protective equipment is used.
- The temperature of the flushing fluid for emergency drenching and flushing equipment should be tepid (lukewarm). A means of controlling the temperature to more than 15.6^0 C and less than 37.8^0 C must be included in tempered flushing fluid systems.
- Flushing fluid shut off valves located within branch lines serving emergency eyewash and safety shower equipment should be tagged to indicate that turning off the valve would turn off the supply to the emergency equipment.
- Emergency drenching and flushing equipment must be identified by highly visible signage in green[1].

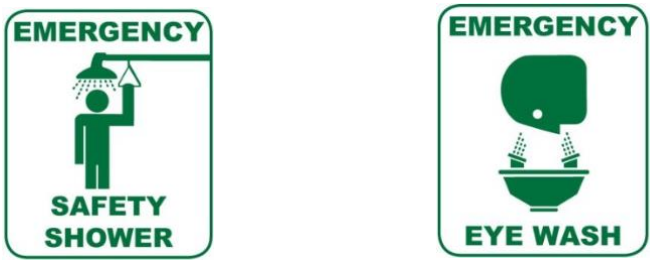


Figure 6. Standard Signage for Emergency Shower / Eye Wash Station

First Aid Stations & AED

First aid stations and AED are situated throughout campus. A list of the locations of these devices can be found here. A map with these devices is also located within this program on page 19.

First Aid Kits

First aid kits should be present in every area/lab at where hazards present may lead to injuries requiring first aid. It is the duty of the lab supervisor to keep this kit well stocked for lab users under their supervision. The first aid kit composition should be based on an assessment of the possible injuries that may result from the hazards present and the lab activities. This, along with every other safety equipment, should be taken note of before beginning lab work.

[1] The color code for safety signage and equipment is green as established by the ANSI standard Z535.1.

The Gases Monitoring System in MC G200

This section describes the setup installed in MC G200 to detect elevated concentrations of the gases CO_2, Chlorine, and Nitric Oxide, and low concentrations of Oxygen.

For the emergency procedures in relation to these gases, refer to Procedures for Alarms in MC G200

Sensors: The gas storage room in MC G200 is equipped with four distinct sensors for the detection of (Refer to Figure 7)

- increased air concentration of Carbon dioxide (CO2),
- increased air concentration of Chlorine (CL2),
- increased air concentration of Nitric Oxide (NO), and
- decreased air concentration of Oxygen (O2)

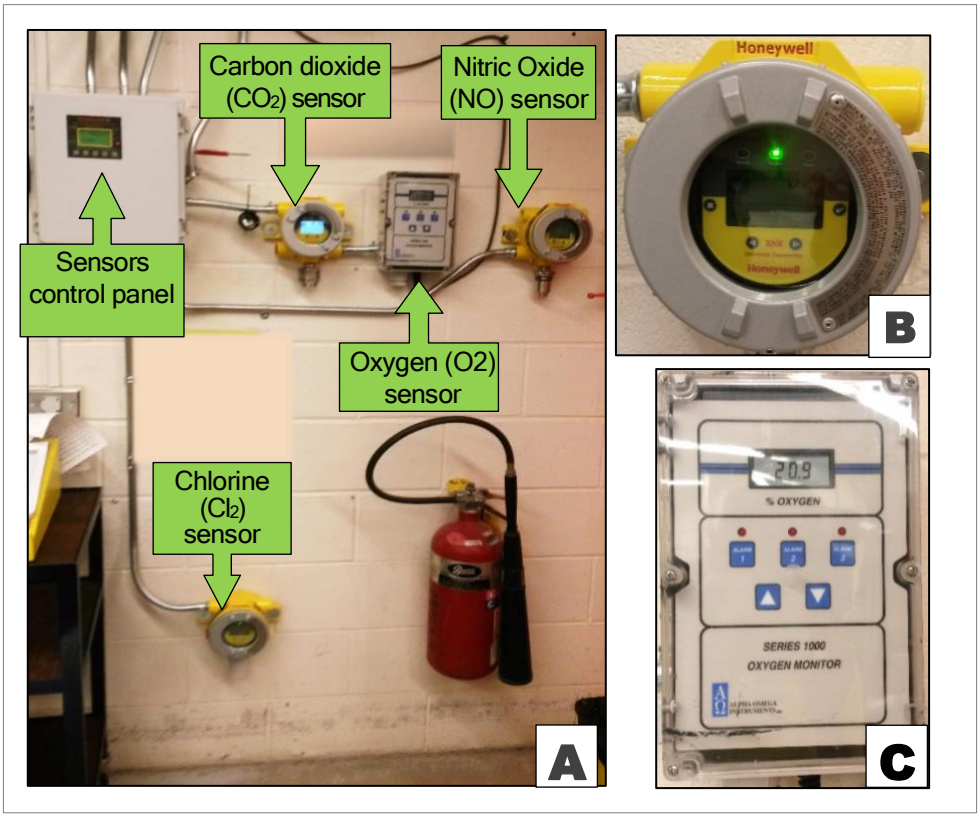


Figure 7. A- Position of gases sensors in the gas storage room in MC G200. B Close-up of individual sensors (Cl_2, CO_2, NO). C- Close-up of the Oxygen sensor.

In addition to the gas sensors, the operational status of fan #1 is monitored by a sensor that registers the passage of electrical current. When no current is detected, a signal is sent to the security control panel indicating fan failure. The Oxygen sensor settings are different to the rest of the three other gases in that when the concentration reaches the value 19.5 % the fan #1 will start but no alarm will be heard. When the concentration decreases to 19% the Stage 2 alarm is triggered.

Alarms

When the concentration of any of these elements reaches a pre-set value defined Table 4 Stage 1 (S1) or Stage 2 (S2) alarm is triggered as described below.

The pre-set values for the S1 and S2 alarms are substantially lower than the Immediately Dangerous to Life and Health (IDLH) concentrations set by OHSA for each element, which accommodates sufficient time for room occupants to evacuate upon alarm activation.

Stage 1 (S1) alarm

When the concentration of any of the following gases: **Carbon Dioxide, Nitric Oxide or Chlorine** in the room reach the Stage 1 set point in Table 5, the following events will automatically kick off:

a) An audible alarm in addition to a clear strobe light is activated within the room and can be seen from both the room by the users and via the entrance door viewing window.

b) Exhaust fan #1 (the lower fan located next to the nitrogen generator) starts.

c) Campus Security Services (CSS) is notified via pager, and

d) The sensor's display activates, and red lights start flashing on each sensor display and, on the sensors control panel.

e) **FOR OXYGEN ONLY:** when the concentration of Oxygen reaches 19.5% the only event triggered is the start of Fan # 1. The fan will go on until the concentration of Oxygen increases over 19.5%.

Table 4. IDHL concentrations and alarms pre-set values for CL2, CO2, NO and O2 in room MC G200

Chemical Element	Concentration (ppm) on *S1 Alarm*	Concentration (ppm) on *S2 Alarm*	IDLH* concentration
Chlorine -Cl_2	1	2	10
Carbon Dioxide- CO_2	5000	10 000	40 000
Nitric Oxide- NO	40	100	100
Oxygen- O_2	19.5	19.0	N/A

*IDLH – Immediately dangerous to life and death, the concentration of any dangerous substance that poses an immediate threat to life.

Stage 2 (S2) alarm

When the concentration of any of the following gases: **Carbon Dioxide, Nitric Oxide or Chlorine** including **Oxygen** in the room reach the Stage 2 set point in Table 4, the following events will automatically occur:

a) An audible alarm and a red strobe light generated in the hallway outside the room are evident to persons approaching; and

b) Campus Security Services (CSS) is notified.

c) The alarm continues until the concentration of the element (s) that have activated it drops below the value shown in Table 1 for the case of Chlorine, Carbon Dioxide and Nitric Oxide gases, or rises above 19% in case of an alarm due to Oxygen depletion.

[Table of Contents]

SECTION 8: SAFETY PROTOCOLS AND EQUIPMENT

LABORATORY EQUIPMENT

Lab equipment that can reasonably help mitigate any risks posed by an experiment should be used. For example, performing steps in the fume hood (see further down) to prevent fumes from accumulating in the lab is a good way to mitigate risk. Any equipment that requires repair or preventative maintenance must be addressed by the supervisor of the lab.

Other equipment, such as flammable storage cabinets, is required by the Occupational Health and Safety Act to mitigate risks posed by storing flammables, especially high quantities. An additional resource about flammable storage cabinets can be found here.

Any lab equipment that will be moved from the lab area for repair, replacement, movement to another area etc. must be decontaminated before leaving.

BIOLOGICAL SAFETY

Biologicals that are being used in the lab must be handled with care. Biological hazards are any biological agent, substance, or material (whether alive or not) present in or arising from living organisms, that are or may be hazardous to the health or welling being of environment or people. Be aware of the risk group any live specimens are a part of and follow guidelines to proper containment and handling methods. Any biological substance that falls under a designated risk group must be stored and used in the containment level as outlined by Canadian Biosafety Standards. Refer to the biosafety manual for further information about safety considerations in contained biology labs.

FIRE SAFETY

In addition to using flammable storage cabinets to store volatile chemicals, a plan in case of a fire needs to be implemented in every lab. The safest route to exit the building must be identified before an emergency should the need to evacuate arise.

If you discover a fire, activate the nearest Fire Alarm Pull Station, and evacuate the lab immediately. Warn others immediately to leave the building at the nearest safe exit or fire stair- help any handicapped person reach the stairwell. Attempt suffocating the fire with a cover or extinguisher ONLY if safe (small, contained fire & exit route clear) and able, up to 1-minute maximum, otherwise leave the fire area and close doors. Call Emergency Services (911) from a safe location to ensure response and then Brock campus security (905-688- 5550) X3200 to advise of location/circumstance. Return to the lab only when advised by a person of authority, e.g., fire warden, campus security staff, emergency responders, safety personnel.

If you hear a fire alarm, immediately leave the building at the nearest safe exit or fire stair- help any handicapped person to reach the stairwell and advise campus security at ext. 3200. Return to the lab only when advised by a person of authority, e.g., fire warden, campus security staff, emergency responders, safety personnel.

RADIATION SAFETY

Radiation safety training offered through Brock is required for all people who will be working with radioisotopes to outline safe practices and procedures that comply with requirements established by the Canadian Nuclear Safety Commission. A document called Radiation Safety Policy and Procedures is available on SharePoint that outlines requirements, training, risks and responsibilities of a worker that handles or works with nuclear energy sources.

ELECTRICAL SAFETY

Like almost every other workplace, laboratories contain electronic equipment. Electrical safety rules help prevent the misuse of electronic instruments, electric shocks, and other injuries, and ensure that any damaged equipment, cords, or plugs are reported to the appropriate authorities so they can be repaired or replaced.

Facilities management should be contacted for installing new equipment. Extension cords, power strips or multiple outlets on regular sockets should never be used due to the energy required for most lab equipment and an overloaded circuit could be particularly dangerous and consequential in a lab. If necessary, they should only be used temporarily and not run under doors, across walkways, through windows or holes or near sinks.

- Before using any high voltage equipment (voltages above 50V rms ac and 50V dc), make sure you get permission from your lab supervisor.
- High voltage equipment should never be changed or modified in any way.
- Always turn off a high voltage power supply when you are attaching it.
- Use only one hand if you need to adjust any high voltage equipment. It's safest to place your other hand either behind your back or in a pocket.
- Make sure all electrical panels are unobstructed and easily accessible.
- Do not use or store highly flammable liquids near electrical equipment.
- Do not use any electrical equipment found to be frayed or damaged. Contact FM for a replacement, never attempt to repair equipment yourself.

LASER SAFETY

Perhaps not as common as some of the other laboratory safety rules listed here, many laboratories do use lasers and it’s important to follow some key rules of thumb to prevent injuries. In particular, accidents due to reflection are something that many employees may not think about. A clear set of rules for the use of lasers is essential to ensure that everyone is aware of all hazards and that the appropriate personal protective equipment is worn at all times.

- Even if you are certain that a laser beam is "eye" safe or low power, you should never look into it.
- Always wear the appropriate goggles in areas of the lab where lasers are present. The most common laser injuries are those caused by scattered laser light reflecting either off the shiny surface of optical tables, the sides of mirrors, or off of mountings. Goggles will help you avoid damage from such scattered light.
- You should never keep your head at the same level as the laser beam.

- Always keep the laser beam at or below chest level.
- Laser beams should never be allowed to spread into the lab. Beam stops should always be used to intercept laser beams.
- Do not walk through laser beams.

GLASSWARE

Good equipment maintenance is essential for safe and efficient operation. Laboratory equipment should be inspected and maintained regularly and serviced on schedules that are based on both the likelihood of and the hazards from failure. Maintenance plans should ensure that any lockout procedures cannot be violated.

Careful handling and storage procedure should be used to avoid damaging glassware. Chipped or cracked items should be discarded or repaired. Vacuum-jacketed glassware should be handled with extreme care to prevent implosions. Evacuated equipment such as Dewar flasks or vacuum desiccators should be taped or shielded. Only glassware designed for vacuum work should be used for that purpose.
Hand protection should be used when picking up broken glass. Small pieces should be swept up with a brush into a dustpan.

Glassblowing operations should not be attempted unless proper annealing facilities are available. Adequate hand protection should be used when inserting glass tubing on glass hose connections. Cuts from forcing glass tubing into stoppers or plastic tubing are the most common kind of laboratory accident and are often serious. Tubing should be fire polished or rounded and lubricated, and hands should be protected with toweling and held close together to limit movement of glass should it fracture. The use of plastic or metal connectors should be considered.

Borosilicate glass Type 1 and 2 is recommended for any lab work because of the additional thermal stability of this glass compound. It is more likely to withstand extreme temperature fluctuations and the shatter will be bigger, less sharp pieces should the glass break. Type 1 is suitable for most lab work. Type 2 contains a treatment to the internal surface of the glass that reduces ion exchange so is used for intravenous fluid administration. Contact Science Stores if you require glassware.

FUME HOODS

A Fume Hood is a mechanically ventilated, partially enclosed workspace intended to contain and remove gas, vapour, or aerosol generated within the enclosure. Airborne contaminants are exhausted from the fume hood chamber to an area outside the building, with the objective of preventing the spread of contaminants to the laboratory. A fume hood is an integral part of the building air handling system. The efficiency of operation is essential in maintaining good air quality in laboratories.
As a rule of thumb, use a hood or other local ventilation device when working with any appreciably volatile substance with a threshold limit value (TLV) of less than 50 ppm.

Since laboratory fume hoods minimize chemical exposure to laboratory users it is important that all potentially harmful chemical work be conducted inside a properly functioning fume hood.

This information applies to Conventional, By-pass, Variable Air Volume (VAV) and Walk-in fume hoods. This information will provide a standard for selection, installation, usage and maintenance of the laboratory exposure control systems.

Specialty fume hoods such as Radioactive Material, Explosion Proof and Perchloric Acid fume hoods require special design considerations that are dealt with on a case-by-case basis through Health, Safety and Wellness.

Hood Types

There are many types of hoods, each with its own design and function. To identify which hood type is present in your lab, a list of definitions describing hood features and their advantages and disadvantages is provided below.

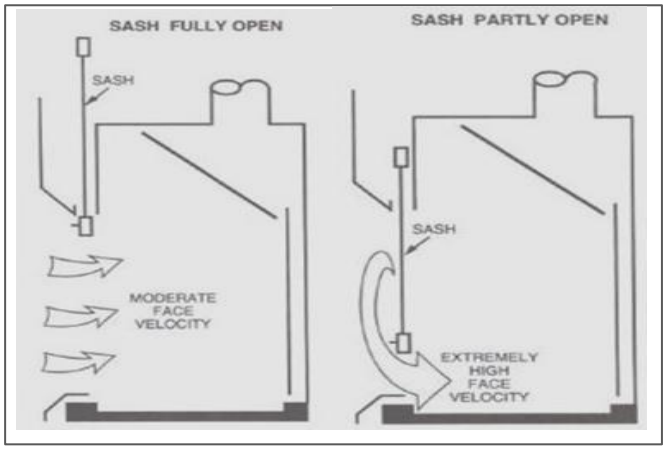


Figure 8. Conventional Fume Hood without bypass

Constant air volume principle

This term is used to describe a constant air volume (CAV) hood, an older, traditionally less elaborate hood design used for general protection of the laboratory worker. Because the amount of exhausted air is constant, the face velocity of a CAV hood is inversely proportional to the sash height. That is, the lower the sash, the higher the face velocity. CAV hoods can be installed with or without a bypass provision which is an additional opening for air supply into the hood.

Conventional hood without a bypass

Some conventional hoods do not have a provision for a bypass. Essentially, they consist of an enclosed cabinet with a connection for an exhaust duct and a movable sash on the front. Most hoods in Mackenzie Chown are of this type.

Conventional bypass fume hood

The bypass fume hood is an improved variation on the conventional fume hood. The bypass is located above the sash face opening and protected by a grille which helps to direct air flow. The bypass is intended to address the varying face velocities that create air turbulence leading to air spillage. The bypass limits the increase in face velocity as the sash nears the fully closed position, maintaining a relatively constant volume of exhausted air regardless of sash position.

Auxiliary air hoods

This fume hood, sometimes referred to as a makeup air fume hood, was developed as a variation on the bypass fume hood and reduces the amount of conditioned room air that is consumed. The auxiliary fume hood is a bypass hood with the addition of direct auxiliary air connection to provide unconditioned or partially conditioned outside makeup air. Auxiliary air hoods were designed to save heating and cooling energy costs, but tend to increase the mechanical and operational costs due to the additional ductwork, fans, and air tempering facilities. In general, installation of this type of hood is discouraged since the disadvantages usually outweigh the benefits.

Variable air volume principle

Variable air volume (VAV) hoods differ from constant air volume (CAV) hoods because of their ability to vary air volume exhausted through the hood depending on the hood sash position.

A VAV hood maintains a constant face velocity regardless of sash position. To ensure accurate control of the average face velocity, VAV hoods incorporate a closed loop control system. The system continuously measures and adjusts the amount of air being exhausted to maintain the required average face velocity. The addition of the VAV fume hood control system significantly increases the hood's ability to protect against exposure to chemical vapors or other contaminants. Many VAV hoods are also equipped with visual and audible alarms and gauges to notify the laboratory worker of hood malfunction or insufficient face velocity. Vast majority of the fume hoods in the Cairns building are of this type.

Specialty Lab Exhaust Systems

The following is the list of specialty fume hoods available in the market.

Walk-in hood

A walk-in hood is a hood which sits directly on the floor and is characterized by a very tall and deep chamber that can accommodate large pieces of equipment. Walk-in hoods may be designed as conventional, bypass, auxiliary air, or VAV.

Fume exhaust connections

Fume exhaust duct connections, commonly called snorkels, elephant trunks or flex ducts, are designed to be somewhat mobile allowing the user to place it over small area needing ventilation. However, for optimal efficiency, these connections must be placed within six (6) inches of an experiment, process, or equipment. These funnel-shaped exhausts aid in the removal of contaminated or irritating air from a point source to the outside.

Canopy hoods

Canopy hoods are horizontal enclosures having an open central duct suspended above a work bench or other area. Canopy hoods are most often used to exhaust areas that are too large to be enclosed within a fume hood. The major disadvantage with the canopy hood is that the contaminants are drawn directly past the user's breathing zone.

Glove boxes

Glove boxes are used when the toxicity, radioactivity level, or oxygen reactivity of the substances under study pose too great a hazard for use within a fume hood. The major advantage of the glove box is protection for the laboratory worker and the product.

Perchloric acid and radioisotope fume hoods

Perchloric acid hoods have wash-down capabilities to prevent the buildup of explosive perchlorate salts within the exhaust systems. Both perchloric acid and volatile radioisotope work require specific fume hood use protocols.

Hydrofluoric Acid work in fume hoods

Hydrofluoric acid is highly corrosive and toxic. Since some fume hoods are old, they may not be up-to-standard to work a highly corrosive substance, therefore, before engaging in work with HF, interested

users are to contact HSW to coordinate assessing the integrity of the hood with facilities management. For your own protection and that of others, DO NOT use HF until you have been approved to do so.

Operating Performance of Fume Hoods

Location

The location of the hood affects its efficiency. Ideally, fume hoods should be located in an area of minimal traffic. When a person walks by a fume hood, turbulence can be created causing contaminants to be drawn outside the hood. Also, if the air diffuser is located directly above the fume hood, air turbulence may be created causing contaminants to escape into the room. The air flow into the room influences the fume hood. All doors and windows should be kept closed to maintain the negative pressure of the lab with respect to the outside corridor. This ensures that any contaminants in the lab will be exhausted through the fume hood and not escape into the hallway.

Face velocity

Face velocity is a measurement of the average velocity at which air is drawn through the face of the fume hood. Face velocities too high or too low can be detrimental to the performance of the fume hood. The acceptable range of the average face velocity may vary between 80-130 feet per minute (fpm).

At face velocities greater than 150 fpm, studies have demonstrated that the creation of turbulence causes contaminants to flow out of the hood and into the user's breathing zone.

In modern hoods, such those installed in the Cairns building, airflow alarms are built into the units to provide an audible signal when the hood face velocity falls below safe values, as established by the manufacturer (80 fpm in these hoods). These hoods are also equipped with a small display that indicates the current average face velocity.

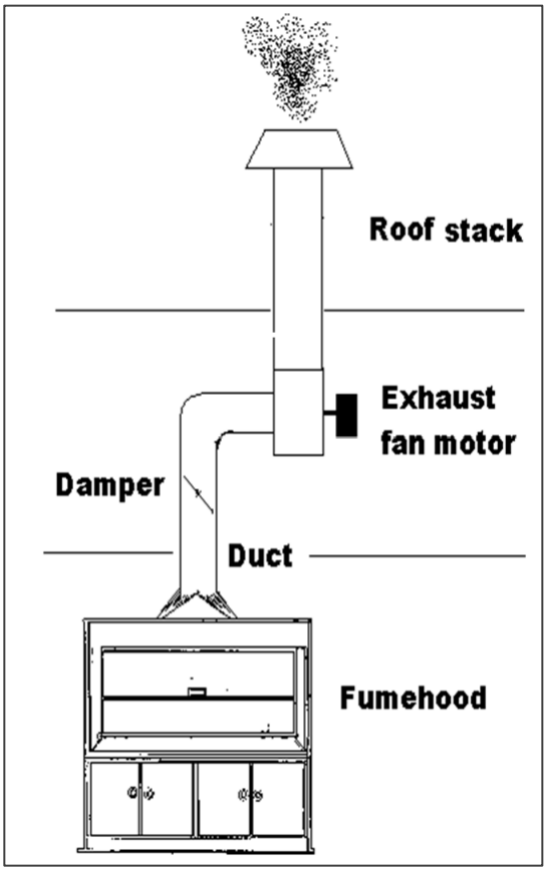


Figure 9. Schematics of a fume hood connected to ductwork that exhausts to the outside of the building.

Alarms

When an alarm is sounding or when a display shows lower than 80 fpm, DO NOT CONTINUE using the hood and report Facilities Management. Proceed to set up experiments in another hood until the required face velocity (80-120 fpm) has been restored; DO NOT SILENCE the alarm until these instructions have been followed.

Air Flow Indicators

If an alarm is not installed, as is the case for many fume hoods in the Mackenzie Chown buildings, check for inward airflow with a paper strip hung from the bottom of the hood sash. Do not rely on noise from the fume hood to indicate proper operation as blower motor noise may persist even if a fan belt breaks.

Laboratory fume hoods are the first defense to minimize chemical exposure to lab users. They are considered the primary means of protection from inhalation of hazardous airborne contaminants. It is,

therefore, important that all potentially harmful chemical work be conducted inside a properly functioning fume hood.

To achieve the maximum operator protection, it is essential that fume hoods are used only for the application they were designed for. Chemical fume hoods must not be used for biological work, chemical storage, spray painting or any operation incompatible with materials used in the hood construction.

Maintenance Checks

The efficiency of a fume hood is very dependent on its functional status and on how it is used. Users must ensure proper operation of fume hoods by performing the following "maintenance checks" before each use:

- Inspect the physical condition of the hood interior, sash, and visible duct work.
- Check sash for ease of operation. The fume hood safety-glass sash protects the user in case of fire or explosion as well as from fumes.
- Test airflow monitoring device when present or read the flow rate on display. It should read 80-120 fpm. Alternatively, for older hoods without monitoring capabilities, check for inward airflow with a paper strip hung from the bottom of the hood sash.
- Check mechanical services inside the hood, eg. water, steam, compressed air, gas, vacuum, etc.

Prudent Work Practices

When using a fume hood, it must remember that the hood does not provide absolute containment from the materials in the hood under every circumstance but, a properly designed hood in a properly designed room can provide adequate protection if the following practices are observed:

- Ensure that the hood has a certification sticker listing date within a year and confirm adequate hood performance before use.
- DO NOT EVER conduct work in a malfunctioning fume hood.
- Clean and tidy the hood workspace, especially to remove hazardous material not pertinent to the work at hand as they may magnify an accidental fire or explosion.
- Don’t block airflow. Raise large objects 2 inches (5 cm) off the counter (See Figure 9A). This allows airflow underneath and prevents stagnant areas.

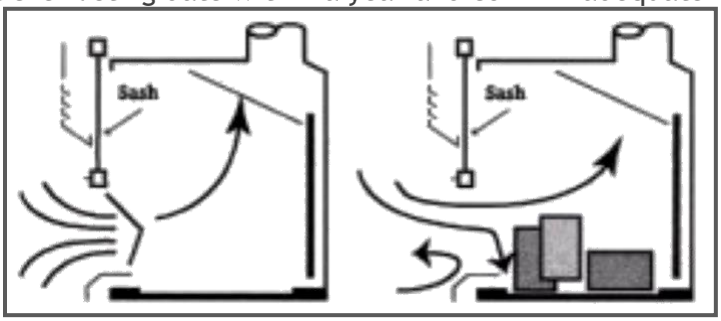


Figure 10. Airflow patterns through empty and cluttered fume hoods.

- Place equipment and materials at least 6 inches back from the face of the hood so these items do not obstruct the movement of air into the hood (see Figure 9B) or across the baffle's slots. This also reduces influence of drafts from people, doors, air supply diffusers, etc.

- Keep the hood free of unnecessary equipment. Stored materials may cause disruption to airflow patterns within the hood and pose a risk to the user. See diagram below (Figure 8) of airflow patterns through empty and cluttered fume hoods.

- During manipulation and operation within the fume hood, sashes shall be kept at the certification sticker height to ensure proper air flow for protection. Close the sash as much as possible when working at the fume hood- use the glass as a face shield.

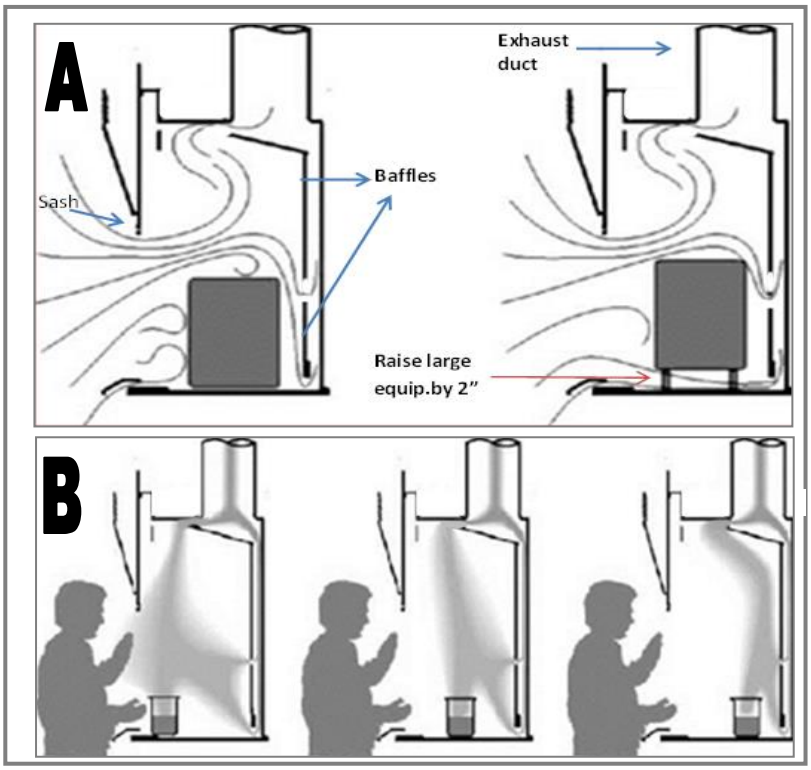


Figure 11. A- Large equipment is raised to allow air flow through. B- Experiments conducted 6 inch back from sash to prevent contaminants from escaping back into lab.

- Avoid potential exposures by not putting any part of your body, with the exception of hands and forearms, into the fume hood.
- Leave the hood "on" when it is not in active use if toxic substances are stored in it or if it is uncertain whether adequate general laboratory ventilation will be maintained when it is "off".
- When fume hoods are not being used, fully lower the sash to offer protection from experiments inside the hood or otherwise contribute with the building ventilation system efficient balance to decrease the carbon footprint.
- The hood should not be used as a storage area or overloaded with unnecessary equipment and materials. The presence of these materials can seriously affect the air flow in the hood.
- Use an appropriate barricade if there is a chance of an explosion.
- If the fume hood is covered with materials to protect light sensitive substances, then an opening not less than that which can be considered safe for operation shall be maintained.
- Electrical receptacles or other spark sources must not be placed inside the hood when flammable liquids or gases are present. Electrical connections should be made outside the hood and no permanent electrical receptacles are permitted in the hood

- Traffic past the face of the hood must be minimized. Air flow caused by such traffic can seriously disrupt the operation of the hood and cause gases and vapors to be drawn out of the hood into the room.

Fume Hood Dysfunction

In case of fume hood malfunction, do the following:

- Discontinue use of fume hood
- Post the notice **DO NOT USE, OUT OF ORDER**, as to prevent anyone from using it
- Inform your supervisor
- Contact Facilities Management at x 3717 or HSW x 7233. Report the problem, exact location, your name and a phone extension.

Additional information about fume hoods can be found in the Laboratory Fume Hood Program on the Health, Safety and Wellness Toolbox. This provides guidance on role and responsibilities, annual testing and certification and system maintenance.

USE AND MAINTENANCE OF AUTOCLAVES

Autoclave access and use must be predeceased by training and ideally an in-person demonstration of appropriate use. If there are any mechanical issues while operating an autoclave, contact machine shop and inform them of waste that is inside.

Smaller lab autoclaves

Small, lab specific autoclaves must be monitored by the lab supervisor. FM can be contacted for any concerns on the operation

Cairns 108

CRN108 is home to the general-use autoclave. Proxy access to enter this room is required and is conditional upon completion of training. Contact cbucciarelli@brocku.ca if you require access to this room. Autoclaves require routine validation that is performed by HSW at this site. There are cycles programmed in the autoclave and are listed below:

Cycle ID	Material Type	Temp (^{0}C)	Ster. time (min.)	Dry time (min.)
1. WRAPPED (Dynamic Air Removal, aka Prevacuum)	Wrapped instruments; Textile packs; Wrapped utensils.	132	4	5
2. GLASSWAR (Gravity Displacement)	Glassware	132	20	20
3. PLASTICW (Gravity Displacement)	Plasticware	121	25	20
4. LIQ 15 (Liquid)	Liquids/semi-liquids.	121	15	-
5. LIQ 45 (Liquid)	Liquids/semiquids or media. Liquid biohazardous waste.	121	45	-

6. BIOWASTE (Prevacuum)	Solid biohazardous waste (may contain residual/small volumes of liquid) in the standard orange bags. Soil and soil waste.	132	4	0

MC H321

The autoclaves in MCH321 are maintained by the biology department and are its main users. Therefore, with a few exceptions, only active biology researchers and lab demonstrators have keys to this room. There are 2 autoclaves in this room with different sizes, capacities and sterilization cycles. Specific training is required to acquire access to this room, contact jciolfi@brocku.ca for more information about access and training. These autoclaves have the following programmed cycles:

CYCLE ID	MATERIAL TYPE	TEMP (°C)	STER. TIME (MIN)	AUTOCLAVE #
PREVAC 5	Solid biohazardous waste	132	4	3
LIQUID 6	Liquid or semiliquid biohazardous waste	121	45	3
PREVAC1	Solid biohazardous waste	132	4	4
LIQUID 13	Liquid or semiliquid biohazardous waste	121	45	4

CENTRIFUGES

As one of the most used pieces of lab equipment and one that can result in serious injury if used in correctly, some risk mitigation strategies are taught.

- Tabletop centrifuges are to be securely anchored in a location where its vibration will not cause bottles or other equipment to fall
- Ensure that the load balances and the balanced tubes are placed opposing one another
- Always close the centrifuge's lid during operation
- Do not leave until full operating speed is attained and the centrifuge appears to be running safely without Vibration
- Stop immediately and check the load balances if vibration occurs
- Regularly clean rotors and buckets with noncorrosive solutions

A separate SOP of safe centrifuge use and operation can be found here.

[Table of Contents]

SECTION 9. LABORATORY SAFETY PRACTICES AND PROCEDURES

Science laboratories present various kinds of hazards; some are common to all labs, whereas others are specific to that space. This section covers the general practices and procedures that when followed properly will minimize the risk to health and safety posed by said hazards. Laboratory supervisors are responsible to expand these general guidelines to suit their individual needs and to develop procedures specific to their lab and activities which are not covered here.

General Lab Safety Rules

The following are rules that relate to almost every laboratory and should be included in most safety policies. They cover what you should know in the event of an emergency, proper signage, safety equipment, safely using laboratory equipment, and basic common-sense rules.

1. Be sure to read all fire alarm and safety signs and follow the instructions in the event of an accident or emergency.
2. Ensure you are fully aware of your facility's/building's evacuation procedures.
3. Make sure you know where your lab's safety equipment—including first aid kit(s), fire extinguishers, eye wash stations, and safety showers—is located and how to properly use it.
4. Know emergency phone numbers to use to call for help in case of an emergency.
5. Before you start an experiment, make sure you are fully aware of the hazards of the materials you'll be using.
6. When refluxing, distilling, or transferring volatile liquids, always exercise extreme caution.
7. Always pour chemicals from large containers to smaller ones.
8. Never pour chemicals that have been used back into the stock container.
9. Never tap flasks that are under vacuum.
10. Chemicals should never be mixed, measured, or heated in front of your face.
11. Water should not be poured into concentrated acid. Instead, pour acid slowly into water while stirring constantly. In many cases, mixing acid with water is exothermic.
12. Lab areas containing carcinogens, radioisotopes, biohazards, and lasers should be properly marked with the appropriate warning signs.
13. Open flames should never be used in the laboratory unless you have permission from a qualified supervisor.
14. Make sure you are aware of where your lab's exits and fire alarms are located.
15. An area of 36" diameter must be kept clear at all times around all fire sprinkler heads.
16. If there is a fire drill, be sure to turn off all electrical equipment and close all containers.
17. Always work in properly ventilated areas.
18. Do not chew gum, drink, or eat while working in the lab.
19. Laboratory glassware should never be utilized as food or beverage containers.

20. Each time you use glassware, be sure to check it for chips and cracks. Notify your lab supervisor of any damaged glassware so it can be properly disposed of.
21. Never use lab equipment that you are not approved or trained by your supervisor to operate.
22. If an instrument or piece of equipment fails during use, or isn't operating properly, report the issue to a technician right away. Never try to repair an equipment problem on your own.
23. If you are the last person to leave the lab, make sure to lock all the doors and turn off all ignition sources.
24. Do not work alone in the lab.
25. Never leave an ongoing experiment unattended.
26. Never lift any glassware, solutions, or other types of apparatus above eye level.
27. Never smell or taste chemicals.
28. Do not pipette by mouth.
29. Make sure you always follow the proper procedures for disposing lab waste.
30. Report all injuries, accidents, and broken equipment or glass right away, even if the incident seems small or unimportant.
31. If you have been injured, yell out immediately and as loud as you can to ensure you get help.
32. In the event of a chemical splashing into your eye(s) or on your skin, immediately flush the affected area(s) with running water for at least 20 minutes.
33. If you notice any unsafe conditions in the lab, let your supervisor know as soon as possible.

Lab Entry requirements

Entry to labs is restricted to authorized personnel only. Access to labs may be granted only to individuals on official business with the University, who have received training on the safety elements and access protocols needed to enter and work in labs. This training is part of the control measures to minimizing the risks posed by labs hazards. Training is commensurate to the risks posed by the activity the personnel will be performing in the lab, therefore, there are different levels of training for different groups of individuals. As of 2021, all lab-based training is offered on Sakai. Questions about training can be sent to cbucciarelli@brocku.ca. Arrangements for additional training can be requested, when needed, support staff from Facilities Management and ITS to besafe@brocku.ca or lvistorte@brocku.ca.

Departmental heads ought to ensure that their personnel tasked with granting access have verified that the training requirement has been met before they enable access to labs. Once a student completes a training module, a certificate will be emailed to them. It is the responsibility of the supervisor and their students to maintain a record of training and to renew training as recommended.

Access to custodial, maintenance, ITS or other support personnel is subjected to the same requirements mentioned above and should only be enabled to individuals who need to enter labs to provide services as part of their employment.

Awareness

- Be familiar with the locations and operation of safety and emergency devices/equipment such as:
  - fire pull stations,
  - fire extinguishers,
  - fire hose cabinets,
  - emergency exits routes – both primary and secondary,
  - first aid stations and kits,
  - emergency eyewash station and showers,
  - spill kits,
  - emergency communication devices, including telephones, panic buttons.
- Be alert to conditions in the workplace, including potential unsafe conditions that may develop.
- Determine the potential hazards, appropriate safety precautions, and proper waste segregation and disposal techniques well in advance.
- Promptly report unsafe conditions, accidents, incidents, near misses and concerns to your supervisor.
- Complete safety training before starting to work in the lab, including job-specific training. If you have questions, ask your supervisor (professor, senior lab coordinator/instructor, or other staff).
- Follow the instructions of entry signage posted on the lab door regarding use of proper protective equipment.

Proper Usage of Laboratories

- Workspaces must be kept clean and free of clutter, including chemical products, specimens, empty boxes, containers and pieces of styrofoam, empty solvent bottles/cans, unused devices/ equipment). Poor housekeeping can be a cause of incidents, such as:
  - tripping over loose objects on floors,
  - slipping on greasy, wet or dirty surfaces,
  - being hit by falling objects,
  - cutting, puncturing, or tearing the skin of hands or other parts of the body on sharp objects,
  - contaminating skin with substances left on work surfaces,
  - striking against projecting, poorly stacked items or misplaced material.
- Smoking, eating, drinking and chewing of gum is not permitted in laboratories or workshops.
- Running, horseplay or inappropriate use of lab materials or equipment is not permitted.
- Keep laboratory and workshop doors closed to maintain proper air balancing of the space and to ensure security and that engineering controls, i.e. fume hoods, BSCs, will function as intended.

- Exits, passageways and access to emergency equipment- including eye / face wash stations, emergency showers, fire extinguishers, first aid kits, spill kits and electrical panels- must always be keep readily accessible.

General Storage Guidelines

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

Conducting Experiments and Performing Work

- Performing unauthorized work, preparations or experiments is prohibited.
- Conduct pre-experiment hazard identification and risk assessment before beginning work. Use the template available here.
- Implement appropriate hazard controls for the risks identified, as ascertained on the assessment and update written experiment protocols with this information, e.g. conduct experiment inside a fume hood, wear gloves, etc.
- Specify hazardous steps that must be performed with special control measures, e.g., inert atmosphere, special type of glove material.
- Read and understand the Safety Data Sheets (SDS) prior to using a product.
- Work with materials only when you know their hazardous properties- flammability, reactivity, toxicity, etc., handling and storage requirements, their interactions with other substances and the associated emergency procedure(s).
- Check equipment to be used for damage prior to setting up experimental apparatus.
- Select a suitable experiment location. Experiments involving hazardous materials should be conducted within a vented fume hood or within other suitable containment means.
- Advise users of shared lab spaces of hazardous experiments in progress.

- Do not leave any experiment unattended. If necessary, post signs including the type of experiment, your name and the direct number where you can be reached. If an emergency occurs which involves or impacts the experiment, emergency responders will attempt to notify you and ask for information as needed.
- Label reagents and samples according to WHMIS legislation. Unlabelled containers are not allowed.
- Verify expiry properties, i.e. condition, date, etc. of hazardous materials and follow them, especially for reactive substances.
- Store hazardous materials according to chemical compatibilities.
- Store hazardous materials in appropriate locations, e.g., flammable, corrosive storage cabinets.
- Reagent bottles – empty or full – must not be stored on the floor or in the sink.
- Transport hazardous chemicals and chemical waste in secondary carriers or on suitable transport carts- Follow the transportation of chemicals route and instructions- a map can be found below)
- Do not pipette by mouth.
- When working with concentrated acid and bases, have a neutralizer readily available before starting work.
- Ensure the spill kit is supplied with clean-up materials prior to starting work.
- Clean up spills immediately following the procedure outlined in Section 1. Custodians will not clean up lab spills, as they are not knowledgeable on or trained to handle lab hazards.
- Wear and use applicable personal protective equipment and safety devices.
- When working with hazardous substances follow specific instructions outlined below in this document.

Pregnant Personnel

Personnel who are, or may become, pregnant while working in a laboratory environment require special consideration.

The Ontario Human Rights Code requires the accommodation – without penalty – for any pregnant worker in cases where pregnant workers are exposed to risks that may not otherwise be present. There is a duty for the University and the pregnant worker to enter into a cooperative and respectful dialogue as early as possible in order to develop, implement and maintain appropriate accommodation measures to ensure the health and safety of the pregnant worker and unborn child. This dialogue may involve the University, the pregnant worker and the workplace bargaining unit, if/where applicable.

The University has an obligation to offer reasonable accommodation measures and to make reasonable effort to eliminate barriers to a pregnant worker. Reasonable accommodation measures may refer to a change to the work, work method or workplace so as to enable the person to satisfy the bona fide occupational requirements of the job and to achieve the outcomes or deliverables of the job. An accommodation is not an entitlement program; it is a method of enabling a worker to deliver the required results of the job.

Chemical Safety Rules

Since almost every lab uses chemicals of some sort, chemical safety rules are a must. Following these policies helps employees avoid spills and other accidents, as well as damage to the environment outside of the lab. These rules also set a clear procedure for employees to follow in the event that a spill does occur, in order to ensure it is cleaned up properly and injuries are avoided.

- Every chemical should be treated as though it were dangerous.
- Do not allow any solvent to come into contact with your skin.
- All chemicals should always be clearly labeled with the name of the substance, its concentration, the date it was received, and the name of the person responsible for it.
- Before removing any of the contents from a chemical bottle, read the label twice.
- Never take more chemicals from a bottle than you need for your work.
- Do not put unused chemicals back into their original container.
- Chemicals or other materials should never be taken out of the laboratory.
- Chemicals should never be mixed in sink drains.
- Flammable and volatile chemicals should only be used in a fume hood.
- If a chemical spill occurs, clean it up right away.
- Ensure that all chemical waste is disposed of properly.

Working With Scaled-Up Reactions

Scale-up of reactions from those producing a few milligrams or grams to those producing more than 100 g of a product may represent several orders of magnitude of added risk. The attitudes, procedures, and controls applicable to large-scale laboratory reactions are fundamentally the same as those for smaller-scale procedures. However, differences in heat transfer, stirring effects, times for dissolution, and effects of concentration and the fact that substantial amounts of materials are being used introduce the need for special vigilance for scaled-up work. Careful planning and consultation with experienced workers to prepare for any eventuality are essential for large-scale laboratory work. Although it is not always possible to predict whether a scaled-up reaction has increased risk, hazards should be evaluated if the following conditions exist:

- The starting material and/or intermediates contain functional groups that have a history of being explosive e.g., N-N, N-O, N-halogen, O-O, and O-halogen bonds-or that could explode to give a large increase in pressure.
- A reactant or product is unstable near the reaction or work-up temperature. A preliminary test consists of heating a small sample in a melting point tube.
- A reaction is delayed; that is, an induction period is required.
- Gaseous by-products are formed.
- A reaction is exothermic. What can be done to provide cooling if the reaction begins to run away?

- A reaction requires a long reflux period. What will happen if solvent is lost owing to poor condenser cooling?
- A reaction requires temperatures below 0 °C. What will happen if the reaction warms to room temperature?

In addition, thermal phenomena that produce significant effects on a larger scale may not have been detected in smaller-scale reactions and therefore could be less obvious than toxic and/ or environmental hazards. Thermal analytical techniques should be used to determine whether any process modifications are necessary.

Use, Handling & Storage of Compressed Gases

- Working with any compressed gases requires additional training available on Sakai.
- All compressed gas cylinders must be secured upright to a study, solid structure that prevents falling or sliding when not in use. This can be done using a rack, clamp or bracket system.
- Never leave a cylinder on a cart or standing without securing it; carts are only to transport cylinders.
- The number of cylinders of a single type must be limited to one in use and one spare.
- If a cylinder is stuck, do not use a hammer, wrench or force it open.
- Never use grease or oils or allow them to come in contact with valve threads, especially near oxidizing gases.
- A gas cylinder should be clearly labelled with a supplier before use, do not rely on the colour of the cylinder to determine its contents.
- Do not use or store compressed gases near open flames (ie Bunsen burners) or near other sources of ignition or heat.
- See the below section of transporting cryogens and compressed gasses through Brock.

Use, Handling & Storage of Flammables

- The most common fire hazard in the laboratory is a flammable liquid or the vapour produced from such a liquid. While flammable substances cannot always be avoided, the control of ignition sources is imperative to reduce the risk of flammability.
- All flammables must be store in a flammable storage safety cabinet. A separate document outlining requirements can be found here.
- When using flammable substances, it is recommended to use them in a fume hood or BSC.
- Do not use flammable solvents as cleaning agents unless your supervisor specifically requires their use.
- Understanding why a chemical is flammable helps to be better able to work with flammable materials in the future.

Use, Handling & Storage of Oxidizers

Oxidizing materials are liquids or solids that readily give off oxygen or other oxidizing substances (such as bromine, chlorine, or fluorine). They also include materials that react chemically to oxidize combustible (burnable) materials; this means that oxygen combines chemically with the other material in a way that increases the chance of a fire or explosion. This reaction may be spontaneous at either room temperature or may occur under slight heating. The primary risk of working with oxidizing materials is they can intensify combustion of material by providing oxygen to a fire. Oxidizers are broken down into four NFPA categories based on the risk presented when mixed with other material.

Table 5. NFPA categories of oxidizers and examples.

NFPA Class	Definition	Examples
1	An oxidizer that does not moderately increase the burn rate of another material	– Aluminum nitrate – Ammonium persulfate – Barium peroxide – Hydrogen peroxide solutions (8% to 27.5% by weight) – Magnesium nitrate – Nitric acid (40% concentration or less) – Perchloric acid solutions (less than 50% by weight) – Potassium dichromate – Potassium nitrate – Silver nitrate – Sodium dichloroisocyanurate dihydrate – Sodium dichromate – Sodium nitrate – Sodium nitrite – Sodium perborate (and its monohydrate) – Sodium persulfate
2	An oxidizer that will moderately increase the burn rate	– Calcium chlorate – Calcium hypochlorite (50% or less by weight) – Chromic acid (chromium trioxide) – 1,3-dichloro-5,5-dimethylhydantoin – Hydrogen peroxide (27.5 to 52% by weight) – Magnesium perchlorate – Nitric acid (concentration greater than 40% but less than 86%) – Potassium permanganate

		– Sodium permanganate – Sodium chlorite (40% or less by weight) – Sodium perchlorate (and its monohydrate) – Sodium peroxide
3	An oxidizer that will cause a severe increase in burn rate.	– Ammonium dichromate – Hydrogen peroxide (52 to 91% by weight) – Nitric acid, fuming (concentration greater than 86%) – Perchloric acid solutions (60 to 72% by weight) – Potassium bromate – Potassium chlorate – Potassium dichloroisocyanurate – Sodium chlorate – Sodium chlorite (greater than 40% by weight) – Sodium dichloroisocyanurate
4	An oxidizer that has the potential to lead to an explosive oxidation when combined with other materials	– Ammonium perchlorate (particle size greater than 15 microns) – Ammonium permanganate – Hydrogen peroxide (greater than 91% by weight) – Perchloric acid solutions (greater than 72.5% by weight) – Tetranitromethane

Adequate safety glasses must meet the used and must be equipped with side shields.
Gloves should be worn when handling oxidizing chemicals. Disposable nitrile gloves provide adequate protection against accidental hand contact with small quantities of most laboratory chemicals.

Oxidizers should be stored in a cool and dry location. Segregate oxidizers from all other chemicals in the laboratory. Minimize the quantities of strong oxidizers stored in the laboratory.

DO NOT return excess chemicals to the original container. Impurities may be introduced into the container which may cause a fire, explosion or other unwanted event or contamination.

Anticipate emergency situations, have proper handling equipment in the lab and readily available for spills. Check the MSDS to determine what is appropriate. Spill control materials for oxidizers are designed to be inert and will not react with the reagent (i.e., Speedy Dry).

In the event of a spill or adverse reaction notify lab personnel immediately that an incident has occurred. Do not attempt to handle a large spill/reaction/fire, or one in which you are not trained or equipped for. Turn off all ignition sources if this can be done safely; vacate the area and call for assistance. All materials contaminated with oxidizing chemicals pose a fire hazard and should be disposed of as hazardous waste.

Use, Handling & Storage of Reactive Chemicals

- A highly reactive chemical may undergo vigorous, uncontrolled reactions that can cause an explosion or fire or rupture sealed reaction vessels or storage containers.
- Chemical classes must be determined and their compatibility to other chemicals found. Brock has several resources for MSDSs and other chemical qualities. A chemical compatibility chart can be found on Science Stores' site.
- Be mindful of where chemicals are being stored – try to limit the amount of incompatible chemicals being stored together.
- Water reactive materials react violently with water and may have an exothermic reaction if there is insufficient coolant water to dissipate the heat produced.
- For pyrophoric materials, the compound oxidizes so rapidly that ignition occurs. Their degree of reactivity depends on particle size as well as the presence of moisture and the thermodynamics of metal oxide or metal nitride formation.
- Incompatible substances could result in a serious explosion or the formation of highly toxic or flammable.
- Compounds can pose either a reactive or toxic hazard. For example, HCN is incompatible with bases because of the addition of acid inhibitor. Concentrated oxidizing agents are incompatible with concentrated reducing agents.
- Use the guide for incompatible substances provided on page 106. This is a general guideline; the magnitude of the risk depends on the quantities.

Chemical Name	Reaction with Water
Acetic anhydride	May boil explosively
Acetyl chloride	Violently decomposes to HCl and acetic acid
Aluminum bromide	Violent hydrolysis
Aluminum chloride	Violent decomposition forming HCl gas
Boron tribromide	Violent or explosive reaction when water added
Butyl lithium	Ignites on contact with water
Calcium carbide	Gives off explosive acetylene gas
Calcium hydride	Hydrogen gas liberated
Chlorosulfonic acid	Highly exothermic violent reaction
Chlorotrimethyl Silane	Violent reaction
Dichlorodimethyl Silane	Violent reaction
Lithium aluminum hydride	Releases and ignites hydrogen gas

Lithium hydride	Violent decomposition
Lithium metal	Powder reacts explosively with water
Methyltrichlosilane	Violent reaction forming HCl
Oxalyl chloride	Violent reaction forming HCl
Phosphorous pentachloride	Violent reaction
Phosphorous pentoxide	Violent exothermic reaction
Phosphorous tribromide	Reacts violently with limited amounts of warm H2O
Phosphorous trichloride	Violent reaction releasing Flammable diphosphane
Phosphoryl chloride	Slow reaction which may become violent
Potassium amide	Violent reaction which may cause ignition
Potassium hydride	Releases hydrogen gas
Potassium metal	Forms KOH and hydrogen gas
Silicon tetrachloride	Violent reaction producing silicic acid
Sodium amide	Generates NaOH and NH3 (flammable)
Sodium azide	Violent reaction with strongly heated azide
Sodium hydride	Reacts explosively with water
Sodium hydrosulfite	Heating and spontaneous ignition with 10% H2O
Sodium metal	Generates flammable hydrogen gas
Tetrachloro silane	Violent reaction
Thionyl chloride	Violent reaction which forms HCL and SO2
Titanium tetrachloride	Violent reaction that produces HCL gas
Trichloro silane	Releases toxic and corrosive fumes
Triethyl aluminum	Explodes violently in water
Triisobutyl aluminum	Violent reaction with water
Zirconium Tetrachloride	Violent reaction with water

Use, Handling & Storage of Cyanides

Cyanides must be stored in tightly closed containers (ideally propylene) that are securely locked in a cool dry cabinet to which access is restricted.

- Cyanide salts must be separated from acids to prevent the generation of highly toxic hydrogen cyanide gas.
- Cyanide should be separate from any other chemical that is incompatible such as oxidizing materials, flammable and combustible materials, water or products containing water.
- Inspect and wear appropriate PPE whenever it is handled. Reduce the level of exposure when possible.
- The compound in which cyanide is found can affect the designation of the substance and by extension the risks and handling/disposal protocols. Therefore, it is necessary to have MSDSs on hand for every chemical in a laboratory.

Use, Handling & Storage of Pyrophoric Chemicals

A chemical is considered pyrophoric if a small quantity of the material will ignite within 5 minutes after coming into contact with atmospheric oxygen. Ignition due to moisture in the air is no longer a part of the definition of pyrophoric but special considerations should still be taken.

Pyrophoric chemicals can come in every state of matter and therefore many different approaches must be considered when reacting to a breach in containment. The best way to prevent any spills/releases of pyrophoric chemicals is to control the hazards. Safer chemical alternatives should always be considered. An efficient glove box can use its inert atmosphere to safety manipulate a reagent. The MSDS should be read before beginning any work on a pyrophoric chemical and appropriate training should be implemented including specifics of materials and methods. This will include good work practices such as keeping combustibles materials away, minimizing the quantity of reagents being used or stored and using the best equipment such as needles and pressurized containers. Other general risk mitigation strategies should be followed such as:

- Chemical splash goggles or safety glasses are necessary when handling pyrophorics. A face shield is needed when there is a risk of explosion, large splash hazard or a highly exothermic reaction. Gloves must also be worn, and a lab coat made of material that is not easily combustible must be worn. See Section 5: Personal Protective Equipment for more recommendations
- Practicing your technique with a non- hazardous material before handling and have your technique evaluated by an experienced person.
- Verify the accessibility and operability of a safety shower in the immediate work area.
- Purchase the most stable chemical that will do the job. Purchase those that contain stabilizing diluents or other hazard reducing additives.
- Keep amounts on-hand to a minimum and conduct work on the smallest scale possible.
- Use a fume hood for any work that cannot be done in a glovebox. Secure all apparatus including product containers where appropriate. Keep the sashes closed as much as possible.

Excess chemical should never be returned to the original container. Small impurities introduced to a container may cause a fire or explosion. The storage of pyrophoric chemicals should be referenced from the MSDS. Always plan ahead to minimize the available flammable material (i.e. solvents) in the immediate vicinity. Be aware of disposal recommendations for small amounts (i.e. quenching) or as hazardous waste for larger amounts.

TRANSPORTATION OF COMPRESSED GASES, CRYOGENS AND HAZARDOUS CHEMICALS ACROSS LABS

- A hazardous chemical is any chemical that is a health or physical hazard.
- Transporting compressed gases requires the completion of additional training available on Sakai.
- Cryogens, compressed gas cylinders and dry ice must travel alone in the elevator due to the potential risks being elevated in a confined space.
- Dewars should be handled with care and not 'walked', rolled or dragged along the floor. Dewars >20 L should be carried by two persons at minimum or secured on trolleys or tipping trolleys.
- Stairs and doorways present an added risk of spillage due to tripping or colliding with someone. Unsealed dewars may spill their contents upon accidental collision. To avoid this, carts must be used when transporting liquid nitrogen from a dispensing station to its final destination within same building appropriate. Appropriate carts are those:
    - able to withstand the weight of its load (check out the manufacturer instructions),
    - with properly sized and sturdy wheels that wiggle around with ease,
    - with a flat, solid surface where the container can sit stable,
    - that are low rise to provide for easy loading/unloading of heavy containers,
    - on which small containers can be strapped or otherwise secured (i.e., carts with slots to cradle the small dewars),
    - that are maintained regularly and adjusted/repaired as required.
- Any other container that poses a risk of breakage, spillage, explosion or otherwise exposure of its contents to the surrounding environment must also ride alone.
    - If possible, transport these items while the elevator is in service mode so it will not open on any other floors. Contact FM for more details.
- A specific, safest route determined by the science safety committee must be followed for any movement. See this document for a map outlining this route or refer to it below.
- Cylinders shall be moved by tilting and rolling them on their bottom edges. They shall not be intentionally dropped, struck or permitted to strike each other violently.
- Acetylene cylinders must NEVER be stored or transported in a horizontal position. Keep them vertical at all times. If an acetylene cylinder is inadvertently upended, it shall be stored upright for eight hours prior to use.
- Valve protection caps shall not be used for lifting cylinders from one vertical position to another.
- Bars shall not be used under valves or valve protection caps to pry cylinders loose.
- Warm, not boiling water shall be used to thaw cylinders loose.
- Unless cylinders are firmly secured on a special carrier intended for this purpose, regulators shall be removed and valve protection caps put in place before cylinders are moved.

- A suitable cylinder truck, chain or other steadying device shall be use
- Cylinders shall be moved by tilting and rolling them on their bottom edges. They shall not be intentionally dropped, struck or permitted to strike each other violently.
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- Warm, not boiling water shall be used to thaw cylinders loose.
- Unless cylinders are firmly secured on a special carrier intended for this purpose, regulators shall be removed and valve protection caps put in place before cylinders are moved.
- A suitable cylinder truck, chain or other steadying device shall be used to keep cylinders from being knocked over while in use.
- When work is finished, when cylinders are empty, or when cylinders are moved at any time, the cylinder valve shall be closed with the valve protection cap in place.
- Compressed gas cylinders shall be secured in position during transportation, storage or use. When containing acetylene, they shall be secured in the upright position.
- When cylinders are hoisted, they shall be secured on a cradle, sling board, or a pallet. They shall not be hoisted or transported by means of magnets or choker slings.
- Compressed gas cylinders shall be legibly marked for the purpose of identifying the gas content, with either the chemical or the trade name of the gas. Such marking shall be by means of stenciling, stamping or labeling and shall not be readily removable.
- The numbers and markings stamped into cylinders shall not be tampered with.
- Do not use any cylinder that is not positively identified.

Liquid Nitrogen Containers and Safe Handling Procedures

Generally speaking, in quantities up to about 50 L, liquid nitrogen is stored and distributed in simple open-topped vessels, designed to operate at atmospheric pressure (“tulips” or dewar flasks). They are of lightweight construction and should be handled with care to avoid damage to the insulation. The smaller flasks may be easily knocked over.

Larger quantities (up to 250 L) are generally held in transportable liquid cylinders designed to deliver liquid or gas. They operate at above atmospheric pressure, so they are fitted with safety devices to allow them to vent excess pressure. The manufacturer’s recommended intervals for inspection and replacement of the safety devices must be observed. Care must be taken to ensure that any venting takes place safely (as supplied, many such cylinders have safety devices discharging horizontally at eye level), and venting may need to be directed to a safe place outside

of the storage area. Transportable cylinders should be handled with care. In particular, trolleys used for moving them, or the trolley bases fitted to some cylinders, must be suitably designed and in good condition to avoid accidents resulting in the cylinder tipping over.

Users should be alert to the signs of insulation failure (the need for frequent topping-up, or excessive condensation on the dewar) as the high boil-off rate increases the risk of oxygen depletion.

Procedure to dispense liquid nitrogen from the generator in MC G200

- Be familiar with hazards associated with cryogen use. Only those who have been suitably trained may fill dewars using a hose from a transportable container or bulk tank. This is a potentially dangerous operation, and appropriate PPE must be used,
- Work in an open, well-ventilated location. Consider ventilation monitors or oxygen deficient sensors and alarms. Check the monitors and alarms before and during cryogen use.
- Wear a face shield and insulated gloves when dispensing or transferring liquid nitrogen. Safety glasses will not protect your face; cold liquids can move around glasses into your eyes. All skin should be covered, but gloves should be loose enough that they could be removed rapidly if they came in contact with liquid nitrogen as it's extreme temperature can quickly cause tissue damage. Do not wear metal jewelry or watches.
- Closed toe shoes are required when handling cryogenic liquids. Leather will shed the spilled liquid. Cuffless pants should cover the shoe top. Sneakers should not be used as are typically made with absorbent materials which could draw liquid toward your skin.
- Long sleeve shirts made of non-absorbent material are best.
- As most clothing will absorb spilled liquid cryogens- bringing the liquid close to the skin- an apron made of PVC, leather or other non-absorbent material should be used when working with cryogenic liquids.
- Before dispensing, check the liquid level. If it is at 10% or lower, do not use. Contact srenda@brocku.ca if this is shown.
- Always use a Dewar vessel meant for cryogenic liquids and not a flask or container not specified for this purpose as a pressure build up can lead to an explosion.
- Examine containers and pressure relief valves for signs of defect. Never use a container that has defects.
- Ensure that all equipment and containers are free of oil, grease, dirt, or other materials which may lead to flammability hazard upon contact with liquid oxygen.
- Select working materials carefully. Cold cryogenic liquids may alter the physical characteristics of many materials, make them brittle and fail.
- Verify there is pressure relief for any place that there can be a pressure build-up.
- In MC G200, the oxygen sensor is located relatively close to the LN tank. To prevent the alarm going off, take a few steps back before dispensing LN. Fan #1 will start when an oxygen concentration reaches 19.5% and an alarm will sound when 19% concentration is reached. Other concentrations that will activate alarms are below.

Chemical Element	Concentration (ppm) on S1 Alarm	Concentration (ppm) on S2 Alarm	IDLH* concentration
Chlorine -Cl_2	1	2	10
Carbon Dioxide-CO_2	5000	10 000	40 000
Nitric Oxide- NO	40	100	100
Oxygen- O_2	19.5	19.0	N/A

*IDLH – Immediately dangerous to life and death, the concentration of any dangerous substance that poses an immediate threat to life.

Table 6. Gases sensors in MC G200 and air concentration that trigger alarms in event of leaks/spills.

- Begin by releasing a small amount in to a dewar with the nozzle inserted completely to the blue hilt. This will allow for an adjust in temperature from the cold gas to the room temperature container.
- Open the valve completely and fill the dewar to ¾ full.
- A relatively small volume of liquid nitrogen can create an oxygen deficient atmosphere. Be aware of the sensors in the room that will alert of any air composition abnormalities.
- Never use liquid nitrogen or liquid air as a cold trap to collect vaporized flammable or combustible materials as oxygen may also condense and lead to an explosion hazard.

Cryogenic Liquids Transfer and Use

- All cryogenic systems and dewars must have pressure relief valves to release excessive pressure and bursting discs and loose-fitting lids on dewar flasks. The pressure relief valves should be inspected regularly.
- Use only fitted transfer tubes designed for use with the dewar container. Damaged transfer tubes should be replaced. Do not handle transfer tubes with your bare hands as the fitting is not insulated.
- When transferring to a secondary container, do not fill the secondary container to more than 80% of capacity (60% if the temperature is likely to be above 30 °C).
- Do not lower warm experiments into dewars containing a cryogen.
- Immediately re-cap any container to prevent atmospheric moisture from entering and forming an ice plug in the opening of a vessel containing a cryogen.
- Provide proper venting for the dewars used in experiments.
- Use care in transporting cryogens; do not use fragile containers. Use a hand truck or the lowest shelf of a cart for transport of cryogens.

Cryogenic Liquid Storage

- Store cryogens in well-ventilated areas to prevent oxygen deficiency.
- Use only approved storage vessels that have pressure relief valves.
- Never adjust, block, or plug a pressure relief valve. The vendor is required to check the pressure relief valve before filling the dewar.

- Avoid contact of moisture with storage containers to prevent ice plugs in relief devices.
- Periodically check container necks for ice plugs, core out ice plugs if present.
- Keep all heat sources away from cryogenic liquids.
- Do not use cryogens or dry ice in walk-in cold rooms, because they may not have sufficient air exchange and could become hazardously oxygen deficient.

Injuries related to cryogens

- If skin comes into contact with a cryogen, run the area under cool or warm water for fifteen minutes. Never use hot or cold water. The re-warming, or thawing, of affected area(s) should be done gradually. It may take up to 60 minutes to thaw the affected area(s) and bring back the natural color of the skin.
- If your finger is burned, do not put it in your mouth as the cold will burn your mouth or tongue.
- Do not rub a burned area: rubbing can cause further tissue damage.
- Always seek medical attention for frostbite injuries. You should obtain medical assistance as soon as possible when cryogens contact your skin. Immediately upon exposure, the frozen skin appears waxy and yellow, and the burn usually is not painful. Then it painfully swells and blisters while the skin defrosts.

[Table of Contents]

SECTION 10: LESSONS LEARNED

An Action Plan has been developed to address the causes and consequences of the fire accident that occurred in the chemistry laboratory Cairns 466 on August 8th 2014 that resulted in injuries to one worker. While intended to minimize similar occurrences on Campus, this plan requires that all responsible individuals, e.g. Professors, Principal Investigator, Senior Demonstrator, etc., who oversee and perform any type of activities with hazardous chemicals adhere to the following:

1. Laboratory users must follow proper lab safety practices at all times.
2. Laboratory supervisors must develop and maintain written procedures for the handling of any hazardous chemicals and train applicable individuals; this also includes emergency response procedures and personal protective equipment.
3. Training records must be kept and indicate which lab specific protocols have been provided. A facilitating template is attached. This template is currently in place and will be submitted to the Science Safety Committee for review and revision, if required. These records must be made available to the Lab Safety Officer during annual inspections.
4. White boards will be installed at the end of all fume hoods or banks of fume hoods for Supervisors to outline (1) the PI responsible for the lab and, (2) or should he/she be absent who is designated as competent supervisor for that particular day. In addition, each board shall display information for its fume hood or for all fume hoods in a bank including the reaction(s) for fume hood, and the name and phone number for the responsible student in each case. It is required that this information be updated daily, as necessary.
5. Personal protective equipment suitable for the hazards being handled must be worn in the labs; e.g. flame retardant lab coats for work posing a fire risk.
6. Work areas must be kept clean and free of excess hazardous materials. Work fume hoods may not be used for storage. Chemicals must be stored in proper storage cabinets, designated storage fume hoods, or in shelves, as applicable in relation to their class.

[Table of Contents]

SECTION 11. WASTE MANAGEMENT

GENERATION, SEGREGATION, COLLECTION AND DISPOSAL OF LAB WASTES

Hazardous waste is waste that, when present in quantities and concentrations that are high enough, pose a threat to human health or the environment if they are improperly stored, transported, treated, or disposed. Details on this can be found within the O. Reg 437: General- Waste Management.

As part of the cradle-to-grave management system of the MOECP, hazardous waste requires special handling with respect to how it is collected, stored, transported, treated, recovered and disposed to reduce adverse effects to human health and the environment.

At Brock, Science Stores staff coordinate the chemical hazardous waste collection. An external contactor licensed to haul and dispose of hazardous waste collects said waste from the labs in the company of the Brock staff.

Lab users that cause the generation of hazardous waste shall follow the procedures outlined below in alignment with the safety and environmental protection legislation that apply (Environmental Protection Act, O. Reg 437: General- Waste Management). In following these procedures, the handling and disposal of hazardous waste can be made safely.

Most questions about when and how waste is collected and what type of resources are available can be responded by the Science Stores staff. In addition, staff from HSW who oversee these activities and can also respond any questions or concerns.

Generation and Labelling

- Minimize volume and hazard upon ordering, when possible.
- Under no circumstances will hazardous chemicals/wastes be disposed of down a sink. Chemical wastes sent to the drain may react and cause significant damage which may result in loss of drains, impeding lab activities until they can be replaced. In addition, they may pollute the environment.
- Plan for biweekly waste disposal. Designate a place for the waste. If a fume hood is used for keeping waste, that hood cannot accommodate any other activity/work.
- Plan for safe segregation of waste by compatibility and reactivity before beginning an experiment. Incompatible and highly reactive chemicals must always be kept separately.
- Minimum segregation groups include organics vs inorganic, acids vs bases, halogenated vs non-halogenated. Segregate further according to below.
- Use safety data sheets to determine segregation groups and/or the compatibility chart found at the Academic Safety SharePoint.
- Two types of containers (Figure 12) are available for liquid hazardous waste: red, hard polypropylene (PP) spring-lidded safety containers with flame arrestor; and white, semitransparent, PP containers with screw cap;
    - Use the Red containers are for flammable waste.

- Use the screw cap plastic white containers for aqueous waste solutions, not for flammable liquid waste, unless the flammable is also very corrosive.

Figure 12. Containers for liquid chemical hazardous waste.

- Check the containers before using them. They must be intact and suitable to contain the chemical, and capable of a tight closure to prevent leaks during transport
- Discard containers with a deteriorated flame arrestor, without a lid/cap or with a compromised integrity.
- Obtain the Yellow Chemical Waste Label (Figure 14) sticker from Science Stores (MC E303) and affix it to every waste container prior to start adding wastes in.
    - Fill out all the parameters that asked for on the label.
    - Do not use abbreviations or short forms.
- Represent the waste properly, ie. if your mixture results in a product, list the product of the reaction and not individual reactants. This may have significant safety or legal implications.
- Containers must be filled to the shoulder only. NEVER fill them completely. It may lead to leaks.

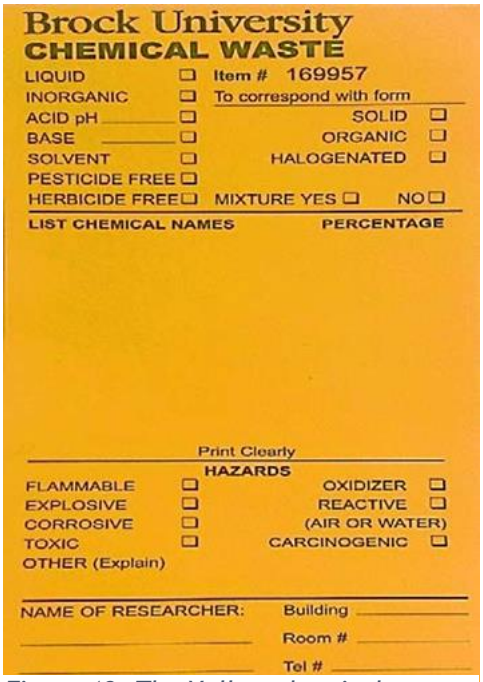

Brock University
CHEMICAL WASTE
LIQUID ☐ Item # 169957
INORGANIC ☐ To correspond with form
ACID pH _____ ☐ SOLID ☐
BASE _____ ☐ ORGANIC ☐
SOLVENT ☐ HALOGENATED ☐
PESTICIDE FREE ☐
HERBICIDE FREE ☐ MIXTURE YES ☐ NO ☐
LIST CHEMICAL NAMES PERCENTAGE
Print Clearly
HAZARDS
FLAMMABLE ☐ OXIDIZER ☐
EXPLOSIVE ☐ REACTIVE ☐
CORROSIVE ☐ (AIR OR WATER)
TOXIC ☐ CARCINOGENIC ☐
OTHER (Explain)
NAME OF RESEARCHER: Building
Room #
Tel #

Figure 13. The Yellow chemical waste label

- Always maintain all containers closed except when pouring in, even if they are inside a hood. Vapors or fumes emanating unnecessarily pollute the environment or the lab air depending on where the container is situated.
- While containers must be kept closed, do not seal screw cap closures until the day of collection from the lab to avoid any pressure buildup.
- Screw cap containers must be closed tightly the day of collection from the lab to prevent leakage during its transport.

- When little waste is foreseen for the week, use the smallest container available to avoid carrying waste over to the following week.
- When preparing the waste for pickup, check that containers are not overfilled or overflowing. Containers that are overflowing or filled past the shoulder line will not be collected under regular pickup procedures. Since this may carry a safety implication or cause a spill cleanup surcharge ENSURE proper fill.
- Metal and glass containers are not allowed for hazardous waste, unless extraordinary situations exist. If that is the case, use a secondary container to catch any spill in the event of a breakage.

Figure 14. Bucket for solid hazardous waste.

- When additional or replacement containers are needed, ask the Science Stores staff.
- For silica waste ask the Science Stores staff for a container. White, PP, wide mouthed 20 L pails with a lid (**Error! Reference source not found.**) are available for this type of waste.

Hazardous Waste Registration and Pick Up from Labs

For the waste to be picked up from your lab, the science stores staff must be notified.

- Use the Chemical Waste Disposal Record form to request a pickup. The form is available from Science Stores webpage, on the right hand side under WASTE REMOVAL FORM, and can be downloaded at http://brocku.ca/mathematics-science/departments-and-centers/sciencestores/waste-disposal
- All containers which are filled to the shoulder level must be disposed of. This contributes to your lab being compliant with the allowable limit of flammable liquids and to safety by reducing hazardous products in the lab.
- Each container registered for disposal must list the number which corresponds to the item # located on the upper right of the Yellow Chemical Waste Label.
- Submit the completed form to Science Stores by Tuesday at 3:00 pm on the week of the pick up either in person (MC E303), by fax (905 984 4864), or email (sciencestores@brocku.ca).
- External waste technicians and staff from Science Stores will pick up waste every Wednesday morning from every lab that registered waste.
- Wastes that are not properly labelled will not be picked up.
- Wastes that are overflowing or present any safety problem will not picked up under regular collection procedures and may be left behind until an arrangement for spill cleanup can be made. Since this carries a surcharge, follow waste procedures strictly to prevent unnecessary expenses.

Recycling Empty Metal Containers

Metal containers where hazardous chemicals come in eg., 20L & 4L capacity containers for solvents ought to be removed from the lab when empty. This is to eliminate crowdedness and sources of clutter that are a tripping hazard. Before its removal ensure that:

Figure 15. Safe for disposal label.

- Cans must be emptied and triple rinsed. Collect the rinsate as hazardous waste.
- Affix the Safe for disposal label which can be obtained from Science Stores.
- Place the labelled container in the hallway by the main entry door to your lab every Monday.
- Custodial services will pick up containers that meet the above criteria.

Other Waste Streams

Sharps waste

Incorrectly using sharp objects and disposing of them inappropriately may place people at risk of injury and possibly infection. This document provides guidance for the safe handling and disposal of sharps to prevent injuries. Other objects that are not technically classified as a sharp, but which can puncture/rip garbage bags, also need special attention.

A ***sharp*** is defined as any object that can puncture or cut the skin, e.g., syringes and needles contaminated or not with infectious or biological material, scalpels, blades, lancets, glass slides, pipettes, pipette tips, test tubes, glass blood vials, broken glass, and empty reagent bottles and unused glassware.

Safe practices for the use and handling of sharps

- Wear protective gloves when handling contaminated sharps.
- Do not handle broken glassware directly; instead use a broom and dustpan, tongs or forceps to pick it up.
- Needles shall not be bent or tampered with.
- Not safety-engineered needles shall not be recapped.
- After using a syringe-needle assembly dispose of in whole without detaching them.
- When syringes/needles are used in a chemistry work, non-compatible chemical residues will be segregated into separate containers.
- Cover sharp edges safely when not in use and do not leave on work surfaces, e.g. cork needle tips between uses.
- Glass items should be substituted by plastic ones when possible.
- Do not attempt to catch a sharp object if dropped.
- Sharps made for a purpose shall only be used for what they are intended.

- When working with cutting sharps e.g., blade, scalpel or lancet:
  - Do not use a blade without its handle.
  - Always cut away from your body.
  - Make sure no one is "down range" while you cut.
  - Carry knives with their blade pointing towards the floor.
  - Change the blade regularly. A dull blade is also dangerous as it requires more force to be applied or various attempts to lead to a successful outcome.
  - Do not force the knife; make many light cuts instead of a single hard cut.
  - Eye protection is advised; blades that break may travel a significant distance.
  - Use a device for the safe removal of blades when they are frequently used.

Sharps classification and segregation

Sharps **cannot be disposed of in the general garbage!!!** Segregate sharps according to the following classification:

- **CONTAMINATED with CHEMICALS**: Sharps contaminated with hazardous chemicals.
- **CONTAMINATED with BIOHAZARDS**: Sharps contaminated with known or potentially infectious material.
- NON-CONTAMINATED CLEAN GLASS / HARD PLASTIC WASTE:
  - Broken or intact glassware that is clean, e.g. empty unused lab flasks, reagents bottles, glass pipettes, pieces of broken glass. Before its disposal, bottles that contained any hazardous substance must be triple rinsed with the rinsate collected as hazardous waste. See poster below.
  - Non-volumetric laboratory glassware that may be repaired in the glassblowing shop, e.g., ground glass connectors. They are placed in a hard-plastic pail, lid on, to be transported to the shop in MC G201.
  - Non-contaminated hard plastic waste. Waste consisting of non-contaminated plastic pipettes and pipette tips or other pointy hard plastic. These do not meet the definition of a sharp but can cause the garbage bag to get punctured or ripped, so it cannot be disposed in the general garbage either.

Dispose of sharps properly following the instructions below.

- Dispose of sharps in containers according to their classification. Refer to the poster at the end of the document.
- Red and yellow sharps containers and accompanying labels (yellow and white stickers, respectively) are available for free at Science Stores (MC E304), ext. 3407.
- Sharps contaminated with biohazards shall be disposed of in yellow, plastic containers that must be closable, puncture-proof, and leak proof. Affix the white sticker (Figure 1) to identify the origin of the container.

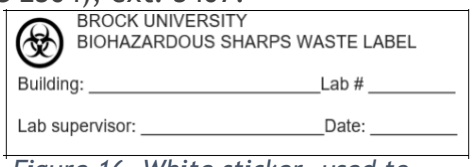
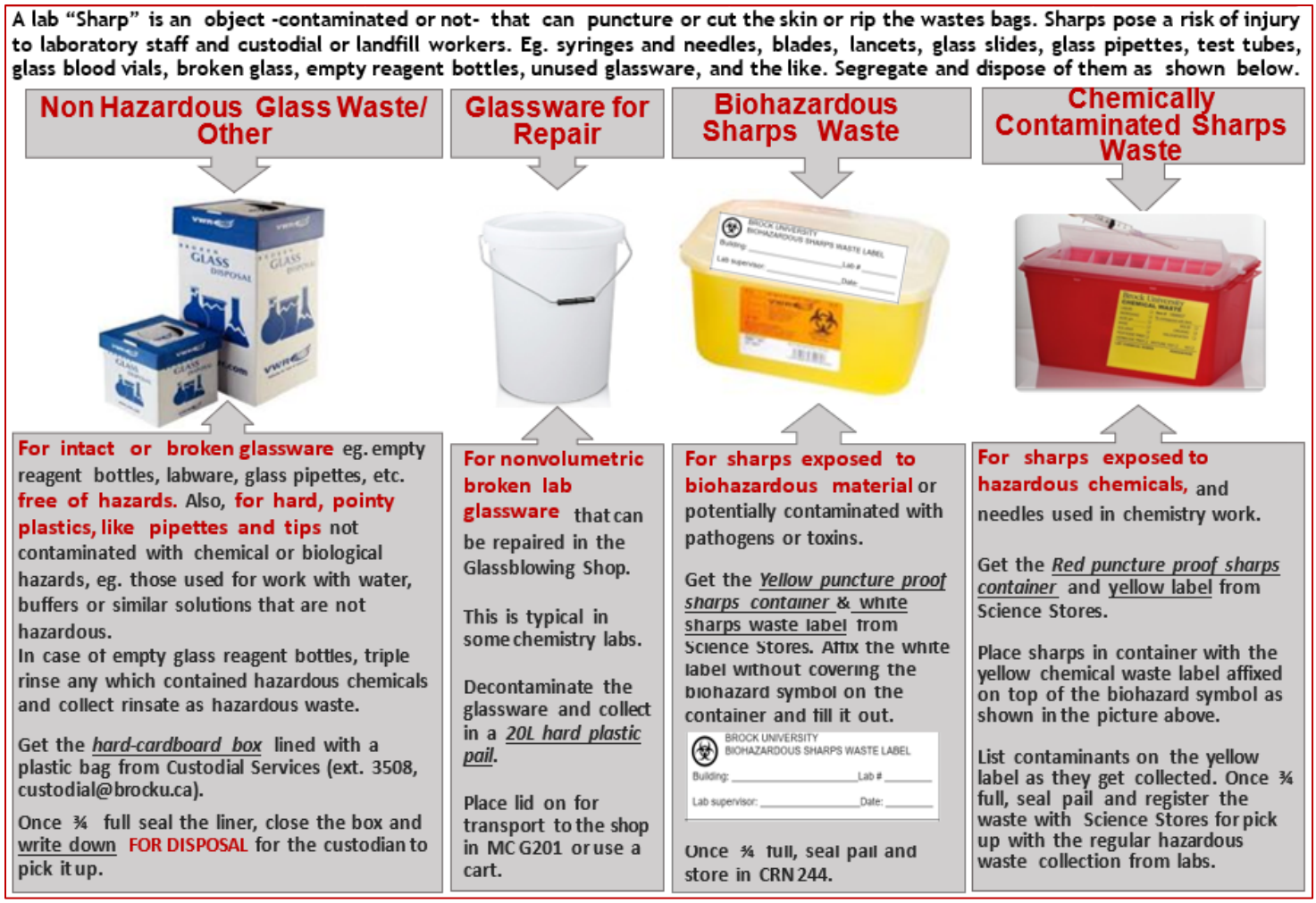

BROCK UNIVERSITY
BIOHAZARDOUS SHARPS WASTE LABEL
Building: _____ Lab # _____
Lab supervisor: _____ Date: _____

Figure 16. White sticker, used to identify the origin of sharps containers.

- Sharps contaminated with hazardous chemicals shall be disposed of in red, plastic containers that must be closable, puncture-proof, and leak proof. Also, ask for the yellow waste label, (used for all

- hazardous waste containers) which will serve to identify the origin of the container and the chemicals.
- Clean glass and hard plastic wastes will be disposed in hard cardboard boxes. 'Glass Only' hard cardboard boxes lined with a plastic bag are provided by custodial services. Send an email to custodial@brocku.ca, call ext. 3508, or contact your room custodian to get a box. Alternatively, for the non-contaminated hard plastic waste any corrugated cardboard box that is closable can be used.



  - corrugated cardboard boxes can be saved from some of your previous purchases; also, Science Stores or Shipping/Receiving (MC G204) may have empties available. However, it is not advisable to save many of these boxes in the lab as they contribute to fungal contamination since they are known carriers of fungal spores, they also contribute to clutter and can be a tripping hazard.
  - Place the sharps containers next to where the sharps are being used, in an area of easy access and away from traffic.
- All containers shall be labelled with the lab number and the applicable hazards as outlined below:
  - biohazardous sharps containers shall bear the international biohazard symbol and have the white sticker (Figure 1) affixed and filled out.

- chemically hazardous sharps containers shall bear the yellow chemical waste label. Affix the yellow waste label (on top of biohazard symbol that came with the box to cover it) and fill it out.

- Every waste container shall be closed when ¾ full, and:
  - the cardboard boxes' plastic lining must be closed first. Put the box lid back and write "FOR DISPOSAL" on the box to indicate custodial services personnel to pick it up and replace the box with a new one;
  - transport the yellow biohazard sharps containers Cairns 244 (Biomedical Waste storage room) or place it in a designated laboratory area for transport to CRN 244- contact your departmental safety representative or senior lab demonstrator for details.
  - register the chemically contaminated sharps container for disposal with the weekly hazardous waste pickup. Contact Sciences Stores for more details.
  - the laboratory glassware that will be sent to the Glassblowing Shop for repairs are to be decontaminated if applicable, collected in a 20L hard plastic pail (not in cardboard boxes as the other broken glass) and transported to the shop (MC G201) by the lab user for repair. Non-repairable pieces are disposed of by the shop personnel.

Nonhazardous waste

Unused paper and cardboard, styrofoam, pieces of wood from pallets are a significant source of clutter and air pollution in the lab as they feed mites, harbour mold spores; some may get contaminated with hazardous chemicals during their life cycle in the lab. Therefore, it is important to get rid of them promptly. Nonhazardous waste should be sorted and disposed of as appropriate in the waste bins for plastic and prints/cardboards available across hallways and around most common areas on campus. Science Stores will take empty plastic chemical containers, a separate form for this is found at this link.

SPECIAL WASTES: ETBR, RADIOACTIVE, CYTOTOXIC, CYANIDE, HF

Disposal of ethidium bromide (EtBr) must be done carefully with additional precautions in place. Since it is highly toxic if inhaled or absorbed through the skin, the smallest quantity possible for its intended use should be obtained at one time. Further, hazardous waste generators have the responsibility to minimize the generation of wastes whenever possible.

- Separate solid and liquid EtBr waste into separate containers and:
- Affix a yellow hazardous waste label (can be obtained from Science Stores) that has the date waste is first placed into the container and legibly lists all waste ingredients (including water) and approximate concentrations.
- List pH on the label if potentially corrosive (pH<2.0 or >12.5)
- Keep the container closed, not sealed, except when actively adding waste.
- All EtBr waste should be stored in well-sized secondary containment devices (meaning it can hold 100% of the total waste volume)
- If in gel form, waste should be in an appropriately labelled dated hazardous waste container. When possible, gels should be allowed to dry out before disposing of as waste charges are determined by weight.

Figure 17. Sharps waste segregation and disposal

Guidance when dealing with aqueous EtBr solutions is available here.

Radioactive waste must be disposed of by a certified 3rd party contractor. Additionally, the waste must be signed off on by the Radiation Safety Officer (RSO) who has been trained and certified to handle radioactive waste. Contact lvistorte@brocku.ca if you have radioactive waste that needs to be disposed of.

Cytotoxic waste must be disposed of with the biohazardous waste stream as mandated by provincial and federal regulations. It should be placed in a red biohazard bag found at Science Stores and Brock's biohazardous waste contractor should be contacted for pick up and incineration. Contact cbucciarelli@brocku.ca if you require a cytotoxic waste pick up.

Cyanide is a poisonous, toxic substance that should be stored in a cool, dry, ventilated area away from other hazard classes. This class of liquids should be in chemically resistant secondary containment. They are incompatible with most other hazard classes, particularly acids, bases and oxidizers. An acute exposure of cyanide will result in an immediate, acute poisoning effect.

Hydrofluoric acid (HF) is a very corrosive and toxic substance, for which special precautions apply. If you are new to work with HF, please contact the Lab Safety Specialist at ext. 6179 for an assessment of your fume hood and the especial instructions that apply.

Hydrofluoric acid waste is collected in specific type of containers (UN 3H1/Y) different to the ones used for other chemical hazardous wastes and rated for holding HF waste. They are provided by Science Stores. Two types of containers are available.

- For work with small volumes and a concentration of HF of up to 48%, containers are of 2L capacity, made of PE, with a secure lid.
- For work with large volumes and a concentration of HF up to 48%, containers are of 4 L capacity, made of HDPE, with a secure lid.
- Dispose HF waste according to the schedule and registration protocol used for other hazardous waste at the University.
- Containers may only be filled to the shoulder level.
- Waste containers must always be kept tightly closed and clean from any residues.
- If you apply any solution to neutralize residues of HF that there may be on the container surface, the remains of said solution must be cleaned before the waste is offered for disposal to the waste contractor.
- HF waste must not be mixed with any other material.
- Containers with HF waste may not be reused.

SECTION 12. SHIPPING, RECEIVING AND TRANSPORTING HAZARDOUS SUBSTANCES

Any person who will be packaging, shipping, receiving, or transporting hazardous substances outside the university must undergo Transportation of Dangerous Goods (TDG) training as outlined by O.Reg. 347.

This training is offered for all Brock staff and faculty every 3 years as the certificate is valid for that amount of time. An un-trained individual may handle dangerous goods provided the goods are handled in the presence and under the direct supervision of an individual who holds a training certificate. A trained person will be issued a training certificate that they must carry whenever handling dangerous goods. This certificate must be provided to an inspector immediately upon request.

If you require training in between these times, contact cbucciarelli@brocku.ca for individual enrollment. Lab-related hazardous and dangerous goods and lab waste receival and disposal is coordinated through Science Stores and HSW as outlined in Section 10. An additional resource for transporting dangerous goods can be found here.

[Table of Contents]

SECTION 13. TRAINING, DOCUMENTATION AND RECORD KEEPING

General Safety Training

Science labs are a hazardous environment as many hazards are present in them. Lab users will conduct experiments with hazardous materials as required under their academic curriculums or as part of their work, and that most be done in a safe manner. The department of HSW has developed various training modules that over the spectrum of hazards present in labs. These modules are available on Sakai for workers and students alike.

While it is HSW's responsibility to provide general lab safety modules, it is the responsibility of lab supervisors to determine which modules must be taken by their supervisees based on the type of hazards present in the lab and the type of activities with hazardous material that lab users will perform; supervisor are expected to ensure that the necessary/required training has been taken, and to maintain records of completion for each person under their purview.

Access to labs must not be granted until the pertinent training(s) module(s) have been completed. Training completion verification has been facilitated by the issuance of certificates. This is a feature built into Sakai page which becomes active to the trainee once the training has been completed successfully. Questions about access and certificates issues can be directed to cbucciarelly@brocku.ca.

The modules available and the recommended audience for each module are as follows:

Science Safety – Required for Brock University faculty, staff, students, and visiting scholars or other personnel with an official relationship with the University, who will work in sciences labs. Since procedures and legislation change relatively frequently, this training is valid for 4 years after which term it shall be retaken.

Autoclave Training – For users of the autoclave in CRN108. User of the autoclaves in MCH 321 shall contact jciolfi@brocku.ca

Biosafety Training - Required for Brock University faculty, staff, students, and visiting scholars or other personnel with an official relationship with the University, who will work with biohazards or in areas where biohazards are present within the university campuses. It also applies to work outside the University that it is within the University auspices. Access to work in containment level 2 laboratories is contingent upon successful training completion. This training shall be updated every three years to maintain access, in accordance with the applicable biosafety regulations and procedures.

Biosafety Emergencies Training – For users of Containment Level 2 (CL2) labs. It is required to be taken annually. You require 80% to pass this particular training.

Workplace Hazardous Materials Information Systems (WHMIS) Training - Required to be taken by anyone at Brock who work with or are in close proximity to hazardous materials.

Bloodborne Pathogen Safety Training – Required to be taken by anyone at Brock who will be working with blood an does work in a CL2 lab.

CL1 Biosafety Training – Required to be taken by anyone at Brock who will be working with RG1 pathogens or in a CL1 Lab.

Health & Safety Awareness Training - Required to be taken at least one time by everyone.

Radiation Safety Training – Required for employees who work with or are in close proximity to radioactive materials on campus.

Transportation of Chemicals, Compressed Gases and Cryogens- Required for Brock University faculty, staff, and students who work with or handle cylinders of compressed substances, liquid nitrogen or other cryogens, and solid carbon dioxide. Access to the storage rooms MC G200, CRN 245, and the storage cage for cylinders of flammable compressed substances in the MC building is contingent upon successful completion of this training. Supervisors must ensure their supervisees have completed training before requesting access to these spaces on their behalf.

X-Ray Safety Training - Required to be taken by those who work with X-ray equipment on campus.

Hydrofluoric Acid Safety Training – Required for anyone at Brock who will be working with hydrofluoric acid. Contact cbucciarelli@brocku.ca if you require this particular training.

Lab-Specific Training

It is the responsibility of the principal investigator and lab supervisor to ensure that lab personnel receive appropriate site-specific orientation and training. Since there is a wide range of hazards present in laboratories, laboratory specific safe work procedures will be required to supplement the information provided in this manual and the training modules. Laboratory supervisors and faculty members must ensure that lab specific standards and procedures are developed that address the hazards associated with the equipment, chemicals, and work procedures in their particular laboratories.

[Table of Contents]

SECTION 14. DESIGNATED SUBSTANCES

The use, handling, storage, and exposure to these 11 designated substances (DS) is regulated by the Ontario Ministry of Labour:

- Acrylonitrile,
- Arsenic,
- Asbestos,
- Benzene,
- Coke Oven Emissions,
- Ethylene Oxide,
- Isocyanates,
- Lead,
- Mercury,
- Silica,
- Vinyl Chloride

The appropriate regulations should be consulted before any work with these substances occurs. Worker exposure to these chemicals in a given time period, should be carefully monitored, prohibited, or strictly controlled. These are other requirements that apply to the use of DS.

- Atmospheric conditions in the lab should be controlled
- Lab instructors have the authority, at any time, to prohibit or restrict the use of these designated substances
- These chemicals must be properly labeled to ensure safe handling.
- A current written assessment is required for usage of these substances. This assessment can be found in the appendix A 5, more info is also available Section 15. Forms.
- If an assessment shows a risk of exposure, a control program is necessary, which involves air monitoring, medical monitoring, and instituting engineering controls.
- Contact the office of HSW if you are planning to use any of the DS and have questions on how to conduct the risk assessment.

The following is general info on the hazards of DS.

Mercury

Chronic exposure to mercury through any route can cause central nervous system damage. Mercury filled equipment such as thermometers and manometers are the most common sources of mercury in the laboratory, and mercury-free substitutes are available.

In addition to personnel exposure, laboratory and environmental contamination is also of concern. Refer to the spills section for more information on mercury spill clean ups. All mercury must be disposed of as hazardous waste and should be picked up by Brock's 3rd party contractor.

Mercury can affect the body through several routes of exposure.

Inhalation. Even as a low-pressure chemical, the resulting equilibrium concentration is 13 mg/ m^3, three times higher than the threshold limit value. As a volatile chemical, spilled mercury can create

high airborne concentrations. Long term exposure to vapours, usually through spills or inadequate clean up of one, can affect the central nervous system as mercury is a neurotoxin.

Contact with skin or eyes – Mercury can cause skin irritation in the form of rashes and inflammation. Although dermal absorption is relatively slow, chronic exposure can lead to nausea, vomiting and severe abdominal pain. If you are exposed to organic mercury compounds rather than elemental liquid mercury, effects can be even more severe. Dermal exposure is especially dangerous as it is easy to receive toxic doses.

Silica

Silica refers to any type of crystalline silica in respirable form. Recommended practices are to designate a fume hood for silica work and placing appropriate signage. Do not work with silica powder/gel in the open lab. Work clothing should not be brought out of the laboratory and contaminated clothing (lab coats) should be disposed of as hazardous waste. Wet wipe down areas after work is completed (not dry dusting).

Silica can come in crystalline and amorphous forms. Amorphous silica's chemical, physical, and toxicological properties have not been thoroughly investigated. Therefore, amorphous silica should be handled as if possessing the same hazards as the crystalline form.

Silica gel may be harmful if inhaled, swallowed or absorbed through skin as it may cause skin, eye and respiratory tract irritation. It is a known carcinogen to humans; and it also can cause silicosis, tuberculosis and other infections and chronic obstructive pulmonary disease.

[Table of Contents]

SECTION 15. FORMS

Injury/Incident Report Form

An injury/incident must be reported to your supervisor and then a report form must be filled out within 24 hours of the incident and sent to besafe@brocku.ca. This form can be found here. This form outlines the definitions of an injury and incident and the responsibilities of the reporter and supervisor.

Volunteer Appointment Form

A volunteer appointment procedure is important to be in place to outline conditions with the intent to minimize risks and clearly define responsibilities of both University employees and volunteers. A form with the University's procedure can be found here.

Travel and Field Work Risk Assessment

PIs/RAs should review proposed travel and activities with their respective supervisor to ensure that there is support and endorsement as required, prior to proceeding with trip planning. Once the PI/RA has received support from their supervisor, they can proceed with completing the (Travel Risk & Emergency Management Plan) TREMP form. More information on travel risk management, including the TREMP form, can be found here.

Designated Substance Risk Assessment

A written assessment must be filled out by the person that wishes to work with a designated substance. This form can be found here. A guideline for benzene is available here.

Waste Registration

All new waste steams must be registered before disposal. Waste generators need to determine if the wastes they produce or accumulate are subject to Ontario's registration requirements. Registering waste classes is part of the University's contract with RPR Environmental. An additional document that includes the registration process, exemptions and creating a generator registration report can be found and in Appendix

Designated Substance Assessment Form

This form should be completed by any researcher at Brock who is planning to utilize any designated substances in their lab. These substances require special precautions when used as outlined by O.Reg. 490/09: Designated Substances. This form will help identify any gaps in training, containment measures or other safety precautions and can be found in the Appendix .

Laboratory Risk Assessment Template

This form can be used by any researcher at Brock to identify hazards at each step of research and to provide essential information for enhancing safety practices, establishing proper procedures, and ensuring all lab members are properly trained. This template can be used to help with gathering all relevant information and is found in the Appendix below.

[Table of Contents]

A 1. Appendices. Chemical Compatibility Chart

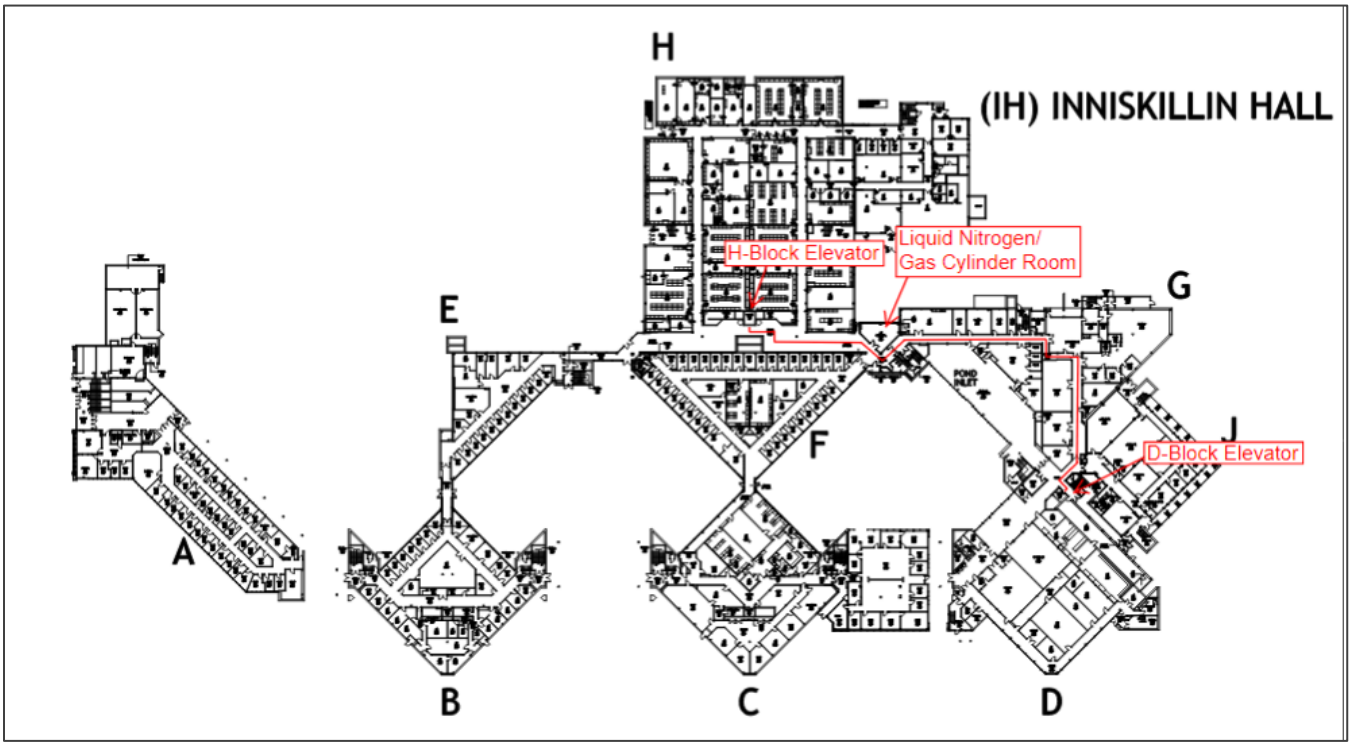
The chemical compatibility chart below with 24 groups is adapted from the CRC Laboratory Handbook. It is not a comprehensive list but a representation of the most commonly used chemicals in the lab. This chart is meant for making decisions on waste sorting and mixing and for the storage of chemicals. For a more complete information check the safety data sheet (SDS) of the chemical.

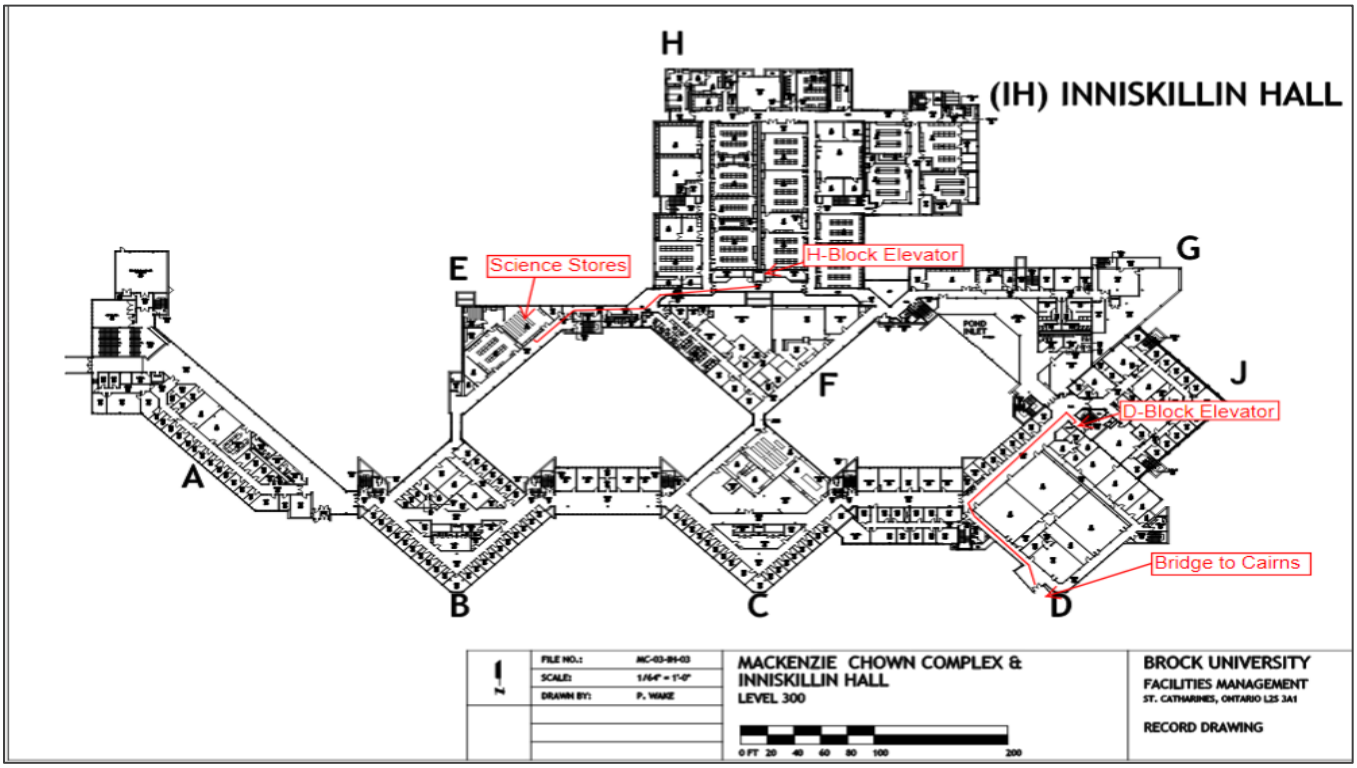
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	Inorganic Acids																								
2	Organic acids	X																							
3	Caustics	X	X																						
4	Amines & Alkanol amines	X	X																						
5	Halogenated Compounds	X		X	X																				
6	Alcohols, Glycols & Glycol Ethers	X																							
7	Aldehydes	X	X	X	X		X																		
8	Ketone	X		X	X			X																	
9	Saturated Hydrocarbons																								
10	Aromatic Hydrocarbons	X																							
11	Olefins	X				X																			
12	Petroleum Oils																								
13	Esters	X		X	X																				
14	Monomers & Polymerizable Esters	X	X	X	X	X	X																		
15	Phenols			X	X			X							X										
16	Alkylene Oxides	X	X	X	X		X	X							X	X									
17	Cyanohydrins	X	X	X	X	X		X									X								
18	Nitriles	X	X	X	X												X								
19	Ammonia	X	X					X	X					X	X	X	X	X							
20	Halogens			X			X	X	X	X	X	X	X	X	X	X				X					
21	Ethers	X													X						X				
22	Phosphorus, Elemental	X	X	X																	X				
23	Sulfur, Molten									X	X	X	X				X								
24	Acid Anhydrides	X		X	X		X	X							X		X	X	X	X					

X Represents unsafe combinations Represents safe combinations

[Table of Contents]

A 2. Route for transporting cryogens and cylinders of compressed substances





[Table of Contents]

A 3. Brock University Laboratory Safety Self-Inspection Checklist

Y/N/NA **I. Laboratory Work Practices & Housekeeping**

☐☐☐ No food & beverages consumed* or stored; no applying contact lenses & cosmetic permitted.

☐☐☐ Fume hoods & BSCs are used properly (sash height maintained, not overcrowded, no improper storage, no excess traffic).

☐☐☐ Lab & storage areas are uncluttered and reasonably orderly, including bench top.

☐☐☐ Hands are washed after removing gloves and before leaving lab.

☐☐☐ Floor, aisles & exits are clear and unobstructed & free from loose material, spills & worn floor coverings.

☐☐☐ Floors are cleaned regularly.

☐☐☐ Dust levels are low.

II. Personal Protective Equipment

☐☐☐ Protective gloves are available and matched to hazards involved; removed to go out the lab/ to touch common surfaces.

☐☐☐ Eye protection is available/ in use as appropriate

☐☐☐ Lab coats are available/ in use, as appropriate.

☐☐☐ Lab coats are worn only in lab & not in public spaces.

☐☐☐ Cryogenic gloves & spill goggles are used for handling cryogens.

☐☐☐ Respirators, if needed, are used correctly, cleaned after every use and stored in accessible and clean area.

☐☐☐ Spill goggles are worn by all in chemistry labs.

☐☐☐ Only closed-toe shoes are worn in chemistry labs.

III. Safety Equipment- Eyewash Station/Safety Showers are:

☐☐☐ Located within 17 m of reach.

☐☐☐ Labeled and free from obstruction.

☐☐☐ Clean and in good working condition.

☐☐☐ Checked monthly and signed.

IV. Safety Equipment- Fire Extinguishers are:

☐☐☐ Available.

☐☐☐ Appropriate for the type for the hazard present.

☐☐☐ Checked monthly and signed.

☐☐☐ Fire detection devices, smoke alarms, sprinkler systems, lighted exit signs are in good working condition.

V. Safety Equipment- First Aid Supplies

☐☐☐ First-aid kit is readily available and clearly visible.

☐☐☐ Spill kit is available, supplied and clearly posted.

Y/N/NA **VI. Hazard Communication**

☐☐☐ Entry doors show emergency contact info & hazard signage matching hazards present.

☐☐☐ Chemical containers and hazardous waste containers are labelled appropriately.

☐☐☐ Special hazards are labelled conspicuously (eg. x-ray, radioactive).

☐☐☐ SDS are available for chemicals used and stored in area.

VII. Chemical Storage

☐☐☐ Incompatible materials are segregated.

☐☐☐ Corrosives and flammables are stored below eye level.

☐☐☐ Flammables are stored in approved safety cabinets.

VIII. Flammable Liquids Storage & Handling

☐☐☐ Flammable liquids are stored and used away from ignition sources.

☐☐☐ Bulk quantities of flammable liquids are stored in approved storage cabinets.

☐☐☐ Flammable liquid storage cabinets are properly labeled and close properly.

☐☐☐ Flammable liquids do not exceed 500L per fire compartment.

☐☐☐ Flammable liquids in use in the open lab do not exceed 50 L per fire compartment.

☐☐☐ Containers for dispensing flammable liquids are bonded and grounded.

☐☐☐ Nothing is stored on top of flammable cabinets.

IX. Compressed Gas Cylinders

☐☐☐ Are secured to a non-movable/sturdy structure.

☐☐☐ A maximum of one in-use and one spare cylinder per type of substance are present.

☐☐☐ Caps are in place when cylinders are not in use or being moved.

☐☐☐ Are transported securely on a cart.

☐☐☐ Are stored away from heat sources.

☐☐☐ Are properly marked as to their contents.

☐☐☐ Empty cylinders are not kept in lab.

☐☐☐ Hoses, tubing and regulators are in good working condition.

☐☐☐ No chemicals and hazardous waste (HW) are disposed of down the sinks or the sewer.

Y/N/NA I. Laboratory Work Practices & Housekeeping

☐☐☐ No food & beverages consumed* or stored; no applying contact lenses & cosmetic permitted.

☐☐☐ Fume hoods & BSCs are used properly (sash height maintained, not overcrowded, no improper storage, no excess traffic).

☐☐☐ Lab & storage areas are uncluttered and reasonably orderly, including bench top.

☐☐☐ Hands are washed after removing gloves and before leaving lab.

☐☐☐ Floor, aisles & exits are clear and unobstructed & free from loose material, spills & worn floor coverings.

☐☐☐ Floors are cleaned regularly.

☐☐☐ Dust levels are low.

II. Personal Protective Equipment

☐☐☐ Protective gloves are available and matched to hazards involved; removed to go out the lab/ to touch common surfaces.

☐☐☐ Eye protection is available/ in use as appropriate

☐☐☐ Lab coats are available/ in use, as appropriate.

☐☐☐ Lab coats are worn only in lab & not in public spaces.

☐☐☐ Cryogenic gloves & spill goggles are used for handling cryogens.

☐☐☐ Respirators, if needed, are used correctly, cleaned after every use and stored in accessible and clean area.

☐☐☐ Spill goggles are worn by all in chemistry labs.

☐☐☐ Only closed-toe shoes are worn in chemistry labs.

III. Safety Equipment- Eyewash Station/Safety Showers are:

☐☐☐ Located within 17 m of reach.

☐☐☐ Labeled and free from obstruction.

☐☐☐ Clean and in good working condition.

☐☐☐ Checked monthly and signed.

IV. Safety Equipment- Fire Extinguishers are:

☐☐☐ Available.

☐☐☐ Appropriate for the type for the hazard present.

☐☐☐ Checked monthly and signed.

☐☐☐ Fire detection devices, smoke alarms, sprinkler systems, lighted exit signs are in good working condition.

V. Safety Equipment- First Aid Supplies

☐☐☐ First-aid kit is readily available and clearly visible.

☐☐☐ Spill kit is available, supplied and clearly posted.

Y/N/NA VI. Hazard Communication

☐☐☐ Entry doors show emergency contact info & hazard signage matching hazards present.

☐☐☐ Chemical containers and hazardous waste containers are labelled appropriately.

☐☐☐ Special hazards are labelled conspicuously (eg. x-ray, radioactive).

☐☐☐ SDS are available for chemicals used and stored in area.

VII. Chemical Storage

☐☐☐ Incompatible materials are segregated.

☐☐☐ Corrosives and flammables are stored below eye level.

☐☐☐ Flammables are stored in approved safety cabinets.

VIII. Flammable Liquids Storage & Handling

☐☐☐ Flammable liquids are stored and used away from ignition sources.

☐☐☐ Bulk quantities of flammable liquids are stored in approved storage cabinets.

☐☐☐ Flammable liquid storage cabinets are properly labeled and close properly.

☐☐☐ Flammable liquids do not exceed 500L per fire compartment.

☐☐☐ Flammable liquids in use in the open lab do not exceed 50 L per fire compartment.

☐☐☐ Containers for dispensing flammable liquids are bonded and grounded.

☐☐☐ Nothing is stored on top of flammable cabinets.

IX. Compressed Gas Cylinders

☐☐☐ Are secured to a non-movable/sturdy structure.

☐☐☐ A maximum of one in-use and one spare cylinder per type of substance are present.

☐☐☐ Caps are in place when cylinders are not in use or being moved.

☐☐☐ Are transported securely on a cart.

☐☐☐ Are stored away from heat sources.

☐☐☐ Are properly marked as to their contents.

☐☐☐ Empty cylinders are not kept in lab.

☐☐☐ Hoses, tubing and regulators are in good working condition.

☐☐☐ No chemicals and hazardous waste (HW) are disposed of down the sinks or the sewer.

[Table of Contents]

A 4. Laboratory Emergency Preparedness Checklist

Lab Checklist:

Secure chemicals and hazardous agents

- ☐ Remove all chemicals and glassware from benchtops and store in cabinets as appropriate.
- ☐ Ensure that water reactive chemicals are in sealed containers and stored as appropriate.
- ☐ Remove biological materials/waste from biosafety cabinets and/or benches, disinfect or autoclave, or safely store them as appropriate.
- ☐ Ensure that all chemical, radioactive, and hazardous waste containers are properly stored according to practices.
- ☐ Ensure all gas valves are closed. If available, shut off gas to area.
- ☐ Check that all compressed gas cylinders are secured. Remove regulators and use caps.
- ☐ Consolidate storage of valuable perishable items within storage units that have backup systems if possible.

Secure equipment and room

- ☐ Secure/shut down all experiments that could be affected by loss of electricity, water, or other services.
- ☐ Shut off and unplug sensitive electric equipment.
- ☐ Close biosafety cabinets.
- ☐ Turn off appliances, computers, hot plates, ovens, and other equipment. Unplug equipment if possible.
- ☐ Fill dewars and cryogen containers for sample storage and critical equipment.
- ☐ If possible, elevate equipment, materials and supplies, including electrical wires and chemicals, off the floor.
- ☐ Inspect all equipment requiring uninterrupted power for electricity supplied through an Uninterrupted Power Supply (UPS) and by emergency power (emergency generator).
- ☐ Close all windows and lock all doors.

Secure information and communications

- ☐ Secure lab notebooks and other data storage media.
- ☐ Ensure emergency contact and phone numbers are up to date.
- ☐ Take phone tree with you or copy of your department's business continuity plan, if available.
- ☐ Prepare for telecommuting as applicable and as procedures and policies of your department and division.
- ☐ Ensure you know how to contact your principal investigator, department representatives/research operations manager, and facility management group.

Contacts

Principal Investigator:

Home phone	
Mobile	
Email	

Designated Lab Supervisor 1

Home phone	
Mobile	
Email	

Designated Lab Supervisor 2

Home phone	
Mobile	
Email	

Department Representative / Research Operations Manager/Safety Representative:

Home phone	
Mobile	
email	

Facility Manager:

Home phone	
Mobile	
email	

Reporting an Emergency

- Call emergency services at 9-1-1
- Notify Campus Security- Emergency: 905-688-5550 ext 3200
- Health, Safety & Wellness- Emergency: ext. 7233
  Incident reporting: besafe@brocku.ca
  Lab Safety Spec. Emergency: 289-241-5373

Reporting an incident or accident

- https://brocku.ca/human-resources/health-safety-and-wellness/

Latest U of T COVID-19 information

- https://brocku.ca/coronavirus/

[Table of Contents]

A 5. Designated Substance Assessment Form

Substance:
Principal Investigator:
Work Location:
Date Prepared:

Designated Substances Include:
Acrylonitrile
Arsenic
Asbestos
Benzene
Coke oven emissions
Ethylene oxide
Isocyanates
Lead
Mercury
Silica
Vinyl chloride

Part A: Use and Storage

Product Name	Location	Nature of Use (Teaching/Research/Storage)	Quantity	Frequency of Use (# times per day/month/year)

1. ☐ Substance is in use and an assessment is required

2. ☐ Substance is not in use and can be disposed of as hazardous waste

Disposal Date:

3.

Part B: User Interaction with the Designated Substance

4. In what form is the substance purchased from the supplier/manufacturer?

Product Name:

Type of Container:

Size of Container:

5. Is this form altered during use?

☐ Yes
☐ No

If yes, indicate altered form:

Is there a possibility of the substance being released into the workplace environment during normal use?

☐ Yes
☐ No

6. If yes, indicate the step during use or area(s) where this may occur:

If yes to question 3, specify the job functions and approximate number of individuals who might be exposed.

Job Function	Number of Individuals

7. **If yes to question 3**, indicate how individuals could be exposed:

☐ Inhalation
☐ Ingestion
☐ Skin absorption
☐ Skin contact

If no to question 3, is there a likelihood of escape due to leaks, spills, accidents, etc.?

☒ Yes
☐ No

Are there any activities or situations where exposure by any route is possible?

☐ Yes
☐ No

If yes, please provide an explanation:

Part C: Process Description and Controls

Include information such as:

Process Description and Controls	Likely Exposure (Yes/No)
Identify type of engineering control used, i.e. fume hood, glove box, local exhaust ventilation and note down the fume hood number, face velocity value, and time of last testing:	
Describe the personal protective equipment in use:	
Describe storage precautions:	
Describe waste disposal procedures:	
Describe spill procedure or attach a separate document:	
Indicate what training provided is provided:	

Other controls:	

Applicable Designated Substance Exposure Limits

Designated Substance	Time Weighted Average[1]	Maximum Exposure[2]
Benzene	0.5 ppm	2.5 ppm

Airborne concentrations of a designated substance are expressed as,
(a) parts of the agent per million parts of air by volume (ppm);
(b) milligrams of the agent per cubic metre of air (mg/m^3); or
© fibres per cubic centimetre of air (f/cc).

[1] Time Weighted Average (TWA) is calculated on the basis of cumulative weekly exposure (40 hours), based on an 8 hour work day.
[2] Maximum Exposure must:

- Not last longer than 15 minutes at any one time;
- Not occur more than four times in a work day; and
- Not occur until at least 60 minutes after the last previous exposure to such concentration.

[Table of Contents]

A 6. Laboratory Risk Assessment Template

Part A: Procedure Details

Title:
Brief summary of procedure: (append detailed procedures to risk assessment)
Location Details:

Part B: Review

Prepared by: (add additional rows if required)		
Name :	Signature:	Date:
This Risk Assessment is to be reviewed by the Biosafety Committee. Please send the completed form to lvistorte@brocku.ca, through interoffice mail, or to Cairns 507.		
Date: / /		

Part C: Hazards Identification
Add additional rows as required

	Hazardous Substances/Materials				
Substance name	Hazard Classifications	**Routes of exposure** (adsorption, inhalation, ingestion, or puncture)	Occupational Exposure limits	Max Conc. used	Max Qty used

Hazardous Equipment/Processes	Hazard

Part D: Risk Assessment

Use the table below to document the risks associated with the procedure (the potential injury or harm that could arise from the hazards identification in Section C), including the likelihood (using the descriptors on the right as a guide) and consequences.

[1]Likelihood Descriptors	
Likelihood	Description
Negligible	Cannot occur or is extremely improbable
Unlikely	Not expected to occur during normal

Consider the likelihood and consequences with no controls implemented (pre-control). Once you have documented your controls in Section E, reassess the likelihood and consequences (post-control).	

	operations but conceivable it could
Likely	Could be expected to occur from time to time during normal operations
Almost certain	Expected to occur during normal operations

Description of risk (Add rows as needed)	Pre-control risk assessment (with no controls implemented)		Post-control risk assessment (with controls stipulated in Section E implemented)	
	Likelihood[1]	Consequences	Likelihood[1]	Consequences

Part E: Control Plan
Specify the controls to be implemented to minimize the risks identified, following the boxes below as a guide.

Engineering/Equipment Controls
Any items or equipment (other than PPE) used to minimize a hazard e.g., fume hood, guards, spill kit supplies (specific neutralizers, etc.):

Personal Protective Equipment
Please specify. E.g., UV rated goggles; coat of specific material composition; if gloves are to be used, are nitrile/latex disposable or is a chemical resistant glove required? Where chemical resistant gloves are required, specify the make/model to be used):

Administrative Controls
Work practices or procedures followed to minimize a hazard:

Supervision and Working in Isolation Controls
Is the procedure subject to any restrictions on working in isolation due to increased risks? E.g., task may only be conducted at specified hours and days, or more than one or a specifically qualified person must be present. ☐ No, the procedure can be safely done any time or day and without special supervision. ☐ Yes, specify below:

Hazardous Waste Disposal
Is the procedure expected to generate a special stream of hazardous wastes? ☐No ☐Yes, specify disposal method:

Emergency Procedures
Does the procedure require any specific emergency procedures not covered by the Brock University Emergency Procedures available in the Brock Lab Safety Manual? ☐No ☐Yes, specify below:

Additional Information:
Specify any other important additional information:

Part F: Training

Approved Trainers – Specify personnel approved to train users in this procedure:		
Name	Position	Laboratory

Training Record – Record trained users below				
Trainee Name	Signature	Trainer Name	Trainer Signature	Date

[Table of Contents]

A 7. WHMIS Door Signage

Room: CRN / MC …- Specialty lab

Personal Protective Equipment

Spill-resistant goggles

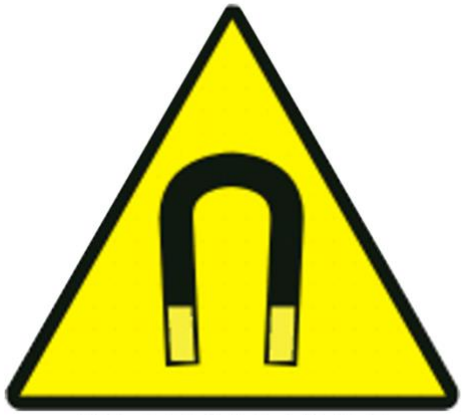
Lab coat

Emergency Contacts – Call Campus Security
905 688 5550 ext. 3200

Dr. John Doe: Safety Rep. Office ext. 1234

Dr. John Doe. Office ext. 1234

Gloves	Dr. John Doe. Office ext. 1234
Closed shoes	Dr. John Doe. Office ext. 1234
	Dr. John Doe. Office ext. 1234
	See map on inner door side for rooms distribution

 MAGNETIC FIELD	 X-RAY RADIATION	 RADIATION | RAYONNEMENT
 LASER BEAM		

[Table of Contents]

A 8. Gloves Chemical Compatibility Chart

8th EDITION Permeation/Degradation Resistance Guide for Ansell Gloves

The first square in each column for each glove type is color coded to provide an overall rating for both Degradation and Permeation. The letter in each colored square is for Degradation alone.

- GREEN: The glove is very well suited for application with that chemical.
- YELLOW: The glove is suitable for that application under careful control of its use.
- RED: Avoid use of the glove with this chemical.

SPECIAL NOTE: The chemicals in this guide highlighted in BLUE are experimental carcinogens, according to the ninth edition of Sax' *Dangerous Properties of Industrial Materials*. Chemicals highlighted in GRAY are listed as suspected carcinogens, experimental carcinogens at extremely high dosages, and other materials which pose a lesser risk of cancer.

CHEMICAL	LAMINATE FILM BARRIER™			NITRILE SOL-VEX®			UNSUPPORTED NEOPRENE 29-SERIES			SUPPORTED POLYVINYL ALCOHOL PVA™			POLYVINYL CHLORIDE (Vinyl) SNORKEL®			NATURAL RUBBER *CANNERS AND HANDLERS™			NEOPRENE/ NATURAL RUBBER BLEND *CHEMI-PRO®			BUTYL UNSUPPORTED CHEMTEK™ BUTYL			VITON/BUTYL UNSUPPORTED CHEMTEK™ VITON/BUTYL		
	Degradation Rating	Permeation: Breakthrough	Permeation: Rate	Degradation Rating	Permeation: Breakthrough	Permeation: Rate	Degradation Rating	Permeation: Breakthrough	Permeation: Rate	Degradation Rating	Permeation: Breakthrough	Permeation: Rate	Degradation Rating	Permeation: Breakthrough	Permeation: Rate	Degradation Rating	Permeation: Breakthrough	Permeation: Rate	Degradation Rating	Permeation: Breakthrough	Permeation: Rate	Degradation Rating	Permeation: Breakthrough	Permeation: Rate	Degradation Rating	Permeation: Breakthrough	Permeation: Rate
1. Acetaldehyde	■	380	E	P	—	—	E	10	F	NR	—	—	NR	—	—	E	13	F	E	10	F	—	—	—	—	—	—
2. Acetic Acid, Glacial, 99.7%	■	150	—	G	158	—	E	390	—	NR	—	—	F	45	G	E	110	—	E	263	—	E	>480	—	DD	>480	—
3. Acetone	▲	>480	E	NR	—	—	G	10	F	P	143	G	NR	<5	—	E	10	F	G	12	G	E	>480	E	DD	93	VG
4. Acetonitrile	▲	>480	E	F	30	F	E	20	VG	■	150	G	NR	—	—	E	4	VG	E	13	VG	E	>480	E	DD	70	E
5. Acrylic Acid	—	—	—	G	120	—	E	395	—	NR	—	—	NR	—	—	E	80	—	E	67	—	—	—	—	—	—	—
6. Acrylonitrile	▲	>480	E	—	—	—	—	—	—	▲	>480	—	—	—	—	E	5	F	—	—	—	E	>480	—	E	>480	—
7. Allyl Alcohol	▲	>480	E	F	140	F	E	140	VG	P	—	—	P	60	G	E	10	VG	E	20	VG	E	>480	—	E	>180	—
8. Ammonia Gas	■	19	E	▲	>480	E	▲	>480	—	—	—	—	—	—	—	—	—	—	■	27	E	—	—	—	—	—	—
9. Ammonium Fluoride, 40%	▲	>480	E	E	>360	—	E	>480	—	NR	—	—	E	>360	—	E	>360	—	E	>360	—	—	—	—	—	—	—
10. Ammonium Hydroxide, Conc. (28-30% Ammonia)	E	30	—	E	>360	—	E	250	—	NR	—	—	E	240	—	E	90	—	E	247	—	E	>480	—	E	>480	—
11. n-Amyl Acetate	▲	470	E	E	198	G	NR	—	—	G	>360	E	P	—	—	NR	—	—	P	—	—	E	128	G	F	<10	F
12. Amyl Alcohol	▲	>480	E	E	>480	E	E	348	VG	G	180	G	G	12	E	E	25	VG	E	≤2	VG	E	>480	E	E	>480	E
13. Aniline	▲	>480	E	NR	—	—	E	145	F	F	>360	E	F	62	G	E	25	VG	E	82	G	E	>480	E	E	>480	E
14. Aqua Regia	—	—	—	F	>360	—	G	>480	—	NR	—	—	G	120	—	NR	—	—	G	193	—	E	>480	—	E	>480	—
15. Benzaldehyde	▲	>480	E	NR	—	—	NR	—	—	G	>360	E	NR	—	—	G	10	VG	G	27	F	E	>480	E	E	100	E
16. Benzene (Benzol)	▲	>480	E	P	—	—	NR	—	—	E	>360	E	NR	—	—	NR	—	—	NR	—	—	E	20	F	E	253	VG
17. Benzotrichloride	▲	>480	E	E	>480	E	NR	—	—	—	—	—	G	—	—	NR	—	—	NR	—	—	—	—	—	—	—	—
18. Benzotrifluoride	▲	>480	E	E	170	G	—	—	—	—	—	—	G	<10	F	P	≤0	G	P	—	—	—	—	—	—	—	—
19. Bromine Water	—	—	—	E	>480	E	E	>480	E	NR	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
20. 1-Bromopropane (Propyl Bromide)	▲	>480	E	▼	23	F	▼	<10	P	▲	>480	E	▼	<10	F	▼	<10	P	▼	<10	P	▼	10	P	■	182	VG
21. 2-Bromopropionic Acid	▲	>480	—	F	120	—	E	460	—	—	—	—	G	180	—	E	190	—	G	190	—	—	—	—	—	—	—
22. n-Butyl Acetate	▲	>480	E	F	75	F	NR	—	—	G	>360	E	NR	—	—	NR	—	—	P	—	—	E	80	G	DD	<10	F
23. n-Butyl Alcohol	▲	>480	E	E	>360	E	E	270	E	F	75	G	G	180	VG	E	35	VG	E	75	VG	E	>480	E	E	>480	E
24. Butyl Carbitol	—	—	—	E	>323	E	G	188	F	E	>480	E	E	397	VG	E	44	G	E	148	G	—	—	—	—	—	—
25. Butyl Cellosolve	▲	>480	E	E	470	VG	E	180	G	■	120	G	P	60	G	E	45	G	E	48	G	E	>480	—	E	>480	—
26. gamma-Butyrolactone	▲	>480	E	NR	—	—	E	245	G	E	120	VG	NR	—	—	E	60	G	E	104	F	E	>480	E	E	>480	E
27. Carbon Disulfide	▲	>480	E	G	30	F	NR	—	—	E	>360	E	NR	<5	—	NR	—	—	NR	—	—	▼	7	G	■	138	E
28. Carbon Tetrachloride	—	—	—	G	150	G	NR	—	—	E	>360	E	F	25	F	NR	—	—	NR	—	—	F	≤3	P	—	—	—
29. Cellosolve® (Ethyl Glycol Ether, 2-Ethoxyethanol)	E	>480	E	G	293	G	E	128	G	■	75	G	P	38	G	E	25	VG	E	25	VG	E	>480	E	E	465	E
30. Cellosolve Acetate® (2-Ethoxyethyl Acetate, EGEAA)	▲	>480	E	F	90	G	G	40	F	■	>360	E	NR	—	—	E	10	G	E	23	G	E	>480	E	DD	105	VG

CHEMICAL	BARRIER			SOL-VEX			29-SERIES			PVA			SHORELS			CANNERS AND HANDLERS*			CHEMI-PRO*			CHEMTEX BUTYL			CHEMTEX VITON/BUTYL		
31. Chlorine Gas	▲	>480	E	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
32. Chlorobenzene	▲	>480	E	NR	—	—	NR	—	—	E	>360	E	NR	—	—	NR	—	—	NR	—	—	P	9	P	F	>480	E
33. 4-Chlorobenzotrifluoride	—	—	—	E	220	VG	F	60	F	F	—	—	F	—	—	P	—	—	P	—	—	■	75	F	■	48	F
34. 2-Chlorobenzyl Chloride	E	120	E	—	—	—	F	200	E	E	>480	E	F	66	E	F	20	F	—	—	—	E	>480	E	E	>480	E
35. Chloroform	E	20	G	NR	—	—	NR	—	—	E	>360	E	NR	—	—	NR	—	—	NR	—	—	P	6	P	■	212	VG
36. 1-Chloronaphthalene	▲	>480	E	P	—	—	NR	—	—	G	>360	E	NR	—	—	NR	—	—	P	—	—	E	>480	E	E	>480	E
37. 2-Chlorotoluene	▲	>480	E	G	120	G	NR	—	—	—	—	—	—	—	—	NR	—	—	NR	—	—	NR	—	—	—	—	—
38. 4-Chlorotoluene	▲	>480	E	P	—	—	NR	—	—	—	—	—	P	—	—	NR	—	—	NR	—	—	▼	30	F	▲	>480	E
39. "Chromic Acid" Cleaning Solution	—	—	—	F	240	—	NR	—	—	NR	—	—	G	>360	—	NR	—	—	NR	—	—	E	>480	—	E	>480	—
40. Citric Acid, 10%	—	—	—	E	>360	—	E	>480	—	F	90	—	E	>360	E	E	>360	—	E	>480	—	—	—	—	—	—	—
41. Cyclohexane	—	—	—	▲	>360	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	G	30	F	▲	>480	—
42. Cyclohexanol	▲	>480	E	E	>360	E	E	390	VG	G	>360	E	E	360	E	E	103	VG	E	47	G	E	>480	E	▲	>480	E
43. Cyclohexanone	▲	>480	E	F	103	G	P	23	F	E	>480	E	NR	—	—	P	—	—	P	—	—	E	>480	—	▼	150	—
44. 1,5-Cyclooctadiene	▲	>480	E	E	>480	E	NR	—	—	—	—	—	NR	—	—	NR	—	—	NR	—	—	P	—	—	—	—	—
45. Diacetone Alcohol	▲	>480	E	G	240	E	E	208	VG	■	150	G	NR	—	—	E	43	VG	E	60	VG	E	>480	—	DD	—	—
46. Dibutyl Phthalate	—	—	—	G	>360	E	F	132	G	E	>360	E	NR	—	—	E	20	—	G	>480	E	—	—	—	—	—	—
47. 1,2-Dichloroethane (Ethylene Dichloride, EDC)	▲	>480	E	NR	—	—	NR	—	—	E	>360	E	NR	—	—	P	—	—	P	—	—	—	—	—	—	—	—
48. Diethylamine	▲	>480	E	F	61	F	P	—	—	NR	—	—	NR	—	—	NR	—	—	NR	—	—	F	18	—	▼	19	—
49. Diisobutyl Ketone (DIBK)	▲	>480	E	E	283	G	P	—	—	G	>360	E	P	—	—	P	—	—	P	—	—	E	231	G	DD	15	G
50. Dimethyl Sulfoxide (DMSO)	▲	>480	E	E	240	VG	E	398	G	NR	—	—	NR	—	—	E	180	E	E	150	E	E	>480	—	DD	>480	—
51. Dimethylacetamide (DMAC)	▲	>480	E	NR	—	—	NR	—	—	NR	—	—	NR	—	—	E	15	G	E	30	G	E	>480	—	DD	>480	—
52. Dimethylformamide (DMF)	▲	>480	E	NR	—	—	E	45	F	NR	—	—	NR	19	—	E	25	VG	E	40	G	E	>480	E	DD	>480	E
53. Dioctyl Phthalate (DOP, DEHP)	▲	>480	E	G	>360	E	G	>480	E	E	30	F	NR	—	—	P	—	—	E	>360	E	—	—	—	—	—	—
54. Di-n-Octyl Phthalate (DNOP)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	E	>480	—	—	—	—
55. 1,4-Dioxane	▲	>480	E	NR	—	—	NR	—	—	P	—	—	NR	—	—	F	15	F	F	18	F	E	>480	—	—	—	—
56. Electroless Copper Plating Solution	—	—	—	E	>360	—	E	>360	—	NR	—	—	E	>360	—	E	>360	—	—	—	—	—	—	—	—	—	—
57. Electroless Nickel Plating Solution	—	—	—	E	>360	—	E	>360	—	NR	—	—	E	>360	—	E	>360	—	—	—	—	—	—	—	—	—	—
58. Epichlorohydrin	▲	>480	E	NR	—	—	P	—	—	E	300	E	NR	—	—	E	15	F	E	17	VG	E	>480	—	—	—	—
59. Ethidium Bromide, 10%	▲	>480	E	▲	>480	E	—	—	—	NR	—	—	—	—	—	—	—	—	—	—	—	E	>480	—	E	>480	—
60. Ethyl Acetate	▲	>480	E	NR	—	—	F	10	P	F	>360	E	NR	—	—	G	15	F	F	10	F	E	196	G	DD	10	G
61. Ethyl Alcohol, Denatured, 92% Ethanol	▲	>480	E	E	240	VG	E	113	VG	NR	—	—	G	60	VG	E	15	VG	E	27	VG	E	>480	E	E	>480	E
62. Ethylene Glycol	▲	>480	E	E	>360	E	E	>480	E	F	120	VG	E	>360	E	E	>360	E	E	>480	E	—	—	—	—	—	—
63. Ethylene Oxide Gas	■	234	E	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
64. Ethyl Ether	▲	>480	E	E	96	G	F	<10	F	G	>360	E	NR	—	—	NR	—	—	NR	—	—	—	—	—	—	—	—
65. Ethyl L-Lactate	E	>480	E	E	273	G	E	125	VG	E	125	G	E	15	G	E	15	VG	E	28	VG	E	>480	E	E	>480	E
66. Formaldehyde, 37% in 1/3 Methanol/Water	▲	>480	E	E	>360	E	E	89	VG	P	—	—	E	100	E	E	10	G	E	32	E	E	>480	—	E	>480	—
67. Formic acid, 90%	▲	>480	—	F	240	—	E	>480	—	NR	—	—	E	>360	—	E	150	—	E	>360	—	E	>480	—	—	—	—
68. Furfural	▲	>480	E	NR	—	—	E	40	P	F	>360	E	NR	—	—	E	15	VG	E	43	VG	E	>480	—	G	>480	—
69. Freon TF	—	—	—	E	>360	E	E	240	E	G	>360	E	NR	—	—	NR	—	—	NR	—	—	—	—	—	—	—	—
70. Gasoline, Unleaded (Shell Premium winter blend)	▲	170	E	E	>480	E	NR	—	—	G	>360	E	P	—	—	NR	—	—	NR	—	—	F	20	F	E	>480	E
71. Glutaraldehyde, 25%	—	—	—	E	>360	E	E	>480	E	P	<10	F	E	>360	E	E	210	VG	—	—	—	—	—	—	—	—	—
72. HCFC-141B	▲	>480	E	E	92	F	F	33	F	P	—	—	NR	—	—	NR	—	—	NR	—	—	F	40	F	F	<10	F
73. n-Heptane	▲	>480	E	—	—	—	—	—	—	▲	>480	—	NR	—	—	—	—	—	—	—	—	P	10	F	E	>480	E
74. Hexamethyldisilazane	▲	>480	E	E	>360	—	E	42	—	G	>360	—	P	—	—	F	15	F	F	43	G	■	306	G	■	>480	G
75. n-Hexane	▲	>480	E	E	>480	E	E	48	G	G	>360	E	NR	—	—	NR	—	—	P	—	—	P	6	F	E	>480	E
76. HFE 7100	▲	>480	E	E	>480	E	E	>480	E	P	—	—	E	>480	E	E	120	E	—	—	—	—	—	—	—	—	—
77. HFE 71DE	■	164	E	F	10	F	F	<10	F	F	>480	E	NR	—	—	NR	—	—	—	—	—	—	—	—	—	—	—
78. Hydrazine, 60%	—	—	—	E	>480	—	E	386	—	NR	—	—	E	>360	—	E	150	VG	E	>360	—	E	>480	—	—	—	—
79. Hydrobromic Acid, 48%	▲	>480	—	E	>360	—	E	>480	—	NR	—	—	E	>360	—	E	>360	—	E	>360	—	—	—	—	—	—	—

80. Hydrochloric Acid, 10%	—	—	—	E	>360	—	E	>480	—	NR	—	—	E	>360	—	E	>360	—	E	>360	—	—	—	—	—	—	—
81. Hydrochloric Acid, 37% (Concentrated)	▲	>480	—	E	>480	—	E	>480	—	NR	—	—	E	300	—	E	290	—	E	>360	—	—	—	—	—	—	—
82. Hydrofluoric Acid, 48%	▲	>480	—	E	334	—	■	>480	—	NR	—	—	■	155	—	▲	>480	—	—	—	—	E	>480	—	▲	>480	—
83. Hydrofluoric Acid, 98%	▲	>480	E	—	—	—	■	342	VG	—	—	—	—	—	—	—	—	—	—	—	—	▲	>480	E	—	—	—
84. Hydrogen Fluoride Gas	▲	>480	E	■	<15	P	—	—	—	—	—	—	■	2	—	■	15	F	■	<15	F	—	—	—	—	—	—
85. Hydrogen Peroxide, 30%	—	—	—	E	>360	—	E	>480	—	NR	—	—	E	>360	—	E	>360	—	G	>360	—	—	—	—	▲	>480	—
86. Hydroquinone, saturated solution	—	—	—	E	>360	E	E	108	E	NR	—	—	E	>360	E	G	>360	E	E	>360	E	—	—	—	—	—	—
87. Hypophosphorus Acid, 50%	—	—	—	E	>480	—	E	>240	—	NR	—	—	E	—	—	E	>480	—	—	—	—	—	—	—	—	—	—
88. Isobutyl Alcohol	▲	>480	E	E	>360	E	E	478	E	P	—	—	F	10	VG	E	1s	VG	E	s2	E	E	>480	E	E	>480	E
89. Isooctane	▲	>480	E	E	>360	E	E	268	VG	E	>360	E	P	—	—	NR	—	—	P	—	—	■	s8	F	▲	>480	E
90. Isopropyl Alcohol	▲	>480	E	E	>360	E	E	110	E	NR	—	—	G	1s0	E	E	3s	VG	E	57	E	—	—	—	—	—	—
91. Kerosene	▲	>480	E	E	>360	E	E	18s	G	G	>360	E	F	>360	E	NR	—	—	P	—	—	G	82	—	E	>480	—
92. Lactic Acid, 85%	▲	>480	—	E	>360	—	E	>480	—	F	>360	—	E	>360	—	E	>360	—	E	>360	—	—	—	—	—	—	—
93. Lauric Acid, 36% in Ethanol	—	—	—	E	>360	—	E	>480	—	NR	—	—	F	1s	—	E	>360	—	E	>360	—	—	—	—	—	—	—
94. d-Limonene	▲	>480	E	E	>480	E	NR	—	—	G	>480	E	G	12s	G	NR	—	—	NR	—	—	F	57	F	F	>480	E
95. Maleic Acid, saturated solution	—	—	—	E	>360	—	E	>480	—	NR	—	—	G	>360	—	E	>360	—	E	>360	—	—	—	—	—	—	—
96. Mercury	—	—	—	▲	>480	E	—	—	—	—	—	—	▲	>480	E	▲	>480	E	—	—	—	—	—	—	—	—	—
97. Methyl Alcohol (Methanol)	▲	>480	E	E	103	VG	E	73	VG	NR	—	—	G	4s	G	E	12	VG	E	22	E	E	>480	—	DD	363	—
98. Methylamine, 40%	▲	>480	E	E	>360	E	E	1s3	G	NR	—	—	E	13s	VG	E	55	VG	E	100	E	E	>480	—	E	>480	—
99. Methyl Amyl Ketone (MAK)	▲	>480	E	F	s3	F	F	10	F	E	>360	E	NR	—	—	F	<10	F	F	<10	F	E	1ss	G	DD	17	F
100. Methyl-t-Butyl Ether (MTBE)	E	>480	E	E	>360	E	P	—	—	G	>360	E	NR	—	—	NR	—	—	NR	—	—	G	38	F	—	—	—
101. Methyl Cellosolve®	■	470	F	F	208	G	E	10	F	E	30	G	P	55	G	E	20	VG	—	—	—	▲	>480	E	▲	>480	E
102. Methylene Bromide (DBM)	▲	>480	E	NR	—	—	NR	—	—	G	>360	E	NR	—	—	NR	—	—	NR	—	—	E	70	F	E	>480	E
103. Methylene Chloride (DCM)	E	20	VG	NR	—	—	NR	—	—	G	>360	E	NR	—	—	NR	—	—	NR	—	—	G	13	P	E	29	G
104. Methylene bis(4-Phenylisocyanate) (MDI)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	▲	>480	E	▲	>480	E	—	—	—	—	—	—
105. Methyl Ethyl Ketone (MEK)	▲	>480	E	NR	—	—	P	—	—	F	90	VG	NR	—	—	F	5	F	P	<10	F	E	183	G	DD	20	G
106. Methyl Ethyl Ketone (MEK)/Toluene, 1/1	▲	>480	E	—	—	—	—	—	—	—	—	—	—	—	—	F	5	F	—	—	—	F	60	—	—	—	—
107. Methyl Iodide (Iodomethane)	▲	>480	E	NR	—	—	NR	—	—	F	>360	E	NR	—	—	NR	—	—	NR	—	—	F	1s	P	G	21s	VG
108. Methyl Isobutyl Ketone (MIBK)	▲	>480	E	P	4s	F	NR	—	—	F	>360	E	NR	—	—	P	—	—	P	—	—	E	24s	G	DD	30	G
109. Methyl Methacrylate (MMA)	▲	>480	E	P	3s	P	NR	—	—	G	>360	E	NR	—	—	P	—	—	NR	—	—	E	8s	G	DD	10	F
110. N-Methyl-2-Pyrrolidone (NMP)	▲	>480	E	NR	—	—	NR	—	—	NR	—	—	NR	—	—	E	75	VG	F	47	VG	E	>480	—	DD	—	—
111. Mineral Spirits, Rule 66	▲	>480	E	E	>480	E	E	12s	G	E	>360	E	F	1s0	VG	NR	—	—	G	23	G	—	—	—	—	—	—
112. Monoethanolamine	—	—	—	E	>360	E	E	400	E	E	>360	E	E	>480	E	E	90	E	E	57	E	—	—	—	■	>120	—
113. Morpholine	▲	>480	E	NR	—	—	P	—	—	G	90	G	NR	—	—	G	20	G	E	43	G	E	>480	E	DD	23s	VG
114. Naphtha, VM&P	▲	>480	E	E	>360	E	G	103	G	E	420	E	F	120	VG	NR	—	—	NR	—	—	—	—	—	—	—	—
115. Nitric Acid, 10%	▲	>480	—	E	>360	—	E	>480	—	NR	—	—	G	>360	—	G	>360	—	E	>360	—	—	—	—	—	—	—
116. Nitric Acid, 70% (Concentrated)	E	>480	—	NR	—	—	▲	>480	—	NR	—	—	F	109	—	NR	—	—	NR	—	—	—	—	—	—	—	—
117. Nitric Acid, Red Fuming	▲	>480	E	NR	—	—	NR	—	—	NR	—	—	P	—	—	P	—	—	NR	—	—	—	—	—	—	—	—
118. Nitrobenzene	▲	>480	E	NR	—	—	NR	—	—	G	>360	E	NR	—	—	F	1s	G	F	42	G	E	>480	—	E	>480	—
119. Nitromethane	▲	>480	E	F	30	F	E	60	G	G	>360	E	P	—	—	E	10	G	E	30	E	E	>480	E	E	249	E
120. 1-Nitropropane	■	368	E	NR	—	—	F	30	G	E	>480	G	NR	—	—	E	1s	G	E	2s	G	E	>480	E	DD	2ss	E
121. 2-Nitropropane	▲	>480	E	NR	—	—	F	2s	F	E	>360	E	NR	—	—	E	5	G	E	30	VG	—	—	—	—	—	—
122. n-Octyl Alcohol	—	—	—	E	>360	E	E	218	E	G	>360	E	F	>360	E	E	30	VG	E	s3	G	—	—	—	—	—	—
123. Oleic Acid	—	—	—	E	>360	E	F	13	VG	G	60	E	F	90	VG	F	>360	E	G	120	—	—	—	—	—	—	—
124. Oxalic Acid, saturated solution	—	—	—	E	>360	—	E	>480	—	P	—	—	E	>360	—	E	>360	—	E	>360	—	—	—	—	—	—	—
125. Pad Etch® 1 (Ashland Chemical)	—	—	—	E	>360	—	E	>360	—	F	34	—	E	>360	—	E	>360	—	E	>360	—	—	—	—	—	—	—
126. Palmitic Acid, saturated solution	—	—	—	G	30	—	E	>480	—	P	—	—	G	75	—	G	5	—	E	193	—	—	—	—	—	—	—
127. Pentachlorophenol, 5% in Mineral Spirits	—	—	—	E	>360	E	E	1s1	F	E	5	F	F	180	E	NR	—	—	—	—	—	—	—	—	—	—	—
128. n-Pentane	E	>480	E	E	>360	E	G	30	G	G	>360	E	NR	—	—	P	—	—	E	13	G	—	—	—	—	—	—

129. Perchloric Acid, 60%	—	—	—	E	>360	—	E	>480	—	NR	—	—	E	>360	—	F	>360	—	E	>360	—	—	—	—	—	—	—	—	—
130. Perchloroethylene (PERC)	▲	>480	E	G	361	VG	NR	—	—	E	>360	E	NR	—	—	NR	—	—	NR	—	—	P	<10	F	E	>480	E		
131. Phenol, 90%	▲	>480	E	NR	—	—	E	353	G	F	>360	E	G	75	VG	E	90	—	E	180	E	E	>480	—	E	>480	—		
132. Phosphoric Acid, 85% (Concentrated)	▲	>480	—	E	>360	—	G	>360	—	NR	—	—	G	>360	—	F	>360	—	G	>360	—	—	—	—	—	—	—		
133. Potassium Hydroxide, 50%	—	—	—	E	>360	—	E	>480	—	NR	—	—	E	>360	—	E	>360	—	E	>360	—	—	—	—	—	—	—		
134. Propane Gas	—	—	—	▲	>480	E	▲	>480	E	—	—	—	■	7	VG	—	—	—	—	—	—	—	—	—	—	—	—		
135. n-Propyl Acetate	—	—	—	F	20	G	P	—	—	G	120	VG	NR	—	—	P	—	—	P	—	—	E	135	G	DD	<10	F		
136. n-Propyl Alcohol	E	>480	E	E	>360	E	E	323	E	P	—	—	F	90	VG	E	23	VG	E	30	E	E	>480	—	E	>480	—		
137. Propylene Glycol Methyl Ether Acetate (PGMEA)	▲	>480	E	E	200	F	G	37	F	E	>360	E	P	—	—	G	13	F	G	18	F	▲	>480	E	■	334	E		
138. Propylene Glycol Monomethyl Ether (PGME)	—	—	—	—	—	—	P	—	—	—	—	—	P	—	—	—	—	—	—	—	—	▲	>480	E	▲	>480	E		
139. Propylene Oxide	▲	>480	E	NR	—	—	NR	—	—	G	35	G	NR	—	—	P	—	—	P	—	—	■	43	F	DD	<10	F		
140. Pyridine	▲	>480	E	NR	—	—	NR	—	—	G	10	F	NR	—	—	F	10	F	P	10	F	▲	465	E	DD	40	—		
141. Rubber Solvent	—	—	—	E	>360	E	E	43	G	E	>360	E	NR	—	—	NR	—	—	NR	—	—	—	—	—	—	—	—		
142. Silicon Etch	▲	>480	E	NR	—	—	E	>480	—	NR	—	—	F	150	—	NR	—	—	P	—	—	—	—	—	—	—	—		
143. Skydrol® 500B-4	▲	>480	E	NR	—	—	NR	—	—	—	—	—	NR	—	—	NR	—	—	NR	—	—	E	>480	E	DD	>480	E		
144. Sodium Hydroxide, 50%	E	>480	—	E	>360	—	E	>480	—	NR	—	—	G	>480	—	E	>360	—	E	>360	—	E	>480	—	E	>480	—		
145. Stoddard Solvent	▲	>480	E	E	>360	E	E	139	G	E	>360	E	F	57	G	NR	—	—	G	10	G	—	—	—	—	—	—		
146. Styrene	▲	>480	E	NR	—	—	NR	—	—	G	>360	E	NR	—	—	NR	—	—	NR	—	—	G	26	—	E	>480	—		
147. Sulfur Dichloride	—	—	—	P	>480	E	NR	—	—	—	—	—	—	—	—	NR	—	—	NR	—	—	—	—	—	—	—	—		
148. Sulfuric Acid, 47% (Battery Acid)	—	—	—	E	>360	—	E	>360	—	NR	—	—	G	>360	—	E	>360	—	E	>360	—	—	—	—	—	—	—		
149. Sulfuric Acid, 95-98% (Concentrated)	E	>480	E	NR	—	—	F	24	—	NR	—	—	G	26	—	NR	—	—	NR	—	—	E	>480	—	E	>480	—		
150. Sulfuric Acid, 120% (Oleum)	▲	>480	E	—	—	—	F	53	G	NR	—	—	▼	25	G	—	—	—	—	—	—	—	—	—	—	—	—		
151. Tannic Acid, 65%	—	—	—	E	>360	—	E	>480	E	P	—	—	E	>360	—	E	>360	—	E	>360	—	—	—	—	—	—	—		
152. Tetrahydrofuran (THF)	▲	>480	E	NR	—	—	NR	—	—	P	115	F	NR	—	—	NR	—	—	NR	—	—	F	13	F	DD	10	F		
153. Toluene (Toluol)	▲	>480	E	F	34	F	NR	—	—	G	>1440	E	NR	—	—	NR	—	—	NR	—	—	P	20	F	E	313	—		
154. Toluene Diisocyanate (TDI)	▲	>480	E	NR	—	—	NR	—	—	G	>360	E	P	—	—	G	7	G	G	65	VG	E	>480	—	E	>480	—		
155. Triallylamine	▲	>480	E	▲	>480	E	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
156. Trichloroethylene (TCE)	▲	>480	E	NR	—	—	NR	—	—	E	>360	E	NR	—	—	NR	—	—	NR	—	—	NR	—	—	DD	204	VG		
157. Tricresyl Phosphate (TCP)	—	—	—	E	>360	E	F	253	F	G	>360	E	F	>360	E	E	45	E	E	>360	E	E	>480	—	E	>480	—		
158. Triethanolamine (TEA)	—	—	—	E	>360	E	E	170	VG	G	>360	E	E	>360	E	G	>360	E	—	—	—	—	—	—	—	—	—		
159. Turpentine	▲	>480	E	E	>480	E	NR	—	—	G	>360	E	P	—	—	NR	—	—	NR	—	—	■	98	—	■	>480	E		
160. Vertrel® MCA	▲	>480	E	E	110	G	E	23	G	F	>360	E	G	13	F	G	<10	F	G	<10	F	■	173	VG	DD	20	G		
161. Vertrel® SMT	E	10	G	P	—	—	F	<10	F	G	17	G	G	<10	F	F	<10	F	P	<10	P	▼	18	F	DD	<10	F		
162. Vertrel® XE	E	105	E	E	>480	E	E	47	G	F	40	VG	G	303	E	E	17	VG	E	43	VG	E	>480	E	DD	398	E		
163. Vertrel® XF	E	>480	E	E	>480	E	E	>480	E	F	387	VG	E	>480	E	E	337	VG	E	204	G	E	>480	E	DD	>480	E		
164. Vertrel® XM	E	>480	E	E	>480	E	E	105	E	F	10	G	P	55	G	E	23	VG	E	30	VG	—	—	—	—	—	—		
165. Vinyl Acetate	▲	>480	E	F	18	F	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	NR	—	—		
166. Vinyl Chloride Gas	▲	>480	E	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
167. Xylenes, Mixed (Xylol)	▲	>480	E	G	96	F	NR	—	—	E	>360	E	NR	—	—	NR	—	—	NR	—	—	P	27	F	E	>480	E		

▲ A degradation test against this chemical was not run. However, since its breakthrough time is greater than 480 minutes, the Degradation Rating is expected to be Good to Excellent. ■ A degradation test against this chemical was not run. However, in view of degradation tests performed with similar compounds, the Degradation Rating is expected to be Good to Excellent. ▼ A degradation test against this chemical was not run. However, in view of data obtained with similar compounds, the Degradation Rating is expected to be Fair to Poor. *CAUTION: This product contains natural rubber latex which may cause allergic reactions in some individuals.

NOTE:

These recommendations are based on laboratory tests, and reflect the best judgement of Ansell in the light of data available at the time of preparation and in accordance with the current revision of ASTM F 739. They are intended to guide and inform qualified professionals engaged in ensuring safety in the workplace. Because the conditions of ultimate use are beyond our control, and because we cannot run permeation tests in all possible work environments and across all combinations of chemicals and solutions, these recommendations are advisory only. The suitability of a product for a specific application must be determined by testing by the purchaser.

The data in this guide are subject to revision as additional knowledge and experience are gained. Test data herein reflect laboratory performance of partial gloves and not necessarily the complete unit. Anyone intending to use these recommendations should first verify that the glove selected is suitable for the intended use and meets all appropriate health standards. Upon written request, Ansell will provide a sample of material to aid you in making your own selection under your own individual safety requirements.

NEITHER THIS GUIDE NOR ANY OTHER STATEMENT MADE HEREIN BY OR ON BEHALF OF ANSELL SHOULD BE CONSTRUED AS A WARRANTY OF MERCHANTABILITY OR THAT ANY ANSELL GLOVE IS FIT FOR A PARTICULAR PURPOSE. ANSELL ASSUMES NO RESPONSIBILITY FOR THE SUITABILITY OR ADEQUACY OF AN END-USER'S SELECTION OF A PRODUCT FOR A SPECIFIC APPLICATION.

Skydrol is a registered trademark of Solutia Inc. Vertrel is a registered trademark of DuPont.

Ansell

www.ansellpro.com

[Table of Contents]

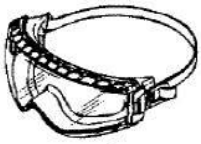
A 9. Classification of Protective Eyewear

This figure offers examples of acceptable eyewear in each class of eye protection taken from University of Toronto's "Protective Eye and Face wear Standard: Selection and Use"

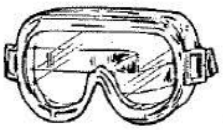
CLASSIFICATION OF PROTECTIVE EAYEWEAR:

Class 1A - Spectacle-type with side protection

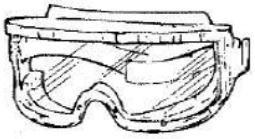
Class 1B - Spectacle-type with side and radiation protection

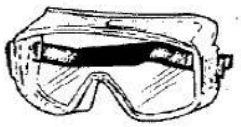


Class 2A – Direct ventilated goggles



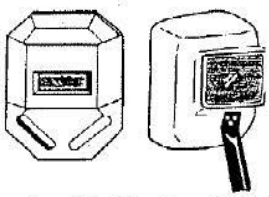
Class 2B - Non-ventilated goggles





Class 2C - Direct/non-ventilated goggles with radiation protection

Class 3 - Welding Helmets



Class 4 - Welding Hand Shields

Class 5A - Non-rigid helmet (hood) with impact-resistance window
Class 5B - Non-rigid helmet (hood) for dust, splash, and abrasive materials protection
Class 5C - Non-rigid helmet (hood) with radiation protection
Class 5D - Non-rigid helmet (hood) for high-heat applications

Class 6A - Face shields for impact and splash protection
Class 6B - Face shields for radiation protection
Class 6C - Face shields for high-heat applications

Reference: CSA Z94.3.1-09

[Table of Contents]

A 10. Protective Glove Standard: Selection and Use

This table offers guidance on chemical resistance and physical properties of common glove materials taken from University of Toronto's "Protective Glove Standard: Selection and Use"

GLOVE MATERIAL	CHEMICAL RESISTANCE PROPERTIES		PHYSICAL PROPERTIES E: Excellent G: Good F: Fair P: Poor						
	RECOMMENDED FOR USE WITH	NOT RECOMMENDED FOR USE WITH	ABRASION RESISTANCE	CUT RESISTANCE	FLEXIBILITY	HEAT RESISTANCE	OZONE RESISTANCE	PUNCTURE RESISTANCE	TEAR RESISTANCE
Natural rubber latex	Acids, bases, alcohols, aqueous solutions.	Oils, greases, organics.	E	E	E	F	P	E	E
Butyl rubber	Aldehydes, ketones, esters, glycol ethers, polar organic solvents.	Hydrocarbons, chlorinated solvents.	F	G	G	E	E	G	G
Neoprene	Oxidizing acids, caustics, alcohols, oils, fats, aniline, phenol, glycol ethers.	Chlorinated hydrocarbons.	E	E	G	G	E	G	G
Nitrile	Oils, greases, acids, caustics, aliphatic chemicals.	Aromatics, many ketones, esters, many chlorinated solvents.	E	E	E	G	F	E	G
Polyvinyl alcohol (PVA)	Aliphatics, aromatics, chlorinated solvents, ketones (except acetone), esters, ethers.	Acids, alcohols, bases.	F	F	P	G	E	F	G
Polyvinyl chloride (PVC)	Strong acids and bases, salts, other aqueous solutions, alcohols, glycol ethers.	Aromatics, hydrocarbons, chlorinated solvents, aldehydes, ketones, nitrocompounds.	G	P	F	P	E	G	G
Fluoroelastomer (Viton®)	Aromatic and chlorinated solvents, aliphatics and alcohols.	Some ketones, esters, amines.	G	G	G	G	E	G	G
Silver Shield™ (Norfoil™, 4H™)	Wide range of solvents, acids and bases.		F	P	E	F	E	F	E

[Table of Contents]

A 11. Chemical Weapons Convention Declaration Schedules

Key Points To Register Before Starting Your Annual Declaration

This annex includes some basic definitions that are essential to ensuring that you declare only what you are required to report, to avoid double counting and other errors. It also includes the basic instructions on what needs to be reported for each chemical found on the Schedules of the Chemical Weapons Convention (CWC). It also offers additional guidance for Other Chemical Production Facilities (OCPFs) which produce Discrete Organic Chemicals (DOCs).

The last page denotes an upcoming amendment to Schedule 1A of the CWC, of which all those affected by the *CWC Implementation Act* must be made aware.

A number of tools are available to assist you in the identification of scheduled chemicals relevant to your company. The *Handbook on Chemicals* contains identifiers such as Chemical Abstracts Service (CAS) Registry numbers, International Union of Pure and Applied Chemistry (IUPAC) and CAS chemical names, synonyms and World Customs Organisation (WCO) Harmonized System (HS) Codes. It can be consulted on the official website of the OPCW at:
https://www.opcw.org/our-work/non-proliferation/declarations-adviser/handbook-on-chemicals/
Another useful tool is the "*Scheduled Chemicals Database*," a searchable database developed by the OPCW, which can be accessed on its website at https://apps.opcw.org/cas/.

We encourage all Canadian companies and institutions to review the information below prior to completing their declarations.

QUANTITIES/WEIGHT: The quantities that have to be declared refer to the *weight of the scheduled chemical* contained in a mixture and *not* to the total weight of the mixture.

IMPORT: For the purposes of submitting declarations, the term 'import' shall be understood to mean the physical movement of scheduled chemicals into Canada from the territory or any other place under the jurisdiction or control of another country, *excluding transit operations*. For the purposes of declaring imports, the declaring company or institution must specify the country from which the scheduled chemicals *were dispatched*, excluding any countries through which the scheduled chemicals might have transited and *regardless of the country in which the scheduled chemicals were produced, if different from the country of dispatch*.

EXPORT: The term 'export' shall be understood to mean the physical movement of scheduled chemicals out of Canada into the territory or any other place under the jurisdiction or control of another country, *excluding transit operations*. For the purposes of declaring exports, the declaring company or institution must specify the *intended* country of destination, *excluding the countries through which the scheduled chemicals may have transited*.

TRANSIT OPERATIONS: Transit operations refer to the physical movement of scheduled chemicals whereby they pass through the territory of another country on the way to their intended country of destination. Transit operations include changes in the means of transport, *including temporary storage* only for that purpose.

IMPORTER OF RECORD: In order to prevent double accounting, only the "*Importer of Record*" should declare the import of scheduled chemicals. Importer of Record is *the person or entity who causes the goods to be imported and is responsible for accounting for the goods and paying applicable duties and taxes*.

SCHEDULE 1 CHEMICALS

Canadian companies or institutions producing, acquiring, consuming, storing, transferring, importing and/or exporting any amount of Schedule 1 chemicals are required to declare their activities to the National Authority. There are no quantity or concentration thresholds for declarations.

CHEMICAL NAME	*CAS REGISTRY NUMBER*
A. Toxic Chemicals	
1. O-Alkyl (<=C10, incl. cycloalkyl) alkyl (Me, Et, n-Pr or i-Pr)-phosphonofluoridates	
e.g. *Sarin*: O-Isopropyl methylphosphonofluoridate	(107-44-8)
Soman: O-Pinacolyl methylphosphonofluoridate	(96-64-0)
2. O-Alkyl (<=C10, incl. cycloalkyl) N,N-dialkyl (Me, Et, n-Pr or i-Pr) phosphoramidocyanidates	
e.g. *Tabun*: O-Ethyl N,N-dimethyl phosphoramido/cyanidate	(77-81-6)
3. O-Alkyl (H or <=C10, incl. cycloalkyl) S-2-dialkyl (Me, Et, n-Pr or i-Pr) -aminoethyl alkyl (Me, Et, n-Pr or i-Pr) phosphonothiolates, and corresponding alkylated or protonated salts	
e.g. *VX*: O-Ethyl S-2-diisopropylaminoethyl methyl phosphonothiolate	(50782-69-9)
4. *Sulphur Mustards*	
2-Chloroethylchloromethylsulfide	(2625-76-5)
Mustard gas: Bis (2-chloroethyl) sulfide	(505-60-2)
Bis (2-chloroethylthio)methane	(63869-13- 6)
Sesquimustard: 1, 2-Bis (2-chloroethylthio) ethane	(3563-36-8)
1, 3-Bis (2-chloroethylthio) -n-propane	(63905-10-2)
1, 4-Bis (2-chloroethylthio) -n-butane	(142868-93-7)
1, 5-Bis (2-chloroethylthio) -n-pentane	(142868-94-8)
Bis (2-chloroethylthiomethyl) ether	(63918-90-1)
O-Mustard: Bis (2-chloroethylthioethyl) ether	(63918-89-8)
5. *Lewisites*	
Lewisite 1: 2-Chlorovinyldichloroarsine	(541-25-3)
Lewisite 2: Bis (2-chlorovinyl) chloroarsine	(40334-69-8)
Lewisite 3: Tris (2-chlorovinyl) arsine	(40334-70-1)
6. *Nitrogen Mustards*	
HN1: Bis (2-chloroethyl) ethylamine	(538-07-8)
HN2: Bis (2-chloroethyl) methylamine	(51-75-2)
HN3: Tris (2-chloroethyl) amine	(555-77-1)
7. *Saxitoxin*	(35523-89-8)
8. *Ricin*	(9009-86-3)
13. P-alkyl (H or ≤C10, incl. cycloalkyl) N-(1-(dialkyl (≤C10, incl. cycloalkyl)amino))alkylidene (H or ≤C10, incl. cycloalkyl) phosphonamidic	

fluorides and corresponding alkylated or protonated salts

e.g. N-(1-(di-n-decylamino)-n-decylidene)
-P-decylphosphonamidic fluoride (2387495-99-8)
Methyl-(1-(diethylamino)ethylidene)
phosphonamidofluoridate (2387496-12-8)

14. O-alkyl (H or ≤C10, incl. cycloalkyl) N-(1-(dialkyl (≤C10, incl. cycloalkyl)amino))alkylidene (H or ≤C10, incl. cycloalkyl) phosphoramidofluoridates and corresponding alkylated or protonated salts

e.g. O-n-Decyl N-(1-(di-n-decylamino)
-n-decylidene)phosphoramidofluoridate (2387496-00-4)
Methyl (1-(diethylamino)ethylidene)phosphoramidofluoridate (2387496-04-8)
Ethyl (1-(diethylamino)ethylidene)phosphoramidofluoridate (2387496-06-0)

15. Methyl-(bis(diethylamino)methylene)phosphonamidofluoridate (2387496-14-0)

16. Carbamates (quaternaries and bisquaternaries of dimethylcarbamoyloxypyridines)

Quaternaries of dimethylcarbamoyloxypyridines:
1-[N,N-dialkyl(≤C10)-N-(n-(hydroxyl, cyano, acetoxy)
alkyl(≤C10))ammonio]-n-[N-(3-dimethylcarbamoxy-α-picolinyl)
-N,N-dialkyl(≤C10) ammonio]decane dibromide (n=1-8)

e.g. 1-[N,N-dimethyl-N-(2-hydroxy)ethylammonio]-10-
[N-(3-dimethylcarbamoxy-α-picolinyl)-N,N-
dimethylammonio]decane dibromide (77104-62-2)

Bisquaternaries of dimethylcarbamoyloxypyridines:
1,n-Bis[N-(3-dimethylcarbamoxy-α-picolyl)-N,N-dialkyl(≤C10)
ammonio]-alkane-(2,(n-1)-dione) dibromide (n=2-12)

e.g. 1,10-Bis[N-(3-dimethylcarbamoxy-α-picolyl)-N-ethyl
-N-methylammonio]decane-2,9-dione dibromide (77104-00-8)

B. Precursors

9. Alkyl (Me, Et, n-Pr or i-Pr) phosphonyldifluorides

e.g. DF: Methylphosphonyldiflouride (676-99-3)

10. O-Alkyl (H or <=C10, incl. cycloalkyl) 0-2-dialkyl (Me, Et, n-Pr or i-Pr) aminoethyl alkyl (Me, Et, n-Pr or i-Pr) aminoethyl alkyl (Me, Et, n-Pr or i-Pr) phosphonites, and corresponding alkylated or protonated salts

e.g. *QL*: O-Ethyl O-2-diisopropylaminoethyl methylphosphonite (57856-11-8)

11. Chlorosarin: O-Isopropyl methylphosphonochloridate (1445-76-7)

12. Chlorosoman: O-Pinacolyl methylphosphonochloridate (7040-57-5)

SCHEDULE 2 CHEMICALS

Canadian companies or institutions must declare if, in the previous calendar year, they have been involved in producing, processing, or consuming any chemical listed in Schedule 2 that *meets or exceeds both of the declaration thresholds* noted below. In addition, you must declare if your company or institution is involved in importing or exporting *any amount* of a mixture, *that is not a consumer product*, meeting the *concentration* thresholds noted below.

1. Quantitative Thresholds

Plants producing, consuming or processing at or above these thresholds:

- 100 grams of a chemical designated "*" in Schedule 2, Part A
- 10 kg of any other chemical listed in Schedule 2, Part A
- 100 kg of a chemical listed in Schedule 2, Part B

2. Concentration Thresholds

Mixtures containing 10% or more by weight of a Schedule 2B chemical, 0.5% or more by weight of a Schedule 2A or 2A* chemical :

CHEMICAL NAME *CAS REGISTRY NUMBER*

A. Toxic Chemicals

1. Amiton: O,O-Diethyl S-{2- (diethylamino)ethyl} phosphorothiolate, andcorresponding alkylated or protonated salts (78-53-5)

2. PFIB: 1, 1, 3, 3, 3-Pentafluoro-2- (trifluoromethyl) -1-propene (382-21-8)

3. BZ: 3-Quinuclidinyl benzilate (*) (6581-06-2)

B. Precursors

4. Chemicals, except for those in Schedule 1, containing a phosphorous atom to which is bonded one methyl, ethyl or propyl (normal or iso) group but not further carbon atoms.

   e.g. Methylphosphonyl dichloride (676-97-1)
   Dimethyl methylphosphonate (756-79-6)

   Exemption: Fonofos:O-Ethyl S-phenyl Ethylphosphonothiolothionate (944-22-9)

5. N, N-Dialkyl (Me, Et, n-Pr or i-Pr) phosphoramidic dihalides

6. Dialkyl (Me, Et, n-Pr or i-Pr) N, N-dialkyl (Me, Et, n-Pr or i-Pr) phosphoramidates

7. Arsenic trichloride (7784-34-1)

8. 2, 2-Diphenyl-2-hydroxyacetic acid (76-93-7)

9. Quinuclidin-3-ol (1619-34-7)

10. N, N-Dialkyl (Me, Et, n-Pr or i-Pr) aminoethyl-2-chlorides, and corresponding protonated salts

11. N, N-Dialkyl (Me, Et, n-Pr or i-Pr) aminoethane-2-ols, and corresponding protonated salts.

Exemption: N, N-Dimethylaminoethanol and corresponding protonated salts (108-01-0)

Exemption: N, N-Diethylaminoethanol and corresponding protonated salts (100-37-8)

12. N, N-Dialkyl (Me, Et, n-Pr or i-Pr) aminoethane-2-thiols, and corresponding protonated salts

13. T hiodiglycol: Bis(2-hydroxyethyl) sulfide (111-48-8)

14. Pinacolyl alcohol: 3, 3-Dimethylbutane-2-ol (464-07-3)

SCHEDULE 3 CHEMICALS

Companies or institutions must declare if they have been involved in the previous calendar year in producing *3 tonnes or more* of any chemical listed in Schedule 3 as a chemical, or in a mixture that contains 25% or more of the Schedule 3 chemical by weight. Companies must also declare if they are involved in importing or exporting any amount of a Schedule 3 chemical or a mixture *that is not a consumer product* that contains 25% or more of a Schedule 3 chemical by weight.

CHEMICAL NAME	*CAS REGISTRY NUMBER*
A. Toxic Chemicals	
Phosgene - Carbonyl dichloride	(75-44-5)
Cyanogen chloride	(506-77-4)
Hydrogen cyanide	(74-90-8)
Chloropicrin - Trichloronitromethane	(76-06-2)
B. Precursors	
Phosphorus oxychloride	(10025-87-3)
Phosphorus trichloride	(7719-12-2)
Phosphorus pentachloride	(10026-13-8)

Trimethyl phosphite	(121-45-9)
Triethyl phosphite	(122-52-1)
Dimethyl phosphite	(868-85-9)
Diethyl phosphite	(762-04-9)
Sulphur monochloride	(10025-67-9)
Sulphur dichloride	(10545-99-0)
Thionyl chloride	(7719-09-7)
Ethyldiethanolamine	(139-87-7)
Methyldiethanolamine	(105-59-9)
Triethanolamine	(102-71-6)

DISCRETE ORGANIC CHEMICALS

The official CWC definition of Discrete Organic Chemicals (DOCs) is:

> "*any chemical belonging to the class of chemical compounds consisting of all compounds of carbon except for its oxides, sulfides and metal carbonates, identifiable by chemical name, by structural formula, if known, and by Chemical Abstracts Service registry number, if assigned*".

It should be noted that in this category, it is not the DOC chemicals themselves that are important, but the *plant sites and equipment used to produce them*, because of the possibility that the equipment might be modified to produce chemicals listed in the three Schedules.

The DOC exemptions are as follows:

- Plant sites that exclusively produce hydrocarbons. However, if the plant site also produces non-hydrocarbon DOCs such as MTBE at a refinery, the total production is reportable.
- Plant sites that exclusively produce explosives.
- Breweries, distilleries, and wineries.
- Oligomers and polymers, whether or not containing the elements, phosphorus, sulfur or fluorine

NEW: Please note that the **"Standard International Trade Classification" (SITC) subcategory codes** for methanol (**512A**), urea (**514A**), formaldehyde (**516A**), methyl tert-butyl ether (**516B**), detergents produced by neutralisation of sulphonic acids (**554A**) and soaps produced by saponification of a fatty acid (**554B**) have been merged into one single sub-code for bulk chemicals - **519**. All other sub-codes have been discarded. These codes are used to identify site activities that make the site declarable to the Canadian National Authority and hence to the Organisation for the Prohibition of Chemical Weapons. The revised list of codes is attached.

Product Group Codes

Code	Description

	Chemicals and related products
511	Hydrocarbons and their halogenated, sulphonated, nitrated or nitrosated derivatives
512	Alcohols, phenols, phenol-alcohols, and their halogenated, sulphonated, nitrated or nitrosated derivatives, except Methanol (see Code 519)
513	Carboxylic acids and their anhydrides, halides, peroxides and peroxyacids; their halogenated, sulphonated, nitrated or nitrosated derivatives
514	Nitrogen-function compounds, except Urea (see Code 519)
515	Organo-inorganic compounds, heterocyclic compounds, nucleic acids and their salts, and sulphonamides
516	Other organic chemicals, except Formaldehyde & Methyl *tert*-butyl ether (MTBE) (see Code 519)
519	Methanol, urea, formaldehyde, methyl tert-butyl ether (MTBE), detergents produced by neutralisation of sulphonic acids and soap produced by saponification of a fatty acid
522	Inorganic chemical elements, oxides and halogen salts
523	Metal salts and peroxysalts, of inorganic acids
524	Other inorganic chemicals; organic and inorganic compounds of precious metals
525	Radioactive and associated materials
531	Synthetic organic colouring matter and colour lakes, and preparations based thereon
532	Dyeing and tanning extracts, and synthetic tanning materials
533	Pigments, paints, varnishes and related materials
541	Medicinal and pharmaceutical products, other than medicaments of Group 542
542	Medicaments (including veterinary medicaments)
551	Essential oils, perfume and flavour materials
553	Perfumery, cosmetic or toilet preparations (excluding soaps)
554	Soap, cleansing and polishing preparations, except Detergents produced by neutralisation of sulphonic acids & Soap produced by saponification of a fatty acid (see Code 519)
562	Synthetic Fertilizers
571	Polymers of ethylene, in primary forms
572	Polymers of styrene, in primary forms
573	Polymers of vinyl chloride or of other halogenated olefins in primary forms
574	Polyacetals, other polyethers and epoxide resins, in primary forms; Polycarbonates, alkyd resins, polyallyl esters and other polyesters
575	Other plastics, in primary forms

579	Waste, parings and scrap, of plastics
581	Tubes, pipes and hoses, and fittings therefor, of plastics
582	Plates, sheets, film, foil and strip, of plastics
583	Monofilament of which any cross-sectional dimension exceeds 1 mm, rods, sticks and profile shapes, whether or not surface-worked but not otherwise worked, of plastics
591	Insecticides, rodenticides, fungicides, herbicides, anti-sprouting products and plant-growth regulators, disinfectants and similar products, put up in forms or packings for retail sale or as preparations or articles (e.g. sulphur-treated bands, wicks and candles, and fly papers)
592	Starches, inulin and wheat gluten; albuminoidal substances; glues
593	Explosives and pyrotechnic products
597	Prepared additives for mineral oils and the like; Prepared liquids for hydraulic transmission; Anti-freezing preparations and prepared de-icing fluids; Lubricating preparations
598	Miscellaneous chemical products
599	Others

[Table of Contents]

A 12. Waste Registration Form

Faculty of Math & Science - Science Stores
MacKenzie Chown Building Room E304
Ph (905) 688-5550 ext.3407 / Fx (905) 984-4864

Brock University

Chemical Waste Disposal Record

Researcher _____ Date - *(MM/DD/YY)* _____

Technician/Contact _____

Department _____ Ext. _____ Building _____

Room# _____

Do not use abbreviations or short forms

Waste Label #	Oxidizer Corrosive-pH	% and Chemical Name - Include Water	Physical Form	Volume of Container

Waste containers may not be overfilled, overflowing or otherwise unsafe. Mark below to indicate compliance.

☐ This waste container is not overflowing

☐ This waste container is not overfilled

I certify that the above information is correct and complete. I hereby declare that the contents are fully and accurately described above and are in all respects in proper condition for waste disposal.

Signature: _____

Type in your full name

[Table of Contents]

REFERENCES & BIBLIOGRAPHY

1. National Research Council. Prudent Practices in the Laboratory. Handling and Management of Chemical Hazards, Updated Version. Retrieved March 4, 2022. https://www.nap.edu/download/12654
2.