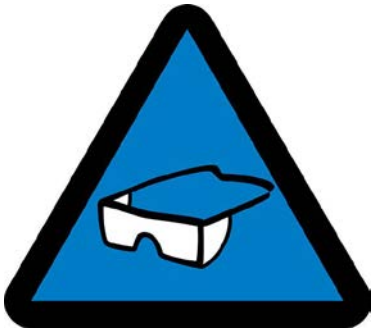
Advanced Analysis Centre

Health & Safety Handbook

2019 Edition



Advanced
Analysis
Centre

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1. Introduction

This handbook provides an overview of the safety program in the Advanced Analysis Centre (AAC). Although it touches on many of the hazards that are commonly encountered in the biological and physical sciences, it is far from comprehensive. The handbook is complemented by safety training (both general and specific) and a variety of other references and resources.

Different risks and hazards are encountered on a daily basis. Our researchers and educators work at the leading edge of science - to keep you safe and does its best to equip you with the knowledge to anticipate, recognize and avoid undue risks. Make sure you understand the nature of the hazards in your work and what must be done to control them.

2. Responsibility for Safety

Everyone at the University of Guelph has a stake in maintaining a safe environment. At work, at school and at home, each one of us is accountable for our own actions. When we take on positions of authority, we assume some additional responsibility for the safety of those under our supervision as well.

This handbook covers the basics – if you need specific information on any aspect of the legislation, departmental procedures, or the controls necessary for the various physical, chemical, biological or radiological hazards, more detailed resources are available and are discussed in further detail below.

The University of Guelph operates under the Ontario *Occupational Health & Safety Act (RSO 1990 c.O.1)* (OHSA) which is administered by the Ministry of Labour. The central premise of OHSA is the **Internal Responsibility System**, which prescribes certain rights and responsibilities for workers, directors and employers.

All employees of the University of Guelph have 3 fundamental rights under the OHSA:

- The right to **know**.
- The right to **participate**.
- The right to **refuse** unsafe work.

In addition, employees have some common responsibilities under the Act:

- Follow safe work practices & wear protective equipment when appropriate.
- Report all hazards or defects that could become hazards.
- Avoid putting your safety or the safety of others in jeopardy.

As well, when you are in a position of authority you are required to:

- Ensure people under you are following safe work practices and using the correct protective equipment.
- Point out potential hazards so people are aware of dangers in the workplace.
- Take every reasonable precaution in the circumstances to protect the health and safety of those under you (i.e., exercise due diligence).

Be aware that the Ministry of Labour is an enforcement agency. Inspectors have right of entry, power to issue orders, to ticket and to lay fines against individuals and the institution. It is also important to note that in 2004 the Criminal Code was amended to allow the crown to pursue criminal charges against corporations and individuals in cases where there is reckless disregard for safety resulting in injury or death.

2.1. Working Alone

In an academic institution, people should avoid working alone but practically this may be impossible. The work or a research project may necessitate people working after hours and on occasion working alone. Working Alone is defined as working by oneself such that assistance is not readily available should some injury, illness or emergency arise. Alone is interpreted as being out of visual or verbal contact, and when contact cannot be expected from another person for more than an hour. It includes working in physical isolation, e.g. as the sole occupant of a laboratory. It can occur during normal working hours as well as in the evening, overnight or during weekends. Depending on the type of work being done, the work area, and the time of day or night, working alone can be harmless or it can be dangerous.

Volunteers under an approved program are considered workers. Volunteers are only allowed to work in the presence of adequately trained personnel during normal business hours. Under no circumstances are volunteers allowed to work alone.

Undergraduate students may not have adequate training or experience to recognize, identify or evaluate hazards or hazardous situations and it is not advisable for these students to work alone or work alone after hours. A checklist of points has been created to which the student and director must agree to safeguard the student before any working alone situation.

Staff, graduate students, and postdocs enrolled in research courses or being paid by the University can work alone after normal business hours and on weekends as long as they have gone through adequate safety training, are aware of the safety practices and have been instructed to follow protocols and safe work practices.

Depending on the hazards of the work, when you work alone, you should make use of these precautionary plans and communication tools:

- access control – lock doors and do not to leave valuables (i.e., money, electronics, medications) in plain sight.
- buddy system – prearrange with someone (e.g. via text message) that you are going to the lab, when you expect to be done, and then text again when you are

leaving. The “buddy” should be knowledgeable about the work being performed and capable of rendering assistance if necessary. This includes having access to the locked work area. Follow up with buddy or director when you arrive home safely.

- SAFEGryphon – a free campus safety app for your smartphone. Access a real time security feed, emergency contact, support resources, and more. Draw attention to yourself in an emergency situation by sounding a loud alarm. The flashlight feature is also important in the event of an emergency or for personal safety.
- WorkAlone feature in SAFEGryphon app is a way for anyone to virtually check in with a family member, friend, co-worker or anyone they choose if the user is working late at night or is working alone or would feel safer if they were being checked up on during this time.
- SafeWalk - is a student-run organization dedicated to providing people on campus with a safe and reliable escort after dark, 7:30pm until 2:30am every night.
- notification of Campus Community Police.

Supervisors/directors shall be made aware of work alone situations and as appropriate develop a written plan tailored to the individual work situation, with workers to assess risks, identify potential hazards and establish an effective communication system for working alone or after hours. This will also include consideration of personal safety and outline any activities that cannot be done while working alone.

PROHIBITED WORK-ALONE / AFTER HOURS ACTIVITIES:

- Working with hazardous materials - dispensing highly flammable liquids; dangerously reactive substances (e.g. peroxides, pyrophorics or water reactives); highly corrosive substances (e.g. hydrofluoric acid)
- Handling of acutely toxic materials (to be identified / discussed with Director)
- Any work involving possible exposure to high voltage electricity (voltages of approximately 2000 V and currents of more than 80 mA in electrophoresis procedures create the potential for a lethal electrical shock if the equipment is not operated properly)
- Changing compressed gas cylinders or working with compressed gases
- Temperature extremes
- Manipulation of pathogenic biological organisms
- Physical hazards (radiation, noise, electricity, slippery or unsafe surfaces)
- Dispensing cryogenics (liquid nitrogen or dry ice from bulk storage e.g. the 50L tanks)
- Any work requiring the use of respirators
- Work at heights (portable ladders greater than 6m, work with a ladder that may be endangered by traffic, use of fall arrest equipment, scaffolds)

Schedule these higher risk tasks to be done during normal business hours, or when another worker capable of helping in an emergency is present.

2.2. University of Guelph Policies

Healthy Workplace Policy - The University of Guelph believes that healthy employees help to create a healthy organization. Greater health, safety and wellness leads to improved satisfaction and morale, which contribute to a more effective organization, and the University strives to support the well-being of the whole person through a comprehensive effort that includes the following key elements of a healthy workplace: physical environment; healthy lifestyles; mental health and workplace culture; and organizational social responsibility.

The Cannabis Act came into place on October 17, 2018, making cannabis legal in Canada. The Act protects public health through creating strict safety and quality regulations. In addition, public education efforts are currently underway to raise awareness about safety measures and any potential health risks. In Ontario, consuming recreational cannabis in an enclosed workplace remains illegal.

Consumption of Alcoholic Beverages, Illicit Drugs or Recreational Cannabis at Work - HR Policy 511 strictly prohibits all employees from the consumption of alcoholic beverages, illicit drugs or recreational cannabis during working hours and/or break periods or presenting for work under the influence of these substances. The University is committed to the health and safety of all employees and inappropriate use of these substances can adversely affect job performance, the work environment and the safety and wellbeing of employees.

Smoke-Free Ontario Act prohibits smoking or vaping in any enclosed workplace. The University of Guelph campus becomes tobacco- and smoke-free as of May 31, 2019. This initiative can be followed on the Smoke-Free U of G webpage.

Smoking in the Workplace Policy, sets out rules, which prohibit smoking and use of tobacco and cannabis products on the University's Guelph Campus and in any University vehicle regardless of location. The policy applies to everyone (all students, employees and visitors) on the University's Guelph Campus. A tobacco-free policy eliminates any confusion about what is or is not allowed on campus and aligns with the rationale of creating a healthier campus community and fostering a positive shift in the campus culture.

A comprehensive education and awareness work plan have been created to help support those wanting to quit and those who choose not to quit. Support kit resources and information is available to anyone interested in reducing their tobacco use or quitting smoking. Designated smoking areas will not be provided anywhere on the Guelph Campus.

3. Safety Resources

It is good to have questions. You are encouraged to think critically and understand the hazards you face, and the precautions required to protect your health and wellbeing.

The best place to start is with your director/supervisor. Issues that can't be easily addressed can be raised to the AAC Manager, AAC safety representative, the Environmental Health & Safety department, or other resources across campus.

You should also familiarize yourself with your building and know the closest location to an emergency exit, emergency call station, fire cabinet (containing a fire hose and extinguisher), pull station and automatic external defibrillator (AED). Each floor of the Summerlee Science Complex and MacNaughton have wall mounts of the floor plan indicating the location of these emergency devices.

The University's Environmental Health and Safety department (EHS) also has a useful website where you can access all University safety policies, register for safety training sessions, and review resources and guidance on many aspects of the University's environmental, health and safety programs.

For further information on University security and emergency preparedness, check out the websites of Campus Community Police and Fire Safety.

The Ontario Occupational Health & Safety Act (RSO 1990, c.O.1) and provincial occupational health and safety regulations are available on line. The Canadian Centre for Occupational Health & Safety has many great resources for workplace safety.

Hardcopies of required and essential information are posted on the EHS Bulletin Boards across campus, including:

- University of Guelph Environmental Health & Safety Policy
- Referral to Ontario Occupational Health & Safety Act
- Contact information for Central and Local Safety Committees
- Campus First Aid Station locations
- 'Injury at Work' poster from the WSIB (a.k.a., Form 82) that lays out the 4 steps to be taken post-injury
- All relevant Ministry of Labour Notices or Orders

You are always welcome to discuss any safety or environmental issue with the University of Guelph EHS staff.

3.1. Mental Health

The AAC considers the mental health and psychological safety of its employees to be as important as other aspects of health and safety. The AAC is committed to working collaboratively with all its employees to prevent injury and ill health, and to create and sustain a psychologically and physically safe workplace.

The AAC has individuals trained as Mental Health First Aiders who can be approached to discuss your concerns. The current AAC Contact List (posted on the H&S bulletin board and in each facility) identifies these individuals. They are familiar with signs of mental illness i.e. burnout; signs of depression and signs of anxiety. Managers are not expected

to act as psychologists, but rather to recognize a change in behavior or the signs of mental illness and respond with a conversation offering support. Their duty as a leader is to guide employees to appropriate resources and accommodate work to help employees be successful at their job.

Counselling Services website has assembled a list of Mental Health Resources that you may find helpful. Resources include general information, campus supports, stress management tips, relaxation techniques, breathing exercises, motivational videos, inspiring TED talks, guided meditation and mental health apps.

Human Resources also has information about Healthy Workplaces on its website. It offers a variety of strategic wellness initiatives and resources to assist staff members in optimizing their health and well-being.

All regular full time staff have access to Employee Assistance Program (EAP), which provides confidential employee counselling for personal, family, relationship and wellness issues. Access to counselling is available 24 hours per day, seven days per week through the University's EAP provider, Homewood Employee Health by calling 1-800-663-1142.

3.2. Safety Representatives

The AAC has 3 safety representatives (2 of which are certified) which support the safety program on campus by identifying hazards, raising safety issues, and conducting monthly workplace inspections. The AAC does not require a Joint Health and Safety Committee as it has fewer than 20 staff members and no usage of designated substances. There are safety representatives from both employer and worker designations.

In addition to our local safety representatives, the University has a Central Joint Health and Safety Committee. The Central JHSC has representatives of all employee groups on campus, as well as representatives from management. The responsibilities laid out in the OHSA are accomplished by both the local and the central committees; the focus of the local committees and safety representative is to conduct inspections, identify hazards and support local safety programs. Members of the central committee fulfill other requirements such as conducting accident investigations, attending to work refusals, and submitting formal recommendations to the employer.

These committees and safety representatives exist to represent your interests, and the interests of your colleagues. If you have an issue you would like investigated, contact an AAC safety representative – current contact information is posted on the AAC safety bulletin board and the AAC website. The safety representatives are always happy to help.

4. Safety Training

Everyone has to learn from someone, so don’t be afraid to ask for help. Training is a critical component of any safety program – no one can reasonably expect you to do the right thing if you haven’t been given instruction and expectations are not clear.

The training available to personnel in AAC can be subdivided into two categories: general or specific. General training is provided by the University Environmental Health and Safety Department. WHMIS, EHS Worker Health and Safety Awareness, and Laboratory Safety training is mandatory for anyone involved in laboratory work providing services or undertaking research. Additionally, courses like Biosafety, Radiation Safety, Laser Safety and First Aid/CPR may be mandatory due to the nature of the research being performed. Supervisory roles will need to complete the EHS Supervisor Health and Safety Awareness and Due Diligence training. These courses may be offered in class or on-line. External 3rd parties can be contracted to provide more detailed training on Compressed Gases, or Liquid Nitrogen handling.

Job-specific training is the responsibility of the unit within the AAC. This includes on-the-job demonstration of equipment, lab methods and experimental techniques. If you are unsure of how to safely and properly complete a task, ask for assistance.

All training undertaken is to be documented and updated on a continuous basis as new training is provided.

5. Standard Operating Procedures

AAC has developed a catalogue of Standard Operating Procedures (SOPs). These are documents that lay out specific directions on what to do in certain emergency situations, or instruction on the use of common lab equipment.

Standard Operating Procedures for the Advanced Analysis Centre are available on the AAC website, under ‘Safety’.

6. Emergency Procedures

Knowing what to do in an emergency could save your life. All emergency response on campus is centrally coordinated through Campus Community Police (x52000). They will centrally dispatch any emergency responders to the location of the emergency providing directions and wayfinding. Additionally, Campus Community Police will escort any emergency vehicle on campus utilizing emergency access locations.

6.1. Evacuation

When you hear the evacuation alarm, **immediately:**

- Extinguish any open flames and close any open gas valves.
- Close the sash on fume hoods and biosafety cabinets.
- Exit the lab or office and close the door behind you.
- Move quickly and calmly to the nearest safe exit or stairwell. Do not use the elevator.

- Anyone requiring assisted evacuation must be moved to the landing of the nearest safe stairwell. Ensure a fire warden or colleague notifies the emergency authorities of the person's location.
- Once outside, move well away from the building and meet at an established gathering point.
- Pass any relevant information on to fire wardens.
- Reentry to the building may proceed once the alarm bells have stopped ringing (for a minimum of 2 minutes) unless instructed otherwise by emergency response personnel.

6.2. Fire

In the event of a fire, getting out safely is the top priority. Please follow this evacuation plan:

- Pull the closest pull station to sound the alarm.
- Notify others in the lab and move quickly to the nearest safe exit or stairwell.
- If you need assistance to evacuate, move to the nearest safe stairwell and have a colleague or fire warden notify the emergency authorities of your location.
- DO NOT attempt to use the elevator.
- If you are last to leave an area or room, close the doors behind you.
- Pass any relevant information on to fire wardens and be available if the emergency authorities need to speak with you.
- If able to, call x52000 from a neighbouring building to relay information to Campus Community Police.
- Once outside, follow instruction of fire wardens and move well away from the building.
- Reentry to the building may proceed once the alarm bells have stopped ringing (for a minimum of 2 minutes) unless instructed otherwise by emergency response personnel.

Resources for the proper use of a fire extinguisher can be found at the Fire Equipment Manufacturer's Association website. This video puts forth considerations for assessing a small fire and the poster below demonstrates the P-A-S-S technique. Fire safety training is also available through our campus fire department. These are the basic steps to be followed:

1. Assess the fire – if it is small and controllable, you may use one portable extinguisher to put out the fire.
2. Before attempting to extinguish a fire ensure that the fire department has been notified, others in the vicinity have been alerted and the evacuation has begun.
3. Always have an exit behind you, if the fire does not go out you will be able to safely exit without having to navigate around the fire.
4. Make sure you are familiar with the operation of an extinguisher (now is not the time to figure it out) and that the extinguisher is suitable for the type of fire. Your

safety is paramount, if it is unsafe or you are uncomfortable trying to put the fire out, don't.

5. To operate an extinguisher, use the **P-A-S-S** technique:

   P - **Pull** the pin. Hold the extinguisher by the carrying handle and pull/twist the pin out. You do not want to place your hand on the trigger because this will make it impossible to pull the pin out.

   A - **Aim** at the base of the fire. Aim the nozzle at the leading edge of the fire.

   S - **Squeeze** the trigger. Fully depress the trigger with the palm of your hand and expel the entire extinguisher onto the fire.

   S - **Sweep** back and forth. Sweep the extinguisher side to side; ensure that you extend beyond the edges of the fire to completely cover the base of the fire.

Figure 1 PASS Technique Poster

Each building on campus has people who voluntarily serve as Fire Wardens. During an evacuation they are identifiable by their bright orange hats; please follow their instructions and be respectful. Evacuation is mandatory, and the Fire Safety Officer may take disciplinary action against anyone refusing to leave.

Please refer to the University of Guelph's Fire Safety Plan for more detailed information regarding fire safety. The Fire Safety Plan, extinguisher classifications and other related information can be found on the Fire Safety website.

6.3. Chemical Spill

Spills can be classed as major (i.e. you need help) or minor (i.e. you can handle it yourself).

A critical factor in chemical spill emergencies is knowing when you need to evacuate and get help. If you are ever in doubt of your ability to handle and clean a chemical spill, evacuate the lab and dial x52000 for assistance.

Refer to the EHS Lab Safety Manual and the AAC SOP for detailed instructions on how to manage a chemical spill.

A major chemical spill requires lab evacuation and to get help if you have a spill that:

- You are not comfortable cleaning yourself.

- Is greater than 4L and is a flammable, combustible or other organic liquid.
- Poses a risk of fire or explosion.
- Creates a respiratory hazard (e.g., corrosive vapours, highly toxic chemicals).
- Involves unknown chemicals.
- Involves >1L of a concentrated strongly oxidizing acid (e.g., nitric, perchloric or chromic acid).

Following a spill, do a 'self-check'. If you have been splashed with a hazardous chemical, flush the area immediately. Remove all contaminated clothing and continue to flush the area; caustic or corrosive chemicals trapped against your skin can cause severe burns.

There are certain chemicals (e.g., hydrofluoric acid, mercury, and formaldehyde) that require specific neutralizers or absorbents not commonly found in lab spill kits. If these materials are used in your lab, make sure the spill kit has the supplemental items recommended in the SOP before you start using the chemical. The Chemistry Stockroom in the Summerlee Science Complex has three chemical handlers available for purchase to supplement your spill kits; a Base Control, an Acid Handler and a Solvent Handler.

Once a minor spill has been cleaned up it is important to notify your director of the spill and complete an EHS Incident Report.

6.4. Biohazard Spill

The important principles when managing a biohazard spill are to know the hazards of what you are working with, to avoid aerosol exposure or contact with contaminants, and to use the proper disinfectant in the right way. Review the EHS Biological Spill Response Plan.

The first consideration is your safety. If biohazardous material has spilled on you, remove contaminated clothing and thoroughly wash the affected areas. If material gets in your eye, flush at the eyewash for 15 minutes. If it is a spill that that creates a hazard for others in the area (e.g. aerosolized pathogen), notify everyone in the lab and have them evacuate.

You want to avoid inhalation of pathogens. If the spill is in the lab and there is concern of airborne exposure, evacuate the room and allow 30 minutes for aerosols to settle. If the spill occurs in a biosafety cabinet, lower the sash and ensure the fan is running for at least 10 minutes. If a tube of pathogenic material breaks in a centrifuge, put a sign on the equipment and leave the centrifuge closed for 30 minutes for droplets to settle before you attempt to clean the spill.

Specific directions are provided in the SOP. The basic technique is to cover the spill with absorbent material, soak with a suitable chemical disinfectant, allow enough contact time for the disinfectant to work, then bag all waste and send for autoclaving. It is also important to notify your director of the spill and complete an EHS Incident Report.

6.5. Medical Emergency

- Obtain first aid assistance. The names and contact numbers of AAC first aiders are posted in every lab. In addition, the University's first aid stations are:
    - Occupational Health and Wellness (OHW), Alexander Hall
    - Student Health Services, JT Powell Building
    - Campus Community Police/Fire Safety, mobile service
- Employees can seek medical treatment or advice through Occupational Health and Wellness. Students may obtain further medical treatment from Student Health Services.
- **For emergencies, dial x52000 and request emergency assistance.**
- In an emergency, do not attempt to transport the casualty to the hospital yourself. Dial x52000 and request an ambulance.
- Severe injuries require **immediate** notification of EHS. If an injury meets the regulated definition of 'critical', the Ministry of Labour must be notified and the scene preserved.
- A critical injury is an injury of a serious nature that:
    - Is potentially life threatening.
    - Causes loss of sight in an eye.
    - Burns more than 10% of the body.
    - Produces unconsciousness.
    - Causes substantial loss of blood.
    - Causes fracture or amputation of a limb.

For non-critical injuries, notify your director as soon as possible and ensure an EHS Incident Report is submitted to OHW (Fax: (519) 780-1796) within 24 hours.

Specific Incidents:

Cuts – if someone suffers a severe cut, place pressure on the wound, and if possible elevate the wound above the heart.

Punctures – if the object is still lodged in the person's body, do not remove it. Call x52000 immediately and request medical assistance.

Fainting – if someone is about to faint, have them sit or lie down. If they have fainted in a seated position, steady them and put their head between their knees. If they have fallen to the ground, roll them to their back and elevate the legs 20-30 cm. If someone sustained an injury during the fall, begins convulsing, or does not recover within two minutes, dial x52000 and request emergency medical assistance.

Needle sticks – Rinse the wound for 15 minutes and encourage bleeding. Determine whether it is a 'clean' or potentially 'dirty' needle. If the needle was potentially contaminated with an infectious substance, advise the victim to immediately contact Occupational Health and Wellness (x52647) or Student Health Services (x52131) and seek medical treatment. Outside of regular hours, advise the victim to seek immediate

medical treatment (i.e. Emergency Room). Prophylaxis for hepatitis and HIV must be started as soon as possible following exposure.

Seizures – help the person to the floor and clear away nearby objects. Try to prevent the person from striking objects in the area and harming themselves during the seizure. Do not attempt to restrain the victim or force anything into their mouth. Placing any object in the mouth of a seizure victim only increases the likelihood of choking. Dial x52000 immediately and request medical assistance; be sure to inform them if the victim is having trouble breathing or any other relevant details.

Choking – call for help. If the airway is only partially obstructed and there is air exchange, encourage the victim to continue coughing. If the airway is fully obstructed, characterized by the inability to speak, cough, or breathe adequately, administer the Heimlich maneuver by alternating 5 back blows with 5 abdominal thrusts to dislodge an upper airway obstruction.

Cardiac emergency - if someone is showing symptoms of a heart attack (sudden pain in arm, chest, neck, jaw or back; pale skin), call x52000 and request an ambulance be sent to your location. Get the person to a sitting position and remove any constrictive clothing. Monitor their pulse and provide reassurance. If the victim goes into cardiac arrest and you are trained, administer CPR until emergency authorities arrive. Campus Community Police and Fire Division vehicles are equipped with portable Automated External Defibrillators (AED) and provide mobile first aid services. Additionally, an AED is in the atrium of the Summerlee Science Complex.

6.6. Active Threat

If you become aware of a violent situation, such as an armed person on campus:

- If possible, lock yourself in the nearest safe room and stay out of sight.
- If safe to do so, dial x52000 and request help.
- If you are certain you can get to an exit safely, move quickly and evacuate the building.

6.7. Power outage

Many of the areas occupied by the Advanced Analysis Centre are supplied with back-up power by generator, either from a stand-alone system or via the university's essential service grid. The time required for back-up power to come on-line is typically about 30 seconds, so if the power does go out, stay where you are for a moment to see if it comes back on. If it doesn't, check to see if the rest of the building is out as well. If it is a problem in only a portion of the building, have one person contact the Physical Resources work order desk at x53854.

Fume hoods and biosafety cabinets must be closed during a power outage to prevent migration of hazardous aerosols or vapours into the lab. Keep away from the hoods to

prevent introducing air currents and minimize exposure to any accumulated vapours or aerosols.

If it is a widespread outage and back-up power has not come on-line, before leaving the lab for any length of time, shut off any open gas valves, compressed air/vacuum valves, light switches, fans, and any other equipment. One person from the AAC should call Physical Resources at ext. 53854 to notify them of the outage and notify the AAC Manager who will relay the information to all AAC personnel.

6.8. Flood

If you discover a flooded area and it is safe to do so, try to cut off the source of the water. If there is an electrocution hazard (e.g., the water has risen to the level of electrical outlets, submerged electrical cords), evacuate everyone from the area and contact Physical Resources at x53854. Outside of regular hours, notify Campus Community Police at x52000 or x52245.

7. Hazard & Incident Reporting

7.1. Reporting of Hazardous Conditions

Under OHSA, every worker has a duty to report unchecked hazards. With the nature of the work in the AAC, there are many hazards; but with proper planning and precautions the risk can be controlled to an acceptable level. If you have concern about a hazard in your work area, start by discussing it with your director or supervisor. If the scope of the problem is too large or if there is question on what should be done, the issue can be raised to the AAC Manager, an AAC safety representative and/or EHS.

If your concern is not resolved, remember that as workers in Ontario, you have a legal right to refuse work that you legitimately feel would put you in danger. Refer to section 43 of the OHSA for more details.

7.2. Incident Reporting

If you are injured at work, get appropriate first aid and notify your supervisor or facility director as soon as possible. An Incident Report Form must be filled out, signed by your supervisor or facility director, provided to the AAC Manager and employee group and submitted to EHS within 24 hours – but if an injury is serious and potentially life threatening, after getting help for the victim, call EHS (x53282) to report the incident as soon as possible. Allow Campus Community Police to notify the next of kin to avoid miscommunication and confusion.

A near-miss incident, i.e. an unplanned event that did not result in injury, illness or loss of property but had the potential to do should also be reported. Incident Report Forms are available through the EHS.

8. Laboratory Safety

8.1. General Laboratory Safety

The goal of the safety program is not to have you memorize an arbitrary set of rules – it is much better if you try to understand the rationale behind the rules. In a lab, we need to do three fundamental things:

1. protect ourselves from exposure to the hazards present
2. prevent the migration of contaminants out of the lab
3. put systems in place to mitigate the impact of a serious incident (e.g., fire, spill)

Key points:

- Report all potential hazards or safety issues to lab director/supervisor.
- Familiarize yourself with the emergency response procedures.
- Know evacuation routes from your lab and the location of emergency equipment such as pull stations, fire extinguishers, spill kits, emergency showers/eyewashes, first aid kits, phones and emergency call boxes.
- Do not bring food, drinks, cosmetics, tobacco or cannabis products into the lab.
- **Closed-toe, closed-heel shoes are required to be worn in all laboratory areas.** Bare feet, sandals, and open-toed shoes are not permitted while working in any laboratory as there is the potential for exposure to physical hazards and hazardous materials.
- Always wear suitable clothing, a lab coat, closed-toe/heel shoes constructed of a resistant material (preferably leather), and required personal protective equipment (PPE) when working with potentially hazardous materials.
- Dispense hazardous materials inside a fume hood.
- Never allow gloved hands to touch surfaces outside of the lab, or ‘clean’ surfaces in the lab such as door knobs, phone receivers, or computer keyboards.
- Do not wear lab coats in common areas or stairwells.
- Keep personal items separated from hazardous materials.
- Never leave lab doors propped open.
- All materials dispensed from their original containers must be properly labeled.
- Place a sign on any unattended experiments and provide contact information so you can be reached if something goes awry. A template is provided on the CBS Safety Forms page. A printed copy is to be posted on the door of the lab and a copy submitted to the supervisor.
- Avoid use of personal headphones when doing lab work – you need to be able to hear if equipment is functioning properly and emergency alarms. It is also important to be aware of the location of people around you.

- Keep incompatible chemicals separate (no acids with bases, no flammables with oxidizers) – look at the labels and/or SDSs if you aren't sure.
- Practice good housekeeping and good hygiene.

Safety rules and regulations in a laboratory environment are unavoidable - it is an environment where fires, explosions, injuries, and exposures to chemical/biological/radiological/physical threats are a very real possibility. We have had serious incidents in AAC in the past that we do not want to repeat, so please take lab safety seriously.

Proper control measures are to be implemented as appropriate to the situation. Before engaging in a new procedure or operation, every effort should be made to determine the potential hazards and appropriate safety precautions required. The schematic below depicts the order in which control strategies should be ranked; the more reliable and effective preventative measures are given preference. In practice, multiple controls are used together to reduce exposure to a hazard.

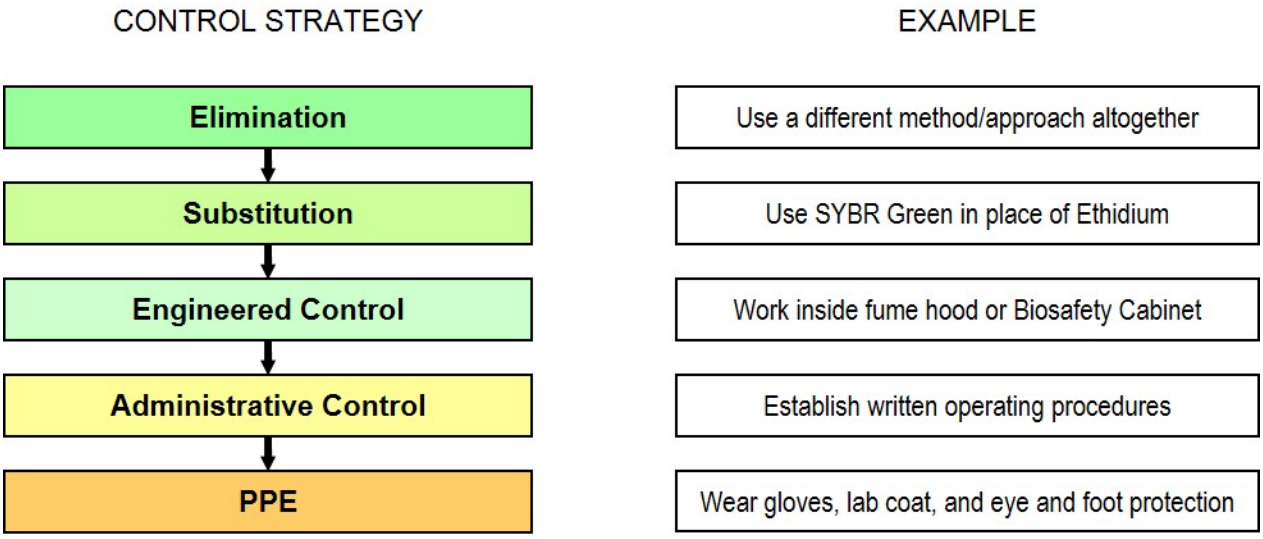


Figure 2 Hazard Control Strategies

Keep these concepts in mind when critically evaluating the work that you do in your lab.

To demonstrate the type of precautions needed to protect oneself, consider the simple task of decanting strong acid into a beaker for dilution. To do this properly one would:

- plan and anticipate hazards
- perform all tasks inside a fume hood, with the sash in a low position (an engineered control that keeps corrosive fumes from entering the breathing zone)
- ensure there is clear space to work in the fume hood (a work practice control that reduces the likelihood of a spill/accidental exposure, and a clutter free fume hood ensures proper air flow)

- wear close-toed/heeled shoes, long pants or long skirt to fully cover the legs, a lab coat, acid-resistant gloves, and goggles (personal protective equipment to protect the skin and eyes in the event of small spills and splashes)
- slowly pour the acid into a beaker partially filled with water (a work practice control that reduces the amount of undiluted acid splashing up)

The above emphasizes the use of engineered controls, safe work practices or administrative controls, and personal protective equipment to maintain exposures at a safe level. It is a demonstration in the hierarchy of controls, which is a model for the evaluation of protective measures.

Some key points about preventing contamination:

- Always assume gloves are contaminated. You put on gloves to prevent one thing or another from touching your skin. The logical conclusion is that whatever it was you didn't want on your skin is now on the exterior of the glove. Change gloves frequently and never allow a gloved hand to touch a common surface (like a door knob, light switch, phone receiver, etc.).
- Lab coats protect you, and the clothes that you own, from becoming contaminated. It is a requirement that lab coats be worn in all labs for any work involving hazardous materials. Lab coats cannot be worn outside of the research wings in AAC. If you will need a lab coat at your destination on another floor, simply place your coat in a plastic bag and carry it with you.
- A clean work area goes a long way to reducing cross-contamination. For any hazardous agent it is important to consider how the inevitable small spills, droplets and splashes can be controlled. Working over disposable bench paper is an easy way to control contamination. Alternatively, you can work over a low tray that has cleanable surfaces. Regardless of the method you use, be sure to clean your work area when finished, and if there are any small spills, clean them up using an appropriate method as soon as possible (refer to AAC SOPs on spills for more details).
- Another area with high potential for spreading chemical/biological or radiological contamination is the transport of materials through hallways. Make use of carts, secondary containment trays and safety bottle carriers when moving materials around the building.
- Another factor to consider is the storage of your personal belongings; as much as possible, you should keep personal items out of the lab. If you do have items you need in the lab, keep them well separated from potentially contaminated areas.

There are additional aspects of contamination control that pertain to the design of equipment and the laboratory itself, but the list above covers most of the basic responsibilities.

Finally, to manage the potential impact of emergencies, the general responsibilities of lab personnel include:

- Familiarize yourself with evacuation routes, emergency procedures, as well as the locations of phones, call boxes, and emergency equipment in your work area.
- Notify others of incidents such as spills or fires; verbally for minor incidents, or by activating an alarm pull station for more serious situations.
- Keep aisle and exit routes clear.
- Ensure that the access to eyewash stations, showers, and fire extinguishers is unobstructed.
- Ensure that fire extinguishers have adequate charge (needle on pressure gauge is in green zone).
- Ensure spill kits and first aid kits are readily accessible and appropriately stocked.

Further information can be found at the EHS website.

8.2. Workplace Hazardous Materials Information System (WHMIS)

The Workplace Hazardous Materials Information System, or WHMIS, is a very important component of the hazard communication scheme in a university laboratory.

Anyone working in a laboratory environment must receive WHMIS training.

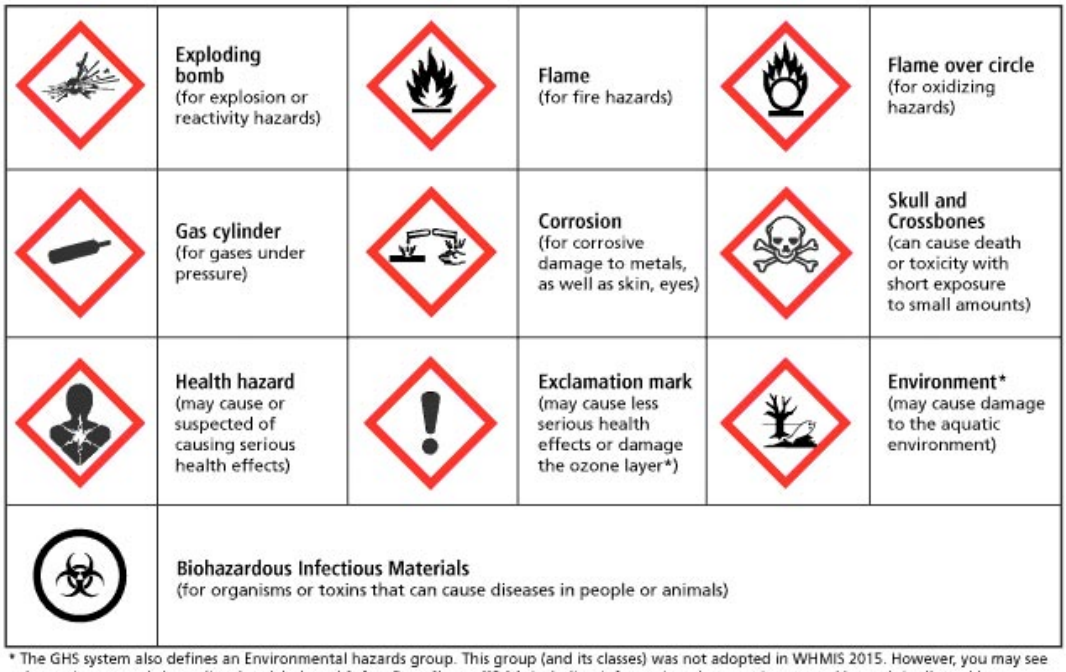
EHS provides online training modules to meet this requirement and offers training modules for WHMIS. To register for EHS courses use the EHS Course Registration System and Training Record Database.

The main elements of WHMIS are:

- Labels provide basic information that a worker needs to know to safely use a hazardous product.
- Safety Data Sheets (SDS) supplement the label with more detailed information about a product's physical and chemical characteristics, its hazardous properties, and necessary handling precautions.
- Worker Education ensures workers understand the information on labels and SDSs and can apply this knowledge on the job.

WHMIS 2015, introduced pictograms to replace WHMIS symbols, revised hazard classifications (with prescribed signal words, hazard statements and precautionary statements), and standardized Safety Data Sheets (SDSs) to replace Material Safety Data Sheets.

Figure 3 WHMIS2015 Pictograms



* The GHS system also defines an Environmental hazards group. This group (and its classes) was not adopted in WHMIS 2015. However, you may see the environmental classes listed on labels and Safety Data Sheets (SDSs). Including information about environmental hazards is allowed by WHMIS 2015.

WHMIS 2015 is now in full force, and any elements (labels and Material Safety Data Sheets) of WHMIS 1988 need to be removed. There should be no hazardous products in the workplace with WHMIS 1988 labels and safety data sheets.

The University subscribes to an online SDS subscription service. It is advised that each lab keep a hardcopy of the 20 most used solvents or chemicals on hand, but for most chemicals, access to SDS can be electronic. The University's online SDS can be accessed from the University of Guelph network.

All hazardous materials decanted from their original container must be properly labeled. Containers that will not leave the laboratory require only a product identifier (i.e. the name of the product written on the exterior). If a decanted hazardous material will be moved out of the lab, it requires a workplace label, which needs to include a product identifier, directions for safe handling, and a reference to the SDS. The above website has a template for creating secondary container labels.

8.3. Monthly Laboratory Self-inspections

Key Points:

- Activate eyewash stations weekly to flush out contaminants, discourage microbial growth, ensure adequate water flow and document weekly checks.
- Ensure the access to the emergency eyewash/shower is not obstructed.
- Check the fire extinguisher – it should be easy to access (i.e. unobstructed), and the pressure indicator should be in the green area of the gauge.

- Check the spill kit – it should contain neutralizers (usually 3; an acid, a base, and an organic solvent suppressant), absorbent materials, gloves, goggles, a dustpan/scraper or dustpan/broom and bags for waste material. Other hazard specific materials may be required depending on the hazards in the lab.
- Check first aid boxes – the kit should contain gloves, tweezers, scissors, adhesive bandages, tape, gauze, and pads or compress bandages.
- Check certification of fume hoods and biological safety cabinets and notify EHS if certification has expired. Ensure work area and airflow is not obstructed.
- Visually inspect chemical storage areas to ensure there is no leakage and incompatibles are separated each month.
- Look for issues with unsecured gas cylinders, poor housekeeping, electrical hazards, and access to exits.
- Report any issues to your director.

It is important that laboratory inspections be completed regularly to monitor and maintain the safety of each work area. In any given lab there can be a combination of physical, chemical, biological and radiological hazards - diligence is required to control these hazards and keep the work environment safe.

8.4. Fume Hoods

Key Points:

- Keep sash closed when not in use.
- Ensure that the fume hood is on prior to use.
- Work with sash as low as possible (less than 18”/50cm).
- Keep all work at least 6”/15cm back from front edge.
- Do not obstruct air vents at rear of hood.
- Do not allow hoods to become cluttered or to be used as extra storage.
- Uncap containers inside the hood; recap them as soon as you are finished.
- Do not use a fume hood if the alarm indicates low flow.
- Completely close the sash if you are working in a hood when the fire alarm goes off.
- To prevent the formation of explosive perchlorate compounds and residues, any solution of perchloric acid above 70% being heated must be handled in a specially designed hood with wash-down features.

Further instructions on the proper use of fume hoods are provided in the SOP.

When a hood is not in use, keep the sash fully closed. This is a simple thing that can conserve a lot of energy - fume hoods exhaust a large volume of air when they are open, and it requires a great deal of energy to heat or cool the replacement air.

When you are working in a hood, keep the sash as low as you reasonably can. This improves ability of the hood to keep airborne contaminants out of your breathing space, offers some protection to your face should there be a splash or spill, and conserves energy.

Fume hoods on campus are equipped with a warning device that will alarm when the airflow is inadequate for the hood to function as designed. The alarm will go off if the airflow falls below a preset threshold (typically a face velocity of 80 feet per minute). Do not attempt to use the hood if the alarm is sounding and stop any experiments taking place inside the hood if the alarm persists. Close the sash fully to prevent hazardous vapours from migrating into the lab.

If large equipment is required inside a hood, it should be raised to permit adequate airflow. To determine if low flow may be resulting from a disruption of airflow, remove items that may be obstructing the movement of air through the vents at the back of the hood; Also, lower the sash and reset the alarm if possible. Sash position will affect the face velocity, which is an important factor in effective capture of airborne contaminants. Baffles should not be adjusted by users.

Large disruptions in the air around a hood (e.g., the opening/closing of a door) may temporarily affect the airflow through the hood; if this is suspected as the cause of the problem; try resetting the alarm if possible. If the above changes do not rectify the issue, label the hood as 'OUT OF ORDER' and notify Physical Resources (x53854) or the appropriate AAC contact for equipment problems.

EHS coordinates a program for annual calibration and testing of fume hood air flow alarms.

8.5. Liquid Nitrogen

Liquid nitrogen is a hazardous material, Class A compressed gas under WHMIS. It can be potentially harmful; as a cryogenic liquid it can cause severe frostbite and leaking gas can displace oxygen leading to asphyxiation. Exposure to oxygen-deficient atmospheres may produce dizziness, nausea, vomiting, loss of consciousness and death. Such symptoms may occur in seconds without warning. Death may result from errors in judgement, confusion or loss of consciousness which prevents self-rescue.

Key Points:

- Always wear insulated gloves and eye protection when handling liquid nitrogen.
- Follow the operational practices outlined in the SOP.
- Keep the door open when dispensing from bulk storage dewars.
- If you have a spill, you need to evacuate immediately. Make sure everyone gets out of the immediate area and wait 30 minutes for the air to clear. If a spill is >4L, call EHS, as air testing may be required to verify the oxygen level has returned to normal. Report the spill using the EHS Incident Report Form.

Some storage areas for dewars are equipped with an oxygen monitor. If the alarm sounds, close any open valves immediately and leave the room.

8.6. Compressed Gas Cylinders

Compressed gas cylinders are under high pressure and contain a lot of potential energy. The principle hazards are that a failure in the tank or the valve will cause a rapid release of pressure (i.e. an explosion), and a release of the contents (leaking or open valve) that could be hazardous. A leak of a toxic gas can rapidly reach a hazardous level. Similarly, a leaking cylinder of flammable gas could potentially lead to a fire or explosion.

Key points:

- Changing compressed gas cylinders or working with compressed gases should not be conducted while working alone, or after regular business hours. Transfer of cylinders should be done by TWO PEOPLE.
- Do not attempt to change a tank unless you have been trained to do so. WHMIS training addresses this topic, and further details are provided by your director/supervisor.
- Transport of cylinders may involve movement to different floors of the building, workers who are required to use freight elevators will also need to complete Freight Elevator Handling training offered through EHS.
- If an elevator must be used for transporting a compressed gas cylinder it must be transported in an unoccupied freight elevator, which can be operated from outside of the elevator. Do not ride in a freight elevator with a compressed gas cylinder. In the event of a gas leak, there may be insufficient ventilation to maintain adequate oxygen levels. Post a sign to warn people not to enter the elevator during transport and send the cylinder unaccompanied to the destination floor. Have second person wait for the freight elevator at the destination.
- Label empty cylinders clearly with either “EMPTY” or “MT”.
- Always secure tanks vertically using a strap or chain whether in storage or in use, i.e. secured in an upright position with a regulator attached.
- Never store tanks of incompatible materials together (e.g., flammable gases beside oxygen).
- Do not expose cylinders to high temperature extremes.
- Do not force, lubricate or modify cylinder valves in any way. The mixture of lubricant and oxidizing gases could be explosive.
- To prevent accumulation of electrostatic charge cylinders containing flammable gases need to be grounded.
- Never expose skin or clothing to compressed gas flow as high velocity gas could penetrate the skin leading to serious injury.

Hazards of Compressed Gases

Compressed gases are inherently hazardous due to the high pressure inside the cylinders.

Knocking over an unsecured, uncapped cylinder of compressed gas can damage the cylinder valve resulting in a rapid release of gas that can transform a cylinder into an uncontrollable rocket or pinwheel and cause serious injury or damage. Poorly controlled release of compressed gas in the laboratory can burst reaction vessels, cause leaks in equipment and hoses or result in runaway chemical reactions. Compressed gases may also have flammable, oxidizing, dangerously reactive, corrosive or toxic properties. Inert gases such as nitrogen, argon, helium and neon can displace air, reducing oxygen levels in poorly ventilated or restricted areas and cause asphyxiation.

Handling and Transport of Gas Cylinders

The following points describe safe handling and transport guidelines for gas cylinders;

- Return unlabelled cylinders unopened to the supplier. Colour coding does not provide enough identification.
- When moving a tank – remove the tank regulator and ensure the safety cap or valve protection cap is completely screwed on. This rule applies irrespective of the content (inert, toxic, flammable or corrosive) and status (full or empty) of the cylinder.
- The tank must be chained or strapped to a cylinder cart designed for moving cylinders. A 4-point trolley is recommended. Never drag or roll a cylinder.
- Never bleed a cylinder completely empty; leave a residual pressure of at least 25 psi to prevent contamination or “suck back”.
- To use a cylinder:
    - Ensure the pressure regulating valve (adjusting screw) is closed.
    - Open the cylinder valve slowly.
    - Open the pressure regulating valve to the desired pressure.
- To shut off the gas:
    - Close the cylinder valve.
    - Open the pressure regulating valve to relieve the pressure.

Regulator

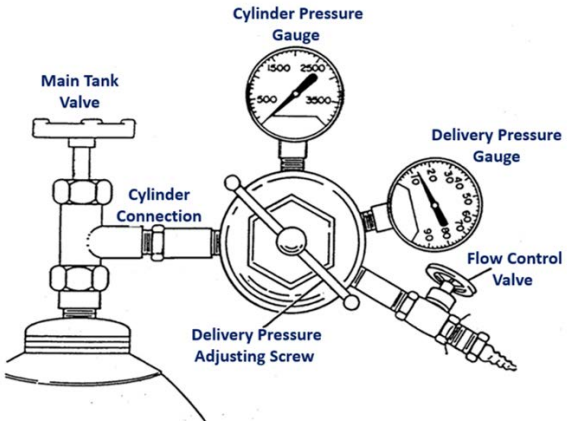


Figure 4 Schematic of a two-stage compressed gas regulator and cylinder top

Regulator Operation

1. Attach the regulator to the cylinder valve outlet.
2. Turn the delivery pressure adjustment knob counter clockwise until it turns freely.
3. Ensure the flow control valve is in the closed position.
4. Slowly open the cylinder valve until the regulator registers the cylinder pressure.
5. Turn the delivery pressure adjustment knob clockwise until the desired delivery pressure is reached.

- Verify that the regulator is appropriate for the gas being used and the pressure being delivered. Regulators are not universal and have to be chosen based on the gas and cylinder being used. Compressed Gas Association (CGA) connector numbers are to be the same on the regulator and cylinder valve.
- Label all regulators appropriately and do not use interchangeably with different gases.
- Do not rely upon the pressure gauge to indicate the maximum pressure ratings; check the regulator's specifications.
- Do not use adaptors or Teflon tape to attach regulators to gas cylinders. Regulator inlet connections are designed to fit the outlet connection of the cylinder valve for a particular gas. Gas tight connections are made using metal to metal seals which can be weakened or plugged using Teflon tape.
- Use a properly sized wrench to attach a regulator to a cylinder. Adjustable wrenches are not to be used as they can damage the fittings.

Leaks

To prevent leaks, always use the right type of regulator, fittings, and hoses for your application. Inspect all components prior to assembling to ensure they are clean, dry, and functioning properly. When appropriate, check all connections by brushing on a soapy solution to ensure there is no errant gas escaping. In some applications a gas detector may be required. Gas systems must be leak tested at the following intervals:

- Upon receipt
- At installation
- Periodically during operation
- At disconnect / shipping

Storage of Gas Cylinders

Storage of gas cylinders is regulated through the Ontario Fire Code Section 5.6. Proper storage room/locations for compressed gas cylinders are available throughout the University that meet the requirements of the Fire Code. Only cylinders that are in use are to be in research or teaching labs.

- Storage areas are to be conspicuously labelled as such.
- Cylinders of flammable gases are to be segregated from oxidizing gases (e.g. oxygen stored separately from hydrogen).
- All gas cylinders are to be securely supported in an upright position using suitable racks, straps, chains or stands. Cylinders should be secured at approximately ⅔ of their height. Cylinders with a height of less than 46 cm can be secured in specialized racks.
- All cylinders are to be protected from mechanical damage.

- Position cylinders in a dry location away from direct sunlight and heat sources.
- Cylinders are to be well removed from doors, aisles, stairs and elevators.
- Outdoor propane tanks must not be stored or used indoors.

8.7. Chemical Safety

Safely storing chemicals in a laboratory or stockroom requires diligence and careful consideration. Correct use of containers and common lab equipment is critical. Safe storage of chemicals can minimize incompatible chemical reactions, spillage, breaking, or waste due to expiration in the laboratory.

Key Points:

- Don’t accumulate unnecessary inventory - check to see if your lab already has the chemical, and order only as much as you need.
- Know the hazards of the materials with which you are working. Review the SDS prior to handling a new chemical.
- Maintain a chemical inventory list and inspect annually for outdated or unneeded items, illegible labels, leaking containers, etc.
- Label all chemical containers appropriately, including the date received.
- Provide a specific storage space for each chemical and return after each use.
- Store chemicals by hazard class, or compatibility group, not alphabetically
- Never store incompatible materials together. Acids cannot be stored with bases; flammables cannot be stored with oxidizers.
- Never put flammable solvents in a fridge unless the fridge is specifically designed to accommodate flammables. Ordinary household refrigerators are not appropriate because vapors from the stored chemicals can accumulate over time and can come into contact with a spark from the normal operation of the thermostat, light switch, or defrost timer thus creating a powerful explosion.
- Store large breakable containers, particularly of liquids, below shoulder height.

Chemical Storage Facilities:

Fume Hood – Do not store chemicals in laboratory hoods. Excessive containers may impede airflow and thereby reduce the effectiveness of the hood.

Ventilated cabinets - These are cabinets which are fitted with forced ventilation. They may be free-standing with their own extract system or may be situated beneath a fume hood and attached to its duct. They are designed to safely store chemicals that give off noxious fumes and smells. These fumes are exhausted by the forced ventilation.

Cabinets – You can use cabinets under hoods and laboratory benches for storage of chemicals. However, do not store laboratory chemicals near or under sinks where there may be exposure to water. Storage of cleaning supplies under sinks is acceptable. Cabinets for chemical carcinogens or highly toxic chemicals should have a lock.

Flammable Storage Cabinets - Must be labelled in conspicuous lettering to indicate that the cabinet contains flammable materials and that open flames must be kept away. These metal cabinets shall conform to ULC-C1275: Storage Cabinets for Flammable Liquid Containers. The maximum quantities of flammable and combustible liquids which are allowed in laboratories is regulated by various agencies. At the University of Guelph, containers of flammable and combustible liquids in laboratories must be;

- <5 litres (ON Fire Code Section 4.12.3.1(1))
- have a WHMIS supplier or workplace label affixed
- <50L of flammables in the lab, outside of cabinet (ON Fire code 4.12.3.1(2))
- <235L of flammables inside the cabinet (R.R.O. 1990, Reg. 851, s. 22(3))
- no more than 3 cabinets per lab

Refrigerated Storage – Store flammable solvents that require storage at reduced temperature in refrigerators or freezers designed for storage of flammable liquids. “Safety” refrigerators for flammable liquid storage and “explosion proof” refrigerators are both acceptable. Because refrigerators and freezers have no interior space venting, all chemicals should have tightly sealed caps. Apply signage to the doors of chemical refrigerators stating:

CHEMICAL STORAGE ONLY
NO FOOD, BEVERAGE, OR ICE FOR HUMAN CONSUMPTION

Cold Room – Cold rooms have closed air circulation systems that re-circulate escaped vapours within the chamber. The refrigeration coils in cold rooms are aluminum and subject to damage from corrosive atmospheres. The electrical systems normally have vapour proof lights and duplex outlets but added-on extension cords and plug strips compromise these safety features. Cold rooms are not acceptable for storage of flammables, dry ice, highly toxic liquid chemicals, or compressed gases.

Desiccator Jars – Desiccator jars are useful for storage of air and water reactive, toxic, and malodorous chemicals. In case of especially malodorous compounds, replace the desiccator material with a vapour adsorber (e.g. charcoal) to control odours.

Bench top – Chemical storage on bench tops is undesirable, and is vulnerable to accidental breakage by laboratory, housekeeping, and emergency response personnel. These work spaces should contain only chemicals currently in use.

Optimally, incompatible chemicals such as acids and alkalis should be stored separate from one another to prevent mixing in the event of an accidental spill or release of the materials. Limited storage space sometimes prevents such prudent practice of chemical segregation and storage. If space is limited, you can store incompatible chemicals in the

same storage cabinet if you segregate the chemicals according to their hazard class and you store them in tubs, trays, or buckets while in the cabinet. These secondary containers reduce the chance that incompatible chemicals will inadvertently contact each other.

Table 1 Chemical Compatibility and Storage

Compatibility Group	Group Name	Chemical Class	Storage
Group A	Inorganic Acids, Inorganic Salts	inorganic acids (except nitric), sulfur, arsenic, halides, sulfates, sulfites, thiosulfates, halogens, phosphorus, phosphates	Store acids separate from bases and other reducing agents. Place acids in plastic trays for secondary containment in case of breakage.
Group B	Inorganic Bases	hydroxides, oxides, silicates, carbonates	Segregate bases from acids and oxidizers on shelves near the floor. Use secondary containment trays.
Group C	Organics	alcohols, glycols, amines, amides, hydrocarbons, esters, aldehydes, phenol cresols, organic sulfides, organic acids	Segregate organic compounds from inorganics. Store organics in ascending order according to the number of carbons.
Group D	Flammables, Combustibles	ethers, aliphatic solvents, aromatic solvents Containers must be <5L	Store flammable and combustible materials away from sources of ignition such as heat, sparks, or open flames, and segregated from oxidizers.
Group E	Inorganic Oxidizers	borates, chromates, manganates, permanganates, chlorates, perchlorates, chlorites, hypochlorites, hydrogen peroxides, amides, nitrates, nitrites, azides	Store inorganic oxidizers in a cool, dry place away from combustible materials such as zinc, alkaline metals, formic acid, and other reducing agents. Store ammonium nitrate separately.
Group F	Organic Peroxides and Explosives	peroxides, azides, hydroperoxides	Store shock and heat-sensitive chemicals in a dedicated cabinet.

Compatibility Group	Group Name	Chemical Class	Storage
Group G	Reactives	air and water reactives, metals and hydrides	Store water reactives in a cool dry place protected from water sources. As an added precaution, use secondary container trays filled with sand. Store pyrophorics in a cool, dry place, and provide for an air tight seal.
Group H	Cyanides, Sulfides	cyanides, cyanates, sulfides, carbides, nitrides	Cyanides and sulfides react with acids to release highly toxic gases. Isolate from acids and other oxidizers.
Group I	Highly Toxics, Carcinogens, Reproductive Toxins	highly toxic compounds, carcinogens, mutagens, teratogens	A dedicated lockable storage cabinet is the preferred storage method

8.8. Working at Height

If the nature of your research requires any work more than 3 metres off the ground, you must have appropriate training and equipment.

Equipment for working at height can come in several forms – make sure you are fully trained on the equipment you will be using, and that all equipment is inspected pre-use and kept in good condition. The type of safety gear or fall arrest equipment required will depend on the type of work being done.

Do not work at height alone. It is imperative there be someone present to get help if you do fall and injure yourself.

8.9. Transportation of Dangerous Goods (TDG)

Anyone who ships, carries or receives dangerous goods must be trained and hold a valid Transportation of Dangerous Goods (TDG) Training Certificate. TDG training is offered on-line by Environmental Health and Safety. TDG training certificates are valid for a period of 3 years.

Information regarding training as well as general TDG requirements can be found here. Anyone requiring TDG training should contact EHS at x53282.

8.10. Biosafety

All employees and graduate students handling biohazards are required to participate in the Occupational Health and Wellness (OHW) biosafety medical surveillance program as required under the Human Pathogens & Toxins Act and the national standard, Canadian Biosafety Standards 2nd edition (2015).

Risk Groups and Containment Levels

Biological materials are classified into 'Risk Groups' based on their ability to cause disease in humans and/or animals.

Risk Group 1 – low individual and community risk
Risk Group 2 – moderate individual risk, limited community risk
Risk Group 3 – high individual risk, low community risk
Risk Group 4 – high individual risk, high community risk

The Risk Group indicates the relative level of risk to workers and to public health, but the more relevant classification from an operational perspective is the **Containment Level**. The Containment Level defines the nature of the engineering and procedural controls required for handling different organisms. There are four levels of containment ranging from Containment Level 1 (CL-1) with the lowest level of risk to CL-4 with the highest level of risk. CL-1 and CL-2 facilities are identified by standard signage.

Prions, RG3 and 4 biohazardous materials are prohibited in University of Guelph facilities.

The University of Guelph does not have CL-3 or CL-4 facilities.

Anyone performing work with human or animal pathogens must familiarize themselves with the Canadian Biosafety Standard (CBS) 2nd edition issued by Public Health Agency of Canada (PHAC

ePATHogen is PHAC's new database for biological agents and provides risk group and containment level classifications for human and terrestrial animal pathogens. Containment levels may also be obtained from the Pathogen Safety Data Sheet (PSDS). Visit the Canadian Food Inspection Agency (CFIA) Disease Agent Information page to view the animal disease fact sheets, and obtain information for aquatic animal pathogens and plant pests. Another resource is the BioSafety App which is a free download for Android and Apple devices and provides facility containment requirements.

If you are unable to find information on a pathogen, contact the University of Guelph Biosafety Officer (BSO) for assistance.

The containment level for recombinant DNA and genetic manipulation will depend on a risk assessment that takes into account the pathogenicity of the donor/source organism and the recipient organism, as well as the properties of the recombinant organism with respect

to protein expression and replication. For assistance in determining the proper containment level, contact the U of G Biosafety Officer by email with all the relevant information and documentation.

Cell lines may be biohazardous because of the organism's inherent pathogenicity, or due to contamination with other agents such as viruses, fungi, bacteria or prions. At the University of Guelph, the policy is to work with human cell lines/cell cultures under Containment Level 2. In cases where there is a high potential for laboratory-acquired infection (e.g., cell lines derived from macaques that may be contaminated with *Herpesvirus simiae*) Containment Level 3 will be required – the University of Guelph does not have a license to work with Risk Group 3 or 4 material. Conversely in cases where the risk is assessed and deemed to be low, work with animal cell lines may be downgraded to Containment Level 1 in accordance to the Safety Data Sheets provided by the distributor or vendor documentation.

Operational Requirements

The requirements for the various Biosafety Containment Levels are defined in detail in the CBS and reiterated in the reference materials including the Canadian Biosafety Handbook, 2nd Edition, that support the biosafety program.

As discussed in the section on lab safety, the purpose of the various requirements is to keep you, as a worker, from being exposed; to prevent contamination from being carried out of the lab and spread to other parts of our facilities; and to put plans in place to deal with emergencies that may arise.

A few of the essential operational requirements for Containment Level 2 (many of which are applicable in all labs) are listed below:

- All personnel must wear fastened lab coats when working in the lab. Lab coats are not to be worn in stairwells or common areas of the building. Contaminated lab coats should be autoclaved or chemically disinfected prior to laundering (unless laundering has been proven to effectively decontaminate lab coats).
- Eye or face protection is required whenever there is a risk of splashes, aerosols or flying objects. Minimum eye protection in the lab is safety glasses.
- Closed-toe, closed-heel shoes are required when working in all laboratories, including Containment Level 2 areas.
- Gloves must be worn while handling or working with a pathogen and/or infectious materials and removed prior to leaving the work area. Any cuts or scrapes must remain covered at all times with a waterproof dressing. Hands should be washed thoroughly (at least 15-20 seconds of rubbing with soap) whenever gloves are removed, and prior to leaving the laboratory.
- A soap dispenser (pump style) and paper towels must be available at the sink.

- To prevent accidental contamination, legs must be covered to the ankle so there is no exposed skin, long hair must be tied back, and lab coats must be worn by all personnel when working in the lab. Dangling jewelry and spiked rings must not be worn while working in a CL-2 lab.
- To reduce the probability of ingestion, food, drink and cosmetics are not permitted in the lab, and oral pipetting is prohibited.
- To prevent indirect or cross contamination, gloves should be preferably changed or removed before handling items likely to be touched by others not wearing gloves, such as doorknobs, light switches, equipment/computer controls, lab notebooks, written instructions or writing instruments. The use of equipment controls such as flexible keyboard covers that can easily be disinfected is encouraged. Laminated copies of SOP's or instructions lend themselves to decontamination and, pens and markers can be cleaned with ethanol after use.
- Routine chemical disinfection of work surfaces is necessary to prevent the spread of potentially pathogenic material. Benchkote should be changed on a regular basis and following any minor spills. Non-essential items and personal belongings must be kept away from areas where biohazards are handled.
- Sharps are to be discarded in containers that are leakproof, puncture-resistant, and fitted with lids, or specially constructed for the disposal of sharps waste. Sharps are never to be disposed in the regular waste.
- All biohazardous waste materials must be decontaminated. Liquid biohazardous materials are to be chemically disinfected or autoclaved prior to release to sanitary sewers. Dry biohazardous materials are to be autoclaved prior to disposal in the regular waste stream or collected by a disposal company specializing in the handling of biohazardous waste. For questions related to chemical and biohazardous waste contact the U of G Lab Safety Officer. For questions related to radioactive waste contact the Radiation Safety Officer.
- Fundamentally RG1 and RG2 waste is to be sterilized in the same manner as described above, however, the reasoning behind these actions is different. In the case of RG2 it is a requirement of the Human Pathogens & Toxins Act to reduce the risk of pathogen release from the containment zone to the environment and community, thus protecting your safety and the safety of others. In the case of RG1 organisms (which are not regulated by PHAC or CFIA) they can act as opportunistic pathogens for immunocompromised or immunosuppressed individuals so all RG1 biological waste should be sterilized and good microbiological laboratory practices followed. Autoclave runs must use a biological indicator i.e. spore strips/vials to ensure efficacy of the sterilization cycle.

Permits

A valid biosafety permit, issued by the University of Guelph Biosafety Committee, must be obtained for all activities involving use or storage of biohazardous materials. For more

details and all relevant forms please refer to forms section of the Biosafety Program on the EHS website.

In accordance to the Human Pathogens and Toxins Regulations (HPTR) 4 (1), the Biological Safety Officer (BSO) must be notified before arrangements are made to do the following:

- import/export a human/animal pathogen or toxin
- receive a human/animal pathogen or toxin from another facility
- transfer a human/animal pathogen or toxin to another facility

Import/Export of Pathogens

The Public Health Agency of Canada (PHAC), under the authority of the Human Pathogens and Toxins Act (HPTA), regulates researchers who require a Pathogen and Toxic License document for human pathogens and an importation permit for terrestrial animal pathogens. The Canadian Food Inspection Agency (CFIA) issues permits for aquatic animal pathogens, plant pathogens, bee pathogens, foreign animal pathogens and pathogens causing emerging animal disease, animal products and animal by-products.

More information is available from EHS and their Quick Reference Guide, and at the following resources:

- Government of Canada Laboratory of Biosafety and Biosecurity
- CFIA Animal Pathogen Imports

Material Transfer Agreements

Before we release biohazardous materials to another individual, organization or institution, it is incumbent on us take reasonable steps to ensure that the material will be handled properly.

For materials that fall into Risk Group 2 (the highest level at U of G), we must ensure the destination facility also fulfills all requirements of a Containment Level 2 laboratory, as described in Canadian Biosafety Handbook, 2nd Edition, and that a Biohazard Agent Transfer Notification form is completed. As well, shipments of RG-2 materials may fall under the Transportation of Dangerous Goods (TDG); refer to the AAC SOP on Transport of Dangerous Goods for further details (currently being updated).

For transfers within the University of Guelph, an Internal Biohazardous Material Transfer Agreement (IBMTA) must be completed and authorized by the Biosafety Officer.

Another consideration is the protection of intellectual property. The Material Transfer Agreement governs the transfer of proprietary materials to third parties. A Material Transfer Agreement form can be downloaded from the Research Innovation Office.

Purchases (Commercial)

Pathogens, biological toxins and recombinant DNA cannot be ordered by way of a low value purchase order. Requisitions for biological hazardous materials need to be submitted as a high value purchase order via the iProcurement Online Requisition. The category code for biological hazardous materials is BIOHAZ.SUPP. In order for the Biosafety Officer to complete the purchase process, the Principal Investigators (PI's) must hold a valid University of Guelph Biohazard Permit.

Biosecurity

In recent years the level of concern over the security of pathogenic materials has grown. From the perspective of the end user, the key points surround access and inventory control.

1. Access control is an important aspect of biosecurity. Never prop open doors or tamper with locking mechanisms, and please report any suspicious activities or behavior to your director. Generally speaking, doors can be unlocked during the day when the lab is occupied, but after hours lab doors must be securely closed and locked. If freezers or storage rooms are kept locked, be sure to relock them when you are finished using them.
2. To facilitate proper inventory control, make sure you keep your materials well organized, properly labeled, secured and accounted for using the inventory system in your lab. In accordance with the CBS 2nd edition, principle investigators (PIs) must maintain an inventory of - all authorized users and all others who have access to their lab; pathogens (including genus and species), cell lines and microbial toxins. Prior to biosafety inspection, permit application or renewal, PIs will be requested by BSO to submit their inventory records.

8.11. Radiation Safety

The AAC is not equipped to handle radioactive materials. It does not have a permit to safely work with such substances nor does it have approved laboratory space to safely handle radiolabeled samples.

The EHS website provides information on Radiation Safety training which is required for students and staff prior to any work with radioactive materials.

Laser Safety

All Class 3B and Class 4 lasers or devices with Class 3B and 4 Lasers must be registered with the Radiation Safety Office (EHS).

Class 3B lasers are medium powered with energies of 5 - 500mW and can be visible or invisible. Class 3B can be hazardous under direct and specular reflection viewing conditions but is normally not a diffuse reflection or fire hazard. Safety procedures need to be implemented while working with class 3B lasers.

Class 4 lasers are high powered and have energies above 500mW, which can be visible or invisible. Class 4 is a hazard to the eye or skin from the direct beam and may pose a diffuse reflection or fire hazard. Some of the class 4 lasers can also produce laser generated air contaminations (LGAC).

The AAC houses several pieces of equipment that use lasers to operate.

In Genomics, the 3730 DNA Sequencer is equipped with 2 lasers;

- a Class 2 laser for reading the barcode on the plate; and
- a Class 3B laser for illuminating the fluorescent dyes. When safety interlocks are disabled during certain servicing procedures, the laser can cause permanent eye damage, and, therefore, is classified under those conditions as a Class 3B laser. Under normal operating conditions, the instrument laser is categorized as a Class 1 laser.

In Molecular and Cellular Imaging, Class 3B lasers are used to operate the two confocal laser scanning microscopes;

- CLSM SP5 Laser system: Radius: 405 nm; Argon (50 mW): 458 nm, 476 nm, 488 nm, 496 nm, 514 nm; GreenHeNe (1.2 mW): 543 nm; Orange: 594 nm; RedHeNe (10 mW): 633 nm
- CLSM SP2 Laser system: Argon (50 mW): 458 nm, 476 nm, 488 nm, 514 nm; GreenHeNe (1.2 mW): 543 nm; RedHeNe (10 mW): 633 nm

All the operators (including Principal Investigators) working with these instruments must complete the Laser Safety Training provided by EHS prior to handling or working with laser equipped instruments. Laser users must participate in refresher training at least every 3 years. Passing the quiz with a mark of 75% or greater will suffice as having completed the refresher course.

Further to the Laser Training, all Laser users must also complete practical hands-on training for the equipment that they would be working with. It is the responsibility of the Principal Investigator to organize training and ensure no untrained individuals operate the device. All training records should be kept by the Principal Investigator and will be audited during routine inspections conducted by the RSO.

8.12. Human Research

The use of human participants for research has obvious ethical and safety implications. Any research projects that will involve human participants must be reviewed and approved by the University of Guelph Research Ethics Board for compliance with federal guidelines. Samples submitted for analysis from human research participants must be accompanied by a REB project number verifiying that the project has been reviewed and approved by the REB. Further details are available online at the Office of Research website; Ethics and Regulatory Compliance.

8.13. Animal Care

The use of animals in biological research is under the oversight of the Animal Care Services (ACS) within the Office of Research. Prior to initiating any study involving animals, an Animal Utilization Protocol (AUP) must be approved by the Animal Care Committee (ACC), and participants must successfully complete training as animal users. This training involves:

- 5 compulsory online core modules to be completed with a minimum score of 70%
- Orientation of animal facilities
- Hands on animal training. (Workshop list)

Samples processed from these projects must be accompanied by documentation that the project has been reviewed and approved by the ACS. Compliance can be demonstrated by providing an ACS project number.

8.14. Laboratory Wastes

Across the AAC many different types of waste are generated. The proper segregation of waste is an important issue; placing hazardous waste in the normal garbage can put the safety of the custodial staff at risk, and leads to serious fines and penalties to the University. The pouring of chemicals down the drain is irresponsible, damaging to the environment, and is prohibited by law.

If you are unsure of how a certain chemical or material might be classified as a waste, ask for clarification from your supervisor, or the EHS Laboratory Safety Officer.

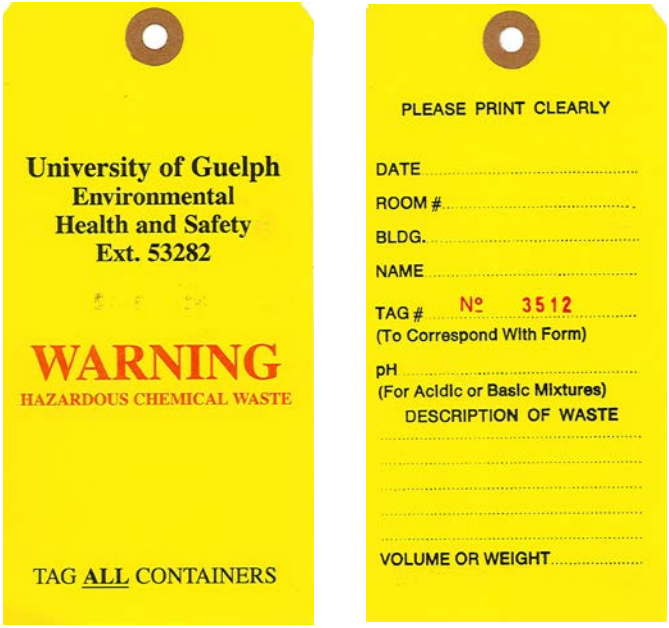


Figure 5 Hazardous Waste Tag

Hazardous Waste tags, like the one shown to the left, (front and back) are available from the Chemistry Stockroom or from the EHS Department.

You may contact EHS at x53282 to request a supply of tags through interoffice mail.

Affix a tag to the waste container when you begin collecting waste.

The following table itemizes the types of waste we routinely have in the AAC, and what should be done with each.

Table 2 Waste Disposal Procedures

Waste	Examples	Disposal Procedure
Regular, non-hazardous garbage	Paper towel, gloves	Place in garbage container (black bag).
Recyclable materials (not contaminated with hazardous materials)	Fine paper, newspaper	Place in blue bin (clear bag).
Cardboard	Shipping boxes	Break down boxes and collect near garbage container within the lab. DO NOT LEAVE IN HALLWAYS.
Expanded Polystyrene (EPS) (Styrofoam)	Shipping containers	Recycle by leaving containers near the lab garbage collection point for housekeeping to pick up and transfer to recycle station. Some shippers/suppliers have a mail back option.
Polystyrene packing peanuts	Not recyclable	Dispose of in garbage.
Shrink wrap, wrappers, bubble-wrap, or bags	Not recyclable	Dispose of in garbage.
Clean Glass Waste	Clean glassware	Clean/sterilized glass, including broken glassware can be placed in the containers marked as 'Glass' (white pail, yellow bag). Ensure any glass going into this waste stream is clean.
Expired/Unneeded chemicals	Chemicals that are no longer used, Expired chemicals	Do not remove from original container. Place in a safe area of the lab, affix a waste tag and submit a Surplus Chemical & "Sharps" Disposal Request Form to EHS.
Compressed gas tanks	Empty N2 cylinder	In most cases, tanks can be returned to the supplier. If you are left with a tank that cannot be returned, affix a waste tag and submit requisition to EHS for disposal.

Waste	Examples	Disposal Procedure
Aqueous solutions	Phosphate buffer, Tris buffer	Aqueous solutions that contain any hazardous materials (metals, dyes, stains) must be collected and disposed of as hazardous waste. Components of solutions must be identified on the hazardous waste tag and corresponding form. NOTE – if solutions are strongly acidic or basic, label and separate. Do not mix acids and bases in waste jugs. Affix a waste tag and when full submit a Surplus Chemical & "Sharps" Disposal Request Form to EHS.
Halogenated organic solvent waste	Chloroform, methylene chloride	Collect in either a safety canister <25L or an empty 4L bottle. Safety canisters will be returned within a week of pick-up. If using a safety canister, affix a waste tag to indicate the type of waste. Keep lid closed except when filling, and store in flammable storage cabinet. If reusing a 4L bottle, ensure it either contained a compatible chemical or has been cleaned of any residue. The original label must be defaced or removed, and the bottle must be labeled with a waste tag indicating the type of waste it contains. Store in the flammable storage cabinet. When canister or bottle is full submit a Surplus Chemical & "Sharps" Disposal Request Form to EHS.
Non-halogenated organic solvent waste	Acetone, ethanol, isopropanol	Collect in either a safety canister or an empty 4L bottle. If using a safety canister, affix a waste tag to indicate the type of waste. Keep lid closed except when filling, and store in flammable storage cabinet. If reusing a 4L bottle, ensure it either contained a compatible chemical or has been cleaned of any residue. The original label must be defaced or removed, and the bottle must be labeled with a waste tag indicating the type of waste it contains. Store in the flammable storage cabinet. When canister or bottle is full submit a Surplus Chemical & "Sharps" Disposal Request Form to EHS.

Waste	Examples	Disposal Procedure
Biohazardous Waste	Used culture plates/tubes/flasks, disposable pipettes	Collect in an autoclavable bag (typically orange or red). Regularly (e.g. daily) close the top of the bag, place in a secondary container, and use a cart to take it to the autoclave designated for waste. Do not pack waste tightly; penetration of the steam is imperative for effective decontamination. Note – in departments/areas where suitable autoclaves are not available, a specialized waste contractor can be contracted to regularly pick up collected biohazard waste. Contact EHS to initiate this type of agreement.
Biohazardous sharps	Syringes, blades, contaminated broken glass (including Pasteur pipettes) or other sharp objects potentially contaminated with a biohazardous material	Sharps must be collected in a puncture-resistant container designed for sharps collection. When the bin has reached the fill line, the lid must be secured shut. The sharps are classified as biohazardous waste hence forward the Surplus Chemical & "Sharps" Disposal Request Form to Lab Safety Officer for an external vendor “Biohazard” pick-up.
Ethidium bromide waste	Stock solutions	Stained gels and contaminated solid wastes (weigh paper/tray, benchkote) should be collected in a sealable container (e.g. 20L pail with lid, lined with heavy gauge plastic bag & labeled as HAZARDOUS - EtBr WASTE). To dispose of container contents, affix a waste tag and submit a Surplus Chemical & "Sharps" Disposal Request Form to EHS. Stock solutions should be collected in a labeled bottle and stored in a safe location. When necessary, submit a Surplus Chemical & "Sharps" Disposal Request Form to EHS for disposal. Staining solutions can be treated in the same manner as stock solutions or detoxified by chemical reaction or specialized filtration. By-products of the filtration method must be treated as hazardous waste.
Acrylamide	Stock solutions, polymerized gels	Acrylamide monomer (i.e. powder or in solution) must be treated as a hazardous waste. Uncontaminated polymerized gels can be discarded in the regular garbage.

Waste	Examples	Disposal Procedure
Formaldehyde	Formalin preservative, Hi-Di formamide	Formaldehyde is an irritant and a human carcinogen and must be treated as a hazardous waste. Collect in a suitable container, affix tag and when full submit a Surplus Chemical & "Sharps" Disposal Request Form to EHS.

9. Travel Safety

9.1. Security

Traveling abroad for research can be a rewarding experience, but it is important to be familiar with the political and socioeconomic conditions of your destination. Make use of local contacts to gain an understanding of the potential issues that may arise. The University of Guelph's Centre for International Programs provides a great deal of information to ensure safe international travel. Travel advisories issued by Global Affairs Canada provide destination-specific travel information.

9.2. Vehicles

Use of personal vehicles for University business is not recommended. Whenever possible, make use of University-owned vehicles for field work and field trips. Employees, students and volunteers must comply with the University of Guelph policies, procedures and guidelines when driving or using University-owned, leased or rented vehicles while conducting University business. Personal vehicles are not covered under the University's insurance, so if you do intend to use a personal vehicle it is your responsibility to ensure you have appropriate coverage.

Prior to using a University vehicle, submit a Driver Information Profile Form, authorized by the Facility Director, to both Treasury Operations and Transport Services.

If your research requires the transport of dangerous goods, refer to the SOP for further details (currently unavailable).

10. Forms, SOP's and Other Resources

This handbook addresses the basic hazards faced within AAC, and a rudimentary discussion of the types of safety measures that need to be considered. More detailed information on specific procedures and equipment is presented in the EHS policies, and CPES or AAC SOP's.

Commonly used forms are also posted on the AAC website. The table below explains the purpose of the various forms.

Table 2 Commonly used Forms

Form	When do you need this form?
Incident Report Form	You are required to complete an incident report following any injury or spill. It must be signed off by the unit Director and sent to EHS within 24 hours of the incident. You can also use this form to report a near miss of a hazardous condition.
Surplus Chemical & "Sharps" Disposal Request Form	Submit this requisition for chemical or sharps waste pickup to EHS when you have materials ready for disposal.
AAC Safety Orientation Record	The training of new personnel is documented on this form.
AAC Ongoing Safety Training Record	This record is to be updated on a continuous basis as new training is provided.
Laser Registration Form	To identify lasers and laser systems, for which appropriate engineering and/or administrative or procedural controls may need to be implemented, and to be used as a basis for laboratory laser safety inspections.