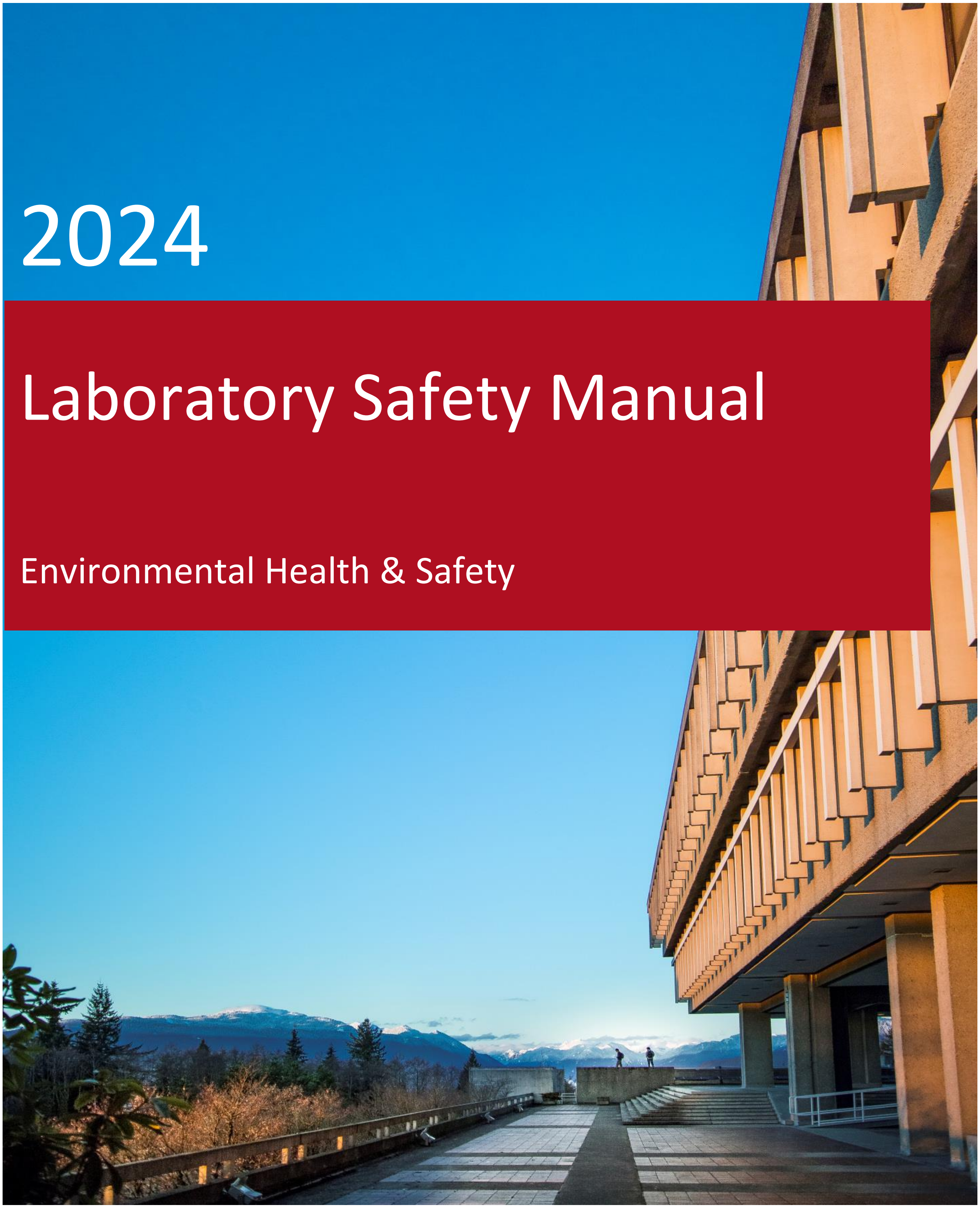
SFU SAFETY & RISK SERVICES
ENVIRONMENTAL HEALTH & SAFETY

2024

Laboratory Safety Manual

Environmental Health & Safety



This document was last updated on February 28, 2024.

SFU SAFETY & RISK SERVICES
ENVIRONMENTAL HEALTH & SAFETY

Record of Changes

Date	Revised by	Revision
February 28, 2024	Carol Wu	Addition of Landline Telephone information.
October 25, 2023	Carol Wu	Updated Chemical Containers and Glass Waste Disposal Protocol.
August 30, 2023	Carol Wu	Complete reformatting of the manual's template. Content updates.

Contact Information

SFU Emergencies

IN AN EMERGENCY CALL 911

Emergency Support/First Aid Line	24 hours/day at any campus	2-4500 or 778-782-4500
Non-Emergency/Safe Walk Line	24 hours/day at any campus	2-7991 or 778-782-7991

Safety Contacts

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Safety Committees

Central University Safety Committees

The Central University Health and Safety Committee is a group representing both workers and the employer working together to improve occupational health and safety in their workplace. They meet on a monthly basis and reports to the Chief Safety Officer. The Central University Health and Safety Committee is responsible for:

1. Addressing health and safety issues within University-wide implications, including health and safety issues arising in public areas.
2. Reviewing University occupational health and safety policies and programs.
3. Overseeing the implementation of Local Safety Committees and addressing issues that are not resolved by these committees.

The Central University Health and Safety Committee promotes communication and information sharing among local safety committees.

Further information and an up to date list of the Central University Safety Committee contacts can be found on the Central University Health and Safety Committee webpage at ***https://www.sfu.ca/srs/work-research-safety/safety-committees/cuhsc.html***

Local Safety Committee

Should you feel that your concerns are not being addressed through the standard channels (i.e. your supervisor, lab coordinator and department chair), the Local Safety Committees meet on a monthly basis and are responsible for:

1. Ensuring that the safety program is maintained and reinforced.
2. Reviewing concerns and suggestions submitted to them by members of their section.

Faculty of Science Safety Committee Animal Care Services, Biology, BPK, Chemistry, Earth Sciences, Mathematics, MBB, Physics, Statistics and Actuarial Sciences, Science Stores and Science Technical Centre. More information can be found on the webpage at ***https://www.sfu.ca/srs/work-research-safety/safety-committees/ljhsc/faculty-science.html***

South East Campus Safety Committee: Communication, Engineering, Computing Science, DISC 1 & 2, Big Data, REM, Major Projects Office and Office of the Dean (Faculty of Environment and Faculty of Applied Science)

North East Campus Safety Committee: Faculty of Health Sciences, Canadian Urban Research Studies, Clinical Psychology Centre, Criminology, First Nation Studies, Psychology, Archaeology, Education, TLC, Cognitive Science Program, English Bridge Program, Geography, Language Training Institute, Linguistics

Surrey Campus Safety Committee: Surrey Central, Surrey Engineeering, PIMS

Further information and an up to date list of your local Safety Committee contacts can be found on the Local Joint University Safety Committee webpage at ***https://www.sfu.ca/srs/work-research-safety/safety-committees/ljhsc.html***

Table of Contents

Laboratory Safety Essentials

University Health and Safety (GP 17)

SIMON FRASER UNIVERSITY
POLICIES AND PROCEDURES

University Health and Safety - GP 17

Full policy and Appendix attachments can be found on the Policy Gazette webpage at ***https://www.sfu.ca/policies/gazette/general/gp17.html***

Incident and Hazard Reporting

Incident Reporting

Immediately report a work related injury to the First Aid Attendant (who may refer you to a physician).

Immediately report an accident or incident (which had a potential for serious injury, time loss or property damage) to your supervisor, who will investigate.

The incident report form is available online or at the Environmental Health and Safety Department (EHS), Safety & Risk Services Discovery 1.

http://www.sfu.ca/srs/report

Examples of incidents include, but are not limited to:

- Situations causing personal injury
- Occupational illness
- Fire, major flooding, or explosion
- Chemical, biological or radioactive spills/escapes/discharges
- Collapse or structural failure
- Motor vehicle collisions/damages
- Near-miss incidents (any of the above)

Responsibilities

Supervisors and Instructors are responsible for:

1. Eliminating or minimizing the hazard
2. Investigating accidents and serious incidents
3. Ensuring that a WorkSafeBC Form 7 is completed and sent to EHS.

The WorkSafeBC Form 7 must be completed when an employee is either absent from work or has visited a physician due to a work related incident.

The top half of the incident report form is completed by the supervisor. If there was potential for major injury, a copy is sent to the local safety committee AND to EHS. If it was a minor incident, the employee and supervisor investigate, complete the form, and then send it to the safety committee and EHS.

The WorkSafeBC Form 7 is available online or at the Environmental Health and Safety Department (EHS), Safety & Risk Services Discovery 1. http://www.worksafebc.com/forms/assets/pdf/7.PDF

Worker

1. Report accidents or near miss incidents to the supervisor
2. Report to First Aid when injured
3. Advise the supervisor when a physician is visited or when absent from work due to a work related injury
4. Co-operate during an investigation
5. Eliminate or minimize a hazard if within capability.

Visitors and Students:

1. Seek First Aid when injured
2. Report accidents to the class supervisor during class time
3. Report accidents, outside of class time, to Campus Security (non-emergency number is local 2-3100).
4. Report near miss incidents experienced during or outside class time, to the class supervisor.

Occupational First Aid:

1. Maintain treatment record books for all work-related injuries, keeping these records for at least five years, and
2. Fill out Form 7 for work-related injuries where an employee is referred to a physician. Forward a copy to the supervisor within 24 hours.

Environmental Health and Safety Department:

1. Review incident investigation reports
2. Recommend appropriate corrective action where necessary
3. Confirm that recommended corrective actions have been taken
4. Investigate serious incidents or near misses
5. Maintain records of all incidents
6. Prepare a monthly incident summary
7. Distribute the monthly incident summary to the Central University Health & Safety Committee

Hazard Reporting

All hazards must be reported.

HAZARDS REQUIRING IMMEDIATE ATTENTION

Contact campus security at your campus.

Examples of situations requiring immediate action include:

a suspicious package appearing in your area, a gas or chemical smell, suspicious person, etc.

HAZARDS IN YOUR DEPARTMENT

This applies to non-emergency situations and includes blocked emergency evacuation routes, poor workstation ergonomics, indoor air quality issues, etc.

Report all hazards to your supervisor who is responsible for investigating and initiating appropriate action.

If your supervisor fails to address your perceived hazard, contact your local joint safety committee or the Environmental Health and Safety Assistant at 778-782-5935 (25935), or email ehs_sfu@sfu.ca.

Working Alone or in Isolation (GP 39)

SIMON FRASER UNIVERSITY
POLICIES AND PROCEDURES

Working Alone or in Isolation - GP 39

Full policy, procedures and Appendix attachments can be found on the Policy Gazette webpage at ***https://www.sfu.ca/policies/gazette/general/gp39.html***

Biosafety (R 20.02)

SIMON FRASER UNIVERSITY
POLICIES AND PROCEDURES

Biosafety - R 20.02

Full policy, procedures and Appendix attachments can be found on the Policy Gazette webpage at ***https://www.sfu.ca/policies/gazette/research/r20-02.html***

Radiation Safety (R 20.04)

SIMON FRASER UNIVERSITY
POLICIES AND PROCEDURES

Radiation Safety - R 20.04

Full policy and Appendix attachments can be found on the Policy Gazette webpage at ***https://www.sfu.ca/policies/gazette/research/r20-04.html***

Emergency Management (GP 31)

SIMON FRASER UNIVERSITY
POLICIES AND PROCEDURES

Emergency Management - GP 31

Full policy can be found on the Policy Gazette webpage at ***https://www.sfu.ca/policies/gazette/general/gp31.html***

Fire Safety (GP22)

SIMON FRASER UNIVERSITY
POLICIES AND PROCEDURES

Fire Safety - GP 22

Full policy and Appendix attachments can be found on the Policy Gazette webpage at ***https://www.sfu.ca/policies/gazette/general/gp22.html***

Landline Telephones

It is strongly recommended that all research and laboratory areas where hazardous substances and equipment are handled have at least one landline telephone, especially in areas with limited cellular coverage.

Emergency contact information (including 911 and Campus Public Safety 778-782-4500) should also be posted in a conspicuous area ideally near the landline telephone.

The use of cellular phones while working with hazardous substances that pose a contamination risk (e.g., chemicals, biohazardous substances, radioactive substances, etc.) is discouraged.

Fire Emergency & Evacuation

When you Discover a Fire

1. Activate the "PULL" station
2. Call 911 if safe to do so
3. Extinguish the fire - only if it is small, and you are trained to do so
4. Remove anyone in immediate danger
5. Close windows/doors to prevent the fire from spreading
6. Evacuate via the nearest emergency exit - do not use the elevator!
7. Proceed to assembly area

Note: If you extinguish a fire, be sure to complete a SFU

incident report and request replacement of your fire extinguisher immediately.

http://www.sfu.ca/fs/Services/Burnaby/Maintenance-Requests.html

http://www.sfu.ca/incidentreporting

When you Hear the Alarm

1. Stop activities
2. Close windows/doors
3. Evacuate via the nearest emergency exit. DO NOT USE THE ELEVATOR!
4. Proceed to assembly area

Fire Evacuation Teaching Staff

Do not re-enter the building unless the "all clear" signal has been given by the fire department or security personnel.

Instructors and teaching staff must give direction to students during an emergency evacuation.

Always identify the following before entering a classroom

- Location of the Fire Alarm
- Location of the Fire extinguishing equipment
- Exit routes
- Refuge areas
- Assembly area(s)

When a fire breaks out in the classroom

- Activate the alarm
- Initiate the evacuation
- Attempt to extinguish the fire only if:
  the fire is small or contained and you are trained in the use of a fire extinguisher.

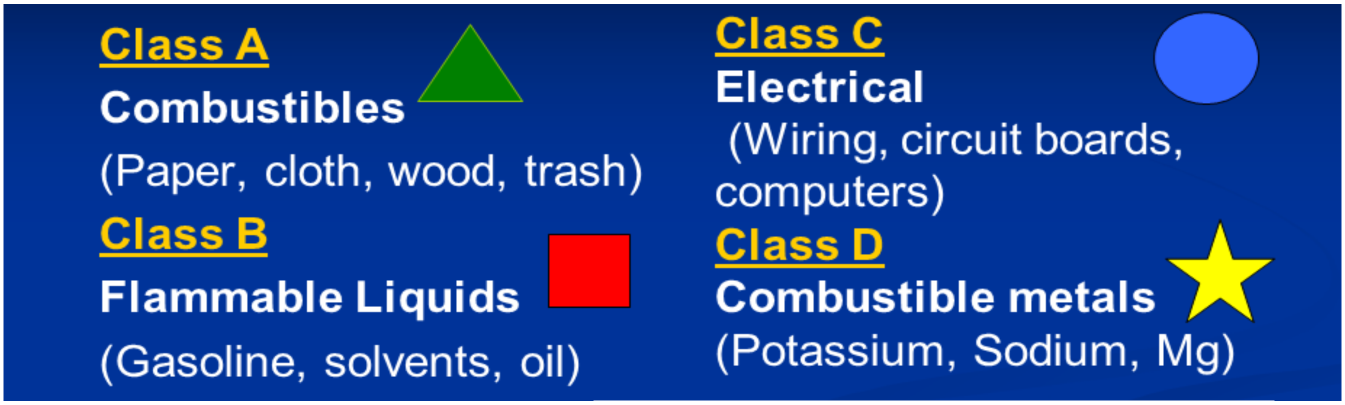
In all other cases, continue with instructions below upon hearing the fire alarm

- Initiate evacuation
- Direct students to the designated assembly area
- Direct or assist students with disabilities to the refuge area
- Close the door after the classroom has been evacuated
- Inform the Building Evacuation Coordinator (who can be found at the annunciator panel) of the disabled students in refuge areas
- Proceed to the assembly area

Disabled Persons

If you are not on the ground floor and are unable to exit the building, proceed to a refuge area. Once you have arrived at the refuge area, you will need to wait for the Fire Department who is equipped and trained to get you down the stairs.

Fire Extinguisher Types and Classification



Firehoses (use 1.5 inch only)				
A FIRES	A			
Dry Chemical Fire Extinguishers				
A&B&C FIRES	A	B	C	
CO_2 Fire Extinguishers				
B & C FIRES		B	C	
Graphite Powder, Some Dry Chemical Fire Extinguishers				
D FIRES				D

Using Fire Exinguishers

Use a portable fire extinguisher only when trained to do so and only on small fires. For example: A garbage can on fire or a fire, which has not yet spread beyond the immediate area.

If you even have to think whether the fire is too big to be extinguished with a portable fire extinguisher, the fire is most likely too big!

Rules when using a portable fire extinguisher

Sound the alarm at a pull station first .

Make sure you can use the extinguisher!

ALWAYS keep your back towards an unobstructed exit and stand at least six feet away from the fire and follow the four-step PASS procedure (See below).

A fire extinguisher only lasts for approximately 10 to 15 seconds. **Never risk your safety**.

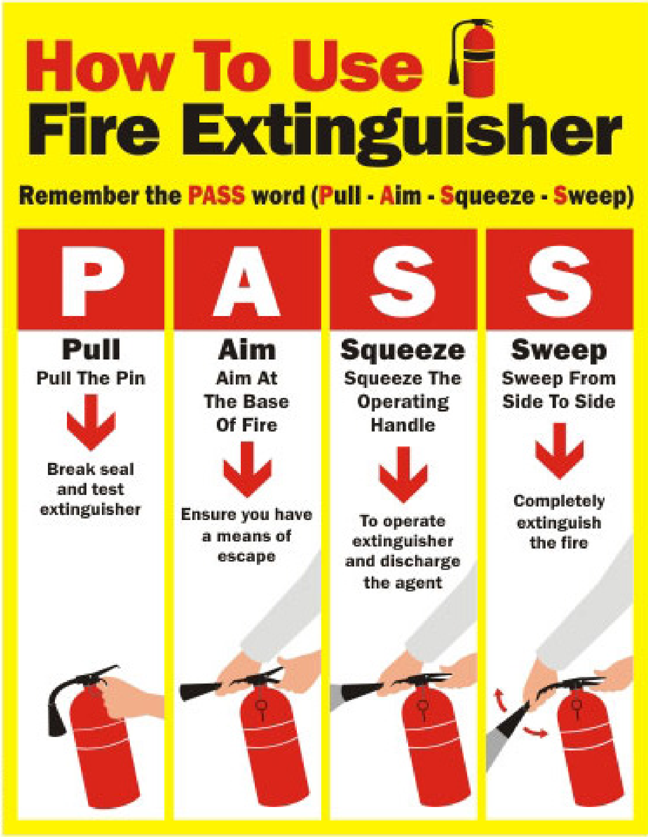
PASS Procedure

PULL - Pull the Pin

AIM - Aim the extinguisher nozzle at the base of the flames

SQUEEZE - Squeeze the trigger while holding the extinguisher upright

SWEEP - Sweep the extinguisher from side to side, covering the area of the fire with the extinguishing agent.



Earthquake Safety in Labs

SFU SIMON FRASER UNIVERSITY
ENGAGING THE WORLD

Earthquake Safety in Labs

Before an Earthquake:

Do a **risk assessment** of your work/study area to determine the best course of action to take in the event of an earthquake. Lab supervisors should conduct a risk assessment of their labs and communicate the results to those who work there. When conducting your risk assessment, please consider the following:

- Assess what hazards would be present in your lab during an earthquake.
- **Pre- identify safe areas** within your lab where you will try to take cover. Consider 2-3 areas that you can quickly crawl to and that are away from:
  - Benches or heavy equipment that could move or shift during an earthquake
  - Hazardous materials or objects that are not secured
  - Breakable items and windows
- Ensure wheels on equipment and carts are in the locked position
- If you identify areas of concern during your risk assessment, be sure to **take action** to remedy problems as soon as possible.

During an Earthquake:

Always follow the internationally recognized **Drop, Cover, Hold-on** safety technique but consider how you may need to adapt this technique based on where you are at the time of the shaking and the results of your risk assessment.

- If you are in a place where the bench areas have been deemed hazardous, based on the risk assessment, **drop** to the ground so you are not knocked over by the shaking and then quickly move to one of your pre-identified safe locations (i.e. the ends of the bench or to the front of the room away from windows)
- No matter where you are **cover** your head and neck with your arms and **hold on** to a stable object in the room so you are not knocked over in violent shaking

Labs at SFU are varied and therefore you must look at the unique aspects of your lab to determine the safest way to protect yourself during an earthquake. The internationally recognized approach of "**Drop, Cover, and Hold on**" should still be followed; however, moving to the end of a lab bench or to the perimeter of the lab may increase safety during an earthquake, depending on the specific hazards present in your lab.

After an Earthquake:

- Move cautiously as objects may have shifted in the shaking and may pose obstacles to maneuvering around the room
- Turn off gas or other valves (if possible these should be turned off as soon as any shaking is felt)
- If there are known hazardous materials in the room that may have been released during the earthquake, evacuate the area immediately but move cautiously.
- Move outdoors away from buildings as **aftershocks may occur**.
- Do not re-enter the building until it has had a damage assessment and been given the ok by First Responders, Facilities, health and safety and security staff.
- Make sure you **check in** with the building evacuation coordinator/fire warden or your supervisor before leaving the area so that you can be accounted for and so they know you are safe.

For more information about Earthquake Safety visit: https://www.sfu.ca/srs/risk-emergency-planning/emergency-preparedness/emergency-procedures/earthquake.html

Developed by:
The Faculty of Science Safety Committee, the South East Campus Safety Committee, Environmental Health & Safety and Emergency & Continuity Planning

Working Safely with Hot Plates, Heat Guns and Oil Baths

Hot plates, heat guns and oil baths can produce temperatures high enough to ignite combustibles. Several fires have resulted at SFU from unsafe practices when working with heating equipment. Please incorporate the following safe work practices into your risk assessment and laboratory procedures.

Mandatory Safe Work Practices

- Unplug heating equipment when not in use and ensure electrical cords do not come in contact with hot surfaces.
- When the temperature setting on heating equipment is changed or adjusted, the researcher must monitor the temperature until the reaction mixture, oil/heat bath and equipment has thermally equilibrated.
- Do not heat material in a closed container unless the container or vessel is specifically designed to withstand high pressures. Always follow manufacturers' specifications.
- Do not use working fume hoods for storage (i.e. fume hoods that are not labelled for storage only) and use the minimum quantity of flammable and combustible materials required for the experiment.
- Work areas must be clean and free of clutter.
- Familiarize yourself with the location of fire extinguishers and the shortest evacuation route to the nearest emergency exit. Contact EHS to get trained in using a fire extinguisher. Only use a fire extinguisher if you have been trained and the fire is small and contained.

Laboratory Hot Plates

On many brands of combined stirrer/hot plates, the controls for the stirrer and temperature control are not easily differentiated. Care must be taken to distinguish their functions. A fire or explosion may occur if the temperature rather than the stirrer speed is increased inadvertently.

Heat Guns

Never leave a heat gun unattended! The heating element in a heat gun typically becomes red-hot during use and, necessarily cannot be enclosed. The on/off switches and fan motors are not usually spark-free and heat guns are designed to pull lab air into and across the red-hot heating element. This combination increases the risk of ignition. Keep a heat gun away from nearby solvents or other flammable materials.

Oil Baths

Where possible, researchers should use heating mantles, sand baths or bead baths instead of oil baths. If an oil bath is necessary, care must be taken with hot oil baths not to generate smoke or have the oil burst into flames from overheating. Always monitor an oil bath by using a thermometer or other thermal sensing device to ensure that its temperature does not exceed the flash point of the oil being used. The researcher should consider requiring the use of external feedback monitoring and control of temperature (i.e. maximum temperature is set on a digital display).

Equipment

- Keep equipment in good repair and check before each use. If you have any concerns contact the Electronics Shop in room Shrum Science Centre C8008 or at 778-782-3303. See page 14 for more information about the Electronics Shop.
- Equipment not up to standards must be tagged and removed from service. The equipment must only be returned to service once repaired by a certified technician and must operate according to the manufacturers' instructions.
- Use the right tool for the job: Use combination hot plate/stirrers only when both stirring and heating are required; if heating is not required, use a dedicated stirrer.

Electricity

Energized equipment can be very dangerous

- You can be killed or maimed by electrical energy that is not well controlled.
- If you are not confident of your ability to work safely with a piece of electrical or electronic equipment, don't do it. Obtain assistance or training.

Common equipment safety design features

- Three wire ground circuit
- Double insulation
- On-off switches
- Fuses and circuit breakers
- GFCI (ground fault current interrupter)
- AFCI (arc fault current interrupter) * New *

Avoiding exposure to electrical hazards

- Use well-grounded or double insulated equipment.
- Don't open enclosures of energized electrical equipment.
- Avoid using electrical equipment under wet conditions (unless the equipment is designed to be used under such conditions). GFCI outlets should be installed in wet labs.
- Avoid the unnecessary use of extension cords or outlet boxes. Don't daisy chain electrical cords.

- Don't use damaged power cords.
- Unplug equipment before working on it.
- Don't overload outlets, or extension cords.
- If equipment sparks, smokes or shocks, repair it.
- Replace fuses only with the correct type.
- Use common sense. Stop. Think. Is it safe?

Need Help?

If you are making or want to make some electrical device and need some help or advice, come and talk to us at the Electronics Shop, Shrum Science Centre room C8008 or local 2-3303 If you have modified or repaired some equipment yourself, please bring it to the Electronics Shop where we can inspect it and certify that it is safe to use. In the Electronics Shop, we can repair almost any device that runs on electricity.

Type of Contact	Ohms
Dry Skin	100,000 to 600,000
Wet Skin (fresh Water)	1,000
Internal Body	400 to 600

Table 1: Human resistance to electrical current.

Effect	DC mA	AC(60Hz) mA	AC (10 kHz) mA
Slight sensation	0.6	0.3	5
Threshold of perception	3.5	0.7	8
Painful, muscle control maintained	41	6	37
Painful, unable to let go of wires	51	10.5	50
Severe pain, difficulty breathing	60	15	63
Possible heart fibrillation after 3 seconds	500	100	

Table 2: Effect of current on human body.

Ohm's Law

E volt [V] ÷ **R** ohm [Ω] = **I** ampére [A]

Dry: 110 V ÷ 100,000 Ω = 0.0011 A = 1.1 mA

Wet: 110 V ÷ 1000 Ω = 0.11 A = 110 mA

Overloaded Outlets

Most 110V wall outlets are rated for 15A maximum. This allows a quick calculation of how many Watts you may draw from that outlet. [Watts = Volts x Amps. W = 110 x 15 = 1650 Watts]. To be safe, we should round that number down to 1500 Watts. If we take 1500 Watts as our self imposed limit and solve the above equation for Amps, we can calculate that we should try not to exceed drawing more than 13.6 Amps [A = W/V, A = 1500/110 = 13.6].

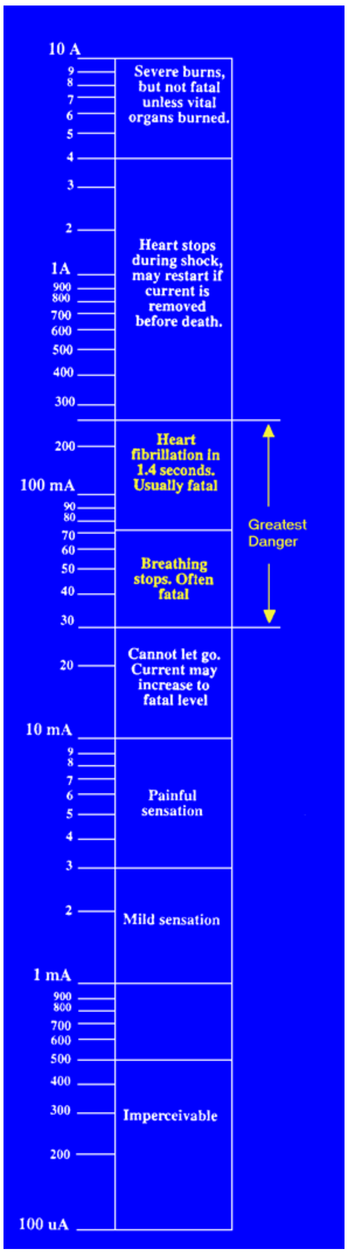
Electrical appliances you plug in to the wall outlet will usually be labeled with how many Amps the device will draw when operating. If they are not labeled, check the instruction manual. If you add up all the Amps from all the loads and you get more than 13, you are getting very close to overloading the outlet. Some examples are shown in the following table.

Device	Current, A	Watts, W
17 inch computer monitor	1.5	165
typical desktop computer	2.3 – 2.8	250 - 300
electric kettle	13.6	1500
microwave oven	13.2	1450
laser printer	8	880
desk lamp (incandescent)	0.9	100
desk lamp (fluorescent)	0.3	22

Table 3: Typical loads for equipment

Outlet Extension Devices or Power Bars are usually rated at 15A maximum. So all the above discussion applies. You really should not attempt to draw more than 13.6A through a power bar.

Another error that people sometimes make is attempting to plug two power bars into the same wall outlet which commonly has two sockets. Both power bars are rated for 15A and they think this means they can safely draw 30A from the same wall outlet. In most cases, the two sockets on a standard 110V wall outlet are connected together and the combined total current for the two sockets together is still 15 Amps.



Currents between 30 and 250mA are most likely to be fatal.

This is based on normal adult body weight. For smaller people, especially children, the effects occur at lower current levels. The effects also depend upon the path the current takes through the body. Currents passing through the heart and diaphragm are most dangerous.

Electrical Certification

In accordance with the BC Electrical Safety Regulation (2004), all electrical equipment, including medical devices, must contain a certification mark as indicated by the British Columbia Safety Authority. To determine whether a piece of equipment has an approved certification mark, please refer to the Technical Safety BC webpage:

https://www.technicalsafetybc.ca/regulatory-resources/regulatory-notices/approved-certification-marks-electrical-products

Examples of approved certification marks:

If a piece of equipment does not have an approved certification mark, Intertek Testing Services, located in Coquitlam, can certify the equipment for a fee. Intertek's phone number is 604-520-3321.

Please note that battery operated equipment does not require electrical certification. However, the associated battery charger must contain a Technical Safety BC approved certification mark.

For more information see the EHS website:

https://www.sfu.ca/srs/work-research-safety/research-safety/other-research/electronic-devices.html

Field Research

Field Research is defined as work activities conducted primarily for the purpose of research undertaken by employees or students of the university beyond the geographical boundaries of the university property.

Researchers who authorize research activities in the field are required to assess the risks of the research activities, mitigate risks, ensure researchers have the appropriate training to undertake the work tasks, and adequate personal protective equipment. Research team members should be informed of the risks. In addition, field teams should have adequate training in first aid, first aid supplies and a written procedure for securing assistance in an emergency.

Items to consider BEFORE performing Field Research:

Transportation

- Transportation of Dangerous Goods (certification, placards, etc.)
- Ground (insurance, maintenance, SFU Vehicle and Drivers Policies)
- Air (pilot instructions and communication)
- Water (personal safety equipment, communication, boating safety and certification)

First Aid

- Occupational First Aid (WorkSafeBC)
- Wilderness/Survival First Aid
- Accident/Emergency plan
- Medical Information forms for all field personnel

Outdoor Preparedness/Camping

- Maps and navigation
- Equipment and clothing
- Food and water
- Being Bear Aware and other wildlife
- Fire safety
- Private Property
- Private/Industrial Camps
- Parks and Crown Land

Potential Conditions

- Working in remote areas/working in isolation (include check-in procedures)
- Wet/Arid/Hot/Cold (clothing and equipment considerations)
- Ice and snow (hypothermia, avalanches, glaciers (crevasses), …)
- Steep slopes/Uneven terrain
- Landslides/Debris flows
- Abandoned mines/Caves
- Flowing water/Floods (swimming, drowning, cold water, …)
- Trench/Pit Safety
- Confined spaces
- Industrial activity (logging, mining, blasting, construction, …)

Other

- Train Safety (working near rail lines)
- Electrical Safety (especially high voltage lines)
- Firearms Safety
- Chainsaw Safety
- Hunting Season

Planning and documentation tools

EHS has developed a planning guideline document and a template for generating a planning record.

On request, we will also assist you with risk assessment, first aid training and procedures for securing emergency assistance. For assistance email fsac@sfu.ca.

https://www.sfu.ca/srs/work-research-safety/research-safety/field-safety.html

Laboratory Safety

Hazard Identification

WHMIS 2015 – Workplace Hazardous Materials Information System

WHMIS is a comprehensive system for providing health and safety information on the safe use of hazardous products in Canadian workplaces. Recent changes in federal and provincial legislation have updated WHMIS, now known as WHMIS 2015, to reflect alignment with the worldwide hazard communication system known as GHS - the globally harmonized system of classification and labelling of chemicals.

Hazard classification

WHMIS 2015 defines two major groups of hazards: physical and health. In each hazard group, there are several specific hazard classes, which can be further broken down into categories and sub-categories, which represent levels of severity. Some classes are broken down into types.

Pictograms

Most hazard classes and categories or types have a prescribed pictogram. Pictograms relate to the severity of the hazard. For example, the hazard class Flammable liquids, category 1, 2 or 3 will have the 'flame' pictogram, but Flammable liquid, category 4, will not.

	Pictogram	Hazard Classes
PHYSICAL HAZARDS		Self-reactive (type A and B) Organic peroxides (type A and B)
		Flammable aerosols, gases, liquids and solids Pyrophoric gases, liquids and solids Self-heating substances and mixtures Substances and mixtures which, in contact with water, emit flammable gases Self-reactive substances and mixtures Organic peroxides
		Oxidizing gases, liquids and solids
		Gas under pressure - compressed gas - liquefied gas - refrigerated liquefied gas - dissolved gas
		Corrosive to metals

	Pictogram	Hazard Classes
HEALTH HAZARDS		Acute toxicity, oral Acute toxicity, dermal Acute toxicity, inhalation
		Carcinogenicity Respiratory sensitization Reproductive toxicity Specific target organ toxicity Germ cell mutagenicity Aspiration hazard
		Acute toxicity Skin corrosion/irritation Serious eye damage/eye irritation Respiratory or skin sensitization Specific target organ toxicity - single exposure
		Serious eye damage/eye irritation Skin corrosion/irritation
		Biohazardous infectious materials

Table 1. WHMIS 2015 pictograms and hazard classes

Labels

All hazardous products in the workplace must be labelled. It is also advisable to label non hazardous products in the lab to ensure everyone knows what is hazardous and what is not.

A supplier label must appear on all products distributed or sold in Canada. It will include the product identifier, the product pictograms (if applicable), a standard signal word "Warning" or "Danger", standard hazard statements, precautionary statements and the supplier identifier.

A workplace label is the responsibility of the users of the product and is applied in the following situations:

- chemicals are transferred from their original container
- solutions are prepared in the lab
- original product label is missing or illegible

The workplace label must contain the following elements:

a. product identifier

b. safe handling information (e.g., hazards associated with the product and basic precautions)

c. referral to the Safety Data Sheet (SDS)

Hazard Identification

Safety Data Sheets (SDSs)

Previously called Material Safety Data Sheets, these are detailed technical documents created by the manufacturer or supplier of a hazardous product. Electronic or paper copies should be accessible in your lab for every hazardous product used or stored there.

Each safety data sheet is valid for 3 years, so if you keep paper copies, remember to update them.

SDSs follow a standard 16 section format:

1. Identification
2. Hazards identification
3. Composition/information on ingredients
4. First aid measures
5. Firefighting measures
6. Accidental release measures
7. Handling and storage
8. Exposure controls/personal protection
9. Physical and chemical properties
10. Stability and reactivity
11. Toxicological information
12. Ecological information
13. Disposal considerations
14. Transport information
15. Regulatory information
16. Other information

SDS Glossary

Refer to the following table for terms and acronyms commonly found in an SDS.

ACGIH	American conference of governmental industrial hygienists
autoignition temperature	the temperature at which a vapour ignites spontaneously without an ignition source
flash point	the minimum point (or temperature) at which a compound gives off sufficient vapour to ignite in air when given an ignition source (spark or flame)
IARC	International Agency for Research on Cancer
IDLH	immediately dangerous to life and health
LC50 Lethal concentration	concentration of material in air that kills 50% of the test animals during a set period of observation (usually 4 hours)
LD50 Lethal dose	amount of material, given all at once, that causes death in 50% of a group of test animals
LEL/UEL	lower or upper explosive limit expressed as a % concentration in air
OEL	occupational exposure limit stated by WorkSafeBC.
PEL	permissable exposure limit
TLV-C	threshold limit value ceiling exposure limit to never be exceeded
TLV-STEL	threshold limit value short term exposure limit for a 15 minute exposure
TLV-TWA	threshold limit value time weighted average exposure limit for an 8 hr (day) or 40 hr (week) exposure

Table 2. SDS terms and acronyms

Electronic access to SDSs

SFU subscribes to the online SDS service offered by the Canadian Centre for Occupational Health and Safety (CCOHS). The CCOHS SDS database can be accessed here:

https://sds.ccohs.ca/#/

CCOHS covers an extensive list of suppliers with the notable exception of Sigma-Aldrich products. The SDS from this supplier can be found at www.sigmaaldrich.com.

Education and training

All SFU employees who work where hazardous products are used, stored or handled must receive training and education related to WHMIS. Basic background information about WHMIS is provided by EHS through an online WHMIS 2015 module, available on Canvas.

https://canvas.sfu.ca/enroll/33KWC8

Furthermore, all users of WHMIS products must also receive training and education specific to their lab about:

- procedures for the safe use, storage, handling and disposal of the hazardous product
- procedures to be followed if the hazardous product releases/spills
- procedures to be followed in case of an emergency involving the hazardous product.

Additional training specific to the hazardous product and how it is used in the lab must be provided by the employee's supervisor.

Four key questions

As a result of the training and education you receive, you should be able to answer the following questions for every product you work with:

1. What are the hazards of the product you are using?
2. How to you protect yourself from that product?
3. What should you do in case of an emergency or spill?
4. Where do you get more information about this product?

Other symbols and pictograms

You should recognize the other pictograms and symbols that may be on products in your lab. WHMIS 1988 (the previous version of WHMIS) pictograms and hazard classes can be found at https://www.ccohs.ca/oshanswers/legisl/whmis_classifi.html. The following page shows the symbols associated with consumer or household hazardous products.

Hazard Identification

Public Services Health & Safety Association™

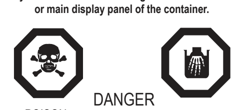
CONSUMER PRODUCT SYMBOLS

These warning labels are used for household, science education kits and special products

	Hazard Category	Precautions	Degrees of Hazard	Label Warning
TOXIC PRODUCT 	**Poisonous** May be lethal. *or* May cause serious and irreversible effects.	Do not get in eyes or on skin. Do not breathe fumes. Wear protective clothing and safety equipment as indicated on the label.	**Very toxic** **Toxic** **Harmful**	- Extreme Danger - Sales Restricted - Danger - Caution
CORROSIVE PRODUCT 	**Causes Burns** Will cause chemical burns to the skin, eyes and lungs. May form dangerous fumes when mixed with other chemicals.	Do not mix with other chemicals. Do not get in eyes or on skin. Do not breathe fumes. Do not swallow. Wear protective clothing as indicated on the label.	**Very Corrosive** **Corrosive** **Irritant**	- Extreme Danger - Danger - Caution
FLAMMABLE PRODUCT 	**Fire hazard** May ignite if exposed to a spark or flame or May spontaneously ignite	Read the specific instructions on the label. Use only in well ventilated areas. Keep away from flames and objects that spark. Store in a safe location.	**Very Flammable** **Flammable** **Spontaneously Combustible**	- Extreme danger - Danger - Caution
PRESSURIZED CONTAINER 	**Explosion Hazard** Under Pressure may explode if heated. If ruptured hazardous contents will be released	Do not puncture. Do not burn. Store away from heat.		
QUICK SKIN BONDING ADHESIVES	**Bonds Skin Instantly**	Do not get in mouth, eyes or on skin.		

Example of Consumer Labelling

The symbols and hazard warnings must be on the front or main display panel of the container.



These warnings may be located in a border anywhere on the displayed part of the container.

English	Français
warnings, precautions, first aid, and hazardous ingredients	avertissements, précautions, premiers soins, et ingrédients dangereux

For More Information:

Health & Safety Ontario | ESAO The Education Safety Association of Ontario | Municipal Health & Safety Association | Ontario Safety Association for Community & Healthcare

Public Services Health & Safety Association 4950 Yonge Street, Suite 902, Toronto ON M2N 6K1 416-250-2131 or 1-877-250-7444 www.pshsa.ca

ODCCP-POSAEN010810

Hazard Inventory System

Purpose

The Laboratory Hazard Inventory System allows SFU labs or any area on campus with hazardous chemicals to maintain and manage their chemical inventories, and to create related chemical hazard door signage.

Getting started

Log in to the system, accessible online at:

labhazindex.its.sfu.ca

Search for your lab group and request to join. Lab groups are generally named for the Supervisor (e.g., Smith lab group.) If unsure about the lab group name, check with your Supervisor. If your lab group has not yet been created, contact your department administrator or EHS.

Once a lab group is established, components are added in the following order (order is important):

1. Members are added
2. Rooms are added
3. Inventory is created

Once the lab's chemical inventory has been created, then the chemical hazard door sign can be printed.

What to include in your inventory?

Hazardous items that should be inventoried include flammables, explosives, oxidizers, corrosives, gas cylinders, and chemicals causing serious health effects. Non-hazardous items, for example, buffers, salts, amino acids, sugars, and growth media, do not need to be included in the inventory.

When to update your inventory?

EHS recommends keeping your chemical inventory up-to-date on an ongoing basis (e.g., by ensuring all incoming items are entered in the inventory and all depleted or unwanted items are removed from the inventory in a timely fashion). Keeping your inventory up-to-date provides economical and environmental benefits: it reduces chemical waste and overpurchasing.

High Hazard Chemicals

When entering in chemicals that are peroxides, peroxide forming, pyrophoric, and/or explosive into the inventory system, it will automatically be flagged as a high hazard chemical. Precautions should be taken when handling these chemicals.

What else can I do with the inventory system?

It can also be used to facilitate sharing of chemicals between labs, as approved members of a lab group can search for a desired chemical elsewhere on campus, which can reduce overpurchasing and chemical waste from disposal of unused reagents. If you require only a small amount of material, use the global (all SFU or your department only) inventory searches to help you locate the chemical needed. You can then contact the lab to request some.

Annual Review

Once an inventory is established, it must be reviewed at least annually to ensure it accurately reflects the chemicals in the lab. This review will serve as a reminder to:

- check chemicals with limited shelf lives;
- identify and remove expired or unwanted chemicals;
- check the integrity of all storage vessels for cracks, aging or leaks; and
- prevent the unnecessary purchase of chemicals which are already on hand.

If you have any questions about the SFU Laboratory Hazard Inventory System, contact Miles Garcia in EHS at miles_garcia@sfu.ca.

Laboratory Door Signage

Purpose

The SFU door signage program provides emergency responders with information about the hazardous materials and equipment in a room so that they can plan a safe entry response in the event of an emergency. Without this information, they may not risk sending crews into rooms where the hazards are unknown, or they may create unnecessary damage to equipment and research.

Chemical hazard sign

This signage is mandatory for spaces that have hazardous chemicals. It is also used for areas without chemical hazards but who wish to display emergency contacts for the lab.

Emergency contacts must be familiar with the hazardous materials present and the activities of the lab, and be available by phone, including during evenings and weekends. During an emergency or incident in the lab, emergency contacts will be called and asked to provide crucial information for internal and external responders.

Chemical hazards present in the lab are represented by the NFPA (National Fire Protection Association) diamond and the WHMIS pictograms. The NFPA ratings for chemicals are weight averaged and they indicate the health (blue), flammability (red) and reactivity (yellow) hazards of chemicals present, whereas the number in white is an indicator of quantity. Each number is on a scale from 0 (no hazard/none) to 4 (severe hazard/high quantity).

How do I generate a Chemical hazard door sign?

These signs are generated in the SFU Laboratory Hazard Inventory System, available online at: labhazindex.its.sfu.ca.

When does the Chemical hazard sign need to be updated?

The sign should be updated whenever laboratory contacts change or when there is a significant change to the type and quantity of chemicals in the lab. At minimum, the sign must be reprinted on an annual basis.

Additional signage

<u>Biohazard</u> This orange and black sign is only for labs requiring level 2 containment for the organisms they are working with. Level 1 labs do not require a biohazard sign but must still comply with applicable requirements.

<u>Radiation</u> This red and yellow trefoil identifies areas containing radioisotopes. Contact the Radiation safety for more information or signage.

<u>Wet Mopping</u> For rooms with a biohazard or radioactive sign, wet mopping will only be provided if it has been pre-arranged for a designated night, and if the wet-mop sign is displayed on that night. By displaying the wet-mop sign, you are ensuring the cleaning staff that there are no biohazardous or radioactive contaminants on the floors. On your designated night of each two-week period, the cleaning staff will check your door plaque for the wet-mop sign; if no wet-mop sign is displayed on your designated night, the cleaning staff will not wet mop your lab, but they will still collect regular trash and dry mop the lab.

<u>No Entry/No Janitorial Service</u> This sign is used to restrict access to a lab by janitorial staff. It is useful for restricting entrance due to light sensitive reactions, as well as equipment and safety concerns. Lab occupants are responsible for managing the use of this sign, as it can be added or removed from the door plaque as needed. Note that when this sign is in place, janitors will not enter the room for any reason, so garbage and recycling bins should be left in the hall for collection.

<u>Other Signage</u> Laser, magnet, and X-ray signs are also available to slide into the door plaques.

Custom Signage

If custom signage is needed for a lab, contact EHS.

Restricted access

Service personnel (Facilities Services, Contractors, Janitors and Campus Safety & Security Services) are required to enter rooms for repair, renovation, cleaning and routine maintenance. There are rooms where immediate entry by service personnel may pose a hazard to the individual or occupant, or may compromise specific security or safety protocols which are in place.

When this sign is posted, service personnel must contact the responsible parties displayed directly on the sign itself or those listed on the hazardous chemical sign (if present). Do not enter the room without an escort.

To obtain a Restricted Access sign, contact miles_garcia@sfu.ca.

More information

https://www.sfu.ca/srs/work-research-safety/research-safety/lab-safety/signage.html

Carcinogens

IARC - International Agency for Research on Cancer

Category 1

For substances for which there is sufficient evidence for a causal relationship with cancer in humans (confirmed human carcinogen).

Category 2A

For substances for which there is a lesser degree of evidence in humans but sufficient evidence in animal studies, or degrees of evidence considered appropriate to this category, e.g. unequivocal evidence of mutagenicity in mammalian cells (probable human carcinogen).

Category 2B

For substances for which there is sufficient evidence in animal tests, or degrees of evidence considered appropriate to this category (possible human carcinogen).

Category 3

Excluded from the list above are IARC category 3 carcinogens for which assessment evidence is 'limited'.

ACGIH - American Conference of Governmental Industrial Hygienists

A1 Confirmed human carcinogen

The agent is carcinogenic to humans based on the weight of evidence from epidemiologic studies.

A2 Suspected human carcinogen

Human data are accepted as adequate in quality but are conflicting or insufficient to classify the agent as a confirmed human carcinogen; or, the agent is carcinogenic in experimental animals at dose(s), by route(s) of exposure, at site(s), of histologic type(s), or by mechanism(s) considered relevant to worker exposure. The A2 is used primarily when there is limited evidence of carcinogenicity in experimental animals with relevance to humans.

A3 Confirmed animal carcinogen with unknown relevance to humans

The agent is carcinogenic in experimental animals at a relatively high dose, by route(s) of administration, at site(s), of histologic type(s), or by mechanism(s) that may not be relevant to worker exposure. Available epidemiologic studies do not confirm an increased risk of cancer in exposed humans. Available evidence does not suggest that the agent is likely to cause cancer in humans except under uncommon or unlikely routes or levels of exposure.

A4 Not classifiable as a human carcinogen

Agents which cause concern that they could be carcinogenic for humans but which cannot be assessed conclusively because of a lack of data. In vitro or animals studies do not provide indications of carcinogenicity which are sufficient to classify the agent into one of the other categories.

A5 Not suspected as a human carcinogen

The agent is not suspected to be a human carcinogen on the basis of properly conducted epidemiologic studies in humans. These studies have sufficiently long follow-up, reliable exposure histories, sufficiently high dose, and adequate statistical power to conclude that exposure to the agent does not convey a significant risk of cancer to humans; or, the evidence suggesting a lack of carcinogenicity in experimental animals is supported by mechanistic data.

OSHA - Occupational Safety and Health Administration (US Dept. of Labor)

Group R

OSHA regulated carcinogen (may require medical or biological monitoring)

Group S

OSHA select carcinogen

Natural Gas Hazards

Detection Response

If you open a door and smell gas in the room, or if you are in a room, smell gas, and cannot shut it off, then proceed with step 1.

1. Evacuate room and close door.
2. **Only in the Shrum Chemistry, South Science Building and TASC 2**:
   Press the nearest gas shut off button on the appropriate side of the hallway (this shuts off all gas to that quadrant of rooms).
3. Notify the Facilities Services desk (local 2-3582) that there may be a gas leak.
   Or for Shrum Chemistry, SSB and TASC 2:
   Notify Facilities Services that the gas was shut off due to a potential leak and needs to be reset.
4. During off hours, call security at 2-4500 and they will contact Facilities Services.
5. Notify room occupants on that quadrant that the gas has been shut off.

Chemical Spill Response

Information

1. Advise lab occupants of the spill and evacuate the area.

2. Notify your supervisor and/or lab coordinator of the spill. Provide details such as quantity spilled and chemical name.

Risk Assessment

3. Conduct an initial risk assessment to determine if:

   (i) building evacuation is required. If yes, pull the fire alarm and call 911.

   (ii) external resources are required to contain and clean-up the spill. If not, continue with step 4.

Clean-Up

4. Ensure the spill area has adequate ventilation to clear gases or vapours generated during the neutralization process. If there is a potential for gases to concentrate in the area, or if odours are overpowering, leave, mark the door, and contact security at **2-4500**.

5. Wear appropriate personal safety equipment such as safety glasses, a lab coat and gloves.

6. Select the appropriate neutralizer or vapour inhibitor.
   Spill-X-A for acid spills
   Spill-X-C for caustic spills
   Spill-X-S for solvent spills.

7. Apply the powder around the edge of the liquid.

8. Sprinkle the powder toward the centre. With a plastic dustpan and brush, push the powder toward the centre until all liquid is absorbed. If necessary, add more neutralizing powder.

9. If cleaning up a solvent, proceed to step 13.

10. For acids and caustics, use a spatula to place a small quantity of mixture into a beaker of water.

11. Stir the mixture and test with pH paper. The pH should be between 3 and 10.

Disposal

12. When neutralization is achieved, scoop the mixture with a dustpan into a disposal bag.

13. Rinse the spill area with water and wipe up.

14. If uncertain about disposal, contact your supervisor or Environmental Health and Safety.

15. Disposal will vary depending on the liquid neutralized. After neutralization, some liquids produce a mixture which can go to landfill. Other liquids retain toxic properties and must be handled as special waste. For example, chromic acid can be neutralized but not detoxified.

Documentation

16. Complete and SFU incident report form. http://www.sfu.ca/srs/report

17. If an employee visited a physician, or was absent beyond the day of the incident (due to the incident), then the supervisor must complete a WorkSafeBC Form 7.

Chemical Spill Kit

Recommended items to include in a chemical spill kit:

- Spill Response Procedures
- Spill – X neutralizer for acid, caustic and solvent spills
- Dust pan and broom
- 20 L plastic pail
- Garbage bags
- Disposable Nitrile gloves
- Safety goggles
- pH paper
- Small glass beaker

The majority of these items can be purchased at Science Stores.

For biohazardous and radioactive spills, refer to their respective manuals for spill response procedures.

https://www.sfu.ca/srs/work-research-safety/research-safety/biosafety/program-manuals.html

https://www.sfu.ca/srs/work-research-safety/research-safety/radiation-safety/program-manuals.html

Mercury Spill Response Procedure

Mercury spill response procedure

EHS is equipped with a specialized mercury spill kit. Contact EHS for assistance.

	SFU Local
Director, Research and Laboratory Safety	2-7265
Program Manager, Chemical Safety & Hazardous Waste	2-8633

Overview

Mercury is a very toxic heavy metal. Primary routes of exposure are skin absorption and inhalation, since mercury will vaporize at room temperature. Mercury is not considered a skin irritant but with long term exposure can lead to allergic skin reaction. It is a developmental hazard and may harm the unborn child, but is not considered a reproductive toxin or carcinogenic.

Small spills (no more than a few milliliters) may be cleaned by lab personnel with assistance from EHS. For large spills or if you are unsure about safely cleaning up a spill, then evacuate the lab, restrict access and contact Campus Security at 778-782-4500.

Initial response

- Notify lab occupants of the mercury spill.
- Evacuate lab. Mercury is volatile at room temperature and releases vapour that is colorless, odorless, tasteless and toxic.
- If possible, shut off room heat and any heat-producing equipment. Vapourization is increased at elevated temperatures.
- Post a "do not enter" sign on the door.
- Advise your supervisor and/or department lab coordinator of the spill.
- Contact EHS at numbers above for the mercury spill kit and for assistance. If EHS cannot be reached, call Campus Security and ask for EHS to be contacted.

Mercury spill kit contents

EHS maintains two mercury spill kits at Burnaby campus. They contain:

- Disposable latex gloves (box)
- Eye goggles (1 pr)
- N95 respirators* (2)
- Shoe covers
- Flashlight
- Large trash bag (1)
- Clear plastic bags, 3 mil (6)
- Chemical waste labels
- Duct tape
- Caution tape
- Pasteur pipettes and bulbs (5)
- Glass vials with screw caps (4)
- Cardstock/playing cards

- MerconSpray™
- MerconWIPES™
- Mercon aspirator (only in DISC1 kit)
- Mercury spill response procedure
- Safety Data Sheet (SDS) for MerconSpray™
- SDS for MerconWIPES™

Mercon™ is a line of mercury vapour-suppressing products which convert elemental mercury to more stable non-vapour producing salts (e.g., mercuric sulfide or mercuric iodide).

**Note: N95 respirators are intended to protect against MerconSpray™ aerosol, not mercury vapour.*

Additional items (not included in the kit) may be sourced at the lab:

- Protective clothing (lab coat)
- Disposable nitrile gloves
- Paper towel

Mercury cleanup

Do NOT attempt to clean up a mercury spill on your own. Use the EHS mercury spill kit and the procedure below. A minimum of two people are needed: one person cleaning and one helper.

1. Remove jewelry because it can form bonds with the mercury.
2. Don personal protective equipment: lab coat, gloves (2 pairs), safety goggles, N95 respirator and shoe covers (if contamination is suspected on floor). Note: one pair of disposable latex + one pair of disposable nitrile gloves are recommended, but 2 pairs of either may be substituted.
3. Spray the ambient air zone above the spill with MerconSPRAY™. Spray generously (18-20 pumps), starting at the breathing level and working down towards the floor/affected area, concentrating on the actual spill itself.
4. Cover all visible mercury with MerconSPRAY™ solution, leaving a wide margin for any unseen mercury beads. Ensure that any cracks in the flooring are saturated with the solution to suppress any mercury beads that may be out of sight. CAUTION: After applying MerconSPRAY™ floor may be slippery.
5. Prepare plastic bag for waste. If needed, one plastic bag can be cut open to create a plastic sheet to place under the waste bag.
6. Carefully pick up any broken glass and smaller debris using pieces cardstock or playing cards and transfer to waste bag. Avoid pushing mercury beads into cracks or crevices.
7. Collect all visible beads of mercury using either a Pasteur pipette, the Mercon aspirator tool or duct tape. A flashlight will help illuminate any small droplets. If the mercury has spilled onto carpeting or other porous items, these must be disposed as hazardous waste. The affected area of contaminated carpet should be cut out and double bagged.

8. If using a Pasteur pipette, pick up visible mercury beads and deposit them in a glass vial.
9. If using the Mercon aspirator (included in the Mercury spill kit in Discovery 1):
    a. Push loading knob all the way down.
    b. Release trigger and suction up 20-30 mL of MerconSPRAY™ solution, then release liquid into a waste bag.
    c. Place tip of aspirator near mercury beads, push knob all the way down and gently release to collect the mercury.
    d. Tilt the aspirator tip above the body to prevent mercury from being inadvertently released.
    e. Place tip inside a glass vial, ensuring tip is below upper rim, and gently press knob to release mercury into container.
    f. Repeat steps c. through e. until all visible mercury is collected, then cap the vial.
    g. Repeat steps a. and b. to clean aspirator. Wipe exterior surfaces of aspirator using a MerconWIPE™ and place in waste bag.

Mercon aspirator tool

10. Use MerconWIPES™ and/or paper towel to wipe up remaining residue from the spill area, then thoroughly rinse with water and wipe dry with paper towel.
11. Place all contaminated debris, the glass vial containing mercury and used clean up materials into heavy mil waste bag and seal with duct tape. Place bag inside second bag along with gloves and any personal protective equipment for disposal (shoe covers, respirator, gloves), and seal second (outside) bag with duct tape. Fill out a chemical waste label with "Contains elemental mercury" and affix to bag. Request waste pickup through online hazardous waste system: hazmatwaste.its.sfu.ca. Store waste bag(s) in a fume hood until the waste contractor collects it.
12. Items that may have come in contact with mercury vapour during clean-up (e.g. lab coat and other personal clothing) may be laundered as usual.

Documentation

13. Complete an SFU incident report. If an employee visited a physician, or was absent beyond the day of the incident (due to the incident), then the supervisor must complete a WorksafeBC Form 7.

References

WorkSafeBC "Cleanup procedure for minor mercury spills" February 2007, www.worksafebc.com

Environment and Climate Change Canada "Cleaning up small mercury spills", updated Sept 2016, https://www.ec.gc.ca/mercure-mercury/default.asp?lang=En&n=D2B2AD47-1

Canadian Centre for Occupational Health and Safety "OSH Answers: Mercury", https://www.ccohs.ca/oshanswers/chemicals/chem_profiles/mercury.html

Ross Healthcare "Mercon™: How to handle spill and cleanup mercury"

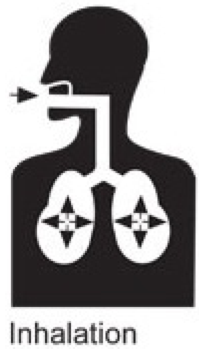
Ross Healthcare "MerconKit Instruction booklet"

Exposure Routes & Control

Routes of Exposure

The most common routes of exposure for laboratory chemicals include:

Inhalation



Dermal absorption (includes skin and eyes)

Ingestion (eating with contaminated hands)

Modes of Controlling Exposure

Elimination/Substitution

- Most desirable control
- Can potentially remove the hazard completely
- Find products that are less toxic and easier to dispose of
- Ensure the safety and suitability of the product to be substituted is thoroughly examined
- Example: using water based instead of solvent based

Engineering Controls

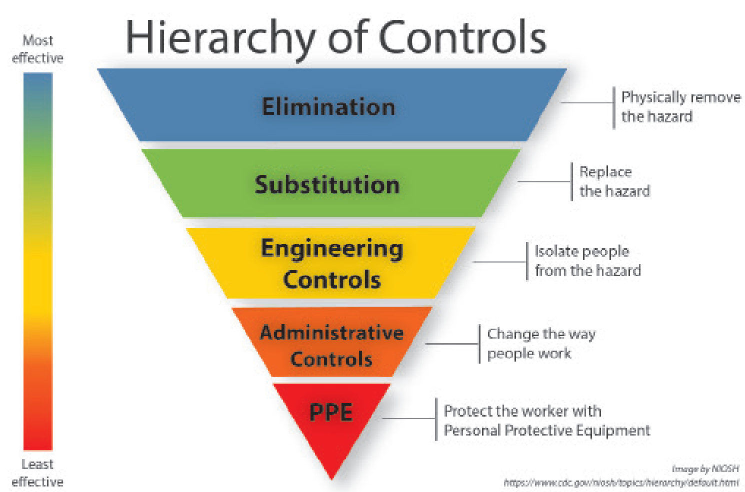
- Usually built into equipment
- Can be expensive, and can take a long time to implement
- Example: local exhaust ventilation, fume hood

Administrative Controls

- Limit exposure time
- Implement safe working procedures for specific chemicals (EHS can assist in reviewing these for your lab)
- Example: brush or dip instead of spraying

Personal Protective Equipment (PPE)

- Most common but is the last line of defense in the event of a failure in administrative or engineering controls
- Does not control the exposure at the source, exposure is controlled at the user
- Limited protection
- Examples: respirators, gloves, safety glasses



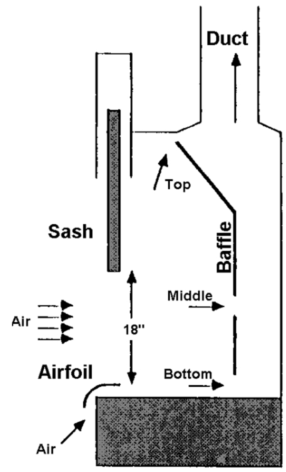
https://www.cdc.gov/niosh/topics/hierarchy/default.html

Fume Hood Safety

General Guidelines for Safe Fume Hood Use

- At SFU, fume hood testing and certification is arranged annually by SFU Facilities Services
- Confirm the fume hood is fully operational before each use (ensure hood is not in standby mode and check the magnehelic gauge, indicator ribbon or the visual face velocity display).
- Work with the sash at the proper operating level as indicated by the sash arrows. Ensure the sash is always in front of your face and body while manipulating objects. The sash not only helps contain chemical vapors but acts as a physical shield against splashes, spills, particulates and debris.
- Set up apparatus as close to the back of the hood as possible. Apparatus should not be closer than 15 cm (6 inches) from the front of the hood.
- Set up your apparatus BEFORE you begin your experiment, this minimizes the disruption of air currents caused by adding and removing equipment.

- Do not block airflow. Raise large objects 5 cm (2 inches) off the counter by placing them on blocks.
- Avoid rapid removal of objects or arms from the hood and never place your head inside the hood.
- Avoid filling the hood with excessive equipment and do not store chemicals in the fume hood. Excess clutter and chemicals can impede airflow.
- Limit foot traffic around the fume hood. People walking by the hood face will disrupt the airflow.
- Radioisotopes and perchloric acid must only be used in designated fume hoods.
- Keep lab doors and windows closed at all times to ensure maximum hood performance and to maintain negative pressure in the room.



- Use only grounded (3-prong) electrical equipment
- NEVER bend or kneel down so low that the sash no longer forms a safety barrier between your head and the items inside the fume hood. ALWAYS position the sash between your face and your experiment.

In Case of Emergency

- If the low flow alarm sounds, lower the sash to the designated operating level. If the alarm continues to sound, immediately stop work, turn off all equipment and close the sash. Evacuate the area if highly volatile or toxic chemicals are being used. The alarm can be silenced but do not reset it. Contact Facilities Services (local 2-3582).
- If a power failure or other emergency occurs (e.g., building fire or explosion within the fume hood) immediately stop work, turn off all equipment, close the sash and evacuate the building. Contact Campus Security (local 2-4500).

Emergency Shower & Eyewash

Emergency shower and eyewash stations are among the most important pieces of safety equipment in any lab. All laboratory workers should take the time to locate the nearest emergency shower and eyewash station and familiarize themselves with its operation. The first 10-15 seconds of skin or eye exposure to a hazardous chemical is the critical period when flushing with water should begin in order to minimize the risk of serious injury.

Regulations

Per WorkSafeBC Occupational Health and Safety Regulation Part 5, provision and location of emergency eyewash and emergency shower depends upon the level of risk present in the lab. Please refer to the OHS Regulation Part 5: Chemical Agents and Biological Agents for details.

https://www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation/ohs-regulation/part-05-chemical-and-biological-substances#TableNumber:5-3

At SFU, emergency washing facilities are tested regularly by SFU Facilities Services staff.

General Precautions

The emergency shower and eyewash station is in place to mitigate damage after a chemical exposure event. It is by no means a replacement for proper personal protective equipment (PPE). All laboratory workers should be equipped with suitable PPE and attire:

- Wear eye protection, preferably chemical splash goggles
- Wear chemical-resistant gloves
- Wear long sleeves, long pants, and closed-toe shoes

Before an Incident

- Locate the nearest shower and eyewash station
- Ensure there is a clear path to the shower and eyewash station - it may be difficult to see and navigate a crowded path in the event of chemical splash to the eyes
- Test the operation of the eyewash station to clearly understand how it is activated

Eyewash Stations

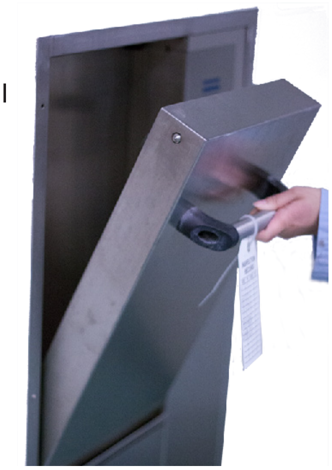
Note that there are a variety of eyewash stations on campus and not all types are necessarily listed here. In some spaces, an eyewash squeeze bottle is available. A squeeze bottle is only a temporary measure, providing immediate relief on the way to the eyewash facility. Take the time to understand how to use each style of eyewash properly before an emergency.

Traditional

This style of eyewash is activated by pressing the paddle forward. The paddle will remain in the open position, freeing the user's hands to hold both eyelids open. When finished, the paddle must be pulled back to the vertical position to stop the flow of water.

Integrated

This style of eyewash is activated by pulling the horizontal bar handle forward to open the eyewash unit. As the unit pivots open, the flow of water will begin automatically and continue for as long as it remains open. There is no need to support the eyewash, freeing the user's hands to hold both eyelids open. To stop the flow of water, lift the end of the unit to pivot it closed.



Drench Hose

This style of eyewash is usually located next to a sink and is activated by depressing the handle. The handle can be locked into the open position, allowing for a continuous flow of water. If the unit must be pulled closer to the user, it is recommended that a helper hold the handle to allow the user to hold open both eyelids. To stop the flow of water, depress the handle, lift the locking bar above the detent, and release the handle.

Emergency Showers

There are mostly two types of emergency shower on campus, though there may be others not listed here. Take the time to understand how to use each properly before an emergency.

Hanging Handle

This style of shower is activated by pulling the handle straight down as far as it will go. The valve will remain in the open position, freeing the user's hands to remove contaminated apparel. To stop the flow of water, push the handle straight up.

Integrated

This style of shower is activated by pulling down the wall-mounted handle as indicated on the integrated housing. The valve will remain in the open position, freeing the user's hands to remove contaminated apparel. To stop the flow of water, return the handle to the original position. As integrated eyewash and emergency shower units have two handles placed side-by-side, take a moment to know which handle controls which washing feature.

Hazardous Exposure Incident

In the event of an emergency requiring use of the washing facilities, **YOUR HEALTH AND SAFETY IS PARAM0UNT**.

The minimum required flushing time for eyewash and emergency shower is **15 MINUTES**, but up to an hour can be required - other workers, first aid, and EHS can consult the SDS for the hazardous material to determine flushing time.

- In the event of hazardous material exposure, make noise, call for help, ensuring that other workers in the laboratory know what is happening and are available to provide any assistance necessary
- A free worker should call security for first aid immediately
- When using the eyewash, both eyelids should be held open and pulled away from the eye to allow water to rinse away any chemicals that would otherwise be trapped under the eyelids
- When using the emergency shower, go under the shower fully clothed to immediately begin diluting and washing away chemicals that are on clothing and contacting skin
- Once under the shower, begin disrobing to separate contaminated clothing from skin
- Some showers on campus have been equipped with curtains; for showers without curtains, other workers in the lab can hold up lab coats or towels to afford some privacy
- In many cases, the floor drain is not conveniently located to effectively remove water during emergency shower use - other workers in the laboratory can use mops and brooms to clear water towards the drain
- If the exposure is localized to hands or lower arms, it may be acceptable to rinse under a sink in lieu of an emergency shower
- If a sink is used, be sure to adjust the water temperature to a comfortable level as flushing for a minimum of 15 minutes is still required
- If the spilled material is concentrated strong acid or base, the immediate addition of water from flushing can potentially lead to burns from exothermic dilution - a quick application of SpillX-A or SpillX-B to neutralize the acid or base before going under the shower can mitigate the risk of burns

PPE: Lab Coats

SFU requires lab coats to be worn in labs when hazardous materials are present; appropriate laboratory coats should be worn, buttoned, with the sleeves rolled down. Be sure that your lab coat is appropriate for the hazard you are working with, contact EHS if you are not sure which lab coat is the most appropriate:

- Cotton-poly lab coat, for use with acids, caustics or materials that are not very flammable or combustible
- 100% cotton lab coat, for use with flammable or combustible materials
- Nomex lab coat, for use with pyrophorics, highly flammable or combustible materials, and large quantities of flammable or combustible materials

Lab coats should be left in the laboratory to minimize the possibility of spreading hazardous material to public assembly, eating, or office areas. They must be cleaned regularly. For information on lab coat rental, purchase and laundering contact Science Stores.

PPE: Glasses & Goggles

Safety glasses/goggles must be worn whenever there is a risk of eye injury from contact with pressurized gases, sharp or moving particles, lasers or hazardous materials. Safety glasses/goggles must meet specific safety standards that are not required for prescription eyewear. If you are a prescription eyeglass wearer, you still must wear safety glasses/goggles over the top of eyeglasses.

Individuals working with lasers and/or radioactive materials must wear specific goggles. Refer to the respective online safety training courses for more information.

https://www.sfu.ca/srs/work-research-safety/training.html#main_content_reference_1

Lens Colours

Clear - Indoor: for normal indoor use.

Yellow - Indoor: for low light applications where contrast enhancement is required

Blue - Indoor: for areas with high levels of yellow light (such as sodium vapour lights)

Pink - Indoor: for use where contrast enhancement is required. They reduce glare from fluorescent and halogen lights without compromising colour perception.

Tinted - Outdoor: use where glare reduction is desired. Easy for eyes to adjust between indoor and outdoor environments.

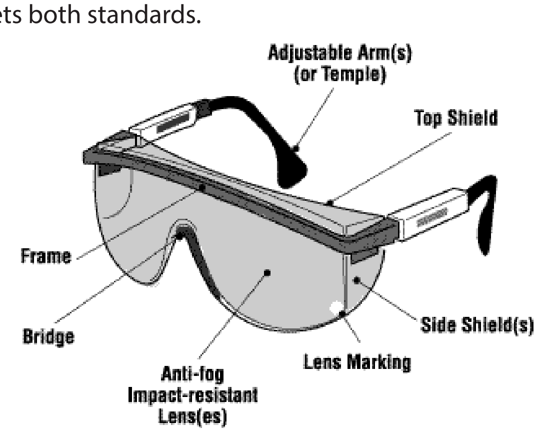
Mirror - Outdoor: for use where bright sunlight and glare cause eye strain and fatigue.

Standards

Canada - The CSA standard (Z94.3) specifies that a quarter inch steel ball is fired at the lens and frame at 152 ft/s (104 mph). Side shields are required with the following minimum dimensions: 2 cm from eyeball centre to outside, and 1 cm for each of eyeball centre to top and eyeball centre to bottom edge of lens.

United States - The ANSI standard (Z87.1-1989) specifies that a quarter inch steel ball is fired at the frame at 150 ft/s (102 mph). Then, a one inch steel ball is dropped from 50 inches on the lens. No side shields are specified.

The UVEX Genesis glasses available in Science Stores meets both standards.



PPE: Particulate Respirators

Anyone who needs a respirator to do their work will require annual fit testing by EHS to ensure the respirator fits correctly and provides adequate protection. Users must be clean shaven for the fit test and at any time the respirator is in use.

If you believe you require a respirator in your work, contact your supervisor and ensure you have considered all possible control measures before resorting to a respirator. In many cases, it may be preferable to modify the work to take advantage of existing engineering controls, such as moving an experiment into a fume hood. If you decide that a respirator is appropriate, contact EHS for guidance on respirator selection. EHS will work with you and your supervisor to gain an understanding of the work being performed.

There are a variety of respirator classes, each with specific properties to protect the user depending on the hazards of the work being performed. Full facepiece respirators, half face respirators, and N95 respirators can all be fitted to an individual user using a qualitative fit test administered by EHS. Be advised that a single-stringed mask (often called a dust mask or comfort mask) is not a respirator.

PPE: Gloves

Gloves must be worn when working with hazardous materials in the laboratory. Not all types of glove afford the same level of protection against different chemicals. For example, nitrile performs poorly compared to latex in acetone breakthrough tests, potentially exposing the user to not just acetone but also whatever other chemicals they may have dissolved in this solvent.

The compatibility charts across the next few pages provide a primer on glove selection. Workers should consult reference material provided by the manufacturer of the particular gloves available as there can be variability in thickness and other properties across brands. If there are any concerns, workers should contact their supervisor for assistance in selecting the type of gloves that will afford them an adequate and appropriate level of protection.

Gloves should not be worn in hallways to minimize the possibility of spreading hazardous material to public places and contaminating exterior door handles. If gloves must be worn to protect the worker transporting items between labs, one hand should remain ungloved to open doors. If both hands must be gloved to protect the worker, another worker should accompany them to open doors with ungloved hands. When possible, efforts should be made to avoid or minimize the transport of hazardous materials between labs.

How to Read the Charts

Three categories of data are represented for each Ansell product and corresponding chemical: 1) overall degradation resistance rating; 2) permeation breakthrough time, and 3) permeation rate.

Standards for Color-Coding

A glove-chemical combination receives GREEN if either set of the following conditions is met:

- The degradation rating is Excellent or Good
- The permeation breakthrough time is 30 minutes or longer
- The permeation rate is Excellent, Very Good, or Good.

OR

- The permeation rate is not specified
- The permeation breakthrough time is 240 minutes or longer
- The degradation rating is Excellent, Very Good, or Good

A glove-chemical combination receives RED if: the degradation rating is Poor or Not Recommended, regardless of the permeation rating.

All other glove-chemical combinations receive YELLOW. In other words, any glove-chemical combination not meeting either set of conditions required for Green, and not having a Red degradation rating of either Poor or Not Recommended, receives a YELLOW rating.

Key to Permeation Rate

	Simply Stated, Drops/hr Through a Glove (eyedropper-size drops)
E – Excellent; permeation rate of less than 0.9 µg/cm²/min.	0 to 1/2 drop
VG – Very Good; permeation rate of less than 9 µg/cm²/min.	1 to 5 drops
G – Good; permeation rate of less than 90 µg/cm²/min.	6 to 50 drops
F – Fair; permeation rate of less than 900 µg/cm²/min.	51 to 500 drops
P – Poor; permeation rate of less than 9000 µg/cm²/min.	501 to 5000 drops
NR – Not Recommended; permeation rate greater than 9000 µg/cm²/min.	5001 drops up

Note: The current revision to the ASTM standard permeation test calls for permeation to be reported in micrograms of chemical permeated per square centimeter of material exposed per minute of exposure, "µg/cm²/min."

Key to Permeation Breakthrough

> Greater than (time) < Less than (time)

Key to Degradation Ratings

E – Excellent; fluid has very little degrading effect.
G – Good; fluid has minor degrading effect.
F – Fair; fluid has moderate degrading effect.
P – Poor; fluid has pronounced degrading effect.
NR – Fluid was not tested against this material.

NOTE: Any test samples rated P (poor) or NR (not recommended) in degradation testing were not tested for permeation resistance. A dash (–) appears in those cases.

Specific Gloves Used for Testing

	Degradation	Permeation
Nitrile	Sol-Vex® 37-145 (11 mil/0.28 mm)	Sol-Vex® 37-165 (22 mil/0.54 mm)
Neoprene Unsupported	29-865 (18 mil/0.46 mm)	29-865 (18 mil/0.46 mm)
Polyvinyl Alcohol Supported	PVA™	PVA™
Polyvinyl Chloride Supported	Snorkel®	Monkey Grip™
Natural Rubber Latex	Canners 392 (19 mil/0.48 mm)	Canners 392 (19 mil/0.48 mm)
Neoprene/Latex Blend	Chemi-Pro 224 (27 mil/0.67 mm)	Chemi-Pro 224 (27 mil/0.67 mm)
Laminated LCP™ Film	Barrier 2-100 (2.5 mil/0.06 mm)	Barrier 2-100 (2.5 mil/0.06 mm)

Single palm thickness is listed in both mil and metric millimeter (mm) for Unsupported Gloves. Supported Gloves are specified by glove weight, not thickness.

Why is a product with a shorter breakthrough time sometimes given a better rating than one with a longer breakthrough time?

One glove has a breakthrough time of just 4 minutes. It is rated "very good," while another with a breakthrough time of 30 minutes is rated only "fair." Why? The reason is simple: in some cases the rate is more significant than the time.

Imagine connecting two hoses of the same length but different diameters to a faucet using a "Y" connector. When you turn on the water, what happens? Water goes through the smaller hose first because there is less space inside that needs to be filled. But when the water finally gets through the larger hose it really gushes out. In only a few minutes, the larger hose will discharge much more water than the smaller one, even though the smaller one started first.

The situation is similar with gloves. A combination of a short breakthrough time and a low permeation rate may expose a glove wearer to less chemical than a combination of a longer breakthrough time and a much higher breakthrough rate, if the glove is worn long enough.

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

Permeation/Degradation Resistance Guide for Ansell Gloves

The first square in each column for each glove type is color coded. This is an easy-to-read indication of how we rate this type of glove in relation to its applicability for each chemical listed. The color represents an overall rating for both degradation and permeation. The letter in each square is for Degradation alone…

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







	LAMINATE FILM			NITRILE			UNSUPPORTED NEOPRENE			SUPPORTED POLYVINYL ALCOHOL			POLYVINYL CHLORIDE (Vinyl)			NATURAL RUBBER			NEOPRENE/ NATURAL RUBBER BLEND		
	BARRIER			SOL-VEX			29-865			PVA			SNORKEL			CANNERS AND HANDLERS*			CHEMI-PRO*		
CHEMICAL	Degradation Rating	Permeation: Breakthrough	Permeation: Rate	Degradation Rating	Permeation: Breakthrough	Permeation: Rate	Degradation Rating	Permeation: Breakthrough	Permeation: Rate	Degradation Rating	Permeation: Breakthrough	Permeation: Rate	Degradation Rating	Permeation: Breakthrough	Permeation: Rate	Degradation Rating	Permeation: Breakthrough	Permeation: Rate	Degradation Rating	Permeation: Breakthrough	Permeation: Rate
1. Acetaldehyde	■	380	E	P	—	—	E	10	F	NR	—	—	NR	—	—	E	7	F	E	10	F
2. Acetic Acid	■	150	—	G	270	—	E	60	—	NR	—	—	F	180	—	E	110	—	E	260	—
3. Acetone	▲	>480	E	NR	—	—	E	10	F	P	—	—	NR	—	—	E	10	F	G	10	G
4. Acetonitrile	▲	>480	E	F	30	F	E	20	G	■	150	G	NR	—	—	E	4	VG	E	10	VG
5. Acrylic Acid	—	—	—	G	120	—	E	390	—	NR	—	—	NR	—	—	E	80	—	E	65	—
6. Acrylonitrile	E	>480	E	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7. Allyl Alcohol	▲	>480	E	F	140	F	E	140	VG	P	—	—	P	60	G	E	>10	VG	E	20	VG
8. Ammonia Gas	■	19	E	▲	>480	—	▲	>480	—	—	—	—	■	6	VG	—	—	—	■	27	VG
9. Ammonium Fluoride, 40%	—	—	—	E	>360	—	E	>480	—	NR	—	—	E	>360	—	E	>360	—	E	>360	—
10. Ammonium Hydroxide	E	30	—	E	>360	—	E	250	—	NR	—	—	E	240	—	E	90	—	E	240	—
11. Amyl Acetate	▲	>480	E	E	60	G	NR	—	—	G	>360	E	P	—	—	NR	—	—	P	—	—
12. Amyl Alcohol	—	—	—	E	30	E	E	290	VG	G	180	G	G	12	E	E	25	VG	E	45	VG
13. Aniline	▲	>480	E	NR	—	—	E	100	P	F	>360	E	F	180	VG	E	25	VG	E	50	G
14. Aqua Regia	—	—	—	F	>360	—	G	>480	—	NR	—	—	G	120	—	NR	—	—	G	180	—
15. Benzaldehyde	▲	>480	E	NR	—	—	NR	—	—	G	>360	E	NR	—	—	G	10	VG	G	25	F
16. Benzene, Benzol	▲	>480	E	P	—	—	NR	—	—	E	>360	E	NR	—	—	NR	—	—	NR	—	—
17. Benzotrichloride	—	—	—	E	>480	E	NR	—	—	—	—	—	—	—	—	NR	—	—	NR	—	—
18. Benzotrifluoride	—	—	—	E	170	G	F	—	—	E	—	—	G	<10	F	P	50	G	—	—	—
19. Bromine Water	—	—	—	E	>480	E	E	>480	E	—	—	—	—	—	—	—	—	—	—	—	—
20. 1-Bromopropane	▲	>480	E	■	23	F	■	<10	P	▲	>480	E	■	<10	F	■	<10	P	■	<10	P
21. Bromopropionic Acid	▲	>480	—	F	120	—	E	420	—	NR	—	—	G	180	—	E	190	—	G	180	—
22. Butyl Acetate	▲	>480	E	F	75	F	NR	—	—	G	>360	E	NR	—	—	NR	—	—	P	—	—
23. Butyl Alcohol	▲	>480	E	E	>360	E	E	210	VG	F	75	G	G	180	VG	E	20	VG	E	45	VG
24. Butyl Carbitol	—	—	—	E	323	E	G	188	F	E	>480	E	E	397	VG	E	44	G	E	148	G
25. Butyl Cellosolve	▲	>480	E	E	90	VG	E	120	F	■	120	G	P	—	—	E	45	G	E	40	G
26. gamma-Butyrolactone	▲	>480	E	NR	—	—	E	190	F	E	120	VG	NR	—	—	E	60	G	E	100	F
27. Carbon Disulfide	▲	>480	E	G	30	F	NR	—	—	E	>360	E	NR	—	—	NR	—	—	NR	—	—
28. Carbon Tetrachloride	—	—	—	G	150	G	NR	—	—	E	>360	E	F	25	F	NR	—	—	NR	—	—
29. Cellosolve Acetate	▲	>480	E	F	90	G	E	40	P	▲	>360	E	NR	—	—	E	10	G	E	15	G
30. Cellosolve Solvent	E	>480	E	G	210	G	E	120	F	—	75	G	P	—	—	E	25	VG	E	20	VG
31. Chlorine Gas	▲	>480	E	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
32. 2-Chlorobenzyl Chloride	—	—	—	E	120	E	P	—	—	E	>480	E	F	65	E	F	20	F	—	—	—
33. Chlorobenzene	▲	>480	E	NR	—	—	NR	—	—	E	>360	E	NR	—	—	NR	—	—	NR	—	—
34. Chloroform	E	20	G	NR	—	—	NR	—	—	E	>360	E	NR	—	—	NR	—	—	NR	—	—
35. Chloronaphthalene	▲	>480	E	P	—	—	NR	—	—	G	>360	E	NR	—	—	NR	—	—	P	—	—
36. 2-Chlorotoluene	—	—	—	G	120	G	NR	—	—	F	—	—	F	—	—	NR	—	—	NR	—	—
37. ortho-Chlorotoluene	—	—	—	G	120	G	NR	—	—	F	—	—	F	—	—	NR	—	—	NR	—	—
38. Chromic Acid, 50%	—	—	—	F	240	—	NR	—	—	NR	—	—	G	>360	—	NR	—	—	NR	—	—
39. Citric Acid, 10%	—	—	—	E	>360	—	E	>480	—	P	—	—	E	>360	—	E	>360	—	E	>360	—
40. Cyclohexanol	▲	>480	E	E	>360	E	E	390	VG	G	>360	E	E	360	E	E	10	G	E	20	G
41. Cyclohexanone	▲	>480	E	F	103	G	P	—	—	E	>480	E	NR	—	—	P	—	—	P	—	—
42. 1, 5-Cyclooctadiene	—	—	—	E	>480	E	NR	—	—	—	—	—	P	—	—	NR	—	—	NR	—	—
43. Diacetone Alcohol	▲	>480	E	G	240	E	E	140	G	■	150	G	NR	—	—	E	15	VG	E	60	VG
44. Dibutyl Phthalate	—	—	—	G	>360	E	F	<10	F	E	>360	E	NR	—	—	E	20	—	G	>360	E
45. Diethylamine	▲	>480	E	F	45	F	P	—	—	NR	—	—	NR	—	—	NR	—	—	NR	—	—

Note: All numeric designations within the product classifications are denoted in minutes.

▲ A degradation test against this chemical was not run. However, since its breakthrough time is greater than 480 minutes, the Degradation Rating is expected to be Good to Excellent.

■ A degradation test against this chemical was not run. However, in view of degradation tests performed with similar compounds, the Degradation Rating is expected to be Good to Excellent.

* CAUTION: This product contains natural rubber latex which may cause allergic reactions in some individuals.

This Information Applies Only to Ansell Occupational Healthcare Glove Brands

CHEMICAL	LAMINATE FILM BARRIER: Degradation Rating	LAMINATE FILM BARRIER: Permeation: Breakthrough	LAMINATE FILM BARRIER: Permeation: Rate	NITRILE SOL-VEX: Degradation Rating	NITRILE SOL-VEX: Permeation: Breakthrough	NITRILE SOL-VEX: Permeation: Rate	UNSUPPORTED NEOPRENE 29-865: Degradation Rating	UNSUPPORTED NEOPRENE 29-865: Permeation: Breakthrough	UNSUPPORTED NEOPRENE 29-865: Permeation: Rate	SUPPORTED POLYVINYL ALCOHOL PVA: Degradation Rating	SUPPORTED POLYVINYL ALCOHOL PVA: Permeation: Breakthrough	SUPPORTED POLYVINYL ALCOHOL PVA: Permeation: Rate	POLYVINYL CHLORIDE (Vinyl) SNORKEL: Degradation Rating	POLYVINYL CHLORIDE (Vinyl) SNORKEL: Permeation: Breakthrough	POLYVINYL CHLORIDE (Vinyl) SNORKEL: Permeation: Rate	NATURAL RUBBER CANNERS AND HANDLERS*: Degradation Rating	NATURAL RUBBER CANNERS AND HANDLERS*: Permeation: Breakthrough	NATURAL RUBBER CANNERS AND HANDLERS*: Permeation: Rate	NEOPRENE/ NATURAL RUBBER BLEND CHEMI-PRO*: Degradation Rating	NEOPRENE/ NATURAL RUBBER BLEND CHEMI-PRO*: Permeation: Breakthrough	NEOPRENE/ NATURAL RUBBER BLEND CHEMI-PRO*: Permeation: Rate
46. Di-Isobutyl Ketone, DIBK	▲	>480	E	E	120	F	P	—	—	G	>360	E	P	—	—	P	—	—	P	—	—
47. Dimethyl Acetamide, DMAC	▲	>480	E	NR	—	—	NR	—	—	NR	—	—	NR	—	—	E	15	G	E	30	G
48. Dimethyl Formamide, DMF	▲	>480	E	NR	—	—	E	40	F	NR	—	—	NR	—	—	E	25	VG	E	40	G
49. Dimethyl Sulfoxide, DMSO	▲	>480	E	E	>240	VG	E	360	G	NR	—	—	NR	—	—	E	180	E	E	150	E
50. Dioctyl Phthalate, DOP	▲	>480	E	G	>360	E	G	>480	E	E	30	F	NR	—	—	P	—	—	E	>360	E
51. Dioxane	▲	>480	E	NR	—	—	NR	—	—	P	—	—	NR	—	—	F	5	F	F	15	F
52. Electroless Copper	—	—	—	E	>360	—	E	>360	—	NR	—	—	E	>360	—	E	>360	—	—	—	—
53. Electroless Nickel	—	—	—	E	>360	—	E	>360	—	NR	—	—	E	>360	—	E	>360	—	E	>360	—
54. Epichlorohydrin	▲	>480	E	NR	—	—	P	—	—	E	300	E	NR	—	—	E	5	F	E	15	G
55. Ethidium Bromide, 10%	▲	>480	E	▲	>480	E	—	—	—	NR	—	—	—	—	—	—	—	—	—	—	—
56. Ethyl Acetate	▲	>480	E	NR	—	—	F	10	P	F	>360	E	NR	—	—	G	5	F	F	10	F
57. Ethyl Alcohol	▲	>480	E	E	240	VG	E	113	VG	NR	—	—	G	60	VG	E	37	VG	E	20	G
58. Ethylene Dichloride	▲	>480	—	NR	—	—	NR	—	—	E	>360	E	NR	—	—	P	—	—	P	—	—
59. Ethylene Glycol	▲	>480	E	E	>360	E	E	>480	—	F	120	VG	E	>360	E	E	>360	E	E	>480	E
60. Ethylene Oxide Gas	▲	234	E	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
61. Ethyl Ether	▲	>480	E	E	120	G	F	<10	P	G	>360	E	NR	—	—	NR	—	—	NR	—	—
62. Ethyl Glycol Ether	▲	>480	E	G	210	G	E	120	F	■	75	G	P	—	—	E	25	VG	E	20	VG
63. Formaldehyde	▲	>480	E	E	>360	E	E	105	G	P	—	—	E	100	VG	E	10	G	E	15	VG
64. Formic Acid, 90%	▲	>480	—	F	240	—	E	>480	—	NR	—	—	E	>360	—	E	150	—	E	>360	—
65. Furfural	▲	>480	E	NR	—	—	E	30	P	F	>360	E	NR	—	—	E	15	VG	E	40	G-VG
66. Glutaraldehyde, 25%	—	—	—	—	>360	—	E	>480	E	P	—	—	E	>360	E	E	210	VG	E	—	—
67. Gasoline (hi-test)	■	170	E	E	>360	E	NR	—	—	G	>360	E	P	—	—	NR	—	—	NR	—	—
68. HCFC-141b	▲	>480	E	E	92	F	F	33	P	P	—	—	NR	—	—	NR	—	—	NR	—	—
69. HFE 7100	▲	>480	E	E	>480	E	E	>480	E	P	—	—	E	>480	E	E	120	E	—	—	—
70. HFE 71DE	▲	164	E	F	10	F	F	<10	F	F	>480	E	NR	—	—	NR	—	—	NR	—	—
71. Hexamethyldisilazane	▲	>480	E	E	>360	—	E	15	—	G	>360	—	P	—	—	F	15	F	F	40	F-G
72. Hexane	▲	>480	E	E	>360	E	E	40	F	G	>360	E	NR	—	—	NR	—	—	P	—	—
73. Hydrazine, 65%	—	—	—	E	>360	—	E	380	—	NR	—	—	E	>360	—	E	150	VG	E	>360	—
74. Hydrobromic Acid	▲	>480	—	E	>360	E	E	>480	—	NR	—	—	E	>360	E	E	>360	E	E	>360	E
75. Hydrochloric Acid, conc.	▲	>480	—	E	>360	—	E	>480	—	NR	—	—	E	>300	—	E	290	—	E	>360	—
76. Hydrochloric Acid, 10%	—	—	—	E	>360	—	E	>480	—	NR	—	—	E	>360	—	E	>360	—	E	>360	—
77. Hydrofluoric Acid, 48%	E	>480	—	E	334	—	E	>480	—	NR	—	—	G	155	—	E	190	—	E	153	—
78. Hydrogen Fluoride Gas	▲	>480	E	■	<15	P	—	—	—	—	—	—	—	—	—	E	<15	F	■	<15	F
79. Hydrogen Peroxide, 30%	—	—	—	E	>360	—	E	>480	—	NR	—	—	E	>360	—	E	>360	—	G	90	—
80. Hydroquinone, saturated	—	—	—	E	>360	E	E	140	F	NR	—	—	E	>360	E	G	>360	E	E	>360	—
81. Hypophosphorus Acid	—	—	—	E	>480	—	E	>480	—	—	—	—	—	—	—	E	>480	—	—	—	—
82. Isobutyl Alcohol	▲	>480	E	E	>360	E	E	470	E	P	—	—	F	10	VG	E	15	VG	E	45	VG
83. Iso-Octane	▲	>480	E	E	360	E	E	230	G	E	>360	E	P	—	—	NR	—	—	P	—	—
84. Isopropyl Alcohol	▲	>480	E	E	>360	E	E	<10	VG	NR	—	—	G	150	E	E	20	VG	E	40	VG
85. Kerosene	▲	>480	E	E	>360	E	E	170	P	G	>360	E	F	>360	E	NR	—	—	P	—	—
86. Lactic Acid, 85%	▲	>480	—	E	>360	E	E	>480	—	F	>360	E	E	>360	E	E	>360	—	E	>360	—
87. Lauric Acid, 36%/EtOH	—	—	—	E	>360	—	E	>480	—	NR	—	—	F	15	—	E	>360	—	E	>360	—
88. d-Limonene	▲	>480	E	E	>480	E	P	—	—	G	>480	E	G	125	G	NR	—	—	NR	—	—
89. Maleic Acid, saturated	—	—	—	E	>360	—	E	>480	—	NR	—	—	G	>360	—	E	>360	—	E	>360	—
90. Mercury	—	—	—	▲	>480	E	—	—	—	—	—	—	▲	>480	E	▲	>480	E	—	—	—

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This Information Applies Only to Ansell Occupational Healthcare Glove Brands	LAMINATE FILM BARRIER			NITRILE SOL-VEX			UNSUPPORTED NEOPRENE 29-865			SUPPORTED POLYVINYL ALCOHOL PVA			POLYVINYL CHLORIDE (Vinyl) SNORKEL			NATURAL RUBBER CANNERS AND HANDLERS*			NEOPRENE/ NATURAL RUBBER BLEND CHEMI-PRO*		
CHEMICAL	Degradation Rating	Permeation: Breakthrough	Permeation: Rate	Degradation Rating	Permeation: Breakthrough	Permeation: Rate	Degradation Rating	Permeation: Breakthrough	Permeation: Rate	Degradation Rating	Permeation: Breakthrough	Permeation: Rate	Degradation Rating	Permeation: Breakthrough	Permeation: Rate	Degradation Rating	Permeation: Breakthrough	Permeation: Rate	Degradation Rating	Permeation: Breakthrough	Permeation: Rate
91. 1-methoxy-2-acetoxypropane	▲	>480	E	E	200	F	G	37	F	E	>360	E	P	—	—	G	13	F	G	18	F
92. Methyl Alcohol	E	>480	E	E	198	VG	E	65	G	NR	—	—	G	45	G	E	20	VG	E	20	VG
93. Methylamine	▲	>480	E	E	>360	E	E	140	G	NR	—	—	E	135	VG	E	55	VG	E	80	VG
94. Methyl Cellosolve	E	440	E	F	11	G	P	—	—	G	30	G	P	—	—	E	20	VG	E	20	VG
95. Methylene Bromide	▲	>480	E	NR	—	—	NR	—	—	G	>360	E	NR	—	—	NR	—	—	NR	—	—
96. Methylene Chloride	E	20	VG	NR	—	—	NR	—	—	G	>360	E	NR	—	—	NR	—	—	NR	—	—
97. MDI (Isocyanate)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	▲	>480	E
98. Methyl Amyl Ketone	E	>480	E	F	53	F	F	10	F	E	>360	E	NR	—	—	F	<10	F	F	<10	F
99. Methyl Ethyl Ketone, MEK	E	>480	E	NR	—	—	P	—	—	F	90	VG	NR	—	—	F	5	F	P	—	—
100. Methyl Glycol Ether	▲	>480	E	F	11	G	P	—	—	G	30	G	P	—	—	E	20	VG	E	20	VG
101. Methyl Iodide	▲	>480	E	NR	—	—	NR	—	—	F	>360	E	NR	—	—	NR	—	—	NR	—	—
102. Methyl Isobutyl Ketone	▲	>480	E	P	—	—	NR	—	—	F	>360	E	NR	—	—	P	—	—	P	—	—
103. Methyl Methacrylate	▲	>480	E	P	—	—	NR	—	—	G	>360	E	NR	—	—	P	—	—	NR	—	—
104. N-Methyl-2-Pyrrolidone	▲	>480	E	NR	—	—	NR	—	—	NR	—	—	NR	—	—	E	75	VG	F	40	G
105. Methyl t-Butyl Ether	E	>480	E	E	>360	E	P	—	—	G	>360	E	NR	—	—	NR	—	—	NR	—	—
106. Mineral Spirits, rule 66	▲	>480	E	E	>360	E	E	100	F	E	>360	E	F	150	VG	NR	—	—	G	20	F
107. Monoethanolamine	—	—	—	E	>360	E	E	260	E	F	>360	E	E	>360	E	E	50	E	E	50	E
108. Morpholine	▲	>480	E	NR	—	—	P	—	—	G	90	G	NR	—	—	G	20	G	E	30	F-G
109. Muriatic Acid	▲	>480	—	E	>360	—	E	>480	—	NR	—	—	E	>300	—	E	290	—	E	>360	—
110. Naphtha VM&P	▲	>480	E	E	>360	E	G	100	F	E	>420	E	F	120	VG	NR	—	—	NR	—	—
111. Nitric Acid, 10%	▲	>480	—	E	>360	—	E	>480	—	NR	—	—	G	>360	—	G	>360	—	E	>360	—
112. Nitric Acid, 70%	E	>480	—	NR	—	—	E	>480	—	NR	—	—	F	104	—	NR	—	—	G	90	—
113. Nitric Acid, Red Fuming	▲	>480	—	NR	—	—	NR	—	—	NR	—	—	P	—	—	NR	—	—	NR	—	—
114. Nitrobenzene	▲	>480	E	NR	—	—	NR	—	—	G	>360	E	NR	—	—	F	15	G	F	40	G
115. Nitromethane, 95.5%	▲	>480	E	F	30	F	E	60	G	G	>360	E	P	—	—	E	10	G	E	30	VG
116. Nitropropane, 95.5%	▲	>480	E	NR	—	—	E	<10	F	E	>360	E	NR	—	—	E	5	G	E	10	G
117. Octyl Alcohol	—	—	—	E	>360	E	E	218	E	G	>360	E	F	>360	E	E	30	VG	E	53	G
118. Oleic Acid	—	—	—	E	>360	E	F	13	G	G	60	E	F	90	VG	F	>360	—	G	120	—
119. Oxalic Acid, saturated	—	—	—	E	>360	—	E	>480	—	P	—	—	E	>360	—	E	>360	—	E	>360	—
120. Pad Etch 1(Ashland Chem.)	—	—	—	F	>360	—	E	>480	—	F	34	—	E	>360	—	E	>360	—	E	>360	—
121. Palmitic Acid, saturated	—	—	—	G	30	—	E	>480	—	P	—	—	G	75	—	G	5	—	E	193	—
122. Pentane	E	>480	E	E	>360	E	G	30	G	G	>360	E	NR	—	—	P	—	—	E	13	G
123. Pentachlorophenol, 5%	—	—	—	E	>360	E	E	151	F	E	5	F	F	180	E	NR	—	—	—	—	—
124. Perchloric Acid, 60%	—	—	—	E	>360	—	E	>480	—	NR	—	—	E	>360	—	F	>360	—	E	>360	—
125. Perchloroethylene	▲	>480	E	G	300	VG	NR	—	—	E	>360	E	NR	—	—	NR	—	—	NR	—	—
126. Phenol	▲	>480	E	NR	—	—	E	353	G	F	>360	E	G	75	VG	E	90	—	E	180	—
127. Phosphoric Acid, conc.	▲	>480	—	E	>360	—	G	>480	—	NR	—	—	G	>360	—	F	>360	—	G	>360	—
128. PMA Glycol Ether Acetate	▲	>480	E	E	200	F	G	37	F	E	>360	E	P	—	—	G	13	F	G	18	F
129. Potassium Hydroxide, 50%	—	—	—	E	>360	—	E	>480	—	NR	—	—	E	>360	—	E	>360	—	E	>360	—
130. Propane Gas	—	—	—	▲	>480	E	▲	>480	E	—	—	—	■	7	VG	—	—	—	—	—	—
131. Propyl Acetate	—	—	—	F	20	G	P	—	—	G	120	VG	NR	—	—	P	—	—	P	—	—
132. Propyl Alcohol	▲	>480	—	E	>360	E	E	323	E	P	—	—	F	90	VG	E	20	VG	E	30	VG
133. Propylene Oxide	▲	>480	—	NR	—	—	NR	—	—	G	35	G	NR	—	—	P	—	—	P	—	—
134. Pyridine	▲	>480	E	NR	—	—	NR	—	—	G	10	F	NR	—	—	F	10	F	P	—	—
135. Rubber Solvent	—	—	—	E	>360	E	E	43	F	E	>360	E	NR	—	—	NR	—	—	NR	—	—

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136. Silicon Etch	—	—	—	NR	—	—	E	>480	—	NR	—	—	F	150	—	NR	—	—	P	—	—
137. Skydrol hydraulic fluid	E	>480	E	NR	—	—	NR	—	—	F	—	—	NR	—	—	NR	—	—	NR	—	—
138. Sodium Hydroxide, 50%	E	>480	—	E	>360	—	E	>480	—	NR	—	—	G	>360	—	E	>360	—	E	>360	—
139. Stoddard Solvent	▲	>480	E	E	>360	E	E	139	F	E	>360	E	F	360	E	NR	—	—	G	10	F
140. Styrene	▲	>480	E	NR	—	—	NR	—	—	G	>360	E	NR	—	—	NR	—	—	NR	—	—
141. Sulfur Dichloride	—	—	—	G	>480	E	NR	—	—	—	—	—	—	—	—	NR	—	—	—	—	—
142. Sulfuric Acid, 95%	E	>480	—	NR	—	—	F	105	—	NR	—	—	G	70	—	NR	—	—	NR	—	—
143. Sulfuric Acid 120%, Oleum	▲	>480	E	—	—	—	F	53	G	—	—	—	F	25	G	—	—	—	—	—	—
144. Sulfuric 47% battery acid	—	—	—	E	>360	—	E	>480	—	NR	—	—	G	>360	—	E	>360	—	E	>360	—
145. Tannic Acid, 65%	—	—	—	E	>360	E	E	>480	—	P	—	—	E	>360	E	E	>360	—	E	>360	—
146. Tetrachloroethene	▲	>480	E	G	300	VG	NR	—	—	E	>360	E	NR	—	—	NR	—	—	NR	—	—
147. Tetrahydrofuran, THF	▲	>480	E	NR	—	—	NR	—	—	P	90	G	NR	—	—	NR	—	—	NR	—	—
148. Toluene, toluol	▲	>480	E	F	10	F	NR	—	—	G	>360	E	NR	—	—	NR	—	—	NR	—	—
149. Toluene Di-Isocyanate (TDI)	▲	>480	E	NR	—	—	NR	—	—	G	>360	E	P	—	—	G	7	G	—	—	—
150. Triallylamine	▲	>480	E	—	>480	E	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
151. Trichloroethylene, TCE	▲	>480	E	NR	—	—	NR	—	—	E	>360	E	NR	—	—	NR	—	—	NR	—	—
152. Trichlorotrifluoroethane	—	—	—	E	>360	E	E	240	E	G	>360	E	NR	—	—	NR	—	—	NR	—	—
153. Tricresyl Phosphate, TCP	—	—	—	E	>360	E	G	<10	P	G	>360	E	F	>360	E	E	45	E	E	>360	E
154. Triethanolamine, 85%	—	—	—	E	>360	E	E	<10	G	G	>360	E	E	>360	E	G	>360	E	E	—	—
155. Turpentine	▲	>480	E	E	30	E	NR	—	—	G	>360	E	P	—	—	NR	—	—	NR	—	—
156. Vertrel MCA	▲	>480	E	E	110	G	E	20	F	F	>480	E	G	13	F	G	<10	F	G	<10	F
157. Vertrel SMT	E	<10	G	P	—	—	F	<10	P	G	17	G	G	<10	F	F	<10	F	P	—	—
158. Vertrel XE	E	105	E	E	>480	E	E	47	G	F	40	VG	G	303	E	E	17	VG	E	43	VG
159. Vertrel XF	E	>480	E	E	>480	E	E	>480	E	F	387	VG	E	>480	E	E	337	VG	E	204	VG
160. Vertrel XM	E	120	E	E	>480	E	E	105	E	F	10	G	P	—	—	E	23	VG	E	30	VG
161. Vinyl Acetate	▲	>480	E	F	18	F	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
162. Vinyl Chloride Gas	▲	>480	E	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
163. Xylene, Xylol	▲	>480	E	G	75	F	NR	—	—	E	>360	E	NR	—	—	NR	—	—	NR	—	—

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NOTE:

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

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

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

PPE DONNING SEQUENCE

1. REMOVE JEWELRY.
   TIE BACK HAIR AND SECURE HEADWEAR
   (EG. HIJAB, TURBAN, KIPPAH, TAQIYAH)
2. WASH HANDS
3. SCRUBS (IF REQUIRED)
4. BOOTIES (IF REQUIRED)
5. LAB COAT* OR GOWN
6. HEAD COVER (IF REQUIRED)
7. RESPIRATOR/FACE MASK (IF REQUIRED)
8. EYE PROTECTION
9. GLOVES** (DOUBLE GLOVE IF REQUIRED)

* Snap closures on the front is recommended for easy removal in case of contamination.
** Gloves with extended cuff is recommended. If double gloving, extended cuff is recommended for base layer.

PPE DOFFING SEQUENCE

1. BOOTIES (IF WEARING)
2. GLOVES (OUTER GLOVE ONLY IF DOUBLE GLOVED)
3. LAB COAT OR GOWN
4. REMOVE BASE LAYER GLOVE (IF DOUBLE GLOVED)
5. WASH HANDS
6. EYE PROTECTION*
7. RESPIRATOR**/FACE MASK (IF WEARING)
8. HEAD COVER (IF WEARING)
9. SCRUBS (IF WEARING)
10. WASH HANDS

* Avoid touching face while removing safety glasses and respirator/face mask
** Do not touch the front of respirator

Transportation of Dangerous Goods (TDG)

As per the federal Transportation of Dangerous Goods (TDG) Act and Regulations, faculty, staff and students at SFU involved with the transport or transport-related handling of regulated dangerous goods must have valid training certification. For full details, refer to the SFU TDG Program at https://www.sfu.ca/srs/work-research-safety/research-safety/lab-safety/transport.html.

Dangerous goods are solids, liquids or gases that are capable of posing a significant risk to people, health, property or the environment when transported in quantity. Examples include corrosives, flammables, toxics, oxidizers, compressed gases, infectious materials and/or radioactive materials.

The **Guide to transportation of dangerous goods** document (found on the EHS website) is available for trained faculty, staff and students. For movement of dangerous goods exempted from the training requirement, individuals may use the guide for information but must also contact a TDG-certified individual for assistance.

Determining TDG

To determine whether a product is subject to TDG, check the Safety Data Sheet under Section 14, Transport information. Products subject to TDG will have an associated "UN number" such as UN1013 for carbon dioxide gas.

A TDG package will display distinctive labels associated with one or more of the 9 TDG classes. See Appendix A in the **Guide to transportation of dangerous goods** document for labels associated with each class.

- Class 1 - Explosives
- Class 2 - Gases
- Class 3 - Flammable liquids
- Class 4 - Flammable solids
- Class 5 - Oxidizing substances & organic peroxides
- Class 6 - Toxic and infectious substances
- Class 7 - Radioactive materials
- Class 8 - Corrosive substances
- Class 9 - Miscellaneous products, substances, or organisms

Shipping & receiving dangerous goods

Class 7 Radioactive materials must be received by EHS Radiation Safety personnel. For shipment of Class 7 Radioactive materials, contact EHS Radiation Safety personnel. For all other dangerous goods, faculties and departments should have a designated receiver. Goods destined for the Faculty of Science must pass through Burnaby campus Science Receiving. If you are receiving shipments, you do not require the valid TDG training certificate unless you are receiving imported shipments. You must complete all other relevant workplace safety training (e.g., WHMIS 2015) for the dangerous goods you expect to receive.

Transport On Campus

Hazardous Material Delivery Service

A free delivery service is available for all hazardous material purchases (including stock items) made through Science Stores. Complete the requisition on the following page under "Delivery of hazardous chemicals":

> http://www.sfu.ca/science/faculty-support/facilities-services/science-stores.html

All labs are encouraged to use the delivery service, especially those labs which are located furthest away from Science Stores (e.g., Blusson Hall, Saywell Hall).

Important information for transporting chemicals

If you choose to pick up your chemicals/biological materials from Science Receiving or if you must transport samples or reagents between labs, observe the following precautions:

- preferably use a sealed primary container for your hazardous material
- the container size should be as small as possible and should not exceed 4.4 liters
- choose products in containers with a protective plastic coating whenever available
- either use a cart with raised edges and secondary containment or a bottle carrier (limit of one carrier per person)
- always use a carrier with a handle, even for a single small container of hazardous material, and add supports/cushioning if necessary
- ensure supports such as test tube racks or cork rings are properly sized for the items they hold
- use required personal protective equipment for the material being transported (e.g., lab coat, safety glasses and gloves) but keep one hand glove free to open doors and press elevator buttons
- try to avoid areas and times where many people are gathered
- assess beforehand how to respond to a potential spill along your route and consider having a basic spill kit with you
- If there is a spill: never leave a spill unattended, unless you require first aid

Additional safety for flammable liquids

- Place in metal safety cans whenever feasible.
- Use only appropriate manufacturer supplied containers. The size should be as small as possible and should not exceed 4.4 liters. For containers exceeding 4.4 liters, prior department approval is required.

Chemical Storage

Proper chemical storage is a complex and challenging component of laboratory management. Poor or incorrect chemical storage practices can result in inadvertent reactions between incompatible materials with potential to cause chemical exposure, injury, fire or explosion.

Hazardous chemical storage manual

SFU's Hazardous Chemical Storage Manual is intended to promote the safe storage of chemicals by offering information on regulatory compliance and best practices for chemical labelling and general storage requirements, as well as specific storage and segregation information for certain types of chemicals. This manual applies to all faculty, staff, students and visitors at the University who will be involved in the use and management of chemical storage in laboratories. It can be found here:

> https://www.sfu.ca/srs/work-research-safety/research-safety/chemical-safety/program-manuals.html

General storage requirements

See below for some basic storage requirements and refer to the manual, as well as the SFU Chemical Storage and Handling page for additional details:

- Chemicals must be stored according to chemical compatibility such that incompatible materials do not come in contact with each other in the event of a breakage or spill.
- In cases where it is not practical to store incompatible chemicals in physically separate locations, it is acceptable to segregate chemicals using glass, porcelain or heavy gauge plastic secondary containers. The secondary containers must be compatible with the material being stored and large enough to contain any spills.
- Ensure storage areas have adequate lighting and ventilation, and are maintained at a consistent, cool temperature.
- Ensure chemical storage areas do not block aisles, hallways, doorways, exits or emergency equipment (e.g., eyewash, shower, pull stations, fire extinguisher).
- Do not store chemicals in a fume hood unless the fume hood is used exclusively for storage and is labelled as such.

https://www.sfu.ca/srs/work-research-safety/research-safety/chemical-safety/storage-handling.html

Storage equipment

Using specially designed equipment for storage of flammables, acids, or corrosives allows certain specific requirements to be met. Equipment should be labelled with the hazard class(es) of the chemicals stored within.

<u>Flammable storage cabinets</u> are not required to be vented and it is not recommended. Ensure safety caps (bungs) are in place over ventilation ports to contain/protect contents from fire.

<u>Acid and corrosive storage cabinets</u> must be completely lined with corrosion-resistant materials and include corrosion-resistant hardware. It is recommended that they be located below the fume hood and vented in order to prevent the buildup of corrosive vapours, which can degrade the inside of the cabinet.

<u>Fume hoods</u> should not be used for long-term chemical storage. Fume hoods which have been designated for temporary chemical storage must be labelled "For Storage Only".

Ordinary (domestic) <u>refrigerators and freezers</u> used for chemical storage must never be used to store food (and labelled "NO FOOD - LAB CHEMICAL STORAGE ONLY") and must not be used for storage of flammable liquids.

Specific storage requirements

Storage requirements for the most common chemical hazard classes are summarized below. Refer to the manual for additional details related to these and other hazard classes.

Note that many chemicals fall into multiple hazard classes. Consequently, it may be necessary to consult several sections to determine how to store a chemical safely. Furthermore, some complex substances may not fit easily into any category, in which case it becomes necessary to consult various other resources (e.g., Safety Data Sheet or SDS, literature, your Supervisor, EHS) in order to determine safe storage conditions.

Flammable and combustible liquids

- Examples include: acetone, diethyl ether, ethanol, hexane, methanol, tetrahydrofuran, toluene, and xylene.
- Store a maximum of 25 L of flammable and combustible liquids in the open laboratory. Larger volumes must be stored in an approved flammable storage cabinet, up to a maximum of 500 L per fire compartment (i.e., a laboratory or a shared laboratory).
- Keep flammable and combustible materials away from any ignition sources: heat, flames, sparks, hot surfaces and direct sunlight.
- Keep flammable and combustible materials away from strong oxidizing agents, such as nitric or chromic acid, permanganates, chlorates, perchlorates and peroxides.
- Containers of flammable and combustible liquids must not exceed a capacity of 5 L.
- Ensure an appropriate fire extinguisher is readily available in the laboratory and that laboratory occupants are trained to use it.
- Flammable cabinets are used preferentially for flammable liquids and if space allows, for combustible liquids.
- Refrigerators and freezers used for storing flammable or combustible liquids must be "Lab safe" or rated for flammable material storage.

Chemical Storage

Corrosives

- Examples include: organic acids such as acetic and citric acids; inorganic acids such as hydrochloric, hydrofluoric, nitric, and sulfuric acids; organic bases such as diethylamine and piperidine; and inorganic bases such as potassium hydroxide and sodium hydroxide.
- If storage space permits, acids and bases should be stored in separate cabinets, but can be stored together when segregation is ensured with secondary containment bins.
- Segregate inorganic acids from organic acids and inorganic bases from organic bases, as a general rule of thumb.
- Nitric acid is a strong oxidizer and it must be isolated from other acids and stored separately from incompatibles: flammables, bases, hydrogen sulfide, organic materials, metals and metal compounds.
- Hydrofluoric acid attacks glass and should be stored in tightly closed polyethylene, Teflon, neoprene or nitrile containers. For long-term storage, check permeation ratings for chosen container material. For more information, refer to the link for Hydrofluoric acid in Substance specific procedures.
- Do not store corrosives on metal shelves.
- Use corrosion resistant bins (e.g., polypropylene) as secondary containment for spills, leaks, drips or weeping.
- Cabinets used for corrosives storage should be made of corrosion resistant materials and vented.

Toxics

- Examples include: acrylamide, ammonia, aniline, 2-mercaptoethanol, mercury, phenol, and sodium cyanide.
- Non-volatile toxic chemicals may be stored in a normal cabinet, separate from incompatibles.
- Volatile toxic chemicals should be stored in a ventilated cabinet.
- Ensure containers are tightly sealed to minimize exposure to personnel and contamination of other chemicals.
- Toxic chemicals that are acid sensitive, such as cyanides and sulfides, must be stored in a separate location from acids and protected from contact.
- Store severe poisons in a dedicated cabinet.
- Controlled substances have additional precautions for secure storage. Contact EHS for assistance.

Oxidizers

- Examples include: ammonium persulfate, nitric acid, potassium permanganate, chlorates, perchlorates, and peroxides.
- Store in a cool, dry place. Some may require refrigeration – consult the SDS.
- Segregate from flammable and combustible materials, including paper and cardboard.
- Store separately from reducing agents (e.g., zinc, alkaline metals, formic acid).

Substance Specific Procedures

Special precautions must be taken when working with potentially dangerous hazardous materials. Several SFU specific safe work procedures have been developed for the following materials or classes of materials:

- Aqua regia
- Azides
- Compressed gases
- Cryogens and dry ice
- Cyanides
- Cyanogen bromide
- Energetic material
- Engineered Nanomaterials
- Ethidium bromide
- Hydrofluoric acid
- New Substances (Unknown Health Hazards)
- Perchloric acid
- Peroxide-formers
- Piranha Clean
- Pyrophoric compounds

For access to the procedures listed above, refer to the EHS webpage:

https://www.sfu.ca/srs/work-research-safety/research-safety/chemical-safety/procedures.html

An example of the information available in these substance specific procedures is shown in the following excerpt on working safely with perchloric acid.

Perchloric acid

Precautions

The chemical formula for perchloric acid is $HClO_4$. It is a strong oxidizing agent that will ignite when in contact with organic materials. Anhydrous perchoric acid may explode at room temperature. This acid must be inspected monthly for discoloration.

Fume Hood Use

Perchloric acid bottles are only stored in Science Stores. Room temperature perchloric acid may be used on open (non-wooden) bench tops, however, any experiments requiring exhaust extraction may only be conducted in the designated perchloric acid fume hood located in SSB 6166. No other fume hood at SFU may be used for this acid. Please arrange with the staff of this laboratory if you must use the special stainless steel fume hood that allows the duct work and inside walls to be washed down after use.

Spill Kit

Transfer of perchoric acid to and from Science Stores must be accompanied by the perchloric acid spill kit which consists of acid neutralizer and items enabling a user to scoop the material into a metal can to be filled with water.

Incompatibilities

The following chemicals have been known to cause fires or explosions upon contact with perchloric acid; therefore, do not store perchloric acid with, or allow contact with the following chemicals:

Acetic acid	Glycol ethers
Acetic anhydride	Hydriodic acid
Alcohols	Hydrochloric acid
Aniline & formaldehyde mixtures	Hydrophosphites
Antimony compounds (trivalent)	Ketones
Bismuth	Nitrogen triiodide
Dehydrating agents	Nitrosophenol
Diethyl ether	Organic matter (paper, wood)
Fluorine	Sodium iodide
Glycerine and lead oxide mixtures	Sulfoxides
Glycols	Sulfur trioxide

Substance Specific Procedures

Guideline for Working with New Substances that have Unknown Properties and Unknown Health Hazards

Research laboratories frequently generate new substances that have unknown properties. The specific health hazards associated with these compounds are not known. For this reason, it is important for laboratory personnel to conduct their research under conditions that minimize the risks from substances with both known and **unknown hazardous properties**. The MSDS must be used for substances that have had their health hazards identified. All new compounds should be considered hazardous. This guideline outlines general work practices designed to achieve risk reduction for known but **specifically for substances that have unknown properties and unknown health hazards.**

Please include the following actions into your risk assessment when generating a new substance. All reagents, reaction intermediates, possible reaction byproducts and potential unknown substances must be considered during the risk assessment. If available, review MSDS *http://ccinfoweb.ccohs.ca/msds/search.html*

Actions to take when PROPOSING a project that involves a new substance that has unknown properties and unknown health hazards:

1. You must discuss the proposed project and new substance with your supervisor.
2. Consult other principal investigators or lab personnel who may have worked with similar material(s).
3. If available, consult multiple published papers. Pay attention to the potential safety implications of subtle changes to experimental procedures (i.e. solvent, concentration, reagent (side groups, state or form) and equipment material). Subtle changes could bring unintended consequences.
4. Consult the EHS website to determine if a substance specific procedure is applicable to your research project (i.e. Energetic Materials Guide). *https://www.sfu.ca/srs/work-research-safety/research-safety/chemical-safety/procedures.html*

Actions to take BEFORE you start working with a new substance that has unknown properties and unknown health hazards:

1. Scale down the synthesis. By minimizing the amount of material available, you reduce the risk and also increase the chance that if something goes wrong the situation will be more manageable (i.e. chemical spill or fire). When larger amounts of materials are needed, consider running parallel 'batch' reactions so one reaction does not contain large amounts of material.
2. Work in a fume hood. The fume hood should be clear of obstructions and unnecessary chemical containers. By working in a fume hood you minimize exposure to potentially harmful gases, vapours and fumes. The sash also provides a physical barrier that can protect you from splashes and debris from a minor explosion.
3. Wear personal protective equipment, this includes (but is not limited to) a lab coat, goggles and gloves. **Note: No single glove material provides effective protection for all uses.** *https://www.sfu.ca/srs/work-research-safety/research-safety/lab-safety/personal-protective-equipment.html*
4. Assume that any chemical mixture will be more toxic/flammable/unstable than its toxic/flammable/unstable components.
5. Communicate to other lab personnel what you are doing (i.e. have your name and reaction written on the fume hood sash (including reagents and reaction intermediates) and discuss your project in a weekly group meeting). Members of your lab group may be able to offer guidance or may need to take precautions themselves.
6. Be prepared for an accident. Before you begin your experiment know the specific actions needed in the event of an accidental release of hazardous material.

For more information, consult *http://www.sfu.ca/srs/ehs.html* or contact EHS at local 27265

Explosive and Unstable Chemicals

Azides

Azides have the chemical formula $R(N_3)X$. All heavy metal azides, most light metal ones, and many organic azides are explosive.

Picric Acid

Picric acid has the chemical formula $C_6H_2(NO_2)_3OH$. Do not open old bottles as crystals may have formed within the cap threads, creating the potential for a shock-sensitive explosion. Bottles with less than 10% water should not be touched or moved.

Other Explosive Compounds

The following compounds may detonate, decompose, or explode at normal room temperature and pressure. Some are also heat and shock sensitive.

acetyl peroxide (25% in dimethyl phthalate)	tert-dibutyl peroxide
ammonium perchlorate	diethyl peroxide
3-bromopropane	diisopropyl peroxydicarbonate
tert-butyl hydroperoxide	o-dinitrobenzene
tert-butyl perbenzoate	ethyl methyl ketone peroxide
tert-butyl peroxyacetate (75% in benzene)	ethyl nitrate
tert-butyl peroxypivalate (75% in mineral spirits)	nitroglycerine
nitromethane	2-nitro-p-toluidine
1-chloro-2,4-dinitrobenzene	peroxyacetic acid (in 60% acetic acid)
cumene hydroperoxide	picric acid
diacetyl peroxide	trinitrotolune
dibenzoyl peroxide	trinitrobenzene

Peroxides

A peroxide is any compound containing an O-O bond. Since these compounds can readily release oxygen, they are considered to be strong oxidizing agents and fire hazards. They are sensitive to shock, sparks and flames. The danger is increased when peroxide forming chemicals are concentrated by distillation or evaporation. When possible, purchase chemicals with stabilizers to inhibit the formation of peroxides.

Test Every 3 Months

Test the following compounds for peroxides every 3 months, after opening, and before use. They can form explosive peroxides during storage.

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

Test Every 12 Months

Test the following compounds for peroxides every 12 months, after opening, and before use. They can form explosive peroxides during concentration.

acetal	4-Heptanol
acetylaldehyde	2-hexanol
benzyl alcohol	methyl acetylene
2-butanol	3-methyl 1-butanol
Cumene	methylcyclopentane
Cyclohexanol	methyl isobutyl ketone
cyclohexene	2-pentanol
decahydronaphthalene	4-penten-1-ol
diacetylene	1-phenylethanol
dicyclopentadiene	2-phenylethanol
diethylene glycol dimethyl ether	2-propanol
diethyl ether	tetrahydrofuran
dioxanes	tetrahydronaphthalene
dimethyl ether	vinyl ethers
ethylene glycol dimethyl ether (glyme)	

Test these compounds every 12 months also. They can initiate explosive conditions once peroxides are formed.

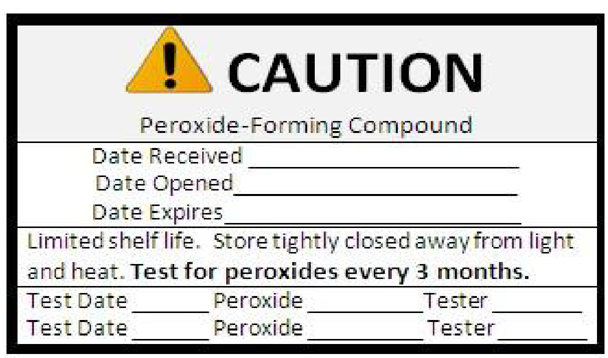
acrylic acid	tetrafluoroethylene
acrylonitrile	vinyl acetate
butadiene	vinyl acetylene
choroprene	vinyl chloride
chlorotrifluoroethylene	vinylidene chloride
methyl methacrylate	vinyl pyridine
styrene	

Please note these lists are not exhaustive. Check the Safety Data Sheet (SDS) of all chemicals to determine if they form peroxides and for additional safe handling procedures.

Labels for Peroxide Forming Compounds

Labels for peroxide-forming compounds are available at Science Stores and on the EHS webpage at http://www.sfu.ca/srs/ehs.html.

Peroxide formers are required to have labels. Science Stores will put labels on peroxide formers kept in stock.



Incompatible Chemicals

acetaldehyde	acetic anhydride, acetic acid, acetone, ethanol, sulfuric acid
acetic acid	chromic acid, nitric acid, hydroxyl, compounds, ethylene, glycol, perchloric acid, peroxides, permanganates
acetone	concentrated nitric and sulfuric, acid mixtures
acetylene	chlorine, bromine, copper, fluorine, silver, mercury
alkaline metals	water, carbon tetrachloride and other chlorinated hydrocarbons, carbon dioxide, halogens
ammonia (anhydrous)	mercury, chlorine, calcium, hypochlorite, iodine, bromine, hydrofluoric acid (anhydrous)
ammonium nitrate	acids, powdered metals, flammable liquids, chlorates, nitrites, sulfur, finely divided, organic or combustible materials
aniline	nitric acid, chromic acid, hydrogen peroxide
bromine	ammonia, acetylene, butadiene, butane, methane, propane (or other petroleum gases) hydrogen, sodium carbide, turpentine, benzene, finely divided metals
carbon (activated)	calcium hypochlorite, all oxidizing agents
carbon tetrachloride	diborane, fluorine
chlorates	ammonium salts, acids, powdered metals, sulfur, finely divided organic or combustible materials
chromic acid and chromium trioxide	acetic acid, napthalene, camphor, glycerol, alcohol, turpentine, all other flammable, liquids
chlorine	ammonia, acetylene, butadiene, butane, methane, propane (or other petroleum gases), hydrogen, sodium carbide, turpentine, benzene and finely divided metals
chlorine dioxide	ammonia, methane, phosphine, hydrogen sulfide
copper	acetylene, hydrogen peroxide
cumene hydroperoxide	acids (organic or inorganic)
cyanides	acids
dimethyl sulfoxide	perchloric acid, silver fluoride, potassium permanganate, acetylchloride, benzene, sulfonyl chloride
flammable liquids	ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens
fluorine	isolate from everything
hydrocarbons (propane, benzene, gasoline, etc.)	fluorine, bromine, chlorine, chromic acid, sodium peroxide
hydrocyanic acid	nitric acid, alkali
hydrofluoric acid (anhydrous)	ammonia, aqueous or anhydrous
hydrogen peroxide	cooper, chromium, iron, most metals or their salts, alcohols, acetone, organic materials, aniline, nitromethane, flammable liquids, combustible materials
hydrogen sulfide	fuming nitric acid, oxidizing gases
iodine	acetylene, ammonia (aqueous or anhydrous), hydrogen
mercury	acetylene, fulminic acid, ammonia, oxalic acid
nitric acid (concentrated)	acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen sulfide, flammable liquids, flammable gases
oxalic acid	silver, mercury agents
phosphorus (white)	air, oxygen, alkalis, reducing
potassium	carbon tetrachloride, carbon dioxide, water
potassium chlorate	sulfuric and other acids
potassium permanganate	glycerol, ethylene glycol, benzaldehyde, sulfuric acid
silver	acetylene, oxalic acid, tartaric acid, ammonium compounds
sodium	carbon tetrachloride, carbon dioxide, water
sodium peroxide	ethyl or methyl alcohol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerin, ethylene glycol, ethyl acetate, methyl acetate, furfural
sulfuric acid	potassium chlorate, potassium perchlorate, potassium permanganate (similar compounds of light metals such as sodium, lithium)

Working with Laboratory Glassware

A significant part of working safely involves hazard awareness. The most frequent laboratory glassware accidents result in minor cuts. More serious accidents include hazards associated with flying glass, fire, and chemical exposure.

Wear safety goggles when working in the laboratory! Aside from injury reduction, hazard awareness can save you time (ruined reactions) and money (broken glassware and ruined reagents).

Glass Types

Glass contains silica, an element found in sand. There are three primary glass types found in laboratories: soda lime (soft), borosilicate (hard) and pure fused quartz (99% silica). Pyrex™ is a brand of hard glass. Soft, hard and quartz glass have working temperatures of up to 110, 230, and 1000 ºC, respectively.

Hot Glass

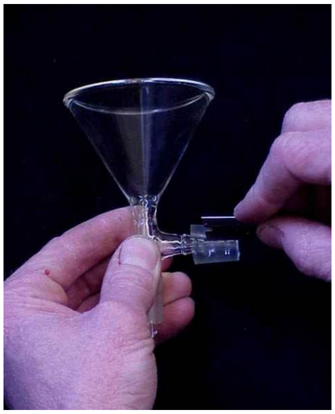
A problem with hot glass is that it looks the same as cool glass. Try to establish routines that allow hot glass to cool in out-of-the-way locations. For example, before removing glassware from an autoclave, crack the door and allow the glass to cool for several minutes before handling. The use of gloves and tongs can prevent burns, but they may make handling items awkward.

Preventing Cuts

Heavy gloves should be worn when washing glassware by hand. Glassware cuts are more common than you might expect and can be serious. In one accident, an Iowa State University laboratory employee suffered cuts to five wrist tendons. Fortunately, the cuts were shallow and the injury did not result in permanent impairment.

Inserting glass stems into rubber stoppers, or connecting tubing to glass nipples (as on a side arm flask) can be made safer and easier by first lubricating the glass. Laboratory grease works well, but even deionized water is better than nothing. Protect hands with gloves, rags, or a shield fashioned from wood or plastic. Then, with some type of hand protection, slowly work the tubing onto the glass nipple or the glass stem into the stopper.

When removing tubing from glassware, do not attempt to pull it off. First lay the item on the lab bench, if possible. Cut the tubing near the end of the glass. Always cut away from your body. Next, slice the tubing lengthwise and slide the material off the glass nipple.



Fittings

An alternative to barbed glass nipples are threaded fittings. Plastic tubing is typically connected via a screw cap with a plastic barb fitting and synthetic "rubber" gasket.

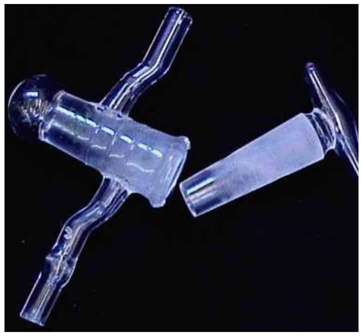
Several manufacturers also offer "quick-connect" fittings. One piece of the connector is threaded semi-permanently into glass. The other side attaches to tubing.

The most common method of connecting laboratory glass apparatus is by ground-glass joints. Typically these are round (image) or tapered. Of the two types, round ground-glass joints are less likely to "freeze."

Frozen Joints

When taper joints are used, the likelihood of "freezing" can be reduced by applying grease. If grease is not an option, or if solvents remove the grease, tetrafluoroethylene (Teflon®) sleeves (inset) can be used to eliminate "freezing".

Once a joint is frozen, try soaking it overnight. If it remains frozen, do not attempt to force it apart. It may be possible to loosen the joint with heat. A hot air gun may be used, but a bunsen burner will likely result in better outcomes. Once all flammable solvents are removed, and proper personal protective eyewear is donned, rapidly apply heat to the outer surface (try to keep the inner glass piece from heating).



While heating, apply a modest pulling force on the two pieces. Tapping lightly with a wooden stick may help. If using a bunsen burner, do not heat for more than 30 seconds. If you do not have a burner or are not interested in performing this procedure, the Glass Shop staff can provide this service for you.

Pressure/Vacuum

When glass is used under pressure or vacuum, taking extra precautions is advised. Surface scratches are the most common defect causing weakness and breakage. Be sure to inspect glassware for small defects before applying pressure or vacuum.

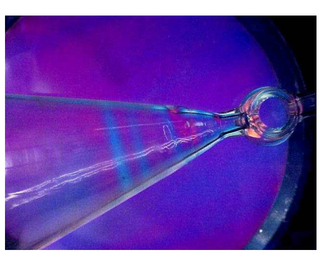
If possible, mechanically pressurized or vacuum pump systems should be operated in a fume hood with the sash down. Pressure-relief and vacuum-relief devices can reduce hazards and improve research outcomes by reducing the chance of glass breakage.

When working with vacuum systems outside of a fume hood, consider using epoxy-coated apparatus or tape the vessel to help contain glass in the event of failure. Where practical, use a bench-top shield. Keep in mind that round vessels will tolerate more pressure or vacuum than flat-sided vessels of similar construction.

Glass Repair

Star cracks and other small defects can be "repaired" at the Glass Shop by annealing. Annealing is a process of heating glass to a specified temperature followed by slow cooling. The "harder" the glass, the higher the applied temperature.

A more insidious glassware hazard is glass stress. Glass can be stressed when heated unevenly above its strain point. It is difficult to stress quartz glass, but relatively easy to stress borosilicate (Pyrex™) glass, which has a strain point of 510 ºC. Additionally, thermal strain is most



severe in thick glass. Glass Shop staff use polarized light to identify glass stress lines.

If you have borosilicate glass that is routinely heated (e.g., distillation equipment), you may wish to get glassware checked out regularly. Annealing removes the stress, making the glassware safer and more reliable.

Chips weaken glassware and may present an injury hazard. Chips and major breaks can be taken to the Glass Shop for economical repair. Before taking glassware in for repair, be sure to empty and clean each item. If acetone or other flammable solvents are used, rinse glassware with water and allow to dry.

Apparatus Set-up

When connecting lab apparatus, it may be necessary to clamp glass to ring stands or other supports. Care should be taken to avoid over-tightening glassware clamps as this may induce mechanical strain.

Glass Disposal

Used and/or broken glassware should be free of chemical and biological hazards prior to disposal. Place glass in a broken glass container. Do not dispose of broken glass in regular garbage.

See next page for more information.

Hazardous Waste Disposal

Hazardous wastes are generated by the University through research, academic and operational activities. Environmental Health and Safety coordinates the collection, consolidation and recycling or disposal of hazardous wastes through our qualified Waste Contractor. Hazardous waste is defined as a product, substance or organism that is no longer used for its original purpose and presents a risk or potential risk to human health and/or the environment due to certain characteristics (ignitability, corrosivity, reactivity, toxicity, infectivity). **Guidelines in this section do not replace the risk assessment that users must perform when working with hazardous materials to determine their safest method of disposal. This section applies to hazardous chemical waste only; for other wastes, refer to:**

Biohazardous Waste	Biosafety Manual
Radioactive Waste	Radiation Safety Manual

Segregation

Many lab wastes that do not exhibit any of the hazardous characteristics (ignitability, corrosivity, reactivity, toxicity, infectivity) can potentially be designated as non-hazardous. Examples include certain salts (i.e., potassium chloride and sodium carbonate), natural products (i.e., sugars and amino acids) and inert materials (non-contaminated chromatography resins and gels). They can be disposed in the regular garbage if not contaminated.

When practical and safe to do so, waste segregation makes economic and environmental sense since it can significantly reduce costs associated with hazardous waste disposal and prevent non-hazardous materials from being incinerated and/or sent to secure landfill.

Liquid Waste

Metro Vancouver, through its Sewer Use Bylaw No. 299, regulates waste discharges into all sewers in the district. Liquid waste is divided into Prohibited Waste (see Table 1), which may never be disposed down the drains, and Restricted Waste, which must meet established concentration limits (see Table 2) in order to be disposed of through the sewer system. Prohibited wastes (as shown in Table 1) or wastes which exceed maximum concentrations in Table 2 are treated as Hazardous Waste. Note: In accordance with the BC Hazardous Waste Regulation, waste may NOT be diluted for the purpose of meeting the allowable concentration limits (Table 2).

Flammable or Explosive waste
Biohazardous waste. Refer to the Biosafety Manual.
Radioactive waste. Refer to the Radiation Safety Manual.
High Temperature waste. Any liquid waste at a temperature higher than 65 °C or any waste that will raise the temperature of waste entering a sewage facility to 40 °C or more.
Corrosive waste. Any waste with a pH of lower than 5.5 or higher than 10.5 or any corrosive properties that may damage drain, building or sewer infrastructure.

Table 1: Prohibited Waste

Aluminum (50.0 mg/L)	Lead (1.0 mg/L)
Arsenic (1.0 mg/L)	Manganese (5.0 mg/L)
Boron (50.0 mg/L)	Mercury (0.05 mg/L)
Cadmium (0.20 mg/L)	Molybdenum (1.0 mg/L)
Chromium (4.0 mg/L)	Nickel (2.0 mg/L)
Cobalt (5.0 mg/L)	Selenium (1.0 mg/L)
Copper (2.0 mg/L)	Silver (1.0 mg/L)
Iron (10.0 mg/L)	Zinc (3.0 mg/L)
Benzene (0.1 mg/L)	Total Oil and Grease (150 mg/L)
Total BETX (1.0 mg/L)	Oil and Grease (hydrocarbons) (15 mg/L)
Biochemical Oxygen Demand (BOD) (500 mg/L)	Polycyclic Aromatic Hydrocarbons (PAHs) (0.05 mg/L)
Chlorophenols including tetra- & penta- chlorophenols (0.05 mg/L)	Sulphate (1500 mg/L)
Cyanide (1.0 mg/L)	Sulphide (1.0 mg/L)
Phenols (1.0 mg/L)	Suspended Solids (600 mg/L)

Table 2: Restricted Waste

Solid Waste

Solid waste that is contaminated with chemicals or other hazardous materials must be collected and disposed of as hazardous waste. Examples include materials such as gloves (and other personal protective equipment), tubing, silica, drying agents, chromatography reagents and filter papers. Laboratory chemicals, in solid form, including surplus hazardous chemicals or experimental by-products, are also disposed of as hazardous waste if they exhibit one or more of the following characteristics: flammability, spontaneously combustible, dangerous when wet, oxidizers, poisonous/toxic, corrosives, environmentally hazardous or containing polycyclic aromatic hydrocarbons.

For additional information, refer to: https://www.sfu.ca/srs/work-research-safety/research-safety/lab-safety/hazardous-waste.html

Common hazardous waste streams at SFU

The following table indicates the common hazardous waste streams generated in campus laboratories:

Category	Waste Description
Organic solvent waste	Segregated into halogenated and non-halogenated
Aqueous waste	Water based liquid waste that may have a pH that falls outside the 5.5-10.5 range, or contains other hazardous contaminants (e.g. heavy metals)
Dry waste with residual contaminants	Any material, but not limited to, plastic bags, empty bottles, plastic containers, paper towel, gloves, pipette tips, filter paper, etc. contaminated with hazardous residue
Surplus chemicals or experimental waste and by-products	Any solid or liquid in an appropriate means of containment, which exhibits one or more of the following characteristics: flammability, spontaneously combustible, dangerous when wet, oxidizer, poisonous/toxic, corrosive, environmentally hazardous, or containing polycyclic aromatic hydrocarbons

Hazardous Waste Disposal

Category	Waste Description
Mercury waste	Includes any equipment containing mercury such as thermometers, barometers, blood pressure gauges, flasks of mercury, etc. as well as materials or containers contaminated with mercury
Gas cylinders	Any cylinder used to hold a gas or any container used to hold a liquefied gas at or above atmospheric pressure
Electrophoresis Gel waste	Gels containing trace amounts of chemicals (i.e. ethidium bromide gel waste).
HPLC/GC sample vials	Small vials containing solutions from analysis on gas chromatography (GC) or high performance liquid chromatography (HPLC) instruments
Sharps	Needles, syringes, blades or laboratory glass capable of causing punctures or cuts
Glass Waste	Contaminated broken and unbroken glass waste and empty glass containers.
Unknowns	A chemical where the chemical composition characteristics are unknown
Unstable/Expired	Chemicals that have decomposed or dried into potentially unstable compounds that may react or become explosive under certain conditions (e.g. ether or other peroxide forming compounds, picric acid).
Vacuum Pump Oil	Hydraulic fluids no longer required for their intended purpose or are waste products

Table 3: Common Hazardous waste streams

Hazardous Waste Collection and Packaging

It is the responsibility of the lab to use good judgment and safe practices if and when combining different wastes in a single container. Always wear PPE, work in a fume hood and allow any reaction to occur before capping waste containers.

Containers

Hazardous waste containers can be obtained through Science Stores. Alternatively, empty containers may be reused for waste provided that:

1. the waste and the original container material are compatible;
2. the original label is defaced; and
3. the waste container is clearly labeled with the contents.

To ensure the safety of laboratory personnel, support staff, and Hazardous Waste Contractors, it is important to consider the following when collecting hazardous waste for proper disposal:

- Always refer to Safety Data Sheets (SDS) of the different chemicals before beginning work to be aware of the specific hazards.
- Check the chemical compatibility of any hazardous waste generated. Do NOT combine incompatible hazardous waste in the same container to avoid fires, explosions and/or spills.
- Check that the waste container is made of a compatible material.
- Ensure your waste container is large enough to safely collect all hazardous waste being generated.
- Use a funnel to avoid contaminating the outside of the container.
- Do not overfill containers. Allow for expansion by filling containers to 75% of total capacity.
- Use venting caps (available from Science Stores) for aqueous waste bottles if it is possible for hazardous waste to generate gases or vapours while being stored in the laboratory.
- Ensure lids are secured to avoid spillage during transport.
- When packing several smaller containers in single box, use suitable packing material (i.e., vermiculite) to prevent breakage; ensure the use of a sufficiently sturdy outer box.

Vented caps

Vented caps are designed to relieve pressure in containers while maintaining their integrity against liquid leaks. The cap is designed to SLOWLY vent gas; the cap will not release pressure from an instantaneous reaction. Vented caps can be obtained through Science Stores. EHS recommends using these caps when collecting different wastes in one container.

Labeling

Hazardous waste labels are required for hazardous chemical waste being collected from SFU laboratories. Individual labels are available from EHS and Science Stores for waste streams as outlined in Table 4.

Waste type	Waste description	Label type
Halogenated Liquid Waste	Organic solvents which contain halogen atoms: chlorine (Cl), fluorine (F), bromine (Br) or iodine (I); including, but not limited to: chloroform, dichloromethane (methylene chloride), carbon tetrachloride and chlorobenzene.	Yellow cardstock, affix with wire twist tie or tie-wrap
Non-halogenated Flammable Liquid Waste	Non-halogenated solvents which do not contain halogen atoms; including, but not limited to: alcohols (methanol, ethanol, isopropanol), acetone, xylenes, ethyl acetate, hexanes and toluene.	White cardstock, affix with wire twist tie or tie-wrap
Chemical Waste	Laboratory chemicals, in solid or liquid form, or materials (i.e., gloves) that come in contact with chemicals, including surplus hazardous chemicals or experimental by-products which exhibit one or more of the following: flammability, spontaneously combustible, dangerous when wet, oxidizers, poisonous/toxic, corrosives, environmentally hazardous or containing polycyclic aromatic hydrocarbons.	Green self-adhesive

See next page for labels

Hazardous Waste Disposal

All waste containers and packages must be properly identified according to the following requirements:

1. Any non-applicable labels must be removed from waste containers and packages or otherwise defaced.

2. The label must be completed in ink and clearly legible.

3. Complete all fields on the label in full (see Figures 1, 2 and 3). Where required, write full chemical name and avoid acronyms, formulas and trade names.

4. Affix the label securely to the waste container or package. Labels for halogenated liquid waste and for non-halogenated liquid waste must be secured using wire twist ties or plastic tie-wraps (cable ties). Labels for chemical wastes are self-adhesive.

5. Peroxide forming chemicals which are being collected for disposal must also be labeled as required for peroxide-forming compounds. For more detailed information on peroxide-forming compounds, consult: https://www.sfu.ca/srs/work-research-safety/research-safety/chemical-safety/procedures.html

Figure 1 – Non-halogenated Flammable Liquid Waste
(NB: actual label size is approx. 10 cm x 14.5 cm)

Figure 2 – Halogenated Liquid Waste
(NB: actual label size is approx. 10 cm x 10.5 cm)

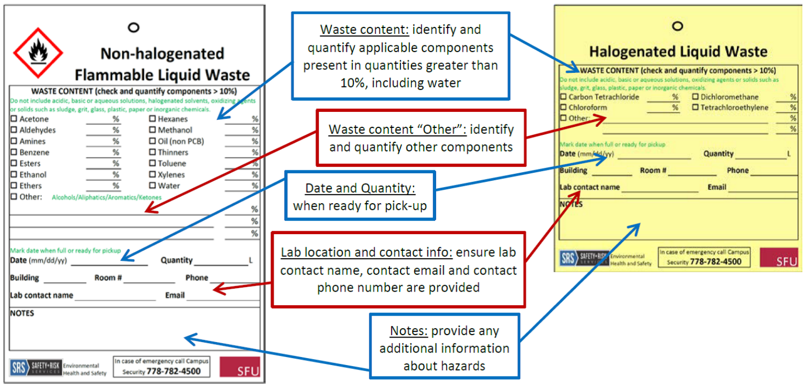
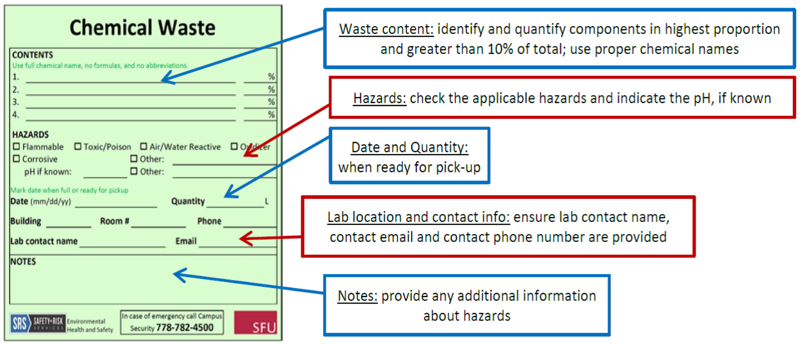


Figure 3 – Chemical Waste
(NB: actual label size is approx. 10 cm x 11.5 cm)



Storage

Hazardous waste should not be stockpiled in the lab but regularly removed by the Hazardous Waste Contractor. The following are guidelines to consider when storing hazardous waste:

• Do not store hazardous waste in high traffic areas, where the likelihood of a spill or knocking over a waste container is higher.

• Storage areas must be well ventilated.

• Store incompatible wastes separately, so they cannot react in the event of a spill or a leak. Consult relevant SDSs for incompatibilities.

• Use secondary containment to contain any spills or leaks.

• Fume hoods that are being used for experiments and reactions are not to be used to store hazardous waste. If a fume hood is designated as a storage for hazardous waste, it may only be used for storage (e.g., no experiments or reactions), and the fume hood must be clearly labeled as such.

• Solvent waste containers should be stored in flammable storage cabinets. The maximum volume of flammable material that may be stored outside a flammable storage cabinet is 25 liters.

• Flammable storage cabinets do not require mechanical ventilation if the safety caps remain in place and the doors remain closed. If ventilation is required for a cabinet, contact Environmental Health and Safety.

Pick up from Laboratories

Hazardous waste is collected from the Burnaby, Surrey and Vancouver campuses by SFU's Hazardous Waste Contractor, GFL, repacked and shipped to a licensed facility for disposal. Pick up days at the Burnaby Campus are Tuesdays and Fridays, pick up at the Surrey Campus is on every other Thursday, and pick up from Vancouver campuses are scheduled when requested.

To request hazardous waste removal, complete a request through the online system at: https://hazmatwaste.its.sfu.ca. The following information must be provided:

• Identification of the waste to be picked up

• Quantity

• How the waste is being stored

• Location of the waste within the laboratory or work area

• Any specific instructions regarding accessing laboratories in restricted areas

• Contact information of someone familiar with the hazardous waste being picked up

The disposal form must be submitted by 3 PM on the day prior to the preferred collection day. Hazardous waste generators must ensure waste containers are ready for collection and at the designated location by 9 AM on the day of collection. Hazardous Waste Contractor personnel have the right to refuse to pick up waste which is inadequately packaged, improperly labeled or in containers with visible external contamination.

Chemical Containers and Glass Waste Disposal Protocol

Chemical Containers and Glass Waste Disposal Protocol

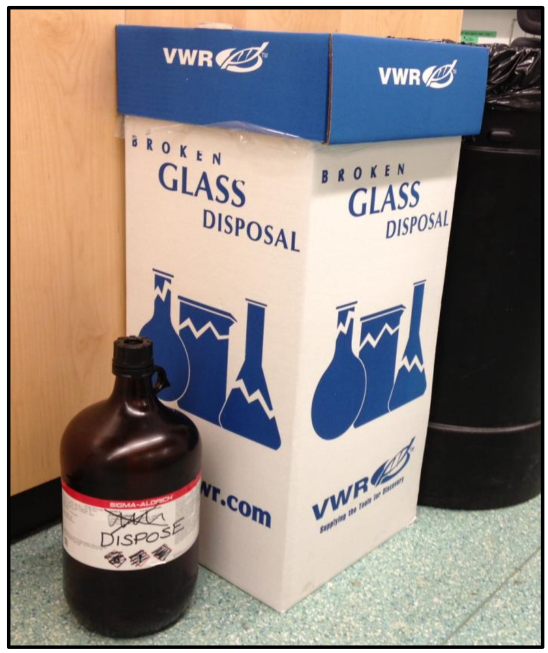
SFU does not recycle chemical containers and laboratory glass waste. All chemical containers and glass waste contaminated with hazardous material must be **TRIPLE** rinsed prior to disposal and the washings disposed of through the appropriate waste stream. All containers and waste contaminated with radioactive material must be brought to the Hot Lab with a completed Radioactive Waste Disposal Acknowledgment Form. Glass waste contaminated with infectious material must be either autoclaved or soaked in bleach for an appropriate contact time prior to disposal. The non-contaminated glass waste is then accumulated in the lab as outlined below and disposed in a landfill by SFU janitorial services.

- If you are unsure about the appropriate disposal method for glass waste contaminated with radioactive material, please contact radsafe-info@sfu.ca
- For all other contaminated glass waste that poses a risk of injury when rinsing or decontaminating, please contact Miles Garcia (EHS, 28633)

Glass and Plastic Chemical Containers

1. Glass and plastic chemical containers must be **TRIPLE** rinsed with water or other suitable solvent and air dried in a fume hood to ensure that it is free of liquid or other chemical residue before disposal.
2. If the glass or plastic chemical container's rinses are classified as hazardous, the washings should be collected and disposed of as hazardous waste.
3. Remove or deface all labels and hazard warnings on the container.

- **Small (< 4 L) glass containers** should be placed inside the plastic liner of the glass waste cardboard container (provided through Facilities Service request).
- **Large (≥ 4 L) glass containers** should have the label removed or defaced and marked "DISPOSE". Place glass containers on the floor, beside the glass waste cardboard container (4L bottles take up a lot of space in the glass waste cardboard container).
- **All plastic containers** should be placed in the garbage can.



Other Laboratory Glassware
Laboratory glassware NOT contaminated with biological, radioactive, or chemical hazards should be disposed of by placing inside the plastic liner of the glass waste cardboard container (e.g., broken glass, pipettes, slides, beakers, vials).

Pick-Up Procedures
When the glass waste cardboard container is full, tie bag and close cardboard lid. Send a request for pick up to *https://fmrequests.sfu.ca*. New glass waste cardboard containers can be requested through the "Photocopy Paper, Personal Protective Equipment and Cleaning Supplies" option in the Facilities Request form with a comment in the Additional Notes box.

If you are unsure of the appropriate disposal method, please contact Miles Garcia (EHS, 28633).

Lab and Equipment Decommissioning

Purpose

A process of decommissioning is necessary for laboratories that are changing hands, are vacated or are undergoing renovations, as well as when a piece of equipment will be removed from a laboratory for service, storage, or disposal. Decommissioning provides assurance that chemical and biological health and safety hazards are minimized for all personnel involved.

Application

Decommissioning applies to the preparation of equipment for moving or servicing and to full or partial renovations of a laboratory including but not limited to any room where chemical, biological, or radioactive materials were handled or stored.

Responsibilities

Principal Investigator - Ensures that all applicable lab equipment and surfaces have been cleared of chemical, physical, biological and radiological hazards; reviews and completes the Decontamination Checklist, if applicable, and signs a Laboratory Clearance Notice or Equipment Clearance Notice; ensures emergency equipment such as eye wash stations, safety showers and fire extinguishers remain operational during the decommissioning and/or move.

Lab Administrator or Designate - Conducts a final inspection and signs the Laboratory Clearance Notice or Equipment Clearance Notice; notifies EHS prior to the lab being cleared and at the time of final inspection; ensures a copy of the Laboratory Clearance Notice or Equipment Clearance Notice is left with the equipment or lab.

Decommissioning guide and checklist

For the detailed guide to decommissioning labs and equipment, the decommissioning checklist and the clearance notices, refer to the EHS webpage:

> https://www.sfu.ca/srs/work-research-safety/research-safety/lab-safety/lab-decommissioning.html

Lab Personnel Departure

When lab personnel leave SFU, the Laboratory Personnel Departure Checklist must be completed prior to the individual's last day. The checklist shall be submitted to the individual's supervisor.

> https://www.sfu.ca/srs/work-research-safety/research-safety/lab-safety/lab-decommissioning.html

Liquefied Gases and Cryogenic Liquids

Cryogens used on Campus

Cryogenic liquids are materials with boiling points of less than -73 °C (-100 °F). Examples for cryogenic liquids used on campus are:

Liquid Helium	-269 °C
Liquid Nitrogen	-196 °C
Solid Carbon Dioxide/Dry Ice	-78 °C

Remember your ABC's...

The primary hazards of cyrogenic liquids are Asphyxiation, Boom (pressure buildup) and Cold (ABC).

Asphyxiation

Adequate ventilation is essential when working with cryogenics. A small amount of cryogenic liquid can rapidly convert to a large volume of gas and create a breathing hazard, and in the case of hydrogen, an explosive mixture. After a recorded double fatality where the victims did nothing to escape or attract attention, safety engineers identified the following physiological stages associated with reduced oxygen:

1st Stage

Oxygen reduced from 21 to 14 percent by volume - The breathing volume increases, the pulse rate is accelerated, and the ability to maintain attention and think clearly is diminished. Muscular coordination is somewhat disturbed.

2nd Stage

Oxygen reduced to between 14 and 10 percent by volume - Consciousness continues, but judgment becomes faulty. Severe injuries may cause no pain. Muscular efforts lead to rapid fatigue. Emotions, particularly ill temper, are easily aroused.

3rd Stage

Oxygen reduced to between 10 and 6 percent by volume - Nausea and vomiting may occur. Victim loses ability to perform any vigorous muscular movements or even to move at all. Up to this stage, or even in it, the person may be unaware that anything is wrong. Then their legs give way, leaving them unable to stand, walk, or even crawl. This is often the first and only warning and it comes too late. The victim may realize that he/she is dying, but he/she does not greatly care. It is all quite painless. Even if resuscitation is possible, permanent damage to the brain may result.

4th Stage

Oxygen reduced below 6 percent - Respiration consists of gasps, separated by periods of increasing duration. Convulsive movements may occur. Breathing then stops but the heart may continue to beat for a few minutes.

Hazards

As can be seen from the descriptions, any reduction in the normal content of the oxygen in the breathing atmosphere must be considered a hazard. In sudden asphyxia, such as that from inhalation of pure nitrogen, unconsciousness is immediate. The individual falls as if struck on the head and may die in a few minutes. If a person becomes groggy or loses consciousness because of displaced breathing air, get the person to a well-ventilated area immediately. If breathing has stopped, apply CPR. Whenever a person loses consciousness, call a doctor immediately.

Where cryogenics are used, a hazard assessment is required to determine the potential for an oxygen-deficient condition. Controls such as ventilation and/or gas detection systems may be required to safeguard personnel.

BOOM - Pressure Buildup

Venting

Containers or pipes containing cryogenic gases need to be vented to limit pressure buildup.

LHe, LN_2 and dry ice all expand by a factor of about 1000 upon warming. If confined, this would lead to pressures of up to 15,000 psi ... BOOM.

Beware of warming up of cryopumped materials.

Ice and Air Plugs

Never leave a dewar open to the air. Liquid Helium can freeze air and cause a plug in the dewar neck leading to pressure buildup. Ice plugs can also form in liquid nitrogen dewars. To properly remove an ice plug, use a heat gun to gently warm up the valve. Keep in mind that too much heat or heat on adjacent areas can cause problems. An alternative to using a heat gun is to pour warm water over the valve, as recommended by Linde .

Water

Water can freeze valves and vents when dewars are repeatedly used. This is caused by frost building up and melting, causing water to run into the valve stem. If this occurs and the valve is stuck open, vent the dewar to relieve pressure.

Oxygen Enrichment

Oxygen in the air will condense on to liquid nitrogen cooled surfaces. Collection of liquid oxygen in organic insulation results in an explosive mixture. Cryotrapped organic compounds mixed with oxygen from an air leak creates an explosive mixture. Liquid oxygen-methane mixtures can be detonated with light. As liquid air evaporates, it becomes enriched in oxygen.

Cold

Contact with cold surfaces can cause cryogenic burns.

Cryogenic Burns: Immediately place affected part in warm water bath (40-46 ºC) and get help!

Contact with cryogrenic gases can occur from splashing when the cryogenic liquid boils. The vapor that boils off from a liquid can cause the same problems as the liquid itself. Never allow any unprotected part of your body to touch uninsulated pipes or apparatus.

Pour slowly to avoid splashing and stand clear of boiling or splashing liquids

There are two types of boiling which can cause uncontrollable movement of the cyrogenic liquid:

Vigorous boiling

Occurs on contact with room temperature objects (mostly for liquid nitrogen).

Film boiling

Room temperature objects are so hot that liquid nitrogen does not wet them but rather floats on a film of nitrogen vapour. There is no friction, and the heat transfer rate is moderate until the liquid wets the surface.

Low temperature baths (dry ice and acetone): No gas film forms so cold liquid sticks to your body.

Embrittlement of Structural Material

Cold can also cause the embrittlement of structural materials. Materials that are pliable under normal conditions can become brittle at low temperatures. Rubber hoses can shatter so ensure you will not be hit with liquid nitrogen if the hose breaks or falls off.

High pressure cylinders may explode if cooled.

Superconducting Magnets:

Large forces on ferromagnetic objects (Iron)
A magnet quench can boil all of the liquid helium releasing large amounts of cold gas.

Personal Protective Equipment must be worn when handling cryogenic liquids

Goggles and face shield: Wear eye protection for the job, chemical splash goggles and a face shield are recommended when handling cryogenic liquids.

Gloves: Gloves must be insulated, impervious to the fluid being handled, and loose enough to be tossed off easily in case the cryogenic liquid becomes trapped close to the skin. Never wear tight gloves when working with cryogenic liquid.

Footwear: High top shoes are recommended. You don't want liquid nitrogen soaking into your socks.

Dewar Recommendations

Given that large Dewars are heavy enough to cause significant injuries if they tip over, it is recommended that:

1. When moving a wheeled Dewar along a route which will present a tipping hazard, no fewer than two personnel shall be present to maintain the stability of the Dewar.

2. For future purchases of Dewars, larger wheels and wider bases should be selected if possible.

Acknowledging that there is a significant risk of asphyxiation by the large volumes of gas contained in these Dewars, it is recommended that:

1. If more than 1 liter of cryogen (He, LN_2 or Dry Ice) per 20 m^3 of air volume is evaporated then precautions must be taken to prevent the creation of an Oxygen depleted atmosphere.

2. If more than 0.1 liter of Dry Ice (CO_2) per 20 m^3 of air volume is evaporated then precautions must be taken to prevent Carbon Dioxide poisoning.

3. Due to the small air volume in an elevator and the restricted access, no actively venting Dewars should be moved in an elevator. Also, the liquid and gas valves must remain closed while in the elevator. Small wheels can become lodged in the gap at the elevator threshold, so when loading the Dewar into the elevator, carefully pull the Dewar so that one wheel passes the gap at a time.

4. Two people are required when moving a Dewar by elevator. After the Dewar is placed inside, the first person should remain outside the elevator and send the elevator to the receiving floor. The second person is stationed at the receiving floor to remove the Dewar. Additional signage is recommended to restrict access while the Dewar is moving between floors.

Cryogenic vial safety

Cryogenic vial safety

An incident involving the explosion of several cryogenic vials is an important reminder that personnel working with cryogenic vials wear the necessary PPE, i.e. cryogenic gloves, lab coat, safety glasses (not prescription eye glasses), and a full face shield with neck protection.

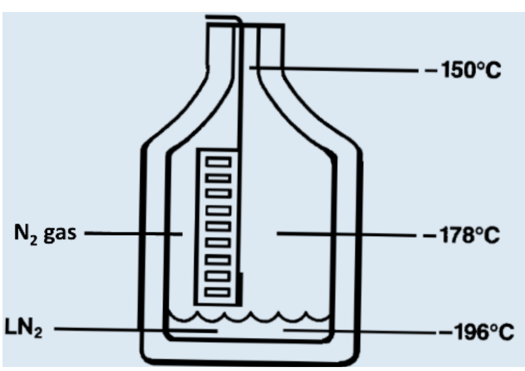
Cryogenic vial specifications

Cryogenic vials should be internally threaded with a silicone gasket (do not over tighten). Glass vials should not be used.

Source: Corning website

Storage of cryogenic vials in liquid nitrogen Dewars

Cryogenic vials should be stored in the gas phase of the liquid nitrogen storage Dewar. Storage by immersion in liquid nitrogen is not advised as liquid can enter the vials and when the vials are removed from the Dewar and warmed up, the liquid nitrogen will expand by a factor of 700 times. Over pressurization of the vial resulting in an explosion could occur.



Source: Columbia University

If vials require storage in the liquid phase, ensure that vials are sealed in CryoFlex™ tubing (cryogenic heat shrink tubing).

Retrieval and thawing of cryogenic vials

Cryogenic vials stored in the liquid phase of the liquid nitrogen storage Dewar should be moved and stored in the gas phase of the Dewar for at least 24 - 48 hrs to allow for any liquid nitrogen inside the vial to evaporate.

If feasible (based on pathogenicity of the material), loosen the lid on the cryogenic vial immediately after removing the vial from the liquid nitrogen storage Dewar.

Thawing of cryogenic vials should take place immediately in a thick-walled container or a fume hood or biosafety cabinet.

It is reccomended that cryogenic vials are not reused.

Compressed Gases & Gas Regulators

Compressed Gas Cylinders

Compressed gas cylinders are very heavy. Don't become injured trying to stop a cylinder from falling. Stand back and let it fall.

Purchase of Cylinders

Before purchasing cylinders, check your lab's current inventory to prevent unnecessary stockpiling.

Do not accept a gas cylinder that does not identify its contents legibly by name.

Transporting Cylinders

The cap must be on while transporting. If the valve is knocked off of a full cylinder, it will take off like a rocket.

Do not drag, roll or slide gas cylinders, they must be transported on a specially designed cart with retaining straps or chains.

Storage of Cylinders

The following general precautions should be taken when storing compressed gas cylinders or lecture bottles:

- Always label cylinders with their contents; do not depend on the manufacturer's color code. They may vary across companies.
- Cylinders must always be securely restrained. Securely strap or chain gas cylinders to a wall or benchtop. In seismically active areas, use more than one strap or chain. EHS recommends using two restraints chains at the levels of 1/3 and 2/3 the height of a K sized cylinder.

- When cylinders are no longer in use, shut the valves, relieve the pressure in the gas regulators, remove the regulators, and cap the cylinders.
- Segregate gas cylinder storage from the storage of other chemicals.
- Do not store corrosives near gas cylinders or lecture bottles. Corrosive vapors from mineral acids can deface markings and damage valves.
- Keep incompatible classes of gases stored separately. Keep flammables away from reactives, which include oxidizers and corrosives.
- Segregate empty cylinders from full cylinders.
- Keep in mind the physical state (compressed, cryogenic, or liquefied) of the gases.
- Store compressed gas cylinders in a cool, dry area, away from flammable materials, sparks, flames, excessive heat, and sources of potential physical damage, electrical contact or corrosion

The protection cap should be left in place until the gas cylinder is secured and ready for use.

Removing the cap

Be careful not to open the valve when removing a tight cylinder cap.

CGA Fittings

There are a large number of different connections used on the cylinders and regulators. These connections vary in diameter, some are male and some are female, and some are right-handed threads and some are left-handed threads. This is done to prevent mixing of incompatible gases or the use of unsuitable regulators.

Venting

The system should have a properly vented relief valve. Vent pressure-relief devices protecting equipment that is attached to cylinders of flammable, toxic, or otherwise hazardous gases to a safe place.

Sudden Release

Would you be safe if there was a sudden release of gas? Know what hazards the gas presents:

Is it toxic? Flammable? Reactive?

Adiabatic Compression & Oxygen/Reactive Gas Hazards

Never allow any lubricant to be in contact with compressed oxygen.

Open valves slowly, high velocities or rapid compression of the gas in the pipe can ignite the tubing (even stainless steel).

Hydrogen requires special care due to its wide flammability limits.

Never lay an acetylene cylinder on its side.

Consult the Linde catalogue for more information on the specific hazards of the compressed gas you are working with.

Pressure Regulators

Pressure regulators are required to reduce a high-pressure supplied gas to a desirable lower pressure and to maintain a satisfactory delivery pressure and flow level for the required operating conditions.

Under no circumstances should oil or grease be used on regulator valves or cylinder valves because these substances may react with some gases (e.g., oxygen).

With the regulator in hand, make certain the pressure adjustment knob is turned counterclockwise as far as it will go. Make sure the on-off valve is in the off position. Tighten the regulator onto the cylinder with a wrench, using no more force than you can exert with two fingers on the end of the wrench.

Stand to the side so that you are not in front of or behind the pressure gauge. Slowly open the cylinder valve, a quarter turn at first, until steady pressure is shown on the inlet gauge. Then open the valve all the way and back it off a half turn. In that way, someone can later sense the position of the valve. A valve that's open all the way feels the same as one that's stuck in the closed position. Acetylene cylinder valves are opened only a quarter turn and no further. Turn the pressure-adjusting knob slowly clockwise until the desired delivery pressure is observed on the process pressure gauge.

Check the entire regulator, including the gauge connections, for leaks. If leaks appear, turn off the cylinder, repair the leaks, and turn it on again. If the body of the regulator leaks, call your supplier.

Fully open the on-off valve. Check all downstream fittings, including the on-off valve. Do not tamper with the packing nut on the on-off valve. Only a qualified mechanic should do any repairs to the pressure regulator.

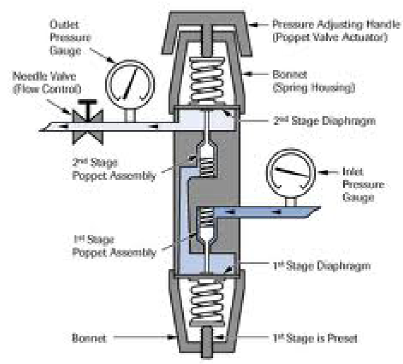
To shut down the system, first turn off the cylinder or the main cylinder valve. Allow the pressure gauge to vent, then back out the adjusting valve counterclockwise and, finally, slowly disconnect the cylinder valve and the system. Slowly disconnect the process or instrument fitting. Slowly remove the regulator from the cylinder, bearing in mind that a small amount of gas might be trapped in the fitting. Recap the cylinder.

What is the difference between a Single Stage and Two Stage regulator?

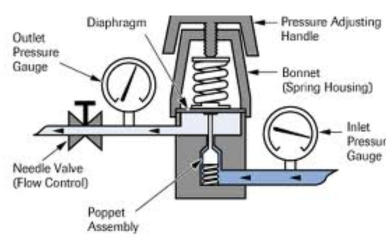
Single-stage pressure regulators reduce the cylinder pressure to the delivery or outlet pressure in one step. Two-stage pressure regulators reduce the cylinder pressure to a working level in two steps.

The best recommended action is to determine how you intend to use the pressure regulator. Generally a single-stage regulator is good for short duration applications; a two-stage regulator is good for long duration applications, such as gas chromatography.

Two-Stage regulator



Single Stage Regulator



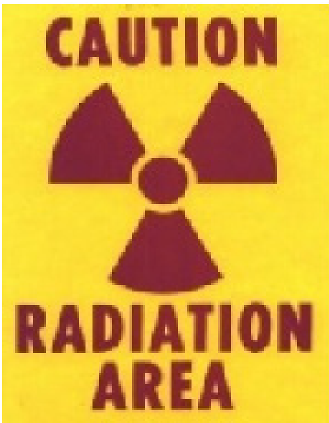
Note: The output of a single stage regulator will rise as the tank drains.

Disposal of cylinders

Do not abandon cylinders in the dock storage areas.

Return cylinders to the supplier when you are finished with them. For more information, contact Science Stores.

Additional Safety Resources



Additional Safety Resources

Biosafety

https://www.sfu.ca/srs/work-research-safety/research-safety/biosafety/program-manuals.html

Radiation Safety

https://www.sfu.ca/srs/work-research-safety/research-safety/radiation-safety/program-manuals.html

Laser Safety

https://www.sfu.ca/srs/work-research-safety/research-safety/laser-safety/program-manuals.html

Magnet Safety

https://www.sfu.ca/srs/work-research-safety/research-safety/magnet-safety/program-manuals.html

X-ray Safety

https://www.sfu.ca/srs/work-research-safety/research-safety/xray-safety/program-manuals.html

Diving Safety

https://www.sfu.ca/srs/work-research-safety/research-safety/diving-safety/program-manual.html

Field Safety

https://www.sfu.ca/srs/work-research-safety/research-safety/field-safety.html

Vessel Safety

https://www.sfu.ca/research/researcher-resources/research-safety/vessel-safety

Lab Ergonomics

https://www.sfu.ca/srs/work-research-safety/general-safety/ergonomics/Lab-Ergonomics.html

Laboratory waste handling guide

For waste that fits in more than one category (e.g., radioactive & biohazardous), contact EHS for guidance labsafe@sfu.ca

Non-hazardous waste

Waste:
- *Non-contaminated* Solid waste → Container: Regular garbage cans → Disposal: Regular pick up by Janitors
- Paper & Cardboard → Container: Paper recycling bin → Disposal: Regular pick up by Janitors
- *Non-contaminated* Glass (broken/ unbroken) → Container: Glass waste boxes → Disposal: Submit Facilities Service Request for pick up by janitors http://fmrequests.sfu.ca

Radiological waste

Waste → Container:
- Low level solids — Supplies (bench paper, gloves, underpads, drained scintillation vials, etc.) which may have been in contact with radioactive material → Clear plastic bag + ID tag + Low level waste can
- High level solids → Clear plastic bag + ID tag + appropriately shielded container
- Empty vial → Pig + vial
- Anatomical waste (animal/ fish carcasses, blood, tissues) → Clear, colourless, 2 mil plastic bag (max 10 kg) + ID tag
- Liquids — Aqueous → Appropriate container in clear plastic bag + ID tag
- Liquids — Organic → SFU solvent waste container + ID tag
- Sharps → Sharps Container + ID tag

Disposal: Return to Hot Lab SSC-B7249, tel. 2-3506

Biohazardous waste

Waste → Container → Disinfection/Labelling* → Disposal:
- Liquids → Decon with appropriate disinfectant (e.g., 10% bleach for 30 min) or autoclave → Dispose down drain
- Anatomical waste (animal/ fish carcasses, blood, tissues) *non-radioactive* → Max 10 kg in black 2 - 4 mil plastic bags + placed in dept. carcass freezer → Anatomical waste label* → Animal Care + Biology: Staff arrange pickup for AC and BISC freezers. For help, contact AC at 2-5905 / acf@sfu.ca or BISC at 2-3301 / biscmlo@sfu.ca; all other depts: Hazardous waste collection
- Solids RG 2 → Orange autoclave bags → RG 2 label* → Autoclave → Hazardous waste collection
- Solids RG 1 → Colourless autoclave bags → RG 1 label* → Hazardous waste collection
- Sharps RG 2 → Red sharps container (RG 2) → RG 2 label* → Autoclave → Hazardous waste collection
- Sharps RG 1 → Red sharps container (RG 1) → RG 1 label* → Hazardous waste collection

Hazardous chemical waste

Waste → Container → Labelling* → Disposal:
- Sharps → Yellow sharps container (Do not autoclave) → Chemical waste label* → Hazardous waste collection
- Solids → Appropriate container (bag, bottle, vial or original packaging) → Chemical waste label* → Hazardous waste collection
- Liquids — Halogenated solvents → SFU solvent waste container (For organic solvents only. No mercury, no oxidizers. Fill 75% max.) → Halogenated solvent waste label* → Hazardous waste collection
- Liquids — Non halogenated solvents → SFU solvent waste container → Non halogenated solvent waste label* → Hazardous waste collection
- Liquids — Other, Aqueous → Appropriate container (20 L carboy; Empty reagent bottle) → Chemical waste label* → Hazardous waste collection
- Cylinders — Lecture size → Chemical waste label* → Hazardous waste collection
- Cylinders — Lecture size / Re-fillable → Return to vendor
- Batteries → Yellow pail at Science Stores → Regular pick up by Facilities staff

Hazardous waste collection:

* Hazardous waste labels are available at Science Stores and through EHS, email labsafe@sfu.ca

Hazardous waste collection:

BBY every Tuesday and Friday | SRY every 2nd Thursday | VAN as needed

Request single or recurring (weekly) pickup

→ http://hazmatwaste.its.sfu.ca

EMERGENCY PROCEDURES

IN AN EMERGENCY CALL 911

CAMPUS SECURITY

**EMERGENCY/
FIRST AID LINE**
778.782.4500

**NON-EMERGENCY/
SAFEWALK LINE**
778.782-7991

EMERGENCY NOTIFICATIONS
WWW.SFU.CA/SFUALERTS

- In an emergency, visit www.sfu.ca and follow @SFU on Twitter.
- Download the SFU snap app

SEE SOMETHING, SAY SOMETHING

- Report suspicious persons/objects to Campus Security.

REPORT SAFETY HAZARDS AND INCIDENTS
WWW.SFU.CA/EMERGENCY

FIRE

- Pull the nearest fire alarm, leave the area and close the door
- Evacuate the building via the nearest exit, do not use elevators
- Proceed to the assembly area
- Do not re-enter until authorized by Fire Department or Campus Security

EARTHQUAKE

- **Drop, cover, hold on** under a heavy desk or table, interior wall, or corner
- Wait 60 seconds after the shaking stops
- Proceed to the designated assembly area

ACTIVE THREAT

- **Run** - Evacuate the area if it is safe to do so
- **Hide** - Lockdown and hide yourself if you cannot evacuate safely
- **Take action** - As a last resort, commit yourself to delay, block or overcome the threat

CARDIAC ARREST

- **Phone 911** and shout for an AED. AED locations: www.sfu.ca/aed
- **Push** hard and fast in the centre of the chest
- **Use an AED** following the automated verbal instructions

SEVERE WEATHER

- Know before you go. Visit www.sfu.ca and follow @SFU on Twitter

SHELTER-IN-PLACE

During hazardous outdoor environments:

- Seek shelter indoors
- Close exterior doors and windows
- Stay indoors until officially advised