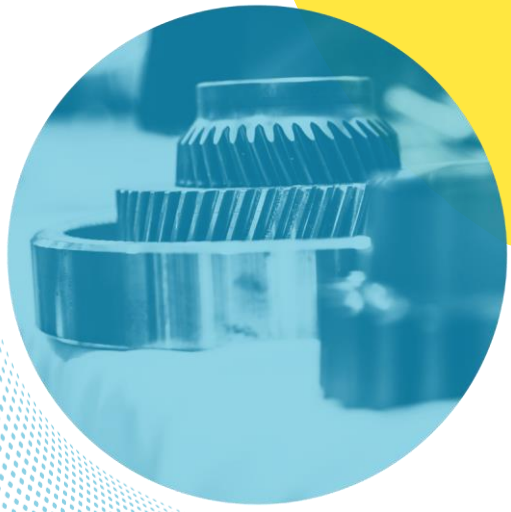
McMaster University Laboratory Manual 2024



For the McMaster University Community
Safety is No Accident

Laboratory Safety: Recognizing, Assessing, Developing, Implementing

BRIGHTER WORLD | uhs@mcmaster.ca | (905) 525-9140 ext. 24352

McMaster University

Acknowledgment

McMaster University and University Health & Safety (UHS) thank the University of California, Los Angeles (UCLA) for permission to adopt their layout of their Chemical Hygiene Plan.

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Introduction

Safety standards at McMaster University are designed to eliminate the risks inherent in the use of dangerous materials and potentially dangerous procedures or practices. All laboratories can be inherently dangerous places and the attitudes and actions of those who work in the laboratory determine their own safety and that of their colleagues and ultimately that of the community.

Different safety procedures and training are set for different levels of risk. High levels of risk require more stringent procedures than lower levels of risks. Changes are therefore made in setting safety procedures and training so as not to impede much needed research while keeping the risks of those involved to a safe minimum. Laboratory equipment and design has become more sophisticated and safer, but safe operation still depends on properly trained and genuinely concerned personnel, who are safety conscious at all times.

Throughout this manual, proper training and knowledge of equipment and materials is reinforced. With the WHMIS 2015 legislation, suppliers are required to provide Safety Data Sheets, and these must always be consulted prior to working with a new material. Always ensure that a knowledgeable and competent person trains you in the safe use of specific equipment. All training must be completed and documented as per the Safety Training Matrix schedule. All job specific hazards must be reviewed. Standard Operating Procedures (SOPs) must be identified and followed. Consult **RMM# 324: Job Hazards Analysis and RMM# 301: Standard Operating Procedures (SOPs) Programs** for details.

This general manual is by no means all-encompassing, and any omission is not an excuse for unsafe practices. If you have questions about how to undertake a task or project safely, contact your supervisor. Roles, responsibilities, specific procedures, and additional information are also outlined in McMaster University's Risk Management Manual (RMM) programs and are referenced below. The individual supervisors must identify and supplement this manual with safe procedures and training specific to the needs of their laboratory safety programs when the safety subject is not adequately covered by this manual. Your Joint Health and Safety Committee (JHSC) members serve as an additional resource.

We trust that this manual will help you to work safely and develop effective safety programs. We welcome any suggestions you have to improve both the manual and McMaster University's health and safety programs as outlined in the Risk Management Manual (RMM).

Further copies of this manual as well as the McMaster University's Workplace and Environmental Health and Safety Policy may be found at the University Health & Safety (UHS) websites and look under Lab Safety Resources and Faculty of Health Science Safety Office (FHSSO) website.

Disclaimer

The Lab Safety Manual is intended to provide basic rules for safe work practices in a laboratory. The procedures may be supplemented with Standard Operating Procedures (SOP) where applicable. Roles, responsibilities, specific procedures, and additional information are also outlined in McMaster University's Risk Management Manual (RMM) and are referenced below.

In all cases the individual supervisor is ultimately responsible for teaching safe work practices and standard operating procedures and must insist upon the use of such proper procedures to eliminate unnecessary hazards.

Purpose

- To define health & safety responsibilities and accountabilities within the University Community
- To outline specific procedures and programs, where applicable
- To explain basic emergency procedures
- To provide information and standards in the form of established Safety Guidelines in laboratories.

This manual may be supplemented as new information becomes available or as new legal standards are developed.

Responsibilities and Rights

Under the Occupational Health and Safety Act (OHSA) and Regulations, supervisors must make their employees aware of dangerous or potential hazards. Employees have a responsibility to report to their supervisors the existence of hazardous conditions which are contrary to good health and safety practices, or which contravene any requirements of the Act or applicable Regulations. It is the supervisor's responsibility to ensure that corrective action is taken at once.

It is the unconditional right of all members of the University to bring without prejudice, health and safety concerns to their supervisors, or to University Health & Safety (UHS)(Human Resources), Faculty of Health Science (FHS.) Safety Office, or to Joint Health and Safety Committees (JHSCs). If possible, the supervisor, in every case, must be informed of a concern before a complaint is taken elsewhere.

It is the responsibility of each member of the McMaster Community to know all emergency procedures, location and use of safety equipment and exit routes in case of an emergency. Consult your supervisor for more information.

Supervisors and PI's

- In the Occupational Health and Safety Act (Section 27) a supervisor is defined as a person who has charge of a workplace, or authority over a worker.

A supervisor is defined by the role they play and not the job title they have. The more responsibility one has over the work being done or the workplace and assigning or overseeing tasks, the more likely that person will be regarded as a supervisor under the Act.

In 2014, the definition of a worker was redefined to mean any of the following, but does not include an inmate of a correctional institution or like institution or facility who participates inside the institution or facility in a work project or rehabilitation program:

1. A person who performs work or supplies services for monetary compensation.
2. A secondary school student who performs work or supplies services for no monetary compensation under a work experience program authorized by the school board that operates the school in which the student is enrolled.
3. A person who performs work or supplies services for no monetary compensation under a program approved by a college of applied arts and technology, university, or other post-secondary institution.

4. A person who receives training from an employer, but who, under the Employment Standards Act, 2000 (ESA), is not an employee for the purposes of that act because the conditions set out in subsection 1 (2) of that act have been met.

5. Such other persons as may be prescribed who perform work or supply services to an employer for no monetary compensation; ("travailleur").

The Occupational Health and Safety Act of Ontario legally requires that the supervisor is held legally accountable for supervisory compliance. Although supervisors may delegate some safety tasks, supervisors are still held accountable for ensuring that the tasks are adequately performed.

Summary of Responsibilities

The following is a summary of responsibilities according to the Occupational Health and Safety Act. Please refer to the OHSA for specific wording.

Employer (McMaster University)

- OHSA, Section 25, 26
- the equipment, materials and protective devices provided by the employer are in good condition
- provide information, instruction, and supervision to a worker to protect the health and safety of the worker
- appoint a competent supervisor
- acquaint a worker or a person in authority over a worker with any hazard in the workplace
- take every reasonable precaution in the circumstances to protect the worker
- prepare and review a written health and safety policy at least annually and post this in the workplace

Supervisors

- OHSA, Section 27
- ensures a worker works in a manner required by the Act and Regulations and with the proper protective devices
- ensures a worker uses or wears the equipment, protective devices or clothing required
- advise the worker of any potential or actual danger to the health and safety of the worker
- provide the worker with written instructions (standard operating procedures) about measures and procedures for protection
- take every reasonable precaution in the circumstances to protect the worker

Workers

- OHSA, Section 28
- work in compliance of the Act and applicable Regulations
- wear any equipment, protective devices, or clothing that the employer requires
- report any defect in protective gear that may endanger him/herself or someone else
- report any contravention of this Act, applicable Regulations, or any hazards
- shall not remove or alter any protective device
- operate or use any equipment in such a manner as to endanger him/herself or someone else
- shall not engage in any prank, contest, feat of strength, unnecessary running, or rough and boisterous conduct

Training Requirements

McMaster's Health and Safety Training Program is designed to provide mandatory as well as some site-specific safety training for all employees, grad students, volunteers and visitors working in the University. Self-registration for training courses offered by UHS, the Faculty of Health Sciences Safety Office (FHSSO), and the Biosafety Office is available through the self-service functionality in Mosaic. Contact the Health Physics Dept if you require training regarding work with nuclear substances or radiation devices.

UHS offers both online training sessions and some in-class training sessions to communicate information regarding hazards. Please see the UHS Training Matrix to determine which courses you are required to take and their frequency. The UHS Training Catalogue has a comprehensive list of the courses offered by UHS. These can be found on the UHS website at https://hr.mcmaster.ca/employees/health_safety_well-being/our-safety/ and following the Health and Safety Training links.

Core Training Requirements

All employees, students, visitors, and volunteers performing work at McMaster University must complete the mandatory, core requirements.

In addition to the mandatory core training requirements, you must complete a Job Hazard Analysis which will indicate any additional training you require for your work. For example, Chemical Handling and Spills Training, Gas Cylinder Training, Laser Safety Training, or Hydrogen Fluoride Training.

Training materials in an accessible format and catered sessions can be provided upon request to uhs@mcmaster.ca.

Workplace Specific Training

Once the Core Training and additional training indicated by the Corporate Training Matrix and Job Hazard Analysis has been completed, a supervisor must ensure that everyone working under their jurisdiction have been thoroughly trained and informed to carry out their duties in a safe manner. The workplace specific training conducted by the supervisor includes hazards identification, electrical safety, storage, handling, use and disposal of chemicals specific to the lab as well as training on equipment and instrumentation within the lab.

Everyone actively engaged in laboratory work is jointly responsible for safety performance as part of the Internal Responsibility System.

Hazardous Chemicals

Chemical Inventory Management System (HECHMET)

The system known as HECHMET (Higher Education Cooperative for Hazardous Materials and Equipment Tracking) is a cooperative of several Canadian institutions with similar goals for management of hazardous materials on campus.

This system allows the University to track hazardous materials for regulatory compliance, it allows users to accurately manage their inventories of hazardous materials and it will aid in emergency response to lab locations.

As part of the implementation of this inventory system, all new chemicals are required to enter the main campus through the Campus Services Building Central Receiving location. **When purchasing chemicals, please ensure your address reads as follows (example):**

Your Name (e.g. Jane Doe)
c/o CSB General Receiving
McMaster University
1280 Main St. W., **BLDG XXX** (this is the lab where the chemicals will be located e.g. ABB 133)
Hamilton, ON L8S 4M1
Attn: Chemicals

At the General Receiving location for campus (CSB), chemicals will be barcoded and entered into HECHMET with the campus location and supervisor name. Facility Services will make every effort to ensure that chemicals are delivered to their campus locations within the same day of arrival to Central Receiving. Late-day arrivals may be delivered on the following day.

For accurate tracking, delisting of chemicals from the inventory system requires the barcode label that was initially affixed to the container to be removed and placed on a Barcode Delisting Sheet and when full or every month, sent to UHS, GH304 through campus mail or by taking a high resolution photo of the sheet and emailing to uhs@mcmaster.ca.

What's Not Included

The inventory system will not include biohazardous materials, radioactive materials, compressed gases, products available for retail purchase (i.e. household cleaners) or non-hazardous substances.

Please visit the UHS webpage for more information on the HECHMET process or contact UHS if you have questions.

WHMIS 2015

The Workplace Hazardous Materials Information System (WHMIS) now incorporates the Global Harmonized System (GHS) of chemical classifications and symbols. Hazards are now classified into two main groups – Physical Hazards and Health Hazards. Within these groups are the following pictograms and their meanings:

Physical Hazards

Gas Cylinder

- Gas cylinder is under pressure and may explode if heated or damaged
- Sudden release of high-pressure gas streams may puncture skin and cause fatal embolism
- Transport and handle with care
- Ensure cylinder is properly secured Store away from heat or fire sources
- Use appropriate regulator

Flame

- Flammable - may burn when heated Burns readily at room temperature Self-Reactive
- Pyrophoric Self-heating
- In contact with water, emits flammable gases Organic peroxide
- Store away from oxidizing (flame over circle) materials Store away from heat, sparks, and flame

Flame Over Circle

- Can cause other materials to burn or explode by providing oxygen
- May burn skin and eyes on contact
- Store away from Class B (flammable and combustible) Store away from heat, sources of ignition
- Wear recommended personal protective equipment

Corrosion

- Will burn eyes and skin on contact Corrosive to metals
- Store acids and bases separately Avoid skin contact
- Wear the recommended personal protective equipment

Exploding Bomb

- Explosive, may be unstable, reacting dangerously to jarring, compression, heat or light exposure
- May burn, explode, or produce dangerous gases when mixed with incompatible materials
- Self-reactive (severe) Organic peroxide (severe)
- Store away from heat sources Avoid shock and friction
- Wear the recommended personal protective equipment

Health Hazards

Exclamation Mark

- Irritation (skin or eyes) Skin sensitization Acute toxicity (harmful)
- Specific target organ toxicity (drowsiness or dizziness, or respiratory irritation)
- Hazardous to the ozone layer
- Use in a fume hood or biosafety cabinet Avoid inhalation and contact with skin
- Wear the recommended personal protective equipment

Skull and Crossbones

- Acute Toxicity (fatal or toxic)
- Avoid inhalation and contact with skin
- Wear the recommended personal protective equipment

Health Hazard

- Carcinogenicity Respiratory sensitization Reproductive toxicity
- Specific target organ toxicity Germ Cell mutagenicity Aspiration hazard
- Use in a fume hood or biosafety cabinet Avoid inhalation and contact with skin
- Wear the recommended personal protective equipment

Biohazardous/Infectious Materials

- Biohazardous infectious materials Use in a biosafety cabinet
- Avoid inhalation and contact with skin
- Wear the recommended personal protective equipment

Within these classes may be one or more categories. The categories are ranked from 1 to 4 with the lowest number (1) being the most hazardous and higher numbers being less hazardous.

Safety Data Sheets (SDS)

Before working with any hazardous material read the Safety Data Sheet (SDS) carefully. SDSs are available for every controlled substance under WHMIS. The SDS has 16 required categories of information. They are: Identification, Hazard Identification, Composition/Information on ingredients, First-aid measures, Fire-fighting measures, Accidental release measures, Handling and storage, Exposure controls/Personal protection, Physical and chemical properties, Stability and reactivity, Toxicological information, Ecological information, Disposal considerations, Transport information, Regulatory information and Other information.

Sections 38(1)(a) and (b) of the OHSA state the employer is required to make copies of SDS readily available to workers, and to joint health and safety committee, if any, or to a health and safety representative. As a rule, readily available means located close to workers, in a physical (paper) or electronic form (computer) that can be printed on paper and accessible to all workers who require this information during the shift.

SDSs must be updated by the supplier within 90 days if new information becomes available, for example, as the result of further testing of the product [Section 29 (1) of the Regulation].

Under Section 38. (6) of the OHSA,

An employer who makes a safety data sheet readily accessible on a computer at a workplace,

- shall take all reasonable steps necessary to keep the computer in working order;
- shall give a worker upon request a copy of the safety data sheet; and
- shall teach all workers who work with or in proximity to hazardous materials, the health and safety representative, if any, at the workplace and the members of the committee how to retrieve the safety data sheet on the computer.

As part of the HECHMET Chemical Inventory Management System, McMaster is licensed to use the ChemWatch GoldFFX program to provide SDSs for all chemicals in your inventory. Contact UHS for password and login. Upon searching for a chemical in your inventory, the last column in the list will have the heading CW – which stands for ChemWatch. Click on the icon next to the chemical of interest under this heading and a window with the SDS for this chemical will be displayed. If you wish to look up a chemical of interest on its own, you can use the ChemWatch link directly, https://jr.chemwatch.net/chemwatch.web/account/autologinbyip.

Note: For those areas providing SDS by computer only, an alternative means must be established to ensure accessibility in emergency situations (e.g. power outages). Alternate means could include accessibility to a battery-powered laptop. Employees must be trained on the alternate means of accessing SDS sheets in the event of an emergency.

Additional information can be obtained in the Canadian Centre of Occupational Health and Safety Centre CCOHS: WHMIS 2015, OSH Answers Facts Sheets (http://www.ccohs.ca/oshanswers/chemicals/whmis_ghs/general.html). WHMIS 2015 training is available through UHS and FHSSO websites.

Designated Substances

These substances have been identified by the Province of Ontario as being cancer causing in humans if not used in the appropriate manner.

The following substances as defined by the Ontario Health & Safety Act, if present in any amount in your laboratory, cause a legally required written assessment to determine the risk of exposure and appropriate controls to implement prior to use. A draft of the assessment should be discussed by the local Joint Health and Safety Committee. The use, handling, storage, and exposure to these chemicals are strictly regulated by the Ontario Ministry of Labour for your protection (see Designated Substances Regulations). Prior to working with any of these substances the appropriate regulation must be consulted. Consult RMM# 500 Designated Substances Control Program for details.

Additional resources include JHSC's, UHS, and FHSSO.

ACRYLONITRILE
ETHYLENE OXIDE
ARSENIC
LEAD
ASBESTOS, including Construction Projects
MERCURY
BENZENE
SILICA (crystalline, but not amorphous)
COKE OVEN EMISSIONS
VINYL CHLORIDE
ISOCYANATES

Declaration of Chemical Weapons

The Federal Department of Foreign and International Trade requires all institutions/businesses link McMaster University to declare the identity and use of toxic chemicals or precursors covered by the Chemical Weapons Convention (Bill C 87). Toxic chemicals and their precursors are classified into three SCHEDULES according to their utility for chemical weapons production.

McMaster's chemical inventory system allows us to identify and report on all of these chemicals acquired, in use, and in storage annually. Additional information is available on the Department of Foreign Affairs website.

Consult **RMM# 503: Control Program for Substances Regulated Under the Chemical Weapons Convention Program**. Specific information can also be obtained by contacting UHS at ext. 24352.

Controlled Goods

The Controlled Goods Program (CPG) of the Canadian Federal Government is for the prevention of the proliferation of weapons of mass destruction, and conventional weapons, and goods that have military or national security significance. University Health & Safety (UHS)has been delegated the administrative responsibilities (Designated Official) for the Controlled Goods Program (CPG) at the University. Please refer to RMM #507: Controlled Goods and/or Controlled Technology Program for more information on working with Controlled Goods or contact UHS at uhs@mcmaster.ca.

Hydrogen Fluoride

Most fluorides produce hydrogen fluoride (HF) when coming into contact with moisture and produce similar burns and health effects. Both liquid and vapour can cause severe burns which may or may not be immediately painful or visible. HF enters the body through skin and eyes, inhalation, and ingestion. HF will penetrate the skin and attack underlying tissues. HF is a systemic toxin that may result in severe hypocalcemia, hypomagnesaemia, hyperkalemia, metabolic acidosis, cardiac dysrhythmias, and death. HF may produce severe ocular and dermal injury as well as acute life-threatening systemic toxicity with minimal external tissue damage. All users must take HF training prior to using HF and have an HF Emergency 1st Aid Kit on hand when working with HF.

Perchloric Acid (Concentrated. 70%)

Before working with perchloric acid, inform yourself well of its properties. Organic chemicals and perchloric acid must never be used in the same fume hood.

- Only use fume hoods designated by your area for use of perchloric acid.
- Store on glass or ceramic trays that have enough volume to hold contents of bottle in case it breaks.
- Separate perchloric acid from sulfuric acid, organic material, and metals.
- Keep perchloric acid in storage area free from dust. Perchloric acid is a powerful oxidizing agent and reacts violently with dust.
- Perchloric acid must only be used in wash-down fume hoods of non-combustible construction if the process is heated or generates vapours

Cryogens

There are specific hazards associated with Cryogens (e.g. liquid nitrogen):

- Asphyxiation due to displacement of oxygen (does not apply to liquid air and oxygen).
- Cracking of materials from cold.
- Frost bite.
- Explosion due to pressure build-up (i.e. in a cold tap).
- Condensation of oxygen and fuel (e.g. hydrocarbons) resulting in explosive mixtures.

- The following guidelines are recommended when handling Cryogenics:
- Always wear a full-face shield, impervious gloves, and proper protective clothing including long pants and closed-toed shoes.
- Use cryogens only in approved containers that are capable of withstanding the extreme cold without becoming brittle.
- Use and store in well-ventilated areas.
- Properly label cryogenic material.
- Keep reactive cryogens away from sparks and flames.
- Do not enter an elevator with a cryogen dewar over 25L– use signage on the elevators to prevent people from entering and station a person at the elevator doors on each floor to transport a dewar from one floor to another

For assistance or advice, please contact UHS at uhs@mcmaster.ca

Radiation Safety

Under the Radiation Protection Regulations of the Canadian Nuclear Safety Commission (CNSC), every licensee is required to implement a Radiation Safety Program that meets specified requirements. At McMaster University, the responsibility for establishing and continually reviewing the radiation safety program is delegated by the Office of the President to the Health Physics Advisory Committee (HPAC). The Health Physics Department is responsible for implementing the radiation safety program on a daily basis.

The radiation safety program for laboratories at McMaster University is described in document RMM # 700-# 702.

The Health Physics Manual also contains policies, practices, and relevant safety information.

For more information contact Health Physics at extension 24226. Also, consult **RMM# 700: Radiation Safety Program for University Laboratories**. See also, **RMM# 701: X-Ray Safety Program; RMM# 702: Non-Ionizing Radiation Safety Program.**

Radioactive Materials

No work with radioactive material may be conducted until the individual has been trained in the safe handling of radioisotopes by Health Physics and provided operational training by the supervisor. Any work with radioactive materials must be approved by Health Physics before work begins.

Training must be in accordance with the requirements of the Canadian Nuclear Safety Commission (CNSC) and approved by the Senior Health Physicist. Training may be extended to include a follow up in the lab by Health Physics for any radioactive material work that may present significant internal or external radiological risks.

Consult **RMM# 502: Hazardous Waste Management Program: Radioisotope Disposal Procedures**

X-Ray Generators

X-ray machines fall under provincial jurisdiction of either the Ontario Ministry of Labour for non-medical x-ray machines, or the Ontario Ministry of Health and Long-Term Care for medical x-ray machines. At McMaster University all x-ray sources are controlled by the Health Physics Advisor Committee (HPAC). The installation and use of each x-ray machine must be approved by Health Physics and the appropriate provincial ministry before the machine is used. The X-ray Safety Program is described in document RMM 701 and is available from the Health Physics Department.

All users of x-ray machines must be trained in x-ray safety by Health Physics and operational safety by the supervisor before they are authorized to operate x-ray equipment.

Consult **RMM # 701: X-Ray Safety Program**.

Microwaves

- Do not attempt to operate microwave ovens with the door open.
- Do not tamper with or defeat safety interlocks.
- Ensure that seals around the door are clean and undamaged.
- Loosen lids on containers to relieve pressure buildup during the heating process.
- Do not use metal containers in microwaves.

Consult **RMM# 702: Non-Ionizing Radiation Safety Program for specific information**.

Laser Safety

To comply with the requirements of ANSI (American National Standards Institute) standard Z136.1, owners of Class 3B and 4 lasers must register their lasers with UHS and users of Class 3B and 4 lasers must attend training available through UHS.

Consult **RMM # 703 Laser Safety Program**.

Magnetic Fields

Nuclear Magnetic Resonance (NMR) instruments and other superconducting magnets can result in serious injury to people and property due to the cryogens used to maintain them at field as well as the high magnetic fields they generate. Warnings indicating high magnetic fields should be clearly marked outside all areas containing magnetic field generating equipment. High magnetic fields can accelerate metallic objects towards the magnet - warnings should include the prohibited use of magnetic tools or equipment within the vicinity of the magnetic fields as well as magnetic media, metallic implants, and pacemakers. Demarcation of high magnetic field lines should be outlined on the floor surrounding the equipment where possible.

Be aware of potential hazards such as the use of cryogens (refer to 33.2) and quenching* of the magnet which could lead to asphyxiation – oxygen sensors may be required in these areas as well as signage and emergency procedures.

*Quenching is the sudden boil-off of cryogens (liquid nitrogen and liquid helium) used to maintain superconductors at field. Many litres of cryogens expanding into gas at room temperature can rapidly displace the oxygen in the room.

Controls to Reduce Exposure to Hazardous Materials

Engineering Controls

General Ventilation

All labs designated for the use of hazardous materials are provided with 100% fresh air. This air is exhausted through fume hoods and or general exhaust. It is important to ensure both supply and exhaust systems are operating before working in the lab. If the exhaust air is down, no experiments can be conducted in the lab, and it is highly recommended to leave the lab until the ventilation system is operational as there will be no venting of chemical cabinets or safety cabinets.

If the supply air is down, lab doors may be difficult to open, and the temperature of the lab may fluctuate. All labs, except for clean rooms, should be under slightly negative pressure with respect to the hallways. To maintain proper pressure and operation of the fume hoods, doors to labs must be kept closed at all times. If you have a question or concern about air flow or the pressurization of your lab, please contact Facility Services at ext. 24740 or the FHS Engineering Services.

Fume Hoods

Properly functioning fume hoods are an important safety device in a laboratory. All hoods should be equipped with a flow monitor to ensure the hood is operating within specifications. You need to familiarize yourself with the values displayed on the monitor (red/yellow/green lights; fpm; cfm etc.) and what is considered proper flow conditions for the hood you work in. In emergency situations such as fires, gaseous emissions or spills in a fume hood always pull the sash down completely and ensure hood exhaust is on emergency flow if this option is available.

All work involving hazardous/malodorous materials must be done in operating fume hoods. If your hood has adjustable baffles, visually inspect the baffles before using the hood to be sure the slots are open and unobstructed, and the hood is operational. Do not use the hood if the exhaust system is not in operation.

Fume hoods are not meant for storage. Use the appropriate safety cabinet for storage of flammables and corrosives. Store chemicals according to the information provided in the SDS.

- Keep all chemicals and equipment 6 inches (15 centimeters) behind the sash during experiments. Do not raise the sash above operating height. Keep the sash clean and clear.
- If possible, set up equipment a couple of inches (5 centimeters) above the working surface of the hood to maintain efficient air flow. Ensure that equipment is stable.
- Keep the sash completely lowered any time no "hands-on" part of an experiment is in progress. Close the sash completely whenever the hood is unattended.
- All electrical devices should be connected outside of the hood to avoid sparks which may ignite a flammable or explosive chemical.
- The hood is not a substitute for personal protective equipment. Wear gloves, aprons, goggles, etc. as appropriate as per the SDS. Do not put your head inside the hood at any time. Clean all chemical residues from the hood chamber after each use.
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On campus fume hood maintenance is the responsibility of Facility Services. Fume hoods are checked annually for: overall condition (lights working, monitor working etc.), proper face velocity, proper capture (smoke test) and monitor calibration. This annual check is performed during the summer months and a certification sticker is affixed to the exterior of the hood. These certification stickers should be checked by the lab occupants and during fall lab inspections by the JHSC representatives to ensure the annual testing has been completed. Off site, and hospital-hosted areas are responsible for maintenance of fume hoods in their locations.

Fume hoods are maintained to operate within the original design specifications. Contact the emergency numbers listed on the Emergency Procedures posters, located on every floor of every building, in the event of a major spill or fume hood malfunction. Before using a fume hood, ensure the hood monitor is operational and reads proper values (100fpm +/- 20 or the proper value of cfm for your type of hood).

In case of malfunction on campus call: Ext. 24740 during normal working hours; Ext. 88 after hours, and state if immediate emergency service is required.

For off-site buildings, follow the specific emergency procedures for your area. For hospital hosted buildings, contact FHSSO at ext. 25956 for information about annual testing and maintenance for your specific facility.

Showers and Eye Wash Stations

Know where the showers and eyewash stations are located before starting your work. Consult your supervisor on the specific instructions on how to use them. Eyewashes and showers must be tested weekly according to ANSI standards and each building that has this equipment has a shower testing kit available for use – contact UHS for locations. Lab occupants should maintain a log of the weekly testing of these facilities and retain these logs for compliance purposes.

Facility Services arranges for an annual certification of all eye wash and shower units, which is usually done during the summer months. During lab inspections, the tag on the eye wash and/or shower units should be checked to ensure the annual certifications have been done. If the tag has not been signed off within the last 12 months, please contact Facility Services at x24740.

Fire Extinguishers and Sand Buckets

All labs should be equipped with fire extinguishers and or sand buckets to put out small fires. One should only attempt to put out a fire if they have had training, it is safe to do so, the fire is small, and the extinguisher is the correct type for the fire. If you do not meet the above requirements or the fire spreads, pull the fire alarm, close the door behind you, and exit the building. Remain at a safe distance near the main entrance to the building to provide

Campus Safety and the Fire Department with information regarding the fire.

Fire extinguishers are checked monthly by a contractor through Facility Services. If you notice that a fire extinguisher is missing or has not been checked within the last month, please contact Facility Services at ext. 24740.

Administrative Controls – Laboratory Operations

- Always be prepared and informed. Know the safety rules, emergency procedures and standard operating procedures. Be familiar with your emergency exit route.
- According to the Ontario Fire Code all laboratory doors are fire doors and must be kept closed at all times. Never prop open doors or block emergency exits, emergency equipment or electrical panels.
- The Electrical Safety Code prohibits the use of extension cords in laboratories as a permanent source of power.
- Before starting an experiment using chemicals, make sure you consult and understand the information presented in the Safety Data Sheets (SDS) as well as other resources, including your supervisor.
- Know the location of emergency equipment in your area and how to use it.
- Wear the appropriate personal protective equipment for the level of hazard. Open toed shoes are not permitted, and long pants should be worn in most labs. Long hair, loose clothing and dangling jewelry should be constrained.
- There is to be no mouth pipetting.
- Working alone, especially at off hours is discouraged; always check with your supervisor if specific procedures require a buddy system. Check the standard operating procedures in your department regarding "working alone" during off hours. Consult Risk Management Manual (RMM) # 304: Persons Working Alone Program.
- Post suitable warning signs if a hazardous situation is present. Include your name and phone number where you can be reached. Communicate with fellow researchers and advise on experiments in progress. Experiments should only be left unattended when it is safe to do so and with proper signage.
- All reagents and samples must be labeled as required by WHMIS 2015 legislation.
- Work involving hazardous materials must be done in a fume hood or other containment facility.
- All hazardous materials must be captured in the HECHMET Chemical Inventory Management System. If you have a hazardous chemical that does not have a McMaster University barcode on it, please call or email UHS to have it entered into the campus system.
- Practice good housekeeping - promptly clean up glassware and dismantle equipment when no longer needed. All lab benches should be kept clear of clutter. Clean up spills immediately and dispose of the waste appropriately.
- No rough-housing or pranks in laboratories. Always report unsafe conditions and accidents promptly to the supervisor.
- Hallways and stairwells are to be clear and with unobstructed egress in case of fire. These areas are not at any time to be used for storage.
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Food/Drink

- Eating and drinking is not allowed in any laboratory or space where hazardous materials are present
- Food and drinks are not to be present or stored in the laboratory or laboratory refrigerators.
- Laboratory glassware, microwaves and utensils that have been used for laboratory operations should never

be used to consume food or drink.

Applies to all blood, body fluids, body tissues or extracts:

- Gloves should be worn when coming in contact with blood or body fluids.
- Wash hands when contaminated and immediately after gloves are removed.
- Take precautions to prevent injuries by sharp instruments.
- DO NOT RECAP NEEDLES
- Use mechanical pipetting devices where possible.
- Use biological safety cabinet or fume hood whenever procedures such as blending, sonicating or vigorous mixing may generate aerosols.
- Decontaminate work surfaces daily and after a spill. Use 1 in 10 dilution of household bleach, 70% ethanol or alternative germicide. Dispose of pathogenic waste in proper containment.
- Remove all lab coats and other protective clothing before leaving the lab.
- Decontaminate all equipment prior to repair or relocation.
- Hepatitis B vaccine or other relevant vaccinations are recommended consult your supervisor.
- While doing tissue culture or working with bacteria or viruses, consult the Biosafety Office at ext. 24956 for grant approval, training, and audits.

Guidelines for Working with Nanomaterials

Nanomaterials are defined in this document as engineered structures, devices and systems that are between 1 and 100 nanometers (nm) in length. At this size, materials begin to exhibit unique properties that affect physical, chemical, and biological behavior – the health effects of which have not been thoroughly studied. There is evidence of nanoparticles crossing cell membranes and interacting with sub-cellular structures. Thus, nanomaterials should be handled with great caution. Common routes of exposure are inhalation, ingestion, and absorption. Using nanomaterials in solid mediums or non-volatile liquids reduces the risk of exposure. Powders and solutions in volatile liquids should be used in gloveboxes or dedicated fume hoods and proper PPE should be worn. SOP's for working with nanomaterials should be reviewed by UHS, the FHSSO, and JHSC's as required. All users of nanomaterials must take Nanomaterials Awareness training offered by UHS and receive site-specific training in the lab.

For further information see the California Nanosafety Consortium of Higher Education's "Nanotoolkit: Working Safely with Engineered Nanomaterials in Academic Research Settings" (https://innovation.luskin.ucla.edu/wp-content/uploads/2019/03/Nanotoolkit-Working_Safely_with_Engineered_Nanomaterials_in_Academic_Research_Settings.pdf), the National Institute of Occupational Safety & Health's (NIOSH) "General Safe Practices for Working with Engineered Nanomaterials in Research Laboratories"(http://www.cdc.gov/niosh/docs/2012-147/pdfs/2012-147.pdf), and the National Institute of Occupational Safety & Health's (NIOSH) "Current Strategies for Engineering Controls in Nanomaterial Production and Downstream Handling Processes."(https://www.cdc.gov/niosh/docs/2014- 102/pdfs/2014-102.pdf)

Standard Operating Procedures

Standard Operating Procedures (SOPs) are required for all work assignments and projects that have the potential to cause critical injury and/or occupational illness, environmental impairment, or major damage to equipment and/or instrumentation and are also required, but not limited to hazards associated with Job Hazard Analyses (JHAs). SOPs are written procedures required by the OHSA under specific regulations and by McMaster University's programs and policies that define the techniques, processes and best practices required to prevent injury, illness, or damage to property and/or environment. Additional details and SOP templates can be found in RMM# 301: Standard

Operating Procedures (SOP'S) Program.

Routes of Entry

Inhalation is the most common route of entry of hazardous materials into the body. Remember that odours may not be detectable at a level which can harm you. Other routes into the body are through skin absorption, splashes to mucous membranes, ingestion, and injection.

Ingestion of toxic materials may occur as a result of eating or drinking in a contaminated work area or by mouth pipetting. Food and drink are not permitted in laboratories. Mouth pipetting is not permitted.

Hazardous material can be absorbed through the skin, mucous membranes and by punctures to the body. Recapping needles is not permitted.

Personal Protective Equipment (PPE)

For any work in a laboratory a lab coat, eye protection, gloves and proper footwear is recommended. Closed toe shoes are a minimum safety requirement. Consult RMM# 320: Personal Protective Equipment Program and RMM # 312: Foot Protection Program. Personal protective equipment suitable for the operation as specified by the supervisor must be worn. All users of respiratory equipment (e.g. N95 masks) must be trained and fit-tested before use. Fit testing is available through UHS and FHSSO.

The supervisors are responsible for supplying the required personal protective equipment. Required equipment may include disposable lab coats, rubber aprons, vinyl, latex, neoprene, nitrile and rubber gloves, insulating gloves, safety glasses and safety goggles, face shields and ear plugs. For specialized personal protective needs consult safety supply companies. It is the individual's responsibility to maintain personal protective equipment in good condition.

Gloves

Gloves can protect your hands from many hazards and there are many different types of protective gloves available. Gloves should be chosen carefully to offer the best protection for specific procedures and chemicals – consult the SDS for the chemical as well as glove charts published by the manufacturers to help you decide which gloves are appropriate. Nitrile and neoprene gloves offer good protection against chemicals but know that different glove materials have different chemical permeabilities and this should be checked with the manufacturer before choosing a specific glove type. Gloves should be changed frequently as they become soiled or exposed to chemicals. Never reuse disposable gloves. Individuals should be trained to remove their gloves properly such that they avoid contaminating their skin.

Always check the integrity of your gloves before starting work. Remove gloves before leaving the laboratory. Always wash hands after removing gloves. Consult **RMM# 321: Hand Protection Program**.

Eye Protection

In most laboratories eye protection is a requirement. Best practices recommend that contact lenses not be worn while working in a laboratory with chemicals. Depending on the protection required during a specific procedure, regular safety glasses, chemical safety goggles, or a full-face shield may be necessary. Follow your supervisor's established procedural guidelines.

Consult **RMM # 310: Eye Protection Program**.

Lab Coats

Lab coats provide additional protection and it is recommended that they be worn at all times in a lab, especially when working with chemicals. Lab coats should not be worn outside of the laboratory, except when going from one lab to another.

Contaminated lab coats should not be washed at home. On campus lab coats, including those contaminated with biological waste, can be laundered in the Hamilton Health Science Customer Support Services area in the McMaster University Medical Centre. An account must be set up and the coats must be labeled prior to use.

Contact ext. 73082 for information.

Hearing Protection

When noise levels reach 82dBA, a full noise survey shall be undertaken and recommendations from the survey implemented. Engineering controls are used to minimize exposure, however, if this is not sufficient, hearing protection is to be used as a last resort.

Consult **RMM# 403: Noise Control and Hearing Protection Program** for information with respect to medical surveillance programs or contact the Occupational Health Nurse in Employee Health Services.

Ergonomic Protection

The risk for the development of musculoskeletal injuries (also referred to as MSDs) increases with repetitive and/or sustained posture. Workstation design, equipment and tools are important in minimizing risk. Equally important is to change your position from standing to sitting on a regular basis. Ergonomic training is available through UHS and FHSSO.

Consult **RMM # 405: Ergonomic Program** which provides you with a self-assessment checklist to ensure your workstation is set up according to ergonomic best practices. If after completing the checklist you require further assessment, please contact the UHS or FHSSO.

Laboratory Upkeep

Guidelines for Storage of Chemicals

- Use the SDS for the material as your reference.
- Store according to chemical compatibilities, not in alphabetical order.
- Choose an area away from offices and emergency exits, if possible.
- Only authorized personnel should have access to the chemical storage area.
- Ventilation should be at the ceiling and at the floor level to prevent the buildup of vapours heavier than air. The area must be temperature controlled.
- Incompatible chemicals should not be stored in close proximity to each other.
- Separate the following groups from each other: OXIDIZERS, WATER REACTIVES,FLAMMABLES, ACIDS, CAUSTICS (BASES)
- Ensure all containers are in good condition and properly labeled
- Fume hoods are not for chemical storage
- Regularly check expiry dates and provide secondary containment as necessary
- Ensure the lab is locked when unoccupied

Compatible Chemical Groups

Inorganic

1. metals, hydrides
2. halides, sulfates, sulfites, thiosulfates, phosphates, halogens
3. amides, nitrates· * (except ammonium nitrate), nitrites u, azides **, nitric acid
4. hydroxides, oxides, silicates, carbonates, carbon
5. sulfides, selenides, phosphides, carbides, nitrides
6. chlorates, perchlorates**, perchloric acid**, hypochlorites, peroxides**, hydrogen peroxide
7. arsenates, cyanides, cyanates
8. borates, chromates, manganates, permanganates
9. acids (except nitric)
10. sulfur, phosphorus, arsenic, phosphorus pentoxide**

Organic

1. acids, anhydrides, peracids
2. alcohols, glycols, amines, amides, imines, imides
3. hydrocarbons, esters, aldehydes
4. ethers**, ketones, ketenes, halogenated hydrocarbons, ethylene oxide
5. epoxy compounds, isocyanates
6. peroxides, hydroperoxides, azides**
7. sulfides, polysulfides, nitriles
8. phenols, cresols
9. *These chemicals deserve special attention due to their potential instability.

Incompatible Chemicals

The previously outlined storage scheme may not suffice to prevent the mixing of incompatible chemicals. Even chemicals of the same classification may form highly hazardous combinations. So always inform yourself by reading the label and the Safety Data Sheet carefully. For compatibility data, more specialized literature may have to be consulted.

The following is a list of some of the common incompatible chemicals. This list is by no means complete. Consult the SDS and/or speak with the supervisor for additional clarification.

Chemical	**Is Incompatible With**
Acetic Acid	Chromic acid, nitric acid, hydroxyl compounds, ethylene glycol, perchloric acid, peroxides, permanganates
Acetone	Concentrated nitric and sulfuric acid mixtures, chlorinated solvent/alkali mixtures
Acetylene	Chlorine, bromine, copper, fluorine, silver, mercury
Alkali & alkaline earth metals (such as powdered aluminum, or magnesium, calcium, lithium, sodium, potassium)	Water, carbon tetrachloride or other chlorinated hydrocarbons, carbon dioxide, halogens

Ammonia (anhydrous)	Mercury (in manometers, for example), chlorine, calcium hypo-chlorite, iodine, bromine, hydro-fluoric acid (anhydrous)
Ammonium nitrate	Acids, powdered metals, flammable liquids, chlorates, nitrites, sulfur, finely divided organic or combustible materials
Aniline	Nitric acid, hydrogen peroxide
Arsenical materials	Any reducing agent
Azides	Acids
Bromine	See chlorine
Calcium oxide	Water
Carbon (activated)	Calcium hypochlorite, all oxidizing agents
Carbon tetrachloride	Sodium
Chlorates	Ammonium salts, acids, powdered metals, sulfur, finely divided organic or combustible materials
Chromic acid & chromium trioxide	Acetic acid, naphthalene, camphor, glycerol, alcohol, flammable liquids in general
Chlorine	Ammonia, acetylene, butadiene, butane, methane, propane (or other petroleum gases), hydrogen, sodium carbide, benzene, finely divided metals, turpentine
Chlorine dioxide	Ammonia, methane, phosphine, hydrogen sulfide
Chloroform	Strong bases, ketones and strong base, alkaline metals, aluminum, strong oxidizers
Copper	Acetylene, hydrogen peroxide
Cumene hydro peroxide	Acids (organic or inorganic)
Cyanides	Acids
Flammable liquids	Ammonium nitrate, chromic acid, hydrogen peroxide, halogens
Fluorine	Everything
Hydrocarbons (such as butane, propane, benzene)	Fluorine, chlorine, bromine, chromic acid, sodium peroxide
Hydrocyanic acid	Nitric acid, alkali
Hydrofluoric acid (anhydrous)	Ammonia (aqueous or anhydrous)
Hydrogen peroxide	Copper, chromium, iron, most metals or their salts, alcohols, acetone, organic materials, aniline, nitro methane, combustible materials
Hydrogen sulfide	Fuming nitric acid. oxidizing gases

Hypochlorites	Acids, activated carbon
Iodine	Acetylene, ammonia (aqueous or anhydrous). Hydrogen
Mercury	Acetylene, fulminic acid, ammonia
Nitrates	Sulfuric acid
Nitric acid (concentrated)	Acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen sulfide, flammable liquids, flammable gases, copper, brass, any heavy metals
Nitrites	Acids
Nitroparaffins	Inorganic bases, amines
Oxalic acid	Silver, mercury
Oxygen	Oils, grease, hydrogen; flammable liquids, solids or gases
Perchloric acid	Acetic anhydride, bismuth and its alloys, alcohol, paper, wood, grease, oils
Peroxides, organic	Acids (organic or mineral), avoid friction, store cold
Phosphorus (white)	Air, oxygen, alkalies, reducing agents
Potassium	Carbon tetrachloride, carbon dioxide, water
Potassium chlorate	Sulfuric and other acids
Potassium perchlorate (see also chlorates)	Sulfuric and other acids
Potassium permanganate	Glycerol, ethylene glycol, benzaldehyde, sulfuric acid
Selenides	Reducing agents
Silver	Acetylene, oxalic acid, tartaric acid, ammonium compounds, fulminic acid
Sodium	Carbon tetrachloride, carbon dioxide, water
Sodium nitrite	Ammonium nitrate and other ammonium salts
Sodium peroxide	Ethyl or methyl alcohol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerin, ethylene glycol, ethyl acetate, methyl acetate, furfural
Sulfides	Acids
Sulfuric acid	Potassium chlorate, potassium perchlorate, potassium permanganate (similar compounds of light metals, such as sodium, lithium)
Tellurides	Reducing agents

Guidelines for Storage of Unstable Chemicals

Many chemicals, most notably ethers, may form explosive decomposition products.

Ethers, Liquid Paraffins and OleFins form peroxides especially in the presence of air and light. Some common examples include isopropyl ether, diethyl ether, tetrahydrofuran and dioxane. Since most of these products have been packaged in an air atmosphere, peroxides can form even if the containers have not been opened.

- Always date chemicals when received, upon opening and when expired.
- Unopened containers of ethers should be discarded after one year, unless inhibitors have been added. Once opened, ethers should only be kept for 6 months maximum.
- Buy only necessary quantities.
- Never return unused chemicals to the original container.
- Store in cool, dry, well-ventilated areas.
- Keep away from sources of heat and shock. Avoid friction and impact.
- Ensure ethers are free of peroxides before distilling.

NOTE: There are specific tests available to check for the presence of peroxides that can be purchased from chemical suppliers

Always check the SDS and review site specific SOP for the use and storage of chemicals.

Guidelines for Handling Compressed Gases

The following is not a comprehensive outline of procedure involving the handling of compressed gases. Consult RMM# 504: Compressed and Liquified Gases Safety Program. All people working with gas cylinders must take the Gas Cylinder Training available through UHS.

The following general precautions must be taken when dealing with compressed gases.

- Cylinders of compressed gases must be properly secured at all times.
- The valve protection cap must always be on when cylinder is not connected to a regulator.
- Do not store full and empty cylinders together. Serious suck-back can occur when an empty cylinder is attached to a pressurized system.
- Move cylinders only with a three or four wheeled cylinder cart – two-wheel carts must not be used to move cylinders.
- Never tamper with safety devices in valves or cylinders - do not use Teflon tape on regulators.
- Never attempt to lift or move the cylinder by holding onto the collar at the top of the cylinder. The collar is not welded onto the cylinder and may dislodge.
- Compressed gas cylinders are potentially dangerous projectiles. Never drop a cylinder and prevent any violent collision with another object.
- The cylinder delivery pressure shall be set to zero before the main cylinder valve is closed.
- When returning empty cylinders close the valve before shipment - leave some positive pressure in the cylinder.
- Replace any valve outlet and protective caps originally shipped with cylinder. Mark "empty" or “M/T" with chalk and store in designated area for return.
- Return cylinders which are of no further use **promptly** to supplier even if only partially used.
- Never use a flame or subject any part of a compressed gas cylinder to high temperatures.

- Use only in well-ventilated areas
- Small cylinders of toxic, flammable and corrosive gases should be used in a properly functioning hood. Larger cylinders of toxic or pyrophoric gases **must** be used in a specialized gas cabinet.
- Purchase the smallest quantity necessary in reusable cylinders (i.e. not lecture bottles).
- When discharging gas into a liquid, a trap or suitable check valve must be used to prevent liquid from re-entering the cylinder or regulator.
- Use the appropriate CGA regulator for the gas
- Never interchange regulators intended to be used for different gases!
- Do not lubricate the high-pressure side of an oxygen cylinder or cylinder containing other oxidizing agents.
- Do not use copper lines with acetylene gas

Storage of Flammable and Combustible Liquids

- Flammable liquids are liquids with a Flashpoint below 37.8 C; Combustible liquids are liquids with a Flashpoint at or above 37.8 C. Both must be stored in FM or UL approved metal storage cabinets.
- Only 50L of flammable liquids may be in the open laboratory at one time
- Store only quantities actually needed.
- Keep flammables cabinet doors closed at all times.
- Flammable liquids should only be stored in flammable materials storage refrigerators (clearly marked as such) if they must be kept cool. All regular refrigerators should be labeled “Non-flammable Only – Do NOT store flammables”.
- Be aware of and implement grounding and bonding requirements.
- Additional information on storage can be located in **Part 4.12 of the Ontario Fire Code, Reg. 213-07**

Bonding and Grounding – Electrical Safety

Static electricity is the electric charge generated when there is friction between two things made of different materials or substances. Electric charges can build up on an object or liquid when certain liquids (e.g. petroleum solvents, fuels) move in contact with other materials. This can occur when liquids are poured, pumped, filtered, agitated, stirred or flow through pipes. This buildup of electrical charge is called static electricity. Even when liquids are transported or handled in non-conductive containers, something rubbing the outside of the surface of the container may cause a static charge to build up in the liquid. The amount of charge that develops depends, in part; on how much liquid is involved and how fast it is flowing or is being agitated or stirred.

Common sources of sparks and static electricity are:

- Decanting of organic liquids from one metal container to another.
- Plastic aprons
- Metal clamps. nipples or wires used with non-conducting hoses
- Gases released quickly from cylinders under high pressure
- Switches and thermostats
- Electrical contacts (light switches & thermocouples, refrigerators) may produce sparks.

To decide if static electricity is likely to be a hazard, you must consider several factors:

- Can a static electric charge be generated under the operating conditions?
- Can the charge accumulate?

- If it discharges, will it cause a spark?
- Is there an ignitable mixture (e.g. solvent vapour or dust in the air) in the area where a static electricity discharge can occur?
- Will the discharge generate an incendive spark, i.e. a spark that has enough energy to ignite the mixture in air?

If the answer to the above five questions is yes where a solvent or fuel is used, then static electricity can be a fire/explosive hazard. It means that the spark can ignite a vapour/air mixture that is in its flammable range, the concentration range between the upper and the lower flammable limits.

Why is it important to bond and ground containers?

Transferring a liquid from one metal container to another may result in static electrical sparks. To prevent the buildup of static electricity and prevent sparks from causing a fire, it is important to bond metal dispensing and receiving containers together before pouring. Bonding is done by making an electrical connection from one metal container to another. This ensures there will be no difference in electrical potential between the two containers, and therefore, no buildup of charge will be formed.

The best way to bond containers is to securely attach a special metal bonding strap or wire to both containers. Some liquid transfer pumps have self-bonding hoses. Bonding can also be done by keeping a solid metal-to-metal contact between the containers themselves or between a metal container and a conducting nozzle. These latter two methods are usually not reliable because a good electrical contact is often hard to make and maintain during the entire transfer.

Do all kinds of containers have to be bonded or grounded?

You only need to bond those containers that conduct electricity, such as those made from metal or special, conductive plastics.

If a container is made from a material that does not conduct electricity, such as polyethylene plastic or glass, bounding and grounding is not necessary: in fact, grounding the container will not have any effect.

Are there special precautions to take when filling non-conductive containers?

If a liquid is conductive, filling or handling plastic or other non-conducting containers can be hazardous. The splashing and turbulence of the liquid in the container can cause a static electric charge to build up in the liquid or on conductive parts on the container that are not grounded. A spark with enough energy to ignite a vapour/air mixture in its flammable range (an incendive discharge) can originate from the liquid or from the container.

For medium size containers (about 19-227 L), it is advisable to ground any metal parts on the container (and nearby conductive surfaces that the container may come in contact with) and fill the container from the bottom through a long, grounded metal pipe. This will reduce the amount of static charge produced and allow the generated charge to dissipate through the metal pipe.

When filling non-conducting portable containers, the NFPA recommends that a grounded dip pipe or grounded wire be in the liquid in the container while it is being filled. Any metal parts of the container and metal funnel, if one is used, should also be grounded. When filling containers with low conductivity liquids (i.e. ones with conductivity less than 50 Pico Siemens, pS), one should keep the grounded dip rod in the liquid for around 30 seconds after the filling is completed.

The above information has been reproduced with permission from the Canadian Centre for Occupational Health and Safety (CCOHS) [2023] from OSH Answers: How Do I Work Safely with …? (Flame Pictogram), https://www.ccohs.ca/oshanswers/chemicals/howto/flame.html Last revised: 2017-10-20. Additional information about bounding and grounding can also be found on this website.

It is important that regular inspections are made of bonding and grounding connections. When bonding and grounding are required, users must refer to the SDS and follow site specific SOPS for step-by-step procedures.

Hazardous Waste Management

Hazardous Waste Program

Please consult RMM # 502: Hazardous Waste Management Program

All Campus Locations, All Faculties of Health Sciences Locations, MARC and MIP:

- Wear personal protective equipment when handling waste (goggles, lab coat and gloves)
- Choose proper containment to match volume and type of waste with a tightly fitting lid. Do not completely fill any bottle more than 80%
- Do not mix incompatible waste chemicals
- Keep halogenated and non-halogenated wastes separate
- Label the waste bottle with the yellow McMaster University waste label prior to putting the waste into the container. Fill out the label completely and ensure proper attachment onto the waste container
- Every contained must be clearly labeled
- Complete Chemical Waste Disposal Record Form recording the Item # from the yellow label

Main Campus, MARC and MIP (not FHS): Send the completed form by email to waste@mcmaster.ca

UHS shall manage the pickup and removal of all non-radioactive hazardous wastes from various locations on campus. Waste is picked up from your location every Tuesday following receipt of the Chemical Waste Disposal Form(deadline is 9AM on the previous Friday). Contact ext. 24352 for assistance or waste@mcmaster.ca.

FHS Locations: The FHSSO will manage the pickup and removal from FHS locations. Return the form by email to mfhsso@mcmaster.ca.

Consult **RMM # 502: Hazardous Waste Management Program** for specific information on Disposal of:

- Liquid Wastes
- Solid Wastes
- Special Wastes (e.g. flammable solids, compressed gases…)
- Biomedical and Infectious Wastes
- Biomedical Waste Disposal Procedures and Pick Up
- Radioisotope Disposal Procedures
- Contaminated Broken Glassware
- Disposal Legends
- Template for Hazardous Waste Disposal Record

Contaminated Broken Glassware (Chemical Only)

Broken glass containing residue but not enough of a substance either solid or liquid where it will come off or flow out/off of the broken glass:

- pack broken glassware in box lined with plastic bag
- close bag and tape box with packing tape
- fill in appropriate paperwork and label box appropriately for chemical waste removal

Radioactive Broken Glassware: Call Health Physics at ext. 24226
Biological Broken Glassware: Call Bio Safety Office at ext. 23453

Consult **RMM # 502: Hazardous Waste Management Program** for specific information.

Non-Contaminated Broken Glassware

- pack broken glassware in box lined with plastic bag
- close bag and tape box with packing tape
- Place beside regular waste for removal by custodial staff

Equipment Disposal

Hazardous chemicals must be removed from equipment before the disposal of the equipment. Some examples of hazardous materials within equipment are heavy metal particulates, polychlorinated biphenyls (PCB's), mercury, oils, chlorofluorocarbons, compressed gas (es), or pressurized containers. Some test equipment may have internal standards such as radioisotope reference standards, that must be removed before disposal. Once free of chemical contaminants, submit a Work Request through Mosaic for removal and disposal**. If equipment cannot be decontaminated,** email uhs@mcmaster.ca for a quote for removal by the hazardous waste contractor.

Equipment cavities, sufficiently large to entrap children, must be left open by complete removal of hinged or fastened doors or coverings.

All equipment which was in contact with BSL 2 agents must be decontaminated and the process recorded in writing. Contact Biosafety Office at ext. 24956 for assistance.

Biomedical Waste Disposal

Any research or work involving biomedical material must be approved by the Biosafety Office.

All Campus Locations (excluding MUMC):

Call UHS at ext. 24352 for assistance. Consult **RMM# 502: Hazardous Waste Management Program** for specific details including how to prepare biomedical waste boxes

- Biomedical waste cannot be stored longer than four days unless refrigerated
- Disposal of biomedical waste will be in yellow bags and anatomical waste in red bags, a biomedical waste box or appropriate sharps container. Double bag to minimize spillage during transport. Contact Facility Services for supplies (fee associated).
- Biomedical waste boxes are provided in two sizes. Place the double bagged waste into the appropriate size box.
- Label the box with: Generator's Name, Department, Building, Room Number and Date. (Life Science

Building (LSB) residents must log waste entry into register located in B120)

- All animals, such as mice, must be disposed of using the Animal Utilization Protocol of the Animal Review Ethics Board, and must be returned to the Central Animal Facility (CAF). All insects must be euthanized before disposal. Animals must be segregated from other biomedical waste; bag separately using red liners.
- Individuals are responsible for cleaning up spills/leaks from their biomedical waste containers
- Once packaged, contact Facility Services for pick up from your lab to the LSB bio-waste location (fee associated). If you reside in LSB, place your waste in the bio-waste room.
-

FHS Locations:

- Dispose biomedical waste into red or yellow bags or appropriate sharp containers
- Double bag biomedical waste before placing into biomedical waste box
- Biomedical waste must be moved to central waste station
- Biomedical waste boxes must be closed and labeled according to posted directions
- All animals must be disposed of as per the instructions of the Animal Review Ethics Board. A system for monitoring radioactivity in animals is in place under the Radiation Program Protocols
- Individuals are responsible for cleaning up spills/leaks from their biomedical waste containers

Any waste generated under the Public Health Agency of Canada Laboratory Biosafety Guidelines needs to be disposed of as directed by the McMaster University Biosafety Committee on a building-by-building basis.

Contact FHSSO at ext. 24956 for assistance. Consult **RMM # 600: Biosafety Program and Appendix 3: Request for Biohazard Approval.**

Explosives, PCB's and Old Gas Cylinders

Most gas cylinders can be returned to the company purchased from such as Praxair, Air Liquide, and Linde. Praxair is the only company that does regular pickups, therefore, if you have a cylinder that is empty, or you need to return, you may have to phone the company of origin and request a pickup. Most companies charge a monthly fee for cylinder rental. The longer your cylinder is on campus, the longer this fee will be charged.

To return a cylinder, ensure the cylinder cap is in place and you have a proper gas cylinder cart to transport it with – a proper cart has at least 3 wheels. Do not use a two-wheeled cart to transport cylinders. Contact the company for pickup and then take the cylinder to the empty cage location for your building.

If the cylinder is very old, for example the stamp around the cylinder collar says “Mattheson” or “Union Carbide” or another company that no longer exists or if you have a lecture bottle – small gas cylinder of approx. 5cm in diameter they must be disposed of as hazardous waste through the waste disposal company. Please contact UHS or FHSSO, as appropriate, for help with this.

Similarly, if you have chemicals that are explosive, for example dry picric acid, or contain PCB’s these require special handling and must be scheduled for pickup separate from the hazardous waste procedures. Please contact UHS for help disposing of these types of materials. Explosive compounds such as dry picric acid are extremely dangerous and should not be moved or even touched as they are highly sensitive and can explode at the slightest disturbance. Contact UHS or FHSSO and restrict access to these materials until they can be assessed and dealt with.

Empty Chemical Bottles

If the content is WATER SOLUBLE:

- Remove the lid and ensure that the container is triple-rinsed. Collect the initial concentrated rinse and discard the rinse chemical via the Hazardous Chemical Waste Stream (RMM# 502).
- Ensure the bottle is dry and deface/remove the chemical label. Place green 'Notice' label on container.
- Remove the HECHMET "McMaster Chemical Inventory" barcode and place on a Barcode Disposal sheet and send to UHS through campus mail for delisting when full (see the HECHMET webpage for detailed instructions and disposal sheet).
- After delisting, place the bottle in the hallway or next to your lab garbage bin for custodial pick up (campus only). In FHS package as appropriate and take to waste closet).
-

If the content is TOXIC:

- Remove the lid and ensure that the container is triple rinsed with appropriate solvent. Collect the initial concentrated rinse and discard the rinse chemical via the Hazardous Chemical Waste Stream (RMM# 502).
- Place bottle in fume hood until all liquid has evaporated.
- Rinse again with water.
- Ensure the bottle is dry and deface/remove the chemical label. Place green 'Notice' label on container.
- Remove the HECHMET "McMaster Chemical Inventory" barcode and place on a Barcode Disposal sheet and send to UHS through campus mail for delisting when full (see the HECHMET webpage for detailed instructions and disposal sheet).
- After delisting, place the bottle in the hallway or next to your lab garbage bin for custodial pick up (campus only). In FHS package as appropriate and take to waste closet).
-

Note – Empty containers of highly toxic materials (ex. Hydrogen Fluoride) should be disposed of as hazardous waste.

If the content is a SOLVENT:

- Remove lid and place bottle in fume hood until all liquid has evaporated. Rinse with water.
- Ensure the bottle is dry and deface/remove the chemical label. Place green 'Notice' label on container.
- Remove the HECHMET "McMaster University Inventory" barcode and place on a Barcode Disposal sheet and send to UHS through campus mail for delisting when full (see the HECHMET webpage for detailed instructions and disposal sheet).
- After delisting, place the bottle in the hallway or next to your lab garbage bin for custodial pick up (campus only). In FHS package as appropriate and take to waste closet).
-

**NOTE – If procedure is not followed, containers will not be collected, and a red 'Notice' label will be attached by Facility Services. The green 'Notice' label is available by contacting UHS or Lab Stores (ABB 133). All bottles left for pick up must have the lid removed.

When UHS scans out the barcode on your empty chemical bottles, they will be delisted from your chemical inventory. In this manner, the chemical inventory will be kept current and accurate.

Emergencies – Accidents & Spills

Ensure your Department Emergency Contact Form information is up to date on the Campus Safety website. This laboratory contact information should list senior graduate students or staff who are familiar with the hazards associated with the lab and able to assist the first responders.

Medical Emergency

On McMaster University campus, call Campus Safety at 88 from any campus phone or dial 905-522-4135 on your cell phone for assistance or if medical aid is required. Report all incidents to your supervisor and to UHS as quickly as possible. Completed Injury/Incident Reports must be submitted to UHS and where applicable to FHSSO within 24 hours of its occurrence.

McMaster staff off-site and in hospital hosted buildings are to follow the emergency protocols of their host buildings. In FHS, this refers to the colour code system of identifying emergency situations. Emergency numbers of Hamilton Health Sciences buildings (5555), St Joseph's Hospital (7777) and 911 for all other locations.

Fire Emergency

The RMM# 1201: Fire Safety Plan provides instruction and direction during a fire emergency for all persons working, studying, or visiting campus buildings – familiarize yourself with this policy.

In Case of a Fire:

- Immediately vacate the building via the nearest Exit Route. DO NOT USE ELEVATORS
- Everyone is responsible for knowing the location of the nearest fire extinguisher, the fire alarm, and the nearest fire escape.
- The safety of all people in the vicinity of a fire is of foremost importance. But do not endanger yourself
- In the event of a fire in your work area shout "FIRE" and pull the nearest fire alarm.
- Do not attempt to extinguish a fire unless you are confident it can be done in a prompt and safe manner, utilizing a hand-held fire extinguisher. Use the appropriate fire extinguisher for the specific type of fire. Most labs have equipment with Class A, B and C extinguishers. Do not attempt to extinguish Class D fires which involve combustible metals such as magnesium, titanium, sodium, potassium, zirconium, lithium, and any other finely divided metals which are oxidizable. Use a fire sand bucket for Class D fires.
- Do not attempt to fight a major fire on your own.
- If possible, leave fume hoods on, close fume hood sashes, make sure the room is evacuated, close but do not lock the door and exit the building using the stairs.
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Main Campus: Using a campus phone dial 88 or from a cell phone, dial 905-522-3135. Give the location and details of the fire.

FHS: For the Health Science Centre: phone 5555 – report a fire, give your name, exact location, and building.

All Other Sites: Follow the emergency protocol of the building.

Report all incidents to your supervisor. Completed Injury/Incident Reports must be submitted to UHS and where applicable to FHSSO within 24 hours of its occurrence.

Clothing on Fire

Douse with water from a safety shower immediately OR roll on the floor and scream for help OR smother the flames with a lab coat or other non-flammable fiber. Do not wrap a standing person, rather, lay the victim down to extinguish the fire. The coat or material should be removed once the fire is out to disperse the heat. DO NOT use a fire extinguisher on people.

Chemical Spills

Use of proper personal protective equipment (PPE) and following the procedures outlined in Safety Data Sheets (SDS) will help to prevent injury. Every lab should have the necessary spill kits for the liquids in use (example: solvents, acids, and bases) along with written spill procedures which have been trained to lab users. Ensure everyone working with chemicals has taken the Chemical Handling and Spills Training and know the emergency and medical procedures outlined in the SDS and the area specific spills procedures before working with chemicals.

In all cases of chemical spills, notify your supervisor, and complete a McMaster Injury/Incident Form and send to UHS and where applicable to FHS. Safety Office within 24 hours of its occurrence.

Consult **RMM# 1202: Spills to the Environment-Emergency Response and Reporting Program**

On Body

- Wash thoroughly with water or use emergency shower immediately for 15 minutes, remove contaminated clothing.
- (Avoid modesty, evacuate the lab if necessary). Prevent further contamination of other body parts, especially face and eyes.
- On Campus, call 88 from any campus phone or dial 905-522-4135 from a cell phone if medical aid required. Provide Safety Data Sheet to attending physician.
- Consult the SDS for specific instructions
- There are specific procedures with Hydrogen Fluoride (HF). Contact Campus Safety (on campus-#88 or 905-522- 4135; MUMC-#5555, DTC-# 911, etc) and follow HF Protocols as per the SOPs in the HF 1st Aid Kit.

In Eye

- Best practices recommend contact lenses not to be worn in the lab. If chemical is splashed in eyes, remove contact lenses immediately
- Flush your eyes with water for at least 20 minutes. Hold eye open during flushing - ask for assistance.
- Approved self-contained eye wash stations must meet requirements for 15 minutes flushing capacity and have water source changes as recommended by the manufacturer.
- Consult the SDS for specific instructions
- There are specific procedures with Hydrogen Fluoride (HF). Contact Campus Safety (on campus-#88 or 905-522- 4135; MUMC-#5555, DTC-# 911, etc) and follow HF Protocols as per the SOPs in the HF 1st Aid Kit

Chemical Spills Indoors

STOP, THINK! Carefully plan cleanup steps ---> get assistance to check your plan. If safe to do so, don proper PPE and:

1. Eliminate all ignition sources if flammable material is involved.
2. Dike, block or contain size or spread of spill by using appropriate absorbing material (sand, vermiculite, commercial absorbent, spill pillows, etc.)

3. Carefully remove other materials, containers, equipment from path of liquid/solid spills.
4. Turn on emergency flow of fume hoods to capture or direct flow of gases/vapours if equipped.
5. Carry out cleanup. Dispose of cleanup material as hazardous waste.

Chemical Spills Outdoors

Contain spill rapidly by diking with suitable material (spill stockings, sand, vermiculite, etc.). Prevent chemicals from contaminating ground water and sewer system.

Immediately contact Campus Safety (88 or 905-522-4135) for assistance. Assure that spill site is not left unattended.

If Unsafe or Unable to Clean Up Spills

1. On campus, call Campus Safety at 88 or 905-522-4135 for assistance or push the panic alarm where available. Fire alarm should only be pulled if the situation is out of control.
2. Evacuate to a safe location and prevent others from entry by posting warning signs.
3. Follow instructions of Special Constables until Campus Safety defers the matter to UHS or FHSSO.

For FHS and off-site spills, follow the procedure as outlined for those areas. For Hamilton Health Sciences locations, contact 5555. For St. Joseph Hospital, contact 7777.

Mercury Spill

Mercury vapours are highly toxic. Don proper PPE. Clean up immediately.

- Small amounts may be picked up with an aspirator bulb, medicine dropper or a mercury sponge.
- Place in container, cover with water and seal it.
- Mercury Spill Kits may be used where available. Mercury Spill Kits can be purchased from various safety and chemical suppliers. A Mercury Vacuum is available in JHE A106. Obtain the vacuum through Campus Safety at 88 or 905-522-4135.
- Once larger droplets are removed wash surface with mercury neutralizing solution such as 20% calcium sulfide or saturated sodium thiosulphate.

If mercury has broken up into many globules, sprinkle sulfur powder, or commercial product over the area, leave for several hours before clean-up.

Waste must be properly sealed and labeled with hazardous waste label**.**

N.B. If a larger spill of mercury (i.e. a broken manometer) is involved the area must be evacuated, closed off and warning signs posted.

Radioactive Spill

MAJOR RADIOACTIVE SPILL and MINOR RADIOACTIVE SPILL procedures are posted in each radioisotope laboratory. Radioisotope users are required to read and understand the written procedures. If clarification is required or if the posted procedures do not appear to be suitable for a particular radiation situation, please consult Health Physics at EXTENSION 24226.

In case of Emergency, other references include the Emergency Guidebook and the McMaster SafetyApp