

TITLE: Lab Safety – EHS Design Requirements	Version: 1
	Version Date: 2024-05-17
Signing Authority: Delaine Russo, Director, Environmental Health and Safety Office	

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1 Purpose

This document is intended to provide lab designers for the University of Manitoba guidance on meeting compliance with environment, health and safety legislation as it applies to laboratory spaces.

It may not always be practical to implement all requirements listed herein and for those cases, the Environmental Health and Safety Office (EHSO) may provide prior approval to variations that properly demonstrate appropriate risk mitigation.

2 Scope

This document applies to new construction and renovations of laboratories at the University of Manitoba, including teaching, research, and instrument laboratories where chemicals, biological agents, and/or radioisotopes are used.

EHSO has considered relevant acts and regulations including but not limited to those under Public Health Agency of Canada, Canadian Food Inspection Agency, Canadian Nuclear Safety Commission, Manitoba Workplace Safety and Health, and Transport Canada.

In addition to these requirements, there may be other applicable codes and standards. This document excludes the design of animal use facilities and Containment Level 3 facilities (where this need arises, please contact EHSO directly for further support). It also does not guide or assess compliance with Manitoba Building Code, the Manitoba Fire Code, or the Accessibility for Manitobans Act.

3 General Laboratory Requirements

The requirements laid out in this section apply to all new or renovated laboratory spaces.

3.1 General Design

- Dedicated paper/computer workstations, including offices, and any areas designated for consumption of food and drink must be segregated from laboratory spaces.
- Office entrances must be connected directly to a hallway or administrative area, not solely through a laboratory space.
- Noise levels produced by ambient conditions and laboratory equipment may not exceed 85 dBA.

3.2 Surfaces and Finishes

- Surfaces and interior coatings, including, but not limited to, floors, ceilings, walls, doors, frames, casework, benchtops, and furniture, must be cleanable, non-absorbent, and resistant to scratches, stains, moisture, chemicals, heat, impact, repeated decontamination and washing, in accordance with function.
- All joints in the flooring material must be sealed. Junctions between floor and vertical surfaces (walls and permanently placed fixtures such as fume hoods) must be smooth, sealed, and continuous with floor.
- All joints on counters must be sealed.
- Carpeting is prohibited in lab/lab support areas.
- Backsplashes, when installed tight to the wall, must be sealed at the wall-bench junction and continuous with work surfaces.
- Floors must be slip resistant.
- Exposed conduits, piping, and other services must be mounted to allow for decontamination of all surfaces.
- Laboratory chairs must be made of material that is non-porous, non-absorptive, chemically resistant, washable, and can be easily decontaminated.

3.3 General Storage

- Storage space must be provided for supplies and consumables such as personal protective equipment as well as laboratory equipment.
- Storage systems must be of solid and sturdy construction.
- Shelves must be anchored to the wall sufficiently to carry the load of materials stored on them.
- Storage space must be provided to store personal protective equipment required for University of Manitoba employees, located near the entrance from public areas.

3.4 Ergonomics

- Lab design should not put workers in awkward positions or that require extended reaches.
- Appropriate lighting for workspaces and tasks is required.
- Sufficient space must be provided for employees to perform tasks. Space requirements need to be based on factors including:
 - the number of people,
 - the equipment,
 - equipment clearances required for maintenance, and
 - set-up and operation.

3.5 Plumbing

- Any laboratory that uses hazardous products (chemical, biological, or radioactive) must have a sink designated for hand washing, separated from equipment washing.
 - Located near the laboratory exit, in a low traffic area adjacent to the work area.
 - Made of a material that is readily decontaminated such as stainless steel or porcelain.
 - Taps to be equipped so they can be operated hands free.
- All sinks to be equipped with overflow protection.
- Sink drain traps must be accessible.
- Drains must be chemical resistant.
- Vacuum systems to be equipped with filters and systems that prevent contamination of pumps and central vacuum supply.
- Back flow protection devices on all faucets with vacuum or cooling line attachments.

3.6 Electrical and Audio Visual

- All cords and electrical outlets should be placed in a location where they cannot come in contact with spills or leaks.
- Electrical outlets should be placed in a way to avoid trip hazards due to the path of the cord.

3.7 Environment

- Installation of fuel tanks, water treatment facilities, and incinerators require an environmental permit prior to installation. Contact EHSO if these elements are included in the design plan.
- All equipment that uses refrigerants, such as fire fighting equipment, air conditioners, refrigerators, freezers, walk-in cold rooms, water fountains, or chillers, must not use Class 1 Ozone Depleting Substances as listed in the *Ozone Depleting Substances and Other Halocarbons Regulation* (MB Regulation 103/94).

3.8 Signage

- Must have holders to display laboratory hazard signage at the doors to public or administrative areas.
- Must have signs indicating the location of all emergency response equipment.

3.9 Security

- Doors to the hallway must be lockable.
- Windows must be lockable or non-openable.
- Must provide lockable storage for potable alcohol, controlled drugs, and other sensitive materials.

3.10 Regulated Building Materials

- Building materials used for new and renovation construction projects must not contain asbestos, polychlorinated biphenyls (PCBs), lead, or mercury.

4 Emergency Response Equipment

The requirements laid out in this section apply to all new or renovated laboratory spaces.

- Where cell phones will be permitted within the lab space, sufficient network coverage and/or wifi must be available.
- Where cell phones will not be permitted or there is insufficient network coverage, phones or other two-way communication devices must be provided inside the laboratory area for use in emergencies.
- Emergency lighting required in all areas containing hazardous products.
- Where hazardous products quantities or risk assessment require it, emergency eye wash and/or safety shower must meet and be installed according to ANSI Z358. 1-2014.
- Consideration is needed for the location of, and space required for the first aid kit. The size of first aid kit is based on the level of risk.
- Must have a designated location for all appropriate spill response kits.

5 Laboratory Ventilation

The ventilation in a laboratory may consist of a combination of general room ventilation, fume hoods, and other local exhaust ventilation to maintain good indoor air quality. Depending on the work conducted in the laboratory, this may include the need to contain specific emissions. Minimum requirements can be found under General Ventilation and each additional type of equipment will add the requirements in the subsequent sections.

All ventilation must be designed and installed in accordance with the requirements outlined in the *Manitoba Building Code*.

5.1 General Ventilation

The requirements laid out in this section apply to all new or renovated lab spaces.

- All ventilation must be designed to provide sufficient amounts of air to replace the air it exhausts.
- Consideration must be given to the location of ventilation openings to ensure they are kept free of obstructions and contamination.
- Air must flow from low hazard areas towards higher hazard areas, eg. air from a hallway would flow into a laboratory.
- During working hours, total exhaust rate must be 1.0 cubic foot per minute per square foot of floor space.

5.2 Requirements for Any Equipment Providing Local Exhaust (including fume hoods)

The requirements laid out in this section apply to all equipment providing localized air exhaustion, including all types of fume hoods and biological safety cabinets.

- Must be designed to capture hazardous fumes, aerosols, dust, or gases as close to the source as possible.
- Air Flow Requirements

- Must be designed to eliminate backflow of exhaust air into the laboratory.
 - Flow rates through local exhaust systems must be maintained 24/7. (Not required 24/7 if local exhaust is used task specific, e.g., when controlled products are used.)
 - The exhaust system must be designed to maintain the exhaust ducts in the building under negative pressure at all times, unless all the hoods on that exhaust system have been decommissioned and decontaminated.
- Cannot be interlocked with fire detection and alarm systems to shut down automatically upon alarm.
- Exhaust ducts must:
 - be constructed to the Seal Class B standards specified in the *SMACNA HVAC Duct Construction Standards*,
 - be constructed of corrosion-resistant material,
 - have all joints smoothly finished and sealed, and
 - be accessible for inspection.
- Exhaust ducts can only be manifolded if:
 - EHSO has been consulted,
 - the hoods are not perchloric acid hoods,
 - deposits, or highly hazardous residues will not accumulate in the duct work,
 - the exhaust does not require HEPA filtration or other special cleaning, and
 - the exhaust ducts are joined in a fire rated shaft, or mechanical room, or outside of the building at the roof line.
- Air must be exhausted outside the building.
- Exhaust fan must:
 - Be placed close to the discharge point in order to maintain negative pressure in the duct work within the building, preferably on the roof,
 - Be made of a material that is appropriate for the chemicals and substances to be used in the fume hood,
 - Be adequately sized to provide sufficient exhaust airflow, including static pressure losses of the fume hood and associated ductwork
 - Have the motor mounted outside the exhaust duct for easy access and to avoid contamination, and
 - noise from the fume hood fan shall not be more than 85 dBA at the face of the capture point.
- Discharge must occur at least 3 meters above and 10 meters horizontally from any air intake, with a discharge velocity of a least 3000 feet per minute. The stack arrangement, height, discharge, velocity, and location must ensure acceptable dilution, dispersion, and elimination of re-entry into buildings.
- The fan, duct, breaker, and motor must be identified with the respective fume hood and room number.
- Chemical exhaust system discharge must be exhausted vertically without obstruction (e.g., rain cap or goose neck).
- Installation records must include:
 - As-built drawings showing the complete installation,
 - identification of the construction materials,

- operating and maintenance instructions, and
- make, model, and serial number.

5.3 Fume Hoods

The requirements laid out in this section apply to all fume hoods which may requested to be installed in laboratories that use chemicals with flammable, toxic, noxious, poisonous, or otherwise hazardous vapours and gasses. This section outlines the placement and installation of fume hoods within a lab, for information on the selection or operation of a fume hood refer to the EHSO document *Chemical Safety – Fume Hood Manual*.

- Fume hoods must meet the design and construction requirements of the most current version of CSA Z316.5 “Fume hoods and associated exhaust system” and MD15128
- Exhaust ductwork must
 - not be fitted with fire dampers,
 - be self-draining and extend to the discharge point with as few horizontal sections as possible.
- The linear face velocity must be 0.5 m/s. There must be a balanced air feature so that the fume hood is vented even if the sash is closed.
- Must be located:
(see CSA Z316.5:20 for clarification or more details)
 - At least 1.0 m from the normal traffic pattern and interfering room air currents created by doors or other general ventilation devices,
 - At least 0.5 m between the side of the fume hood and a wall or large architectural where the face of the obstruction is in front of the plane of the sash,
 - At least 1.5 m between the sash and an opposing wall or other obstruction likely to affect intake airflow.
 - More than 2 m from face to face if installed opposite a fume hood or biological safety cabinet,
 - So that any room air supply diffuser is more than 1.5 m (5 ft) from the sash and the room diffuser shall not affect fume hood performance. The air supply shall not create room air drafts at the face of any hood greater than 0.15 m/s,
 - so that an unobstructed personal work area extends at least 1 m from the face of the fume hood,
 - so that the workstation opposite the face of the cabinet is not one where personnel are likely to spend much of their working day (such as a desk or microscope bench),
 - so that all service fitting controls and access panels are accessible,
- Heated drying base cabinets (drying ovens) must not be located under fume hoods.
- Where providing storage for chemicals or other controlled products under the fume hood, it must meet all relevant storage requirements as listed in *Chemical Safety – Storage*. Consideration should be given to if there is need to electrically bond a safety cabinet to the fume hood.
- If an exhaust filter will be used, it must:
 - Be installed such that there is unobstructed access for filter replacement, inspection, and servicing,

- Allow for the filter to be replaced without contaminating the surrounding environment (i.e. enclosure that allows for bag in/bag out technique),
- Be located as close to the fume hood as possible within the ductwork,
- Be located upstream from the exhaust fan.
- Ductless fume hoods: portable, non-ducted chemical fume hoods must be approved by EHSO.
- Fume hoods used for nuclear substances shall follow the requirements of The Canadian Nuclear Safety Commission.

5.4 Perchloric Acid Fume Hoods

The requirements laid out in this section apply to all perchloric acid fume hoods which are to be installed in laboratories that heat perchloric acid. This is not a common item at the University of Manitoba and, prior to electing to install this type of fume hood, all alternative processes should be considered. This equipment must follow all *MD15129 Guidelines for Perchloric Acid Fume Hoods and their Exhaust Systems* and additional support can be obtained through EHSO to ensure all requirements are met.

- Must be designated solely for perchloric acid work and identified by a prominent and permanent label indicating suitability for use in perchloric acid procedures.
- All surfaces of the hood must be comprised of materials that do not react with the acid to form corrosive, flammable or explosive compounds or byproducts.
- Must be equipped with water wash down capabilities to wash any interior surfaces exposed to perchloric acid vapours, including fume hood, fan, and ductwork. The drain is usually directed to sanitary sewer but may need to be diverted to a holding tank for neutralization prior to release.
- Ductwork must:
 - Be made from welded Type 316 stainless steel,
 - Take the shortest, most direct, and straightest path to the outside of the building,
 - Be winterized,
 - Have a stack with a height a minimum of 3m without a rain cap, and
 - Be self-draining and have no horizontal sections.
- May not be manifolded or joined to non-perchloric acid exhaust systems.
- Must have the hood and duct work labeled "Perchloric Acid Hood".
- A target duct velocity of no less than 7.5 m/s (1500 fpm) must be provided.
- Must have an exhaust fan that is acid and spark resistant. The exhaust fan motor shall not be located within the duct work. Drive belts shall be conductive and shall not be located within the duct work.

6 Chemical Hazard Requirements

6.1 Chemical Hazard Mitigation

The requirements laid out in this section apply to all laboratory spaces where chemicals are used or handled.

- Laboratory must be designed so that use of a respirator is not required for normal operations.
- Areas where materials that produce flammable, noxious, toxic, or poisonous gasses or vapours are used must be appropriately ventilated.

6.2 Chemical Storage

The requirements laid out in this section apply to all laboratory spaces that store chemicals. It is preferred that a chemical storage area is separated from the areas where chemical handling will occur.

- Cabinets and shelving used for chemical storage must be constructed of sufficient materials and anchored appropriately to support the weight of the materials.
- The height of chemical storage must be at or below eye level (typically a maximum of 5 feet).
- There must be sufficient storage space to allow chemicals to be segregated according to hazard classes. This includes chemicals that require refrigeration and hazardous waste.
- Segregated storage for acids and bases must be made from corrosion-resistant materials, may or may not be in a corrosion-resistant safety cabinet.
- Flammables may require a flammable safety cabinet for storage and must always be kept away from any ignition sources and oxidizing agents.
- Gas cylinders must be stored upright, secure, segregated by hazard class, and away from ignition sources. They may not be stored near points of egress or main walkways.

7 Biological Hazard Requirements

7.1 Autoclaves

The requirements laid out in this section apply to all autoclaves, which are to be installed or identified for the sterilization of biological agent waste.

- Autoclave must be provided in or on the same floor as the designated containment zone.
- Autoclave waste must be transported according to standard operating procedure to a central autoclave waste facility.
- Autoclave for waste sterilization must be equipped with cycle log recorders that document the operational parameters of the equipment.

7.2 Class II A Non-Ducted Biological Safety Cabinets

The requirements laid out in this section apply to all Class II A non-ducted biological safety cabinets, which are to be installed in laboratories carrying out aerosol generating procedures with pathogenic or potentially pathogenic biological agents.

- Must be located 1.1 m away from doors, 1.1 m away from parallel adjacent biological safety cabinets, 1.2 m away from perpendicular adjacent biological safety cabinets, and 3.1 m away from biological safety cabinets which face each other.
- Must be located as far as possible from doors, room supply air diffuser and heavily traveled laboratory areas.

- Must maintain 30 cm clearance between the wall and the back and sides of the cabinet and 50 cm between the exhaust filter discharge and the ceiling or overhead obstruction.
- Must be installed and tested in accordance with most current version of CSA Z316.3 or NSF/ANSI standard 49.

7.3 Class II B Ducted Biological Safety Cabinets

The requirements laid out in this section apply to all Class II B ducted biological safety cabinets, which are to be installed in laboratories carrying out aerosol generating procedure with pathogenic or potentially pathogenic biological agents used with hazardous gasses or vapours.

- Must maintain distances of 1.1 m from doors, 1.1 m from parallel adjacent biological safety cabinets, 1.2 m from perpendicular adjacent biological safety cabinets, and 3.1 m from biological safety cabinets which face each other.
- Must be located as far as possible from doors, room supply air diffuser, and heavily traveled laboratory areas.
- Must maintain 30 cm clearance between the wall and the back and sides of the cabinet and 50 cm between the exhaust filter discharge and the ceiling or overhead obstruction.
- Must not be used as the sole source of room air exhaust.
- The room supply air system must be equipped with isolation dampers to prevent cabinet puffback due to HVAC system failure or airflow reversal due to outside environmental conditions.
- Must have manual isolation dampers to permit sealing for decontamination and service.
- Must be installed and tested in accordance with most current version of CSA Z316.3 or NSF/ANSI standard 49.
- Must be specifically approved by the University of Manitoba Biosafety Officer before installation.
- The electrical outlet for BSCs should be considered to have a dedicated circuit breaker. This can help prevent accidental shutdown of the unit if another piece of equipment overloads the circuit.

7.4 Other Containment Equipment

The requirements laid out in this section apply to equipment used to contain pathogenic or potentially pathogenic biological agents. For other special containment equipment, contact the University of Manitoba Biosafety Officer.

- High Efficiency Particulate Air filtered enclosure must be used to contain pathogenic or potentially pathogenic biological agents.
- Centrifuges with sealed rotors must be used to centrifuge biological agents.

8 Radioisotope Hazard Requirements

The requirements laid out in this section apply to all laboratory spaces containing radioisotopes.

- Must have drain(s) of dedicated radioisotope washup sink(s) marked with the radiation warning symbol:

- marked at 3-meter intervals until tied-in to municipal system with the first marker readily visible to maintenance personnel, and
 - identified on building plans supplied to maintenance personnel.
- Provide for installing an appropriate radiation monitoring device as required.
- If a fume hood is required (must meet relevant requirements in Section 6) and
 - Be designed to support any shielding required (plexiglass or lead),
 - have the exhaust duct marked at 3-meter intervals with the radiation warning symbols with the first marker readily visible to maintenance personnel (only fume hoods so marked will be approved for the use of radioactive materials), and
 - have exhaust ducts from fume hoods in radioisotope laboratories identified on building plans supplied to maintenance personnel.
- Must be designed so that radioiodination laboratories or radioactive iodine storage areas are at negative pressure with respect to all adjacent areas.
- Appropriate shielding must be provided for radioactive materials storage areas.
- Lockable refrigerated storage must be provided for radioisotope inventory.

9 Other Considerations

9.1 Glove Boxes

The requirements laid out in this section apply to all glove boxes.

- Must not be located in high traffic areas.
- Must be constructed of materials that are fireproof (with exception of gloves and gasket materials), and with surfaces that are impervious, corrosion-resistant for the intended use, and easily cleanable. Interior cracks at seams and joints must be eliminated or sealed.
- Must be designed such that utility valves and switches are external and conform with applicable codes.
- Must provide spill containment for the maximum volume used.
- Must be provided with exhaust ventilation to result in a pressure inside the box that is at least 0.1" w.g. negative with respect to the room when all openings are closed, and at least 100 fpm inward air velocity when the largest operating opening is open.
- Must include a pressure relief valve.
- Must be designed to clean exhausted air or gases, if necessary, and discharged to the outside atmosphere.
- Must be connected to exhaust ducts in accordance with the ACGIH Industrial Ventilation Manual, ANSI Z9.2.
- If perchloric acid is used, must meet the relevant requirements for perchloric acid fume hoods (Section 6.4).

9.2 Controlled Climate and Walk-in Cold Rooms

The requirements laid out in this section apply to all laboratory spaces with a controlled climate or designated walk-in cold room.

- Ventilation must be provided during periods of personnel occupancy. (EHSO consultation is required.)

- Latches must be able to be operated from the inside to allow escape. These must function under all design conditions. Magnetic latches are recommended.
- Doors must have viewing windows.
- Must have external light switches.
- If used to store asphyxiate gases, must be equipped with oxygen deficiency monitor.

10 References

Public Health Agency of Canada

Canadian Food Inspection Agency

Canadian Nuclear Safety Commission

Manitoba Workplace Safety and Health Act and Regulation

Transport Canada

Manitoba Environment Act

Perchloric Acid Fume Hoods and Their Exhaust Systems, Government of Canada guidelines document MD 15129

ANSI-AIHAZ9.5-2012, Laboratory Ventilation

CSA Z316.5:20 Fume hoods and associated exhaust systems

11 Document History

Version Number	Version Date	Description of Change	Author
1.00	2024-05-17	Initial Release	Nicki Harris

Appendix A – Lab Safety – EHS Design Checklist

Project ID #: _____
 Campus: _____ Unit/Dept: _____
 Building: _____ Room No./Loc: _____

Relevant Sections in the *Guide to EHS Requirements*

Required	Section	Title
<input type="checkbox"/>	3	General Laboratory Requirements (all)
<input type="checkbox"/>	4	Emergency Response Equipment <input type="checkbox"/> Landline required for emergency phone <input type="checkbox"/> Safety Shower and Eyewash Station <input type="checkbox"/> Upgraded First Aid Kit <input type="checkbox"/> Upgraded Spill Kit
<input type="checkbox"/>	5.1	General Ventilation
<input type="checkbox"/>	5.2	Local Exhaust General Requirements
<input type="checkbox"/>	5.3	Fume Hoods
<input type="checkbox"/>	5.4	Perchloric Acid Fume Hoods
<input type="checkbox"/>	5.5	Walk-In Fume Hoods
<input type="checkbox"/>	6.1	Chemical Hazard Mitigation
<input type="checkbox"/>	6.2	Chemical Storage
<input type="checkbox"/>	7.1	Autoclaves
<input type="checkbox"/>	7.2	Class II A Non-Ducted Biological Safety Cabinets
<input type="checkbox"/>	7.3	Class II B Ducted Biological Safety Cabinets
<input type="checkbox"/>	7.4	Other Containment Equipment
<input type="checkbox"/>	8	Radioisotope Hazard Requirements
<input type="checkbox"/>	9.1	Glove Boxes
<input type="checkbox"/>	9.2	Controlled Climate and Walk-in Cold Rooms

EHSO Requirements Sign-Off

Proposal Reviewer: _____ Signature: _____

Date of Review: _____

AES Project Design Sign-Off

I hereby attest that the project design meets all EHSO requirements, or that any deviations or alterations have been discussed with both EHSO and the project requestor.

Notes / Alternative Compliance Items:

AES Project Manager: _____ Signature: _____

Date: _____

EHSO has received the design sign-off and reviewed any deviations or alterations indicated above.

EHSO Representative: _____ Signature: _____

Date: _____

Post-Construction Sign-Off

I hereby attest that construction of this project has been completed with no changes to EHSO requirements, or that any deviations or alterations have been discussed with both EHSO and the project requestor.

Notes / Alternative Compliance Items:

AES Project Manager: _____ Signature: _____

Date: _____

EHSO has received the post-construction sign-off and reviewed any deviations or alterations indicated above.

EHSO Representative: _____ Signature: _____

Date: _____