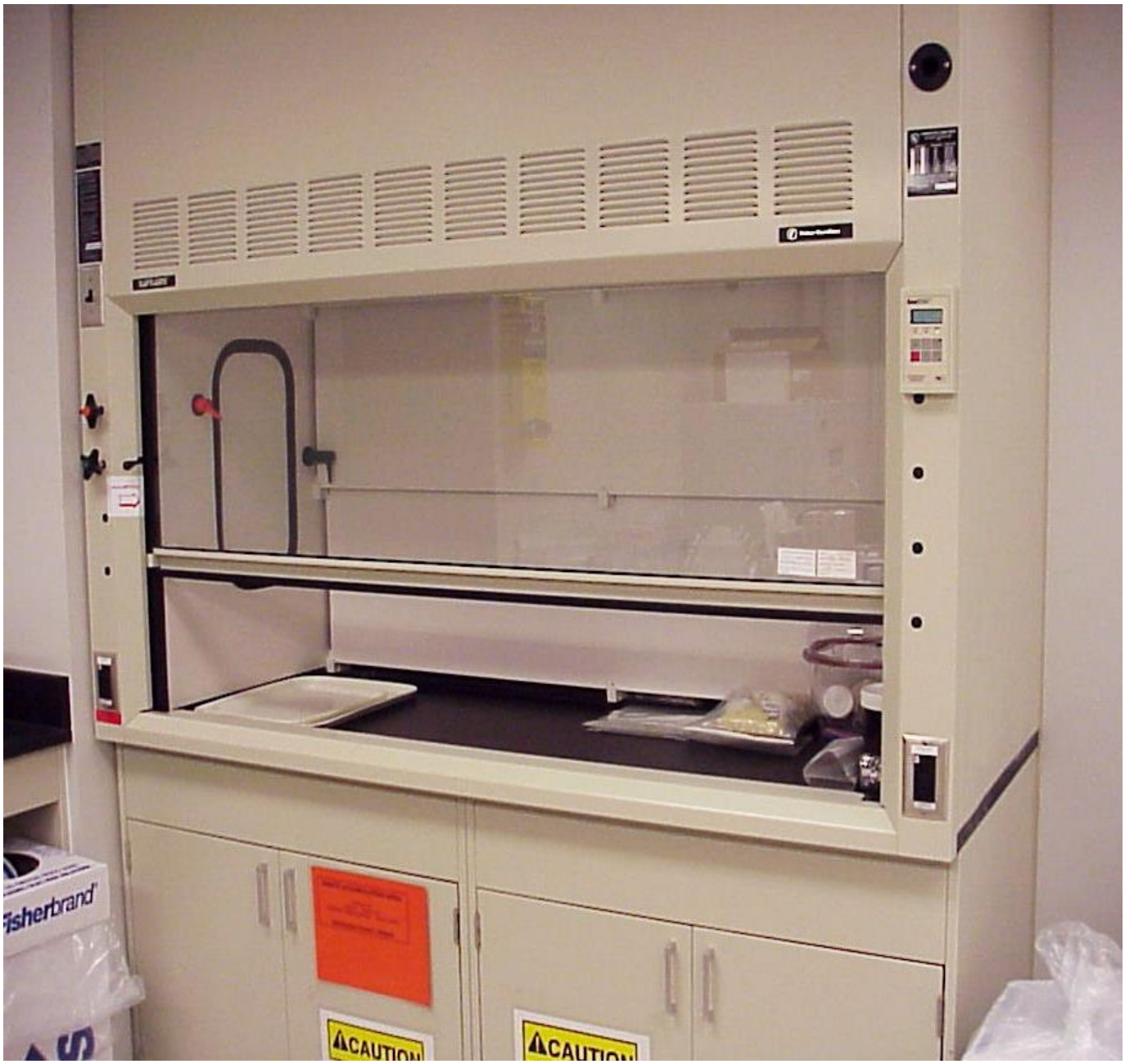
UBC Fume Hood User Manual

Safety & Risk Services

March 2025



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1. Introduction to Fume Hoods

The University of British Columbia (UBC) is committed to establishing a safe working and learning environment by providing appropriate controls to mitigate exposure from the potential adverse health effects of hazardous substances needed to fulfill teaching and research mandates. Fume hoods and the UBC Fume Hood program are integral to providing protection in a wide variety of working and learning spaces on UBC campuses and UBC sites.

This manual is applicable to all UBC faculty, staff, and students who use and operate fume hoods at the UBC Point Grey Campus however there may be useful information present for all employees across UBC Vancouver. The manual is also pertinent to personnel tasked with the management or upkeep of laboratory spaces where fume hoods are located. Where the document references UBC Point Grey service models (ie. Campus Security, Facilities), non-UBC sites will need to seek out their equivalents.

What are Fume Hoods

A fume hood is a ventilated system that consists of a partially enclosed workspace under negative pressure connected to ductwork and an exhaust fan. Air flows inwards into a fume hood through the hood's face opening to capture and contain hazardous airborne gases, vapors, mists, fumes, and particulates before moving upwards into the exhaust duct. These contaminants are then exhausted from the building into the atmosphere, reducing the risk of exposure and injury to lab members. Additionally, as mentioned above, fume hoods offer protection to operators from physical hazards such as splashes, fires and explosions.

Fume Hoods are Key Engineering Controls

To support safety and health protection, as outlined in the British Columbia *Occupational Health and Safety Regulation* (OHSR), UBC personnel must implement the hierarchy of controls when using hazardous substances and processes as part of their work or learning. The hierarchy of controls is a systematic approach for controlling hazards, in order of effectiveness, and can be visualized as:

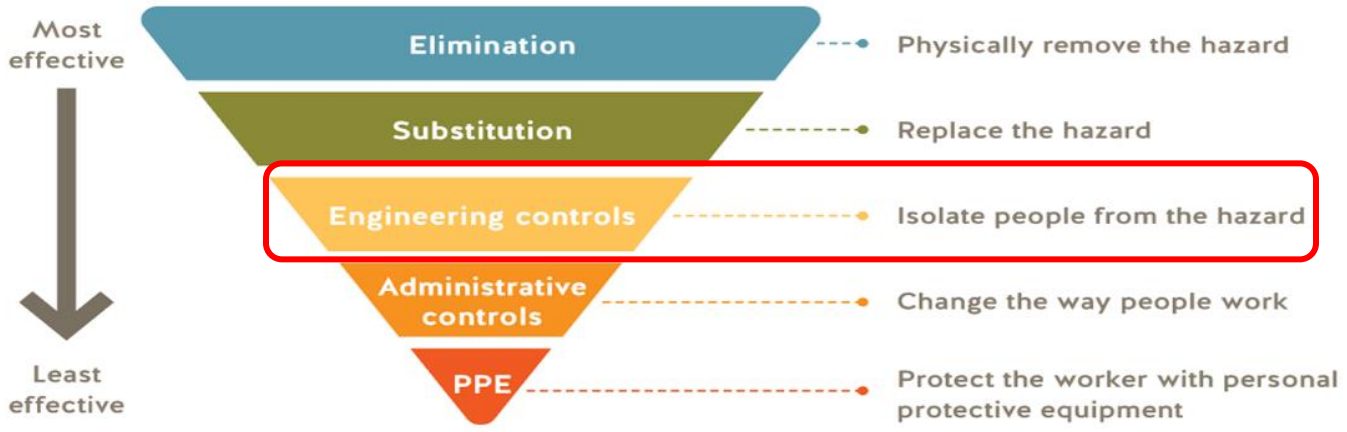


Figure 1: Hierarchy of Controls – Controlling Exposures to Occupational Hazards

In laboratories, it is best practice to use multiple controls to ensure faculty, staff, and students are provided with the safest working environment possible when performing experiments with hazardous products. For instance, it may or may not be possible to eliminate or substitute less hazardous substances or processes and still meet research or

learning objectives. In situations where eliminating or substituting hazardous substances is not feasible, the next step is to isolate those substances in a containment device. **Fume hoods offer engineering control level protection** as they are ventilated enclosures that prevent the release of respiratory contaminants into the entire workspace by removing contaminants through a dedicated exhaust system. The use of fume hoods should always be included in safe work procedures where possible – in addition to administrative controls (e.g. established procedures, training, etc.) and personal protective equipment (e.g. protective clothing) to ensure the wellbeing of all occupants in the air space. Performing experiments inside a fume hood also offers protection from physical hazards such as spills, fires and explosions.

When a Fume Hood Must Be Used

Fume hoods should be used as much as possible when handling any hazardous products. However, it is mandatory to use them when handling reagents and experimental products that are **carcinogens**, **sensitizers** and/or **reproductive toxins**. In addition, chemicals with **exposure limits** and/or **ceiling limits** (Section 5 of the OHSR) require proper ventilation controls for their safe use and fume hoods are the best type of ventilation control. Finally, experiments with a **risk of spills, splashes, fires or explosions** should take place in a fume hood for containment purposes and to shield the user. Generally, products with physical hazards connected to fires/explosions would include the following WHMIS classes: flammable & combustible materials, oxidizing materials, and explosive materials.

2. Legal Requirements & References

Section 30.8 of the OHSR outlines the regulatory requirements for fume hoods. The occupational exposure limits for various hazardous substances can be found in the Table of Exposure Limits for Chemical and Biological Substances within Section 5 the OHSR.

Appendix A provides a detailed list of the regulations, standards, and guidance documents used in the development of this operating manual.

3. Education and Training

Prior to lab users performing experiments within fume hoods, lab-specific and project-specific education and training must be received. Personnel should be trained to a level of “demonstrated competency”, as defined by the supervisor. At minimum, education and training must include UBC SRS Chemical Safety Training and documented training in lab-specific tasks. Records documenting the attendance list, training dates, and training materials must be kept on file by the supervisor.

4. Fume Hood Background

Within UBC laboratory spaces, fume hoods are the primary engineering control for staff and students performing research activities requiring respiratory protection. For example, the UBC Point Grey Campus has approximately 1200 fume hoods in active use. More information on alternative engineering control types can be found in Appendix B.

4.1 Fume Hood Components

Fume hoods and their components are listed below and illustrated in Figure 2A.

Air Foil - a curved sill at the front of the fume hood that reduces the turbulence of air entering the fume hood. A reduction in turbulence improves the capture of contaminants.

Baffles - moveable panels found on the sides and/or back of the fume hood. Baffles create slots from where contaminated air can be exhausted. The setting of the baffles will determine the pattern of air moving in and through a fume hood.

Bypass Slots - allow air to pass into the fume hood even when the sash is completely shut. Conversely, the bypass slots are covered when the sash is completely open. Bypass slots allow for constant airflow through the fume hood.

Exhaust Duct - designed to convey contaminated air through a fume hood before it exits out of the building through the exhaust stacks.

Face Opening - the area between the sash and the airfoil through which work takes place and air capture occurs.

Sash - a movable panel that covers the face opening when closed. The sash provides a barrier between the worker and any possible chemical spills, fires, or explosions inside the fume hood.

Sash Stop – small typically metal plate attached to the face opening to prevent sash movement during fume hood operation. It swivels out of place as needed to open the fume hood for maintenance or equipment set up. See Figure 2B.

Work Surface - the working bench on which experimental procedures take place within the fume hood.

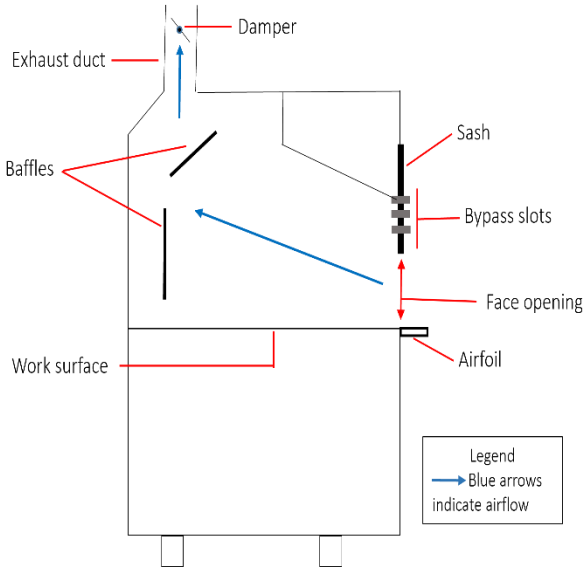


Figure 2A: Fume Hood Components (lateral view)

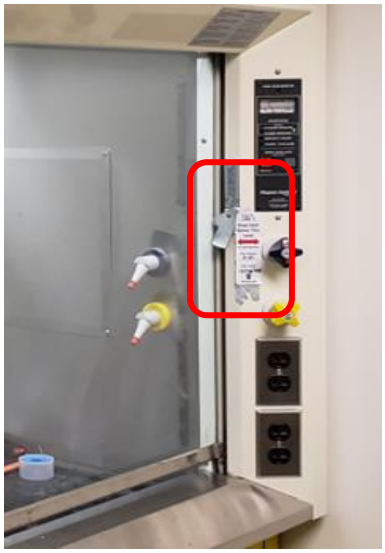


Figure 2B: Sash Stop

Sash Design

Fume hood sashes are designed to be moveable panels that offer a protective barrier between the user and the experiment. The sashes should be kept closed at all times unless access into the fume hood is needed. The vertical sash opening design is the most common type of sash design currently present on campus and is described in more detail below. Note that other specialized fume hood designs exist but are not addressed in this manual for the sake of clear messaging.

Vertical sashes are illustrated in Figure 3A. These sashes are able to move up and down along tracks that are mounted on the interior wall of the fume hood. The sash movement is supported by cables, pulleys and/or chains. The optimum height at which sashes should be raised for ideal airflow is 15 inches as per UBC Technical Guideline 11 53 13. If ideal airflow is not achieved at 15 inches, the sash working height should be between 12 inches and 18 inches. At UBC, a certification decal found on both sides of the fume hood will indicate the safe working height for fume hood sashes based on annual airflow test results. If fume hood sashes are not positioned at the safe working height, based on the certification decal, there is a risk of ineffective air velocities at the face opening compromising containment. An image of a UBC certification decal is shown in Figure 3B. Note that some fume hoods have a sash stop that prevents the sash from being raised above the maximum safe working height (Fig 2B).

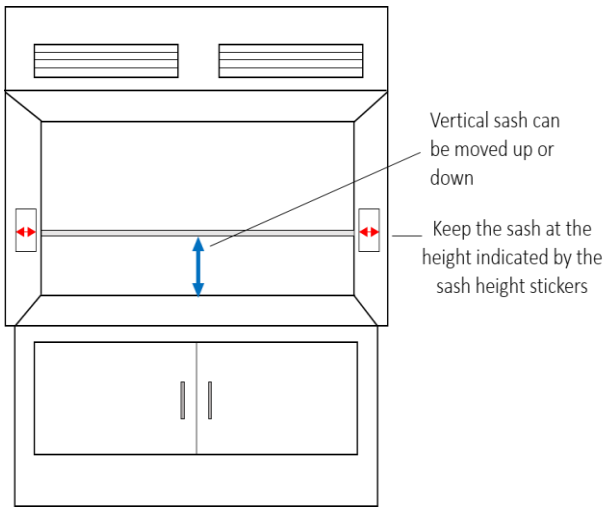


Figure 3A: Vertical Sash Opening

Figure 3B: UBC Certification Decal

Horizontal and combination sash openings are additional configurations for sash design that, while not commonly found on the UBC campus, are available commercially.

Horizontal sashes are capable of moving side-to-side across the fume hood opening as shown in Figure 4. The sash is able to slide on tracks that are located on the bottom and top of the face opening. Fume hoods with horizontal sashes allow lab members to be positioned behind the sash for whole body protection while accessing the workspace through the sides. Horizontal sash openings provide personnel with access to the top interior of the hood but do not allow full access along the width of the hood.

Combination sash fume hoods are illustrated in Figure 5 and are capable of moving both vertically and horizontally to offer the benefits of both options.

Rarely, depending on research requirements, there may be fume hoods without any sashes present.

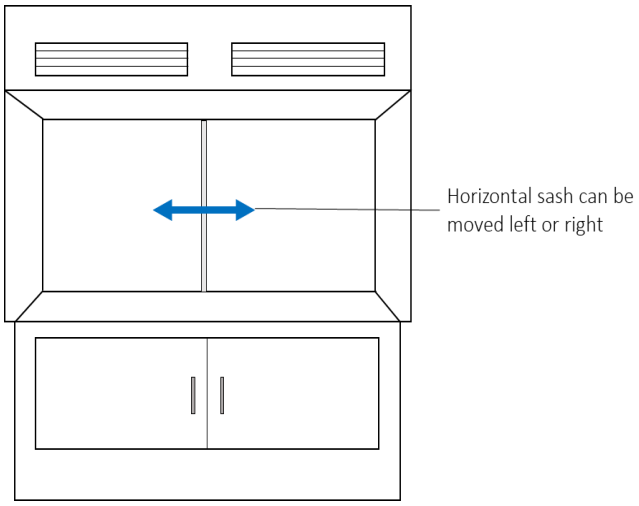


Figure 4: Horizontal Sash Opening

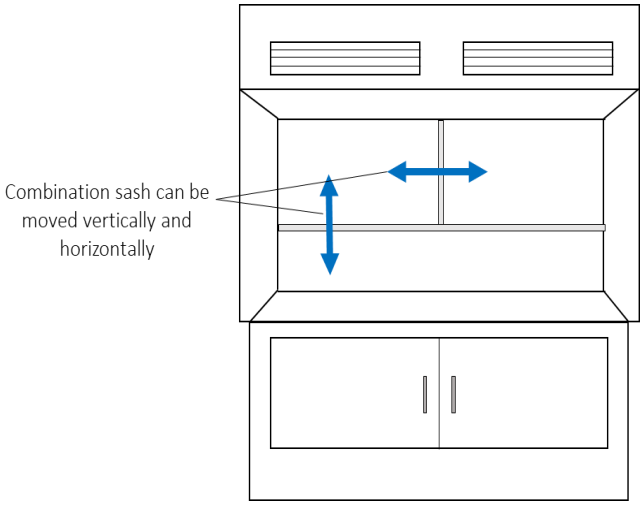


Figure 5: Combination Sash Opening

Airflow Performance and Visual Indicators

Fume hoods at UBC should be equipped with airflow performance indicators to advise operators on whether there is sufficient draw into the hood to offer the required respiratory protection against hazardous airborne contaminants. The airflow indicators on campus are a combination of digital air flow alarms and tell-tales, both of which are described in more detail below.

Note that if lab members suspect that a fume hood's airflow is not adequate, based on the information provided by the indicators, they must place a service request to UBC Facilities to request a re-evaluation of that fume hood. More information on the steps to take once a fume hood performance indicator shows a failure in airflow is provided in Section 5.

Digital Air Flow Alarms

Digital air flow alarms are the most common air flow indicators on campus. This type of alarm measures the real-time face velocity of the hood. The face velocity reading should be between 80 to 100 feet per minute (fpm) or 0.40 to 0.60 meter per second (m/s) to be in compliance with the WorkSafeBC OHSR. Once the average face velocity falls below the minimum average face velocity level required, the alarms become activated to generate audible and/or visual signals to notify hood users that the airflow is no longer within programmed parameters. An example of a digital air flow alarm is shown in Figure 5.

Tell-Tale

In situations where a fume hood is not equipped with a digital alarm, a tell-tale should be used to visually confirm the inward draw of air into a hood. A tell-tale is generally a strip of light material (crepe paper/tissue) taped to hanging from the fume hood's sash. The tell-tale should be drawn inwards into the fume hood. Tell-tales not moving indicate poor airflow across the face opening of a fume hood. An example tell-tale being used in a fume hood is shown in Figure 6. This is a visual indicator that confirms presence/absence of air flow and the direction of it – it does not provide any indication of whether the flow is within the required parameters.

Figure 5: Standard Digital Air Flow Alarm

Figure 6: Example of a Tell-Tale used on a Fume Hood

4.2 Fume Hood System Types

Fume hoods can be categorized by their air flow systems as either constant air volume (CAV) or variable air volume (VAV). The primary difference between these two types of fume hoods is how face velocity is maintained with sash height changes. A VAV hood has an automated control system to regulate the air flow rate when sash height changes. A CAV hood relies upon bypass slots above the glass window. It is important not to block the bypass section with the posting of signs/documents as this will interfere with maintaining face velocity. Both CAV and VAV fume hoods are used on campus. The VAV hoods have reduced energy consumption as compared to CAV hoods.

4.3 Specialized Fume Hoods

Depending on the experimental procedure, the airborne hazards that require mitigation, and the specifications outlined in the OHSR, there may be a need to use a specialized fume hood. Examples of the types of specialized fume hoods at UBC are described in more detail below.

Wash Down Fume Hood (for Perchloric Acid use)

Wash down fume hoods have a built-in water wash down system, equipped with spray nozzles and waste water drain troughs, to remove any chemical deposits and allow for a detailed cleaning of the hood interior.

Wash down fume hoods must be used when handling or performing reactions with perchloric acid as per the OHSR Section 30.21. The specific regulatory requirements for fume hoods used for perchloric acid work include:

- signage to be posted identifying the hood as being for perchloric acid use only (Figure 7)
- statements indicating the use or storage of combustibles inside the hood is prohibited (Figure 7)
- exhaust ductwork kept as short as possible and routed directly to the outdoors with no interconnections to other exhaust ducts

Wash down fume hoods for perchloric acid use are constructed of materials, such as polyvinyl chloride (PVC) or polypropylene, that are resistant to the corrosive properties of perchloric acid. In addition, the wash-down system prevents the buildup of perchlorate salts on the interior of the hood, ductwork, and fan. The washdown system is an

imperative control against perchlorate salts which are extremely shock-sensitive and unstable, having a high risk of explosion when exposed to shocks and vibrations.

It is **mandatory** for the wash down system of fume hoods used for perchloric acid to be activated after **every use** and the use documented. Additional wash down requirements may be necessary during perchloric acid experimental procedures based on a risk assessment and consultation with SRS. Note that **lab specific written safe work procedures** must be developed on the safe use, operation, and cleaning of perchloric acid fume hoods. A template describing the minimum operating and documentation requirements for wash down fume hoods being used for perchloric acid work can be found in Appendix C. Additional resources are available on the SRS website for Working Safely with Perchloric Acid.

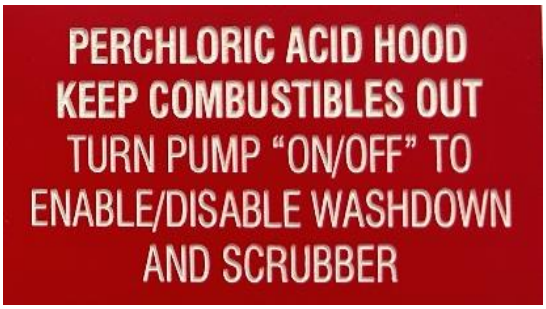


Figure 7: Example of signage that may be present for Perchloric Acid Use in Fume Hood

Radioisotope Use Fume Hood

General chemical fume hoods can be used to provide containment for BASIC or INTERMEDIATE work with radioisotopes. All fume hoods used to handle radioactive materials must be identified with the signage shown in Figure 8.

In rare cases, specialized fume hoods may also be used, most commonly for HIGH level radioisotope work. These specialized fume hoods are constructed with reinforced workbenches that can hold the weight of lead shielding. In addition, the specialized fume hoods have exhaust ductwork that is vented directly to the outside rather than being manifolded with other exhaust systems.

Figure 8: Signage for Radiation Usage in Fume Hood

All fume hoods used for radiation work should be made of stainless steel and have spill containment lips to assist with decontamination. Additional specific requirements on the use of radioactive materials within a fume hood can be found in the UBC Radiation Safety Manual.

Floor Mounted

A floor-mounted fume hood, also referred to as a walk-in fume hood, is similar to other hoods, except that the sash extends to the floor. These fume hoods do not have a working surface and are designed to accommodate for larger equipment, apparatuses, and experimental set ups. To account for the extra height, this style of fume hood typically makes use of two vertical sashes. The airflow requirements of walk-in fume hoods must also meet the OHSR. An illustration of a floor mounted fume hood is shown in Figure 9. Note that despite the name given to this model of fume hood, ***individuals should never walk into this hood type***.

Figure 9: Floor Mounted Fume Hood

5. Fume Hood Usage – Best Practices

This section outlines the requirements for safe fume hood use. A print-out poster to communicate the Fume Hood Safe Work Practices Poster can be found in Appendix D.

In addition, the steps required when responding to an airflow failure in a fume hood are provided in Section 5.

5.1 Daily Practice

Ensuring good laboratory practices are followed will improve the level of protection fume hoods can offer against airborne and physical hazards. The safe work practices provided below are required during the various stages of fume hood use:

Prior to Using a Fume Hood

- Confirm the fume hood is operational by:
  - checking for a sash height sticker indicating airflow was tested within the past 12 months.
  - checking no notices or signage specifying lockout, clearance, or need for repair are posted on the hood.
  - checking the airflow performance and visual indicators verify sufficient airflow into the hood. Refer to section 'Airflow Performance and Visual Indicators' in section 4.1 of this document for additional details.
- Check that the fume hood sash is transparent, smooth moving, without physical defects, and at the designated height level.
- Inspect the fume hood or work surface for physical damage. Place a service request for repair if needed.
- Maintain cleanliness within the work surface of the fume hood.

During Fume Hood Use

- Ensure all equipment, apparatuses, and/or containers are:
  - a minimum of 6 inches away from the face opening of the fume hood.
  - safely elevated to promote air circulation.
  - not obstructing fume hood baffles and slots (see Fig 2A for fume hood components).

- Minimize the effects of cross draft on the fume hood air flow by keeping laboratory doors and windows closed, fans off, etc.
- Clean up any spills inside the fume hood as soon as it is safe to do so and report all spills and incidents to UBC via CAIRS.
- Do not alter the interior of the fume hood (i.e. remove side access panels).
- Do not override or disable mechanical stops on the sash.
- Continue checking airflow performance indicators to ensure continuity of inward directional airflow.
- Do not use the hood as a waste disposal mechanism (e.g. for evaporating chemicals).

After Using a Fume Hood

- Place hazardous materials in closed containers and store them in their designated lab storage (not in the fume hood).
- Remove equipment, apparatuses, and/or containers from the fume hood that are no longer necessary.
- Perform a wash-down cycle if working in a perchloric acid fume hood.
- Close the sash completely.

NOTE: Experiments of sufficiently long duration that need to be left unattended must be labelled to indicate ownership and emergency contact details to allow information to be obtained on the description of the reaction, applicable emergency measures, etc.*

**Please refer to Appendix D for signage that can be printed and posted on fume hoods containing experimental procedures that must be left unattended for longer periods of time (i.e. overnight). During normal working hours, it is expected that lab members knowledgeable of the experiment are present and aware of the work being conducted in case of an emergency.*

6. Fume Hood Failure - Emergency Response Procedures

In the event that there is a fume hood air flow failure (as indicated by the digital air flow alarm or tell-tale), power outage or other emergency the following actions must be taken in the order presented below:

Immediate Actions

1. Discontinue the use of the fume hood by stopping experimental work.
2. Close the sash of the fume hood completely.
3. If there is reason to believe airborne hazards from inside fume hood have breached containment and entered the lab, immediately evacuate the room and notify your supervisor.
4. To obtain additional support, contact UBC Campus Security to alert Safety & Risk Services or 911.

Follow-Up Actions

1. Once it has been determined to be safe:
    a. Turn off and unplug any heat sources or equipment being used in the fume hood.
    b. Cap any open vessels and chemicals in the fume hoods, which includes closing off compressed gas cylinders being supplied into the fume hood.

c. If specialized experimental reactions are inside the fume hood, immediately contact UBC Campus Security to activate the SRS Emergency Resource line and obtain advice on the appropriate situation-based response.

2. Post "Do Not Use" signage on the fume hood and notify lab members that the fume hood is not working.
3. If radiation work is being performed, notify UBC Campus Security to activate the SRS Emergency Resource line.
4. Follow site specific procedures for contacting the UBC Facilities Service Centre and placing a service request for fume hood investigation/repair.
5. Follow Fume Hood Shutdown Procedures in anticipation of repair work.

7. Prohibitions

The misuse of fume hoods can have severe environmental and health implications. The following must be adhered to for the safety of fume hood users and to prevent the fume hood functionality from being compromised.

- Never use a fume hood labeled as '**Do Not Use**'.
- Never circumvent the lock on a **locked-out** hood.
- **Never** place your head below sash height or inside the fume hood.
- Keep loose papers, tissues, or paper towels outside of the hood as they can be drawn into the exhaust ductwork resulting in blockages and adversely affecting the airflow.
- **Never, ever** modify fume hoods and HVAC ducts from their original design or drill into without consultation with and **written approval** from Facilities and SRS.
- Equipment/apparatuses **must not clutter** the fume hood or be **permanently stored** in the fume hood unless dedicated to an often-reoccurring task (e.g. distillation).
- Chemicals must not be stored in an active fume hood. In situations where fume hoods are designated as "chemical storage" the hood must be labeled "Chemical storage" and cannot be used for work purposes.
- Fume hoods must not be used to evaporate hazardous waste.

8. Procurement, Installation & Commissioning

Consultation and agreement with UBC Facilities and UBC SRS must take place prior to the purchase and installation of a new fume hood in a lab space. All new fume hoods are required to meet the specific design criteria outlined in *Industrial Ventilation: A Manual of Recommended Practice*, published by the American Conference of Governmental Industrial Hygienists. Details on the design criteria can also be found in the UBC Technical Guideline 11-53-13. As new fume hoods will impact the balancing of the room air, the consultation will ensure the building ventilation system and its capabilities are appropriately investigated. In addition, the review will allow valuable input to be provided so that fume hood location and positioning can be optimized to prevent adverse airflow effects. Following installation, the fume hood airflow must be tested, as described in Section 8.1 of this manual, to ensure appropriate containment of hazards can be achieved.

9. Scheduled Testing & Maintenance Programs

The University is responsible for verifying containment in fume hoods being operated by UBC employees at the Point Grey campus, as well as nearby affiliated sites including VGH, BC Children's Hospital, and Saint Paul's Hospital. To verify containment, testing is done to meet the requirements outlined in the OHSR and CSA Standard Z316.5-15. The specific conditions and intervals in which fume hoods need to be tested are listed below.

1. During the initial installment and commissioning of a fume hood.
2. Following building HVAC maintenance/renovation work that may impact airflow velocity at the hood face.
3. Following any fume hood maintenance/repairs that could affect the air flow of the hood.
4. Annually by the date of the last airflow test.

9.1 Airflow Performance Testing

Fume hood testing has a quantitative and qualitative component. The quantitative component includes a face velocity test and a cross draft test using a hotwire anemometer. The qualitative component checks for containment using smoke in an airflow visualization test. More details on these tests are provided below. You might see these terms being used in your fume hood testing report.

***Note**: Under special circumstances, when a better understanding of airflow patterns and confirmation of hazard containment is needed, a more detailed Tracer Gas Containment test can be performed. The ASHRAE 110 test is a recognized tracer gas containment method for evaluating the performance of a fume hood and can only be performed by qualified personnel.*

Face Velocity

The velocity of air moving through the face of the fume hood is termed face velocity. Face velocity is measured in either meter per second (m/s) or feet per minute (fpm). The face velocity is used to determine if a hood is functioning properly to contain airborne contaminants. Factors that can affect face velocity include sash height, baffle position, cross draft, and user work practices.

Parameter	WorkSafeBC Regulatory Limits		
Average Face Velocity (AFV)	0.40m/s-0.60m/s (80 fpm – 1200 fpm)		
Minimum Face Velocity	≥80% of AFV	Maximum Face Velocity	≤120% of AFV
Cross Draft Velocity	≤50% of AFV		

Figure 10: Fume Hood Airflow Regulatory Limits

Cross Draft

The air currents external to a fume hood that can impact the performance of a hood is referred to as cross draft. The presence of cross drafts across the face opening of fume hood is especially of concern, as they may draw contaminants out of the hood and into the general lab space, presenting a health and safety hazard to others. For this reason, inspections should be done to ensure the cross drafts around a fume hood are minimized. Sources of cross draft include open windows and doors, supply air grilles, ceiling mounted diffusers, stand-alone fans, and high traffic patterns. The careful consideration of cross draft sources in the design of spaces and orientation of equipment is essential for mitigating cross draft risks in labs.

Airflow Visualization

The airflow patterns of smoke in a fume hood are observed to evaluate a hood's ability to capture, contain, and exhaust air. During this test, smoke is introduced into the fume hood for a qualitative assessment of reverse flow,

stagnation zones, swirling airflow regions, clearance, and escape. Although fume hoods may vary in their smoke flow patterns, if hoods are functioning properly, smoke will not leave the plane of the sash and enter the room.

Record of Test Results

Certification decals are placed on fume hoods that successfully pass the air flow performance testing described above. The decals provide information on the fume hood identification, testing date, sash height, and the average face velocity recorded for that sash height level. An example of the UBC designed certification decal, which is attached to both exterior side walls of fume hoods to identify the correct sash height position for optimal air flow, is shown in Figure 3B.

All fume hoods that have failed the airflow performance testing will be marked with "Do Not Use" signage and are temporarily unavailable for use by lab members. The failed fume hoods will require a service request to be submitted to UBC Facilities, *via* site specific building procedures, for further investigation and potential maintenance work. Once UBC Facilities has made the appropriate adjustments, a re-test of the fume hood will need to be organized through SRS. Only SRS can remove a "Do Not Use" signage placed on fume hoods and confirm a service request is complete. Figure 11 shows the "Do Not Use" signage placed on fume hoods.

Figure 11: Do Not Use Signage for Fume Hoods

9.2 Fume Hood Shutdown/Lock Out Procedures

Prior to maintenance and/or repair of a fume hood and/or its exhaust system, lab members need to prepare the fume hoods and any other equipment connected into the exhaust systems for the upcoming work. The intent of this preparation is to ensure all hazards in the fume hood and/or exhaust system are appropriately controlled and mitigated to protect maintenance staff. The level of preparation required by the lab is dependent on the work planned. The three levels of fume hood preparation and details for each are provided in Figure 12. The sign off forms, including a summary of the expectations from the lab for each level, are provided in Appendix E.

If fume hoods are being used for radioactive work, a wipe test must be performed by lab occupants to verify the fume hood is cleared for maintenance work to proceed. Fume hood system components not accessible by lab occupants (e.g. exhaust fans) will require further coordination and consultation with the SRS Radiation Safety team prior to any maintenance work being performed. All wipe test results must be sent to research.safety@ubc.ca for review and a written sign off from the Radiation Safety Officer must be received and posted on the fume hood. Detailed procedures for wipe testing and clearance for fume hoods can be found in the UBC Radiation Safety Manual.

If fume hoods are being used for perchloric acid work, a methylene blue test must be performed by lab occupants to ensure there is no build-up of perchlorate crystals on the inner surfaces of the fume hood and exhaust ductwork. Appendix C should be referenced for details on the methylene blue surface contamination procedure.

LEVEL1

Cap all chemical bottles
Remove all compressed gases
Shut down/de-energize all equipment, heat sources & stills
Wipe test radioisotope hoods
Test perchloric hoods
Remove all venting sources
Lower sash
Complete, sign & post level 1 shutdown form

LEVEL 2

Remove all chemical bottles and compressed gases
Shut down/de-energize & disconnect power sources for all equipment, & heat sources
Stills may be left in place if capped
Wipe test radioisotope hoods
Test perchloric hoods
Remove all venting sources
Lower sash
Complete, sign & post level 2 shutdown form

LEVEL 3

Completely empty hood
Wipe test radioisotope hoods
Test perchloric hoods
Remove all venting sources
Lower sash
Complete, sign & post level 3 shutdown form

Figure 12: Shut down Levels. Note that for each shutdown level, the corresponding clearance form must be completed and attached.

Appendix A: Links to British Columbia WorkSafe BC Occupational Health and Safety Regulation (OHSR) Requirements and Other References

The table below outlines sections of the BC occupational health and safety regulations and relevant guidelines that are most applicable to this document.

Table A.1 Links to BC Occupational Health and Safety Regulations and Guidelines

Reference	Description
OHSR Section 5.54	Requirements for exposure control plans including information required to prevent and respond to exposures to hazardous substances.
OHSR Section 5.55	Requirements for control options to mitigate risk to hazards.
OHSR Section 5.57	Explanation and requirements for designated substances.
OHSR Section 30.8	Requirements for laboratory fume hoods.
OHSR Guideline Part 5	Controlling Exposure: Table of exposure limits for chemical and biological substances.

Additional standards and reference materials used in the development of this operating manual are provided below:

- CSA Standard Z316.5-15, Fume Hoods and Associated Exhaust Systems
- Industrial Ventilation, A Manual of Recommended Practice
- ANSI/ASHRAE Standard 110-1995, Method of Testing Performance of Laboratory Fume Hoods
- ANSI/AIHA Standard Z9.5-2003, Laboratory Ventilation
- Canadian Nuclear Safety Commission (CNSC) REGDOC-2.5.6 - Section H8
- Public and Government Services Canada Standard MD 15128-2013, Laboratory Fume Hoods: Guidelines for Building Owners, Design Professionals, and Maintenance Personnel
- University Health and Safety Policy - SC1
- UBC Technical Guidelines
- UBC IB-16 Fume Hood System Maintenance and Repairs

Appendix B: Other Types of Engineering Controls

In addition to fume hoods, other forms of engineering controls are available commercially and/or on campus. They are not necessarily able to replace a fume hood but offer other types of protection. A brief description of the common types is provided below.

Ductless or High Performance

Neither ductless or high-performance fume hoods are permitted for use as engineering controls at UBC (as per WorkSafe BC Inspection report #202217748019A from March 2022).

Capture Hoods

Capture hoods are localized ventilating devices that are used to capture contaminants. Extraction arms are a type of capture hood with adjustable and sometimes flexible ducting to seize contaminants. Different models of extraction arms are found on campus such as hanging, benchtop, and portable units. The effectiveness of extraction arms will be dependent on the distance and placement of the arm from the source of contaminant generation. In addition, the exhaust air velocity from the extraction arms will influence containment of hazardous substances. Due to these limitations, **extraction arms must only be used for nuisance particulates/odors and not for substances associated with health hazards**. Note that the performance of extraction arms is not evaluated by SRS.

Spray Booths

Spray booths are ventilated structures designed to contain spray related activities and equipment so that any vapors being generated are isolated and exhausted. Spray booths are equipped with their own exhaust fans and filters. Typical activities performed in spray booths include the application of paints, resins, foams, finishes etc. Spray booths must meet code requirements, which include being intrinsically safe from fires and explosions. When working inside spray booths, individuals are still expected to wear the appropriate personal protective equipment, including respiratory protection.

Glove Boxes

Glove boxes are sealed enclosures designed to provide a controlled atmosphere separate from the external ambient air through airlock systems. The controlled atmosphere may involve the use of inert gases and/or specific temperature and humidity conditions depending on the experimental procedure. Built into the sides of the glove box are gloves that the user can insert their hands into and perform activities inside the box without breaking containment.

Biosafety Cabinets (BSC)

BSCs are enclosed workspaces designed specifically for the containment of biohazardous or infectious agents. There are 3 main classes with subtypes of BSCs.

Class II Type A2: most of the BSCs found at UBC belong to this class. These cabinets must not be used for chemical protection as recirculation of exhaust air both in the cabinet and into a lab space is not permitted.

Class II Type B2: found at a small number of facilities on Point Grey campus. These cabinets are the only appropriate engineering control to provide protection from both biohazards and chemical hazards.

BSCs are thoroughly described in the UBC Biosafety User Reference Manual available on the SRS website. BSC's are not tested by UBC SRS, but are still required to be tested annually by a third-party contractor.

Appendix C: Wash Down Fume Hoods and Perchloric Acid Safe Work Practices

The forms below outline the expectations for using perchloric acid in wash down fume hoods. The forms are also designed to collect the information necessary to ensure wash down fume hoods are being utilized safely so that the formation of explosive perchlorate crystals is prevented.

Operating Instructions and Log Book for Wash Down Fume Hoods used for Perchloric Acid Work

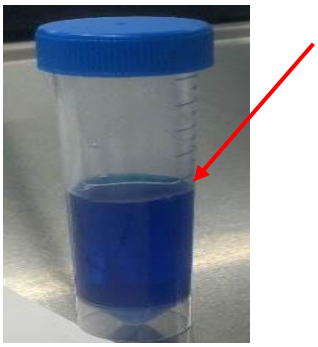
Wash down fume hoods must be used when handling or conducting experiments that require perchloric acid. Vapors of perchloric acid can condense on the metal surfaces and form perchlorate crystals. Perchlorate crystals are shock sensitive and pose an explosion hazard. Wash down fume hoods are designed to have an integrated wash down system to prevent the formation and build-up of perchlorate crystals in both the fume hood interior and the exhaust ductwork. Each lab using a wash down fume hood for perchloric acid must personalize this document as a training tool. In addition, the usage log book below must be kept in the immediate vicinity of each wash down fume hood intended for perchloric acid work.

Principal Investigator Contact Information			
Last Name		**First Name**	
Phone Number		**Email Address**	
Department		**Date**	
Location Information for Wash Down Fume Hood			
Building Name		**Room Number**	
Fume Hood Identification Number		**Fume Hood Wash Down Switch Location**	

Wash Down Fume Hood and Perchloric Acid Operating Instructions

1. Only lab members that are aware of the properties and hazards of perchloric acid should perform perchloric acid procedures. These lab members must be educated and trained on the SRS Perchloric Acid Safe Work Procedures and have read and understood the current version of the perchloric acid safety data sheet.
2. Perchloric acid must be used in a wash down fume hood designed exclusively for its use.
3. Wash down fume hoods must be labelled with signage that identifies the hood as being for perchloric acid use.
4. Non-perchloric acid work must not be performed in the wash down fume hood as there is a risk of incompatible reactions resulting in fires and explosions.
5. Prior to the use of wash down fume hoods there must be
    a. confirmation that no notices or signage specifying lockout, clearance, or need for repair are posted on the hood.
    b. confirmation that the exhaust fan is operational by checking the fume hood air flow performance indicator (i.e. digital airflow alarm).
6. It is mandatory for the wash down system of the wash down fume hood to be activated after each use of perchloric acid to dilute and remove perchloric acid vapors and fumes that may have deposited on the inner surface of the hood and ductwork. Additional wash down requirements may be necessary during perchloric acid experimental procedures based on a risk assessment and consultation with SRS. Note: Make use of the manual spray nozzle, if present, to also wash the working space inside the fume hood after the perchloric acid work is complete.

7. Perform a validation indicator test for perchlorate crystals using the Methylene Blue surface contamination procedure at the end of a wash down cycle when a new experimental procedure is being performed. The validation test will confirm the wash down cycle time is sufficient to remove any build-up of perchlorate crystals on the inner surface of the hood and ductwork. Perchloric acid concentration, perchloric acid volume, and duration of experimental run will affect the wash down times.
    a. To perform a Methylene Blue surface contamination procedure, proceed with the following steps to obtain a control sample and a rinsate sample:

Procedures	Results Interpretation
Collecting the Control Sample 1. Collect 25 mL of tap water as a control sample in a clean vial. 2. Add 1 drop of methylene blue solution to the vial with the tap water. 3. Swirl the vial and put aside. Note: The control sample is used as a baseline to know what the samples would look like if perchlorates are not detected.	Photo 1: A blue color, with no violet precipitate. 
Collecting the Rinsate Sample(s) 1. Collect 25 mL of rinsate in a clean vial. 2. Add 1 drop of methylene blue solution to the vial with the rinsate. 3. Swirl the vial gently and immediately check the colour of the solution. **Note**: The colour of the solution might differ after the initial visual check. Only rely on the initial check for results interpretation.	Photo 2: A violet precipitate if perchlorate is present. 

Wash Down Fume Hood and Perchloric Acid Usage Log Book							
Date (dd/mm/yyyy)	**Brief Description of Perchloric Acid Experimental Procedure**	**Perchloric Acid Volume Used (mL)**	**Concentration of Perchloric Acid Used**	**Duration of Experimental Procedure (minutes)**	**Length of Time Wash Down System Activated (minutes)**	**Methylene Blue Test Results (If Completed)**	**Name of User**
					Before experiment:		
					During experiment:		
					After experiment:		
					Before experiment:		
					During experiment:		
					After experiment:		
					Before experiment:		
					During experiment:		
					After experiment:		
					Before experiment:		
					During experiment:		
					After experiment:		
					Before experiment:		
					During experiment:		
					After experiment:		

Appendix D: Fume Hood Signage

Experiment in Progress

The signage below should be placed on a fume hood if an experimental procedure must be left unattended for longer periods of time (i.e. overnight). During normal working hours, it is expected that lab members knowledgeable of the experiment are present and aware of the work being conducted in case of an emergency.

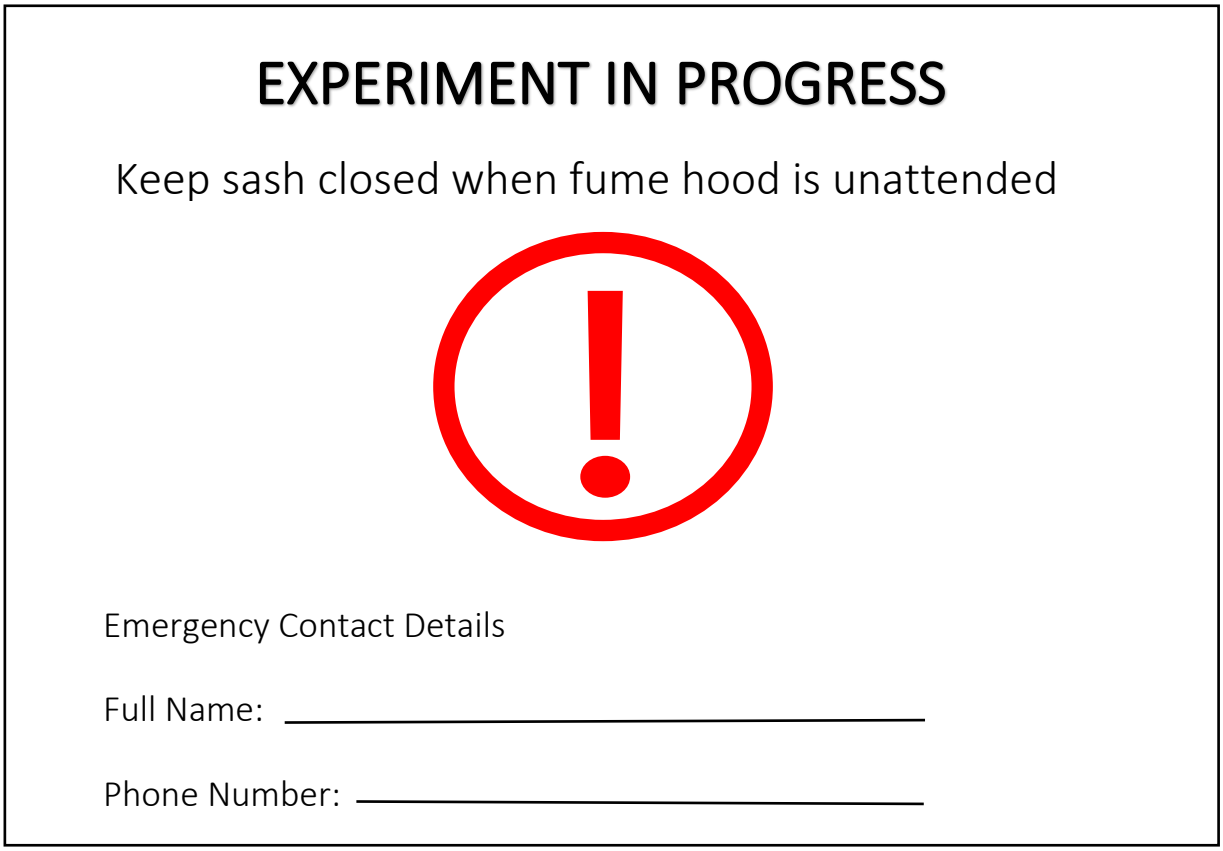


Figure D1: UBC Experiment in Progress Signage

Fume Hood Safe Work Practices Poster

Fume hoods that are maintained in good working condition will offer protection against airborne hazards if used appropriately. The following poster can be placed on fume hoods to educate operators on fume hood safe work practices.

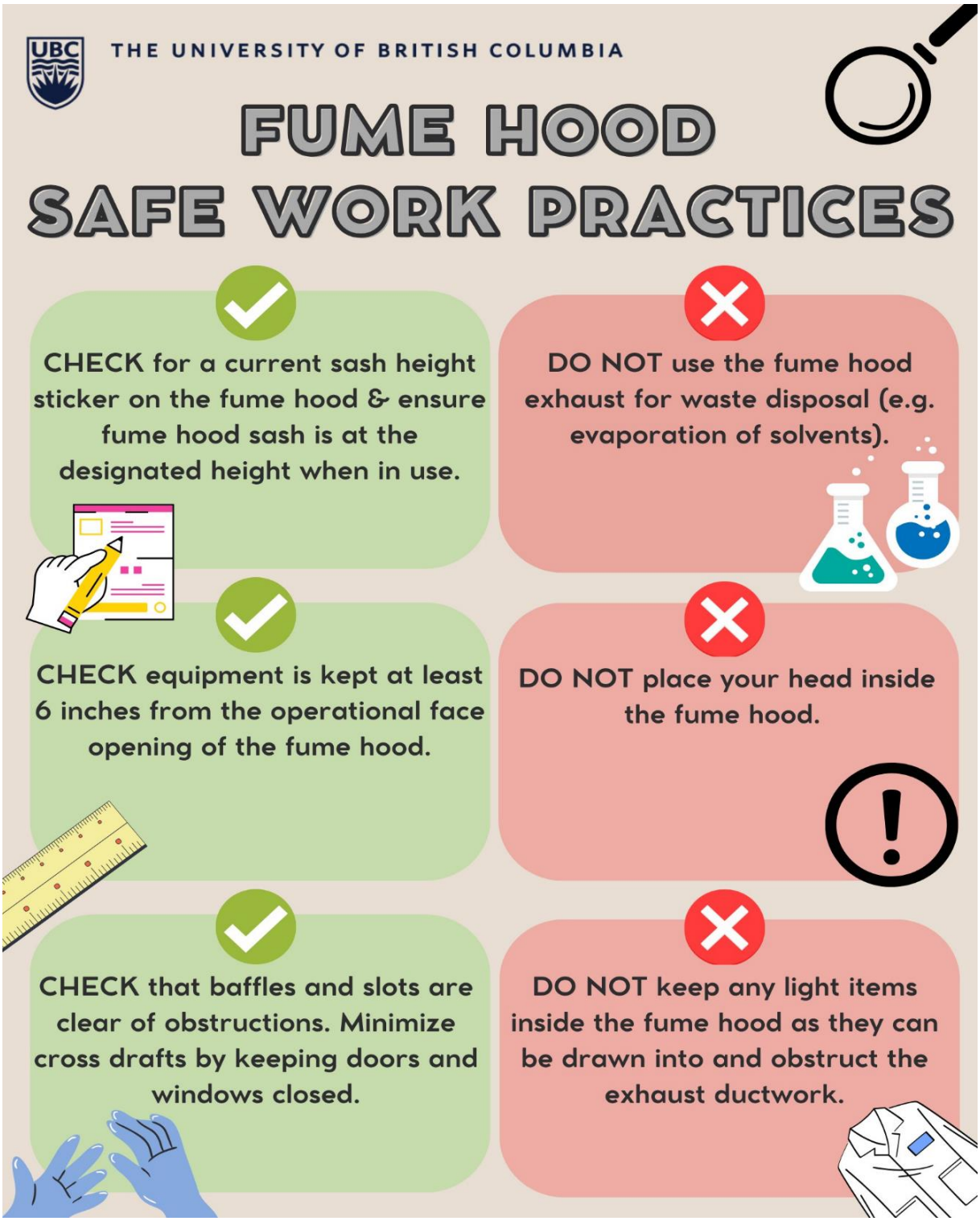


Figure D2: UBC Fume Hood Safe Work Practices Signage

Appendix E: Fume Hood Shut Down & Clearance Forms

a place of mind
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UBC Facilities

LEVEL I FUME HOOD SHUT-DOWN PROCEDURES

DO NOT USE THIS FUME HOOD

For regular maintenance work where the work is done outside the hood and ductwork, where the exhaust system is stacked on the roof and system is intact.

Planned Shut-Down Date: _____

Fume Hood needs to be shut-down by Time: _____ am/pm for Shut-down Safety Inspection

- ☐ all extremely hazardous chemicals, compressed gas and/or lecture bottles must be **REMOVED from fume hood**

The following items may remain in the Fume Hood:

- ☐ all chemical bottles/containers TIGHTLY capped/closed (i.e. no open chemical containers)
- ☐ all equipment inside the hood is shut-down and power sources disconnected (i.e. stir plates unplugged, pumps off etc.)
- ☐ all stills shut-down (i.e. not heated, kept under inert gas)
- ☐ all glass manifolds left in place with all glass traps emptied
- ☐ all mercury bubblers capped/sealed
- ☐ all drying tubes containing drying compounds capped/sealed

Additional general procedures:

- ☐ all vacuum pumps for glove boxes in the adjacent area require hosing to be vented out nearest window
- ☐ shut-down all heat sources
- ☐ Where radioisotopes have been used, wipe test the fume hood for radioactive decontamination, decontaminating as necessary. Send test results to research.safety@ubc.ca with subject "Radiation Clearance Letter Request."
- ☐ ensure that no other equipment or apparatus is vented into the fume hood during shut-down; **ensure all tubing that would obstruct lowering the sash for lock-out is removed**
- ☐ lower the sash of fume hood and attach the completed form to the sash of the fume hood
- ☐ advise all personnel in the area of the planned work and the shut-down

I have prepared this fume hood for REPAIR/MAINTENANCE as per the instructions given above.

Signature of Fume Hood User: _____ **Date:** _____

CAUTION!!!
DO NOT REMOVE THIS TAG OR USE THIS FUME HOOD
UNLESS SIGNED OFF BY THE TRADESPERSON

I have completed the REPAIR/MAINTENANCE and this fume hood may now be used.

Signature of Tradesperson: _____ **Date:** _____

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LEVEL II FUME HOOD SHUT-DOWN PROCEDURES

DO NOT USE THIS FUME HOOD

For regular maintenance work on a roof where: the ductwork must be opened, OR the exhaust fans do NOT have integrity, OR the system is NOT stacked on the roof.

Planned Shut-Down Date: _____

Fume Hood needs to be shut-down by Time: _____ am/pm for Shut-down Safety Inspection

Items to be REMOVED from the Fume Hood:

- ☐ all extremely hazardous chemicals, compressed gas and/or lecture bottles
- ☐ all chemical bottles/containers

The following items may remain in the Fume Hood:

- ☐ all equipment shut-down and power source disconnected (ie stir plates unplugged, pumps off etc) - water/oil baths need to be **clean and dry, free of any liquids and/or chemicals**
- ☐ all stills can be left in place but **MUST BE: off and capped (so all vapors are contained); quenching not required**
- ☐ all glass manifolds left in place with traps emptied
- ☐ all mercury bubblers need to be capped/sealed
- ☐ all drying tubes containing drying compounds need to be capped/sealed

Additional general procedures:

- ☐ all vacuum pumps for glove boxes in the adjacent area require hosing to be vented out nearest window
- ☐ shut-down all heat sources
- ☐ Where radioisotopes have been used, wipe test the fume hood for radioactive decontamination, decontaminating as necessary. Send test results to research.safety@ubc.ca with subject "Radiation Clearance Letter Request."
- ☐ ensure that no other equipment or apparatus is vented into the fume hood during shutdown; **ensure all tubing that would obstruct lowering the sash for lock-out is removed**
- ☐ lower the sash of fume hood and attach the completed form to the sash of the Fume Hood
- ☐ advise all personnel in the area of the planned work and the shut-down

I have prepared this fume hood for REPAIR/MAINTENANCE as per the instructions given above.

Signature of Hood User: _____ **Date:** _____

CAUTION!!!
DO NOT REMOVE THIS TAG OR USE THIS FUME HOOD
UNLESS SIGNED OFF BY THE TRADESPERSON

I have completed the REPAIR/MAINTENANCE and this fume hood may now be used.

Signature of Tradesperson: _____ **Date:** _____

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LEVEL III FUME HOOD SHUT-DOWN PROCEDURES

DO NOT USE THIS FUME HOOD

For regular maintenance work that must be done within the fume hood itself, where the exhaust system is stacked on the roof and that system is intact.

Planned Shut-Down Date: _____

Fume Hood needs to be shut-down by Time: _____ am/pm for Shut-down Safety Inspection

All Items to be REMOVED from the Fume Hood:

- ☐ all extremely hazardous chemicals, compressed gas and/or lecture bottles
- ☐ all chemical bottles/containers
- ☐ all stills
- ☐ all equipment
- ☐ all glass manifolds and all glass traps
- ☐ all mercury bubblers
- ☐ all drying tubes containing drying compounds

Additional general procedures:

- ☐ **wipe down the inside of the fume hood with solvent to ensure all chemical residues removed**
- ☐ all vacuum pumps for glove boxes in the adjacent area require hosing to be vented out nearest window
- ☐ shut-down all heat sources
- ☐ Where radioisotopes have been used, wipe test the fume hood for radioactive decontamination, decontaminating as necessary. Send test results to research.safety@ubc.ca with subject "Radiation Clearance Letter Request."
- ☐ ensure that no other equipment or apparatus is vented into the fume hood during shutdown; **ensure all tubing that would obstruct lowering the sash for lock-out is removed**
- ☐ lower the sash of fume hood and attach the completed form to the sash of the Fume Hood
- ☐ advise all personnel in the area of the planned work and the shut-down

I have prepared this hood for REPAIR/MAINTENANCE as per the instructions given above

Signature of Hood User: _____ **Date:** _____

CAUTION!!!
DO NOT REMOVE THIS TAG OR USE THIS FUME HOOD
UNLESS SIGNED OFF BY THE TRADESPERSON

I have completed the REPAIR/MAINTENANCE and this fume hood may now be used.

Signature of Tradesperson: _____ **Date:** _____