

# Section 23 38 16

## York University Standard on Fume hoods

### 0. Introduction

A fume hood is a mechanically ventilated partially enclosed workspace where harmful materials can be handled safely. The primary function of the fume hood is to protect the user by containing and removing gases, vapours, and aerosols generated within the fume hood enclosure. Fume hoods at York University are used in teaching and research laboratories as well as in a number of other specific applications.

### 1. Scope

This standard highlights the minimum requirements regarding selection criteria, installation, performance tests, maintenance, and decommissioning of the fume hoods. The standard applies to laboratory ducted fume hoods.

This standard does not apply to biological containment cabinets and recirculating fumehoods.

Recirculating fumehoods are of limited use in the laboratory and should not be considered acceptable substitutes for ducted fume hoods when handling hazardous materials.

**Note:** *Requirements applicable to the installation and field testing of biological containment cabinets are found in **NSF/ANSI49**.*

### 2. Applicable Standards

The fume hood must meet the minimum design criteria and performance standards outlined in **CSA Z316.5-04 (Reaffirmed 2009)** and **ANSI/ASHRAE 110-1995**. Both of these standards and other publications used by these standards must be referred to when designing and installing a fume hood.

### 3. Acronyms

**ANSI/AIHA-** *American National Standards Institute / American Industrial Hygiene Association*

**ANSI/ASHRAE-** *American National Standards Institute/American Society of Heating, Refrigerating and Air-Conditioning Engineers*

**ASTM International** - *American Society for Testing and Materials*

**CSA-***Canadian Standards Association*

**NSF/ANSI** - *National Sanitation Foundation/American National Standards Institute*

**SMACNA** - *Sheet Metal and Air Conditioning Contractors' National Association*

## 4. Definitions

**Absorption** — a process whereby one or more gases or vapours from an atmosphere are diffused or dissolved into another phase.

**Adsorption** — a process whereby one or more gases or vapours from an atmosphere adhere to the surface of a material.

**Airflow** — movement of air.

**Airfoil** — a deflector shaped to promote uniform airflow into a fume hood.

**Auxiliary air** — supplemental air delivered to a fume hood to reduce room air consumption.

**Baffle** — a fixed or adjustable panel, located at the rear of a fume hood chamber, which controls the pattern of air moving into and through the fume hood.

**Biological safety cabinet** — a cabinet for containing potentially infectious aerosols generated by microbiological procedures. A biological safety cabinet is not a fume hood.

**Bypass** — an opening that provides an alternative path for entry of air into a fume hood when the sash is lowered.

**Damper** — an adjustable device for controlling airflow.

**Desorption** — a process whereby one or more gases or vapors are released from a filter into the atmosphere.

**Duct** — a passageway used for enclosing moving air.

**Exhaust system** — the components that constitute a system for removing air from a fume hood workspace (these can include ducts, fans, filters, dampers, scrubbers, and stacks).

**Face opening** — that part of a fume hood through which work is performed.

**Face velocity** — the velocity of air moving through a face opening, measured in the plane of the sash.

**Fan** — a device for moving air (sometimes called a blower), consisting of a motor, drive, impeller, and housing.

**Filter** — a device for removing material from air passing through it.

**Fume hood** — a mechanically ventilated, partially enclosed workspace intended to contain and remove gas, vapour, or aerosol generated within the enclosure.

**HEPA (high-efficiency particulate air) filter** — a dry, disposable, extended media filter in a rigid frame housing with a minimum collection efficiency of 99.97% for 0.3 µm monodispersed aerosol.

**HVAC** — heating, ventilation, and air conditioning.

**Makeup air** — the air needed to replace the air taken from a room by a fume hood or other air-exhausting device.

**Occupational exposure limit (OEL)** — the average airborne concentration of a hazardous material to which nearly all workers can be exposed day after day without experiencing adverse health effects.

**Sash** — a usually transparent movable panel set in a fume hood face.

**Scrubber** — a device that removes noxious gases, vapours, or aerosols from the air by bringing them into intimate contact with a liquid.

**Stack** — a structure containing one or more flues for discharging effluent into the external atmosphere.

**Static pressure loss** — the resistance created when air moves through a duct or component, usually expressed in pascals (Pa) or inches of water (in w.g.).

**Workplace** — the room, laboratory, shop, or building where people work.

**Workspace** — that part of a fume hood interior where the work is performed and airborne contaminants are released.

**Work surface** — the countertop inside a fume hood.

## 5. Performance-based construction

### 5.1 Construction materials

(a) All materials, including service fittings and exhaust systems, shall be resistant to the chemicals and substances to be used within the fumehood.

(b) The sash window and the light lens shall be impact resistant.

**Note:** *Sash windows and light lenses should be made of laminated or tempered glass; however, polycarbonate or other impact-resistant plastics can be necessary for certain chemicals.*

(c) Liner and work surfaces shall be impervious to chemicals and radioisotopes that will be within the fume hood.

(d) Interior liners shall be fire resistant, have a flame spread of 25 or less, and a smoke-developed classification of 50 or less when tested in accordance with the requirements of **ASTM E 84**.

(e) Sealants and adhesives shall be resistant to chemical, thermal, and mechanical stress.

(f) Wood shall not be used for fume hood construction.

### 5.2 Electrical Safety

(a) Fume hoods and exhaust systems shall comply with the applicable requirements of the **Canadian Electrical Code, Part 1, CSA C22.2 No.151, or CAN/CSA-C22.2 No. 1010.1**.

(b) A ground fault interrupter (GFI) shall be used when required by applicable Standards, laws, or regulations.

(c) All electrical receptacles shall be readily accessible and external to the fume hood interior.

### 5.3 Design

(a) Sash openings

- Sash openings shall incorporate airfoils to inhibit refluxing of air at the face opening.

(b) Work surface

- The work surface shall have edges raised a minimum of 6mm to help contain spills.
- The work surface shall be strong enough to bear the weight of any necessary apparatus, including radiation shielding.

(c) Workspace lighting

- Light fixture (s) mounted exterior to the fume hood chamber shall be separated from the fume hood interior by a sealed, transparent, impact-resistant light lens.
- Light fixture mounted inside the fume hood chamber shall be resistant to the chemicals that will be present inside the fume hood chamber.
- Light fixture mounted inside the fume hood chamber shall be explosion proof (if explosion hazards are present)
- Light fixture(s) shall be capable of providing an illuminance at the work surface
  - of a minimum average of 861lux (80 fc) and a maximum average of 1614 lux (150 fc); or
  - at the level required by applicable health and safety regulations.

#### 5.4 Services

- (a) All plumbing and electrical services shall be accessible for maintenance and servicing.
- (b) All service fixture controls (e.g., gas, air, water, vacuum) shall be external to the fume hood and clearly identified.
- (c) All service fixtures within the workplace shall be corrosion resistant or have a corrosion-resistant finish.
- (d) If water service is provided, the fume hood shall have a suitable drain  
**Note:** *Whether the drain is connected to a municipal sewer depends on the chemicals that will be used in the fume hood.*
- (e) Sinks shall have a raised edge (a minimum of 6 mm) to prevent spills on work surfaces from entering the sink.

#### 5.5 Alarm

- (a) A fume hood shall have an audible and visual alarm for indicating that the face velocity has fallen below the set point.
- (b) The alarm shall be readily visible to the user during the use of the fume hood. It should have a back up power battery in case of power failure.
- (c) Only authorized personnel shall be allowed to adjust the alarm set point.
- (d) The average face velocity of a fume hood shall be 0.4-0.6m/s (80-120 fpm)  
**(ANSI/AIHA Standard Z9.5-1992 Section 5.7)**

#### 5.6 Exhaust Ducts

- (a) At a minimum, exhaust ducts shall be constructed to the **Seal Class B standards** specified in the **SMACNA HVAC Duct Construction Standards**.
- (b) Exhaust ducts in the building should be maintained under negative pressure to minimize leakage into the building. See subsection 7, clause (a).
- (c) Perchloric acid hoods shall be separately ducted to a point outside the building.  
**Note:** *The Canadian Nuclear Safety Commission recommends that hoods used for radioisotopes should be separately ducted to a point outside the building.*
- (d) **The exhaust stack** shall be designed and located in a way that provides acceptable dilution and dispersion of exhaust air and precludes exhaust re-entry through air intakes and building openings.
- (e) The exhaust stack shall not be fitted with devices that deflect the effluent or reduce the discharge velocity.  
**Note:** *Weather caps and gooseneck ducts that provide rain protection are examples of such devices.*
- (f) Fume hood exhaust ductwork shall not be fitted with fire dampers.

#### 5.7 Exhaust Fan

- (a) The exhaust fan shall be positioned as close as possible to the termination (discharge end) of the duct, preferably on the roof.  
**Notes:**
  - *Such positioning of the exhaust fan will maintain as much of the ducting as possible under pressure, thus minimizing leakage into the building.*
  - *Internal pressure is positive from the fan location to the termination of the duct. Leaks in the duct will allow contaminants to escape from the duct into surrounding spaces.*
  - *Consideration should be given to protecting the fan from adverse weather conditions.*
- (b) The fan motor should be mounted outside the exhaust duct for easy access and to avoid contamination of the motor. Appropriate shaft seals shall be employed.
- (c) Fume hoods with integral (i.e., built-in) fans shall not be used.

#### 5.8 Exhaust Filter

- (a) If an exhaust filter is used, it shall be installed in a space that provides unobstructed access for filter replacement, inspection, and servicing. The filter enclosure shall permit replacement of the filter without contaminating the surrounding environment.
- (b) To minimize the length of contaminated ductwork, the filter should be located as close as possible to the fume hood.
- (c) To permit the exhaust fan to move filtered air, the filter shall be located upstream of or on the suction side of the exhaust fan.

### **5.9 Marking**

The fume hood shall have a plate in a readily visible location on the front of the fume hood. The following shall be clearly and permanently marked on the plate by the manufacturer:

- (a) manufacturer's name and address
- (b) model number; and
- (c) serial number.

### **5.10 Special Design criteria for perchloric acid fume hoods**

Perchloric acid fume hoods shall comply with the requirements specified in this Standard, including the following requirements:

- (a) fume hoods designed for and used with perchloric acid shall be identified by a prominent and permanent label indicating suitability for use in perchloric acid procedures;
- (b) the work surface shall be watertight and furnished with a raised lip to contain spills and washdown water;
- (c) the fume hood shall have a water spray (washdown) system for rinsing the entire duct from the point of stack discharge to the area behind the baffle;
- (d) the ductwork shall be self-draining and have no horizontal sections;
- (e) service fitting controls for internal outlets and for the washdown system shall be outside the fume hood, clearly identified, and within easy reach;
- (f) the baffle shall be removable to allow for cleaning and periodic inspection for damage and corrosion;
- (g) the fume hood shall be constructed of non-porous, acid-resistant, non-reactive material and shall be resistant to perchloric acid; and
- (h) specially designed fans shall be used.

## **6. Fume hood and exhaust system selection criteria**

### **6.1 Assessment**

An assessment of the anticipated processes should be performed before a fume hood is selected to ensure that users are adequately protected and that the fume hood will perform reliably. These processes include

- (a) chemical resistance and reactivity;
- (b) chemical toxicity;
- (c) radiotoxicity;
- (d) thermal stress;
- (e) adsorption and absorption of hazardous substances;
- (f) explosions;
- (g) fire;
- (h) mechanical stress, e.g., vibration; and

- (i) workplace environment.

Professional technical advice, such as that provided by occupational hygienists, occupational health and safety professionals, and mechanical engineers, should be sought when selecting a fume hood.

## **6.2 Exhaust system and associated equipment**

### **General**

Exhaust duct, fan, and scrubber materials should be compatible with the materials handled in the fume hood and with the installation and maintenance of the fume hood.

### **Exhaust duct material**

- (a) Fire-retardant material or carbon steel with an acid-resistant coating may be used for general chemical applications.
- (b) Stainless steel ducts shall be used for radioisotope fume hoods.
- (c) Corrosion-resistant ducts shall be used for perchloric acid fume hoods.

### **Exhaust fans**

**Note:** *Depending on the type of application, several types of material may be used for the construction of the fan. Explosion-proof models are available.*

- (a) Glass fibre, PVC, or equivalent fans shall be used for highly corrosive conditions.
- (b) Coated steel, glass fibre, or PVC fans may be used for mildly to moderately corrosive conditions.
- (c) Fans shall be sized to provide adequate exhaust airflow. The static pressure losses of the fume hood and
- (d) Fans shall be sized to provide adequate exhaust airflow. The static pressure losses of the fume hood and associated ductwork shall be included in the determination of fan size.
- (e) Fans shall be sized to provide adequate exhaust airflow. The static pressure losses of the fume hood and associated ductwork shall be included in the determination of fan size.

## **7. Fume hood placement**

- (a) Fume hoods shall be located out of the normal traffic pattern and away from interfering room air currents, such as those caused by doorways or general ventilation devices;
- (b) The distance between the side of the fume hood and a wall or large architectural obstruction (e.g., an architectural column) projecting beyond the plane of the sash should be great enough to not affect intake airflow;  
**Note:** *The adjoining wall can present a partial obstruction that can affect intake airflow.*
- (c) The distance between the sash and an opposing wall or other obstruction should be great enough to not adversely affect intake airflow;
- (d) Fume hoods should not be installed face to face nor opposite a biological safety cabinet or workstation unless the distance between them is great enough to allow adequate workspace for both users and prevent any disturbance in the intake airflow;
- (e) The user's unobstructed personal work area should extend at least 1.5 m (5 ft) from the face of the fume hood;
- (f) The fume hood should be positioned so that all service fitting controls and access panels are accessible;
- (g) Room supply air should be adequate to replace air being exhausted and to maintain proper air balancing.

## 8. Installation

### 8.1 Fume hood installation

Fume hoods shall be installed in accordance with the manufacturer's instructions.

### 8.2 Exhaust duct installation

- (a) The exhaust duct should be self-draining and extend to the discharge point with as few horizontal sections as possible.

**Note:** *This is to minimize areas in which condensates or liquids coming in from the discharge point can collect.*

- (b) Ducts shall be sealed to prevent leakage in accordance with *Seal Class B standards* specified in the **SMACNA HVAC Duct Construction Standards**.
- (c) All exhaust ducts shall be labelled.

#### Notes:

**(1)** *For example, radioisotope and perchloric ducts should be labelled "Radioisotope fume hood exhaust" or "Perchloric fume hood exhaust".*

**(2)** *It is common practice to place labels every 3 m (10 ft).*

## 9. Field test

### 9.1 General

- (a) In order to maintain fume hoods in good operating condition, the performance tests specified in Clause 9.3 shall be conducted whenever a fume hood is installed, every 12 months thereafter, and whenever a fume hood is relocated.
- (b) The tests specified in Clause 9.3 shall be performed by individuals qualified to make airflow measurements and such other determinations as are necessary to ensure proper operation of the fume hood.
- (c) The tests shall be performed after installation is complete.
- (d) Inadequate performance disclosed by the tests specified in Clause 9.3 shall be corrected before the fume hood is used.

### 9.2 Test conditions

- (a) During the tests specified in Clause 9.3, the building ventilation system shall be operating correctly, the room doors and windows shall be in their normal position, and all other fume hoods and exhaust systems shall be operating at design conditions.
- (b) Fume hoods should normally be empty when tested. If necessary to ensure the safety of test personnel, however, a fume hood shall be tested with fixed equipment in place.

### 9.3 Performance tests

#### Face velocity test

- (a) Face velocity shall be determined in accordance with the containment test specified below. The test results shall be compared with the values provided by the manufacturer, documented, and provided to the user.
- (b) The face velocity test should be performed with a hot wire anemometer or equivalent.

#### Containment test

The test specified in **ASHRAE 110-1995** shall be performed. The test results shall be documented and provided to the user.

**Note:** *This tracer gas test is required because face velocity alone is not a valid indication of containment.*

### **Sash operation**

- (a) Sash operation shall be smooth and easy throughout the sash's travel.
- (b) Sash(es) shall be operable from either end with one hand.
- (c) Sash counterbalances should operate without interference or restriction.
- (d) Vertical rising sashes shall hold at any set height without creeping up or down.

### **Baffle operation**

All adjustable baffles shall operate freely, without binding or restriction. All baffles shall be easily removed for repair, cleaning, and inspection.

### **Exhaust ducts**

- (a) Exhaust ducts shall be under negative pressure.
- (b) Terminal portions of exhaust systems beyond the exhaust fan (positively pressurized) shall be inspected for leaks every 12 months. The results shall be documented.

## **10. Commissioning**

- (a) Commissioning shall be performed after installation is completed to verify that the necessary components of the system are in place and meet specifications.
- (b) Commissioning should be performed in accordance with ASHRAE Guideline 1.
- (c) Commissioning shall include, but not be limited to: electrical safety, lighting, noise, the functioning of components and services, and the field test results specified above.
- (d) Documentation of these requirements shall be included in a commissioning report.

## **11. Maintenance**

### **11.1 General**

Before an inspection or any maintenance work is performed, a risk assessment shall be carried out to determine the extent of hazards resulting from contaminated surfaces. All necessary personal protective equipment or clothing shall be used. In the absence of detailed knowledge of the potential hazards involved, all reasonable precautions shall be taken to protect the worker and the immediate environment. If necessary, decontamination or containment procedures shall be performed before the work is carried out.

Before work begins on a fume hood in which radioisotopes have been used, the Radiation Safety Officer shall verify that the fume hood components are safe to work on.

### **11.2 Hygiene plan**

A written occupational hygiene plan for maintenance activities shall be developed and reviewed. The following requirements shall apply to the plan:

- (a) The plan shall specify the personal protective equipment, including respiratory and protective clothing, to be used by personnel while working on fume hood system components such as fan units, exhaust stacks, filters, and ductwork.
- (b) Provision shall be made for fan motor lockout.



- (c) Fall protection and travel restraint shall be used by personnel performing maintenance work near the edges of roofs, on sloped sections of roofs, and on sloped roofs.
- (d) Power to the fume hood shall be turned off when maintenance is being performed. If the power cannot be shut off, safety procedures shall be in place to protect workers from injury.

**Note:** *Electrical energy should be locked out and tagged out by the person performing the work and his or her supervisor. The fume hood should be emptied of all chemicals and radioactive materials before commencement of the work.*

- (e) Maintenance shall be performed only by personnel trained to conduct such activities. Only authorized personnel shall work on motors, drive systems, and other electrical components.

Refer to **York University Safety Procedure for Work on "General and Local Exhaust Ventilation Systems"** for details of the plan:

<http://www.yorku.ca/dohs/programs.htm>

### **11.3 Maintenance schedule**

#### **General**

Fume hoods and their associated exhaust systems shall be maintained in proper working condition.

#### **Daily maintenance**

The following shall be verified daily by fume hood users:

- (a) the work surface, baffles, and sash are clean;
- (b) controls for services such as water, natural gas, and compressed air are labelled and functional;
- (c) general illumination, indicator lights, and associated switches are in working order;
- (d) sink drains are functional;
- (e) the sash is operable; and
- (f) the airflow alarm is operational.

#### **Monthly maintenance**

All ground-fault circuit interrupters shall be tested monthly.

#### **Six-month maintenance**

The following items shall be inspected and tested every six months:

- (a) fan;
- (b) motor;
- (c) drive belt and shafts; and
- (d) bearings, including machine guards.

#### **Twelve-month maintenance**

The following tasks shall be performed, as applicable, every 12 months:

- (a) inspection of the sash mechanism (including the sash and cables) for corrosion, damage, lubrication, proper operation, and broken glass;
- (b) inspection of the fans (including the integrity of the fan blades, motors, drives, and bearings) for proper operation and corrosion;
- (c) inspection of the integrity of the liner;
- (d) operation of the washdown system (performance shall be observed to ensure thorough washing);
- (e) testing of the controls of the services to the fume hood for proper operation (e.g., water, gas, air, vacuum);

- (f) checking of the stability and condition of the discharge stack, including guy wires;
- (g) inspection of the condition of the exhaust ducting;
- (h) checking of the laboratory makeup air balance and its temperature (the quantity of makeup air to the auxiliary air fume hoods shall be measured and adjusted as necessary);
- (i) measuring of the fume hood face velocity, comparing the measurement to fume hood specifications, and correcting as necessary;
- (j) verification of the calibration of the airflow monitor;
- (k) inspection of the sink drain (if there is one) for corrosion, leakage, and blockage;
- (l) testing of carbon filters (if any) for loading, contamination, and leakage, and replacing the filters if necessary;
- (m) checking of fire suppression systems, if applicable, for proper functioning

Since the items listed in the monthly, six and twelve month inspections require technical knowledge, these inspections shall be conducted by the **Maintenance personnel**.

## **12. Education and training**

### **12.1 General**

- (a) The personnel who use and maintain fume hoods shall be educated and trained to ensure safe operation of these devices.
- (b) Only trained personnel shall work with fume hoods.

### **12.2 Education**

The topics covered in the education program include but are not limited to:

- (a) The fume hood, its use, limitations, types of fume hoods
- (b) Components of a fume hood
- (c) Construction materials
- (d) Makeup and auxiliary air system, exhaust system
- (e) Inspection of a fume hood, maintenance
- (f) Safe operating practices
- (g) Use of personal protective equipment
- (h) Malfunction, steps to taken to prevent potential exposure, contact information for repair personnel
- (i) Emergency procedure
- (j) Records of inspection and maintenance

The above topics are covered in WHMIS Level-II and Laboratory safety and Radiation Safety training offered by the Department of Occupational Health and Safety (DOHS). In addition, specific instructions regarding the use of specific hazardous materials should be provided to the users by the area/lab supervisor.

### **12.3 Training**

Records of the training provided by DOHS are kept by this department. Records of specific training/instructions provided by the area/lab supervisor shall be maintained by those areas.

### **13. Records and other documents**

Facility documents such as those related to the regular maintenance shall be kept by Facilities-Maintenance.

Users shall have records of the users (names), types and amount of reagents used in fume hood, material inventory etc.

The following information and documentation shall be readily accessible to users and maintenance personnel:

- (a) manufacturer's containment test results;
- (b) field performance test results;
- (c) emergency contact numbers;
- (d) user log, types and amounts of reagents used in fume hood;
- (e) installation information;
- (f) commissioning report; and
- (g) manufacturer's instruction manual.

### **14. Decommissioning**

#### **14.1**

Decommissioning of a fume hood is required:

- (a) Prior to final removal of a fume hood
- (b) Prior to retrofit or upgrade of a fume hood system
- (c) Prior to an occupant vacating a laboratory (if the work to be conducted will change in nature)
- (d) Prior to scheduled or corrective maintenance

#### **14.2**

Substances previously used in the fume hood and exhaust system shall be identified, if possible, to aid in the selection of appropriate personal protective equipment and decontamination procedures e.g. wipe tests for removable radioactivity, perchlorate testing etc.

#### **14.3**

The fume hood and exhaust system construction shall be assessed and the appropriate dismantling methodology shall be chosen. This decision will depend on the types of substances present, including asbestos, and their possible interaction with the construction materials.

#### **14.4**

Services shall be shut off and disconnected at points remote from the immediate vicinity of the fume hood.

#### **14.5**

Appropriate decontamination of dangerous residues shall be conducted. Fume hoods and associated ductwork used for perchloric acid work shall be decontaminated by thoroughly rinsing all components with water or steam.

#### **14.6**

Decommissioning personnel shall wear appropriate personal protective equipment.

#### **14.7**

Unless they are recovered, the fume hood and exhaust system shall be disposed of in accordance with applicable environmental regulations.

## **References:**

1. Canadian Standards Association (CSA) Standard Z316.5-04: *Fume hoods and associated exhaust systems*.
2. ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) 110-1995: *Method of Testing Performance of Laboratory Fume Hoods*