Public Works and Government Services Canada
Mechanical and Maintenance Engineering
Real Property Branch

MD 15128 — 2008

Laboratory Fume-Hoods

Guidelines for Building Owners, Design Professionals, and Maintenance Personnel

Public Works and Government Services Canada
Travaux publics et Services gouvernementaux Canada

Canada

PWGSC

Mechanical Design Guidelines

MD 15128 — 2008

LABORATORY FUME–HOODS

Guidelines for Building Owners, Design Professionals, and Maintenance Personnel

Mechanical and Maintenance Engineering

Professional and Technical Programs
Architectural and Engineering Resources Directorate
Real Property Branch
Public Works and Government Services Canada
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Public Information

Public Works and Government Services Canada is pleased to present the Mechanical Design Guideline MD15128 – 2008, Laboratory Fume–hoods. This is a revision of the earlier Mechanical Design Guideline MD15128, published in January 2004.

Building, operating and maintaining laboratory facilities require unique skills and knowledge to protect the health and safety of laboratory workers. The fume–hood is one of the most common protection devices used in laboratories.

A previous version of this guideline was published in 1988. However, the following have led to the revision of this document:

an increased awareness of health and safety concerns regarding improperly operating fume–hoods;

advances in fume–hood technology have made it more challenging to compare fume–hood performance; and

recognition that fume–hoods must not be tested in isolation – the environment in which they operate must also be considered.

The formation of the Public Works and Government Services Canada National Laboratory Knowledge Network has resulted in the sharing of laboratory

Travaux publics et Services gouvernementaux Canada a le plaisir de vous présenter les lignes directrices d'ingénierie mécanique IM15128–2008, Hottes de laboratoire. Ce document est une révision de l'édition antérieure publiée en janvier 2004.

La fabrication, l'exploitation et l'entretien des installations de laboratoire exigent des compétences et des connaissances particulières pour protéger la santé et la sécurité des personnes qui y travaillent. La hotte est l'un des systèmes de protection les plus couramment utilisés dans les laboratoires.

Une première version de ces lignes directrices a été publiée en 1988, mais elle a dû être révisée pour les raisons qui suivent :

une sensibilisation accrue sur les questions de santé et de sécurité liées à une mauvaise exploitation des hottes de laboratoire;

des progrès technologiques qui rendent plus difficile la comparaison des performances des hottes de laboratoire;

le fait de reconnaître que les hottes de laboratoire ne doivent pas être essayées de façon isolée –– le milieu d'exploitation doit aussi être pris en compte.

La création du Réseau national des experts en laboratoire de Travaux publics resource material. This guideline will enable designers, project managers and operating personnel to provide consistent design for installation, procurement, testing and maintenance of safe fume–hoods in federal laboratories.

While ASHRAE 110 has defined basic fume–hood test procedures, a guideline that defines performance of fume–hoods is not currently available. MD15128 has been developed to fulfill this need. A primary feature of MD15128 is the identification of specific pass/fail performance criteria. As additional factors affect the performance of fume–hoods, tests for these criteria cover a broad spectrum, including variable–air–volume, cross draft, alarm/monitor, and other tests to supplement those identified in ASHRAE 110.

The objective of MD15128 dovetails with the branch's commissioning efforts for laboratory projects. Commissioning officers should become familiar with this guideline in order to oversee the collection of data and test results that are required to properly install and safely operate and maintain fume–hood systems.

We encourage you to use this guideline when implementing laboratory projects. Additional copies, as well as an electronic version, can be obtained from the Documentation

et Services gouvernementaux Canada a donné lieu au partage des ressources documentaires en matière de laboratoire. Les présentes lignes directrices aideront les concepteurs, les gestionnaires de projets et le personnel d'exploitation à assurer une conception uniforme et sécuritaire pour l'installation, l'achat, les essais et l'entretien des hottes dans les laboratoires fédéraux.

ASHRAE 110 a établi les méthodes d'essai de base, mais il n'existe pas actuellement de lignes directrices sur la performance des hottes de laboratoire. L'une des principales caractéristiques des IM 5128 est l'établissement de critères précis de performance acceptable et inacceptable. Vu les facteurs additionnels qui influent sur la performance des hottes, les essais prévus par ces critères couvrent une vaste gamme, dont le débit d'air variable, les courants transversaux, les dispositifs d'alarme et de surveillance, et d'autres essais complémentaires à ceux de la norme ASHRAE 110.

L'objectif des IM15128 concorde avec les activités de mise en service de la Direction pour les projets de laboratoire. Les agents de mise en service devraient se familiariser avec les présentes lignes directrices afin de superviser la cueillette des données et les résultats des essais nécessaires à l'installation adéquate ainsi qu'à l'exploitation et à l'entretien sécuritaires des hottes de laboratoire.

Nous vous encourageons à utiliser ces

Centre at doc.centre@pwgsc–tpsgc.gc.ca.

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lignes directrices dans la mise en oeuvre de vos projets de laboratoire. Vous pouvez obtenir des exemplaires additionnels, ainsi qu'une version électronique, au Centre de documentation à l'adresse doc.centre@tpsgc–pwgsc.gc.ca.

Pour plus de renseignements sur les IM15128–2008, veuillez communiquer avec :

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Introduction

General

This document has been developed jointly by the Mechanical and Maintenance Engineering Group of Advisory and Practices (Professional Services) Directorate (APPS), Asset and Facilities Management Services (AFMS) and the PWGSC National Laboratory Knowledge Network.

Feedback

Corrections, recommendations, suggestions for modifications or additional information and instructions that will improve this document and motivate its use are invited. For this purpose the attached form entitled *"Request for change to these guidelines"* may be used and mailed or FAXED to the address shown. E–mail or other forms of electronic transmission may also be used for this purpose.

Conflicts

Any area of conflict between this document and the Project Brief must be brought to the attention of the Project Manager as soon as it is noted.

Advisories

Material printed in italics is relevant information for the designer (and, in some instances, the Laboratory Director) in the application of these Guidelines. They are essentially advisories.

MD15128 – 2008

Laboratory Fume–hoods

REQUEST FOR CHANGES

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Type of change suggested:

☐ Correction of information
☐ Deletion of information
☐ Addition of Information

Details of suggested changes:

If necessary, photocopy relevant page(s) of this manual and attach to this sheet.

Page: Chapter: Paragraph no.:

Details of suggested changes:

(Use additional sheets if necessary)

Signature: ________________ Phone No:._______________ Date: ______________

Table of Contents

Chapter 1 General

1.1 Introduction and purpose

Experience has demonstrated that considerable confusion exists regarding laboratory fume–hood design and installation. There is also a lack of understanding of fume–hood performance criteria and test methods.

These guidelines are intended to improve this situation and to provide a consistent approach to the specification, testing, operation, and maintenance of fume–hoods in laboratories managed by PWGSC, as well as by other Government of Canada agencies**.**

1.2 Definition of "fume–hood"

In the context of these guidelines, "fume–hood" means a ventilated, partially enclosed work space designed to capture, contain and exhaust all contaminants generated within the enclosure and to prevent the spread of contaminants outside the fume–hood to the laboratory user and other laboratory personnel.

1.3 Scope of these guidelines

These guidelines describe requirements for bypass, variable air volume and high performance laboratory fume–hoods only. The criteria described herein apply to all new installations and retrofits of laboratories containing fume–hoods. Note that existing and older fume–hoods may be incapable of meeting the performance criteria contained herein. The Laboratory Director should take appropriate assessment and corrective measures where fume–hood performance is uncertain.

1.4 Exclusions

These guidelines do not cover:

1. Standards for special equipment such as Biological Safety Cabinets or Laminar Flow Clean Benches; these are occasionally confused with laboratory fume–hoods, but have a very different usage;

2. Requirements for canopy exhaust hoods, snorkels (elephant trunks), slotted hoods and all other exhaust devices;

3. Requirements for laboratory fume–hood exhaust systems;

4. Details of the interrelationship between fume–hood exhaust systems and laboratory HVAC and exhaust systems;

5. Requirements for perchloric acid fume–hoods and their exhaust systems; these are described in MD15129 *“Guidelines for Perchloric Acid Fume–hoods and Exhaust Systems.”* and

6. Requirements for radioisotope fume–hoods and their exhaust systems; these are described in Atomic Energy Board of Canada's regulatory document *#R–52 rev 1, “Design Guide for Basic and Intermediate Level Radioisotope Laboratories”.*

1.5 Associated documents

1. These guidelines support the project brief, which is the prime reference document for each project.

2. A list of references is provided in Chapter 7.

1.6 Responsibility for laboratory safety

Part II of the Canada Labour Code is the basis for Canadian Occupational Safety and Health legislation and requires that the employer (in this case the Laboratory Director) take all necessary means to protect the health and well being of all workers.

This includes the use of measures to ensure proper operation of fume–hoods and other protective equipment. Hazards to the worker through improper design or installation of fume–hoods should be avoided by the adopting the following procedures:

1. All new fume–hoods must pass the PWGSC performance criteria described in this document;

2. Changes in the use of fume–hoods should only be made with the full knowledge and approval of the Laboratory Director;

3. The Designer and the Laboratory Director, with the assistance of the laboratory fume–hood manufacturer, should develop detailed safety directives, AND provide training in proper usage of the fume–hoods to all laboratory users, and maintenance of the fume–hoods to the O&M personnel; and

4. The Laboratory Director should organize regular reviews of operation and set in place procedures for reporting and correcting defective equipment and enabling improvements in operating and maintenance procedures.

1.7 Responsibility for laboratory fume–hood selection

The selection of the most suitable fume–hood to meet the laboratory program requirements is the responsibility of the Laboratory Director. This is because the “science” aspect of fume–hood use cannot be ignored. For instance, the nature of the processes and the chemicals used in the fume–hood will affect the required performance criteria. Discussions with the Laboratory Director and the designer (specifier) will indicate whether the criteria contained in this document are sufficient to safely address the program(s) at the specific laboratory.

1.8 Operating and maintenance (O&M) manuals

1. All documentation should form part of the O&M manuals and should be developed concurrently with the design of the facility;

2. It is imperative that the O&M manuals (which form an integral part of the Building Management Manual) are up to date at all times; the Facility Manager is responsible for this, in consultation with the Laboratory Director;

3. Training documentation (e.g. videos, etc.) should be placed in the O&M manuals;

4. The requirements for the O&M manuals can be obtained from PWGSC's series on *Commissioning Manuals and Guidelines*.; and

5. Reference should also be made to Appendix "A", *"Use and maintenance of laboratory fume–hoods".*

1.9 Fume–hood log book

Place a logbook at each fume–hood for entering pertinent data, information, test results, history of use etc. See Appendix "A" for a sample Table of Contents.

Chapter 2 Types of laboratory fume–hoods

2.1 General

A fume–hood or other suitable enclosure is required to confine those contaminants that must not be released into the laboratory environment. This is essential for providing safe working conditions for the fume–hood user and other laboratory personnel.

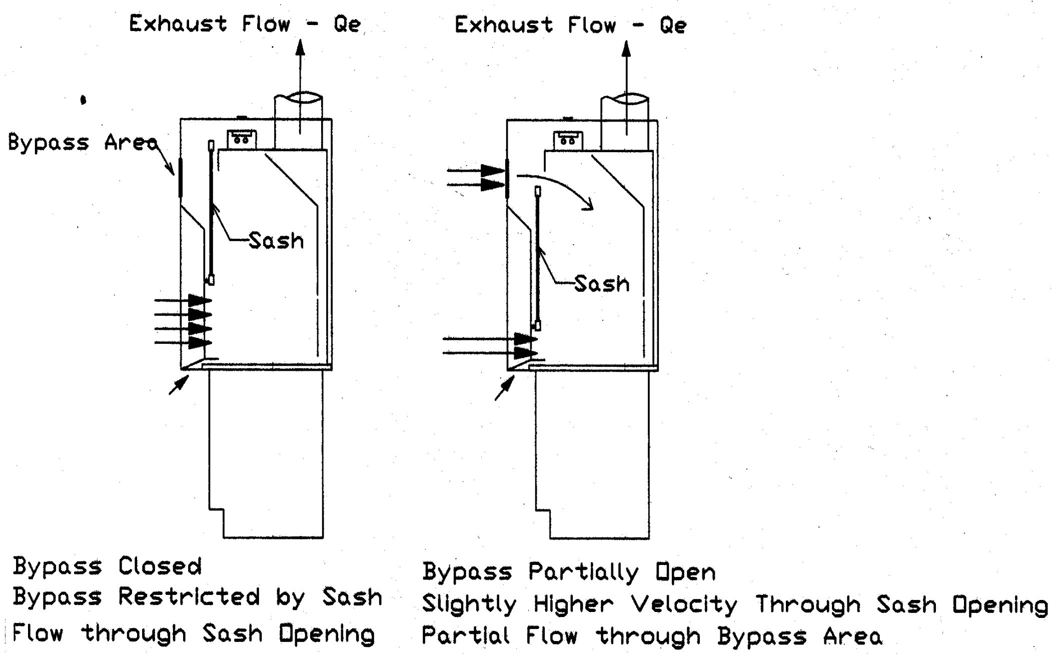
A laboratory fume–hood is designed for a specific use and may not satisfy other laboratory work requirements.

The following describes the most commonly used types of fume–hoods available today, which have been demonstrated as being capable of meeting containment criteria.

2.2 Constant volume bypass fume–hoods

Like all other laboratory fume–hoods, constant volume bypass fume–hoods have fixed vertical airfoils, or angled aerodynamic entries, on each side. There is a fixed horizontal airfoil just below the sash and above the work surface. In addition, adjustable baffles are provided at the rear to adjust airflow patterns. This is to maintain a relatively uniform air velocity through the sash opening independent of sash position.

In addition, Bypass fume–hoods are designed and constructed to allow room air to enter the fume–hood by a route other than the sash opening, when the sash is being lowered. This results in a relatively constant face velocity through the sash opening and a relatively constant exhaust airflow rate over the operating range of the bypass. The principle is illustrated in Figure 1.



Typical bypass fume–hood

These fume–hoods are sometimes called “balanced flow” fume–hoods because the exhaust flow is manually balanced initially to provide a constant face velocity through the sash opening in accordance with the requirements of Table 1: PWGSC Performance Criteria in Chapter 3.

While the height of a full opened sash is approximately 700 mm, the “normal operating position” will constitute a single, specific position of sash opening, often in the range of 300 to 450 mm. This position must be clearly labeled on the fume–hood and a sash stop should be provided at this position. The “normal operating position” imposes a significant restriction on the user in carrying out procedures within the fume–hood, but is necessary to provide optimum protection of the user from contaminant escape.

2.3 *Variable air volume (VAV) fume–hoods*

Many of the design features of variable air volume (VAV) flow hoods are similar to bypass fume–hoods. However, VAV fume–hoods maintain constant face velocity by adjusting the total exhaust airflow as the sash opens or closes, using sophisticated fume–hood and laboratory controllers. This approach minimizes energy costs while maintaining operator protection. Some bypass fume–hoods can be retrofitted for use as VAV hoods by the use of a “blank off” plate or restricted bypass opening, which effectively eliminates or reduces excessive bypass air entering the fume–hood.

2.4 *High Performance fume–hoods*

Also known as “reduced flow” or “low velocities” fume–hoods, high performance fume–hoods have been developed in response to the need for conserving energy. Many different approaches are used in the development of high performance fume–hoods to reduce exhaust airflow requirements while maintaining user safety.

For the purposes of this guideline, a "high performance" fume–hood must provide equivalent containment performance at a nominal face velocity of 0.30 m/s when the sash is at its normal operating position and provide containment at full sash opening (see Table 1).

2.5 *Other fume–hoods*

1. Walk–in fume–hood

The term "walk–in fume–hood" gives the false impression that it is safe to enter these hoods. They can be described more correctly as "floor level" or "floor mounted" fume–hoods, as they are absolutely unsafe to enter. They are suitable for use with large apparatus, roll–in equipment and large instruments where traditional bench top fume–hoods may be inadequate for containment of fumes.

The sashes may be in two or more sections, double vertical or other suitable configuration. The sashes and the doors should provide full height visibility. Access panels on each side should be provided for accessibility to all services.

2. Perchloric acid fume–hood

The perchloric acid fume–hood is designed for a single special purpose, i.e. containment of perchloric acid fumes. It should not be used for any other purpose, due to the highly dangerous characteristics of perchloric acid and its by–products. This type of fume–hood is characterized by the use of particular construction materials and "wash–down capability" of hood and all ductwork. For further details refer to *"MD15129 – Guidelines for Perchloric acid fume–hoods and exhaust systems*."

3. Radioisotope fume–hood

This hood is specifically designed for handling radioactive isotopes, and conforms to AEBC (Atomic Energy Board of Canada) Regulatory Document #R–52 Rev 1, "*Design Guide for Basic and Intermediate Level Radioisotope Laboratories"* and to CSA Z316.5, *"Fume–hoods and Associated Exhaust Systems".*

Document R–52 also provides details relating to radioisotope laboratory HVAC and exhaust systems. For instance, the exhaust ductwork is to be marked at 3.0 meter intervals with radiation warning symbols and all exhaust air from a radioisotope lab must exit through the fume–hood.

All users of radioactive material must be registered on a license issued by the AEBC. The license outlines a set of conditions that must be followed for the use and disposal of the prescribed radioisotopes.

4. Other special–purpose fume–hoods

Many other special–purpose laboratory fume–hoods are available, but have not been included in these guidelines for the sake of brevity.

The need for these special fume–hoods should be determined by the program requirements and by the Laboratory Director.

2.6 *Auxiliary air fume–hoods*

Auxiliary air fume–hoods are not included in this Guideline, since they are no longer recommended by PWGSC for new installations, due to testing difficulties, operational and safety concerns, etc. Existing auxiliary fume–hoods should be tested for face velocity while the auxiliary air supply is turned off; otherwise ASHRAE 110 procedures should be used. Additionally, the velocity of the auxiliary air exiting the auxiliary air plenum should be measured to determine the magnitude and distribution of air supplied above the hood opening.

The average auxiliary air velocity should be determined from the average of grid velocities measured across the plenum outlet. The down flow velocities should be measured approximately 150 mm above the bottom edge of the sash positioned at the design opening height.

The auxiliary air velocity should not exceed 2 times the average face velocity, where the average face velocity is determined with the auxiliary air system off, or, redirected so as to not affect inflow velocities.

The auxiliary air velocity should not vary more than 20% across the outlet of the plenum, or, across the width of the hood opening, unless by design.

Chapter 3 Fume–hood performance and testing requirements

3.1 Fume–hood performance

For containment, fume–hood performance may be defined as a measure of the amount of spillage and the potential for exposure of the user to airborne hazards generated within the hood. It can only be effectively evaluated through performance tests by the manufacturer and also, by on site tests.

The fume–hood face velocity is not the sole criteria by which containment is measured. The fume–hood is only one part of a system that includes the fume–hood exhaust system, general exhaust, air supply system and laboratory design. Many factors affect hood performance including:

- design of the fume–hood;
- design of the laboratory;
- type and location of supply diffusers;
- design and operation of the ventilation systems;
- user work practices;
- position of baffles and the size of the slots;
- the sash position and opening area;
- magnitude, distribution and turbulence of face velocity;
- fume–hood location;
- location of apparatus within the fume–hood;
- turbulence within the fume–hood;
- location of the user relative to the front of the fume–hood;
- room air flow patterns in the vicinity of the fume–hood, including velocity and direction relative to the fume–hood;
- adjacent doors;
- adjacent people traffic;
- arm motions of the user and
- the effect of heat–generating apparatus within the fume–hood.

3.2 PWGSC performance criteria

All tests should meet the criteria established in the PWGSC Performance Criteria Table 1. These criteria should be used to determine "pass" or "fail" of tests for PWGSC installations. Failure of any one item constitutes a failure of the performance of the entire fume–hood.

The values shown in Table 1 are generic and **should not be interpreted as providing safe exposure levels for all processes**. If in doubt, use an application–specific hazard analysis of the chemicals and processes involved, to determine safe exposure levels.

Table 1 – PWGSC Performance Criteria

NOTE TO LABORATORY DIRECTORS
The values shown in this table should be considered as PWGSC minimum requirements. If warranted, consult the A.C.G.I.H. References listed in chapter 7, and undertake a thorough analysis to determine whether more stringent performance criteria should be required.

Cross Draft Tests			
	As Manufactured	**As Installed**	**As Used (Project Specific only)**
Cross drafts measured 0.5 m from hood – test with sash at normal operating position. All visualization, velocity, and containment tests to be done with cross drafts in effect.	Challenge with 0.25 m/s draft*** —Test to establish failure envelope*	Average value less than 50% of average face velocity, any direction	Peak maximum 50% of average face velocity, any direction
*Five conditions to be tested, typically using a 600 mm re–circulation fan, as detailed below: 1. air directed horizontally, parallel to the sash 2. air directed horizontally, at 45 degrees to the plane of the sash 3. air directed horizontally at 90 degrees to the sash 4 .air directed vertically downward, parallel to the sash 5. air directed downward at 45 degrees to the sash			

Visualization Tests			
	As Manufactured	**As Installed**	**As Used (Project Specific only)**
Smoke —– local visualization (reverse air flows and dead space test)	100% containment, and all smoke carried to the back of hood *	100% containment , and all smoke carried to the back of hood	100% containment , and all smoke carried to the back of hood
Smoke —– large volume visualization	100% containment	100% containment	100% containment
RATING	**DESCRIPTION**		
FAIL	• Smoke was visually observed escaping from the hood beyond the plane of the sash		
POOR – Low Pass – investigate further, and correct	• Reverse flow of smoke is evident within six inches of the plane of the sash when generated at least six inches behind the plane of the sash. • Lazy flow into hood along openings • Slow capture and clearance – greater than two minutes for clearance • Observed potential for escape		
FAIR – Pas	• Some reverse flow in hood not within six inches of opening • Smoke is captured and clears readily from interior of hood – less than two minutes • No visible escape		
GOOD – High Pass	• Good capture and relatively quick clearance – approximately 1 minute or less • No Reverse Flow Regions • No Lazy Flow • No visible escape		

<table>
<tr><th colspan="5">Velocity and Flow Tests</th></tr>
<tr><th colspan="2"></th><th>As Manufactured</th><th>As Installed</th><th>As Used (Project Specific only)</th></tr>
<tr><td rowspan="2">By–pass and VAV fume–hoods – face velocity</td><td>Average</td><td>Average</td><td>0.45 to 0.55 m/s</td><td>0.45 to 0.55 m/s</td></tr>
<tr><td>Variation allowed (individual readings)</td><td>+/– 20% of average</td><td>+/– 20% of average</td><td>+/– 20% of average</td></tr>
<tr><td rowspan="2">High performance fume–hoods – face velocity</td><td>Average</td><td>0.3 m/s</td><td>0.30 m/s +/– 5%</td><td>0.30 m/s +/– 5%</td></tr>
<tr><td>Variation allowed (individual. readings)</td><td>+/– 20% of average</td><td>No reading less than 0.25 m/s 0.25 m/s</td><td>No reading less than 0.25 m/s</td></tr>
<tr><td>By–pass effectiveness</td><td>Avg. face vel. at 150 mm sash opening</td><td>maximum 1.0 m/s</td><td>Maximum 1.0 m/s</td><td>maximum 1.0 m/s</td></tr>
<tr><td>VAV flow response*</td><td>return to +/– 10% of avg. face velocity or flow*</td><td>return to +/– 10% of avg. face velocity or flow*</td><td>within 3 seconds</td><td>Within 3 seconds</td></tr>
<tr><td>VAV flow stability*</td><td>Allowable variation (all readings) over the duration of the test</td><td>within +/– 10% of flow average</td><td>Within +/– 10% of flow average</td><td>within +/– 10% of flow average</td></tr>
<tr><td colspan="5">* due to turbulence effects when reading face velocity, measurement of flow (Q) may be more reliable</td></tr>
</table>

<table>
<tr><th colspan="5">Containment Tests</th></tr>
<tr><th colspan="2"></th><th>As Manufactured</th><th>As Installed</th><th>As Used (Project Specific only)</th></tr>
<tr><td rowspan="2">Tracer gas – static sash; perform tests with probe heights of both 660mm and 450mm above work surface.</td><td>Normal operating position</td><td>Avg. < 0.025 ppm
Peak < 0.050 ppm</td><td>Avg. < 0.05 ppm
Peak < 0.10 ppm</td><td>Avg. < 0.05 ppm
Peak < 0.10 ppm</td></tr>
<tr><td>Fully open (for high performance and VAV hoods only)</td><td>Avg. < 0.05 ppm
Peak < 0.10 ppm</td><td colspan="2">On a project specific basis, designers to determine the appropriate extent of fully open sash testing.</td></tr>
<tr><td rowspan="2">Sash movement effect (SME)</td><td>peak</td><td>< 0.10 ppm</td><td>< 0.10 ppm</td><td>< 0.10 ppm</td></tr>
<tr><td>5 min. average</td><td>< 0.05 ppm</td><td>< 0.05 ppm</td><td>< 0.05 ppm</td></tr>
<tr><td colspan="5">** testing to be done at target average face velocity, and at +/– 20% of target face velocity</td></tr>
</table>

Additional Required Tests

		As Manufactured	As Installed	As Used (Project Specific only)
Simulated experimental apparatus placed within fume–hood (adjust set–up to fit fume–hood size)		Repeat all velocity, smoke, and containment tests	Not Required	If deemed necessary, use actual equipment
Minimum flow per NFPA 45 – test 1. with sash at normal operating position, and 2. with sash closed		125 L/s/m^2 of work surface	125 L/s/m^2 of work surface	125 L/s/m^2 of work surface
Fume–hood alarm	Alarm accuracy	Accurate within 5% of average face velocity or flow****	Accurate within 5% of average face velocity or flow****	Accurate within 5% of average face velocity or flow****
	Alarm enunciation	If flow falls below 80% of design flow set point	If flow falls below 80% of design flow set point	If flow falls below 80% of design flow set point
	Alarm response – max. enunciation delay	10 seconds	10 seconds	10 seconds
Sensor calibration		Confirm accurate to stated requirements	Required	Required
**** due to turbulence effects when reading face velocity, measurement of flow (Q) may be more reliable				

Test Equipment Specifications

Parameter	Equipment	Specifications
Any	Data Logger	Speed – minimum 1 sec. Memory – minimum 900 data points
Flow Response	In – Duct Flow Sensor	Accuracy ± 5% Range (95 l/s – 950 l/s)
Velocity	Velocity Anemometer	Accuracy : Below 0.50m/s: ±0.025m/s 0.50m/s and above: ± 5% Time constant: for face velocity – 10 sec. for VAV tests – max.1 sec.
Tracer Gas Containment	Detector	Type – Continuous reading MDL – 0.01 ppm

3.3 *Test Methods*

1. Qualifications of Test Agency

Testing of laboratory fume–hoods should be performed by a qualified, independent testing agency, having proven experience in this type of work. Qualification requirements should be as stated in the project brief, and proof of qualifications should be submitted to the Project Manager and the Laboratory Director. The Project Manager reserves the right to accept or reject the proposed testing agency.

2. Pre–purchase (*As Manufactured*, "AM") tests

The following should form part of laboratory fume–hood purchase specifications:

1. The fume–hood manufacturer should maintain a testing facility at its place of business for conducting tests using ANSI/ASHRAE 110 procedures, and with the capability of demonstrating compliance to the test requirements of Table 1 shown above. For instance, the manufacturer's ventilation system should be capable of adjustment over a range of supply and exhaust flows, including changes in temperature and area pressurization to provide thorough "AM" challenges.

2. Performance tests should be conducted by an independent test agency, at the manufacturer's facility, and should demonstrate that the fume–hood meets the "AM" performance criteria listed in Table 1.

3. The manufacturer should submit performance test results to confirm that specified performance criteria for the most current design of fume–hood have been met. The manufacturer should also provide a performance envelope that clearly indicates failure points for exhaust flow and face velocity. In addition, the tests should be conducted over the full range of baffle positions and sash openings.

4. The equipment used to measure face velocity should be an anemometer mounted on a stand for fixing the probe at each of the traverse grid locations. The anemometer should provide an averaging function over a minimum of 10 seconds for each location (time constant of 10 seconds), or the output of the anemometer should be recorded for a minimum of 10 seconds at a rate of 1 reading per second using a data logger. The test equipment should meet specifications as called for in ANSI Z9.5 or those noted in Table 1, whichever is most stringent.

5. PWGSC should reserve the right to witness "AM" tests and be notified at least two weeks prior to the start of testing.

6. Prior to issuance of a purchase order or shipping, the manufacturer should provide factory performance test report certifying the results and receive approval from PWGSC.

7. For VAV installations, an on–site mock–up should be constructed to demonstrate compliance to the performance criteria found in Table 1, prior to acceptance of the proposed fume–hood.

8. If controls do not form part of the laboratory fume–hood specifications, the controls manufacturer should transport the controls to the fume–hood manufacturing plant, where they are to be installed and calibrated to function as specified. Co–ordination of this activity to be the responsibility of the General Contractor.

9. Tests at the manufacturer must include performance tests with the hood empty <u>and</u> with the hood loaded to simulate experimental apparatus in the hood. The simulated apparatus should consist of: two each 3.8 liter round paint cans, one 300mm x 300 mm x 450 mm cardboard box, and four 150 mm x 150 mm x 300 mm cardboard boxes. These items should be located approximately 150–250 mm behind the plane of the sash according to the general arrangement depicted in Figure 2 below. This arrangement is only illustrative and the dimensions shown in Fig. 2 should be adjusted according to the fume–hood size.

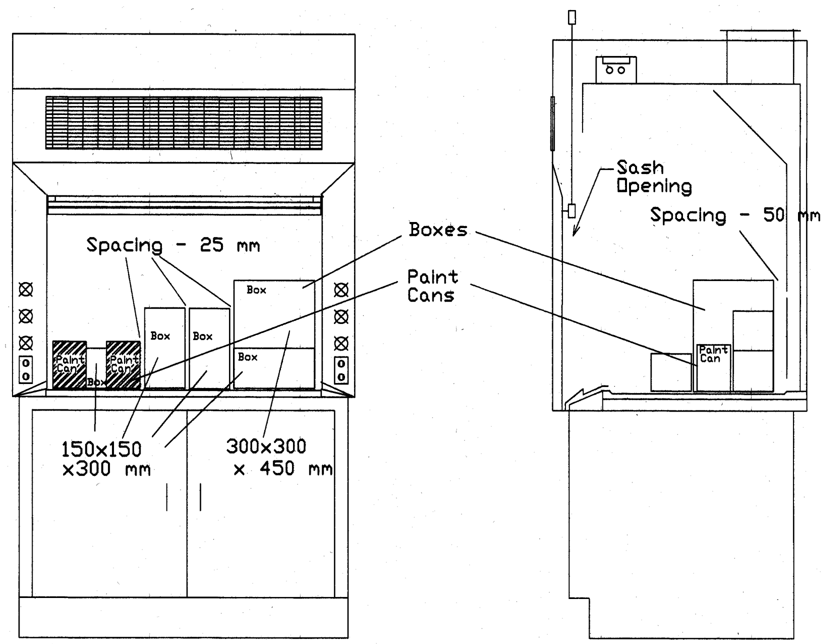


Fig. 2 – Simulated Apparatus Test Setup

3. On arrival acceptance tests

Prior to installation, verification of the fume–hood as meeting the design specifications is required. Each hood is to be “proved” in the field to demonstrate that the unit is consistent with the prototype and shop drawings, has not been damaged in shipping, and bears a CSA approval. Use a component verification check sheet (Appendix “B”) to document this stage of verification. This check sheet should be signed by both the Contractor and the Designer.

4. On site (*As Installed,* "AI") fume–hood and integrated system tests

1. Once installed, test each fume–hood using the procedures of ANSI/ASHRAE 110 (with the exceptions and additional tests noted in Table 1) at the design sash position to ensure that fume–hood performance remains within the design criteria. On a project– specific basis, designers must determine the appropriate extent of full open sash testing, and to include such requirements in the contract documents.

2. Performance tests should be conducted by an independent testing agency, approved by the project manager. It is recommended that a representative from the fume–hood manufacturer be on site to verify the new installation before performance testing.

3. Test for all "AI" performance criteria called for in Table #1.

4. Tests should be performed with the fume–hood empty.

5. The equipment used to measure face velocity should be a hot–wire anemometer mounted on a stand for fixing the probe at each of the traverse grid locations. The anemometer should provide an averaging function over a minimum of 10 seconds for each location (time constant of 10 seconds) or the output if the anemometer should be recorded for a minimum of 10 seconds at a rate of 1 reading per second using a data logger. Test equipment should meet specifications as called for in ANSI Z9.5.

6. In demonstrating compliance with Table 1, documented tests results should include verification of all controls and alarms to:

    1. confirm calibration of all associated sensors and

    2. confirm accuracy and response of alarms.

7. Integrated systems tests: These tests of fume–hoods should be performed:

    1. after the entire laboratory HVAC and exhaust system has been properly tested, adjusted and balanced (TAB) and all TAB and performance verification (PV) reports have been accepted;.

    2. after all HVAC and exhaust systems are in full operation;

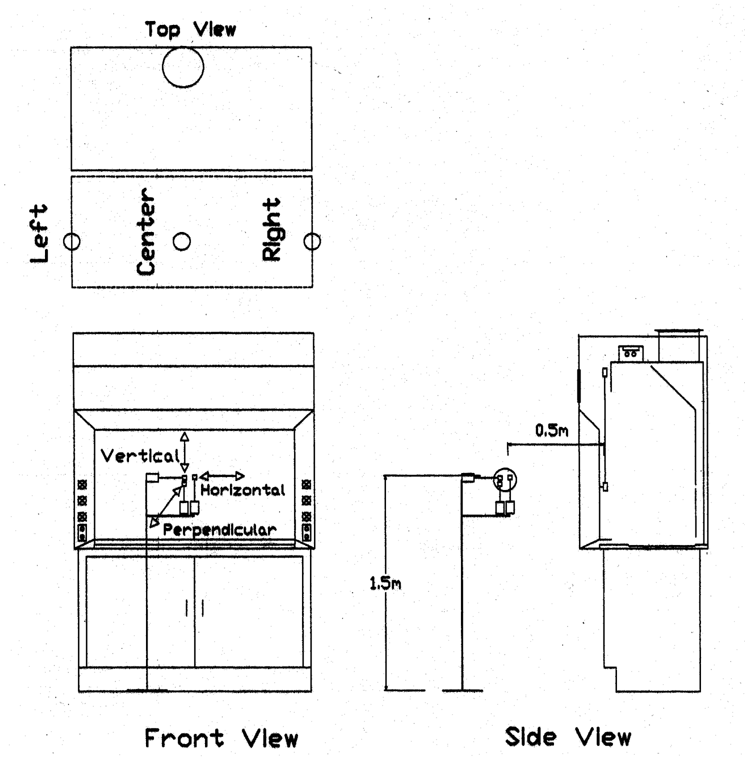
    3. with room temperature maintained between 22^{o} C and 24.5^{o} C, and recorded on the documentation to be submitted;

    4. at specified laboratory space pressurization, as well as under deviation of space pressurization due to lab door opening and closing, change of lab operating modes, upset conditions, etc., and

    5. as part of the commissioning of all integrated HVAC and exhaust systems and laboratory space pressurization tests identified in the project specifications.

8. Room air currents: In addition to the pre–purchase ("AM") tests described above, there should also be tests of air currents external to the hood. Cross drafts should be controlled to limit velocity in all directions to less than 50% of the average face velocity. Measurements are to be taken 0.5 m from the sash, 1.5 m above floor level, and at the centre, left, and right locations, as shown below. Cross drafts should be measured using a hot–wire anemometer over a period of thirty seconds, at one reading per second. The data should be recorded and analyzed to determine the average and maximum velocity during the thirty seconds at each location. If cross drafts exceed the guidelines, testing should be postponed until they are reduced to acceptable levels.

Fig. 3 – Cross Draft Testing



9. VAV Response and Stability Tests: Dynamic VAV Response and Stability Tests are conducted to ensure that the VAV controls meet the criteria established in Table 1 over a range of operating modes. The tests consist of measurement of flow while raising and lowering the sash at a rate of approximately 0.5 meters per second, or, following a change in operating mode.

The VAV tests consist of a 5–minute flow response test and two five– minute flow stability tests.

9.1 The flow response test is conducted by recording slot velocity while raising and lowering the sash three times during a 5– minute period. The sash is raised and lowered smoothly at a rate of approximately 0.5 m/s. The sash is in the closed position for 30 seconds and then at the design operating height for 60 seconds during each of three cycles.

9.2 The flow stability tests are conducted with sash closed for five minutes and opened to the design operating height for five minutes. The stability tests determine the ability of the VAV controls to maintain stable flow at the minimum flow set point and to maintain the flow required to achieve the specified average face velocity at the design sash operating height.

The response and stability tests can be conducted by measuring exhaust flow directly using a flow sensor mounted in the duct, or, by measuring slot velocity (see fig. 4, below). Using slot velocity, flow response is determined by placing the tip of the velocity probe in the slot behind the baffle, where changes in slot velocity are directly proportional to changes in flow. The velocity probe is mounted in a secure stand with the probe located in the center of the baffle slot opening. The velocity probe can be oriented to measure air velocity entering the slot, or, it can protrude through the slot to measure vertical plenum velocity. Slot velocity or flow is recorded at a rate of at least one sample per second using a data acquisition system or data logger, while raising and lowering the sash.

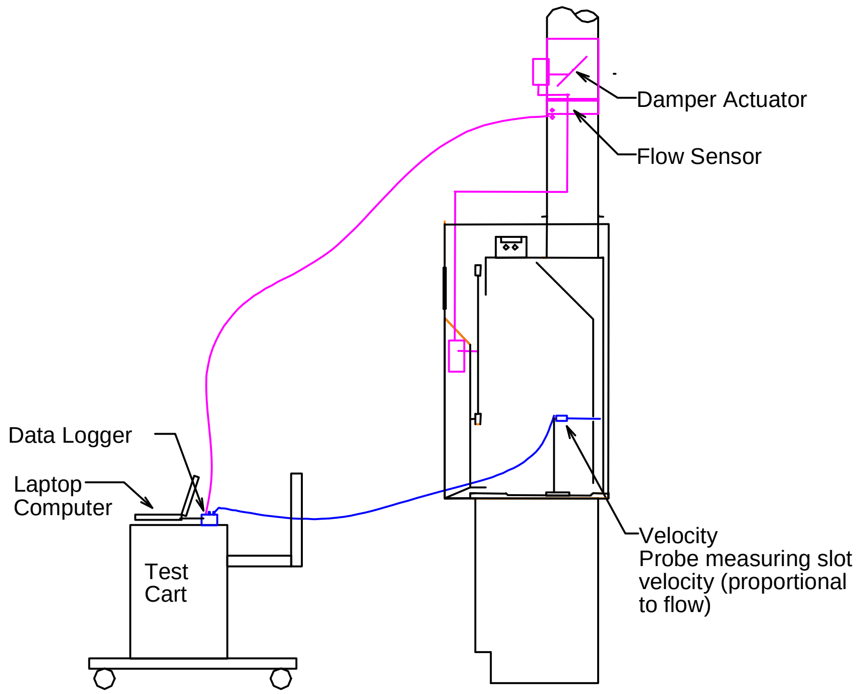


Fig. 4 – Simplified diagram of experimental setup for VAV response test

10. Sash Movement Containment Test: The Sash Movement Containment Test is conducted to determine the potential for escape of contaminants from the hood following movement of the sash. The method follows ANSI/ASHRAE 110 procedures for Sash Movement Effect (SME) testing. A mannequin is placed at the center of the hood opening while tracer gas is generated through an ejector located in the hood directly in front of the mannequin (see fig. 5, below). As in the VAV response test, the sash is raised to design operating height and lowered three times at rate of approximately 0.5m/sec. The sash is closed for 30 seconds and opened for 60 seconds during each of three cycles. Tracer gas escape is measured using an appropriate detector and recorded at a rate of 1 reading per second, using a data acquisition system or data logger. Data is analyzed to determine the five–minute average and maximum (peak) concentration escaping the hood.

For VAV fume–hoods, the VAV Response and Stability Tests and the Sash Movement Containment Test can be conducted simultaneously, to save time and to provide direct correlation between flow variations and escape from the hood.

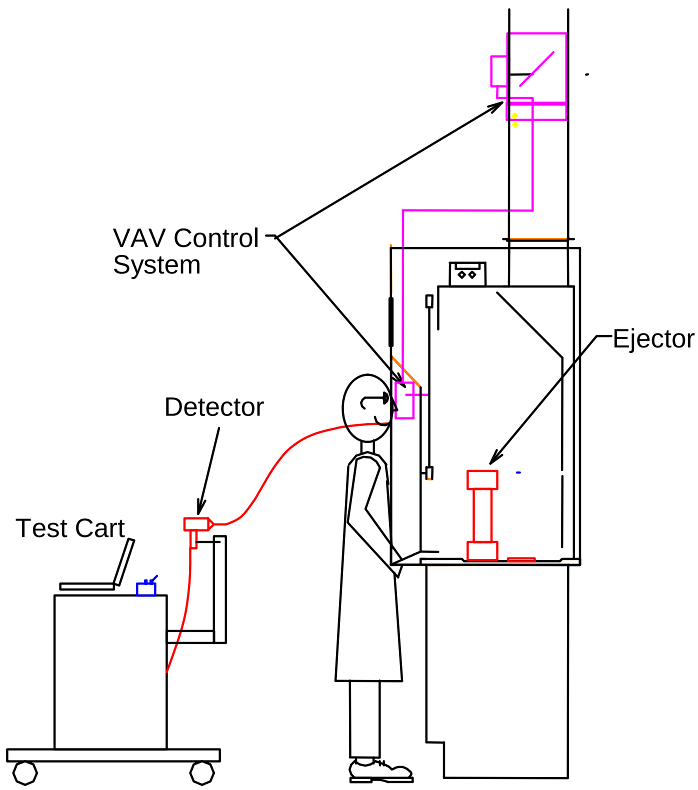


Fig. 5 – Mannequin and ejector during Sash Movement Containment Tests.

11. Tests should include operation of fume–hood monitor (and alarm). The objective of the fume–hood monitor is to provide a reliable indicator of exhaust flow or face velocity. The monitor should have an accuracy of plus or minus 5% of the measured parameter. The monitor should provide a visual display of the parameter and audible alarms configurable to alert, when flow or velocity varies by more than 20% from design flow set point.

12. Test results should be recorded and the test reports should be signed off by the testing agency before acceptance. Tests should be witnessed by the design engineer and certificates or results should be deposited with him.

13. Certificates and test results should be placed in the O&M Manual.

14. A label should be affixed to the front of the hood indicating its verification, by whom, and the date thereof.

5. *As Used* (AU) tests

1. The need for more stringent performance values than those listed in Table 1 should be determined by a laboratory–specific analysis of hazard and/or operational methods.

2. Where large experimental apparatus is used within the hood, AS USED condition testing may be appropriate and warranted to ensure containment. Such testing will also provide the opportunity to instruct the user regarding minor adjustments to

apparatus location, orientation, etc. in order to achieve optimum results.

6. Tests for Existing fume–hood

1. All existing fume–hoods should be tested to the extent indicated in Table 2 (next page), for re–verification against the performance criteria found in Table 1.

2. The following procedures should precede these tests and

    1. Where access allows, check the integrity of all seals around light fixtures, using a smoke pencil;

    2. Check that the sash stop is still in place and operates properly;

    3. Check that all baffles are in the same positions as in previous tests and

    4. Determine whether significant–sized laboratory equipment inside the hood is the same as for previous tests.

3. Perform fume–hood face velocity, cross draft velocity, flow visualization tests and VAV response tests (where applicable). In addition, sensors connected to the BAS should be calibrated annually.

Note

While tracer gas testing is required for new installations, it is not required annually, as long as no changes in the HVAC system have occurred, and as long as face velocity values for each hood are found to be consistent with the previous year's readings.

Table 2 – Fume–hood Test Frequency

	Annually	Every 5 years
Face velocity	X	
Bypass effectiveness	X	
Smoke – local visualization	X	
Smoke – large volume visualization	X	
Tracer gas – static sash position		All, <u>or</u> representative sample*
Tracer gas – effect of sash movement		All, <u>or</u> representative sample*
VAV response and stability	X	X
Minimum flow through hood	X	
Cross drafts	X	
Fume–hood alarms		X
Sensor calibration		
Noise levels		

* Test all fume–hoods, or at the discretion of the Laboratory Director test a minimum of 20% of the total number.

4. Tests should include operation of fume–hood monitor (and alarm). The objective of the fume–hood monitor is to provide a reliable indicator of exhaust flow or face velocity. The monitor should have an accuracy of plus or minus 5% of the measured parameter. The monitor should provide a visual display of the parameter and audible alarms configurable to alert when flow or velocity varies by more than 20% from set point.

5. Examination of results on re–tests of existing fume–hoods:

The results of all tests on existing fume–hoods should be compared with the results of previous tests. A decline of 10% from the initial “As Installed” value of average face velocity is considered significant, and only non–hazardous work should be permitted within the hood until the variation has been diagnosed and repaired.

3.4 Coordination

All on–site testing programs must be coordinated with the Laboratory Director, including:

1. establishing sash heights for each fume–hood;
2. confirmation that smoke generating devices are acceptable and will not affect the ongoing laboratory program and
3. acceptability of using tracer gas.

3.5 Recommended Tests Sequences

The following sequences are recommended for the “As–Installed” tests and Existing Fume–hood tests. It may be necessary to rectify problems causing failure of the cross drafts test before proceeding to smoke and face velocity tests:

1. Cross Drafts Test;
2. Visualization Tests;
3. Velocity and Flow Tests;
4. Containment Tests and
5. Additional Required Tests.

Chapter 4 Fume–hoods and laboratory layouts

4.1 *Laboratory layout, fume–hood locations and fume–hood performance*

Laboratory fume–hood performance is greatly affected by the direction and velocity of the room air in the vicinity of the fume–hood, turbulence of air in the vicinity of the fume–hood, the arrangement of laboratory furniture, the movement of personnel within the laboratory and many other factors listed in Chapter 3.

This is because a 0.5 m/s face velocity is a very low velocity, which can be easily affected by external influences. For instance, a person walking at a leisurely pace will be travelling at a minimum of 1.5 m/s, and the wake that trails a person walking at this speed can easily pull contaminants from a fume–hood.

Consequently:

1. Fume–hoods should be located in areas of minimum turbulence;

2. Fume–hoods should be at least 2,000 mm from entrances into the laboratory;

3. Fume–hoods should not be located in high traffic areas;

4. The sidewall of fume–hoods should be at least 500 mm away from any wall to ensure that airflow is uniform across the face of the fume–hood; distances less than 500 mm could reduce face velocity at the side nearest to the wall, and possibly result in reverse flow or spillage;

5. There should be at least 3,000 mm spacing between fume–hoods facing each other; where there is a need to lessen this distance a specific test protocol is to be written in order to measure fume–hood performance; in this instance, and with oversize or differing types of hoods in close proximity to one another, mock–up testing is required to confirm acceptable performance ; and

6. There should be at least 1,500 mm distance from the face of a fume–hood to the nearest item of furniture and 2,000 mm to the nearest opposite wall or other obstruction taller than the work surface height.

4.2 *Exits routes from the laboratory*

There should be good exit capability, which cannot be blocked in the event of an accident at a fume–hood.

Ideally, two exit routes should be provided. Depending upon the laboratory layout, more than two exits may be required.

Chapter 5 Laboratory fume–hood design elements

5.1 General

This chapter describes some of the essential requirements for constant volume by–pass, variable air volume and high performance fume–hoods. These requirements ensure that the fume–hoods are serviceable, durable, safe to operate, and remain efficient.

5.2 Design elements for constant volume bypass fume–hoods

1. Face velocity:

The face velocity should provide adequate containment when the sash operates at its normal position. Traditionally, 0.5 m/s has been used as a target average face velocity. High performance fume–hoods use values of 0.3 m/s or lower. See Chapter 3 – "Fume–hood performance and testing requirements", Table 1 – PWGSC Performance Criteria.

****Note–** As noted above, extensive surveys have determined that face velocity alone is not a reliable indicator of fume–hood containment. Other tests are required in addition to face velocity tests to verify containment. Once these tests have confirmed acceptable performance, only then is it possible to say that at the tested face velocity, the acceptable degree of containment is achieved.

2. Total exhaust air flow rate:

The total fume–hood exhaust airflow rate with the sash in any position equals the sum of the air flow rate entering the hood through:

1. the sash opening so as to maintain the face velocity specified above, plus
2. the bottom airfoil, plus
3. the bypass grill, plus
4. leakage air.

3. Minimum exhaust airflow rate:

As stipulated by NFPA 45, a minimum air flow rate of 125 l/s per square metre of work surface area (25cfm/ft^2) must be maintained through the fume–hood when it is not in use, to avoid build–up of fumes from products stored within the fume–hood, or, fumes generated during unattended operations within the hood with the sash closed.

4. **Airfoil:**

Airfoils should be used in conjunction with the raised portion of the non–spill work surface. The horizontal airfoil should be of 1.5 mm stainless steel, type 316 with #4 satin finish, typically installed approximately 25 mm above the raised portion of the work surface. It should be designed and installed for eddy–free entry of air into the fume–hood. The air should sweep across the work surface, minimizing eddies and lessening the possibility of fumes generated near the front of the fume–hood from escaping. Airfoil width should project into the fume–hood beyond the plane of the sash. The sash should close on top of the airfoil, leaving a 25 mm opening for entry of air. The airfoil should be designed to eliminate reverse flow within 75 mm of the plane of the sash.

5. **Bypass grille:**

The bypass grille should be of the same material as exterior panels. It should be located in the front face of the fume–hood, to permit air entry as the sash is lowered, or, to close off the air flow as the sash is raised. It should be sized to ensure that exhaust air quantity and face velocity remain relatively constant independent of sash position, within the normal operating range of the sash.

6. **Control of face velocity by user:**

The fume–hood user should <u>not</u> have any means of adjusting the face velocity.

7. **Sash opening:**

The normal operating position of the sash (or sash design position) should:

1. be determined in writing by the Laboratory Director,
2. form part of the fume–hood purchase specification,
3. be stated by the manufacturer in its product data supplied with the fume–hood,
2. be labeled on the front of the fume–hood and be restricted by the sash stop.

For horizontal or combination sashes, the horizontal sliding panels should be arranged so that the maximum opening area for any orientation or configuration of the sash panels does not exceed the design opening area.

8. **Baffles:**

Baffles should be fabricated of the same material as the interior panels. They should be designed to:

1. provide multiple exhaust slots adjustable in width, and
2. minimize variation in face velocity across the sash opening when the sash is in its normal operating position.

The baffles should be set at the factory, <u>permanently marked</u>, and fixed on the basis of prototype testing . They should not be adjusted by the user without a subsequent verification of the fume–hood performance. PWGSC Performance Criteria.

****Note–** Fume–hood performance depends upon correct baffle position. Therefore baffles should not be adjusted by users. Baffle openings should not be set based on the specific gravity of various fumes, though greater or less than that of air. The turbulence within the hood and the relative concentrations of fumes negates any supposed effect from heavier–than–air or lighter–than–air fumes under most laboratory hood usage conditions.

9 Exhaust duct collar:

The exhaust duct collar should be fixed to the top rear of the fume–hood and constructed of the same material as the interior panels. The collar should have bell–mouthed entry and it should be flanged for easy connection to the exhaust duct. It should be sized to provide exhaust air velocities of 5.0 to 7.5 m/s to:

1. minimize pressure drop and noise generation;
2. prevent condensation, and;
3. ensure that normally encountered particulates remain suspended in the air stream.

10. Interior panels:

The material of construction should be selected according to the requirements of the Laboratory Director ,the project brief and/or the tender specifications.

If stainless steel is specified, it should be 1.2 mm thick 316 stainless steel (#4 satin finish), with all interior corners radiused to 12 mm and all welds ground smooth.

If fibreglass reinforced plastic (FRP) is used, it should be 6.4 mm thick, heat– and chemical–resistant and finished with a non–porous white surface. Screws should be stainless steel.

Interior access panels should be gasketted, and removable and replaceable without special tools.

11. Exterior panels:

Exterior panels should typically be of cold rolled steel, finished with powder coating. Exterior panel members should be fastened by means of concealed devices; exposed screws are not acceptable. Panels should be readily removable, to allow access to plumbing lines and fixtures. All screws should be stainless steel.

Provide top closure panels of same material and finish as hood exterior, to enclose ductwork up to the ceiling.

12. Superstructure:

The superstructure should be double wall construction, consisting of an outer sheet metal shell and an inner liner of corrosion – resistant material. The double wall should house and conceal steel framing members, attaching brackets and remote–operating service fixture mechanisms. The entire assembly should be a rigid, self–supporting unit.

13. Vertical sides of fume–hood face:

The vertical sides should have a radiused airfoil shape, to reduce eddies and to promote smooth entry of air into the fume–hood. If service fixtures are installed, they should not disturb the airflow pattern. Removable panels may be provided for maintenance of sash counterbalance mechanisms and service valves.

14. Sash and sash handle, grab bar and frame:

Sash should be 6.4 mm thick laminated safety glass in a corrosion resistant PVC track, with appropriate provisions for raising and lowering, or sliding horizontally, or both.

Rigid acrylic sashes are recommended for acid digestion processes involving hydrofluoric acid and similar acids, **but not perchloric acid.**

Where glass is used, a clear PVC film overlay bonded to the interior surface of the sash may also be considered for protection against hydrofluoric acid fumes.

Sash handle should be of type 316 stainless steel with #4 satin finish, and should not generate eddies in the plane of the sash opening. It should be thin enough in profile to minimize interference with the line of sight of the fume–hood user.

Where heat is considered to be a potential source of danger, the sash may have a Mylar overlay bonded to the exterior surface.

15. Counterbalance mechanism:

The counterbalance mechanism should use single counterweight, stainless steel wires on pulley assembly of 38 mm diameter, with nylon–tired ball bearing pulleys. A cable–retaining device should be provided, assembled to prevent tilting of the sash during operation.

Spring counterbalance mechanisms are not acceptable.

The sash should move easily and quietly and remain in place wherever it is stopped.

The sash should open and close against rubber bumper stops, installed so that the user can readily adjust the sash opening when moving the sash from either end. The design should ensure that, in the event of a failure of the counterbalance mechanism, the sash cannot fall within 50 mm of the bottom airfoil. This is in order to avoid the potential for serious injury to the fume–hood user.

16. Sash stop

A physical sash stop should prevent the sash from opening further than its normal operating position, under regular working conditions. The sash may be opened further by the use of a special key or tool, or by purposely releasing the sash stop, but should reset automatically when the sash is lowered again.

17. Fastenings:

All fastenings inside the fume–hood should be corrosion– resistant and remain unaffected by repeated operations.

18. Work surface:

The work surface should be recessed at least 12.5 mm to contain spills. It should be completely sealed at all interior panels and have covered corners plus raised surface all around the work surface. The choice of material should suit the application; it should be specified by the Laboratory Director and included in the project brief.

19. Light fixture:

The light fixture should be a T8 – 2–tube fluorescent rapid start fixture, mounted on the exterior of the fume–hood with safety lens sealed to isolate the fixture from the fume–hood interior. It should be serviced from outside the hood and should provide a minimum of 860 lux (80 foot candles) of interior illumination at the work surface. The switch should be flush mounted in a weatherproof box in the side post of the fume–hood. The sealant between lens and fume–hood should be of an approved type. Electronic ballasts should be provided.

**Note– The use of germicidal UV lights should be avoided, due to health and safety concerns

5.3 Design elements for variable air volume (VAV) fume–hoods

**Note– The use of germicidal UV lights should be avoided, due to health and safety concerns

VAV fume–hoods should meet all the requirements for Bypass fume–hoods indicated in paragraph 5.2, excepting the requirements for bypass grills, duct transport and outlet collar dimensions. In addition, they should meet the following requirements:

1. Additional testing:

Additional testing of VAV hoods over that required for constant volume fume–hoods is critical, and includes VAV Response and Stability Tests, as described in Chapter 3.

**Note– In VAV hoods, exhaust airflow is typically controlled using a sash position sensor or a through–the–wall (TTW) sensor. The response characteristics for the system are as important as the response time. There is a tendency to overshoot the face velocity set point, and to take time to settle at the appropriate value. Improper location of TTW sensor (e.g. in an unstable location) will exacerbate the situation.

5.4 Design elements for high performance fume–hoods

It is only recently that high performance fume–hoods have been accepted as legitimate alternatives to more traditional fume–hoods. It is important that they meet all performance requirements indicated in the PWGSC Performance Criteria, Table 1 (Chapter 3).

**Note– Face velocity performance criteria for high performance fume–hoods may conflict with local safety and health regulations if the intended face velocity falls outside the range of these regulations. If this occurs, a variance must be obtained prior to the use of hoods.

5.5 Fume–hood accessories

In selected applications, additional elements or accessories may be appropriate. Examples include:

1. Internal wash down system

This should be PVC schedule 80 piping using all PVC wide–angle solid cone nozzles with overlapping sprays. The piping should be designed for connection of cold water service from either side of the fume–hood. Provide an adequate number of control valves and nozzles for effective coverage of the entire wash down area. An integral drain trough is also required across the rear of the fume–hood, with a 1% slope to a 38mm drain and a 76 mm long tailpiece .. The trough should be integral with the work surface. Welds should be finished smooth and polished.

2. Scrubber system:

This is often associated with an internal wash down system. It should be used when it is necessary to clean the exhaust air before it is discharged into the environment. Provide an internal effluent scrubber and eliminator unit consisting of spray nozzles of acid–corrosion resistant material. The scrubber system should be installed in the fume–hood exhaust duct, preferably in close proximity to the fume–hood, to minimize the length of ductwork exposed to chemicals. Hang the scrubber from the structure above, so that parts requiring service are easily accessible. Provide a manual valve at the fume cabinet to initiate the wash down and effluent scrubbing process. The scrubber should operate continuously while the process is underway. The pressure drop should not exceed 250 Pa (1” wg) at the fume–hood design airflow.

The Reservoir, pump and associated piping system should be installed in an acoustically–insulated enclosure. The base furniture may be used for this purpose, if designed as an integral part of the fume–hood.

Neutralizing agents should be incorporated into the design based on the work processes and as required by the Laboratory Director.

The Controls should consist of RED and GREEN lights to indicate whether wash down /scrubber system is OFF or ON, respectively.

Scrubber efficiency tests should be performed by an independent testing laboratory at maximum exhaust airflow rate. The tests should demonstrate the efficiency in terms of the ratio of mass aerosols recovered versus the mass aerosols leaving the fume–hood, for the appropriate micron size.

Because scrubber efficiency varies with the test method used, test procedures should be fully documented so that future tests may be accurately duplicated.

All test results should be recorded on an approved Performance Verification (PV) report form together with the certificate of test submitted to the Project Manager. These documents should be included in the Building Management Manual.

3. Drain trough

The drain trough should be integral to and flush with the work surface. It should be located at the rear of the hood, with 1% slope toward a drain outlet. Welds should be finished smooth and polished. The trough should include a 38 mm drain fitting with integral debris catch and a 76 mm long tailpiece.

4. Heat shields

Heat shields should be installed where it is necessary to protect interior panels from radiant heat. They should be easily removable for cleaning purposes and should not compromise the safe operation of the fume–hood.

5. Vapour warning system

This should be installed for use with volatile and flammable chemicals, when required by the project brief. Sensitivity should suit specific requirements.

6. Filters

Filters, including carbon filters, should be selected according to the type of contaminant to be captured and removed. Selection should be based on the efficiency required, the residence time required for the removal of the contaminant and accessibility for inspection and replacement.

7. Fire control:

Only if deemed necessary, automatic fire protection within a fume–hood should be provided in compliance with NFPA–45, clause 6.10.

5.6 *Laboratory services to laboratory fume–hoods*

1. Electrical:

Provide duplex receptacle: 120 volt, 20 amp, GFI, hospital grade receptacle, mounted in side post. Electrical service to each fume–hood should be on a dedicated electrical circuit.

2. Plumbing services:

1. **Isolating valves:** Plumbing services should include remote–controlled valves located within the end panels, controlled by handles projecting through the side–posts of the fume–hood.

3. Fixtures, except for de–ionized and R.O. water, exposed within the hood are to have a chemical–resistant metallic bronze finish, and portions exposed on the exterior of the fume–hood are to be chrome–plated.

1. **Cup sinks** should be raised above the recessed work surface to prevent spills from entering the plumbing system. Welds should be finished smooth and polished. Include a 38 mm drainpipe with integral debris catch and 76 mm long tailpiece.

2. **De–ionized and R.O. water faucets** should be polyvinyl corrosion resistant finish, with polyoxymethylene lining, and stainless steel valves. Faucets must be aligned with the cup sink to prevent overspray and wetting of interior hood surfaces.

3. **Remote controls** installed on the side posts should be located to avoid any interference with the smooth entry of air into the fume–hood.

4. **Colour coding and identification of service fixtures** should be according to the standard of the laboratory facility, or as noted

Service	Letter coding		Color coding
	English	**French**	
Cold Water	CW	EF	Green
Hot Water	HW	EC	Red
Distilled Water	DIW	ED	White
De–ionized Water	DEW	EDI	White
RO Water	ROW	EOI	White
Vacuum	VAC	VAC	Yellow
Compressed Air	AIR	AIR	Orange
Propane	PRO	PRO	Yellow–Orange
Natural Gas	NG	GN	Yellow–Orange
Oxygen	OXY	OXY	Green
Nitrogen	N	AZ	Blue
Argon	A	AR	White
Steam	ST	VAP	Black

4. Access to services:

Cut–outs for plumbing and electrical services and fitments are to be made in the manufacturer's plant. Provide 5 cut–outs per side post. Unused openings in exterior panels for service connections should be complete with cap plugs of the same material as exterior panels.

Service connections should be accessible from the outside of the fume–hood, using removable panels. Isolating valves must be provided on the building side of the services.

Where two or more hoods are installed side by side, interior service panels may be used.

They should be of the same material as the interior panels, have beveled edges and moulded PVC gasket and should be secured by non–corrosive fasteners set flush with the face of the panel.

5.7 Integration with room HVAC and exhaust systems

Fume–hood exhaust systems must be fully integrated with the heating, ventilation and air conditioning (HVAC) system of the laboratory and the building automation systems (BAS), to maintain the pressurization requirements of the laboratory and the required fume–hood performance.

5.8 Minimum air flow

In spite of the ability to modulate to a fully closed position, VAV fume–hoods must maintain at all times a minimum air flow rate of 125 l/s per square metre of work surface, as per NFPA 45, when the sash is closed or during unoccupied operating modes.

5.9 Definition of fume–hood operating modes

Caution must be exercised at every individual laboratory facility to ensure that the HVAC sequence of operations correctly addresses the various possible fume–hood operating modes. For instance, with a by–pass hood in a situation where 2–position airflow is achievable, it would be appropriate to define both a standard operating mode and a standby mode. *Standby mode* would be applicable for the fume–hood at times when there are no processes involving generation of contaminants. This mode is activated by the user via a switch on the fume–hood or on the fume–hood monitor, and the exhaust box or the individual fume–hood exhaust fan switches to a lower level of ventilation. In such a situation, the monitor's red indicator light would signal that the hood is unsafe to use, as only minimal airflow would be occurring through the fume–hood. The sash should be closed at such time.

For *standard operating mode*, the assumption is that the hood has contaminant generating processes occurring (either attended or not) and that adequate face velocity is achieved, as indicated by the green indicator light on the fume–hood monitor.

To further breakdown the operating modes for any fume–hood, consider the following possible fume–hood activities:

1. Occupied – In use: generation of hazardous products occurring
2. Occupied – Not in use (set up): experimental apparatus being assembled in the fume–hood.
3. Unoccupied – In use (unattended procedures): generation of hazardous products occurring. Sash closed.
4. Unoccupied – Not in use (storage): no active generation of hazardous products. Minimal airflow permitted. Sash closed.

It is only under mode #4 that bypass fume–hoods could be permitted to drop to minimal airflow and be designated as "standby" mode.

These modes should not be confused with laboratory occupied and unoccupied modes of operation, as they will not necessarily coincide.

5.10 Fume–hood operation, controls and alarms

****Note–** Fume–hood exhaust systems are an integral part of the laboratory HVAC system. However, improper integration poses possible dangers and should be studied carefully during the Design Development stage of the project.

1. Fume–hoods with dedicated exhaust fan:

1. Exhaust fan operation: Manual control (on/off switch) should be flush mounted in a weatherproof box in the exterior panel. Clearly label the switch as, "CAUTION: FUME–HOOD OPERATION DISCONNECT SWITCH", and provide a protective cover.

****Note–** Standard Operating Procedures regarding fume–hood operation are required to be developed for laboratories in which the HVAC switches to an "unoccupied" mode during silent hours. Sash management compliance must also form part of the procedures.

2. Fume–hood exhaust fan should <u>not</u> be turned off unless the hood has been de–commissioned and/or for service procedures.

3. Monitor should include a **GREEN** light to indicate **POWER ON** and **SAFE TO OPERATE** conditions for the fume–hood system.

4. Audible and visual alarms: Provide audible (horn, buzzer, or bell) and visual (**RED** light) alarms to indicate air velocity is outside the acceptable range.

5. Fume–hoods should be used only if **ALL** safety controls are satisfied.

6. The audible portion of the alarm can be overridden by pressing a silencing relay switch, but the red light is to remain on until the **ABNORMAL** air velocity condition is rectified. The alarm system will automatically reset when all safety conditions are met.

7. Heater controls (when a heater is used in the fume–hood) should be integrated into the fume–hood control system.

8. The fume–hood, its controls, and alarms are to be ULC labeled.

9. The user should be able to verify the functioning of all operating controls and alarms.

10. Complete operating instructions for the alarm system should be secured to the fume–hood.

11. The fume–hood should be interlocked with HVAC and fume–hood exhaust system, except that the fume–hood exhaust fan should <u>not</u> be interlocked to automatically shut down when the building fire alarm system is in alarm.

2. Dual speed exhaust fan control system:

1. If incorporated into the HVAC and fume–hood exhaust system design, it should operate on **HIGH** speed when the fume–hood is in use. This condition should be indicated by **a GREEN** light to indicate **"FUME–HOOD READY FOR USE**" and a **RED** light to indicate **"FUME–HOOD UNSAFE FOR USE"**. For further information refer to **APPENDIX "C"**

3. Manifold fume–hood exhaust system:

This should be as described under paragraph 6.11.1 "Fume–hoods with dedicated exhaust fans" except that no local control of exhaust fans is permitted. Instead, BMS control of fume–hood exhaust terminals is required.

4. Connection to emergency power:

The requirement for the connection of the laboratory fume–hood alarm/monitor and the fume–hood exhaust fan to an emergency power source should be identified by the Laboratory Director, based on program requirements. Such connections should conform to the requirements of *"CAN/CSA Z316.5 Fume–hoods and associated exhaust systems".*

For manifold systems, at least one of the exhaust fans should be on emergency power, where exhaust system function must be maintained.

5.11 Base furniture

Unless the fume–hood is of the walk–in variety, base furniture may be of any sort, so long as it does not interfere with air entry below the lower (sill) airfoil. Base furniture is not part of the laboratory fume–hood.

****Note–** Base furniture is often a flammable storage cabinet. Such units, if ventilated, should be ventilated separately from the fume–hood and not be connected to the fume–hood exhaust system. See NFPA30 – Flammable and Combustible Liquids Code, 2000.

5.12 Noise levels

Fume–hood decibel level should not exceed 50 NC measured 0.5 m away from and perpendicular to the face of the fume–hood. This is a design criterion that the Design Team should address during design. If it is an area of concern, a noise level test should be specified under “Testing, Adjustment and Balancing” (TAB) for new fume–hoods.

5.13 Governing standards

All relevant standards and references are listed in Chapter 7 – References.

This guideline should be used to establish performance criteria for fume–hood acceptance.

With the exception of those specifically outlined herein, the performance test procedures should be as described in the most recent version of ANSI/ASHRAE 110: *Method of Testing Performance of Laboratory Fume–hoods.*

5.14 Tests

Performance criteria for testing laboratory fume–hoods are described in Chapter 3.

Chapter 6 Glossary of terms

Airfoil – bottom:

Curved or angular horizontal member running the full width of the fume–hood between the work surface and the bottom of the sash when closed, and providing a permanent slot approximately 25mm high to permit a smooth “sweeping” action of air across the entire width of the work surface while minimizing entry turbulence.

Airfoils – side:

Curved or angular vertical members at each side of the fume–hood entrance designed to minimize eddies and promote smooth entry of air into the hood.

Baffles:

Adjustable panels located across the fume–hood at the rear of the work space between the work surface and the point of connection to the fume–hood exhaust system, and forming the front face of the rear plenum. Designed to enable control of airflow distribution and capture within the hood.

Bypass:

An arrangement to allow air to enter the fume–hood other than through the sash opening, designed to ensure a relatively constant exhaust airflow rate regardless of the position of the sash and limit the maximum face velocity.

Contaminants:

Dusts, fumes, gases, vapours, aerosols, allergens, particulate matter, etc. They may be harmless, noxious, poisonous, toxic, allergenic, odorless, odorous, corrosive, flammable, explosive, radioactive, etc.

Face velocity:

Speed of air entering the fume–hood through the sash opening, and measured in the plane of the sash.

Plane of the Sash:

The imaginary vertical plane from the midpoint of the sash frame depth from the bottom of the sash to the point of contact on the airfoil sill.

Sash:

Transparent operable screen between the fume–hood user and the interior of the fume–hood, adjustable either vertically or horizontally, or both, and capable of providing protection for the fume–hood user.

Sash opening:

The aperture in the front of the fume–hood through which all work and manipulations are made.

Fully open:

The maximum height to which the sash can be opened above the bottom airfoil. It is limited only by the design of the fume–hood.

Normal operating position:

The operating position of the sash above the bottom airfoil at which normal operations and manipulations within the fume–hood are performed. It is a single, specific height, typically in the 300 to 450 mm range, depending upon the laboratory program requirements, and must be clearly labeled on the fume–hood. In ANSI/ASHRAE 110, it is referred to as "*sash design position*"**.**

Service fitting:

Laboratory fitting mounted in, on, or fastened to, laboratory fume–hood to control supply of the service to the fume–hood**.**

Slot:

Horizontal opening in or between each baffle panel and designed to regulate airflow distribution, and to maintain the desired face velocity distribution across the entire sash opening.

Superstructure:

That portion of the laboratory fume–hood supported by the work surface, the base furniture or the laboratory floor.

Chapter 7 References

1. Canada Labour Code Act, Part II – Canada Occupational Health and Safety Regulations

2. National Building Code of Canada, latest edition

3. National Fire Code of Canada, latest edition

4. CAN/CSA Standard Z316.5–94 (R2002): Fume–hoods and Associated Exhaust Systems

5. CAN/CSA Standard C22.2 NO. 1010.1–92 (R1999): Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use – Part 1: General Requirements

6. ANSI/ASHRAE 110 – 1995: Method of Testing Performance of Laboratory Fume–hoods

7. NFPA 45–2000: Standard on Fire Protection for Laboratories Using Chemicals

8. NFPA 30–2000: Flammable and Combustible Liquids Code

9. ANSI/AIHA Z9.5 – 2003: American National Standard for Laboratory Ventilation

10. National Research Council (U.S.): Prudent Practices in the Laboratory – Handling and Disposal of Chemicals, 1995, National Academy Press.

11. OSHA: Laboratory Worker Regulation 29 CFR Part 110.1450

12. ACGIH (American Conference of Governmental Industrial Hygienist): Industrial Ventilation – A Manual for Recommended Practices, 24th ed., 2001

13. ACGIH: Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices, 1998

14. Atomic Energy Board of Canada regulation R–52 rev 1: Design Guide for Basic and Intermediate Level Radioisotope Laboratories

15. ASHRAE Laboratory Design Guide, RP–969, 2001

16. SEFA1 (Scientific Equipment and Furniture Association): Laboratory Fume–hoods – Recommended Practices, 2002

17. SEFA3 (Scientific Equipment and Furniture Association): Work Surfaces, 1996

18. PWGSC Mechanical Design Guideline MD15129**:** Guidelines for Perchloric Acid Fume–hoods and exhaust systems

19. LEED (Leadership in Energy and Environmental Design) – U.S. Green Building Council

20. PWGSC Commissioning Manual and Guidelines, consisting of:

CP.1: Project Commissioning Manual

CP.3: Guide to the Development of the Commissioning Plan

CP.4: Guide to the Preparation of the Building Management Manuals

CP.5: Guide to the Preparation of Training Plan

CP.7: Design Guideline for facility Operation and Maintenance

CP.8: Guide to the Preparation of Commissioning Reports

CP.9: Guide to the Development of Installation/Start–up Check Lists

CP.10: Guide to the Development of Report Forms and Schematics

CP.11: Guide to the Preparation of the Commissioning Brief

CP.12: Guide to the Development and Use of Commissioning Specifications

CP.13: Facility Maintenance Policy, Guidelines and Requirements (Draft)

APPENDIX A USE AND MAINTENANCE OF LABORATORY FUME–HOODS

A.1 *Proper operation of laboratory fume–hoods – for users*

Proper operation of laboratory fume–hoods is just as important as proper design and installation.

Before any laboratory personnel are allowed to operate a fume–hood they must receive training in its uses, limitations and safety features. *Given the right attitude and proper knowledge, planning, equipment, and technique, personnel in most laboratories will be able to handle any chemical safely.*

These instructions may include written instructions, live demonstrations and videotapes prepared by manufacturers, experienced researchers, technical institutes, etc.

Before any new fume–hood is used, a notice listing its uses and limitations should be prominently displayed at each fume–hood. The Laboratory Director should produce this notice.

Work involving the use of perchloric acid must always be carried out in fume–hoods specifically designed and designated for perchloric acid. Refer to *MD 15129 – "Guidelines for Perchloric Acid Fume–hoods and Their Exhaust Systems".*

Although it is difficult to be specific in a manual of this nature, proper use of the fume–hood should always include at least the following procedures:

1. Check fume–hood monitor warning lights. Proceed only if green indicator light is illuminated.

2. Keep working surface uncluttered. This will assist in containment and also reduce disruption of airflow patterns. Where possible, equipment used within the hood should be elevated at

least 25 mm above the work surface.

3. Do not block exhaust slots at the back of the hood.

4. Do not use the fume–hood as a storage facility. Shelves should not be installed inside laboratory fume–hoods.

5. Maintain Sash at normal operating position or closed.

6. Position Apparatus and materials towards the centre and at least 150 mm from the face of the fume–hood, to minimize disturbance of air flow into the fume–hood through the sash opening.

7. Set–up clean–up procedures to suit the processes used and the laboratory protocol.

A.2 Proper maintenance of fume–hoods – for O & M personnel

1. Fume–hoods and exhaust systems

1. Preventive maintenance programs:

These are essential aspects of laboratory design and should be developed as the overall design of the facility is developed. Preventive maintenance programs should include, but not be limited to, the following:

1. Lubricating fan bearings and adjusting fan belts.
2. Checking sash operation and counterweight pulleys and cables for wear or deterioration.
3. Checking that sash limit stops are still in place and operate properly.
4. Checking the integrity of seals around lighting fixtures.
5. Inspection of all exhaust ducts for leaks and for unauthorized connections.
6. Checking that the fume–hood is being used only for which it was designed.
7. Checking all surfaces in contact with fumes for damage, abrasion and rough surfaces.

2. Fully detailed operating and maintenance manuals:

These are essential and should be SPECIFIC TO THE PROJECT. The Operating Manual and the Maintenance Manual form an integral part of the Building Management Manual.

3. Operating Instructions:

These should be complete, concise and clear, and should be located in plain view of the fume–hood user. This should also include all warning notices and alarms. See section A.3 – *Fume–hood Log Book, Table of Contents.*

2. Performance tests:

The performance tests described in detail in Chapter 3, "*Fume–hood performance and testing requirements*", should be carried out at the intervals shown in Table 2, *Fume–hood Test Frequency*, in Chapter 3.

2. HVAC systems

Maintenance programs should include verification of HVAC and general exhaust systems, including confirmation of pressure relationships.

3. Laboratory use

The Laboratory Director should organize regular reviews of programs within labs and operation of equipment. This person should also set in place procedures for reporting and correcting defective equipment, and enabling improvements in operating and maintenance procedures.

A.3 Fume–hood Log Book

It is strongly recommended that a log book be kept for each fume–hood and be permanently located at the fume–hood, as a reference for users and O&M personnel. The following is a sample Table of Contents for such a logbook; it should be modified for the specific laboratory installation.

Fume–hood Log Book Table of Contents

PROGRAM USER SECTION

1. **Chemical Usage Log**
2. **System Definition**
    1. *Fume–hood Alarm*
        1. *Function / Description – for User*
        2. *Operation – by User*
    2. *Room Air Systems*
        1. *Description – for User*
        2. *Operation – by User*
    3. *Fume–hood*
        1. *Operation – by User*
        2. *Maintenance – by User*
3. **Test Reports**
    1. *Face velocity Test Report*
    2. *Smoke Test Report*
    3. *Cross Draft Test Report*
    4. *VAV Response and Stability Test Report*
    5. *Alarm/Monitor Test Report*
    6. *Sensors Calibration Report*
    7. *Other reports*
4. **Emergency Procedures**
5. **Program Details**

OPERATIONS AND MAINTENANCE SECTION

1. Fume–hood System Description

   1. Fan Curves

   2. Operational Requirements

2. Fume–hood Manual

3. Fume–hood Alarm Manual

4. Room Schematics (including system schematics)

5 Test Reports

APPENDIX B Component Check List, Performance Verification (PV) and Test Results Forms

B.1 Commissioning check list

<table>
<tr><td colspan="2">Project:</td><td colspan="3">Project no:</td></tr>
<tr><td colspan="4">CHECK LIST</td><td>Page #:</td></tr>
<tr><td colspan="3">LABORATORY FUME–HOODS</td><td colspan="2">Date:</td></tr>
<tr><td colspan="2">Room:</td><td colspan="3">Type:</td></tr>
<tr><td colspan="2">Fume–hood no. on Contract Dwgs.</td><td colspan="3">Overall sizes:</td></tr>
<tr><td>Mfr:</td><td colspan="2">Mfr serial no:</td><td colspan="2">MMS Identifier</td></tr>
<tr><td colspan="2">Installation:
1. Minimum disturbance of smooth air flow into fume–hood by passing traffic
2. No obstructions to airflow into hood
3. Freedom of movement for fume–hood user
4. All labels firmly attached
5. User instructions complete and in place
6. Electronic sketch of the room, showing the location of the hood, windows and doors, all major furniture, air supply and return, etc.</td><td colspan="3"></td></tr>
<tr><td colspan="2">Bypass (if provided):
1. Operates as designed</td><td colspan="3"></td></tr>
<tr><td colspan="2">Work surface:
2. Work surface recessed to contain spills</td><td colspan="3"></td></tr>
</table>

Baffles: 1. Factory settings 2. Unalterable by fume–hood user 3. Position of baffles recorded and dimensioned (mm).	
Bottom airfoil: 1. Height fixed (usually 25 mm)	
Sash: 1. Freedom of movement: 2. Locations of stop set to limit maximum operating position (manual over–ride for set–up)	
Counterbalance mechanism: 1. Sash moveable from one end 2. Sash remains fixed (i.e. no creep)	
Services: 1. Corrosion resist finish as required 2. Electrical: i. Receptacle – correct power ii. Connected to emergency power (if required) 3. Mechanical i. Correct gases from each outlet ii. Outlets properly identified iii. Correct pressure at outlet 4. Isolating controls easily accessible 5. Correct identification on each outlet	
Fire extinguishing system (if installed): 1. Tested and operational	

Scrubber system (if installed): 1. Correct neutralizing agent and concentration for contaminant 2. Fluid pressure developed by pump sufficient for good atomization 3. Atomizing sprays operating properly 4. Spray system drainage operates correctly and is accessible for cleaning 5. Reservoir drainage and recharging facilities easily accessible 6. Control system verified 7. Pump connected to emergency power (if required) 8. Scrubber efficiency tested and verified	
Light fixture: 9. Lens sealed 10. Light level verified	
Controls: 1. Control sequences and alarm systems verified 2. Visual, audible annunciator for power to fume–hood system, adequate air flow for fume–hood operation 3. Visual and audible alarm for low air flow, audible alarms with muting switches 4. Vapor warning system (if required) 5. Connected to emergency power 6. Written instructions available	
Fume–hood exhaust air systems: 1. Exhaust air flow rate confirmed by TAB 2. Minimum air flow when fume–hood not in use verified at 125 L/s.m^2 of work surface area 3. Exhaust systems connected to emergency power (if required)	
Tests completed: 1. AM – As–manufactured (i.e. pre–purchase) 2. AI – As–installed (i.e. after installation) 3. Integrated systems tests 4. Certificates provided	

Training: 1. Familiarization during installation 2. Classroom 3. Hands–on 4. Log books prepared and in place	
Installation verified by:	Date:
Supervisor:	Date:

B.2 Performance Verification (PV) Report Forms – Hood and System Information

Agency Name	
Building Name:	
Laboratory:	
Date:	

Hood Information:

Hood ID:		Hood Type:	
Manufacturer:		Hood Model:	
Serial		Size:	

Hood Design Features:

Sash:	☐ Vertical ☐ Horizontal ☐ Combination ☐ None	Number of Sashes/Panels Panel Widths:	_____. _____ mm .	Baffle:	☐ Adjustable ☐ Fixed ☐ None
			Number of Slots:		_____.
		Interior Depth:			_____ mm.
Internal Construction:	______________________________.		Auxiliary Air Plenum: Width Length:		☐ Yes ☐ No _____ mm. _____ mm.
Services:	______________________________.				

General Comments:

System Information:

System ID: __________.

Exhaust Type: ☐ VAV ☐ CAV ☐ Other

Exhaust Configuration: ☐ Single Hood – Single Fan ☐ Single Hood – Multiple Fan ☐ Multiple Hood – Single Fan ☐ Multiple Hood – Multiple Fan ☐ No Exhaust

Hood Duct Diameter: _____mm.

Monitor: ☐

Duct Material: ____________________.

Monitor Type: _______________.

Filtration: ☐

Alarm: ☐

Filtration Type: ____________________.

Damper: ☐

VAV Control Type: ____________________.

VAV Manufacturer: _________________________.

B.3 Fume–hood Test Summary

Hood ID _________________________.

Tester(s) ____.

Date: _________________.

Hood Inspection		Comments:
☐ Hood Integrity	☐ Liner/Baffle Integrity	
☐ Sash Operation	☐ Monitor Operation	
☐ Light Operation	☐ Alarm Operation	

Summary Performance Rating

Rating: ☐ Pass ☐ Fail ☐ N/A ☐ Restricted Use ☐ Pass/Fail ☐ Marginal

Reason–Comments:

General Comments / Recommendations:

B.4 Laboratory Hood Performance Test Results

Agency Name	____________________________.		
Building Name	____________________________.		
Laboratory	____________________________.		
Hood ID	_______________.	Date: ____.	Cycle: _____.

Test Conditions:

Sash Opening:	____.		
Opening Dimensions:	Width: mm.	Height: mm	Area: m^2
Baffle Opening:	____.		
Apparatus in Hood:	Yes ☐ No ☐		
Monitor Reading:	______________________________.		
Additional Test Comments:			

Cross Draft Test Results:

Horizontal Draft	Left	Centre	Right
Maximum m/s			
Average m/s			
Vertical Draft	Left	Centre	Right
Maximum m/s			
Average m/s			
Perpendicular Draft	Left	Centre	Right
Maximum m/s			

Average m/s			

Smoke Visualization Results:

Low Volume Rating:		High Volume Rating:	
☐ Fail ☐ **Low Pass –** Poor ☐ **Pass –** Fair ☐ High Pass – Good ☐ N/A	Comments:	☐ Fail ☐ **Low Pass –** Poor ☐ **Pass –** Fair ☐ High Pass – Good ☐ N/A	Approximate Clearance Time: Comments:

Face Velocity Traverse Results:

	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8	Col 9	Col 10	Col 11
Row 1											
Row 2											
Row 3											
Row 4											

Ave. Velocity:_____m/s Max. Velocity:_____m/s Min. Velocity:_____m/s

Exhaust Flow:______l/s

Face Velocity Traverse Results, by–pass Effectiveness (Sash at 150 mm):

	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8	Col 9	Col 10	Col 11
Row 1											

Ave. Velocity:_____m/s Max. Velocity:_____m/s Min. Velocity:_____m/s

Exhaust Flow:______l/s

Auxiliary Air – Velocity Traverse Results:

	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8	Col 9	Col 10
Row 1										
Row 2										
Row 3										

Ave. Velocity:_____m/s Max. Velocity:_____m/s Min. Velocity:_____m/s

Tracer Gas Test Results:

1. Sash at Normal Operating Position

	Probe **660 mm** above work surface			Probe **450 mm** above work surface			
Ejector and mannequin position	left	centre	right	left	centre	right	
Average							ppm
Maximum							ppm

2. Sash Fully Open (VAV and High Performance hoods only)

	Probe **660 mm** above work surface			Probe **450 mm** above work surface			
Ejector position within fume–hood	left	centre	right	left	centre	right	
Average							ppm
Maximum							ppm

3. Sash Movement Effect (sash moving from closed to normal operating position)

	Probe **660mm** above work surface	Probe **450mm** above work surface	
5–minute average			ppm
Maximum			ppm

Fume–hood Monitor, Alarm and Sensors:

Calibration: all sensors reporting to BAS calibrated	Yes ________	No ______
Monitor display: to at least 2 decimal points	Yes ________	No ______
Monitor accuracy: display is within +/– 5% of actual value	Yes ________	No ______
Alarm Enunciation: occurs when beyond +/– 20% of design flow set point	Yes ________	No ______
Alarm Response: enunciation delay (maximum 10 seconds)	_______ seconds	

B.5 VAV Laboratory Fume–hood Test Form

Agency Name	____________________________.		
Building Name	____________________________.		
Laboratory	____________________________.		
Hood ID	_______________.	Date: ____.	Cycle: _____.

Test Conditions

Sash Opening Description:	____.			
Normal Operating Position Dimensions:	Width: mm	Height: mm	Area: m^2	Total Area: m^2
Baffle Opening:	____.			
Apparatus in Hood:	Yes ☐ No ☐			
Monitor	Type:__________________________.		Reading: _______________	
Additional Test Comments:				

Cross Draft Test Results:

Horizontal Draft	Left	Centre	Right
Maximum m/s			
Average m/s			
Vertical Draft	**Left**	**Centre**	**Right**
Maximum m/s			
Average m/s			
Perpendicular Draft	**Left**	**Centre**	**Right**
Maximum m/s			
Average m/s			

Face Velocity Traverse Results – 100% Sash Opening:

100	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8	Col 9	Col	Col
Row 1											
Row 2											
Row 3											
Row 4											
Row 5											

Ave. Velocity:_____m/s Max. Velocity:_____m/s Min. Velocity:_____m/s

Exhaust Flow:______l/s

Face Velocity Traverse Results – Sash at Normal Operating Position:

Norm.	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8	Col 9	Col 10	Col 11
Row 1											
Row 2											
Row 3											
Row 4											

Ave. Velocity:_____m/s Max. Velocity:_____m/s Min. Velocity:_____m/s

Exhaust Flow:______l/s

Face Velocity Traverse Results – 150mm Sash Opening:

150mm	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8	Col 9	Col 10	Col 11
Row 1											

Ave. Velocity:_____m/s Max. Velocity:_____m/s Min. Velocity:_____m/s

Exhaust Flow:______l/s

Tracer Gas Test Results:

1. Sash at Normal Operating Position

	Probe **660 mm** above work surface			Probe **450 mm** above work surface			
Ejector and mannequin position	left	centre	right	left	centre	right	
Average							ppm
Maximum							ppm

2. Sash Fully Open

	Probe **660 mm** above work surface			Probe **450 mm** above work surface			
Ejector and mannequin position	left	centre	right	left	centre	right	
Average							ppm
Maximum							ppm

3. Sash Movement Effect (sash moving from closed to normal operating position)

	Probe **660 mm** above work surface	Probe **450 mm** above work surface	
5–minute average			ppm
Maximum			ppm

Fume–hood Monitor, Alarm and Sensors:

Calibration: all sensors reporting to BAS calibrated	Yes __________	No _________
Monitor display: to at least 2 decimal points	Yes __________	No _________
Monitor accuracy: display is within +/– 5% of actual value	Yes __________	No _________
Alarm Annunciation: occurs when beyond +/– 20% of design flow set point	Yes __________	No _________
Alarm Response: Annunciation delay (maximum 10 seconds)	_______ seconds	

Smoke Visualization Results:

Low Volume Rating:		**High Volume Rating:**	
☐ Fail ☐ Low Pass – Poor ☐ Pass – Fair ☐ High Pass – Good ☐ N/A	Comments:	☐ Fail ☐ Low Pass – Poor ☐ Pass – Fair ☐ High Pass – Good ☐ N/A	Approximate Clearance Time: Comments:

VAV Test Results:

Dynamic Sash Movement –VAV Response Test (150mm Sash Height to Sash at Normal Operating Position):

Parameter	Value	Notes
Avg. Steady State Velocity (m/s) – 150mm Sash Opening	DSSV150 = _______m/s	
Steady State Deviation % – 150mm Sash Opening	DSSD150 = _______ %	
Avg. Steady State Velocity (m/s) Sash at Normal Operating Position	DSSVNorm = _______m/s	
Steady State Deviation % – Sash at Normal Operating Position	DSSDNorm = _______ %	
Response Time to achieve Steady State Velocity – Sash at Normal Operating Position	DRTNorm = _______ sec.	
Velocity Overshoot – Maximum Deviation %	DMDNorm = _______ %	

Static Sash – Exhaust Stability Test (150 mm Sash Open):

Parameter	Value	Notes
Avg. Steady State Velocity	SSSV150 = _______m/s	
Steady State Deviation	SSSD150 = _______ %	
BAS Flow Volume	QBAS150 = _______ l/s	

Static Sash – Exhaust Stability Test (Sash at Normal Operating Position):

Parameter	Value	Notes
Avg. Steady State Velocity	SSSVNorm = _______m/s	
Steady State Deviation	SSSDNorm = _______ %	
BAS Flow Volume	QBASNorm = _______ l/s	

Response and Stability Plot:

APPENDIX C Fume–hood Operation, Controls and Alarms —dual speed exhaust fans

Laboratory HVAC system designs will sometimes require the use of two–speed fume–hood exhaust fans with a low speed for standby fume–hood operation and a high speed for standard operation of fume–hood and for maintaining laboratory pressurization requirements.

The high speed should be fixed by pulley selection. The low speed should be achieved using two–speed motors, silicon controlled rectifiers (SCR), rheostats, etc.

The fume–hood exhaust fan should be integrated with the HVAC system and should operate at low speed whenever the fume–hood is not in use, to provide minimum airflow requirements. At the same time a RED pilot light on the monitor should indicate “FUME–HOOD UNSAFE FOR USE” (since airflow rate is inadequate to meet fume–hood face velocity criteria).

To actively use the fume–hood, the fume–hood user should turn a “HIGH SPEED/LOW SPEED” selector switch to “HIGH SPEED”. The RED pilot light should remain on and an audible alarm should sound until the fume–hood exhaust air velocity satisfies the setting of the monitor, at which point they should both be deactivated and a GREEN pilot light should be activated to indicate “FUME–HOOD READY FOR USE”.

When the fume–hood is no longer required, the user should lower the sash to the minimum position and return the selector switch to the “LOW SPEED” or “STANDBY” position. The exhaust fan should return to low speed, the audible alarm should be removed from the circuit and the RED pilot light should again be energized, indicating “FUME–HOOD UNSAFE FOR USE”.

If, when in high speed mode, the exhaust air flow rate varies by +/– 10% of the alarm sensor setting, the GREEN light should be de–energized, the RED light should be energized indicating “FUME–HOOD UNSAFE FOR USE” and the audible alarm should sound.

A muting switch should provide the option of silencing the audible alarm only. It should automatically reset when adequate airflow rate has been re–established.

The monitor panel at the fume–hood may contain all switches and indicator lights within a single unit (preferred), or there may be two separate parts:

1. Operator's panel, consisting of:

1. Two–position selector switch labeled “HIGH” and “LOW”.
2. RED pilot light labeled “FUME–HOOD UNSAFE FOR USE”
3. GREEN pilot light labeled “FUME–HOOD READY FOR USE”

2. Control panel, containing:

1. Pressure switch for airflow monitoring
2. Audible alarm to indicate air flow failure
3. Muting switch to silence audible alarm only
4 Relays for motor and controls

****Note–** When using dual speed controls, shut–off dampers in the exhaust duct are not normally necessary. If provided, however, they should be integrated into the laboratory HVAC control strategy, except that they should not close upon activation of the building fire alarm system.