Fume Hood Committee Web Meeting

Friday, February 20, 2026– 11:00 AM–12:00 PM- NY Time (ET)

Co-Chairs - Andrew Sinnamon and Luke Savage

1. Please join my meeting. https://meet.go.to.com

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Meeting Agenda

- **Approval of Minutes**
- **Review / Approval of SEFA 1 Standard**

Scientific Equipment and Furniture Association

Minutes of the Fume Hood Committee Meeting
Thursday, November 6, 2025 - 4:00 PM
Trump National Doral - White & Gold Ballroom

P R E S E N T:

Co-Chairs	Luke Savage	LABCONCO Corporation
	Andy Sinnamon	Mott Manufacturing
Attendees:	Ken Dixon	Air Control
	Don Nelson	Air Master Systems
	Abbie Gregg	AM Technical Solutions
	Ron Bedard	Bedcolab
	Jorge Santos	CHC Lab Co.
	Mike Last	CiF /NEIS Collective
	Mohammed Maseer	CiF Lab Solutions
	James Sutcliffe	CiF Lab Solutions
	Brant Kelly	Diversified Casework
	Nathan Thornton	Diversified Casework
	Adhiraj Patel	GD Waldner
	Myoung Oh	GT Scien
	Dave LeVene	Hamilton Lab Solutions
	Ross Vlietstra	Hanson Lab Solutions
	Dave Campbell	HEMCO Corp.
	Chris White	HEMCO Corp.
	Estefania Hamelinck	HERA Laboratory Planner
	Tim Dyck	H H Hawkins
	Don Bush	HKS
	Sangun Lee	Jeio Tech
	Mason Cain	Kewaunee Scientific
	Kelly Williams	LABCONCO Corporation
	Bob DeLuca, Jr.	Lab Crafters
	Bob DeLuca, Sr.	Lab Crafters
	Linda J. LeMarie	L'Oreal
	Horace Ng	Mocha Lighting
	Palaksha Karibasappa	Mocha Lighting
	Nathan Waud	Mott Mfg.
	John Peters	NuAire
	Drew Pippin	NuAire
	Ron Arredondo, Jr.,	One Pointe Solutions
	Bob Xu	Shanghai Road Lab Ceramic
	Paul Baldinger	The SLAM Collaborative

David Edwards	The SLAM Collaborative
Robert Pulito	The SLAM Collaborative
Michael Flanagin	Waldner North America
Hiroyuki Kobayashi	Yamato
Akio Nakamura	Yamato

The meeting was called to order at 4:00 PM. The first item on the Agenda was election of Co-Chairs. The current Co-Chairs Luke Savage and Andy Sinnamon advised that if there were no volunteers, they were willing to continue to serve. There were no nominations from the floor and Andy and Luke were re-elected.

The Co-Chairs advised that the focus of today's meeting would be to provide an overview of the progress made by the Red-Draft Sub-Committee and present a Timeline for approval of the SEFA 1 Standard.

PROGRESS MADE SINCE 2022 -

- Revised Purpose and Scope of SEFA 1.
- Updated definitions to align with related industry standards.
- Completed a major redraft and reformatting to convert SEFA 1 from a "Recommended Practice" to a formal Standard.
- Integrated appendices, removed redundancies, and updated all referenced standards (Z9.5, NFPA 45, CSA Z316.5, ASHRAE 110).

2025 REFORMATTING INITIATIVE -

- Objective: streamline layout, eliminate duplication, and standardize terminology.
- Process: editor's draft → subcommittee review → full committee review.

NEXT STEPS:

Committee Members will receive the redrafted standard and a feedback form within the next week and given a 30-day review period.

The Focus of this review is to verify accuracy and consistency—no major new content at this stage.

TIMELINE:

- Committee feedback due on or before December 31, 2025.
- Subcommittee to reconvene if substantive issues arise.
- Final draft circulation: February 2026 → vote to approve.
- Target publication date: June 2026.

FUTURE WORK (2026-27 INITIATIVES):

The committee identified several potential topics for new or expanded SEFA guidance.

- Ventilation of base cabinets (especially in low-flow/VAV systems)
- Variable air volume (VAV) control integration and trade coordination
- Laboratory layout and fume hood placement guidance.
- High-temperature fume hoods (testing, performance thresholds).

At 5:00 PM the Meeting was adjourned on motion of Luke Savage, seconded by Andy Sinnamon and unanimously approved.

A Scientific Equipment & Furniture Association Standard

SEFA 1-2025
Laboratory Fume Hoods and Ventilated Enclosures for Laboratories

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Columbia, SC 29201

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SEFA SPELLS SAFE

TABLE OF CONTENTS

1. Foreword

1.1. ABOUT SEFA

The Scientific Equipment and Furniture Association (SEFA) is an international trade association comprising manufacturers of laboratory furniture, casework, and fume hoods, as well as members of the design and installation professions. SEFA was founded to promote this industry and improve the quality, safety, and timeliness of the construction of laboratory facilities in accordance with customer requirements.

1.2. SEFA STANDARDS

SEFA and its committees actively develop and promote SEFA standards, which have domestic and international applications. Development of these standards considers the work of other standards organizations as well as information provided by government agencies.

SEFA standards are developed in and for the public interest. They are designed to promote a better understanding among designers, architects, manufacturers, purchasers, and end users and to assist purchasers in selecting the proper product to meet the user's specific needs.

These standards are periodically updated via biannual public meetings of the SEFA committee, which is currently co-chaired by Luke Savage (Labconco Corporation) and Andrew Sinnamon (Mott Manufacturing). SEFA welcomes input from all pertinent organizations at these meetings. Please contact SEFA at info@sefalabs.com with comments or questions concerning these standards.

NOTE

To reference SEFA 1 for project specification purposes, we suggest the following: "Fume hoods shall conform to the latest version of SEFA 1."

1.3. GLOSSARY

SEFA-defined terms are frequently used in contracts and other documents that define the products to be furnished or the work involved. To provide uniformity for users of these terms, the association has developed a glossary (SEFA 4 – 2025). Bolded terms in SEFA standard text are included in SEFA 4, as well as at the end of each individual standard (see SEFA 1, Appendix A). The definitions shall be used to help resolve disputes or incorporated into relevant contracts and related documents.

Where a specific standard contains a definition that differs from the one in the glossary, the definition in the standard should be used. SEFA encourages interested parties to submit additional terms or suggest changes to terms already defined by the association.

1.4. ADDITIONAL RESOURCES

An excellent source for engineering principles of ventilation can be found in *Industrial Ventilation: A Manual of Recommended Practice for Design*. The manual highlights the general principles of ventilation supply systems, exhaust systems, airflow, fans, construction guidelines, and testing of ventilation systems. It should be used in conjunction with the SEFA standards. Please see Appendix B for a list of relevant organizations offering additional information.

The following resources provide a body of knowledge that augment SEFA 1:

- ASHRAE Standard 110, *Methods of Testing Performance of Laboratory Fume Hoods,* specifies the test methodology that qualifies the performance of a laboratory fume hood.
- ANSI/ASSP Z9.5 establishes acceptance criteria for fume hood containment.
- NFPA 45, *Standard on Fire Protection for Laboratories Using Chemicals,* provides basic requirements for the protection of life and property through prevention and control of fires and explosions involving the use of chemicals in laboratory-scale operations. The fume hood section provides safety guidelines for hood location in the room, exhaust air discharge, duct construction, manifolds, duct velocity and stack discharge velocity. Fume hood interiors, automatic sash operators, and electrical devices are also addressed.
- *Industrial Ventilation: A Manual of Recommended Practice for Design*
- *Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards*
- *The ASHRAE Handbook*
- *ASHRAE Laboratory Design Guide*

Internal industrial specialists and the organization's management also possess their own experience, education, and information pertinent to their field.

NOTE

Please refer to the current edition of materials referenced in SEFA standards.

1.5. DISCLAIMER

SEFA uses its best effort to promulgate standards for the benefit of the public in light of available information and accepted industry practices. SEFA does not guarantee, certify, or assure the safety or performance of any products, components, or systems tested, installed, or operated in accordance with SEFA standards, or that any tests conducted under a SEFA standard will be non-hazardous or free from risk. SEFA encourages the use of third-party independent testing. The application and installation of fume hoods shall be compliant with all applicable jurisdictional codes in addition to the requirements outlined in this document.

NOTE

Fume hood test results submitted for membership consideration (ASHRAE 110 AM) must be performed and documented by a SEFA-approved third-party testing facility using the test report template in Appendix C. For a current list of approved labs, go to sefalabs.com/sefa-approved-test-labs.

2. An Introduction to Laboratory Fume Hoods

This standard provides a comprehensive first source of information pertaining to **laboratory fume hoods.** Since the laboratory fume hood is a key component of the **laboratory ventilation system**, these practices will address the entire system as it relates to the laboratory fume hood.

2.1. LABORATORY FUME HOOD DEFINITION

A laboratory fume hood is a safety device designed to carry undesirable effluents generated within the hood during a laboratory procedure away from laboratory personnel and out of the building, when connected to a properly designed laboratory ventilation system.

A laboratory fume **hood**, including the top, three fixed sides, and a single **face** opening, shall be made primarily from flame-resistant materials. The face opening is equipped with a **sash** and may be equipped with an additional protective shield. The face opening shall be aerodynamically optimized to maximize containment and may have an **airfoil** designed to reduce reverse airflows on the work surface.

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A laboratory fume hood is typically equipped with a **baffle** and, in most cases, a **bypass** system designed to control airflow within the hood and manage the distribution of air at the opening. A laboratory fume hood may be set on a bench, a pedestal, or the laboratory floor.

Not all ventilated enclosures are laboratory fume hoods. Many enclosures are sized for their application and operate safely for their intended purpose, but may be made of materials and construction unsuitable for use as a fume hood. Fume hoods should not be used for biohazard containment or hazardous airborne materials; refer to the section on biological safety cabinets when using hazardous or infectious biological agents.

2.2. FUME HOOD TERMINOLOGY AND VARIETY

Laboratory fume hoods are perhaps the most widely used (and misused) safety device. While “laboratory fume hood” is used throughout this standard as the proper terminology, other commonly used terms include fume hood, chemical hood, chemical fume hood, hood, and **fume cupboard**.

Fume hoods are available in many shapes, sizes, materials, and finishes. Their flexible design enables them to be configured to accommodate a variety of chemical procedures. That flexibility, however, can result in varying levels of performance and operator protection. Great care shall be employed by the user when using a laboratory fume hood. Consult the manufacturers' recommended practices for specific operation, safety, and maintenance guidelines.

The laboratory fume hood is part of the ventilated laboratory safety device family and can be sub-categorized by type (see Figure 1). Each type is connected to a laboratory ventilation system. These other systems are described in Section 7.

2.3. ASHRAE 110-2016 PROTOCOL

This standard is organized to be consistent with the current version of the ASHRAE 110 protocol. "As Manufactured" issues in this standard refer to fume hood standards that are relevant to the hood manufacturers' location. "As Installed" identifies those issues that occur in a newly constructed or renovated laboratory prior to the user occupying the lab. The "As Used" section refers to issues after the installation is complete and address how the hood is to be or is being used.

2.4. TAXONOMY

Exposure Control Devices (ECDs) are manufactured, installed, and operated to meet the functional requirements of users and to provide the primary engineering control for mitigating the risk of personnel exposure to airborne hazards in laboratories. While laboratory fume hoods are the most widely used ECDs, SEFA recognizes a taxonomy in the types, models, and sizes, as well as features, components, and sub-systems of ECDs.

For example, some ECDs are designed exclusively to provide personnel protection, whereas other designs incorporate special filtration and/or isolation features to provide both personnel and product protection. Certain ECDs are equipped to handle a wide variety of effluents, including gases, vapors, and aerosols, but other ECDs may only be suitable for handling particulates. The primary types of ECDs include:

- Laboratory fume hoods
- Ventilated safety devices
- Local exhaust ventilation
- Laminar flow hoods
- Biological safety cabinets (BSCs)
- Glove box / isolators
- Ductless hoods

Selection and use of appropriate ECDs requires consultation with stakeholders including researchers, lab managers, health and safety personnel, ventilation engineers, and facilities maintenance personnel.

Considerations during ECD selection shall include:

- The hazards and processes
    - Airborne effluent properties
    - Exposure limits and concentration levels of concern
    - Characteristics of generation
    - Quantities
- User-specific needs
- Type, size, and construction
- Required performance capabilities

- Ventilation system and airflow control requirements
- Operating modes
- Potential impact of changing environmental conditions

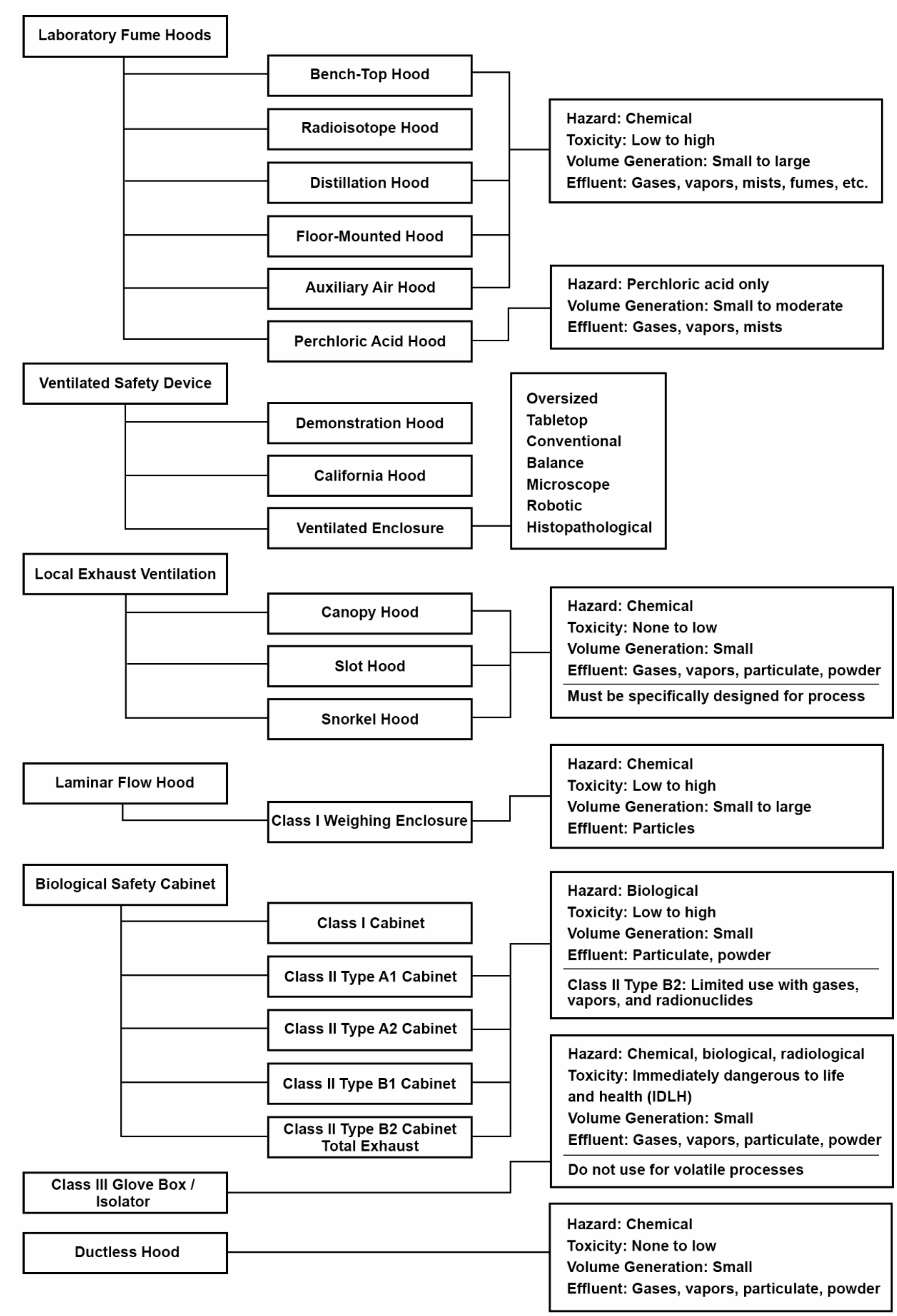
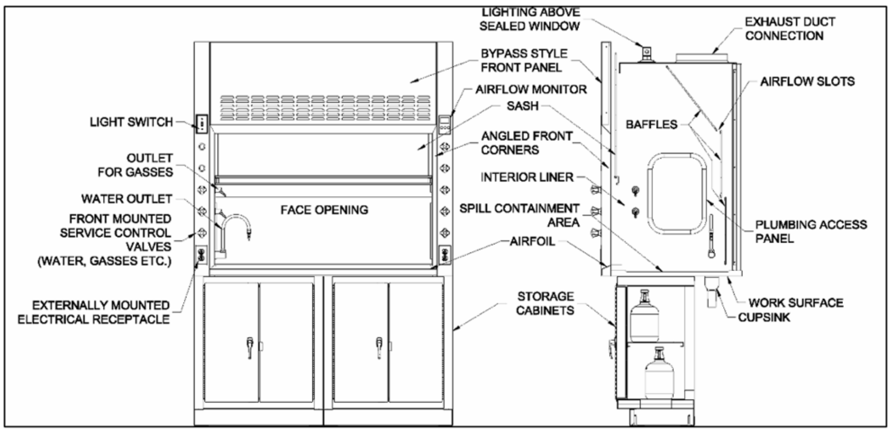

Laboratory Fume Hoods
Bench-Top Hood
Radioisotope Hood
Distillation Hood
Floor-Mounted Hood
Auxiliary Air Hood
Perchloric Acid Hood
Hazard: Chemical
Toxicity: Low to high
Volume Generation: Small to large
Effluent: Gases, vapors, mists, fumes, etc.
Hazard: Perchloric acid only
Volume Generation: Small to moderate
Effluent: Gases, vapors, mists
Ventilated Safety Device
Demonstration Hood
California Hood
Ventilated Enclosure
Oversized
Tabletop
Conventional
Balance
Microscope
Robotic
Histopathological
Local Exhaust Ventilation
Canopy Hood
Slot Hood
Snorkel Hood
Hazard: Chemical
Toxicity: None to low
Volume Generation: Small
Effluent: Gases, vapors, particulate, powder
Must be specifically designed for process
Laminar Flow Hood
Class I Weighing Enclosure
Hazard: Chemical
Toxicity: Low to high
Volume Generation: Small to large
Effluent: Particles
Biological Safety Cabinet
Class I Cabinet
Class II Type A1 Cabinet
Class II Type A2 Cabinet
Class II Type B1 Cabinet
Class II Type B2 Cabinet Total Exhaust
Hazard: Biological
Toxicity: Low to high
Volume Generation: Small
Effluent: Particulate, powder
Class II Type B2: Limited use with gases, vapors, and radionuclides
Class III Glove Box / Isolator
Hazard: Chemical, biological, radiological
Toxicity: Immediately dangerous to life and health (IDLH)
Volume Generation: Small
Effluent: Gases, vapors, particulate, powder
Do not use for volatile processes
Ductless Hood
Hazard: Chemical
Toxicity: None to low
Volume Generation: Small
Effluent: Gases, vapors, particulate, powder

Figure 1. Taxonomy of exposure control devices

3. Laboratory Fume Hoods – As Manufactured

Fume hoods are manufactured in a wide variety of designs, most of which share several characteristics and components. SEFA recommends that the fume hood be classified under Underwriters Laboratories (UL) Standard 1805, which outlines requirements for the structural integrity, flame and chemical resistance, plumbing, and electrical wiring of the fume hood structure. Other standards, such as UL 61010 or applicable national standards, may also be used.



3.1. COMPONENTS OF LABORATORY FUME HOODS

3.1.1. HOOD EXTERIOR

The hood exterior is the external “skin” and is usually made of painted steel. Some hood exteriors are made of stainless steel, polypropylene, wood, or phenolic. The exterior front of the hood is an important design element for fume containment. Properly designed laboratory fume hoods will have a contoured entry, which assists airflow into the hood and can improve hood performance.

The airfoil sill is a radiused or angled air vane positioned on the leading edge of the **work surface**. The sill is designed to enable smooth flow over the work surface and provide an opening when the sash (see section 3.1.6) is lowered or closed. Some flush sills employ a trough for spillage containment and slots to direct airflow over the work surface.

3.1.2. HOOD INTERIOR

The **fume chamber** and baffles should be constructed of materials that are resistant to the chemical fumes, vapors, and condensation particulates that may collect or form deposits on their interior surfaces. Consideration shall be given to the desired color and specifications of **liner** materials that are resistant to chemical exposure and corrosion in the fume chamber. Typical liner materials are fiber-reinforced thermoset composite – epoxy and polyester, phenolic resin, stainless steel type 304 and 316, thermoplastics – polyvinyl chloride, high density polyethylene, polypropylene and melamine, chemical-resistant mineral board, and sheet steel.

Liner materials shall be flame-resistant and self-extinguishing and shall have a flame spread rating of 25 or less in accordance with ASTM-E84. If the fume hood liner is not rated at 25 or less in accordance with ASTM-E84 or there is a high risk of fire hazard in the fume chamber, the fume hood shall be equipped with an automatic fire suppression and alarm system. In some cases, a local jurisdiction may require a wet or dry fire suppression system. For more information on fire suppression systems, see section 3.1.9.

3.1.3. HOOD BAFFLE

The baffle in the rear of the hood interior is designed to control airflow distribution within the hood and through the face opening. The baffle slots may be adjustable. The location, size, shape, and configuration of baffle slots significantly affect the performance of the laboratory fume hood.[1]

3.1.4. HOOD EXHAUST COLLAR

The **exhaust collar** that connects the hood to the exhaust **duct** is located behind the baffle at the top of the interior liner. The collar shall be made of a corrosion-resistant material, or a material appropriate for the fume hood application.

The design of the exhaust collar can affect the **hood static pressure** drop and noise level. For example, “bell-mouth” duct collars can reduce the turbulence associated with the airflow transition from the hood chamber to the exhaust system ductwork.

The number of exhaust collars varies depending on the width of the hood. Hoods wider than 6 ft. (1.83 m) typically have more than one exhaust collar for connection to the exhaust ducts.

3.1.5. HOOD BYPASS

Open Bypass: On hoods equipped with a vertical rising sash, an open bypass is used on constant air volume (CAV) hoods to divert air from the face opening when the sash is lowered. Diverting air through the bypass redirects the volume of air entering the face of the hood and thus limits variation to the **face velocity**.

Bypasses are generally designed to limit the increase in face velocity. The **velocity**, when measured at the sash opened 6 in. (15.24 cm), shall be no more than three times the velocity when the sash is fully opened. Limiting the increase in face velocity is important, as excessive face velocity can cause significant turbulence within the hood and interfere with experiments and apparatus in the hood. The compensating bypass configuration is only available on fume hoods with vertically rising sashes.

Restricted Bypass: A restricted bypass is smaller than an open bypass but serves the same

> **NOTE**
>
> If fume containment is unacceptable when the sash stop is bypassed, a warning label shall be mounted on the fume hood clearly identifying the operating sash height and the potential dangers of bypassing the sash stop.

[1] Knutson, Gerhard W. *Effect of Slot Position on Laboratory Fume Hood Performance*, Heating/Piping/Air Conditioning Feb. 1984: 93-96.

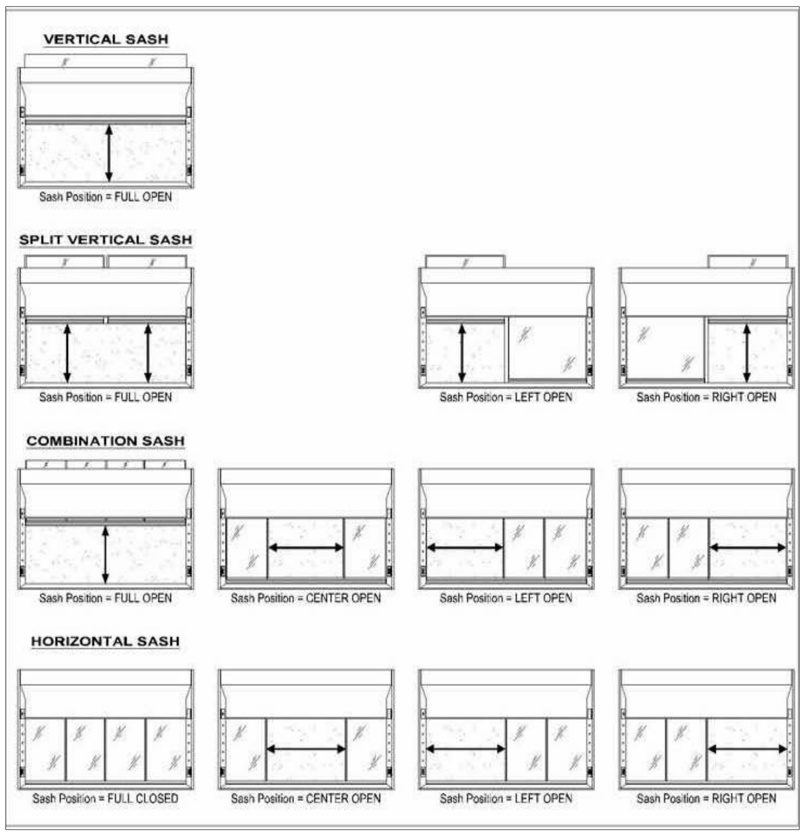
function. A restricted bypass reduces the amount of air required by the laboratory fume hood in the operating mode for variable air volume (VAV) systems as well as horizontal sashes and combination sashes. Eliminating the bypass completely is not recommended due to the potential risk of contaminant leakage. The actual sash closed air change rate should be determined by performing a hazard assessment in accordance with ANSI Z9.5.

3.1.6. HOOD SASH

The sash is a moveable panel(s), typically transparent, provided on fume hoods to restrict the opening and provide a protective barrier between the operator and the experiment. Sashes are typically designed so that closing the sash does not restrict the area beneath the airfoil sill. Sashes are available in a variety of configurations that enable vertical and/or horizontal movement of the sash panels. Although custom fume hoods may have a sash on more than one side, only one side should be open during active use.

The sash shall be designed to move freely and not bind. The force required to open the sash shall be reasonable for the size and weight of the sash. A five-foot hood with a vertical rising sash will require approximately five pounds of force to operate the sash. An additional one pound of force may be required for each additional linear foot of fume hood width. Fume hoods with automatic sash operators are available.

Sash height-limiting devices (also known as sash stops) may be provided to limit the vertical opening of the sash. Sash stops are used to provide a safe operating condition based on having limited available fume hood exhaust **air volume**. The opening at which the sash stop limits the sash opening is called the “operating sash opening” or the “design sash opening.” If the sash stop can be overridden, the sash can be opened to the “maximum sash opening” or the “full open sash position.” The ASHRAE 110 test shall be performed at both the design sash opening and the maximum sash opening.



Sash types are generally referred to as vertical, horizontal, or combination, depending on the allowable movement of the sash panels. Some sashes use a telescoping sash, in which the movements of two or more vertically moving sash elements are linked.

Vertical Sash: A vertical sash has one or more panels that can slide up or down to a height required by the operator. The sash may also be designed to split into multiple vertical rising sashes. The sash controls the opening area, and it is generally advisable to lower the sash below the breathing zone of the operator during generation of hazardous contaminants. Hoods may be equipped with sash stops to restrict the opening height of the sash.

Horizontal Sash: A horizontal sash typically has two or more panels that slide horizontally across the hood opening. The panels slide in tracks located at the top and bottom of the face opening. Horizontal sashes are used to restrict the maximum opening area of the face while allowing access to the interior of the hood enclosure.

Combination Sash: A **combination sash** has horizontal sliding sash panels positioned in a vertically sliding sash frame. The combination sash provides the convenience of both vertical sash operation and horizontal sash operation.

Horizontal and combination sash panels shall be used as a barrier from hazards within the hood. The sash panel shall be placed between the operator and the hazard whenever possible.

3.1.7. HOOD WORK SURFACE

Work surfaces are typically made of a material that provides heat and corrosion resistance and is easily cleaned and decontaminated. The work surface should have a dished or recessed area designed to provide containment of small spills and demarcate the recommended work area inside the hood.[2]

3.1.8. HOOD LIGHTS

Most fume hoods are equipped with a light. The design of the light depends on the anticipated use of the hood. The light shall be designed to provide a minimum of 80 foot-candles on any part of the bench level work surface (36 in. or 91.4 cm from the floor).

Most lights are either LEDs or fluorescent tubes housed outside the hood chamber and separated by a vapor-resistant safety glass panel in the top of the hood. Access to re-lamping these types of lights shall be from the hood exterior.

Vapor-proof lights and explosion-proof lights are optional and available as specified.

3.1.9. HOOD SERVICES

Hoods may be equipped with a variety of services, including electrical outlets, sinks, fixtures, and plumbing for gas, vacuum, and air. For safety, controls for these services shall always be accessible from outside the hood opening.

Service Fixtures: A **service fixture** shall be installed so that service supply lines can be connected or disconnected, either by design of the piping assembly or through an access panel in the hood interior or exterior. All service valves shall be accessible for maintenance. All service fixture controls (e.g., gas, air, water, vacuum) shall be external to the hood interior, clearly identified, and within easy reach. All internal service fixture outlets shall be corrosion resistant to the application.[3]

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[2] For more information, see SEFA 3 – Laboratory Work Surfaces.
[3] For more information, see SEFA 7 – Laboratory Fixtures.

Connections for services will vary depending on the point of origin and the number of fixtures. Service lines may be brought up from below, down from the ceiling, or in from the back wall.

Typical piping requirements are as follows:

- Water: Copper
- Gas: Wrought iron or steel (galvanized or black) or yellow brass (containing not more than 75 percent copper)[4]
- Air: Copper (black iron can be used as an alternate)
- Vacuum: Copper (black iron can be used as an alternate)
- Specialty Gas: Appropriate materials as specified

NOTE

There are regional differences in piping requirements. Check regional or local codes for jurisdiction and material allowance.

Electrical Receptacles: All electrical receptacles shall be readily accessible. Provisions shall be made so that all electrical wiring will be physically separated from vapors handled within the hood interior after the fume hood is installed. The receptacle shall be installed with the ground outlet above the power slots. If electrical receptacles are in the fume hood interior, they shall be installed according to NFPA and UL recommendations.

Although not recommended, receptacles may be installed in the hood chamber with certain limitations. If this is done, a readily accessible external disconnect switch shall also be installed.

Fire Suppression Systems: Flammable materials may be safely used in most hoods. Flammable materials should never be stored directly below a laboratory fume hood in anything but an NFPA-specified, UL-listed, or FM-approved solvent storage cabinet. If there is a very high risk of fire, the fume hood shall be equipped with a fire suppression system.

- Any fire suppression system used in a laboratory fume hood shall be compliant with local codes and regulations, as well as NFPA 17.
- Any fire suppression system shall be rated for fire classes A, B, or C with manual and thermal activation triggers. Other water- or liquid-based systems may be acceptable if appropriate testing and certifications are available.
- No fire dampers of any kind should be installed in a laboratory fume hood exhaust system.

In an extreme case, such as specifying a laboratory fume hood for highly volatile, flammable, hazardous procedures and use, follow NEC codes.[5] NEC divides materials into classes and groups according to the type of explosive agent that may be present.

Sufficient air volume must be exhausted through the hood to dilute flammable effluents below the lower explosive limit level.[6]

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[4] For more information, see the current edition of the Uniform Building Code, International Association of Plumbing and Mechanical Officials, www.iapmo.org.

[5] For a comprehensive classification of gases, vapors, and dusts for electrical equipment in hazardous locations, refer to NFPA 497M.

[6] For more information on minimum recommended exhaust volumes, see the current edition of NFPA 45. See also the current edition of NFPA 70: National Electrical Code.

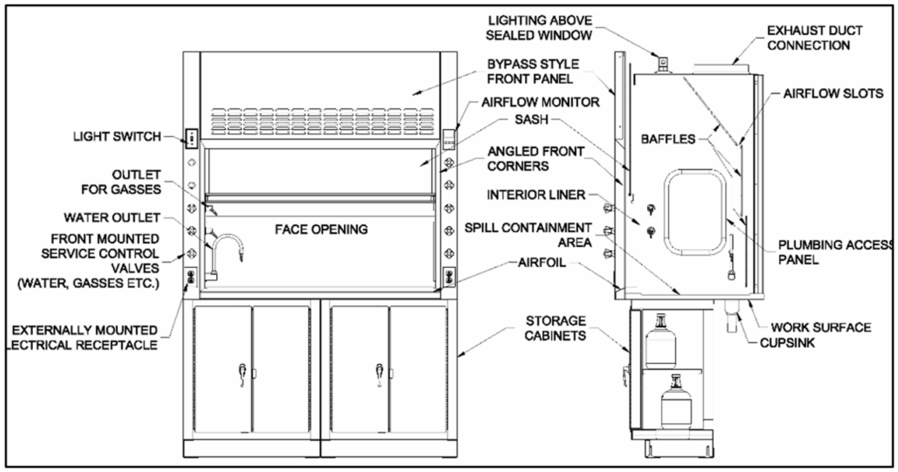
3.1.10. HOOD MONITOR

All hoods shall have a monitor for indicating face velocity or exhaust flow verification. The monitor can be a simple pressure gauge connected to a **pitot tube** in the exhaust duct, one of many electronic monitors, or a vaneometer. Regardless of the monitor installed, it should provide a clear indication to the hood user whether exhaust flow or face velocity is within design parameters. Both an audible and a visual alarm is recommended. A ribbon taped to the bottom of the sash is not acceptable.

3.2. TYPES OF LABORATORY FUME HOODS

3.2.1. BENCH-TOP FUME HOOD

A bench-top fume hood is a hood that is generally placed on a bench top or above a storage cabinet. A bench-top hood is appropriate for use with small to moderate quantities of low to highly toxic materials. Depending on the construction materials and operating configuration, this type of hood can provide effective containment and exhaust of gases, vapors, mists, fumes, and other aerosols having low particle mass.



Bench-top hoods are available in different sizes to accommodate a variety of chemical processes. The critical dimensions for a hood include the width, depth, and interior height. Hood size is generally determined, however, by the overall width of the hood, which includes the width of both the face and the side panels. Side panels range in width from two to eight inches depending on the design and hood manufacturer.

Bench-top hoods can have vertical, horizontal, or combination sash types and open or restricted bypasses, depending on the sash type.

3.2.2. RADIOISOTOPE FUME HOOD

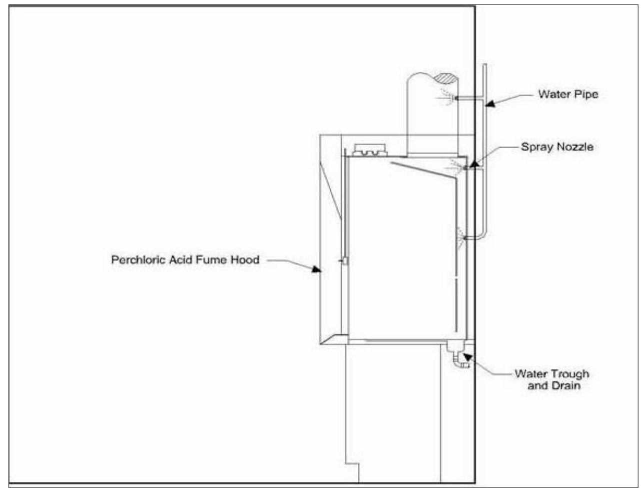
A radioisotope hood is a fume hood that is used for beta and gamma radiation. A radioisotope hood has the general characteristics of a bench-top fume hood, except the work surface and interior lining must be type 304 stainless steel with coved seamless welded seams for easy cleaning and decontamination. The hood design is identical to other hood types in nearly all other aspects.

The work surface shall be dished to contain spills and cleaning liquids and shall be properly reinforced to support lead shielding and shielded containers. The load-bearing capacity shall be 200 psf (90.7 kg/m^2) minimum up to a total weight of 1,000 pounds (453.6 kg) per fume hood or base cabinet section.

Horizontal sash panels are not appropriate for this fume hood type.

3.2.3. PERCHLORIC ACID FUME HOOD

A perchloric acid fume hood has the general characteristics of a bench-top hood. The interior lining, however, must be coved and welded seamless stainless steel. Other non-reactive materials such as CPVC and polypropylene have also been used when heat is not a concern. Non-reactive, corrosion-resistant material should extend all the way through the exhaust system.



In addition, the hood, duct, and fan must have a water washdown system to remove perchlorates and prevent the buildup of potentially explosive perchlorate salts. The drain outlet shall be designed to handle a minimum of 15 gpm (56.8 lpm). The work surface of a perchloric acid fume hood typically has a water trough at the back of the hood interior under the baffle.

The fume hood liner in a perchloric acid fume hood shall have no access holes such as those that may be used for plumbing access. Access panels should be considered in the lab layout for access through the hood exterior. In nearly all other respects, however, the design of a perchloric acid hood is the same as a conventional or bypass fume hood.

A perchloric acid fume hood shall never be tied to a manifold exhaust system.

An acid digestion laboratory fume hood is the same as a perchloric acid fume hood in construction, except the sash material is Lexan instead of safety glass. Acid digestion fume hoods are used for non-perchloric acid digestions with mineral acids.

3.2.4. DISTILLATION FUME HOOD

A distillation fume hood is designed for use with procedures that involve small to medium quantities of low to high toxicity materials. A distillation hood has the same components as a bench-top hood with the exception that the design provides a greater interior height, which enables use of larger apparatus. The distillation hood is mounted on a pedestal that elevates the work surface to a height 12–18 inches (30.5–45.7 cm) above the floor.

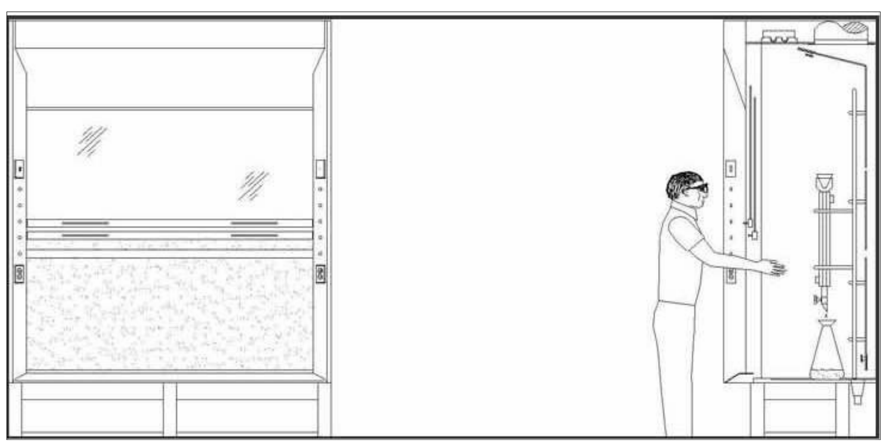


Figure 6. Typical view of distillation fume hood

Distillation hoods can have vertical or horizontal sashes. Generally, more than one sash panel is used on a vertical sash. The vertical sash design generally enables a large opening, and care must be taken in determining the maximum allowable sash opening and required exhaust flow to provide a safe operating condition and ensure effective fume containment.

3.2.5. FLOOR-MOUNTED FUME HOOD (WALK-IN FUME HOOD)

A floor-mounted hood is used for large apparatus and storage of containers that pose a hazard but will not fit into an approved storage cabinet. A floor-mounted hood is suitable for the same type of work conducted in bench-top hoods and distillation hoods.

"Walk-in hood" implies that the hood can be entered; however, the same safety precautions should be applied to this hood as for a bench-top hood. The hood must never be entered during generation of hazardous materials or while concentrations exist within the enclosure. For this reason, SEFA refers to these structures as floor-mounted fume hoods.

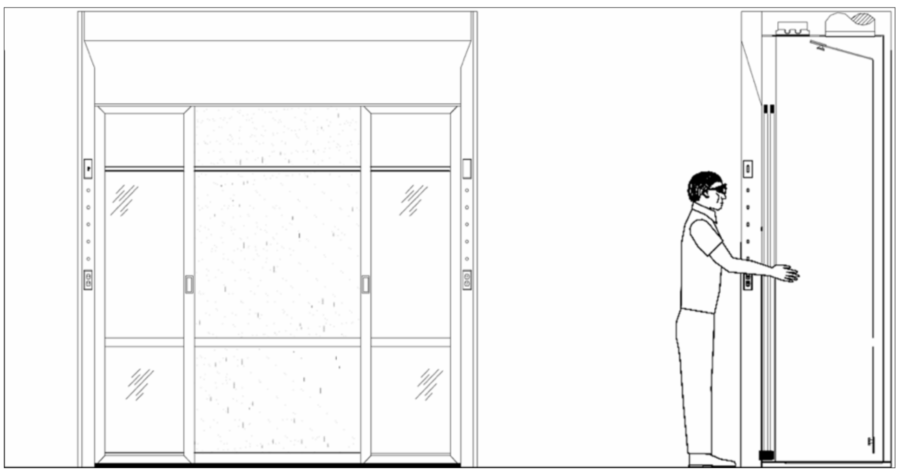


Figure 7. Typical view of floor-mounted fume hood

Floor-mounted hoods are typically equipped with horizontal sliding sashes, although some models are equipped with multiple vertical sliding sashes. Horizontal sashes are recommended on hoods over 8 ft. (2.44 m) wide. On floor-mounted hoods with multiple vertical sashes, it is recommended that only one sash be fully opened during hood operation. Both sashes are to be fully opened during set-up only.

Floor-mounted hoods are particularly susceptible to variations in face velocity across the opening and room air disturbances due to the large opening area presented by the hood design. For this reason, it is not prudent to use a floor-mounted hood for work with highly toxic materials.

3.2.6. AUXILIARY AIR FUME HOOD

Note: Use caution when considering the information presented in this section, as auxiliary air fume hoods are largely obsolete.

When added to a standard laboratory fume hood, the **auxiliary air** system functions to reduce the consumption of conditioned room air. The auxiliary air is typically introduced exterior to the fume hood face and enters the fume hood through the face with the sash open.

> **NOTE**
>
> Consideration should be given to preconditioning and filtering auxiliary air.

With the sash closed, auxiliary air should be drawn into the fume hood interior in such a manner as to aid in the dilution of heat and fumes generated in the work area.

Auxiliary air fume hoods must also:

- Provide safe capture and efficient removal of fumes from the hood when operated at air ratios specified by the manufacturer.
- Capture the percentage of auxiliary air specified by the manufacturer when operated with the sash open or closed.
- Capture, contain, and carry away fumes generated in the work area when operated at a condition of imbalance between the auxiliary air and room air as specified by the manufacturer.
- Function in accordance with the performance characteristics listed above when tested by appropriate evaluation procedures.

The manufacturer shall include auxiliary air static pressure data for all standard catalog models.

NOTE

The hood chamber should never be pressurized with auxiliary air.

Auxiliary air fume hoods were originally developed to help reduce laboratory energy consumption. They have fallen out of favor, however, as they achieved low energy usage at the expense of user safety, violating the primary purpose of a fume hood.

Prudent Practices in the Laboratory states that auxiliary air hoods "should not be purchased for new installations, and existing ones should be replaced or modified to eliminate the supply air feature."[7] *ANSI/ASSP Z9.5-2022* states that "auxiliary supplied air hoods are not recommended." To replace an existing auxiliary air fume hood:

1. Conduct a health and safety risk assessment to determine the required fume hood volumetric rate, face velocity, and containment criteria for the application. Include the assessment in the Chemical Hygiene Plan for the lab space.
2. Identify a new fume hood that meets the safe airflow criteria defined in the Chemical Hygiene Plan. High-performance fume hoods and/or reduced sash openings should be explored due to typical limitations on mechanical system supply air capacity. Most fume hood manufacturers will have air volume (CFM) and related face velocity (fpm) information readily available.
3. Determine the required changes to the building's ventilation system to supply safe airflow. This includes decommissioning the auxiliary air supply to the hood, adjusting the supply air to the laboratory and fume hood exhaust (potentially replacing the exhaust blower). In the simplest cases, the current exhaust air minus the auxiliary air is equal to (or greater than) the minimum airflow for the new system. Under these circumstances, after eliminating the auxiliary air supply, the only mechanical system change is a reduction to the fume hood exhaust air.
4. Certification of the newly installed fume hood will ensure the fume hood and system is operating properly and ready for use.

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[7] For more information, see *Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards*: Updated Version. Washington (DC): National Academies Press (US); 2011. 9, Laboratory Facilities. Available from: https://www.ncbi.nlm.nih.gov/books/NBK55867/

A more comprehensive redesign would include evaluating variable air volume controls with the mechanical system overhaul. The result is a balancing of the supply and exhaust without the use of auxiliary air.

3.3. ENERGY-EFFICIENT FUME HOODS

Energy-efficient (low exhaust volume) fume hood designs can offer significant reductions in the volume of exhaust air required to safely operate a fume hood. Energy-efficient hoods can be divided into two categories: low-flow fume hoods and low-velocity fume hoods.

- **Low-flow fume hoods** – Designed to provide a reduction in the required exhaust air volume when compared to the volume required for the same size fume hood to operate with a face velocity of 100 FPM (0.51 m/s) through a fully opened vertical sash. For example, a typical 6-ft (1.83m) wide bench-top fume hood requires approximately 1100 CFM of exhaust flow to achieve an average face velocity of 100 FPM (0.51 m/s) through a fully opened vertical sash. A 6-ft (1.83m) wide hood operating at less than the 1100 CFM volumetric exhaust flow would be classified as a low-flow fume hood. Low-flow hoods generally maintain a conventional face velocity of 80 to 100 FPM (0.4 to 0.5 m/s) but feature a limited sash opening. A standard fume hood with a defeatable sash stop at the established working height is not considered a low-flow fume hood.
- **Low-velocity fume hoods** – Designed to provide a reduction in the required exhaust air volume when compared to the volume required for the same size fume hood to operate with a face velocity of 100 FPM (0.51 m/s) through a fully opened vertical sash. Provides containment levels equivalent or superior to ASHRAE 110 tracer gas test ratings of AM 0.05 and AI/AU 0.10 with a face velocity of 60 FPM (0.30 m/s) or less through the fully opened sash. Also referred to as high-performance fume hoods or high-efficiency fume hoods.

Energy-efficient fume hoods often feature new designs and features not found on traditional fume hoods, including redesigned bypass systems, new baffle configurations, low-profile airfoil sills, and aerodynamic sash frame designs. Some manufacturers offer unique electrical and mechanical "safety controls" that are integral to the **superstructure** of the energy-efficient fume hood. These control systems can enhance the safety of the fume hood operator during use. The maintenance of these safety control systems shall be performed in accordance with the manufacturer's guidelines to ensure safe and proper operation of the fume hood.

> **NOTE**
>
> Low-flow hoods that achieve a reduction in volumetric flow by restricting the sash opening area do not qualify as low-velocity or high-performance fume hoods unless they also meet the performance requirements listed above through the maximum sash opening. The maximum sash opening should be considered as a sash opening of at least 28 in. (71.1 cm) above the fume hood work surface.

Energy-efficient fume hoods are available in bench-top, floor-mounted, distillation, and specialty hood types. Energy-efficient fume hood designs are appropriate for most of the same applications as traditional fume hood designs. Energy-efficient fume hoods can be integrated into any type of laboratory ventilation system, including constant air volume (CAV) systems, variable air volume (VAV) systems, and two-state control (2SC) systems.[8] The ROI period should be evaluated when deciding which type of system to use.

There is no direct statistical correlation between a fume hood's average face velocity and the containment levels provided by the fume hood. On a properly designed fume hood, a lower face velocity can enhance fume hood performance through aerodynamic design and reduced turbulence.

SEFA recommends the ASHRAE 110 test to evaluate the performance of all laboratory fume hoods, including energy-efficient fume hoods. There are currently no special tests outlined in the ASHRAE standard for fume hoods operating at reduced exhaust flows. Energy-efficient fume hood designs are tested to the same standards as traditional fume hood designs. The ASHRAE standard, however, allows for owners, engineers, and architects to specify challenges to any fume hood design to investigate the fume hood's ability to perform under less-than-ideal conditions.

3.4. TESTING OF LABORATORY FUME HOODS – AS MANUFACTURED

ASHRAE 110 is the recognized method of testing and evaluating the performance of laboratory fume hoods. Three test procedures are required in ASHRAE 110: the face velocity grid test, the flow visualization or smoke test, and the tracer gas containment test. ASHRAE has defined three modes: as manufactured (AM), as installed (AI), and as used (AU); the ASHRAE test shall be conducted by a qualified person who is cognizant of each of the three test modes.

3.4.1. FACE VELOCITY

Face velocity should be adequate to provide containment. The most widely accepted range of average face velocities is 60 FPM (.305 m/s) to 100 FPM (.508 m/s). The measured deviation across the face may vary ±20% of the designed face velocity at the established sash working height. Refer to the current edition of ASHRAE 110 for velocity measurement procedures. The velocity when measured at the sash opened 6 in. (15.24 cm) should be no more than three times the velocity at the sash fully opened.[9]

> **Note:** Face velocity alone is *not* a measure of safety.

3.4.2. CONTAINMENT TEST

The manufacturer shall provide standard AM test data for all standard hoods. This should be done in accordance with the current ASHRAE 110 standard. The AM test demonstrates what the hood is capable of under controlled conditions. The report should verify that all laboratory fume hood types specified have been tested to the current edition of ASHRAE 110 procedures and have achieved ≤ AM 0.05.

≤ AM 0.05 can be achieved with a properly designed laboratory fume hood. It should not, however, be implied that this exposure level is safe. Safe exposure levels are application specific and should be evaluated by properly trained personnel.

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[8] For more information on airflow control systems, see section 7.4.

[9] See current edition of *Industrial Ventilation Manual for Static Pressure Measurement Procedures* and current edition of *Industrial Ventilation: A Manual of Recommended Practice*.

3.4.3. STATIC PRESSURE LOSS – BENCH-TOP FUME HOOD

With the sash fully opened, **static pressure loss** through the fume hood should be no more than 0.25 in. (6.35 mm) of water gauge (**IWG**) (62 pascals) when the fume hood operates at a face velocity of 60 FPM (.305 m/s), 0.5 IWG (12.70 mm) (125 pascals) at 100 FPM (.508 m/s), and 0.75 IWG (12.70 mm) (125 pascals) at 120 FPM (.61 m/s).

The manufacturer shall state the design static pressure loss for all standard catalog models. For all constant air volume (CAV) laboratory fume hoods equipped with a bypass, static pressure loss and exhaust volume should be relatively constant regardless of sash position.

4. Laboratory Fume Hoods – As Installed

4.1. LOCATION IN LABORATORY

Laboratory fume hoods shall be positioned within the laboratory so as to avoid **cross drafts** at the fume hood face due to doors, heating, cooling, or ventilation diffusers. Sufficient make-up air must be available within the laboratory to permit fume hoods to operate at their specified face velocities (see section 4.3.4). Other location factors to be considered include:

- Number and type(s) of fume hoods in the laboratory space
- Location and number of ingress/egress aisles and/or laboratory space exterior doorways
- Frequency and/or volume of expected fume hood users
- Location of laboratory safety equipment

4.1.1. SAFETY CONSIDERATIONS

Laboratory fume hoods are potential locations for fires and explosions due to the types of experiments conducted in these units. As such, fume hoods shall be positioned within the laboratory so that in the event of a fire or explosion within the fume hood, evacuation from the laboratory would not be impeded and would not require personnel to cross in front of fume hoods.

Laboratory fume hoods shall be positioned away from high-traffic lanes within the laboratory. Personnel walking past the sash opening may disrupt the flow of air into the unit and cause turbulence, drawing hazardous fumes into the laboratory.

Sufficient aisle space shall be provided in front of the fume hood to avoid disruption of the work or interference with the operating technician by passing personnel. This generally means an undisturbed zone for the operator that is approximately 36 in. (.91 m) deep and an additional approximately 36 in. (.91 m) deep space for other personnel to pass by the fume hood.

Safety devices such as drench showers, eye-wash stations, fire extinguishers, first aid kits, and fire blankets shall be located convenient to the fume hood operating personnel and plainly labeled as to their use and function.

Other safety factors to be considered include:[10]

- Type of research being conducted
- Proximity to associated bench-mounted or free-standing equipment
- Type and number of associated fume hoods or other ventilated enclosures
- Number of users in the laboratory space

Laboratory fume hood exhaust systems should be balanced with room exhaust systems and may be used in conjunction with room exhaust systems to provide the necessary room ventilation. Constant operation of a fume hood will also provide fume control during non-working hours.

4.2. TESTING OF LABORATORY FUME HOODS – AS INSTALLED

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[10] Refer to SEFA 2 – Standards for Installation and SEFA 7 – Standards for Laboratory Fixtures.

ASHRAE 110 is the recognized method of testing and evaluating the performance of laboratory fume hoods. Three test procedures are required in ASHRAE 110: the face velocity grid test, the flow visualization or smoke test, and the tracer gas containment test. For hoods connected to a variable volume exhaust system, the VAV system accuracy and speed of response is also tested. ASHRAE has defined three modes: as manufactured (AM), as installed (AI), and as used (AU); the ASHRAE test shall be conducted by a qualified person who is cognizant of each of the three test modes.

The AI test of the fume hood shall be performed after the installation is complete, the building ventilation and control system have been balanced, and all connections have been made. The testing shall be performed in conditions appropriate for occupation of the lab space.

The user shall have the following tests performed on all laboratory fume hoods. These tests shall be performed by qualified personnel to verify proper operation of the fume hoods before they are put into use. Testing shall be repeated at least annually, or whenever a significant change in the hood system occurs. Any unsafe conditions indicated by these tests shall be corrected before using the hood.

4.2.1. ROOM CONDITIONS

Check room conditions in front of the fume hood using a **thermal anemometer** and a smoke source to verify that the velocity of cross drafts is no more than 30% of the operating velocity. Any cross drafts that exceed these values should be eliminated before proceeding with the fume hood test. Although it may be possible to certify the fume hood based on tracer gas containment testing, the excessive cross draft shall be disclosed in the test report.

Significant cross drafts can have a detrimental effect on the ability of a fume hood to contain air contaminants. It is therefore advised to keep cross drafts in the vicinity of the face of a fume hood to a minimum.

4.2.2. SASH OPERATIONS

Move each sash through its full range of motion. Sash operation should be smooth and easy. Vertical rising sashes should hold at any height without creeping up or down, unless designed otherwise.

The force required to open the sash should be reasonable for the size and weight of the sash. For example, a five-foot hood with a vertical rising sash should require approximately five pounds of force to operate the sash. An additional one pound of force may be required for each additional linear foot of fume hood width.

4.2.3. LOW AIRFLOW MONITOR EVALUATION

On fume hoods with an **airflow monitor**, the user shall verify that the monitor functions properly and indicates low airflow conditions when they are detected.

4.2.4. FACE VELOCITY

Determine specified average face velocity for the fume hood being tested. Perform the test as per ASHRAE 110 to determine whether fume hood velocities conform to specifications. Face velocity should be adequate to provide containment. The most widely accepted range of average face velocities is 60 FPM (.305

> **Note:** Face velocity alone is *not* a measure of safety.

m/s) to 100 FPM (.508 m/s). The measured deviation across the face may vary ±20% at the established sash working height.

4.2.5. CONTAINMENT TESTING – AS INSTALLED

SEFA recommends using the containment test in the current edition of ASHRAE 110.

4.3. TROUBLESHOOTING

When fume hood test procedures detect improper function, the cause is frequently due to an insufficient quantity of air flowing through the hood, room cross drafts blowing into or across the face of the fume hood, or a combination of both. The following suggestions are offered to help identify and correct the problems.

4.3.1. INSUFFICIENT AIRFLOW

Insufficient airflow through the fume hood can be caused by one or more of the following conditions. Each condition shall be checked to determine which one or combination of conditions may exist.

- Double-check readings to ensure there are no errors.
- Check the airflow velocity meter type. Ensure it is calibrated, the battery is functional, and the instrument was set to zero before taking a reading.
- Ensure the instrument is recommended for low airflow velocities in the 50 FPM–150 FPM (.254 m/s–.762 m/s) range.

If possible, verify readings with another air velocity meter or by checking the air volume using a pitot tube traverse of the exhaust duct.

Low airflow through the fume hood can be caused by a large negative room static pressure due to inadequate make-up air being brought into the room. With the fume hood and other exhaust unit (see section 4.3.3) in operation, check room static pressure by:

- Using a manometer.
- Checking airflow into the room through an open door or window.
- Checking ventilation system balance and verifying the quantity of make-up air.
- Verifying that fume hood baffles are in an open position.
- Ensuring that baffle openings are not blocked with large or bulky apparatus.
- Ensuring proper sizing and/or operation of the exhaust unit, including:
    - Correct direction of exhaust unit rotation
    - Make and model is as specified
    - Supply voltage is correct
    - Motor horsepower and speed is appropriate
    - Exhaust unit inlet and outlet conditions are suitable
- Checking for special or bulky equipment that interferes with airflow through the fume hood.

4.3.2. ROOM CROSS DRAFTS

Cross drafts in front of the fume hood face can cause the fume hood to lose containment, which can present a safety hazard to laboratory space occupants. Cross drafts in front of the fume hood should be kept to a minimum, especially when the fume hood is being used by an operator. The velocity of the cross drafts should not exceed 30% of the face velocity.

Each of the following issues shall be investigated when cross drafts are suspected of causing poor fume hood performance:

- Air moving through an open door located adjacent to the fume hood.
- An open window or room air supply grille located to one side or across from the fume hood.
- High velocity air from ceiling-mounted diffusers or room air supply.

Cross drafts can occur when thermal gradients in the lab space are caused by the introduction of supply air at a significantly different temperature (ΔT) than the ambient temperature in the lab space. The proper operation of the building reheat controls, the position of the lab space thermostats, and the supply **register** location can all affect the creation of these thermal gradients. Room conditions such as these should be avoided by changing the location of the fume hood or changing the design or location of the supply air diffusers.

4.3.3. EXHAUST UNIT AND DUCT CONSIDERATIONS

Where laboratory building design permits, the **exhaust unit** shall be located on the roof of the building to provide a negative pressure in the portion of the duct system located within the building. The exhaust unit shall have sufficient **stack** velocity and orientation to reduce the possibility of re-entrainment of contaminated exhaust air into the lab building or an adjacent building’s supply air intakes.

The exhaust unit shall be sized to exhaust the volume of air necessary to attain the selected fume hood face velocity at the total system static pressure loss. Exhaust units shall be sized to achieve the lowest practical angular speed of the impeller, thereby avoiding high impeller tip speed and minimizing the associated noise.

Ductwork shall be designed and constructed in accordance with approved standards (ASHRAE, NFPA, SMACNA) and regulations. For minimal **friction loss** within the duct, smooth interior surfaces are recommended.

Elbows, bends, and offsets within a duct system shall be kept to a minimum and shall be long sweep in design configuration in order to minimize static pressure losses. When practical, a straight run of duct from the fume hood duct collar for as long a length as possible is preferred.

Fume hood and other exhaust devices shall not interconnect with recirculating systems.

4.3.4. MAKE-UP AIR

Make-up air is the supply of conditioned **outdoor air** to a building to replace air removed by exhaust ventilation systems. A sufficient volume of make-up air must be available to enable fume hoods to develop required face velocities.

In general, the number of volume changes per hour required by laboratories is based on specific risk mitigation (typically four to twelve total volume changes per hour).[11] Special applications may require more air changes per hour. During unoccupied periods, lower air change rates may be acceptable.

Consideration must be given to the make-up air required for air changes in each specific laboratory. This data must be coordinated with fume hoods and ventilation equipment. In order to provide a balanced and functioning system, all factors such as fume hood exhaust volume, air change data, and make-up air systems must be considered.

Due to the possibility of toxic and/or hazardous material being handled within laboratories, air exhausted from laboratories shall not be recirculated.

Laboratories using chemicals should operate at a slight negative pressure as compared to the rest of the building.

4.4. LABORATORY FUME HOOD INSPECTION

Inspection procedures shall consist of a physical examination of liner condition and cleanliness, baffle and sash operation and condition, sash counter-balance systems, light operation and condition, and service fixture function. Velocity and pressure-sensing measurement devices shall be tested at each inspection. Low-flow or no-flow alarms of the visible or audible type shall be tested for functionality at least at each inspection. Fan belts shall be inspected regularly.

Inspection procedures shall also include instrument verification of fume hood face velocity, which should be equal to the velocity recorded at the time of the ASHRAE 110 performance test and fume hood commissioning.

Inspection results shall be recorded and reported to the proper authority for any required action. Where extremely hazardous or corrosive conditions exist or when a **filter** is present in the system, the inspection frequency shall be increased appropriately.

4.5. LABORATORY FUME HOOD MAINTENANCE

Fume hood maintenance procedures consist primarily of clean-up, adjustments, lubrication, and the replacement of worn, damaged, or nonfunctioning parts.

Good housekeeping shall be used in laboratory fume hoods at all times. Periodically clean sash(es), exterior and interior surfaces (removing the baffle), and the light panel. Replace lamps periodically to maintain adequate illumination. Clean-up shall be accomplished by or performed under the supervision of a knowledgeable laboratory safety officer. If the exterior surfaces of a hood exhibit corrosion or deterioration, the source shall be investigated.

Lubrication of sash guides, cables, pulley wheels, sprockets, chains, and other working parts shall be performed as required or in accordance with the manufacturer's recommendations.

[11] Refer to OSHA 1910.1450, NFPA 45, and ANSI/ASSP Z9.5.

5. Laboratory Fume Hoods – As Used

The employer is responsible for ensuring that the hood meets satisfactory safety standards. The hood operator is responsible for ensuring that the hood is used in a safe manner and according to the organization's safety guidelines, and for helping their organization maintain proper operation of the hood systems.

This section provides an overview of the following guidelines that can help employers and hood operators reduce the potential for exposure when working with hazardous materials:

- Plan for conducting experiments
- Wear appropriate personal protective equipment
- Verify proper system operation
- Use proper work practices

5.1. PLAN FOR CONDUCTING EXPERIMENTS

Prior to conducting potentially hazardous procedures in a laboratory fume hood, evaluate the hazards and consult a safety officer to evaluate whether the hoods and systems can provide adequate protection and to develop appropriate safety protocols. In addition, follow the guidelines provided in the chemical hygiene program. If the guidelines are inadequate or irrelevant, help develop or amend procedures with the chemical hygiene officer.

Prior to beginning an experiment in a hood, answer each of the following questions:

- What are the characteristics of the hazards associated with the procedure?
- Is this the right type of hood for this procedure?
- Will the hood accommodate the equipment and experimental apparatus?
- Is the hood capable of capturing and exhausting the contaminants?
- What are the hood capabilities and limitations? What special precautions are required?
- Is the ventilation system functioning properly?

For example, for a procedure involving the use of heated perchloric acid, a perchloric acid hood must be used and the exhaust system must be equipped with a water washdown system. Failure to do so could result in a future explosion or fire. Another example is to be cautious with a heat-generating process. Air currents inside the hood caused by heat could result in disruptive airflow and the release of fumes into the lab. Ensure the fume hood liner is appropriate for the heat loads.

5.2. WEAR APPROPRIATE PERSONAL PROTECTIVE EQUIPMENT

Prior to conducting experiments, put on appropriate **personal protective equipment** (PPE) as required by the chemical hygiene program and safety protocols. At a minimum, the appropriate apparel for working at a laboratory fume hood includes approved eye protection, a lab coat, gloves, long pants, and shoes (safety shoes are preferred; open-toed shoes are not recommended).

Ensure that clothing and glove materials are appropriate for work with the hazards associated with the procedure. For example, vinyl gloves provide excellent resistance to formaldehyde, but poor resistance to chloroform. If unsure of the appropriate type of PPE required, consult with the chemical hygiene officer.

5.3. VERIFY PROPER SYSTEM OPERATION

ASHRAE 110 is the recognized method of testing and evaluating the performance of laboratory fume hoods. Three test procedures are required in ASHRAE 110: the face velocity grid test, the flow visualization or smoke test, and the tracer gas containment test. ASHRAE has defined three modes: as manufactured (AM), as installed (AI), and as used (AU); the ASHRAE test shall be conducted by a qualified person who is trained to perform the required testing.

Safety considerations require that a schedule of inspection and documentation be set up for every laboratory fume hood at least annually. An inspection record shall be maintained that includes, at a minimum sash operation, airflow monitor performance verification, and airflow performance testing. The inspection record may be in the form of a label attached to the fume hood and/or a log maintained by the safety officer or their delegate.

Before generating hazardous materials within the hood, ensure that the hood system is in good working order. Check the hood integrity and verify adequate exhaust flow or face velocity. At a minimum, check the hood inspection record to ensure that the hood has been recently tested and operation was satisfactory at the time of the test. All hoods shall be equipped with a monitor to verify proper exhaust flow and/or average face velocity. Verifying proper system operation without a hood monitor is difficult. If the hood does not have a monitor, request one.

As hoods are part of a mechanical system, it is possible that operational problems could develop between routine performance tests and preventative maintenance activities. If any alarms are triggered or problems are suspected with hood operation, stop using the fume hood, close the sash, and immediately contact the chemical hygiene officer or follow the facility’s procedure for reporting problems.

5.4. USE PROPER WORK PRACTICES

The ability of the hood to provide adequate protection depends on the user. Limitations inherent in many hoods and systems make proper work practices necessary to optimize containment. By using the following list of proper work practices for working in a fume hood, the potential for exposure can be reduced:

- Work at least 6 in. (15 cm) beyond the plane of the sash. The farther the work and apparatus is into the hood, the better.
- Ensure the user’s head and upper body remains outside the plane of the hood opening at all times.
- Elevate large apparatus and equipment above the work surface of the hood to enable airflow beneath and around obstructions.
- Keep rapid movements in the hood and in front of the hood to a minimum. Avoid rapid approach to or withdrawal from the hood. Open and close the sash slowly.
- Keep motion in the lab to a minimum while working in the hood. Traffic past the hood can generate considerable cross drafts. Avoid unnecessary foot traffic across the front of the fume hood.
- Close the sash when not working in the hood.
- Close horizontal panels on combination sashes before opening the sash vertically.
- Do not adjust baffles for as-used conditions without a means of assessing quantifiable improvement to containment with the ASHRAE 110 method.
- Thoroughly clean all spills immediately, using neutralizing compounds as required.

5.4.1. PROPER LOCATION OF EQUIPMENT, MATERIAL, AND APPARATUS

The location of equipment and apparatus affects airflow patterns within the hood. Vortices form downstream of a person standing at the opening. Obstructions placed directly in front of the operator or improperly located within the hood can exacerbate problems with reverse flow and turbulence.

The following guidelines are provided for properly locating equipment, material, and apparatus within the hood:

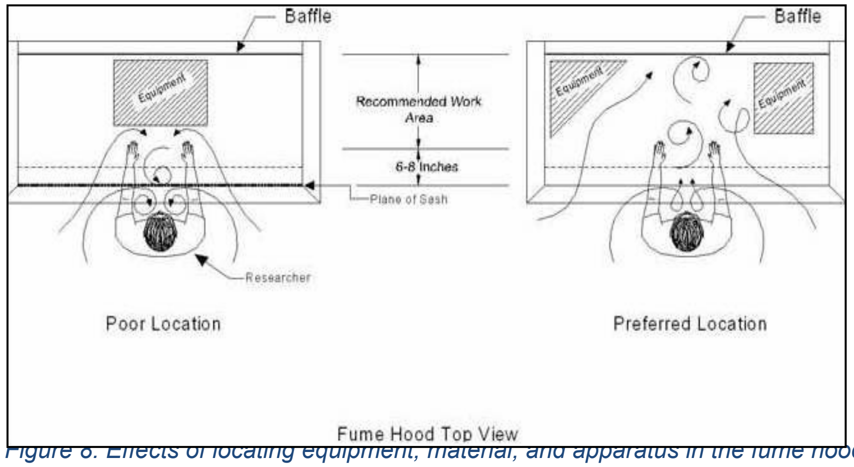


Figure 8. Effects of locating equipment, material, and apparatus in the fume hood

- If temporary material placement is necessary, locate along the sidewalls or well away from the point of contaminant generation.
- Locate equipment as deep into the hood as practical and at least 6 in.–8 in. (15 cm–20 cm) beyond the plane of the sash. For hoods that have a recessed work area, equipment and apparatus should not be placed on the raised ledge in front of the work area. Equipment should never extend beyond the plane of the sash, restrict the sash from closing, or block the bottom slot of the baffle directly in front of the user.
- Elevate equipment 2 in.–3 in. (5 cm–8 cm) above the work surface to provide flow beneath and around the equipment. Ensure that elevated equipment is stable. Plexiglas or stainless steel slotted shelves, which minimize disruption to airflow patterns, can be used to elevate equipment and apparatus above the bottom slot in the baffle. Fume hood performance should be re-evaluated after significant changes, such as the addition of shelves.
- Avoid excessive equipment and apparatus in the hood. Generally, no more than 50% of the work surface should be covered by equipment, apparatus, or other bulky obstructions.
- Use caution when placing equipment requiring electrical power in the hood. The equipment must be properly grounded to reduce the potential for electric shock. Power cords shall be plugged into a properly grounded and approved outlet. GFCI protection should be provided if the fume hood includes a water supply. When using flammable gasses and vapors, ensure electrical equipment is rated for the application.
- If a distillation rack (also known as a lattice rack or monkey bars) is installed in the fume hood, the rack shall be accessible from the operating sash opening. Experiment setups shall be configured such that it is not necessary to insert the user's head into the hood during active use.
- High heat loads create thermal drafts that increase face velocity through the bottom of the fume hood opening and thus lower face velocities at the top of the fume hood opening. Excessive heat loads can cause the fume hood to lose containment. If high heat loads are expected during the normal operation of the fume hood, as-used ASHRAE testing shall be conducted under the same conditions to test fume hood performance. Experience has shown that a typical general purpose fume hood will operate satisfactorily with up to 7500 BTU of heat, but this should be verified by testing.

The hood user should always be aware of locations within the hood where concentrations of contaminants can accumulate. The user should never allow their head to break the plane of the sash, which could cause contaminated air to pass through the breathing zone.

When materials are being generated in the hood, the user should slowly approach and withdraw from the hood. The wake zone created by movement near the hood opening can withdraw materials from within the hood. Rapid arm and body movements near the hood opening should be avoided.

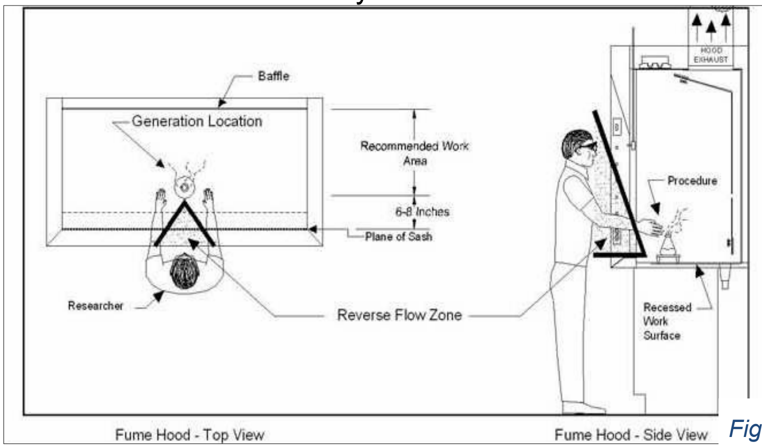


Figure 9. Diagram of proper locations for generating hazardous material within the hood

5.4.2. CONFIGURING VERTICAL AND HORIZONTAL SLIDING SASHES

A vertically sliding sash should always be lowered as much as possible to protect the user and to minimize visual obstruction from the sash handle. Lowering the sash to below the user's breathing zone provides a protective barrier between the user and the experiment. The sash should be raised to the fully open position for setup purposes only.

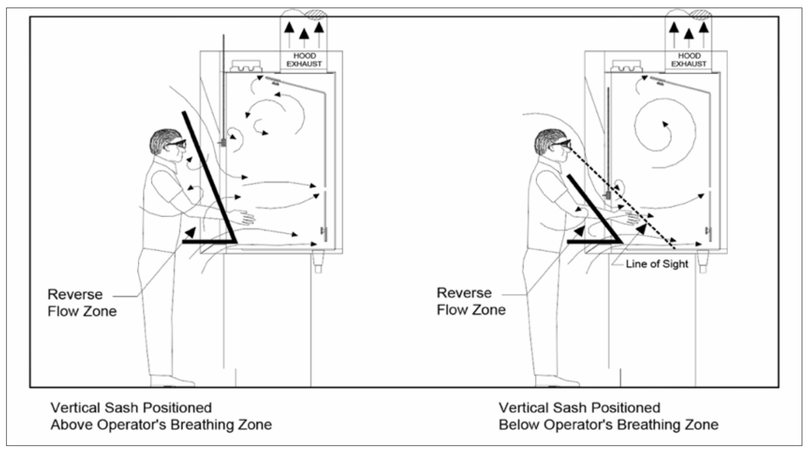
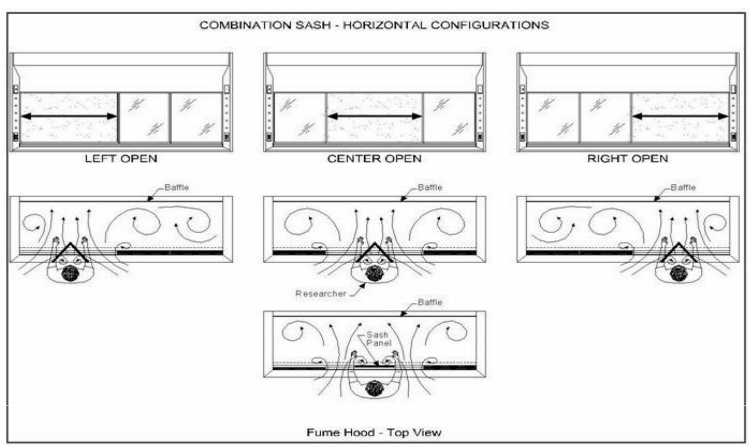


Figure 10. Effects of lowering the sash below operator's breathing zone

As air enters the opening of a hood with horizontal sash panels, turbulent vortices develop along the vertical edges of the sash panels. The vortex, readily visualized using smoke, can extend deep into the hood and draw contaminants toward the edges of the sash panels. High concentrations of contaminants can develop near the edge of the sash panels, regardless of the generation location within the hood. Although escape is not usually observed, rapid movements near the sash edge or turbulence resulting from cross drafts could cause escape. Avoid rapid movements near the vertical edges of the sash panels or rapid withdrawal from the hood.



5.4.3. LIMITING PEDESTRIAN TRAFFIC

A person walking past the hood can generate significant cross drafts. Users generating hazardous materials in the hood shall attempt to divert or limit traffic walking past the hood by informing other laboratory personnel about the work being conducted in the hood.

5.4.4. CLEANING AND DECONTAMINATING THE HOOD

After procedures involving highly toxic, potent, or radioactive materials, the hood interior shall be cleaned and decontaminated. Contaminated hoods shall be clearly labeled.

Maintenance personnel should also be informed of the potential for duct contamination. Hood systems that have been used for work with perchloric acid without appropriate decontamination methods being followed afterward have injured maintenance personnel.

5.4.5. STORING MATERIALS IN THE HOOD

Materials should not be stored in a laboratory fume hood. Hoods should not substitute for an approved chemical storage cabinet. Excessive storage of materials in the hood disrupts performance and reduces the available work surface. Should an adverse event occur in the hood, the severity may be increased by the volume of materials in the fume hood.

5.5. RESPONSIBILITIES FOR ENSURING PROPER HOOD PERFORMANCE

The ANSI/ASSP Z9.5 *American National Standard for Laboratory Ventilation* requires laboratory management to establish a Laboratory Ventilation Management Plan (LVMP) to ensure the proper selection, operation, use, and maintenance of laboratory ventilation equipment used to control airborne hazards generated during laboratory-scale procedures.

Although an organization's ownership is ultimately responsible for the health and safety of laboratory personnel and code compliance, a team approach is required to ensure proper performance of laboratory fume hood systems. The following list provides a summary of the roles for each group involved with ensuring proper operation of laboratory fume hood systems.

5.5.1. MANAGEMENT

The primary role of management is to ensure the health and safety of laboratory personnel. In that role, management is responsible for:

- Demonstrating a commitment to health and safety
- Directing and coordinating activities
- Allocating sufficient resources

5.5.2. PRINCIPAL RESEARCH INVESTIGATORS

The primary role of principal research investigators is to provide information about hazards and scientific procedures. In that role, principal research investigators are responsible for:

- Identifying personnel risks and characterizing scientific procedures
- Evaluating hazard potential
- Working with Environmental Health and Safety (chemical hygiene officer) to develop safety protocols and training programs and to select appropriate hoods
- Submitting all requests for new hoods to health and safety personnel
- Informing health and safety personnel of significant changes in research activities
- Supporting health and safety personnel's standard operating procedures (SOP)

5.5.3. HEALTH AND SAFETY PERSONNEL

The primary role of health and safety personnel is to develop SOP. In that role, health and safety personnel are responsible for:

- Developing and managing the Chemical Hygiene Plan
- Administering the Laboratory Fume Hood Safety Program
- Determining exposure control requirements
- Providing hood operators with safety data sheets (SDS) on materials being used in the fume hood
- Ensuring proper selection, performance, and use of hoods
    - Defining as used (AU) ASHRAE 110 pass/fail criteria at specific sash height and face velocity
    - Defining minimum volumetric rate in the sash closed condition
- Reviewing all requests for new hoods
- Determining protocol for proper hood operation
- Ensuring users are informed of hood capabilities and limitations
- Developing and periodically reviewing safety standards
- Conducting and/or reviewing periodic hood performance tests

5.5.4. LABORATORY DESIGN TEAM AND ENGINEERING

The primary role of the laboratory design team and engineering is to identify needs and design and/or specify appropriate building systems, fume hoods, and laboratory components. In that role, these teams are responsible for:

- Identifying hood user needs
- Designing an appropriate building system (including architectural, mechanical, electrical, plumbing, and structural elements) that meets the criteria identified in the Chemical Hygiene Plan
- Designing and specifying an appropriate fume hood system that meets the criteria identified in the Chemical Hygiene Plan
- Assisting with prequalification of the construction team and reviewing all proposed changes
- Preparing “as built” documents
- Defining as installed (AI) ASHRAE 110 pass/fail criteria
- Defining as manufactured (AM) ASHRAE 110 pass/fail criteria
- Ensuring the design intent is achieved and commissioned

5.5.5. CONSTRUCTION TEAM

The primary role of the construction team (including the laboratory fume hood installer) is to construct and/or install the laboratory fume hood in accordance with contract documents. In that role, this team is responsible for:

- Constructing and installing the fume hood in accordance with contract documents and local, regional, and national codes
- Providing a coordinated effort to meet design and performance requirements
- Coordinating field changes with other appropriate team members

5.5.6. CONTROLS MANUFACTURER

The primary role of the controls manufacturer is to provide product(s) in accordance with contract documents. In that role, the controls manufacturer is responsible for:

- Supporting the design and specification of an appropriate fume hood control system
- Providing product in accordance with specifications and contracts
- Providing startup of a fume hood control system
- Providing training in proper operations and maintenance of product(s)

5.5.7. BUILDING SYSTEM COMMISSIONING

The primary role of the building system commissioning is to verify the function of lab controls and the ability of the system to meet all required set points. In that role, the building system commissioning is responsible for verifying:

- The fume hood flow rate
- The function of controls
- The ability to meet design set points for temperature, airflow, and room pressurization
- That the hoods meet the AI criteria detailed in the construction and commissioning documents

5.5.8. OPERATIONS AND MAINTENANCE

The primary role of operations and maintenance is to develop and implement an operations and maintenance program. In that role, it is responsible for ensuring:

- Regular maintenance of all system components
- Proper operation within specified tolerances
- No unauthorized changes are made to hood systems
- Maintenance personnel are familiar with hazards and safe work procedures
- Maintenance personnel are fully trained

5.5.9. LABORATORY PERSONNEL AND LABORATORY FUME HOOD USERS

The primary role of laboratory personnel and laboratory fume hood users is to comply with SOP. In that role, laboratory personnel and hood users are responsible for:

- Understanding the hazards
- Understanding the capabilities and limitations of hoods
- Verifying proper operation of fume hoods prior to use
- Using proper work practices in compliance with SOP
- Reporting suspected operational problems

5.5.10. LABORATORY FUME HOOD MANUFACTURER

The primary role of the laboratory fume hood manufacturer is to provide products in accordance with contract documents that perform in accordance with safety standards. In that role, hood manufacturers are responsible for:

- Building a hood to specifications
- Ensuring the hood performs as expected “as manufactured”
- Outlining technical information associated with hood design
- Manufacturing the hood in conformance with SEFA 1
- Providing product training and verification as requested
- Clearly posting basic safety precautions on the fume hood
- Providing troubleshooting assistance when the hood fails to meet expectations “as installed”

6. Other Exposure Control Devices

All ventilated devices used in a laboratory are safety devices and shall be carefully examined for application and safe working practice. Products described in this section, however, are not fume hoods according to the definition provided in section 2.1. *Testing of these products is not covered in the current edition of the ASHRAE 110 standard.*

As such, great care must be taken to ensure that the product being evaluated is functioning safely for the intended purpose. It is not possible for SEFA to anticipate all applications. This section is intended to be used as a guideline only, not a definitive source. An organization's chemical hygiene officer should evaluate specific applications.

6.1. SPECIAL PURPOSE HOODS

Special purpose hoods are modified fume hoods designed for a specific purpose. As such, they do not meet the precise definition of a fume hood. Common modifications to fume hoods include: baffle designs, sash configurations and locations, size, and materials. Special purpose hoods shall be designed, tested, and operated with their intended purpose in mind.

6.1.1. DEMONSTRATION HOOD (TEACHING HOOD)

Examples

- Multi-sided hood
- Pass-through hood
- Dual-entry hood
- Trifacial hood

Description

A demonstration hood is a **bench hood** that provides visibility of the hood interior from multiple sides. A demonstration hood often also provides access from two or more sides. Demonstration hoods may have a baffle system.

Application

A demonstration hood is typically used by educators who interact with students via demonstration of experiments. Demonstration hoods typically deviate from traditional baffle systems and sash arrangements and often do not utilize front airfoils. Therefore, they do not necessarily function as a fume hood.

Testing Recommendations

Some hoods may be tested using the current edition of the ASHRAE 110 standard. Others will require test modifications due to size, sash location, or multiple sash positions. Consideration must be made for the toxicity of the experiment and acceptable exposure levels. The manufacturer shall make recommendations for the specific testing of the product including a velocity profile, smoke visualization, and a filter integrity test (if a filter is part of the system).

Additional Comments

Contact the chemical hygiene officer for safe exposure levels and testing recommendations before working in a demonstration hood.

6.1.2. CALIFORNIA HOOD

Description

A California hood provides access to at least two sides and generally provides visibility from all four sides, similar to a demonstration hood. A California hood differs from a demonstration hood in that it is taller than a bench hood (floor-mounted height), is always set atop a pedestal, and comes equipped with a distillation rack.

Application

A California hood is used when large distillation apparatus is required and fumes from the distillation should not be present in the open laboratory.

Testing Recommendations

Because the California hood has a much larger opening than a bench laboratory fume hood and has multiple sash configurations, ASHRAE testing must be modified. Containment levels for California hoods are normally unfavorable to fume hood specifications since the hood rarely has a baffle system and has unique sash configurations. The manufacturer shall make recommendations for the specific testing of this product including a velocity profile, smoke visualization, and a filter integrity test (if a filter is part of the system).

Additional Comments

Before working in a California hood, contact the chemical hygiene officer for safe exposure levels, special considerations during setup and teardown, and testing recommendations.

6.1.3. VENTILATED ENCLOSURES

A ventilated enclosure is a general term used to describe any special-purpose hood that is not specifically described as a California hood or demonstration hood.

Oversized Hood

Description

Laboratory fume hoods are sometimes built in large, non-standard sizes to accommodate a specific application. These larger structures are referred to as oversized hoods, not laboratory fume hoods.

Application

Oversized hoods are often designed to accommodate a specific piece of equipment that must be housed in the hood during the experiment. The scale of the work performed in the hood may determine the desired size of the hood.

Testing Recommendations

Contact the chemical hygiene officer before working in an oversized hood. Extensive knowledge of the testing apparatus, experimentation, and work being performed in the hood is required for determining the safe testing methods of an oversized hood.

The manufacturer shall make recommendations for the specific testing of this product, including a velocity profile, smoke visualization, and a filter integrity test (if a filter is part of the system). *Testing an oversized hood will require extensive interpretations of the test procedures in the current edition of the ASHRAE 110 standard.* Oversized hoods may require more and different diffuser locations, and sash arrangements must be considered before testing.

Additional Comments

Contact the chemical hygiene officer for safe exposure levels, proper use of sash positions, special considerations during setup and teardown, operating procedures, and testing recommendations before working in an oversized hood.

Tabletop Hood

Examples

- Portable hood
- Downdraft hood (a tabletop hood vented down through the tabletop into an exhaust fan system)

Description

A tabletop hood is a small, ventilated enclosure (usually less than 15 $ft.^3$ [$.42m^3$] of working space) often made of alternate materials (e.g., epoxy, polycarbonate, acrylic, sheet metal) for mounting on a tabletop.

Application

Tabletop hoods are used primarily in educational laboratories to control nuisance contaminants or small, microscale experiments.

Testing Recommendations

If the tabletop hood is large enough to contain the apparatus and a sash is apparent, it may be tested according to the current edition of the ASHRAE 110 standard. If not, containment may be evaluated by modifying the test methods or by smoke visualization. The manufacturer shall make recommendations for the specific testing of this product, including a velocity profile, smoke visualization, and a filter integrity test (if a filter is part of the system).

Additional Comments

Do not use a tabletop hood for anything except nuisance vapor protection, unless otherwise certified by the chemical hygiene officer.

Conventional Hood

Examples

- Flat-front hood
- Thin-wall hood

Description

A conventional hood is a ventilated bench-mounted enclosure with a square entry profile. Conventional hoods usually lack a bypass and an airfoil.

Application

Conventional hoods are used primarily in educational laboratories to control nuisance contaminants or small, microscale experiments.

Testing Recommendations

If the conventional hood is large enough to contain the apparatus and a sash is apparent, it may be tested according to the current edition of the ASHRAE 110 standard. If not, containment may be evaluated by modifying the test methods or by smoke visualization. The manufacturer shall make recommendations for the specific testing of this product, including a velocity profile, smoke visualization, and a filter integrity test (if a filter is part of the system).

Additional Comments

This product should be used with caution. Contact the chemical hygiene officer for the proper application, setup, and use of a conventional hood.

Balance Enclosure

Description

A balance enclosure is a ventilated enclosure designed specifically to house a laboratory balance. Balance enclosures require good visibility and are typically made of transparent materials such as acrylic, polycarbonate, or glass. Balance enclosures should include baffles, tapers, slots, or airfoils to reduce turbulent airflow.

Application

Exposure to fumes and particulates from a balance is usually low; the proximity of the user's breathing zone to the use of a balance, however, could result in unacceptable exposure levels. The balance shall be housed in a ventilated enclosure. Balance enclosures are designed to protect users and the laboratory environment by directing the airflow away from the breathing zone of the user and exhausting the contaminated air out of the room.

Testing Recommendations

The manufacturer shall provide testing data and make recommendations for the specific testing of this product including a velocity profile, smoke visualization, and a filter integrity test (if a filter is part of the system).

Microscope Enclosure

Description

A microscope enclosure is a ventilated enclosure designed to house a laboratory microscope and to provide adequate protection to the user of the microscope. These enclosures require good visibility and are typically made of transparent materials such as acrylic, polycarbonate, or glass. Microscope enclosures should include baffles, tapers, slots, or airfoils to reduce turbulent airflow. Access to the microscope enclosure is usually from the front and/or sides and should provide sufficient room for the user to perform necessary operations. Individual designs vary with the size and style of the microscope and application.

Application

Fume exposure from a microscope is usually low; the proximity of the user's breathing zone to the use of a microscope, however, could result in unacceptable exposure levels. The microscope shall be housed in a ventilated enclosure. Microscope enclosures are designed to protect users and the laboratory environment by directing the airflow away from the breathing zone of the user and exhausting the contaminated air out of the room.

Testing Recommendations

The manufacturer shall provide testing data and make recommendations for the specific testing of this product including a velocity profile, smoke visualization, and a filter integrity test (if a filter is part of the system).

Additional Comments

Provisions may be necessary to enable electrical connection of the microscope. Proper care must be exercised to avoid a spark within the chamber, which may contain flammable effluents.

Robotic Enclosure

Description

A robotic enclosure is a ventilated enclosure specifically designed to house a laboratory robot or automated equipment and to provide adequate protection to laboratory personnel near the robot. Robotic enclosures are typically made of transparent materials such as acrylic, polycarbonate, or glass. Robotic enclosures may have a baffle system. Individual designs vary with the size and style of the robotic equipment and application.

Application

Fume exposure from a robot is usually low; the proximity of the user's breathing zone to the use of a robot, however, could result in unacceptable exposure levels. The robot shall be housed in a ventilated enclosure. Robotic enclosures are designed to protect users and the laboratory environment by directing the airflow away from the breathing zone of the user and exhausting the contaminated air out of the room.

Testing Recommendations

The manufacturer shall provide testing data and make recommendations for the specific testing of this product including a velocity profile, smoke visualization, and a filter integrity test (if a filter is part of the system).

Additional Comments

Proper care must be exercised to avoid a spark within the chamber, which may contain flammable effluents.

Histopathological Enclosure

Examples

- Autopsy
- Necropsy enclosures
- Tissue-trimming enclosures

- Tissue staining
- Fixing
- Embedding enclosures

Description

A histopathological enclosure is a hood specifically designed to enclose histopathological operations such as autopsies, necropsies, tissue trimming, tissue staining, fixing, and slide and sample preparation. A histopathological enclosure shall provide adequate protection to laboratory personnel. Histopathological enclosures are typically made of transparent materials such as acrylic, polycarbonate, or glass. Histopathological enclosures usually have a baffle system. Individual designs vary with the equipment and application.

Application

Histopathological enclosures are used to protect the users and their environment from potentially hazardous and noxious aerosols that may be present or form during the histopathological operation. The histopathological enclosure should exhaust the contaminated air away from laboratory personnel and out of the room.

Testing Recommendations

The manufacturer shall provide testing data and make recommendations for the specific testing of this product including a velocity profile, smoke visualization, and a filter integrity test (if a filter is part of the system).

Additional Comments

Proper care must be exercised to avoid a spark within the chamber, which may contain flammable effluents.

Ventilated Wet Bench

Description

Ventilated wet benches, which are manufactured from polypropylene or stainless steel, are typically enclosed and hard-ducted to the building's exhaust system. Some wet benches are equipped with a vertical sash, depending on the application, and may also be equipped with a sink. Wet benches operate with a cross-flow exhaust system to draw hazards away from the user.

Application

A ventilated wet bench can be used for semiconductor industrial processes and medical processes.

Testing Recommendations

The manufacturer shall provide testing data and make recommendations for the specific testing of this product including a velocity profile, smoke visualization, and a filter integrity test (if a filter is part of the system).

Additional Comments

Containment capabilities may be subject to design and should not be used for work with high-hazard chemicals or compounds with which performance has not been tested and confirmed.

Wet Process Workstation

Description

Wet process workstations provide protection for personnel from large-scale acid and solvent usage. Unlike conventional chemical fume hoods, wet process workstations have full-unit-width under-work surface exhaust plenum / spill-containment tubs, allowing for large volumes of heated process chemical baths to be recessed down under the work surface, with fumes captured locally and brought down and away under the station work surface and out the rear exhaust.

Wet process workstations are typically placed in cleanrooms or clean labs due to critical processes performed within, and provide process protection due to unique station physical design which allows the work surface to be "washed" by HEPA-filtered air above. Wet process workstations may have vertically or horizontally closing sashes, or hinged eye shields with fixed access openings. Wet process workstations often incorporate some degree of automation.

Application

Wet process workstations are used for critical parts processing with acids, bases, and solvents, often at elevated temperatures for semiconductor processes, electronics manufacturing, biomedical, nanotech, medical devices, military, aerospace, and other critical processes.

Testing Recommendations

The manufacturer shall provide testing data and make recommendations for the specific testing of this product including a velocity profile, smoke visualization, and a filter integrity test (if a filter is part of the system).

Additional Comments

Due to the larger scale of chemical use in wet process workstations, adequate chemical waste must be planned for. Most wet process workstations have onboard waste systems, each dedicated to a particular waste stream used in wet process workstations, with the construction materials carefully selected for compatibility with the precise chemistry, concentration, and temperature to be contained. Multiple levels of safety interlocks must be included in wet process workstations; otherwise, station use should be limited to lower volumes of chemical usage similar to a chemical fume hood.

6.2. LOCAL EXHAUST VENTILATION

6.2.1. CANOPY HOOD

Description

A canopy hood is a ventilated enclosure suspended directly above the work area.

Application

Canopy hoods are receiving hoods. As such, a canopy hood should be used when there is a force, such as heat, to deliver the contaminant to the receiving hood. By design, canopy hoods do not provide protection of the breathing zone and thus should only be used for receiving heat, moisture, and nuisance vapors unless otherwise certified by the chemical hygiene officer.

Reference Organization

For more information, see the current edition of *Industrial Ventilation*.[12]

Testing Recommendations

The manufacturer shall make recommendations for the specific testing of this product, including a velocity profile and smoke visualization.

Additional Comments

A canopy hood must be positioned to receive the contaminant. Proximity to the delivering source must be considered when using a canopy hood. Contact the chemical hygiene officer for the proper positioning and use of a canopy hood.

6.2.2. SLOT HOOD

Description

A slot hood is a **local exhaust ventilation** device that is positioned adjacent to the work area at a right angle.

Application

A slot hood is used only for the removal of nuisance vapors or particulate. A slot hood is preferred to a canopy hood when the nuisance vapor is at room temperature.

Testing Recommendations

The manufacturer shall make recommendations for the specific testing of this product, including exhaust volume and smoke visualization.

Additional Comments

A slot hood must be positioned to receive the contaminant. Proximity to the delivering source must be considered when using a slot hood. Contact the chemical hygiene officer for the proper positioning and use of a slot hood.

6.2.3. SNORKEL HOOD (FLEXIBLE SPOT EXHAUST)

Examples

- Elephant trunk
- **Spot collector**
- Extractor

Description

A snorkel is a small, localized ventilation hood, usually connected by a flexible duct to an exhaust fan.

[12] *Industrial Ventilation: A Manual of Recommended Practice*, American Conference of Governmental Industrial Hygienists, www.acgih.org.

Application

Snorkel hoods are only used for ventilating laboratory equipment and the exhaust of heat or nuisance vapor.

Testing Recommendations

Contact the chemical hygiene officer for proper use of a snorkel hood. The manufacturer shall make recommendations for the specific testing of this product including exhaust volume and smoke visualization.

Additional Comments

A snorkel hood has an effective capture range of about one hood diameter away from the hood. Snorkel hoods should not be used for anything except heat or nuisance vapor removal unless otherwise certified by the chemical hygiene officer.

6.3. EXHAUSTED LAMINAR FLOW HOODS

Examples

- Clean hoods
- ISO 14644-1 Class 5+ fume hoods
- Clean air chemical hoods
- Trace metals analysis hoods
- Push/pull hoods

Description

An **exhausted laminar flow** (ELF) hood is a ventilated cabinet that contains an integral HEPA/ULPA filtered supply air source. ELF hoods are designed for critical operations where a clean air (ISO 14644-1 Class 5+) process environment is necessary, along with adequate protection to the user from fumes and particles. ELF hoods are usually 100% outside ducted, but may be recirculated in cases where particle entrapment is the principal objective. ELF hoods contain vertically closing sashes, baffle systems, and often localized exhaust systems within the unit.

Application

ELF hoods are used to protect operators from potentially hazardous fumes, typically associated with acid digestion or solvent parts cleaning, while creating the clean environmental conditions required for these types of critical processes.

Reference Documents

- ISO 14644-1
- ISO 14644-7
- ASHRAE 110
- SEFA 13

Testing Recommendations

Because ELF hoods are hybrids between negative and positive pressure environments, strict attention to balance testing is crucial. Testing shall be performed against the current versions of ASHRAE 110 and ISO 14644-21.

Additional Comments

Because of the harsh conditions often present within critical processing environments, ELF hoods are often constructed from corrosion-resistant materials, such as polypropylene. Further, clean-room compatibility often requires non-shedding construction materials. Finally, various critical processes, such as trace metals analysis, require metal-free environments due to data collection concerns.

6.4. BIOLOGICAL SAFETY CABINETS

6.4.1. CLASS I CABINETS

Description

A Class I cabinet is a ventilated cabinet that provides personnel and environmental protection. It is characterized by an un-recirculated inward flow of air away from the operator through a limited fixed-access opening. Exhaust air must be HEPA filtered if recirculated back into the laboratory. A Class I cabinet may be vented via a remote ventilation system. It does not offer product protection.

Reference Organization

NSF International provides additional information in NSF Standard 49.[13]

Additional Comments

There are no nationally recognized specifications or standards governing construction and performance for these configurations.

6.4.2. CLASS II CABINETS

Description

A Class II cabinet is a ventilated cabinet that provides personnel, product, and environmental protection. It is characterized by a limited fixed inward airflow access opening that provides personnel protection, a vertical downward HEPA-filtered work zone that provides product protection, and HEPA-filtered exhaust that provides environmental protection. Class II cabinets are divided into types by NSF and identified in Standard 49.

Examples

- **Class II Type A1 cabinets (formerly designated Type A)**
  - Minimum of 75 FPM (0.38m/s) inflow
  - HEPA-filtered downflow mixed with recycled air
  - May exhaust some or all HEPA-filtered air back into the laboratory
  - May have positive pressure duct systems
- **Class II Type A2 Cabinets (formerly designated Type B3)**
  - Minimum of 100 FPM (0.51 m/s) inflow
  - HEPA-filtered downflow mixed with recycled air
  - May exhaust some or all HEPA-filtered air back into the laboratory
  - Has negative pressure duct systems
- **Class II Type B1 Cabinets**

[13] See the current version of NSF 49 Class II (Laminar Flow) Biohazard Cabinetry, NSF International.

    - Minimum of 100 FPM (0.51 m/s) inflow
    - HEPA-filtered, mostly uncontaminated recirculated air
    - Exhausts most contaminated air to the atmosphere through a dedicated duct system
    - Has or is surrounded by a negative pressure duct system
- **Class II Type B2 Cabinet (total exhaust)**
    - Minimum of 100 FPM (0.51 m/s) inflow
    - HEPA-filtered, non-recirculated, downflow air
    - HEPA-filtered exhaust air to atmosphere
    - Has or is surrounded by a negative pressure duct system

References

- NSF International Standard No. 49
- Refer to the Centers for Disease Control (CDC) and the National Institutes of Health (NIH) for application information[14]

Testing Recommendations

Construction and performance specifications for Class II cabinets are defined by NSF Standard 49.

6.4.3. CLASS III CABINETS

Example

- **Glove box**

Description

A Class III cabinet provides absolute personnel protection and environmental protection and may provide product protection. It is characterized by a completely enclosed, gas-tight, negative-pressure, HEPA-filtered, ventilated **workspace** accessed through attached rubber gloves and purged interchange chambers. Exhaust air is treated by double HEPA filtration and/or incineration.

Reference Organization

The American Glove Box Society

Additional Comments

There are no nationally recognized specifications or standards governing construction and performance for these configurations.[15]

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[14] Centers for Disease Control and Prevention, 1600 Clifton Rd. Atlanta, GA 30333 http://www.cdc.gov/ and National Institutes of Health, Bethesda, MD, 20892 www.nih.gov.

[15] For more information, see NSF Standard 49.

6.5. DUCTLESS HOODS

Examples

- Ductless fume hoods
- Ductless fume cabinets

Description

A ductless hood recirculates air back into the laboratory from the hood chamber.[16] A ductless hood is an open-faced enclosure designed to protect the user from laboratory and industrial airborne contaminates, similar to a laboratory fume hood, but without being connected to a duct system (although options are available for connecting to a duct system). Instead, the air is recirculated back into the room atmosphere. The objective of the filtration system is to reduce the levels of solid, gaseous, or vapor constituent to below the acceptable **TLV** limit at the exhaust.

The benefits of a ductless hood include:

- Low installation cost
- High portability
- No permit required for exhausting outside the building

Application

The ductless hood's scope of use is limited to the capacity and capability of the filtration system. A ductless hood may also be utilized for many ventilated enclosure applications (e.g., balance enclosure, microscope enclosure, rotary evaporator enclosure).

Reference Documents

- United States
    - SEFA 9
    - ANSI/ASSP Z9.5
    - NFPA-45
- Canada – CAN CSA Z316.5 Performance Standard
- France – AFNOR NFX 15-211 Performance Standard
- UK – BS EN 17242 Recirculatory Filtration Fume Cupboards
- Germany – DIN 12927 Laboratory Furniture – Ductless filtering fume enclosures
- Australia – AS2243.9 Approved Code of Practice on Safety in Laboratories – Recirculating Fume Cabinets (Ductless Fume Cabinets)

[16] For more information, see SEFA 9 – Standards for Ductless Enclosures.

7. Laboratory Ventilation Systems

The purpose of a laboratory ventilation system, which includes both exhaust and supply duct systems, is to exhaust a specific volume of air from laboratory fume hoods or other exhaust devices and safely transport the contaminated air from the building in a manner that reduces the potential for re-entrainment of exhaust fumes into the building's fresh air intake.

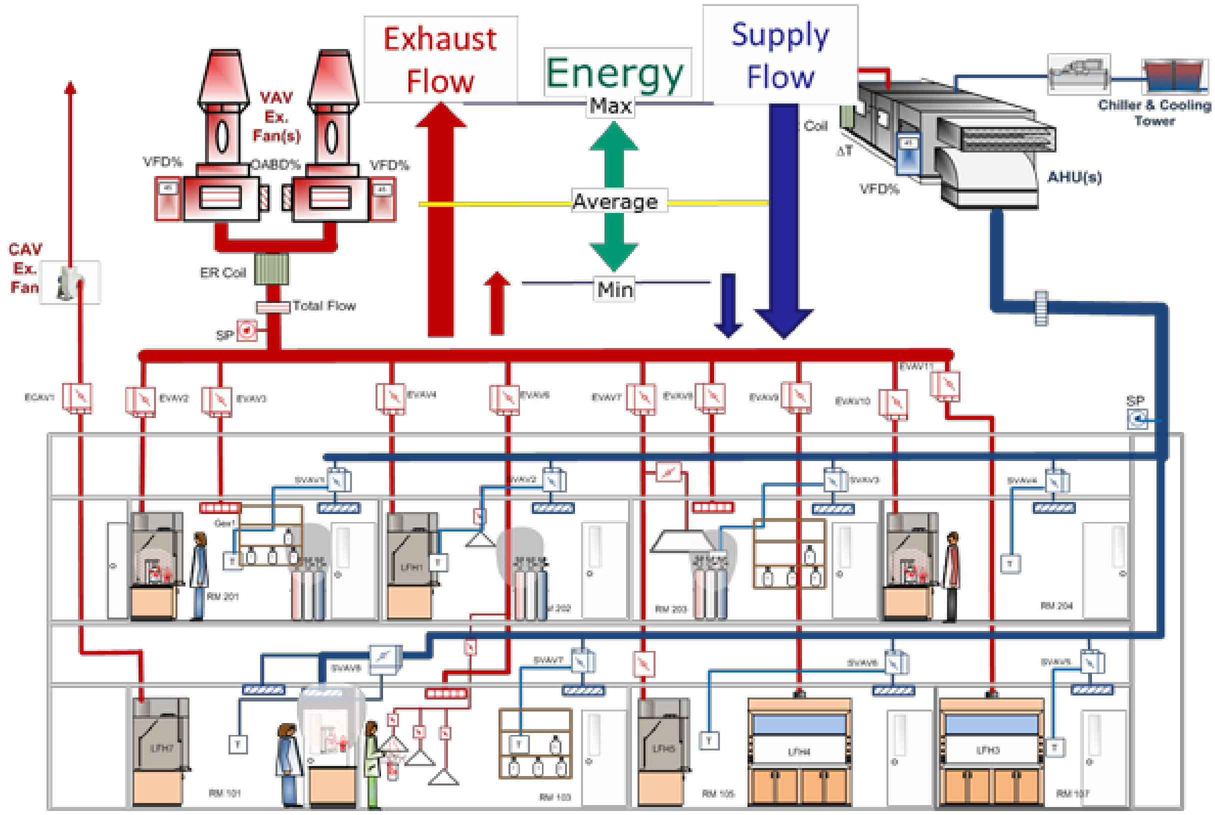


Figure 13. Example ECD system

According to industry standards, the supply air system must make up the air exhausted from the laboratory with 100 percent fresh outside air, conditioning it to provide a safe, comfortable work environment for the lab users. The amount of supply air delivered to a laboratory is controlled to satisfy the demand for minimum ventilation (**ACH**) rate, hood flow demand, or cooling / heating load demand, whichever is greatest.

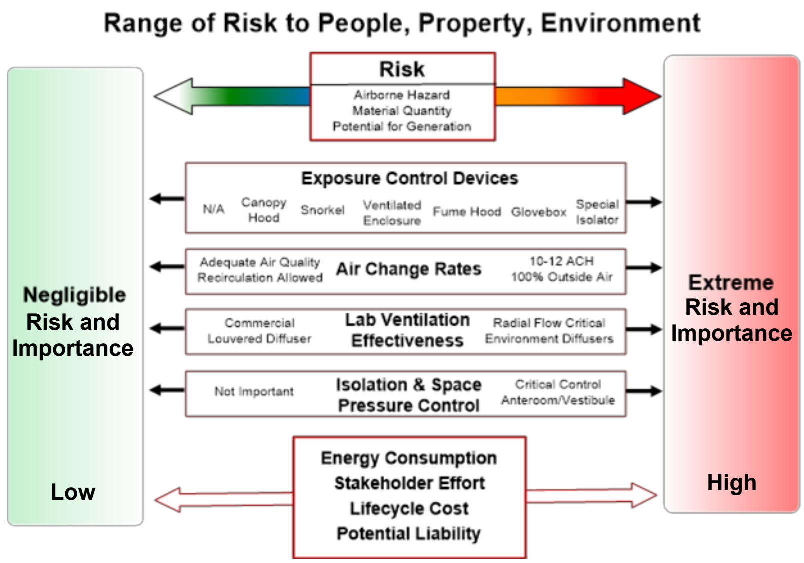
In order to maintain the negative pressure requirement, the total exhaust volume for a lab must always exceed the supply air volume by a specific volumetric offset (most common) or the flows must be controlled by a pressure differential control system. If the total of all hood exhaust is less than the maximum possible supply flow, then an additional exhaust device, typically referred to as a general exhaust valve, is required.

If the laboratory control system provides for proximity sensors at the fume hoods, reducing the face velocity through the open sash when users are not present at the fume hood face, fume control must still be maintained.

7.1. RISK AND ECD PERFORMANCE REQUIREMENTS

7.1.1. SPECTRUM OF RISK

Laboratories present many possible hazards, particularly where activities involve chemical, biological, and/or radioactive materials. People can be exposed to airborne hazards through inhalation, contact with the skin, or ingestion of food or drinks contaminated through contact. The risk or potential for exposure to an airborne contaminant is a function of many factors, including how the contaminants are generated, the magnitude of the resulting concentration, and the duration of the concentration in the occupied space. The potential for exposure and the risk of suffering adverse effects (health or otherwise) is subject to an even more complex interaction of variables that include not only the type of hazard and the dose (concentration times duration), but also the susceptibility of the exposed individual.

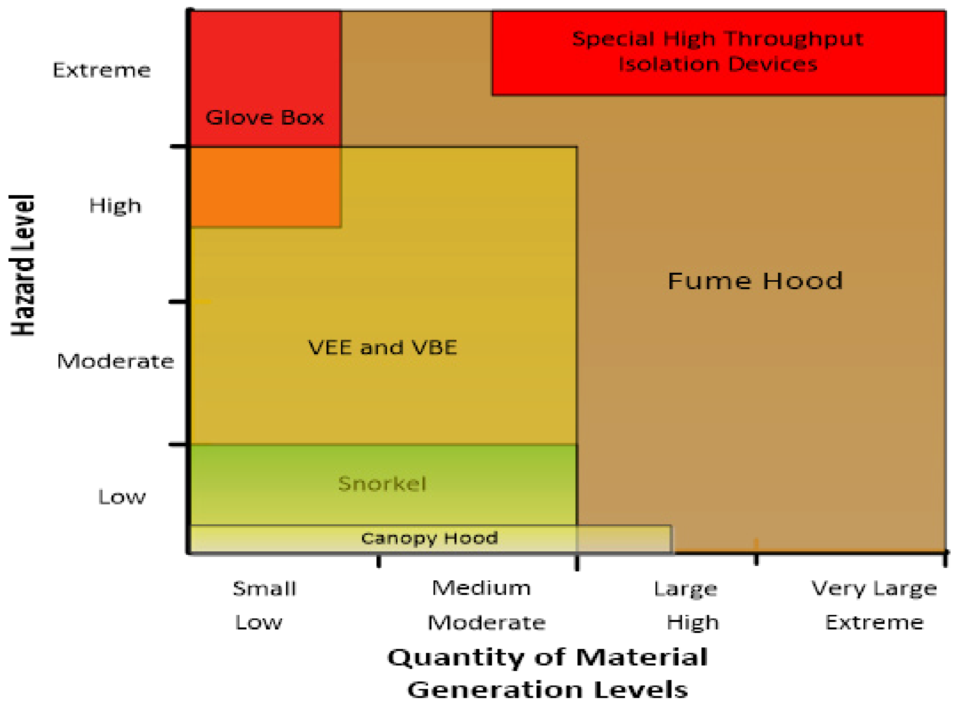


The spectrum of risk of exposure to airborne hazards in labs can range from negligible to extreme. ECDs are employed to reduce the risk to people, property, and the environment by controlling airborne hazards, limiting accumulation of unsafe concentrations, and minimizing the duration of unsafe concentrations. Some ECDs are also used to minimize the potential for and effects of explosions and high-pressure gas releases. As shown in Figure 14, the range of risk can be associated with the design and operating requirements of the ECD and other factors, including energy consumption, stakeholder effort, operating costs, and potential liability.

Risk can be characterized as a function of the type and quantity of airborne hazards, the rate of generation, the duration of generation, and the severity of exposure. Characterization enables better selection and design of ECDs, establishment of airflow specifications, and configuration of the lab supply and exhaust devices to maximize effectiveness of ECDs. Exposure and the risk of adverse health effects can be based on the potential magnitude of the airborne concentration, the potential residence time of the concentration, the severity of the hazard, and the duration of exposure.

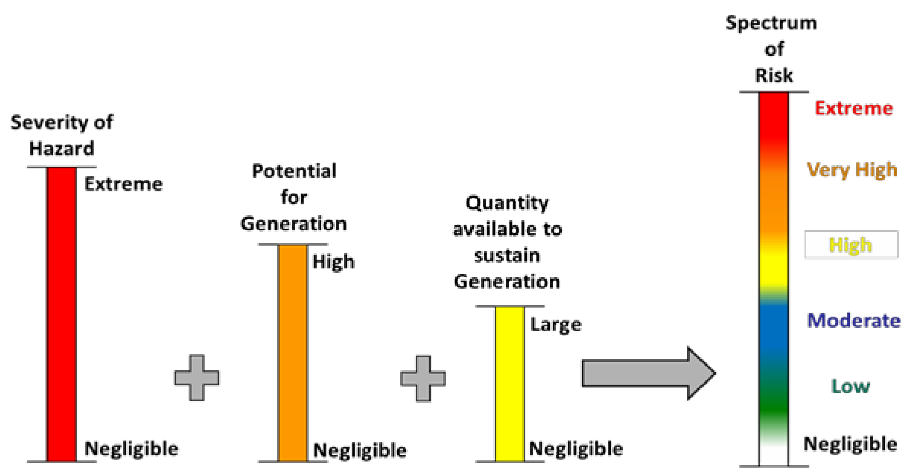
As such, risk factors include the severity of the hazards, the quantities of materials, the rate of generation, the duration of generation and effectiveness of the ECD system to capture, dilute and remove the airborne contaminants. The severity of the hazard indicates the maximum allowable concentration, the potential for generation indicates the rate of generation, and the quantity of material indicates the potential duration of generation.

Figure 15 shows the risk as a function of the hazard, the potential for generation, and the quantity of the material available to sustain generation. In this context, risk is an estimate of the probability that unsafe concentrations of airborne hazards may exist. The range of risk is always greater than 0% and less than 100%. No algorithm may calculate risk precisely, but there is value in understanding and characterizing the factors influencing the level of risk.



7.1.2. AIRBORNE HAZARD AND SEVERITY

The characteristics of airborne hazards and the concentration levels of concern are critical to evaluating risk and ensuring appropriate design and operation of an ECD system. Airborne hazards (effluent) are present in concentrations of gases, vapors, particulates, and other types of aerosols typically composed of chemical, biological, and/or radioactive materials. The characteristics of the effluent can affect the type of ECD, need for filtration, materials of construction, capture velocities, and duct transport velocities.



The following categories can be used to help characterize hazardous effluent:

- **Gas** – A substance that exists in the gaseous state and lacks inherent volume and shape at normal atmospheric conditions (e.g., oxygen, helium).
- **Vapor** – A substance in the gaseous state that is normally a liquid or solid at standard temperature and pressure (e.g., water, formaldehyde, xylene, acetone).
- **Fume** – Condensed solid particles produced by physicochemical reactions such as combustion, sublimation, or distillation (e.g., fumes from spectroscopy samples and laser surgical procedures).
- **Mist** – Airborne liquid droplets associated with the disruption of a liquid (e.g., sonication, spraying, mixing, and violent chemical reactions).
- **Particulate** – Solid particles (e.g., silica gel, aluminum oxide) or nanoparticle products that are temporarily suspended in a volume of air. Deposition of suspended particulates is dependent on particle size and turbulence.

Hazardous materials can be further classified by type, physical properties, negative effects of exposure, and exposure limits. Examples of type and effect classifications include:

- **Carcinogen** – Materials that are known cancer-causing agents.
- **Flammable** – Materials with an elevated risk of catching fire.
- **Reactive** – Materials that violently react with certain substances such as water or oxygen.
- **Corrosive** – Materials that can easily destroy or damage materials of construction or surface materials that the contaminants contact, such as metal, plastic, or skin.
- **Explosive** – Materials that may explode when subjected to high heat, sparks, or other ignition sources.

The concentration level of concern that may lead to adverse health effects may be associated with exposure limits published by organizations such as the Occupational Safety and Health Administration (OSHA), the **American Conference of Governmental Industrial Hygienists** (ACGIH), and other groups, including material producers. Hazards can be described as acute or chronic: acute hazards have more immediate effects from exposure, and chronic hazards may exhibit effects after repeated exposure or after a prolonged period.

The severity of the hazard is based on the potential effects from overexposure and ranges from negligible to immediately dangerous to life and health (IDLH). Exposure limits are typically reported as concentration in mass per unit volume (mg/m^3) and parts per million (ppm). Negligible health hazards may have concentrations with a level of concern (LOC) greater than 1000 ppm (>1 g/m^3), whereas extreme hazards may be associated with concentration LOCs of less than 1 ppm (1 mg/m^3). These definitions for the hazard level, however, may vary and may be subject to the authority having jurisdiction, the prevailing standard (regulatory and institutional), or referenced source.

As the application and protective capability of ECDs varies, understanding the risk can be critical to selecting the appropriate ECD and establishing operating specifications that enable the required control and performance. In the absence of the requisite information, the choice of ECD and operating specifications can be based on a worst-case scenario and account for the ability of the user to safely conduct the hazardous procedure. Most labs operate within a definable range hazard where concentration LOCs can be associated with a level of risk that ranges from negligible to extreme. The LOC then defines the criterion for performance. For example, a concentration LOC of 0.1 ppm indicates that the ECD must be capable of preventing escape greater than 0.1 ppm.

7.1.3. QUANTITY OF MATERIAL

Large amounts of materials can contribute to a longer duration of generation. Local regulations, national fire codes, and mechanical building codes often set limits on the maximum quantities of materials that can be stored and/or used in laboratories. Refer to Figure 17 for example classifications of material quantities that might represent a range anticipated for a small lab. Note that this may be relative, as a “minute” quantity per Figure 17 may represent a very large quantity of a highly hazardous material. It is important to understand the hazards when establishing the volume or mass of material associated with the subjective descriptions in the following table.

Description/Quantity	Volume	Mass
Minute	< 1 mL	< 1 mg
Small	< 10 mL	< 1 g
Moderate	< 1 L	< 10 g
Large	< 10 L	< 100 g
Extra-Large	< 50 L	< 500 g

Figure 17. Range and quantity of materials used in laboratory scale procedures

7.1.4. AIRBORNE HAZARD GENERATION

Health and safety staff should consult with laboratory managers, principal investigators (PIs), and other stakeholders to characterize procedures, evaluate means of generation, estimate the potential rates of generation, and consider future changes in activities. Airborne hazards can be generated during a variety of activities where the rate may be subject to the process and mechanism affecting generation. The following categories characterize hazardous procedures:

- **Storage** – Emissions may occur from improperly sealed or degraded storage containers. The rate and quantity of generation may be small, but not negligible. Complaints of an **odor** may indicate escape of small concentrations from inadequately sealed containers. Note that some chemicals may pose hazards below the odor threshold.
- **Closed Process** – Materials are contained in process apparatus, which may include beakers, flasks, tubing, or equipment. The volume of material that could be released during a catastrophic incident such as accidental over-pressurization, damage to the system, or leaks should be estimated.
- **Normal Process** – A normal process typically involves procedures that result in low volume generation and where little energy is added to the process. Pouring and weighing of materials and pipetting are examples of a normal process where generation of materials is typically through diffusion and/or evaporation.
- **Complex Process** – A complex process generally involves procedures that apply significant energy and produce a large volume of airborne contaminants. Such processes might involve volatile reactions, stirring and mixing, heating and boiling, bulk material transfers, and weighing. The application of energy complicates determining contaminant generation rates.
- **Leaks to Catastrophic Failure** – Leaks to catastrophic failure involve the partial or total sudden release of material resulting from a physical defect such as a worn gasket, rupture in connective tubing, or pinhole in a structural weld.

Figure 18 lists different categories of processes and their associated generation rates for airborne hazards. In the absence of generation rate information, the maximum potential rates for normal operating conditions should be used to determine the hazard emission scenario.

Category	Generation Range (lpm)	Possible Source
Storage and Closed Process*	<0.1	Fugitive emissions from leaky containment vessels
Normal Process	0.1 - 1	Open containers, evaporation
Complex Process	1 - 10	Boiling/mixing/stirring
Leaks to Catastrophic Failure*	<0.1 to >1400	Leaking or failed compressed gas cylinders

*Note: Worst-case release from catastrophic failure should be estimated.

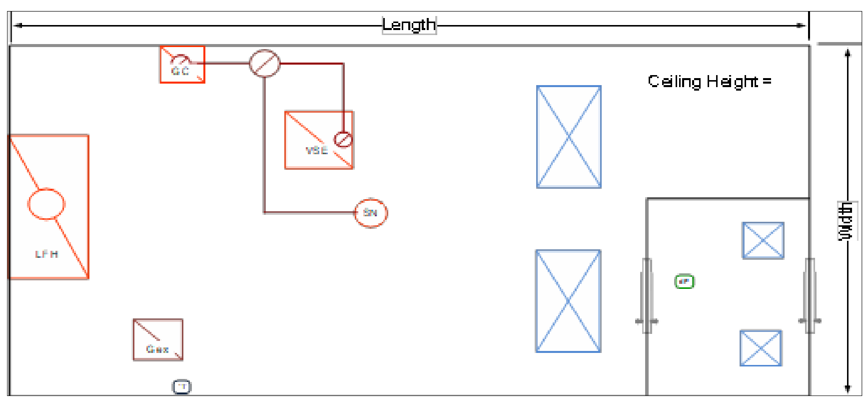
Figure 18. Typical ranges for laboratory scale generation rate

7.2. EXPOSURE CONTROL DEVICE PERFORMANCE

Exposure control devices (ECDs) use airflow to capture, contain, dilute, and remove contaminants, isolate the laboratory from adjacent areas, and control space temperatures. The volume of airflow required to provide adequate protection depends on the risk, the design of the ECD employed, and its operating modes. ECDs such as chemical fume hoods typically require greater exhaust flow than ventilated balance enclosures or snorkel exhaust devices. Furthermore, variable air volume (VAV) fume hoods and other types of ECDs can vary the exhaust flow depending on their utilization and available modes of operation.

Minimizing the volume of airflow and system resistance where possible is desirable for the sake of reducing energy consumption, but it shall not be done at the expense of safety. Safety is an inviolable constraint, and the performance requirements can dictate the minimum airflow and operating specifications for ECDs and laboratories.

Proper performance requires specification of the minimum and maximum flow for each exhaust and supply device for the range of possible operation. Airflow specifications are required for all ECDs, the general exhaust, the air supply, and the offset volume (transfer air) required to maintain space pressurization. Negative pressurization may be critical to provide isolation to prevent contaminant escape or to minimize contaminant infiltration. The flow specifications for ECDs and the lab environment depend on numerous factors, including the risk of exposure and the overall demand for ventilation. Improper airflow specifications can lead to poor ECD performance and deleterious operating conditions.



Modulation of exhaust flow must be balanced with mechanically supplied, properly conditioned **replacement air**, plus or minus the transfer air required for the desired lab pressurization. Changes in the exhaust for any device require an immediate and commensurate change in supply flow to compensate and maintain balance. It is usually preferable to maintain a constant offset volume to maintain space pressure relationships, regardless of changes in operating modes.

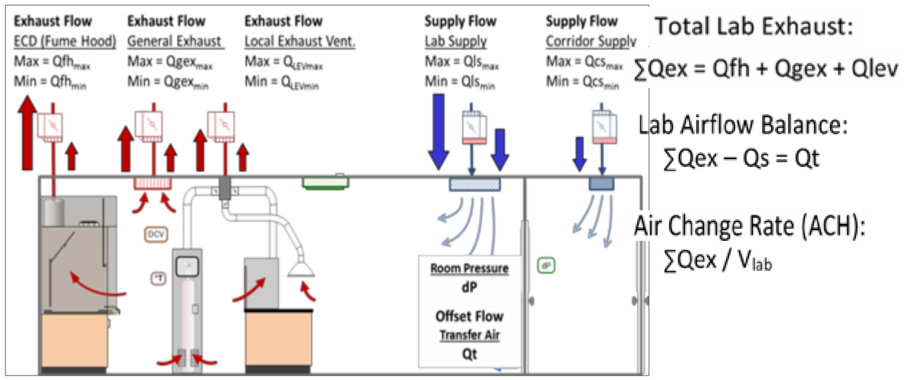


Figure 20. Side view of laboratory showing exhaust and air supply flow

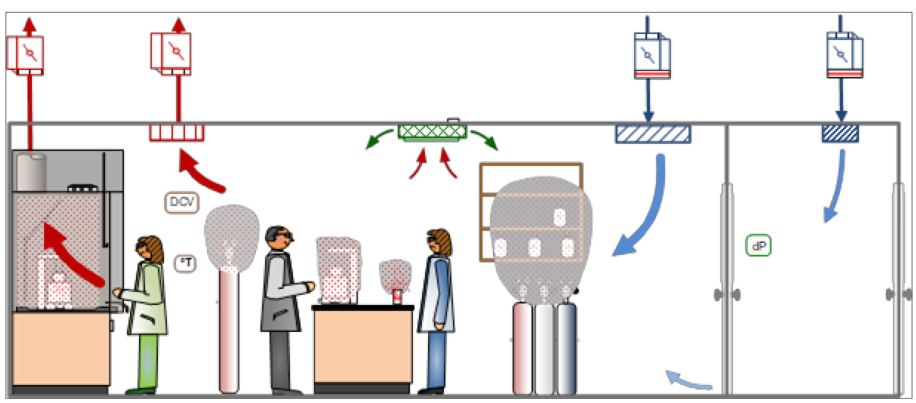
A laboratory containing a VAV fume hood that also modulates general exhaust and air supply flow to control room temperature can have a variety of operating modes, sequences of operation, and a significant range of flow. The total flow through the lab can vary from low when unoccupied to maximum with the fume hood in use and where high conditioning loads require extra supply.

For effective safety and energy consumption management, ECD selection criteria and the establishment of airflow specifications should focus on mitigating risk and satisfying the demand for ventilation without excess or unnecessary ventilation. The safest and most efficient operation results when the ECD modulates flow to meet and track changes in the demand for ventilation.

Systems may suffer due to improper or inadequate evaluation of risk, improper specification of airflow, or failure of the controls to properly modulate air supply and exhaust fans over the range of flow dictated by the demand for ventilation. Failure to properly modulate flow can compromise both safety and energy efficiency.

7.3. VENTILATION FOR PROTECTION OF PERSONNEL

ECDs are designed and operated for varying purposes and offer varying levels of protection depending on their design, use, operation, and the impact of environmental conditions such as room air turbulence, temperature gradients, and pressurization. The location of air supply fixtures, ECDs, and general exhaust, together with the resulting airflow patterns, are critical for supporting ECD performance, providing adequate dilution, and facilitating contaminant removal from the lab environment.



Where the ECDs provide primary protection through source capture, the airflow through the lab environment provides secondary protection through dilution and removal of extraneous contaminants. Figure 21 depicts a laboratory with a fume hood to provide for the capture, containment, and removal of hazards generated therein and relies on dilution and removal of contaminant concentrations in the lab exterior to the fume hood.

Extraneous concentration sources in the lab environment may include escape from ECDs, poorly sealed storage containers, leaking gas cylinders, and analytical equipment operating outside ECDs.

Issues to consider when evaluating potential sources of airborne hazards in labs include:

- The risk of exposure posed by the generation of airborne hazards. For example, some materials can cause acute adverse effects at very low concentrations, whereas other airborne hazards can have more chronic effects after prolonged exposure.
- The effectiveness of available methods to mitigate unacceptable risk.
- The volume of airflow required for dilution and the effectiveness of removal from the lab environment.
- The appropriate ECD type and airflow specifications necessary to provide adequate protection.
- The capabilities and limitations of the ECD. For example, a canopy hood may offer little protection for the operator, whereas a glove box may be required to provide total isolation and maximum protection.
- The factors that influence when a ECD is not appropriate or when the level of performance may not provide adequate protection.
- The methods required to validate performance and the factors that affect performance over time. Measurement of air velocity alone may be inadequate to evaluate potential for exposure. Tracer gas tests or exposure monitoring may be required to assure proper safety performance.
- The impact of changes in hazardous materials, processes or potential for generating airborne contaminants.
- The range of airflow through the laboratory and the potential impact of varying flow on dilution, contaminant removal effectiveness, and ECD containment performance.
- The impact of the airborne hazards on the ECD system. Some materials like acids may degrade the duct and components, leading to premature degradation and inadequate performance. The construction materials can be critical to long-term performance.
- The need for training in and enforcement of the use of proper work practices.

The level of required protection typically depends on the process, the severity of the airborne hazards, the exposure limits, the quantities of materials used in the process, and the characteristics of generation, including the rate and type of effluent. These characteristics define a hazard emission scenario that can be used to specify an ECD and determine appropriate operating specifications for the laboratory and ECD system. The hazard emission scenario must remain within the boundaries dictated by “laboratory-scale” work (i.e., substances in containers used for reactions, transfers, and other applications that are designed to be easily handled by one person).

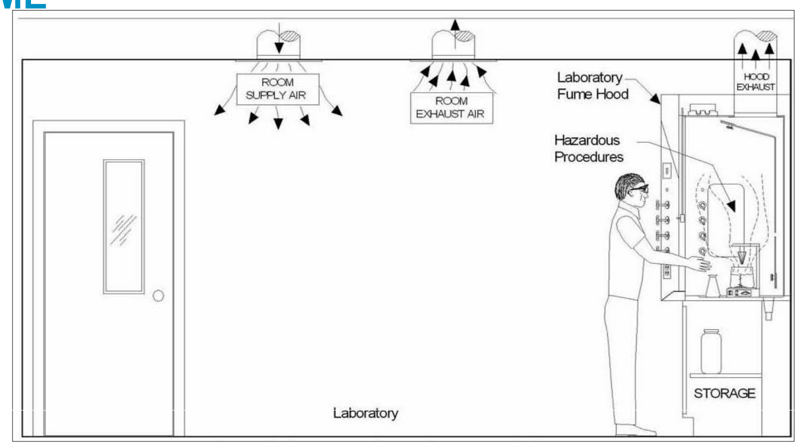
The ECD must be appropriate for the application, operate properly, and provide adequate performance over the range of possible operating conditions. The level of protection afforded by an ECD system is ultimately based on the ability to control and limit concentrations of airborne contaminants where people could be exposed. The rate of contaminant accumulation equals the rate of generation minus the rate of removal.

7.4. AIRFLOW CONTROL STRATEGIES

The airflow control strategy significantly affects laboratory fume hood containment, room pressurization, and energy usage. Laboratories with fume hoods have three main airflow control strategies: constant air volume (CAV), two-state control (2SC), and variable air volume (VAV). Each airflow control strategy is well-suited to specific applications. Energy-efficient fume hood designs can be used on any of these systems and can further reduce the total volumetric flow requirements of the **HVAC** system.

7.4.1. CONSTANT AIR VOLUME

CAV systems are designed to exhaust a constant volume of air from the laboratory fume hood regardless of hood use, sash position, or operating mode. Caution must be exercised by the designer and commissioning agent to ensure that sash stops and flows are properly selected. Consult with the hood manufacturer for proper airflow requirements.



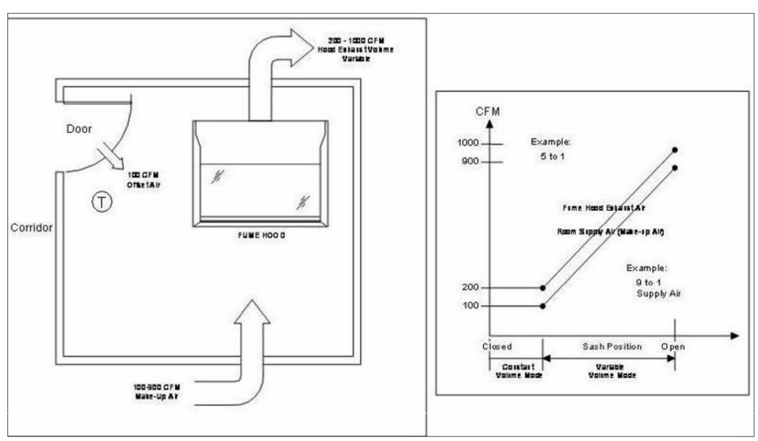
7.4.2. TWO-STATE CONTROL

A two-state fume hood control is a low/high volume control system. The low and high volumes are changed by methods such as sash position switches, light switches, and user presence sensors, the most common of which are sash switches and wall (manual) switches. Sash switches are used to change the flow based on the open area of the fume hood sash.

The two-state control approach gains energy efficiency over CAV systems to the extent that the hood remains on the low-flow level. The complexity is almost as high as a fully variable system, however, and the energy savings potential from a partially lowered sash is lost. The use of controls also increases maintenance costs compared to those of a CAV system.

7.4.3. VARIABLE AIR VOLUME

A **variable air volume** fume hood control system is designed to vary the hood's exhaust rate to achieve specific face velocities at specific sash positions. The complexity of this system requires fast, stable control systems, which are more expensive on an installed cost basis than CAV control systems. Energy savings can be further improved, however, to potentially offset these higher costs.



Room pressurization is generally maintained by adjusting the make-up air to a fixed offset relative to the total exhaust flow. A small percentage of facilities choose to maintain pressurization by controlling the pressure differential.

If the minimum total hood flow for a laboratory is lower than the exhaust flow required to maintain the negative pressure in the lab, a general exhaust device may be required to provide minimum ventilation and proper temperature control. In this case, the total exhaust (hood plus general exhaust) airflow rate is increased to overcome the added supply requirements.

7.4.4. AIR CONTROL STRATEGY COSTS

Operating a laboratory fume hood incurs significant energy costs, which will continue to be a major concern until renewable energy is readily available. Estimates to operate a laboratory ventilation system range from \$5–\$12 (USD) per CFM per year.

Reducing flows when appropriate using an energy-efficient fume hood design and/or a usage-based flow setback can result in significant cost savings.

> Estimates to operate a laboratory ventilation system range from \$5–\$12 (USD) per CFM per year.

7.5. ROOM PRESSURIZATION

One of the primary goals of the designer is to provide a safe environment for researchers. Meeting this objective requires containment at the hood level and at the room level. The standards and guidelines stress the importance of room pressurization for laboratory spaces. Laboratories that use laboratory fume hoods shall be maintained at a relative negative pressure to corridors and other adjacent spaces in the building (with the exception of clean room laboratories, which may operate under positive pressure).

7.6. DIVERSITY

Diversity is used by engineers in designing a system based on its practical or maximum expected use, not its total possible use. When diversity is applied to sizing of systems, the design capacity is less than the sum of peak demands. Diversity can be applied only after providing both the required number of air changes in the laboratory and the minimum flow to control room temperature. For this reason, some laboratories cannot reduce the total hood exhaust flow capacity.

Both existing and new laboratories can benefit from applying diversity to the HVAC design. Diversity enables existing facilities to add fume hood capacity using the current HVAC systems and enables new facilities to reduce capital expenditures on equipment by downsizing the mechanical systems during the design phase.

Some designers are hesitant to use diversity since the savings are only realized when the sashes are lowered. This has led to systems with problematic methods of “forced” diversity. For example, mechanical sash stops prevent a user from opening a sash beyond a predetermined maximum setting. Unfortunately, users often override these mechanical stops. This can create a dangerously low face velocity profile if the controller is not sized for full sash opening and the fume hood is not designed to operate at lower face velocities. Ensure that low-flow alarms are working properly.

A two-state control system, which automatically switches between standard and setback flow, can provide greater diversity than other systems.[17] The hood design shall be tested to the ASHRAE 110 standard at the setback flow if the setback can occur through an open sash.

Factors affecting diversity include:

- **Control Method**
  - Constant Air Volume (CAV)
  - Variable Air Volume (VAV)
  - Two-State Control (2SC)
- **Usage Pattern**
  - Number of users per fume hood
  - Fume hood usage type
  - User compliance
- **Sash**
  - Sash type
  - Sash management
- **Airflow Requirements**
  - Face velocity
  - Cooling airflow rate
  - Minimum ventilation rate
- **Building Attributes**
  - Number of floors
  - Size of building
- **Fume Hood Density**
  - Number of fume hoods per lab
  - Number of fume hoods per manifold

[17] See Varley, J.O.– ASHRAE Trans. 1993, Vol. 99, Part2, Paper number DE-93-18-2, 1072-1080, 2figs., 3tabs., 6refs. AND in Laboratory HVAC, 1995, 45-51 ISBN 1-883413-25-7 and Parker, J.A., Ahmed, O., and Barker, K.A. – ASHRAE Trans., 1993, Vol. 99, Part 2, Paper number DE-9-18-3, 1081-1089, 11figs., 2 tabs.

Appendix A: Glossary

A&E (architect and engineer) – A generic term referring to the designers of a laboratory building or ventilation system.

ACFM – Actual cubic feet per minute of gas opening.

ACGIH (The American Conference of Governmental Industrial Hygienists) – The association that supports or produces the threshold limit values (TLV) list, *Industrial Ventilation: A Manual of Recommended Practice for Design,* and bioaerosol documents.

ACH – The number of times air is theoretically replaced in one hour. *Also* AC/H.

acceptable indoor air quality – Air in which there are no known contaminants at harmful levels as determined by appropriate authorities and with which at least 80 percent of people do not express dissatisfaction.

access opening – The part of the fume hood through which work is performed. *See also* face opening; sash.

airflow monitor – Device installed on a fume hood to observe the flow of air through the fume chamber.

airfoil – A horizontal member across the lower part of the fume hood sash opening, shaped to provide smooth airflow into the chamber and across the work surface.

air volume – Quantity of air expressed in cubic feet ($ft.^3$) or cubic meters (m^3).

auxiliary air – Supply or supplemental air delivered to a laboratory fume hood to reduce room air consumption. *See also* supplemental air.

baffle – Panel located on the rear wall of the fume hood chamber interior that directs the airflow through the fume chamber.

bench-top hood – A fume hood that is located on a work surface. *See also* superstructure.

bypass – Compensating opening in a fume hood that limits the maximum face velocity as the sash is raised or lowered.

combination hood – A fume hood assembly containing a bench hood section and a floor-mounted section.

combination sash – A fume hood sash with a framed member that moves vertically and houses two or more horizontal-sliding transparent viewing panels.

countertop – *See* work surface.

cross draft – An air draft that flows parallel to or across the face of the fume hood.

damper – Device installed in a duct to control airflow volume.

diversity – The design of a system to operate at a lower capacity than the sum of peak demand (ANSI Z9.5). For example, a system designed with a diversity of 60 percent will allow only six out of ten fume hoods to be used at any given time.

duct – Round, square, or rectangular tube used to enclose moving air.

duct velocity – Speed of air moving in a duct, usually expressed in feet per minute (FPM) or meters per second (MPS).

exposure control device (ECD) – A device designed to provide the primary engineering control for mitigating the risk of personnel exposure to airborne hazards in laboratories.

exhaust collar – The connection between a duct and a fume hood through which all exhaust air passes.

exhaust unit – An air-moving device consisting of a motor, impeller, and housing. *Also* fan.

face opening – Front access or sash opening of laboratory fume hood, measured in width and height. *See also* sash; access opening.

face velocity – Average speed of air flowing perpendicular to the face opening and into the fume chamber of the fume hood, measured at the plane of the face or sash opening and expressed in feet per minute (FPM).

fan – *See* exhaust unit.

fan curve – A curve relating pressure to volume flow rate of a fan at a fixed speed (RPM).

filter – A device that removes particles from the air.

friction loss – The static pressure loss in a system due to friction between moving air and the duct wall, expressed as IWG per 100 feet, or fractions of VP per 100 feet of duct.

fume chamber – The interior of the fume hood, measured in width, depth, and height.

fume cupboard – UK term for laboratory fume hood.

fume removal system – A fume hood exhaust that moves air and fumes consistently through the fume hood, duct, and exhaust unit.

fume scrubber – A device used to remove contaminants from fume hood exhaust, generally with water.

gauge pressure – The difference between two absolute pressures, one of which is usually atmospheric pressure, mainly measured in inches of water gauge (IWG).

glove box – A total enclosure used to confine and contain hazardous materials with operator access by means of gloved portals or other limited openings. Not a laboratory fume hood.

grille – A louvered or perforated face over an HVAC system opening.

hood – A device that encloses, captures, or receives emitted contaminants.

hood entry loss – The static pressure loss, stated in IWG, when air enters a duct through a hood. The majority of the loss is usually associated with a vena contracta formed in the duct.

hood static pressure – The static pressure required to accelerate air at rest outside the hood into the duct at duct velocity, calculated as the sum of the duct velocity pressure and the hood entry loss.

HVAC (heating, ventilation, and air conditioning) – Ventilation systems designed primarily for temperature, humidity, odor, and air-quality control.

inches of water gauge (IWG) – The pressure exerted by a column of water one inch in height at a defined reference condition, such as 39°F (4°C) and the standard acceleration of gravity.

indoor air quality (IAQ) – A measure of the cleanliness of indoor air. The study, evaluation, and control of indoor air quality related to temperature, humidity, and airborne contaminants.

industrial ventilation (IV) – The equipment or operation associated with the supply or exhaust of air, by natural or mechanical means, to control occupational hazards in the industrial setting.

laboratory – The net assignable area in which diverse mechanical services and special ventilation systems are available to control emissions and exposures from chemical operations.

laboratory fume hood – A safety device specifically designed to carry undesirable effluents generated within the hood during a laboratory procedure away from laboratory personnel and out of the building. *See also* definition in section 2.1.

laboratory module – A basic unit of space usually accommodating a two-person laboratory operation.

laboratory ventilation system – Air-moving systems and equipment used by laboratories, which includes the supply air system, the laboratory fume hood, other ventilated enclosures, and the exhaust air system (which includes both room air exhaust and laboratory fume hood exhaust).

laminar flow – Airflow in which air molecules travel parallel to all other molecules, characterized by the absence of turbulence.

laminar flow cabinet – A clean bench or biological enclosure. Not a laboratory fume hood.

liner – Interior lining used for side, back, and top enclosure panels, exhaust plenum, and baffle system of a laboratory fume hood.

local exhaust ventilation – An industrial ventilation system that captures and removes emitted contaminants before dilution into the ambient workplace air can occur.

loss – The conversion of static pressure to heat in components of the ventilation system, e.g., “hood entry loss.”

low-flow fume hoods – Fume hood designs that require a reduced exhaust air volume when compared to the volume required for the same size fume hood to operate with a face velocity of 100 FPM (.508 m/s) through a fully opened vertical sash.

low-velocity fume hoods – Fume hood designs that require a reduced exhaust air volume when compared to the volume required for the same size fume hood to operate with a face velocity of 100 FPM (.508 m/s) through a fully opened vertical sash and provide containment levels equivalent or superior to ASHRAE 110 tracer gas test ratings of AM 0.05 and AI/AU 0.10, with a face velocity of 60 FPM or less through a fully opened vertical sash. *Also* high performance fume hood; high efficiency fume hood.

make-up air – Air needed to replace the air removed from the room by laboratory fume hood(s) and other air exhaust devices. *See also* replacement air.

manometer – A device that measures pressure difference; usually a U-shaped glass tube containing water or mercury.

microorganism – A microscopic organism; usually a bacterium, fungus, or protozoan.

minimum transport velocity (MTV) – The minimum velocity that will transport particles in a duct with little settling; varies with air density, particulate loading, and other factors.

natural ventilation – The movement of outdoor air into a space through intentional openings, such as windows, doors, or other non-powered ventilators, or by infiltration.

occupied zone – The region within an occupied space 3 in.–72 in. (7.62 cm–182.88 cm) above the floor and more than 24 in. (61 cm) from the walls for fixed air conditioning equipment, as indicated in ASHRAE Standard 55.

odor – A quality of gases, vapors, or particles that stimulates the olfactory organs; typically unpleasant or objectionable.

outdoor air (OA) – “Fresh” air mixed with return air to dilute contaminants.

particulate matter – Lightweight particles that become airborne in low-velocity air (approximately 50 FPM [.254 m/s]).

personal protective equipment (PPE) – The appropriate apparel for working at a laboratory fume hood, including approved eye protection, a lab coat, gloves, long pants, and shoes.

pitot tube – A device used to measure total and static pressures in an airstream.

pressure drop – The loss of static pressure between two points.

register – A combination grille and damper assembly.

relative humidity (RH) – The ratio of water vapor in air to the amount of water vapor air can hold at saturation; e.g., an RH of 100% is about 2.5% water vapor by volume.

replacement air – Air supplied to a space to replace exhausted air.

respirable particles – Air particles that penetrate into and are deposited in the nonciliated portion of a lung.

return air (RA) – Air returned from the primary space to the fan for recirculation.

room air – The portion of the exhaust air that is taken from the room.

standard cubic feet per minute (SCFM) – Airflow rate in standard conditions.

sash – A moveable panel or door set in the access opening or hood entrance to form a protective shield.

service fixture – Laboratory plumbing item mounted on or fastened to a laboratory fume hood.

sulfur hexafluoride (SF_6) – Tracer gas widely used for ASHRAE testing.

slot velocity – The average velocity of air through a slot, calculated by dividing the total volume flow rate by the slot area; usually Vs = 2,000 fpm.

smoke candle – Smoke-producing device used to enable visual observation of airflow.

spot collector (snorkel) – A small, localized ventilation hood usually connected by a flexible duct to an exhaust fan. Not a laboratory fume hood.

stack – The device on the end of a ventilation system that disperses exhaust contaminates for dilution by the atmosphere.

standard conditions – Dry air at 29.92 in. Hg, 70º F.

static pressure (SP) – The pressure developed in a duct by a fan.

static pressure loss – Measurement of resistance created when air moves through a duct or hood, usually expressed in IWG.

streamline flow – *See* laminar flow.

suction pressure – Archaic. Refers to static pressure on upstream side of fan. *See also* static pressure.

superstructure – The portion of a laboratory fume hood that is supported by the work surface.

supplemental air (SA) – Supply or auxiliary air delivered to a laboratory fume hood to reduce room air consumption.

thermal anemometer – A device for measuring fume hood face velocity using the principle of thermal cooling of a heated element for detection.

threshold limit value–time weighted average (TLV-TWA) – The time-weighted average concentration for a normal eight-hour workday or forty-hour workweek, to which nearly all workers may be repeatedly exposed without adverse effect.

titanium tetrachloride ($TiCl_4$) – Chemical that generates white fumes used in testing laboratory fume hoods.

total pressure (TP) – The pressure exerted in a duct as the sum of the static pressure and the velocity pressure.

total suspended particulate matter – The mass of particles suspended in a unit volume of air (typically 1 m^3) when collected by a high-volume sampler.

transport velocity – Minimum speed of air required to support and carry particles in an air stream.

turbulent flow – Airflow characterized by transverse velocity components, as well as velocity in the primary direction of flow in a duct; mixing velocities.

TWA (time-weighted average) – The average over a duration of time, used to determine the average exposure at the breathing zone.

variable air volume (VAV) – A type of mechanical system that controls the balance and demand for airflow through automated controls and dampers/valves. Exhaust devices that have VAV will automatically adjust their volumetric flow rate, based primarily on the size of the fume hood aperture. Other factors may also be used to vary the volume, such as occupancy status or air quality monitoring.

velocity (V) – The time rate of movement of air, usually measured in FPM.

velocity pressure (VP) – Pressure caused by moving air in a laboratory fume hood or duct, usually expressed in IWG.

volume flow rate (Q) –The quantity of air flowing per minute, usually measured in CFM.

work surface – The surface that a laboratory fume hood is located on and supported by a base cabinet. In the fume chamber, the surface is recessed to contain spills.

workspace – The part of the fume hood interior where apparatus is set up and fumes are generated, generally confined to a space extending from 6 in. (15.2 cm) behind the plane of the sash to the face of the baffle and from the work surface to a plane parallel with the top edge of the access opening.

Appendix B: Relevant Organizations

SEFA acknowledges the importance of government agencies that produce documents concerning laboratory ventilation, laboratory fume hoods, and laboratory safety. This appendix includes an incomplete list of these organizations for reference.

Name	Initialism	Address	Website	Phone Number
Associated Air Balance Council	AABC	1015 18th St. NW Suite 603 Washington, D.C. 20036	www.aabc.com	
American Conference of Governmental Industrial Hygienists	ACGIH	3640 Park 42 Drive Cincinnati, OH 45241	www.acgih.org	(513) 742-2020
Air Duct Council	ADC	1901 N. Roselle Road, Suite 800 Schaumburg, Illinois 60195	www.flexibleduct.org	
American Gas Association	AGA	2300 Wilson Blvd., Suite 300 Arlington, VA 22201	www.aga.com	
Associated General Contractors of America	AGC	1957 E. Street, NW Washington, DC 20006	www.agc.org	
American Glove Box Society	AGS	P.O. Box 9099 Santa Rosa, CA 95405	www.gloveboxsociety.org	(800) 530-1022
American Hardboard Association	AHA	1210 W. Northwest Highway Palatine, IL 60067-1897	www.domensino.com/aha	(847) 934-8800
The American Institute of Architects	AIA	1735 New York Avenue, NW Washington, DC 20006-5292	www.aia.org	(800) 242-3837
American Industrial Hygiene Association	AIHA	3141 Fairview Park Drive Ste 777 Falls Church, VA 22042	www.aiha.org	(703) 849-8888
Air Movement & Control Association International, Inc.	AMCA	30 W. University Drive Arlington Heights, IL 60004-1893	www.amca.org	(847) 394-0150
American National Standards Institute	ANSI	1899 L Street, NW 11th Floor Washington, DC 20036	www.ansi.org	(202) 293-8020
Air Conditioning, Heating, and Refrigeration Institute	AHRI	4301 Fairfax Drive, Suite 425 Arlington, VA 22203	www.ahrinet.org	(703) 524-8800
American Society of Civil Engineers World Headquarters	ASCE	1801 Alexander Graham Bell Drive Reston, VA 20191-4400	www.asce.org	(800) 548-2723 (703) 295-6000
American Society of Certified Engineering Technicians	ASCET	P.O. Box 1348 Flowery Branch, GA 30548	www.ascet.org	(773) 242-7238
American Society of Heating, Refrigerating and Air Conditioning Engineers	ASHRAE	180 Technology Parkway NW Peachtree Corners, Georgia 30092	www.ashrae.org	(800) 527-4723 (404) 636-8400

American Society of Mech. Eng.	ASME	Two Park Avenue New York, NY 10016-5990	www.asme.org	US and Canada: (800) 843-2763 Mexico: 011-(800)-843-2763 Outside North America: (973) 822-1170
American Society of Plumbing Engineers	ASPE	6400 Shafer Ct., Suite 350 Rosemont, IL 60018-4914	www.aspe.org	(847) 296-0002
American Society of Sanitary Engineering	ASSE	18927 Hickory Creek Drive Suite 220 Mokena, Illinois 60448	www.asse-plumbing.org	(708) 995-3019
American Society of Testing & Materials	ASTM	100 Barr Harbor Drive West Conshohocken, PA 19428-2959	www.astm.org	(877) 909-2786
British Standards Institution	BSI	389 Chiswick High Road London W4 4AL United Kingdom	www.bsi-global.com	+44 345 080 9000
California Division of Occupational Safety and Health	CALOSHA	455 Golden Gate Avenue 10th Floor San Francisco, CA 94102	www.dir.ca.gov/dosh	(800) 963-9424 (916) 274-5721
Centers for Disease Control and Prevention	CDC	1600 Clifton Road Atlanta, GA 30333	www.cdc.gov	(800) 232-4636
Construction Specification Institute	CSI	99 Canal Center Plaza, Suite 300 Alexandria, VA 22314	www.csinet.org	(800) 689-2900
Controlled Environmental Testing Association	CETA	230 Washington Avenue Ext. Suite 101 Albany, NY 12203	www.cetainternational.org	
Canadian Standards Association	CSA	5060 Spectrumway, Suite 100 Mississauga, Ontario L4W 5N6	www.csa.ca	(800) 463-6727
German National Standard	DIN	DIN Deutsches Institut füür Normung e. V. 10772 Berlin, Germany	www.din.de	
Engineers' Joint Contract Documents Committee – American Council of Engineering Companies	EJCDC	1015 15th Street NW Washington, DC 20005	www.ejcdc.org	
Environmental Protection Agency	EPA	401 M Street, SW Washington, DC 20460	www.epa.gov	(202) 260-2090
Factory Mutual System	FM	1151 Boston-Providence Turnpike P. O. Box 9102 Norwood, MA 02062-9102	www.fmapprovals.com	(781) 762-4300
Federal Specifications	FS	General Service Administration Specifications and Consumer Information Distribution Center (WFSIS) Washington Navy Yard Building 197 Washington, DC 20407	www.apps.fas.gsa.gov	

International Conference of Building Officials	IBC	5360 Workman Mill Road Whittier, CA 90601-2298	www.icbo.org	(800) 423-6587
Institute of Electrical and Electronics Engineers	IEEE	345 E. 47th Street New York, NY 10017-2394	www.ieee.org	(800) 678-4333 (212) 705-7900
Instrumentation, Systems, and Automation Society	ISA	67 Alexander Drive Research Triangle Park, NC 27709	www.isa.org	(919) 549-8411
International Organization for Standardization	ISO	Case Postal 56 - 1, ch. de la Voie-Creuse, Case postale 56 CH-1211 Geneva 20, Switzerland	www.iso.org	+41 22 749 01 11
Mechanical Contractors Association of America	MCAA	1385 Piccard Drive Rockville, MD 20850-4329	www.mcas.org	(301) 869-5800
Manufacturers Standardization Society of the Valve and Fittings Industry	MSS	127 Park Street NE Vienna, VA 22180-4602	www.mss-hq.com	(703) 281-6613
National Environmental Balancing Bureau	NEBB	8575 Grovemont Circle Gaithersburg, MD 20877	www.nebb.org	301-977-3698
National Electrical Code	NEC	One Batterymarch Park P.O. Box 9101 Quincy, MA 02269-9101	www.nfpa.org	
National Electrical Manufacturers Association	NEMA	1300 N. 17th Street, Suite 1847 Rosslyn, VA 22209	www.nema.org	(703) 841-3200
National Fire Protection Association	NFPA	One Batterymarch Park P. O. Box 9101 Quincy, MA 02269-9101	www.nfpa.org	(800) 344-3555 (617) 770-3000
National Institutes of Health	NIH	9000 Rockville Pike Bethesda, Maryland 20892	www.nih.gov	
National Society of Professional Engineers	NSPE	1420 King Street Alexandria, VA 22314		(703) 684-2800
NSF International	NSF	789 North Dixboro Road Ann Arbor, MI 48105	www.nsf.org	(734) 769-8010
Occupational Safety and Health Administration	OSHA	U.S. Department of Labor 200 Constitution Avenue NW Washington, DC 20201	www.osha.gov	(202) 219-8148
Plumbing and Drainage Institute	PDI	45 Bristol Drive, Suite 101 South Easton, MA 02375	www.pdionline.org	(800) 589-8956 (508) 230-3516
Sheet Metal & Air Conditioning Contractors' National Association	SMACNA	4201 Lafayette Center Drive P. O. Box 221230 Chantilly, VA 20151-1209	www.smacna.org	(703) 803-2980
Underwriters Laboratories Inc.	UL	333 Pfingsten Road Northbrook, IL 60062	www.ul.com	(800) 704-4050 (847) 272-8800

Appendix C: Test Report Template

NOTE

The following pages provide a standardized template for documenting "As Manufactured" (AM) laboratory fume hood performance evaluations conducted in accordance with the current edition of ANSI/ASHRAE 110. Fume hood test results submitted for membership consideration must be performed and documented by a SEFA-approved third-party tester using this template.

“As Manufactured” Laboratory Fume Hood ASHRAE 110 Performance Evaluation Results

Manufacturer: ______________________________

Model Number: _____________________________

Serial Number: _____________________________

Manufacture Date: __________________________

Evaluation Prepared By:

Name: ____________________

Address: __________________

Telephone: ________________

Website: __________________

Date: _____________________

1. EXECUTIVE SUMMARY

This report provides the results of manufacturer's performance tests conducted on one [hood size, model, and manufacturer] laboratory fume hood at [test facility], located in [city, state, country]. Testing and evaluation were performed by [tester name] from [test company] on [date].

The following performance tests were conducted with the sash at the design operational sash height of [height]:

- Cross draft test
- Face velocity test
- Airflow visualization test
- Static tracer gas containment test
- Sash movement effect (SME) test
- Periphery scan test

Testing was performed in accordance with guidelines provided in the most recent edition of ANSI/ASHRAE 110. The criteria for performance were adopted from recommendations by the ACGIH, the National Research Council, SEFA, ANSI, and relevant industry standards on laboratory ventilation.

The hood was tested "As Manufactured" (AM) at the design operational sash height. The data contained in this report is indicative of the performance of the laboratory hood and ventilation system at the time and date of the investigation. The data shall not be interpreted to ascribe performance characteristics to larger sash openings than tested or to lower average face velocities than measured.

Test results indicate that the hood met acceptance criteria as described herein, with tracer gas average concentrations below AM0.05 PPM for static tests and SME-AM0.05 PPM for sash movement effect tests at an inflow face velocity average of [velocity] FPM at the [sash height]. Other data presented is informational only. Please refer to Section 3 for a summary of test data and Appendix B for hood data sheets.

The images below depict the front of the fume hood tested and a sketch of the room layout.

[photo of hood tested]	[depiction of room size, and location of fume hood, supply and exhaust vent, doors and windows, and any large equipment present in the lab]

Figure 1. [Model and manufacturer] fume hood.

Figure 2. Room layout.

8. PERFORMANCE TESTS

The following tests are based on SEFA, ANSI Z9.5, and ACGIH ventilation standards. They are provided as requirements for the evaluation of fume hood performance data for SEFA Certified As-Manufactured tests.

8.1. CROSS DRAFT TEST

The test lab in which AM tests are performed should be effectively draft free. Cross draft velocities shall not exceed 30 FPM (0.15 m/s) near the hood opening. High cross draft velocities are particularly detrimental to hood performance when vertical sashes are raised above the design operational height.

8.2. FACE VELOCITY TEST

The hood should be tested at or slightly below the manufacturer's minimum recommended face velocity. The face velocity shall be 80 FPM (0.4 m/s) or less. The sash shall be at the manufacturer's recommended operating opening or greater.

8.3. AIRFLOW VISUALIZATION TEST

Containment characteristics shall be determined visually and in the absence of a mannequin. Results are reported as a qualitative judgment of airflow distribution according to the latest version of ANSI/ASHRAE 110. SEFA does not assign pass/fail criteria for this segment of the test.

8.4. STATIC TRACER GAS CONTAINMENT TEST

Hood shall provide an ASHRAE 110 As-Manufactured rating below an average of 0.05 ppm (4AM0.050), measured for the specified time in the breathing zone of a stationary mannequin positioned directly in front of the ejector location, as detailed in ASHRAE 110.

8.5. SASH MOVEMENT EFFECT TEST

Hood shall provide an ASHRAE 110 As-Manufactured rating below a 45-second rolling average of 0.05 ppm (4AM0.050) measured in the breathing zone of a stationary mannequin positioned directly in front of the ejector location, as detailed in ASHRAE 110.

8.6. PERIPHERY SCAN TEST

Data should be collected in the absence of a mannequin and recorded per the ASHRAE 110 test method. SEFA does not assign pass/fail criteria for this segment of the test.

8.7. LOW VELOCITY (HIGH PERFORMANCE) TEST

The hood shall be tested at a face velocity of 60 FPM (0.3 m/s) or less.

Vertical rising sashes shall be tested when positioned to the maximum physical opening. There shall not be less than 28 in. (71.1 cm) from the work surface to the bottom of the sash handle.

Horizontal travel sashes shall be tested when positioned to their maximum physical horizontal opening.

Combination sashes shall be tested in two sash configurations:

- With the horizontal travel panels closed, the entire assembly shall be positioned to the maximum physical vertical opening. There shall not be less than 28 in. (71.1 cm) from the work surface to the bottom of the sash handle.
- With the vertical travel assembly closed, the horizontal travel sashes shall be positioned to their maximum physical horizontal opening.

9. AS-MANUFACTURED LABORATORY FUME HOOD PERFORMANCE TEST RESULTS[18]

Test Date:		**Hood ID:**	
Prepared By:		**Manufacturer:**	
Address:		**Model Number:**	
Phone No.:		**Serial Number:**	
Website:		**Manufacture Date:**	

Sash Type	
Vertical:	☐
Horizontal:	☐
Combination:	☐
Other (please detail):	☐

		Sash Position During Test	**Sash Opening Dimensions (l in. x h in.)**	**Average Face Velocity (FPM)**	**Exhaust Flow[19] (CFM)**	**Average Max Cross Draft (FPM)**	**Tracer Gas Average (ppm)[20]**				
							Left	**Center**	**Right**	**SME**	**Perip.**
Test Results											
SEFA Standard Performance Criteria Met (Yes/No)			N/A		N/A						N/A
SEFA Low Velocity (High Performance) Criteria Met (Yes/No)			N/A		N/A						N/A
Airflow Visualization Observations	Small Volume										
	Large Volume										

Meets all SEFA 1 Standard Criteria (Yes/No)	
Meets all SEFA 1 Low Velocity (High Performance) Criteria (Yes/No)	

[18] The data shall not be interpreted to ascribe performance characteristics to larger sash openings than tested or to lower average face velocities than measured.
[19] Calculated exhaust flow (CFM) = measured average face velocity (FPM) x face opening area (sq.ft).
[20] Tracer gas concentration in mannequin's breathing zone.

1.

APPENDIX A:
CERTIFICATES OF CALIBRATION

APPENDIX B:
HOOD INFORMATION AND PERFORMANCE TEST DATA SHEETS