Scientific Equipment & Furniture Association
Recommended Practices

SEFA 1-2010
Laboratory Fume Hoods

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SEFA SPELLS SAFE®

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Foreword

SEFA Profile

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

SEFA Recommended Practices

SEFA and its committees are active in the development and promotion of Recommended Practices having domestic and international applications. Recommended Practices are developed by the association taking into account the work of other standard writing organizations. Liason is also maintained with government agencies in the development of the specifications.

SEFA's Recommended Practices are developed in and for the public interest. These practices are designed to promote a better understanding between designers, architects, manufacturers, purchasers, and end-users and to assist the purchaser in selecting and specifying the proper product to meet the user's particular needs. SEFA's Recommended Practices are periodically updated. The Recommended Practices are numbered to include an annual suffix which reflects the year that they were updated. SEFA encourages architects to specify these Recommended Practices as follows: "SEFA 1-2010".

Glossary of Terms

SEFA has developed a Glossary of Terms (SEFA 4-2010) for the purpose of promoting a greater understanding between designers, architects, manufacturers, purchasers and end users.
The terms defined by SEFA are frequently used in contracts and other documents, which attempt to define the products to be furnished or the work involved. The Association has approved this Glossary in an effort to provide uniformity among those who use these terms. Where a specific Recommended Practice contains definitions which differ from those in the Glossary of Terms, then the definitions in the specific Recommended Practice should be used.

SEFA encourages all interested parties to submit additional terms or to suggest any changes to those terms already defined by the Association. The definitions should be used to help resolve any disputes that may arise or to incorporate the applicable terms in any contract or related documents.

SEFA Disclaimer

SEFA uses its best effort to promulgate Recommended Practices 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 Recommended Practices or that any tests conducted under its Recommended Practices will be non-hazardous or free from risk. SEFA encourages the use of third party independent testing.

Note : ***Testing as described in this document must be performed and documented by a SEFA-approved third party testing facility. See Page 34 of the SEFA Desk Reference 5th Edition Version 2.0, or visit us at SEFALABS.COM for the most current list of SEFA-approved test labs.***

1.0 Purpose

The purpose of these Recommended Practices is to provide architects, engineers, planners, specifiers, manufacturers and end users with the Industry Standard Practices. These Recommended Practices cover the design, construction, installation, testing, maintenance and safe use of laboratory fume hoods.

2.0 Scope

These Recommended Practices provide a comprehensive single source of knowledge pertaining to laboratory fume hoods. Since the laboratory fume hood is integral to the Laboratory Ventilation System, these practices will address the entire system as it relates to the laboratory fume hood.

A Laboratory Ventilation System includes the Supply Air System; the Exhaust Air System (which includes room air exhaust in addition to the laboratory fume hood exhaust); the Laboratory; the Laboratory Fume Hood, and other ventilated enclosures.

3.0 Laboratory Fume Hood Defined

A Laboratory Fume Hood is 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, when connected to a properly designed laboratory ventilation system. A Laboratory Fume Hood shall be made primarily from flame resistant materials including the top, three fixed sides, and a single face opening. Face opening is equipped with a sash and sometimes an additional protective shield. Face opening will have a profiled entry and usually an airfoil designed to sweep and reduce reverse airflows on the lower surface. A Laboratory Fume Hood will be equipped with a baffle and, in most cases, a bypass system designed to control airflow patterns within the hood and manage the even distribution of air at the opening. The bypass system may be partially blocked to accommodate Variable Air Volume (VAV) Systems. A Laboratory Fume Hood will be set on a bench, a pedestal or on the laboratory floor.

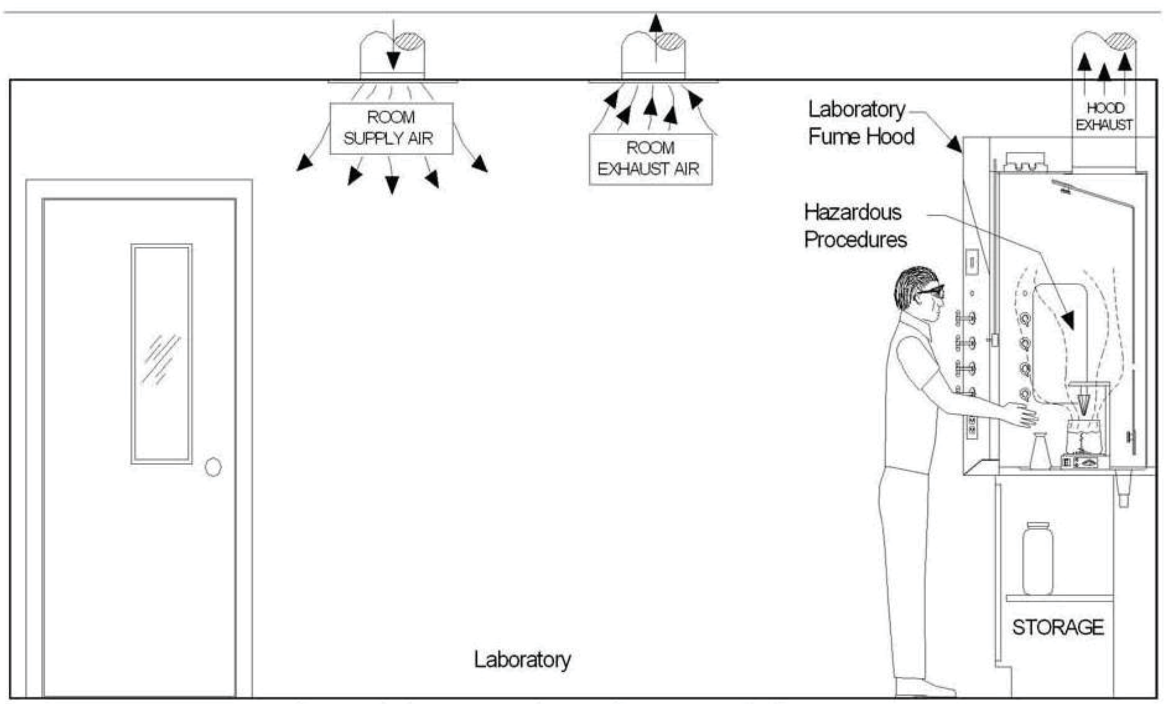

Fig. 1 Typical Constant Volume Laboratory Ventilation System

A Laboratory Fume Hood is given here as the proper terminology. Other widely used terms include --- Fume Hood, Chemical Hood, Chemical Fume Hood, Hood, and Fume Cupboard.

Laboratory fume hoods are perhaps the most widely used and misused safety devices. 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. However, the flexibility offered by different designs and operating configurations can result in varying levels of performance and operator protection. Great care must be employed by the user when using a laboratory fume hood. Consult the manufacturers' Recommended Practices for Specific Operation, Safety and Maintenance Guidelines.

3.1 Family of Ventilated Laboratory Safety Devices

The laboratory fume hood is part of the ventilated laboratory safety device family and can be sub-categorized by type. (See Figure 2)Each type is connected to a laboratory ventilation system. These "other" systems are described in Section 8.0.

3.2 ASHRAE-110 Protocol

This practice is organized to be consistent with the ASHRAE 110 protocol. "As Manufactured" issues in this practice are directed to fume hood practices that are pertinent to the hood manufacturers' location. "As Installed" identifies those that occur in a newly constructed or renovated laboratory prior to the user occupying the lab. The "As Used" section helps with issues after the installation is complete and how the hood is to be or is being used.

Types of Ventilated Devices

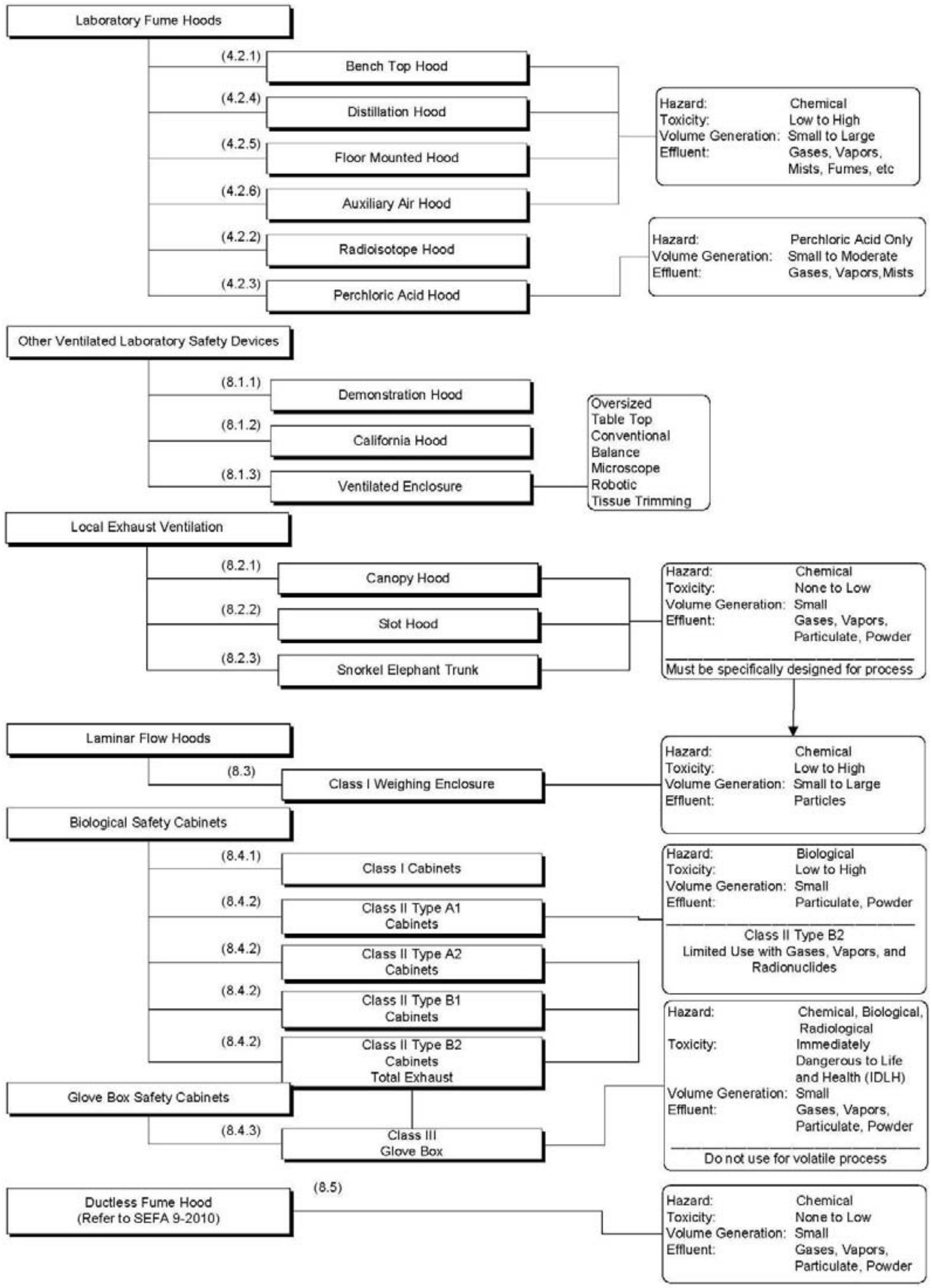

Fig. 2

4.0 Laboratory Fume Hood - As Manufactured

There are a wide variety of fume hood designs. Underwriter's Laboratories (UL) Standard 1805 outlines requirements for the structural integrity, the flame and chemical resistance, the plumbing piping and electrical wiring of the fume hood structure. SEFA recommends the fume hood be classified under UL standard 1805. They generally share a number of similar characteristics and components. The hood depicted in Figure 3 below, shows generalized components of laboratory fume hoods.

4.1 Components of Laboratory Fume Hoods

4.1.1 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 could improve hood performance.

The enclosure of the hood is designed to protect against chemical attack. However, if the exterior surfaces of your hoods exhibit corrosion or deterioration, investigate the source.

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 a bypass opening when the sash is lowered or closed. Some flush sills employ a trough for spillage containment and slots to direct airflow over the work surface.

4.1.2 Hood Interior

Fume chamber and baffles shall be constructed of materials that are resistant to the chemical fumes, vapors and condensation particulate that may collect and deposit on the interior surface of the fume chamber and baffles. Consideration should be given to the desired color and specifications of liner materials that are resistant to the chemical exposure and corrosion resistance 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

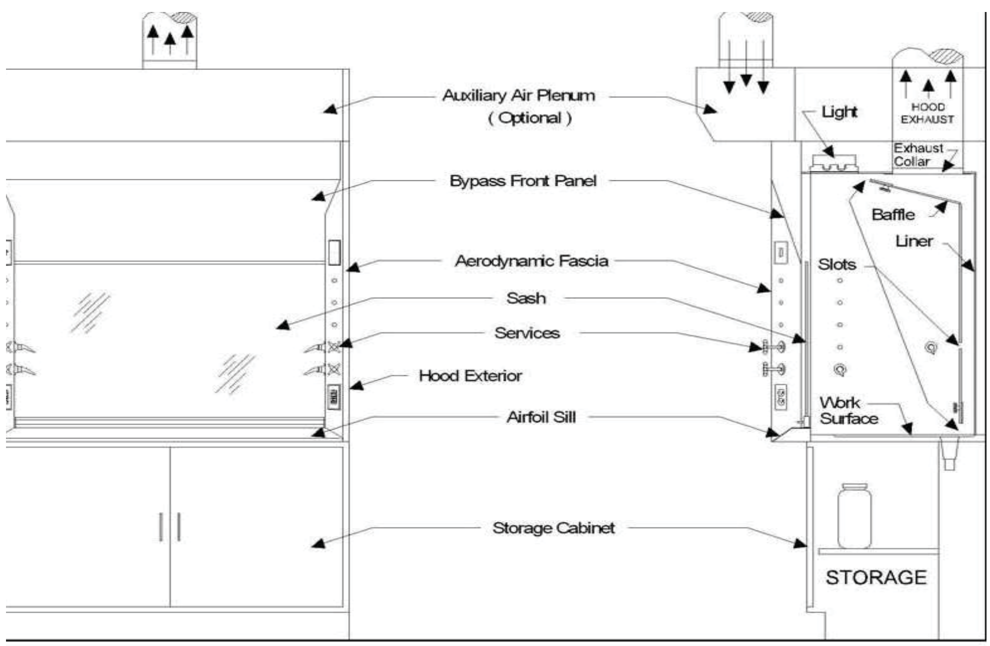

Fig. 3 Typical Components of a Bench Top Hood

melamine, chemical resistant mineral board, and sheet steel. Liner materials should be flame retardant, self-extinguishing and 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 potential of fire hazard in the fume chamber, for safety reasons the fume hood should be equipped with automatic fire suppression and alarm system or, in some cases, local jurisdiction may require fire suppression system, wet or dry.

4.1.3 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 are sometimes adjustable. The location, size, shape and configuration of baffle slots significantly affect the performance of the laboratory fume hood. (See: Knutson, Gerhard W. "Effect of Slot Position on Laboratory Fume Hood Performance", Heating/Piping/Air conditioning Feb. 1984: 93-96).

4.1.4 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 should 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, e.g. "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 length of the hood. Typically hoods longer than six feet have more than one exhaust collar for connection to the exhaust ducts.

4.1.5 Hood Bypass

Open Bypass: On hoods equipped with a vertical rising sash, an open bypass is used 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 six inches, shall be no more than three times the velocity at the sash 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. This helps maintain a constant exhaust volume.

Restricted Bypass: The restricted bypass serves the same function as the open bypass, but the bypass is smaller. This is done to reduce the amount of air required by the laboratory fume hood in the operating mode for VAV systems, horizontal, and combination sashes. Eliminating the bypass completely is not recommended due to the potential risk of contaminate leakage.

Minimum exhaust volume is recommended at 25cfm per square foot of work surface. (See: latest edition of NFPA 45 Standard on Fire Protection for Laboratories Using Chemicals.)

4.1.6 Hood Sash

The sash is a moveable panel(s), most typically transparent, provided on fume hoods to restrict the opening and provide a protective barrier between the operator and the experiment. Sashes are available in a variety of configurations that enable vertical and/or horizontal movement of sash panels. Regardless of configuration, the sash shall be designed to move freely and not bind. Force to open the sash shall be reasonable for the size and weight of the sash.

Typically a five foot hood with a vertical rising sash shall 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.

Sashes are typically designed so that closing the sash does not restrict the area beneath the airfoil sill. This leaves the area beneath the airfoil open when the sash is fully closed.

Sash height limiting devices (also known as sash stops) are sometimes provided to limit the vertical opening of the sash. Sash stops are used to provide a safe operating condition based upon 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 is defeatable, the sash can be opened to the "maximum sash opening" or the "load sash position". ASHRAE 110 testing should be performed at both, the design opening and the maximum opening. If fume containment is unacceptable when the sash stop is bypassed, a warning label should be mounted on the fume hood clearly identifying the operating sash height and the potential dangers on bypassing the sash stop.

Sash types are generally referred to as vertical, horizontal or combination depending on the allowable movement of the sash panels. (See: Figure 4).

Vertical Sash: A vertical sash has one or more panels that can slide up and down to a height required by the operator. 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. Vertical sashes may also be designed split into multiple vertical rising sashes.

Horizontal Sash: A horizontal sash has typically two or more panels that slide horizontally across the hood opening. The sash 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, but allow access to the top 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 should be used as a barrier from hazards within the hood. The sash panel should be placed between the operator and the hazard whenever feasible.

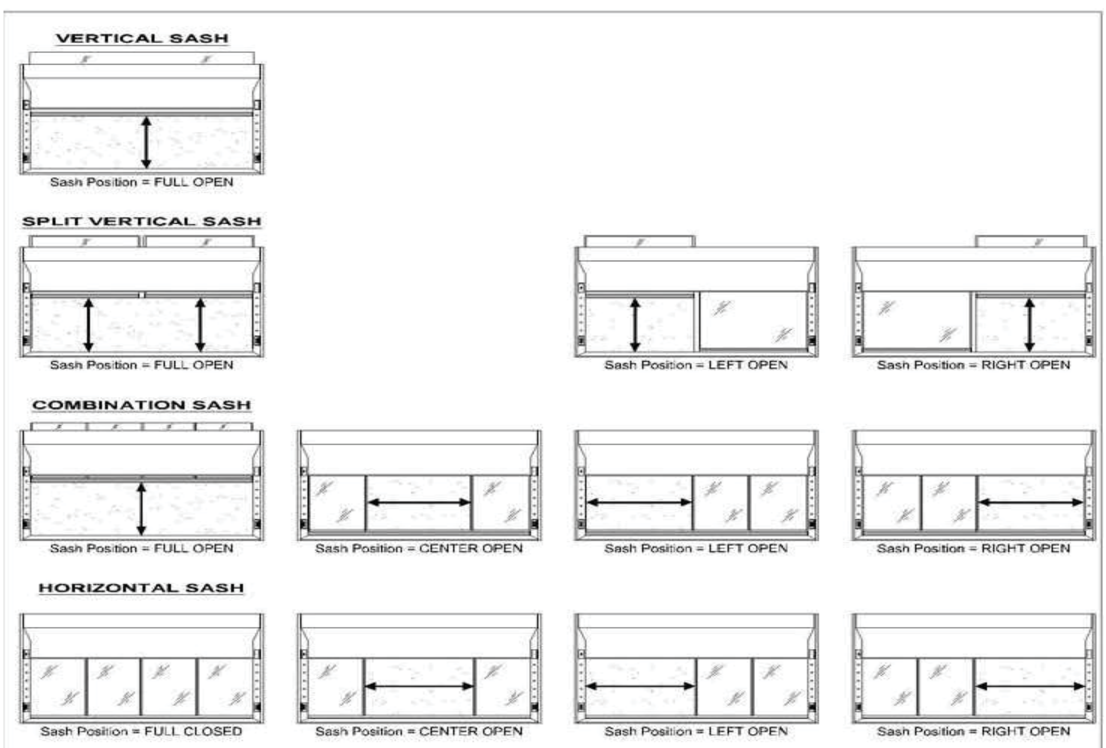

Fig. 4 Typical Sash Configuration for Different Sash Types

Telescoping Sash – Two or more vertically moving sash elements whose movements are linked.

4.1.7 Hood Work Surface

Work surfaces are typically made of a material that provides good heat and corrosion resistance and is easily cleaned and decontaminated. The work surface should have a recessed area. The dished or recessed area is designed to provide containment of small spills and provide demarcation of the recommended work area inside the hood. Refer to SEFA 3 – Recommended Practices for Work Surfaces.

4.1.8 Hood Lights

Most fume hoods are equipped with some type of light. Lights come in a variety of designs depending on the anticipated use of the hood. Most lights are 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 should be from the hood exterior. The light shall be designed to provide a minimum of 80 foot candles on any part of the bench level (36" from the floor) work surface. Incandescent vapor proof lights as well as incandescent and fluorescent explosion proof lights are optional and available as specified. Many manufacturers offer electronic ballasts and energy efficient T8 or T5 bulbs.

4.1.9 Hood Services

Many hood manufacturers can equip hoods with a variety of amenities or services. The more popular services include electrical outlets, sinks, fixtures and plumbing for gas, vacuum, and air. For increased safety, controls for these services should always be accessible from outside the hood opening.

Service Fixtures: All service fixtures 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) should be external to the hood interior, clearly identified and within easy reach. All internal service fixture outlets shall be corrosion resistant to the application. (See SEFA 7—Recommended Practices for Laboratory Fixtures.)

Connections for services will vary, depending on the point of origin and number of fixtures. Service lines may be brought in from below, down from the ceiling, or 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% copper). (See: Uniform Building Code, 2000 Edition, International Association of Plumbing and Mechanical Officials, 20001 Walnut Drive, South Walnut, CA 91789 www.iapmo.org).

- 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: Check your regional or local codes for jurisdiction and material allowance. There are regional differences.

Electrical Receptacles: All electrical receptacles should be readily accessible. Provisions shall be made so that all electrical wiring will be isolated and 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 within fume hood interior, they should be installed per NFPA and UL recommendations.

NOTE NFPA allows electrics inside hood. (See: NFPA 45 Standard on Fire Protection for Laboratories Using Chemicals, latest edition).

Flammable materials are used successfully in most hoods. In an extreme case, such as specifying a laboratory fume hood for highly volatile, flammable, hazardous procedures and use (for a complete list, request NFPA - National Fire Protection Association Publication #497M), follow NEC codes. NEC divides materials into classes and groups according to the type of explosive agent that may be present. In addition, if there is a very high risk of fire, the fume hood should be equipped with a fire suppression system. Sufficient air volume must be exhausted through the hood to dilute flammable effluents below the lower explosive limit level. See NFPA 45 for more information on minimum recommended exhaust volumes. (See: NFPA 70 National Electrical Code, 2002 Edition, NFPA).

Fire Suppression Systems:

• Any fire suppression system used in a chemical fume hood should be compliant with local codes and regulations, and NFPA 17.

• Any fire suppression system should be rated for fire classes A, B, C with manual and thermal activation triggers. Other water or liquid based systems may be acceptable if appropriate testing and certification are available.

• No fire dampers of any kind should ever be installed in a chemical fume hood exhaust system.

• Flammable materials should never be stored directly below a chemical fume hood in anything but an NFPA specified, UL listed or FM approved solvent storage cabinet.

4.1.10 Hood Monitor

All hoods shall have some type of monitor for indicating face velocity or exhaust flow verification. The monitor can be a simple pressure gage 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 clear indication to the hood user whether exhaust flow or face velocity is within design parameters.

A ribbon taped to the bottom of the sash is not acceptable.

4.2 Types of Laboratory Fume Hoods

4.2.1 Bench-Top Fume Hoods

A bench-top fume hood is a hood that is generally placed on a bench-top or above a storage cabinet. Bench-top hoods are available in different sizes to accommodate a variety of chemical processes. The critical dimensions for a hood include length, depth and interior height;

however, hood size is generally determined by the overall width of the hood. A five foot hood includes the width of the face and the side panels and is not a measure of the opening width. 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.

Bench-top hoods can be used for a wide variety of chemical procedures. The bench-top hood is appropriate for use with small to moderate quantities of low to highly toxic materials.

Depending on the materials of construction and operating configuration, this type of hood can provide effective containment, and exhaust of gases, vapor, mists, fumes and other aerosols having low particle mass.

4.2.2 Radioisotope Fume Hood

A fume hood used for Beta and Gamma radiation shall be referred to as a radioisotope hood. 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 respects. Horizontal sash panels are not appropriate for this fume hood type.

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 pounds per square foot (90.71 Kg m2) minimum

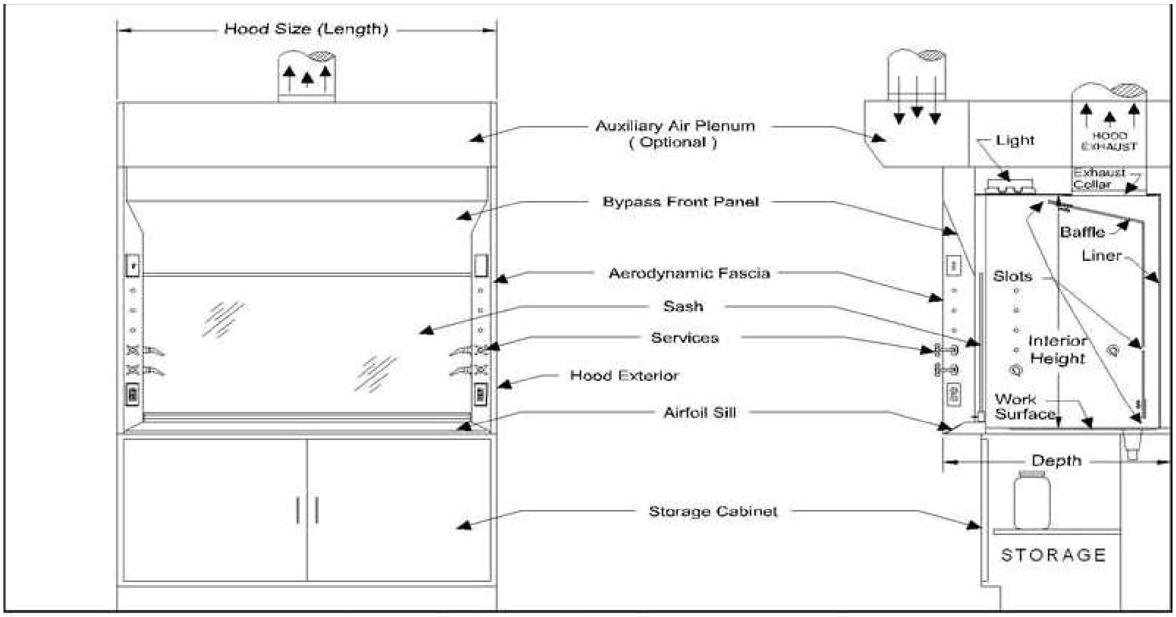

Fig. 5 Typical View of Bench Top Fume Hood

up to a total weight of 1,000 pounds (453.6 Kg) per fume hood or base cabinet section.

4.2.3 Perchloric Acid Fume Hood

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

In addition, the hood, duct, and fan must have a water wash down system to remove perchlorates and prevent the build-up of potentially explosive perchlorate salts. Drain outlet shall be designed to handle a minimum of 15 gallons (56.8 liters) per minute. The work surface on perchloric acid hoods 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 which 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 perchloric acid hood is the same as conventional or bypass fume hoods.

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

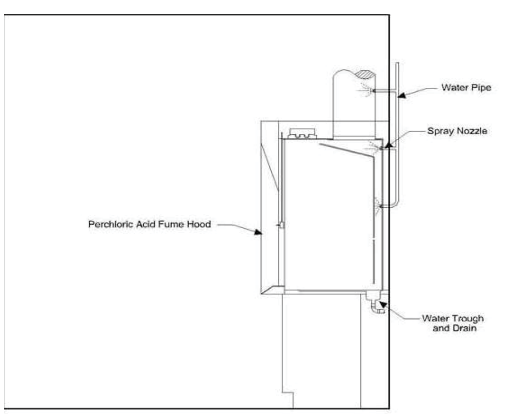

Fig. 6 Typical View of Perchloric Acid Fume Hood

4.2.4 Distillation Fume Hood

A distillation fume hood is designed for use with tall apparatus and 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. The hood is suitable for work that can be conducted in a bench-top hood; however, the greater interior height enables use of larger apparatus.

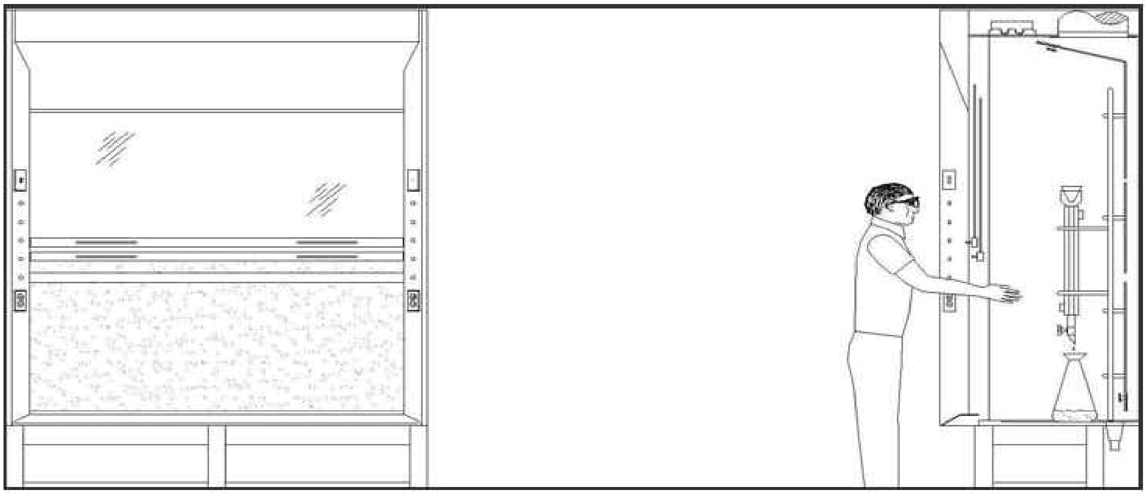

Fig. 7 Typical View of Distillation Fume Hood

The distillation hood is mounted on a pedestal that elevates the work surface to a heightbetween 12 and 18 inches above the floor.

Distillation hoods can have vertical rising sashes or horizontal sliding panels. Generally, more than one sash panel is used on a vertical rising sash. The vertical sash design generally enables a rather 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.

4.2.5 Floor Mounted Fume Hood (Commonly known as a Walk-in Fume Hood)

A floor-mounted hood is used for large apparatus and storage of containers that pose some 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.

Floor mounted hoods are typically equipped with horizontal sliding sashes, although some models

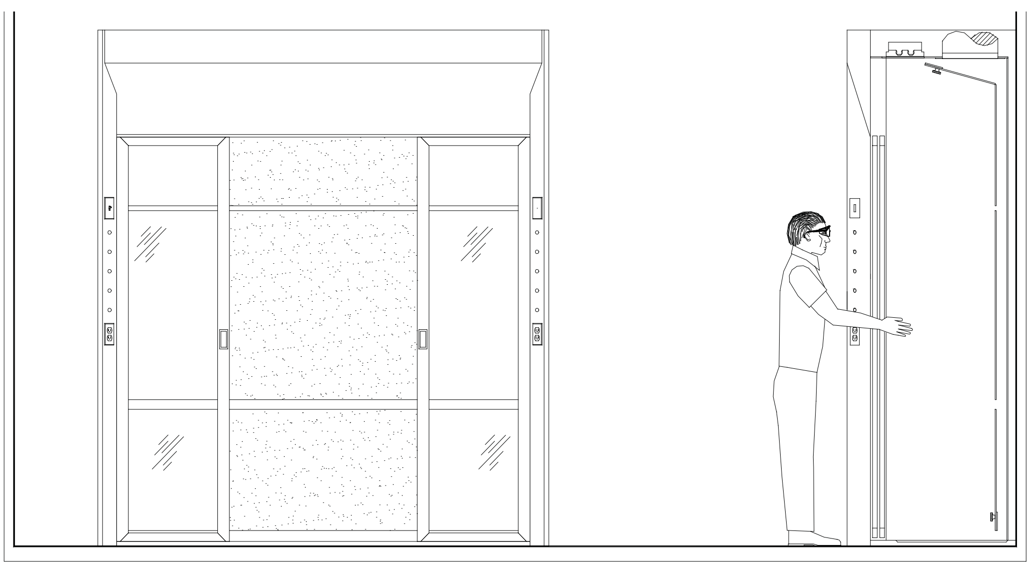

Fig. 8 Typical View of Floor Mounted Fume Hood

are equipped with multiple vertical sliding sashes. Horizontal sashes are recommended on hoods over eight feet in width.

The name "walk-in hood" implies that the hood can be entered; however, the name is a misnomer, as the same safety precautions should be applied to this hood, as those required 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, we refer to these structures as floor mounted fume hoods.

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

It is recommended that only one sash be fully opened during hood operation on floor mounted hoods with multiple vertical sashes. Both sashes are to be fully opened during set up only.

4.2.6 Auxiliary Air Fume Hood

The auxiliary air system, when added to a standard laboratory fume hood, shall function 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(es) open.

With the sash(es) closed, auxiliary air shall 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.

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

Auxiliary air fume hoods shall also conform to the following requirements:

- 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(es) 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 manufactures.
- Function in accordance with the performance characteristics listed above when tested by appropriate evaluation procedures.

- Never pressurize the hood chamber with auxiliary air.

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

4.3 Energy Efficient Fume Hood

Energy efficient fume hood (also known as Low Exhaust Volume, or LEV fume hoods) designs can offer significant reductions in the volume of exhaust air required to safely operate the fume hood. Energy efficient hoods can be divided into two categories: Low Flow Fume Hoods and Low Velocity Fume Hoods.

- Low Flow Laboratory Fume Hoods are hood designs that 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 through a fully opened vertical sash, e.g: a typical 6' wide bench mounted fume hood requires approximately 1100 CFM of exhaust flow to achieve an average face velocity of 100 FPM through a fully opened vertical sash. A 6' wide hood operating at less than the volumetric exhaust flow would be classified as a Low Flow fume hood.

- Low Velocity Laboratory Fume Hoods are hood designs that 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 through a fully opened vertical sash and provides containment levels equivalent or superior to ASHRAE 110 tracer gas test ratings of 4.0 AM 0.05, and 4.0 AI/AU 0.10, with a face velocity of 60 FPM or less through the fully opened vertical sash. Low

Velocity Fume Hoods are also referred to as High Performance Fume Hoods and High Efficiency Fume Hoods.

NOTE: Low Flow hoods which 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" shall be considered a vertical sash opening not less than 25" high off the fume hood work surface.

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" which are integral to the superstructure of the energy efficient fume hood. These control systems often enhance the safety afforded to the fume hood operator during use. The maintenance of these safety control systems should be performed in accordance with the manufacturer's guidelines to ensure safe and proper operation of the fume hood.

Energy efficient fume hoods are available in bench mounted, floor mounted, distillation and specialty hood types. Energy efficient fume hood designs are appropriate for almost all of the same applications as traditional fume hood designs. While energy efficient fume hoods can be integrated into any type of laboratory ventilation system, most often these style fume hoods are installed on Constant Air Volume (CAV) systems. However, these hoods can operate on Variable Air Volume (VAV) systems and Switched Two-State systems. The return-on-investment period should be evaluated when deciding which type of system to use.

It has been determined that there is no direct statistical correlation between a fume hood's average face velocity and the containment levels provided by the fume hood. (See: Hitchings, Dale T. "Laboratory Fume Hood Testing: Face Velocity Does NOT Equal Safety" Laboratory Safety & Environmental Management 3.6 (1995)).

On a properly designed fume hood, a lower face velocity can actually enhance fume hood performance through aerodynamic design and reduced turbulence. SEFA recommends the ANSI/ASHRAE 110 test to evaluate the performance of all laboratory fume hoods, including the energy efficient fume hoods. Currently, there are 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 standard as traditional fume hood designs. However, the ASHRAE Standard allows for owners, engineers and/or architects to specify specific challenges to any fume hood design to investigate the fume hood's ability to perform under less than ideal conditions. Tests have been performed with the hood chamber loaded with equipment and apparatus, thermal challenges within the fume hood chamber, cross drafts, walk-by traffic, etc.

4.4 Testing of Laboratory Fume Hoods - As Manufactured

The ASHRAE 110 test is a method of testing the performance of laboratory fume hoods. There are three test procedures incorporated into the 110 test; the first is the face velocity grid test, the second is the flow visualization or smoke test and the third is the tracer gas containment test. The ASHRAE 110 is the recognized method for evaluating the performance of fume hoods; ASHRAE has defined three modes, As Manufactured (AM), As Installed (AI), and As Used (AU). The ASHRAE test should be conducted by an authorized person cognizant of each of the three test procedures.

4.4.1 Face Velocity

Face velocity shall be adequate to provide containment. Face velocity is not a measure of safety.

Refer to ASHRAE 110 – 1995 (or latest edition) for velocity measurement procedures.

Face Velocity Guide –The most widely accepted range of average face velocities is 60 FPM to 100 FPM. The measured deviation across the face may vary + 20 FPM. (For more information on this topic, refer to Section 12.0 Regulatory and Industry Consensus Standards.)

4.4.2 Containment Testing – As Manufactured

The manufacturer shall provide standard (AM) test data for all standard hoods. This should be done in accordance with the most current ASHRAE 110 Standard. The AM testing demonstrates what the hood is capable of doing under controlled conditions. The report shall verify that all laboratory fume hood types specified have been tested to ASHRAE 110-1995 (or most current edition) procedures and have achieved AM 0.05.

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

The ASHRAE 110 Standard includes procedures for:

Inspection of the Hood;
Evaluation of Laboratory Conditions;
Airflow Visualization;
Airflow Velocity Measurements; and
Tracer Gas Containment Tests.

4.4.3 Static Pressure - Bench Mounted Fume Hood

See Industrial Ventilation Manual for Static Pressure Measurement Procedures. (See: Ind. Ventilation: A manual of recommended practice, 24th Edition, American Conference of Governmental Industrial Hygienists, 1330 Kemper Meadow Drive, Cincinnati, OH 45240 www.acgih.org)

With sash at full-open position, static pressure loss through the fume hood shall be no more than ¼ inch (6.35 mm) of water gauge when the fume hood operates at face velocity of 60 feet per minute (.30 m/s), ½ inch (12.70 mm) of water gauge at 100 feet per minute (.51 m/s), ½ inch (12.70 mm) of water gauge at 120 feet per minute (.62 m/s). The manufacturer shall state the design static pressure loss for all standard catalog models. For all constant volume laboratory fume hoods equipped with a bypass, static pressure loss and exhaust volume shall be relatively constant regardless of sash position. The velocity when measured at the sash opened six inches, shall be no more than three times the velocity at the sash operating opening.

5.0 Laboratory Fume Hoods - As Installed

5.1 Location in Laboratory

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

Laboratory fume hoods should be so located within the laboratory to avoid crosscurrents at the fume hood face due to heating, cooling or ventilating inlets.

Sufficient makeup air must be available within the laboratory to permit fume hoods to operate at their specified face velocities.

Other location factors to be considered are as follows:

Number and types 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.

5.2 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 should be located within the laboratory so that in the event of a fire or explosion within the fume hood, exit from the laboratory would not be impeded.
Laboratory fume hoods should be located away from high traffic lanes within the laboratory because 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 should be provided in front of the fume hood to avoid disruption of the work or interference with the operating technician by passing personnel.

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

Other safety factors to be considered:

Type of research being conducted;

Proximity to associated bench mounted or free standing instrumentation machines;

Type and number of associated fume hood enclosures;

Number of research and/or student users in laboratory space.

Refer to SEFA 2 Recommended Practices for Installation.

Refer to SEFA 7 Recommended Practices for Laboratory Fixtures.

5.3 Fume Hood Evaluation – As Installed

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

It is recommended that the user make provisions to have the following test performed on all laboratory fume hoods. These tests should be performed by qualified personnel to verify proper operation of the fume hoods before they are put to use. Testing should be repeated at least annually, or whenever a significant change in the hood system occurs. Any unsafe conditions disclosed by these tests should be corrected before using the hood. It is recommended that hoods be tested in accordance with ASHRAE 110-1995 (or most current edition) before put into service. Some form of annual certification should be incorporated at the owners discretion.

The ASHRAE 110 test is a method of testing the performance of laboratory fume hoods. There are three test procedures incorporated into the 110 test; the first is the face velocity grid test, the second is the flow visualization or smoke test and the third is the tracer gas containment test. The ASHRAE 110 is the recognized method for evaluating the performance of fume hoods; ASHRAE has defined three modes, As Manufactured (AM), As Installed (AI), and As Used (AU). The ASHRAE test should be conducted by an authorized person cognizant of each of the three test procedures.

5.3.1 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 should be less than 50% of the face velocity, not to exceed 30 FPM. Any cross drafts that exceed these values shall be eliminated before proceeding with fume hood test. Crosscurrents of sufficient magnitude can have a detrimental effect on the ability of a fume hood to contain and exhaust air contaminants. It is therefore advised to keep crosscurrents in the vicinity of the face of a fume hood to a minimum.

5.3.2 Sash Operations

Check operation by moving sash(es) through its (their) full travel. Sash operation shall be smooth and easy. Vertical rising sashes shall hold at any height without creeping up or down, unless designed otherwise. Force to

open the sash shall be reasonable for the size and weight of the sash. Typically a five foot hood with a vertical rising sash shall 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.

5.3.3 Evaluation of Low Air Flow Monitor

On fume hoods with low flow warning devices, verify that monitor functions properly and indicates unsafe conditions.

5.3.4 Face Velocity

Determine specified average face velocity for fume hood being tested. Perform the following test to determine if fume hood velocities conform to specifications.

Face velocity shall be adequate to provide containment. Face velocity is not a measure of safety.

Refer to ASHRAE 110 – 1995 (or latest edition) for velocity measurement procedures.

Face Velocity Guide – The most widely accepted range of average face velocities is 60 FPM to 100 FPM. The measured deviation across the face may vary + 20 %. (For more information on this topic, refer to Section 12.0 Regulatory and Industry Consensus standards.)

5.3.5 Containment Testing – As Installed

SEFA recommends the ASHRAE 110-1995 (or most current edition) test.

5.4 Trouble Shooting

When fume hood test procedures detect improper function, the cause is frequently due to insufficient quantity of air flowing through the hood, or due to 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 pinpoint and correct the problems.

5.4.1 Insufficient Airflow

Insufficient airflow through the fume hood can be caused by one or more of the following conditions. Each condition should be checked, and eliminated if possible to determine which one or combination of conditions may exist:

• Double-check your readings.

• Check airflow velocity meter type. When was it calibrated last? Is the battery good? Was the instrument zeroed before taking readings?

• Check to make sure the instrument is recommended for low air velocities in the 50 to 150 feet per minute (.25 to .76 m/s.) range.

If possible, verify readings with another air velocity meter or by checking air volume using a pitot tube traverse of exhaust duct.
Low airflow through the fume hood can be caused by a large negative room static pressure as a result of inadequate makeup air being brought into the room. With the fume hood and other exhaust unit in operation, check room static pressure by:

• Verification using inclined manometer.

• Checking inrush of air into the room through a door or an open window.

• Checking ventilation system balance and verify the quantity of makeup air.

• Verify that fume hood baffles are in an open position.

• Insure that baffle openings are not blocked with large or bulky apparatus. Improper sizing or operation of exhaust unit or both may be the cause.

• Confirm exhaust unit rotation is correct. Make and model is as specified.

• Supply voltage is correct.

• Motor horsepower and speed is appropriate.

• Exhaust unit inlet and outlet conditions are suitable.

• Check for special or bulky equipment that interferes with airflow through the fume hood.

5.4.2 Room Cross Drafts

Cross drafts in front of the fume hood face can cause the fume hood to lose containment and present a safety hazard to laboratory space occupants. Cross drafts in front of the fume hood should be kept to a minimum at all times and specifically when the fume hood is being used by an operator. Each of these issues should 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 can cause cross drafts.

An open window or room air supply grill located to one side or across from the fume hood can cause disturbing cross drafts.

High velocity air from ceiling-mounted diffusers or room air supply can cause cross drafts or downdrafts.

Cross drafts can occur when thermal gradients in the lab space are caused by the introduction of supply air at a significant T, compared to 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, if at all possible, by the location of the fume hood or changing the design of or modifying the location of supply air diffusers. The velocity of the cross drafts should not exceed 50% of the face velocity or 30 FPM.

5.4.3 Exhaust Unit and Duct Considerations

Where laboratory building design permits, the exhaust unit should be located on the roof of the building to provide a negative pressure in that portion of the duct system located within the building.

The exhaust unit should be sized to exhaust the volume of air necessary to attain the selected fume hood face velocity at the total system static pressure loss. Care should be taken to ensure the exhaust unit has 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.

Exhaust units should be sized to achieve the lowest practical angular speed of the impeller, thereby avoiding high impeller tip speed and minimizing noise associated with this revolving member.

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

Elbows, bends and offsets within a duct system should be kept to a minimum and should 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 re-circulating systems.

5.4.4 Make-up Air

Make-up air is a ventilation term indicating the supply of outdoor air to a building replacing air removed by exhaust ventilation systems. In general, laboratories require four to twelve total volume changes per hour. Refer to OSHA 1910.1450, Page 492 and NFPA 45, 2000, Page 45-27, A.6.3.3. Special applications may require more air changes per hour.

A sufficient quantity of makeup air must be available to allow fume hoods to develop required face velocities.

Consideration must be given to the makeup required for air changes in each specific laboratory involved. 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, makeup air systems and auxiliary air performance, if applicable, must be considered.

Due to the possibility of toxic and/or hazardous material being handled within laboratories, air exhausted from these laboratories should not be re-circulated.

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

5.4.5 Laboratory Fume Hood Inspection and Maintenance

Inspection procedures should include instrument verification of fume hood face velocity, which should be equal to the velocity recorded at the time of the ASHRAE 110-95 (or latest edition) performance test and fume hood commissioning.

Inspection procedures should consist of a physical examination of liner condition and cleanliness, baffle and sash operation and condition, counter balance cables, light operation and condition, and service fixture function.

Inspection results should be recorded and reported to the proper authority for any required action. Where extremely hazardous or corrosive conditions exist or when filters are present in the system, the inspection frequency should be increased appropriately. Velocity and pressure sensing detectors should be tested at each inspection. Low-flow or no-flow alarms of the visible or audible type should be tested for correct operation at least at each inspection. Fan belts should be inspected regularly.

5.5 Maintenance

Fume hood maintenance procedures consists primarily of clean up, adjustments, lubrication and replacement of worn, damaged or nonfunctioning parts. Use good housekeeping in laboratory fume hoods at all times. Periodically clean sash(es), exterior and interior surfaces, including light panel. Replace lamps periodically to maintain adequate illumination.

Clean up should be accomplished by, or under the supervision of a knowledgeable laboratory safety officer and should include removal of the baffle for clean up of all interior surfaces.

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

Flush all spills immediately using neutralizing compounds as required and clean thoroughly.

6.0 Laboratory Fume Hoods - As Used

6.1 Safe Work Practices

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

The following guidelines are provided to help reduce your potential for exposure when working with hazardous materials.

-Plan for conducting experiments.
-Wear appropriate personal protection.
-Verify proper system operation.
-Utilize proper work practices.

6.2 Plan for Conducting Experiments

Prior to conducting potentially hazardous procedures in a laboratory fume hood, evaluate the hazards and consult with a Safety Officer to develop appropriate safety protocols and evaluate whether the hoods and systems have the capability to provide adequate protection. In addition, follow the guidelines provided in your Chemical Hygiene Plan. If the guidelines are inadequate or inappropriate, help develop or amend procedures with your Chemical Hygiene Officer.

Prior to starting an experiment in a hood, answer the following questions:

What are the characteristics of the hazards associated with the procedure?

Is this the right type of hood?
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?

Verify that the ventilation system is working properly.

For example, if you are going to conduct a procedure involving use of heated perchloric acid, you must use a perchloric acid hood and the exhaust system must be equipped with a water wash down system. Failure to use a perchloric acid hood with a water wash down system could result in a future explosion or fire. Another example is to be cautious with a heat generating processes. Generated velocity due to the heat in a hood could result in counterproductive airflow. Is the fume hood liner resistant to the heat loads?

6.3 Wear Appropriate Personal Protection

Prior to conducting experiments wear appropriate personal protective apparel as required by the Chemical Hygiene Program and safety protocols. It is generally accepted that at a minimum, the appropriate apparel for working at a laboratory fume hood includes approved eye protection, lab coat, gloves, long pants and shoes (preferably safety shoes, open shoes such as sandals are not recommended).

Ensure that clothing and glove materials are appropriate for work with the hazards. For example, vinyl gloves provide excellent resistance to formaldehyde, but poor resistance to chloroform.

If unsure of the appropriate type of personal protective equipment required, consult with your Chemical Hygiene Officer.

6.4 Fume Hood Evaluation - As Used

The ASHRAE 110 test is a method of testing the performance of laboratory fume hoods. There are three test procedures incorporated into the 110 test; the first is the face velocity grid test, the second is the flow visualization or smoke test and the third is the tracer gas containment test. The ASHRAE 110 is the recognized method for evaluating the performance of fume hoods; ASHRAE has defined three modes, AS Manufactured (AM), As Installed (AI), and As Used (AU). The ASHRAE test should be conducted by an authorized person cognizant of each of the three test procedures.

Safety considerations require that a schedule of inspection and documentation be set up for every laboratory fume hood at least annually.

An inspection record should be maintained. This record may be in the form of a label attached to the fume hood, and/or a log maintained by the Laboratory Director or Health Safety Director. Include sash operation, low airflow monitor, and containment test evaluations.

Before generating hazardous materials within the hood, you should 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 notice to ensure that the hood has been recently tested and operation was satisfactory at the time of the tests.

As hoods are part of a mechanical system, it is possible that operational problems could develop between routine performance tests and preventative maintenance activities. Report alarms or suspected operational problems immediately.

If any problems are suspected with hood operation, immediately contact your Chemical Hygiene Officer or follow your facility's procedure for reporting problems.

Verifying proper system operation without a hood monitor is very difficult. All hoods shall have some type of monitor to verify proper exhaust flow and/or average face velocity. If your hood does not have a monitor, request one.

6.5 Utilize Proper Work Practices

Ultimately the ability of the hood to provide adequate protection depends on the user. By utilizing proper work practices, the potential for exposure can be reduced. Limitations inherent in many hoods and systems make proper work practices required to optimize containment.

6.5.1 Proper Location of Equipment and Apparatus

The location of equipment and apparatus effects the airflow patterns within the hood. Vortices form downstream of a person standing at the opening. When obstructions are placed directly in front of the operator or improperly located within the hood, the problems with reverse flow and turbulence can be exacerbated.

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

Always locate equipment as deep into the hood as practical and at least six to eight inches 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 or restrict the sash from closing.

Elevate equipment two to three inches above the work surface to provide flow beneath and around the equipment.

Ensure that elevated equipment is stable. Plexiglas or stainless steel slotted shelves can be used to elevate equipment and apparatus above the bottom slot in the baffle. Slotted or perforated shelves minimize disruption to airflow patterns.

Excessive equipment and apparatus in the hood should be avoided. As a rule of thumb, no more than 50% of the work surface should be covered by equipment, apparatus or other bulky obstructions.

Caution is advised when placing equipment requiring electrical power in the hood. The equipment must be properly grounded to reduce the potential for sparks. Power cords should be plugged in a properly grounded and approved outlet.

High heat loads create thermal drafts which

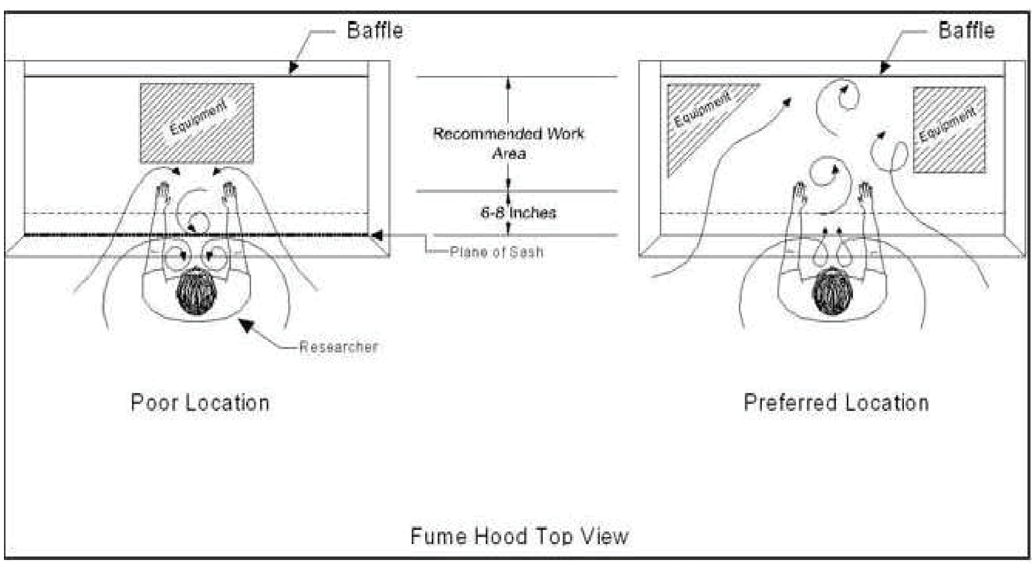

Fig. 9 Diagram Showing Effects of Locating Equipment, Materials and apparatus in the Fume Hood

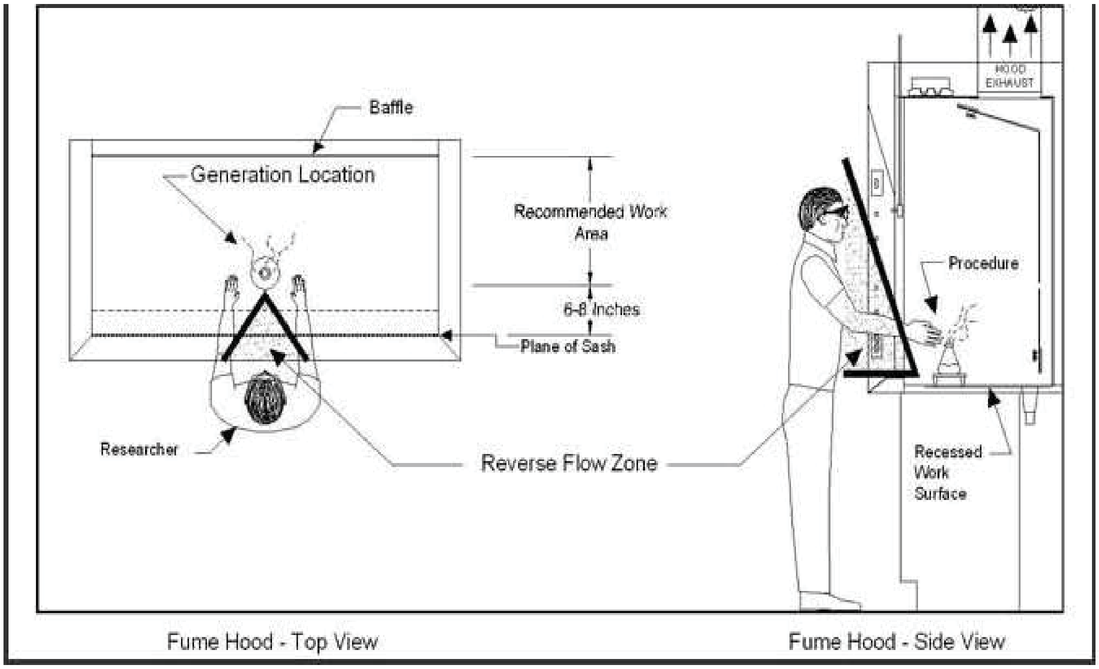

Fig. 10 Diagram of Proper Locations for Generating Hazardous Material within the Hood

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 AU ASHRAE testing should be conducted under the same conditions to test fume hood performance.

If a distillation rack (also known as "lattice rack" or "monkey bars") is installed in the fume hood, the rack should be positioned in such a location that it is accessible from the operating sash opening.

6.5.2 Desired Operator Position and Movements

The hood user should always be aware of locations within the hood where concentrations of contaminants can accumulate. The user should never allow his head to break the plane of the sash because this will cause contaminated air to pass through the breathing zone.

When materials are being generated in the hood, ensure that you 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.

6.5.3 Proper Configuration of Vertical and Horizontal Sliding Sashes

The vertically sliding sash should always be lowered as much as possible to protect the user and to minimize visual obstruction from sash handle. Raise the sash to full open position for set-up purposes only.

Reducing the sash to below the user's breathing zone provides a protective barrier between the researcher and the experiment.
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 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

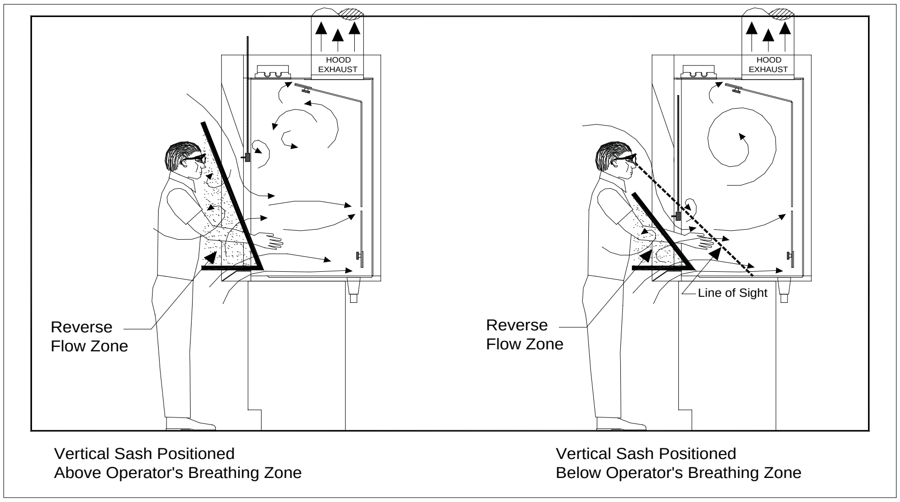

Fig. 11 Diagram Showing Effects of Lowering Sash Below Operators Breathing Zone

edge or turbulence resulting from cross drafts could cause escape.

A horizontal sash panel provides an effective barrier to splashes or explosions, but remember that high concentrations can develop inside the sash panels. As a general rule, you should avoid rapid movements near the vertical edges of the sash panels.

Avoid rapid withdrawal from the hood.

6.5 Utilize Proper Work Practices

Ultimately the ability of the hood to provide adequate protection depends on the user. By utilizing proper work practices, the potential for exposure can be reduced. Limitations inherent in many hoods and systems make proper work practices required to optimize containment.

6.5.1 Proper Location of Equipment and Apparatus

The location of equipment and apparatus effects the airflow patterns within the hood. Vortices form downstream of a person standing at the opening. When obstructions are placed directly in front of the operator or improperly located within the hood, the problems with reverse flow and turbulence can be exacerbated.

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

Always locate equipment as deep into the hood as practical and at least six to eight inches beyond the plane of the sash. For hoods that have a recessed work area, equipment and apparatus should not be placed on the on the raised ledge in front of the work area.
Equipment should never extend beyond the plane of the sash or restrict the sash from closing.

Elevate equipment two to three inches above the work surface to provide flow beneath and around the equipment.

Ensure that elevated equipment is stable. Plexiglas or stainless steel slotted shelves can be used to elevate equipment and apparatus above the bottom slot in the baffle. Slotted or perforated shelves minimize disruption to airflow patterns.

Excessive equipment and apparatus in the hood should be avoided. As a rule of thumb, no more than 50% of the work surface should be covered by equipment, apparatus or other bulky obstructions.

Caution is advised when placing equipment requiring electrical power in the hood. The equipment must be properly grounded to reduce

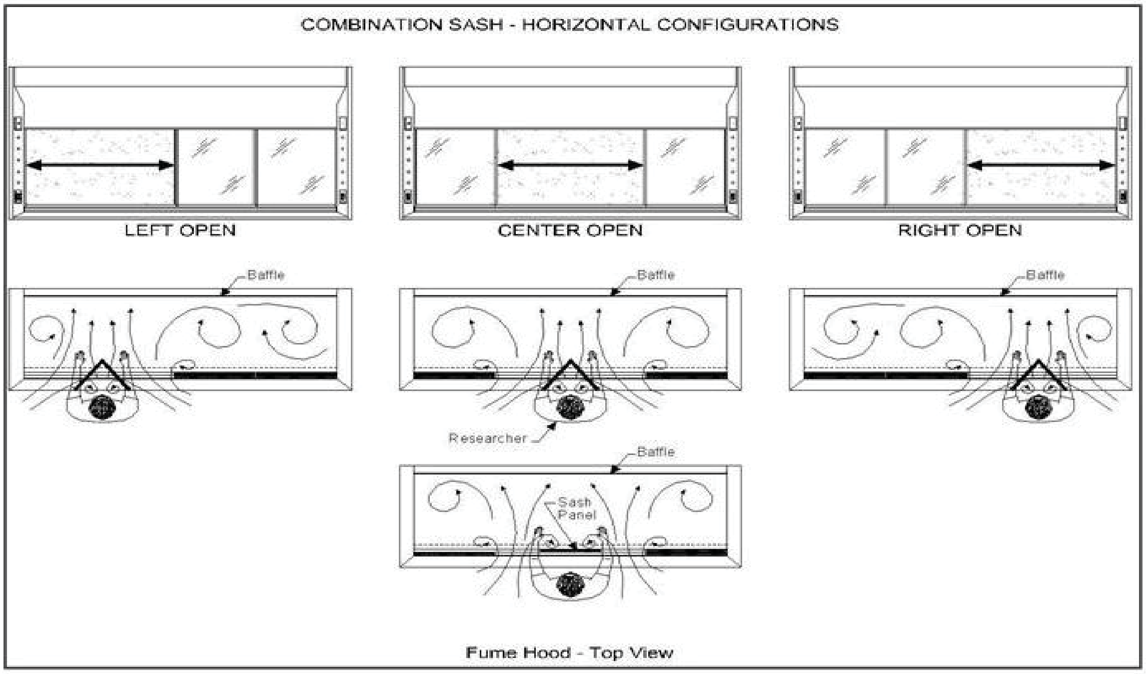

Fig. 12 Diagram of Airflow Patterns for Different Horizontal Sash Configurations

the potential for sparks. Power cords should be plugged in a properly grounded and approved outlet.

High heat loads create thermal drafts which 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 AU ASHRAE testing should be conducted under the same conditions to test fume hood performance.

If a distillation rack (also known as "lattice rack" or "monkey bars") is installed in the fume hood, the rack should be positioned in such a location that it is accessible from the operating sash opening.

6.5.2 Desired Operator Position and Movements

The hood user should always be aware of locations within the hood where concentrations of contaminants can accumulate. The user should never allow his head to break the plane of the sash because this will cause contaminated air to pass through the breathing zone.

When materials are being generated in the hood, ensure that you 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.

6.5.3 Proper Configuration of Vertical and Horizontal Sliding Sashes

The vertically sliding sash should always be lowered as much as possible to protect the user and to minimize visual obstruction from sash handle. Raise the sash to full open position for set-up purposes only.

Reducing the sash to below the user's breathing zone provides a protective barrier between the researcher and the experiment.

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 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.
A horizontal sash panel provides an effective barrier to splashes or explosions, but remember that high concentrations can develop inside the sash panels. As a general rule, you should avoid rapid movements near the vertical edges of the sash panels.

Avoid rapid withdrawal from the hood.

Close horizontal panels on combination sashes before opening the sash vertically, to ensure the open sash area does not exceed the maximum, as per the exhaust flow design.

Always close the sash when not working in the hood.

6.5.4 Reduce Pedestrian Traffic Near The Hood

A person walking past the hood can generate significant cross drafts. When generating hazardous materials in the hoods, attempt to divert or limit traffic past the hood. Inform other laboratory personnel about the work being conducted in the hood.

6.5.5 Ensure Hoods are Cleaned and Decontaminated

Following procedures involving highly toxic, potent or radioactive materials, the hood interior should be cleaned and decontaminated. Contaminated hoods should be clearly labeled. Maintenance personnel should also be informed of the potential for duct contamination. In several cases, maintenance personnel have been injured while working on hood systems that have been used for work with perchloric acid and appropriate decontamination methods had not been followed.

6.5.6 Do Not Store Materials In The Hood

Laboratory fume hoods should not substitute for an approved chemical storage cabinet. Hood performance is impaired by excessive storage of materials in the hood and the available work surface is reduced.

6.5.7 Summary of Proper Work Practices

The following list summarizes guidelines for working in a chemical hood:

Always work at least six inches beyond the plane of the sash. The farther the work is into the hood the better.

Avoid rapid withdrawal from the hood.

Close horizontal panels on combination sashes before opening the sash vertically.

Always close the sash when not working in the hood.

Baffles should only be adjusted per manufacturer's recommendation. If baffle settings are modified, it is recommended that the fume hood is tested to the ASHRAE 110 standard under all baffle configurations.

Elevate contaminants and equipment above the surface of the hood to enable flow beneath and around the obstructions.

If equipment and material storage is necessary, locate along the sidewalls or well away from the point of contaminant generation. Do not store any equipment that restricts the closing of the sash or blocks the bottom slot of the baffle directly in front of the user.

Keep movements in the hood and in front of the hood to a minimum.

Keep motion in the lab to a minimum while working in the hood. Traffic past the hood can generate considerable cross drafts.

Ensure head and upper body remains outside the plane of the hood opening at all times.

Always attempt to slowly approach and withdraw from hood. Open and close the sash slowly.

6.6 Responsibilities for Ensuring Proper Hood Performance

Ensuring performance of laboratory fume hood systems is the combined responsibility of:

Group	Responsibility
Management (6.6.1)	**Ensure health and safety of laboratory personnel**
Principal Research Investigators (6.6.2)	**Provide information about hazards and scientific procedure**
Health and Safety (6.6.3)	**Develop Safety Operating Procedures (SOP**
Lab Design Team And Engineering (6.6.4)	**Identify needs and design/specify appropriate building system, fume hoods and laboratory components**
Construction Team (including laboratory fume hood installer (6.6.5)	**Construct/install in accordance with contract documents**
Controls Manufacturer (6.6.6.)	**Provide Product(s) in accordance with contract documents**
Building System Commissioning (6.6.7)	**Verify function of lab controls and the ability of the system to meet all required set points**
Operations and Maintenance (6.6.8)	**Develop and implement Operations and Maintenance Program**
Laboratory Personnel and Laboratory Fume Hood Users (6.6.9)	**Comply with Standard Operating Procedures (SOP)**
Laboratory Fume Hood Manufacturer (6.6.10)	**Provide product(s) in accordance with contract documents. Provide product(s) that perform in accordance with safety standards**

Although your organization's management is ultimately responsible for the health and safety of laboratory personnel, a team approach is required to ensure proper performance of laboratory fume hood systems.

The following list provides a summary of responsibilities for each group involved with ensuring proper operation of laboratory fume hood systems.

6.6.1 Management

Provide commitment to health and safety.

Provide leadership.

Direct and coordinate activities.

Allocate sufficient resources.

6.6.2 Principal Research Investigators

Identify personnel risks and characterize scientific procedures.

Evaluate hazard potential.

Work with Health and Safety to develop safety protocols, training programs, and select appropriate hoods.

Submit all requests for new hoods to Health and Safety.

Inform Health and Safety of significant changes in research activities.

Support (embrace) Health and Safety's Standard Operating Procedures.

6.6.3 Health and Safety

Develop and manage the Chemical Hygiene Plan (Standard Operating Procedures).

Administer Laboratory Fume Hood Safety Program.

Determine exposure control requirements. Provide hood operators with MSDS information on materials being used in the fume hood.

Ensure proper selection and use of hoods. Determine protocol for proper operation.

Ensure users are informed of hood capabilities and limitations (Training).

Develop and review safety standards periodically.

Conduct and/or review periodic hood performance tests.

Review all requests for new hoods.

Confirm that hood performs as required.

6.6.4 Laboratory Design Team and Engineering Identify needs.

Design appropriate building system(architectural, mechanical, electrical, plumbing, structural etc.).

Design and specify appropriate fume hood system.

Assist with pre-qualification of construction team.

Review all proposed changes.

Prepare "as built" documents.

Ensure design intent is achieved and commissioned.

6.6.5 Construction Team

Construct and install in accordance with contract documents, and regional, local and national codes.

Provide coordinated effort to meet design and performance requirements.

Coordinate field changes with other appropriate team members.

6.6.6 Controls Manufacturer

Supports design and specification of appropriate fume hood control system.

Provide product in accordance with specifications and contracts.

Provide start-up of fume hood control system.

Provide training in proper operations and maintenance for product.

6.6.7 Building System Commissioning

Verify fume hood flow rate.

Verify function of controls.

Verify ability to meet design set points for temperature, airflow, and room pressurization.

6.6.8 Operation and Maintenance

Ensure regular maintenance on all system components.

Ensure proper operation within specified tolerances.

Ensure no unauthorized changes to hood systems.

Ensure maintenance personnel are familiar with hazards and safe work procedures.

Ensure maintenance personnel are fully trained.

6.6.9 Laboratory Personnel and Hood Users

Understand the hazards.

Understand the capabilities and limitations of hoods.

Verify proper operation prior to use.

Use proper work practices in compliance with SOP.

Report suspected operational problems.

6.6.10 Hood Manufacturer

Hood is built to specifications.

Hood performs as expected "as manufactured."

Technical information associated with hood design.

Hood shall be manufactured in conformance with SEFA-1.

Provide product training and verification as requested.

Provide basic safety precautions posted clearly on the fume hood.

Provide troubleshooting assistance when hood fails to meet expectation "as installed."

7.0 Laboratory Ventilation Systems

Laboratory ventilation systems include both exhaust and supply duct systems. The purpose of a laboratory exhaust system 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 fresh air intake in the building. According to a number of industry standards, the supply air system must make up the air exhausted from the laboratory with 100% fresh outside air, conditioning it to provide a safe and comfortable work environment for the lab space occupants. 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 greater. 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 or the flows must be controlled by a pressure differential control system. The volumetric offset method is the most common. If the total of all hood exhaust is less than the maximum possible supply flow, an additional exhaust device, normally referred to as the general exhaust valve, is required.

Many factors affect the performance of hoods and laboratories, none of which receives more discussion than the airflow control strategy. The flow control strategy significantly impacts laboratory fume hood containment, room pressurization and energy usage.

7.1 Airflow Control Strategy

There are three main airflow control strategies for laboratories with fume hoods.

The first and most widely used, Constant Volume (CV), has been in use since the early 20th century. Second is Two-State Control (2SC), introduced in the 1960's. And finally, Variable Air Volume (VAV) has been gaining popularity and effectiveness since the 1980's. Specific applications are well suited to each. The 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.

7.1.1 Constant Volume (CV)

Constant volume 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, and you consult with the hood manufacturer for proper airflow requirements.

7.1.2 Two-State Control

Two-state fume hood control is simply a low/high volume control system. This control approach gains energy efficiency over CV systems to the extent that the hoods remain in the low flow level.

The low and high volumes are changed by various methods such as a sash position switch, light switch, 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 energy savings of the two-state approach is improved over constant volume, but may require an audible alarm that reminds a hood user to close the sash. The use of controls also adds more maintenance costs to the system, compared to a CV system.

7.1.3 Variable Air Volume (VAV) Systems

A variable air volume fume hood control system is designed to vary the hoods' exhaust rate to maintain a constant average face velocity throughout the sash travel. The complexity of this system requires fast, stable control systems, which are more expensive, on an installed cost basis, than constant volume control systems. Energy savings can be further improved to potentially offset these higher costs.

Room pressurization is commonly 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 (hoods plus general exhaust) airflow rate is increased to overcome the added supply requirements.

Below is a diagram of a simple VAV system. (See: Figure 14).

7.1.4 Summary of Air Control Strategies

The cost of operating a laboratory fume hood is very significant and will continue to be a major concern until alternative forms of renewable energy are readily available. As of early 2002, the range of first pass estimates range from $4 to $7 per CFM per year to operate the laboratory ventilation systems. Reducing flows when appropriate, through the use of an energy efficient fume hood design and/or through a usage-based flow setback, can result in significant cost savings.

One of the primary goals of the designer is to provide a safe environment for researchers. Meeting this objective requires containment at hoods and at the room level. Room pressurization is an important consideration for laboratories.

7.2 Room Pressurization

The standards and guidelines stress the importance of room pressurization for laboratory spaces. Laboratories that use laboratory fume hoods should be maintained at a relative negative pressure to corridors and other adjacent spaces in the building (with the exception of clean room laboratories that may operate under positive pressure).

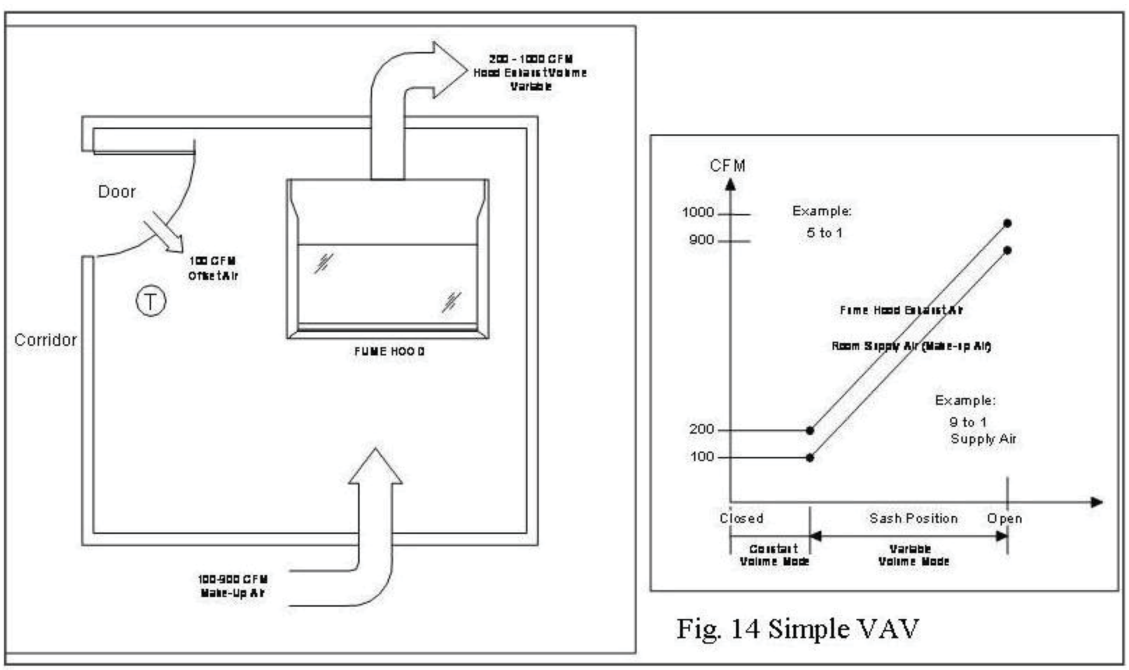

Fig. 14 Simple VAV

7.3 Diversity

Diversity is used by engineers in designing systems 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.

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

Diversity can be applied only after providing the required number of air changes in the laboratory and the minimum flow to control room temperature. For these reasons, some laboratories cannot reduce the total hood exhaust flow capacity.

For either type of facility, designers must develop a solution that best fits the customers' needs. However, some designers are hesitant to use diversity since the savings are only realized when the sashes are lowered. Often, this has lead to systems with methods of "forced" diversity that have proven problematic.

Mechanical sash stops prevent a user from opening a sash beyond a predetermined maximum setting. Unfortunately, users often override these mechanical stops for everyday activity and for setting up experiments. This can create a dangerously low face velocity profile if the controller is not sized for full sash opening and if the fume hood is not designed to operate at lower face velocities. Insure that low flow alarms are working properly.

A system that automatically switches between standard and setback flow can provide greater diversity than other systems. (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. See also: 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.) The hood design should be tested to the ASHRAE 110 Standard at the setback flow if the setback can occur through an open sash.

Some Factors Affecting Diversity:

Control Method
Constant Volume CV
Variable Air Volume VAV
Two State Controls

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

Number of Floors and Size of Building

Fume Hood Density
Number of fume hoods per lab
Number of fume hoods per manifold.

8.0 Other Ventilated Laboratory Safety Devices

All ventilated devices used in a laboratory are safety devices and should be carefully examined for application and safe working practice. Some experts believe that all ventilated enclosures should be called a laboratory fume hood and tested to fume hood standards. This is not possible because many enclosures are suitably made of flammable materials, are sized for their application and operate safely for the intended purpose, but not as a fume hood.

Products described in this section are not fume hoods by the definition in Section 3. Testing of these products is not covered in the ASHRAE 110-1995 (or most current edition) Standard. As such, great care must be taken to insure that the product being evaluated is functioning safely for the intended purpose. It is not possible for SEFA to presuppose all applications and as such this section is intended to be used as a guideline only, not a definitive source. Contact your Chemical Hygiene Officer to evaluate your specific application.

8.1 Special Purpose Hoods

Special purpose hoods are hoods that are modifications of fume hoods. As such, they fail to meet the exacting definition of a fume hood and shall be classified as a special purpose hood. Common modifications to fume hoods include: baffle designs, sash configurations and locations, size, and materials. Special purpose hoods are designed specifically for that purpose, where a fume hood tends to serve a more general application. Special purpose hoods shall be designed, tested, and operated with their respective intended purpose in mind.

8.1.1 Demonstration Hood

Examples – Multi Sided, 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. Often a demonstration hood provides access from two or more sides. Demonstration hoods may or may not have a baffle system.

Purpose or Application

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

Reference Organization

None

Testing Recommendations

Some hoods may be tested using the ASHRAE 110-1995 (or most current edition) Standard. Others will require test modifications due to size, sash location, and when to test for multiple sash positions. Consideration must be made to the toxicity of the experiment and acceptable exposure levels. The manufacturer should 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

Contact your Chemical Hygiene Officer for safe exposure levels and for testing recommendations before working in a demonstration hood.

8.1.2 California Hood

Description

A California hood is an enclosure that has access to at least two sides, and it usually 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.

Purpose or 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.

Reference Organization

None

Testing Recommendations

ASHRAE testing must be modified because the hood opening is much larger than a bench laboratory fume hood and has multiple sash configurations. 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 should 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

Contact your Chemical Hygiene Officer for safe exposure levels, special considerations during set-up and tear-down, and for testing recommendations before working in a California hood.

8.1.3 Ventilated Hoods and Enclosures

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

8.1.3.1 Oversized Hood

Description

Laboratory fume hoods are sometimes built in large, non-standard sizes to accommodate a specific application. Generally, laboratory fume hoods as long as twenty feet reflect the basic tenet of a laboratory fume hood, but larger structures may not. These larger structures shall be referred to as oversized hoods and not a laboratory fume hood.

Purpose or Application

Oversized hoods are often designed to accommodate a specific piece of equipment that must be housed in the hood during the experiment. Sometimes the scale of the work done in the hood determines the desired size of the hood.

Reference Organization

None

Testing Recommendations

Extensive knowledge of the testing apparatus or experimentation, or work being done in the hood is required for determining the safe testing methods of an oversized hood. Contact your Chemical Hygiene Officer before working in an oversized hood. The manufacturer should 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 ASHRAE 110-1995 (or most current edition) test procedure. Oversized hoods may require more and different diffuser locations, and sash arrangements must be considered before testing.

Additional Comments

Contact your Industrial Hygienist for safe exposure levels, proper use of sash positions, special considerations during set-up and tear-down, operating procedures and for testing recommendations before working in an oversized hood

8.1.3.2 Table Top Hood

Examples – Portable Hood, Down Draft Hood (A Down Draft Hood is a Table Top Hood that is vented down through the table top into an exhaust fan system).

Description

A portable hood is a ventilated enclosure that is small (usually less than 15 cubic feet of working space), is often made of alternate materials (such as epoxy, polycarbonate, acrylic or sheet metal) for mounting on a tabletop.

Purpose or Application

Used primarily in educational laboratories to control nuisance contaminants or small, microscale experiments.

Reference Organization

None

Testing Recommendations

A table top hood may be tested to the ASHRAE 110-1995 (or most current edition) test if the hood is large enough to contain the apparatus and a sash is apparent. If not, evaluate containment by modifying the test methods or by smoke visualization. The manufacturer should 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 this product for anything but nuisance vapor protection, unless otherwise certified by your Chemical Hygiene Officer.

8.1.3.3 Conventional Hood

Examples – Flat Front Hood, Thin Wall Hood

Description

A conventional hood is a ventilated bench mounted enclosure that exhibits a square entry profile, and usually lacks a bypass, and airfoil.

Purpose or Application

Used primarily in educational laboratories to control nuisance contaminants or small, microscale experiments.

Reference Organization

None

Testing Recommendations

A conventional hood may be tested to the ASHRAE 110-1995 (or most current edition) test if the hood is large enough to contain the apparatus and a sash is apparent. If not, evaluate containment by modifying the test methods or by smoke visualization. The manufacturer should 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 your Chemical Hygiene Officer for the proper application, set-up and use of a conventional hood.

8.1.3.4 Balance Enclosure Description

A balance enclosure is a ventilated enclosure designed to specifically house a laboratory balance. These 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. Access to the balance enclosure is usually from the sides; however, other access depends upon the accessibility needs.

Purpose or Application

Exposure to fumes from a balance is usually low; however, the proximity of the user's breathing zone to the use of a balance could result in unacceptable exposure levels. It is best to house the balance 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.

Reference Organization

None

Testing Recommendations

The manufacturer should 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

None

8.1.3.5 Microscope Enclosure Description

A microscope enclosure is a ventilated enclosure designed to specifically 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 comfortably. Individual designs vary with the size and style of the microscope and application.

Purpose or Application

Exposure to fumes from a microscope is usually low; however, the proximity of the user's breathing zone to the use of a microscope could result in unacceptable exposure levels. It is best to house the microscope 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.

Reference Organization

None

Testing Recommendations

The manufacturer should 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 allow electrical connection of the microscope. Proper care must be exercised to avoid a spark within the chamber, which may contain flammable effluents.

8.1.3.6 Robotic Enclosure Description

A robotic enclosure is a ventilated enclosure designed to specifically house a laboratory robot or automated equipment and to provide adequate protection to the laboratory personnel near the robot. Robotic enclosures are typically made of transparent materials such as acrylic, polycarbonate, or glass. Robotic enclosures may or may not have a baffle system. Individual designs vary with the size and style of the robotic equipment and application.

Purpose or Application

Exposure to fumes from a robot is usually low; however, the proximity of the user's breathing zone to the use of a robot could result in unacceptable exposure levels. It is best to house the
robot 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.

Reference Organization

None

Testing Recommendations

The manufacturer should 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.

8.1.3.7 Histopathological Enclosures

Examples – Autopsy, Necropsy Enclosures, Tissue Trimming Enclosures, Tissue Staining, Fixing, Embedding Enclosures

Description

A histopathological enclosure is a hood specifically designed to enclose histopathogical operations such as autopsy, necropsy, tissue trimming, tissue staining, fixing, slide and sample preparation. A histopathological enclosure shall provide adequate protection to the user and to the laboratory personnel. Histopathogical 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.

Purpose or Application

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

Reference Organization

None

Testing Recommendations

The manufacturer should 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.

8.2 Local Exhaust Ventilation

8.2.1 Canopy Hood Description

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

Purpose of Application

Canopy hoods are receiving hoods. As such a canopy hood shall be used when there is a force, such as heat, to deliver the contaminant to the receiving hood.

Reference Organization

See the Industrial Ventilation Manual for further details. (Industrial Ventilation: A Manual of Recommended Practice, 25th Edition, or most current edition, American Conference of Governmental Industrial Hygienists, 1330 Kemper Meadow Drive, Cincinnati, OH 45240 www.acgih.org)

Testing Recommendations

The manufacturer should make recommendations for the specific testing of this product including a velocity profile, 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 your Chemical Hygiene Officer for the proper positioning and use of a canopy hood.

8.2.2 Slot Hood Description

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

Purpose or 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.

Reference Organization

None

Testing Recommendations

Contact your Chemical Hygiene Officer for proper use of a slot hood. The manufacturer should 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 your Chemical Hygiene Officer for the proper positioning and use of a slot hood.

8.2.3 Snorkel

Examples – Elephant Trunk, Spot Collector, Extractor

Description

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

Purpose or Application

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

Reference Organization

None

Testing Recommendations

Contact your Chemical Hygiene Officer for proper use of a snorkel hood. The manufacturer should make recommendations for the specific testing of this product including a exhaust volume, and smoke visualization

Additional Comments

A snorkel hood has an effective capture range of about one hood diameter away from the hood. Do not use a snorkel hood for anything but heat or nuisance vapor removal unless otherwise certified by your Chemical Hygiene Officer.

8.3 Exhausted Laminar Flow Hoods

Examples: Clean Hoods, Class 10 Fume Hoods, Clean Air Chemical Hoods, Trace Metals Analysis Hoods, Push/Pull Hoods.

Description

An exhausted laminar flow (ELF) hood is one that is designed for critical operations where both a clean air (class 10+) process environment is necessary, along with adequate protection to the user, from fumes and particles. ELF hoods are ventilated cabinets, which contain an integral HEPA/ULPA filtered supply air source. ELF hoods are usually 100% outside ducted, but may be recirculated in cases where particle entrapment is the principle objective. ELF hoods contain vertically closing sashes, baffle systems and often localized exhaust systems within the unit.

Purpose or Application

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

Reference Organization

ISO 14644-1, ISO 14644-7 and ASHRAE 110-1995.

Testing Recommendations

Because ELF hoods are hybrids between negative and positive pressure environments, strict attention to balance testing is crucial. Testing to be done against ASHRAE 110-1995 and ISO 14644-21 or most current versions.

Additional Comments

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

8.4 Biological Safety Cabinets

8.4.1 Class I Cabinets

Description

A ventilated cabinet that provides personnel and environmental protection. It is characterized by an unrecirculated 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. It may or may not be vented via a remote ventilation system. This cabinet does not offer product protection.

Purpose or Application

Personnel and environmental protection.

Reference Organization

NSF International provides some information in NSF Standard 49. (See: NSF49-2002 Class II (Laminar Flow) Biohazard Cabinetry, NSF International)

Testing Recommendations

None

Additional Comments

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

8.4.2 Class II Cabinets

Description

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 providing environmental protection. They are divided into types by NSF and identified in Standard 49.

- **Class II Type A1 cabinets (Formerly designated Type A)**

  Minimum of 75 FPM (.36m/s) inflow. HEPA filtered down flow 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 (0.5m/s) inflow. HEPA filtered down flow 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**

  Minimum of 100 FPM (.5m/s) inflow.

  HEPA filtered, largely uncontaminated recirculated air.

  Exhausts most contaminated air to atmosphere through a dedicated duct system.

  Has negative pressure duct system or surrounded by a negative pressure duct system.

- **Class II Type B2 Cabinet (Total Exhaust)**

  Minimum of 100 FPM (.5m/s) inflow.

  HEPA filtered, non-recirculated, down flow air.

  HEPA filtered exhaust air to atmosphere.

  Has negative pressure duct system or surrounded by a negative pressure duct system.

Purpose or Application

Refer to the Center for Disease Control (CDC) and the National Institute of Health (NIH) for application information. (Center for Disease Control and Prevention, 1600 Clifton Rd. Atlanta, GA 30333 www.cdc.gov, National Institutes of Health, Bethesda, MD, 20892 www.nih.gov)

Reference Organization

NSF International Standard No. 49.

Testing Recommendations

Construction and Performance Specifications for Class II cabinets are defined by the NSF International Standard No. 49.

Additional Comments

None

8.4.3 Class III Cabinets

Examples: Glove Box

Description

Provides absolute personnel protection, environmental protection and may provide product protection. It is characterized by a totally 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.

Purpose or Application

Reference Organization

The American Glove Box Society. (The American Glove Box society is a relevant organization an is listed in section 11.0 of this document.

Testing Recommendations

None

Additional Comments

There are no nationally recognized specifications/standards governing construction and performance for these configurations. Some additional information can be found in NSF Standard 49.

8.5 Ductless Hoods

(See: SEFA 9-2010 Recommended Practices for Ductless Enclosures)

A ductless hood recirculates air back into the laboratory from the hood chamber.

Examples: Ductless Fume Hoods, Ductless Fume Cabinets

Description

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 is not connected to a duct system (although options are available for connecting to a duct system). Instead, the air is recirculated back to the room atmosphere. The ductless hood's scope of use is limited to the capacity and capability of the filtration system. The objective of the filtration system is to reduce the levels of solids, gaseous or vapor constituent to that below the acceptable TLV limit at the exhaust.

The benefits of a ductless hood include:
Low installation cost
Portability
No permit for exhausting outside the building

Reference Organization

(USA) SEFA 9-2010;

ANSI/AIHA Z9.5-2000 or most current version, Proposed Performance Standard section on Ductless Fume Hoods.

(Canada) CAN CSA Z316.5 Performance Standard.

(France) AFNOR NFX 15-211 Performance Standard.

(England) BSI Specification for 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)

9.0 Terms and Definitions

A&E – The "Architect and Engineer." Generic term refers to designers of laboratory building and ventilation systems.

ACFM – Actual cubic feet per minute of gas opening.

ACGIH – The American Conference of Governmental Industrial Hygienists; association supports or produces TLV list, Industrial Ventilation Manual, bioaerosol documents.

ACH, AC/H (air changes per hour), N – The number of times air is theoretically replaced during an hour.

Acceptable Indoor Air Quality – Air in which there are no known contaminants at harmful levels as determined by appropriate authorities and air with which 80% or more of the people do not express dissatisfaction.

Access Opening – That part of the fume hood through which work is performed; sash or face opening.

Air Flow Monitor — Device installed in a fume hood to monitor the airflow through the fume chamber of a fume hood

Air Foil — A horizontal member across the lower part of the fume hood sash opening. Shaped to provide a smooth airflow into the chamber across the worksurface.

Air Volume — Quantity of air expressed in cubic feet (ft3) or cubic meters (m3).

Auxiliary Air — Supply or supplemental air delivered to a laboratory fume hood to reduce room air consumption.

Baffle — Panel located across the rear wall of the fume hood chamber interior and directs the airflow through the fume chamber.

Bench Hood – A fume hood that is located on a work surface. (See superstructure)

Bypass – Compensating opening in a fume hood that functions to limit 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 housing two or more horizontal sliding transparent viewing panels.

Counter Top – (See Work surface)

Cross Drafts – Air draft that flows parallel to or across the face opening of the fume hood.

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

Diversity – Operating a system at less capacity than the sum of peak demand (ANSI Z9.5)

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).

Exhaust Collar – Connection between duct and fume hood through which all exhaust air passes.

Exhaust Unit – Air moving device, sometimes called a fan, consisting of a motor, impeller and housing.

Face – Front access or sash opening of laboratory fume hood. Face opening measured in width and height. See sash or access opening.

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

Fan – Air moving device, usually called an exhaust unit, consisting of a motor, impeller and housing.

Fan Curve – A curve relating pressure vs. volume flow rate of a given fan at a fixed fan speed (rpm).

Filter – Device to remove particles from air.
Friction Loss – The static pressure loss in a system due to friction between moving air and the duct wall; expressed as inches w. g. 100 feet, or fractions of VP per 100 feet of duct.

Fume Chamber – The interior of the fume hood measured width, depth and height constructed of material suitable for intended use.

Fume Cupboard – British term for laboratory fume hood.

Fume Removal System – A fume hood exhaust engineered to effectively move air and fumes consistently through fume hood, duct and exhaust unit.

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

Glove Box – Total enclosure used to confine and contain hazardous materials with operator access by means of gloved portals or other limited openings; this device is not a laboratory fume hood.

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

Hood - A device which encloses, captures, or receives emitted contaminants.

Hood Entry Loss – The static pressure loss, stated in inches w. g., 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 sum of the duct velocity pressure and the hood entry loss; it is the static pressure required to accelerate air at rest outside the hood into the duct at duct velocity.

HVAC – Heating Ventilating and Air Conditioning. Ventilation systems designed primarily for temperature, humidity, odor control, and air quality.

Inches of Water (inch w.g.) – The pressure exerted by a column of water one inch in height at a defined reference condition such as 39°F or 4°C and the standard acceleration of gravity.

Indoor Air Quality (IAQ) – 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 – See definition in Section 3.0.

Laboratory Module – A basic unit of space usually accommodating a two person laboratory operation.

Laboratory Ventilation – Air moving systems and equipment which serve laboratories.

Laminar Flow (Also Streamline Flow) – Airflow in which air molecules travel parallel to all other molecules; flow characterized by the absence of turbulence.

Laminar Flow Cabinet – Name applied to clean bench or biological enclosures. This device is 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 workplace ambient air can occur.

Loss - Usually refers to the conversion of static pressure to heat in components of the ventilation system, viz., "the hood entry loss."

Low Flow Laboratory Fume Hoods – Fume Hood designs that 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 through a fully opened vertical sash.

Low Velocity Laboratory Fume Hoods – Fume Hood designs that 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 through a fully opened vertical sash and provides containment levels equivalent or superior to ASHRAE 110 tracer gas test ratings of 4.0 AM 0.05, and 4.0 AI/AU 0.10, with a face velocity of 70 FPM or less through the fully opened vertical sash. Low Velocity Fume Hoods are also referred to as High Performance Fume Hoods and High Efficiency Fume Hoods.

Make-up Air – (See Replacement and Compensating Air). Air needed to replace the air taken from the room by laboratory fume hood(s) and other air exhausting devices.

Manometer – A device which 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 which will transport particles in a duct with little settling; the MTV varies with air density, particulate loading, and other factors.

Natural Ventilation – The movement of outdoor air into a space through intentionally provided openings, such as windows, doors, or other non-powered ventilators, or by infiltration.

Occupied Zone – The region within an occupied space between 3" and 72" above the floor and more than two feet from the walls for fixed air conditioning equipment. (From ASHRAE Standard 55-1981).

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

Outdoor Air (OA) – "Fresh" air mixed with return air (RA) to dilute contaminants in the supply air (SA).

Particulate Matter – For thess Recommended Practices, small lightweight particles that will be airborne in low-velocity air [approximately 50 fpm (.25m/s)].

Pitot Tube – A device used to measure total and static pressures in an air stream.

Plenum - A low velocity chamber used to distribute static pressure throughout its interior.

Plenum Chamber – Chamber used to equalize airflow.

Pressure Drop – The loss of static pressure between two points; for example, "The pressure drop across an orifice is 2.0 inches w.g."

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. A "RH" of 100% is about 2.5% water vapor in air, by volume.

Replacement Air – (Also, compensating air, make-up air) Air supplied to a space to replace exhausted air.

Respirable Particles – Those particles in air which penetrate into and are deposited in the nonciliated portion of the lung.

Return Air – Air which is returned from the primary space to the fan for recirculation.
Room Air – That portion of the exhaust air taken from the room.

SCFM (Standard Cubic Feet Per Minute) – Airflow rate at standard conditions; dry air at 29.92 inches Hg gauge, 70 degrees F.

Sash – A moveable panel or door set in the access opening/hood entrance to form a protective shield and to control the face velocity of air into the hood.

Scrubber, Fume – A device used to remove contaminants from fume hood exhaust, normally utilizing water.

Service Fixture – Item of laboratory plumbing mounted on or fastened to laboratory fume hood.

Sulfur Hexafluoride (SF_6) - Tracer gas widely used for ASHRAE testing.

Slot Velocity – The average velocity of air through a slot. It is calculated by dividing the total volume flow by the slot area; usually vs = 2,000 fpm.

Smoke Candle – Smoke producing device used to allow visual observation of airflow.

Spot Collector – A small, localized ventilation hood usually connected by a flexible duct to an exhaust fan. This device is not a laboratory fume hood.

Stack – The device on the end of a ventilation system, which disperses exhaust contaminates for dilution by the atmosphere.

Standard Air — Standard Conditions STP Dry air at 70 degrees F, 29.92 in Hg.

Static Pressure (SP) – The pressure developed in a duct by a fan; SP exerts influence in all directions; the force in inches of water measured perpendicular to flow at the wall of the duct; the difference in pressure between atmospheric pressure and the absolute pressure inside a duct, cleaner, or other equipment.

Static Pressure Loss – Measurement of resistance created when air moves through a duct or hood, usually expressed in inches of water.

Suction Pressure – See Static Pressure (Archaic. Refers to static pressure on upstream side of fan.)

Superstructure – That portion of a laboratory fume hood that is supported by the work surface.

Supplemental Air – 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 utilizing the principle of thermal cooling of a heated element as the detection element.

Threshold Limit Value – Time Weighted Average (TLV-TWA) – The time weighted average concentration for a normal 8-hour workday or 40-hour work week, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect.

Titanium Tetrachloride – 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 one cubic meter) 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 exposure at the breathing zone.

Variable Air Volume (VAV) – In HVAC system, the supply air volume is varied by dampers or fan speed controls to maintain the temperature; in hoods, the exhaust air is varied to reduce the amount of air exhausted.

Velocity Pressure – Pressure caused by moving air in a laboratory fume hood or duct, usually expressed in inches of water.

Velocity (V) – The time rate of movement of air; feet per minute.

Volume Flow Rate (Q) –The quantity of air flowing in cubic feet per minute, cfm, scfm, acfm.

Work Space – The part of the fume hood interior where apparatus is set up and fumes are generated. It is normally confined to a space extending from six inches (15.2 cm) behind the plane of the sash(es) to the face of the baffle, and extending from the work surface to a plane parallel with the top edge of the access opening.

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.

10.0 Basic Calculations

An excellent source for engineering principles of ventilation can be found in Industrial Ventilation, a manual of recommended practice. This manual is prepared by the American Conference of Governmental Industrial Hygienists.
The manual (27th Edition) is available for purchase from the ACGIH website acgih.org. It highlights the general principles of ventilation (including basic calculation) supply systems, exhaust systems, principles of airflow, fans, construction guidelines, and testing of ventilation systems.

This manual should be used in concert with the SEFA Recommended Practices.

11.0 Relevant Organizations

SEFA recognizes and acknowledges the importance of government agencies that produce documents concerning laboratory ventilation, laboratory fume hoods and laboratory safety. These agencies include:

AABC Associated Air Balance Council
1000 Vermont Avenue, NW
Washington, DC 20001
www.aabc.com

ACGIH American Conference of
Governmental Industrial Hygienists
1330 Kemper Meadow Drive
Cincinnati, Ohio 45240
www.acgih.org
http://www.acgih.org
(513) 742-2020

ADC Air Diffusion Council
230 North Michigan Avenue
Chicago, IL 60601
www.flexibleduct.org

AGA American Gas Association
1515 Wilson Blvd.
Arlington, VA 22209
www.aga.com

AGC Associated General Contractors of America
1957 E. Street, NW
Washington, DC 20006
www.agc.org

AGS American Glove Box Society
P. O. BoX 9099
Santa Rosa, CA 95405
www.gloveboxsociety.org
(800) 530-1022

AHA American Hardboard Association
1210 W. Northwest Highway
Palatine, IL 60067-1897
www.domensino.com/aha/
(847) 934-8800

AIA The American Institute of Architects
1735 New York Avenue, NW
Washington, DC 20006-5292
www.aia.org
(202) 626-7300

AIHA American Industrial Hygiene Association
2700 Prosperity Ave., Suite 250
Fairfax, VA 22031
www.aiha.org
(703) 849-8888

AMCA Air Movement & Control Association
International, Inc.
30 W. University Drive
Arlington Heights, IL 60004-1893
www.amca.org
(847) 394-0150

ANSI American National Standards Institute
11 West 42nd Street 13th Floor
New York, NY 10036-8002
www.ansi.org
(888) 267-4683
(212) 642-4900

AHRI **Air Conditioning, Heating, and Refrigeration Institute**
4301 Fairfax Drive, Suite 425
Arlington, VA 22203
www.ari.org
(703) 524-8800

ASCE **American Society of Civil Engineers World Headquarters**
1801 Alexander Graham Bell Drive
Reston, VA 20191-4400
www.asce.org
(800) 548-2723
(703) 295-6000

ASCET **American Society of Certified Engineering Technicians**
P. O. Box 1348
Flowery Branch, GA 30548
Www.ascet.org
(777) 967-9173

ASHRAE **American Society of Heating, Refrigerating and Air Conditioning Engineers**
1791 Tullie Circle, NE
Atlanta, GA 30329-2305
www.ashrae.org
(800) 527-4723
(404) 636-8400

ASME **American Society of Mech. Eng.**
345 East 47th Street
New York, NY 10017-2392
www.asme.org
(800) 843-2763 (US and Canada)
011-(800)-843-2763 (Mexico)
(973)822-1170 (Outside NA)

ASPE **American Society of Plumbing Engineers**
3617 Thousand Oaks Blvd., Suite 210
Westlake Village, CA 91362-3649
www.aspe.org
(805) 495-7120

ASSE **American Society of Sanitary Engineering**
28901 Clemens Road
Westlake, OH 44145
www.asse-plumbing.org
(440) 835-3040

ASTM **American Soc of Testing & Materials**
100 Barr Harbor Drive
West Conshohocken, PA 19428-2959
www.astm.org
(610) 832-9500

BSI **British Standards Institution**
389 Chiswick High Road
London W4 4AL United Kingdom
www.bsi-global.com
+44 (0)20 8996 9000

CALOSHA California Division of Occupational Safety and Health
455 Golden Gate Avenue 10th Floor
San Francisco, CA 94102
www.dir.ca.gov/dosh
(800) 963-9424— (916) 274-5721

CDC **Center for Disease Control and Prevention**
1600 Clifton Road
Atlanta, GA 30333
www.cdc.gov
(404) 639-3311

CSI **Construction Specification Institute**
99 Canal Center Plaza, Suite 300
Alexandria, VA 22314
www.csinet.org
(800) 689-2900

CETA **Controlled Environmental Testing** Association
1500 Sunday Drive, Suite 102
Raleigh, NC 27607
www.cetainternational.org

CSA **Canadian Standards Association**
5060 Spectrumway, Suite 100
Mississauga, Ontario L4W 5N6
www.csa.ca
(800) 463-6727

DIN **German National Standard**
DIN Deutsches Institut füür Normung e. V.
10772 Berlin, Germany
www.din.de

EJCDC Engineers' Joint Contract Documents Committee
American Consulting Engineers Council
1015 15th Street, NW
Washington, DC 20005
www.ejc.org

EPA Environmental Protection Agency
401 M Street, SW
Washington, DC 20460
www.epa.gov
(202) 260-2090

FM Factory Mutual System
1151 Boston-Providence Turnpike
P. O. Box 9102
Norwood, MA 02062-9102
www.factorymutual.com
(781) 762-4300

FS Federal Specifications
General Service Administration
Specifications and Consumer Information
Distribution Center (WFSIS)
Washington Navy Yard Building 197
Washington, DC 20407
http://apps.fas.gsa.gov

IBC International Conference of Building Officials
5360 Workman Mill Road
Whittier, CA 90601-2298
www.icbo.org
(800) 423-6587

IEEE Institute of Electrical and Electronics Engineers
345 E. 47th Street
New York, NY 10017-2394
www.ieee.org
(800) 678-4333
(212) 705-7900

ISA Instrumentation, Systems, and Automation Society
67 Alexander Drive
Research Triangle Park, NC 27709
www.isa.org
(919) 549-8411

ISO Int'l Organization for Standardization
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

MCAA Mechanical Contractors Association of America
1385 Piccard Drive
Rockville, MD 20850-4329
www.mcas.org
(301) 869-5800

M**SS Manufacturers Standardization Society of the Valve and Fittings Industry**
127 Park Street, NE
Vienna, VA 22180-4602
www.mss-hq.com
(703) 281-6613

NEBB National Environmental Balancing Bureau
8575 Grovemont Circle
Gaithersburg, MD 20877
www.nebb.org
301-977-3698

NEC National Electrical Code
One Batterymarch Park
P. O. Box 9101
Quincy, MA 02269-9101
www.nfpa.org

NEMA National Electrical Manufacturers Association
1300 N. 17th Street, Suite 1847
Rosslyn, VA 22209
www.nema.org
(703) 841-3200

NFPA National Fire Protection Association
One Batterymarch Park
P. O. Box 9101
Quincy, MA 02269-9101
www.nfpa.org
(800) 344-3555—(617) 770-3000

NIH National Institute of Health
Bethesda, Maryland 20892
www.nih.gov

NSPE National Society of Professional Engineers
1420 King Street
Alexandria, VA 22314
(703) 684-2800

NSF NSF International
789 North Dixboro Road
Ann Arbor, MI 48105
www.nsf.org
(734) 769-8010

OSHA Occupational Safety and Health Administration
U.S. Department of Labor
200 Constitution Avenue, NW
Washington, DC 20201
www.osha.gov
(202) 219-8148

PDI Plumbing and Drainage Institute
45 Bristol Drive, Suite 101
South Easton, MA 02375
www.pdi-online.org
(800) 589-8956
(508) 230-3516

SMACNA Sheet Metal & Air Conditioning Contractors'
National Association
4201 Lafayette Center Drive
P. O. Box 221230
Chantilly, VA 20151-1209
www.smacna.org
(703) 803-2980

UL Underwriters Laboratories Inc.
333 Pfingsten Road
Northbrook, IL 60062
www.ul.com
(800) 704-4050
(847) 272-8800

12.0 Regulatory and Industry Consensus Standards

The potential for chemical exposure of personnel in laboratories has resulted in the promulgation of a wide variety of standards for ensuring proper operation of laboratory fume hood systems. The requirements and value of the information contained in the different standards will vary depending on your responsibilities.

A few of the relevant standards are briefly described below.

12.1 (ACGIH) American Conference of Governmental Industrial Hygienists

The ACGIH produces a wide variety of useful literature; however, two particularly useful guides are the Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices (TLV Guide) and the Industrial Ventilation: A Manual of Recommended Practice. The TLV Guide provides an excellent source of guidelines to assist with control of occupational hazards.

The Industrial Ventilation Manual provides one of the best sources of information on hood and ventilation system design.

(ACGIH) Industrial Ventilation (24th Edition)
p. 10-40 "Supply Air Distribution – For typical operations at a laboratory fume hood, the worker stands at the face of the hood and manipulates the apparatus in the hood. The indraft at the hood face creates eddy currents around the worker's body, which can drag contaminants in the hood back to the body and up to the breathing zone. The higher the face velocity, the greater the eddy currents. For this reason, higher face velocities do not result in as much greater protection as might be supposed."

p. 10-40
"Selection of Hood Face Velocity – The interaction of supply air distribution and hood face velocity makes any blanket specification of hood face velocity inappropriate. Higher hood face velocities will be wasteful of energy and may provide no better or even poorer worker protection."

"For projected new building, it is frequently necessary to estimate the cost of air conditioning early, before the detailed design and equipment specification are available. For that early estimating, the following guidelines can be used. Hoods near doors are acceptable if 1) there is a second safe egress from the room, 2) traffic past hood is low, and 3) door is normally open.

12.2 ANSI/AIHA Z9.5 – 1992

The American National Standards Institute (ANSI) published Z9.5 An American National Standard for Laboratory Ventilation, "to provide guidance in the selection, design, operation and use of laboratory ventilation system."

This standard is best suited for health and safety and engineering personnel responsible for ensuring proper use and design oflaboratory fume hood systems.

The standard provides non-regulatory guidelines and recommendations. It is the responsibility of an organization to determine the applicability of the recommendations.

Condition	CFM/Sq. Ft. Open Hood Face
Ceiling panels properly located with average panel face velocity <40 fpm. Horizontal-sliding sash hoods. No equipment in hood closer than 12 inches to face of hood. Hoods located away from doors and traffic ways.	60
Same as above; some traffic past hoods. No equipment in hoods closer than six inches to face of hood. Hoods located away from doors and traffic ways.	80
Ceiling panels properly located with average panel face velocity <60 fpm or ceiling diffusers properly located; no diffuser immediately in front of hoods, quadrant facing hood blocked, terminal throw velocity <60 fpm. No equipment in hood closer than six inches to face of hood. Hoods located away from doors or traffic ways.	80
Same as three above; some traffic past hoods. No equipment in hoods closer than six inches to face of hood.	100

A few of the recommendations include:

Develop a Laboratory Ventilation Management Program (LVMP). The program should include specific procedures for ensuring proper selection, design, operation, maintenance and use of laboratory fume hood systems.

Designate a cognizant person to administer the LVMP. Maintain Permanent Records of Performance.

Conduct initial and routine system performance tests.

The ASHRAE 110 Test is the preferred test for initial evaluation of performance.

Routine performance tests should be conducted at least annually or whenever a significant change in the hood system occurs.

New and renovated hoods must be equipped with flow measurement devices.

Supply air velocities (cross drafts) should be limited to less then 50% of target face velocity near hood openings.

The ductwork must be compatible with chemical effluents, sized to ensure 2,000 fpm duct velocities and designed to ensure safe transport and exhaust of materials generated in the hood. All ducts should be under negative pressure within the building.

The sound pressure level of noise should be limited at worker locations to below 85 dBA. Room noise should be limited to below a noise criterial curve rating of 55 dBA.

The catastrophic potential of each laboratory should be determined.

Lab personnel should be trained in proper work practices.

Further recommendations are provided for design and use of bypass fume hoods, VAV hoods, auxiliary air hoods, floor mounted hoods, perchloric acid hoods, and glove boxes.

ANSI /AIHA Z9.5 Committee issued a clarification letter to address this topic:

p. 1 – 3
Discourage the use of a numerical pressure differential between rooms as a basis for design. Although it is true that the difference in pressure is the driving force that causes airflow through any openings from one room to another, specifying quantitative pressure differential is a poor basis for design. What is really desired is an offset air volume. Attempts to design using direct pressure differential measurement and control vs. controlling the offset volume results in either short or extended periods of the loss of pressure when the doors are open or excessive pressure differentials when doors are closed, sufficient to affect the performance of low pressure fans. The direct pressure control systems are also hard to stabilize, and can cause building pressure problems and result in excessively large volume offsets in porous rooms. The need to maintain directional airflow at every instant and the magnitude of airflow needed will depend on individual circumstances. For example, "clean" rooms may have very strict requirements while teaching laboratories may only need to maintain directional airflow during certain activities or emergency conditions. In the later cases, one would simply use the appropriate offset to maintain directional airflow as needed and operational procedures during emergencies (i.e., close doors during a chemical spill).

The amount of offset should be based on two considerations:

The airflow required to keep the room negative (or in some positive) with regard to surrounding air spaces. The 10% offset suggested in the comments may be appropriate in some cases, but has no general validity.

The required "stringency" of the requirement for direction of airflow into or out of any openings in the walls. If the requirement is stringent, two seldom considered factors become important. First, if there is any appreciable temperature difference between the lab and the adjoining space, when a door is opened there will be a thermal exchange of warmer air flowing in one direction at the top of the doorway, and cooler air flowing in an opposite direction near the floor. An airflow velocity of at least 40 fpm is required to inhibit this exchange under normal conditions, a flow rate of 100 fpm is more positive. If there is no airlock, and if there is a definite but not stringent need for direction of airflow, this phenomenon should be made a design consideration.

For situations less than those requiring stringent control, VAV systems should be adequate. The offset volume should be based on the cfm needed to provide at least 50 cfm, (100 fpm is better) through the doorway opening. The increased offset volume can be operated by a mechanical optical switch at or near the door. The volume of offset air required is not related to the ventilation rate of the laboratory.

12.3 ANSI / ASHRAE 110 – 1995

The American Society of Heating, Refrigeration and Air Conditioning Engineers' ANSI / ASHRAE 110 Method of Testing Performance of Laboratory Fume Hoods provides guidelines to conduct qualitative tests to evaluate hood performance and quantitative tests to measure air velocities and containment capability.

The standard is best suited for persons responsible for ensuring proper operation of laboratory fume hoods, typically health and safety, engineering and maintenance.

The standard provides methods for:

Inspecting the hood and operating environment.

Airflow visualization (smoke tests).

Measurement of face velocity.

Tracer gas containment tests.
Limited evaluation of variable air volume operation.

Suggested tests for evaluating dynamic conditions (worker movement, traffic past the hood, etc.).

The standard also describes three methods of specifying the tests:

"As Manufactured" (AM) Tests - AM tests are conducted at the manufacturer's facility to evaluate hood design. AM tests enable pre-purchase evaluation of hood performance and provide critical operating specifications required for proper design of laboratory ventilation systems.

"As Installed" (AI) Tests – AI tests are conducted after experimental apparatus have been placed in the hood. The tests are used to determine hood limitations and the need for special work practices.

"As Used (AU) Tests - AU tests verify the function of the hood in the condition that the user has established the hood.

12.4 ASHRAE Handbook Applications 1999

p. 30.10
Face Velocity.
"If the face velocity (design and operation) must be maintained at 100 fpm (0.5/s) + 10%, this average may be allowed to deteriorate to 85 fpm (0.47 m/s) before correction and then the face velocity must be returned to 100 fpm (0.5/s). Individuals reading may not vary more than + 15% with the hood empty or + 25% with research equipment in the hood.

p. 30.5
"All laboratory fume hoods and safety cabinets should be equipped with visual and audible alarms to warn the laboratory workers of unsafe airflows."

p. 13.11
"In order for the laboratory to act as a secondary confinement barrier …, it must be maintained at a slightly negative pressure with respect to adjoining areas to contain odors and fumes. Exceptions are sterile facilities of clean spaces that may need to be maintained at a positive pressure with respect to adjoining spaces."

12.5 NFPA 45, 2000

p. 5-12
"6.4.5. Laboratory fume hood velocities and exhaust volumes shall be sufficient to contain contaminants generated within the hood and exhaust them outside of the laboratory building. The hood shall provide confinement of the possible hazards and protection for personnel at all times when chemicals are present in the hood."

P 45 – 28
Appendix "A-6.4.6. Laboratory fume hood containment can be evaluated using the procedures contained in the ASHRAE 110, Method of Testing Performance of Laboratory Fume Hoods. Face velocities of 0.4 m/sec to 0.6 m/sec (80 fpm to 120 fpm) generally provide containment if the hood location requirements and laboratory ventilation criteria of this standard are met."

p. 45-13
A measuring device for hood airflow shall be provided on each laboratory hood. The measuring device for hood airflow shall be a permanently installed device and shall provide constant indication to the hood user of adequate or inadequate hood airflow.

p. 45 – 12, Sections 6.3.3, 6.4.1
"Laboratory units in which chemicals are present shall be continuously ventilated. Air exhausted from laboratory fume hoods and other special local exhaust systems shall not be recirculated."

Differential pressure control versus volumetric offset – Room pressurization has been approached using two different methods:

Differential pressure control, and Volumetric offset control.

12.6 OSHA 1910.1450

In 1990, The Occupational Safety and Health Administration (OSHA) published 29 CFR Part 1910.1450 Occupational Exposure to Hazardous Chemicals in Laboratories (Federal Register, Volume 55, No. 21 pages 3327-3335). The standard became effective May 1, 1990 and contains a variety of regulatory requirements and recommendations for laboratories.

The law requires that laboratory facilities have a written Chemical Hygiene Plan that ensures protection for laboratory personnel, proper operation of laboratory fume hood systems and training of all laboratory personnel in safe work practices.

Chemical Hygiene Plan (CHP)

With few exceptions, all laboratories must develop a written CHP.

The standard requires designation of a Chemical Hygiene Officer.

The Chemical Hygiene Officer must develop, implement and administer the CHP.

The CHP must be capable of preventing overexposure of laboratory personnel to all potential chemical hazards.

The CHP must be readily available to all employees.

The CHP must include:

Protocols for identifying hazardous procedures.

Standard Operating Procedures for working with hazardous chemicals

Basis for selection of appropriate exposure control methods.

Measures to assure proper functioning of laboratory fume hoods.

Methods to evaluate system operation upon installation and routinely (recommended quarterly).

The standard recommends installation of monitors on all hoods.

Requires training and dissemination of employee information on all potential hazards.

Federal Register – OSHA
p. 3332. Paragraph G, Quality
"…airflow into and within the hood should not be excessively turbulent." (200)
"…hood face velocity should be adequate (typically 60 – 100 lfm)." (200,204)
Note: Reference to page numbers in Prudent Practices for Handling Hazardous Chemicals in Laboratories are given in parenthesis i.e., (200)

p. 484. Paragraph (B) Hoods
"…each hood should have a continuous monitoring device to allow convenient confirmation of adequate hood performance before use (200, 203)."

p. 484
"4. Ventilation … direct air flow into the laboratory from non-laboratory areas and out to the exterior of the building …"

12.7 Prudent Practices

Prudent Practices in the Laboratory: Handling and Disposal of Chemicals (1995), Committee on Prudent Practices for Handling, Storage, and Disposal of Chemicals in Laboratories, National Research Council.

p. 178
"In most cases, the recommended face velocity is between 80 and 100 feet per minute (fpm). Face velocities between 100 and 120 fpm may be used for substances of very high toxicity or where outside influences adversely affect hood performance. However, energy costs to operate the fume hood are directly proportional to the face velocity. Face velocities approaching or exceeding 150 (fpm) should not be used, because they may cause turbulence around the periphery of the sash opening and actually reduce the capture efficiency of the fume hood."

p. 192
"In all cases, air should flow from the offices, corridors, and support spaces into the laboratories. All air from chemical laboratories should be exhausted out-doors and not recirculated. Thus, the air pressure in chemical laboratories should be negative with respect to the rest of the building unless the laboratory is also a clean room."

p. 200
"2. Hoods should be evaluated before use to ensure adequate face velocity (typically 60 – 100 lfm) …and the absence of excessive turbulence…"

p. 203
"If the hood and the general ventilating system are properly designed, face velocities in the range of 60 –100 fpm will provide a laminar flow of air over the floor and sides of the hood. Higher face velocities (125 fpm or more), which exhaust the general laboratory air at a greater rate, are both wasteful of energy and likely to degrade hood performance by creating air turbulence at the hood face and within the hood. Such air turbulence can cause the vapors within the hood to spill out into the general laboratory atmosphere."

p. 204
"The optimum face velocity of a hood (also called the capture velocity) will vary depending on its configuration. As noted above, too high a face velocity is likely to increase the turbulence within the hood and cause gases or vapors to spill from the hood into the room."

p. 180
"Make sure that a continuous monitoring device for adequate hood performance is present and check it every time the hood is used."

p. 206
"After the face velocity of each hood has been measured (and the airflow balanced if necessary), each hood should be fitted with an inexpensive manometer or other pressure – measuring device (or a velocity-measuring device) to enable the user to determine that the hood is operating as it was when evaluated. This pressure measuring device should be capable of measuring pressure differences in the range of 0.1-2.0 in. of H20 and should have the lower pressure side connected to the duct above the hood and the higher pressure side open to the general laboratory atmosphere.

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p. 117
"If there are administrative, classroom, or service areas within the same building as laboratories, the entire laboratory area should be at a modest negative pressure with respect to these spaces so that any airflow that exists will be from the non-research areas into the space occupied by laboratories.

"…the design of the air exhaust system from a laboratory must be done carefully to provide continuing replacement of fresh air in the room. The fume hood system and the supplementary exhaust system should be interlocked to ensure a stable room air balance at all times."

Please refer to the latest editions for all reference materials.