Northwestern University

The Chemical Fume Hood Handbook

Version 1.2 November2009

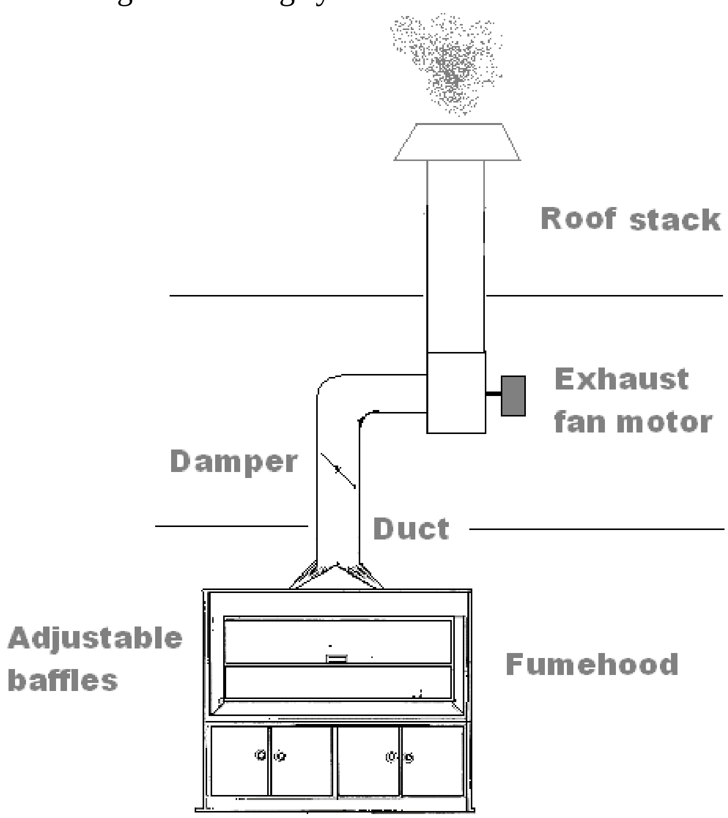
Office for Research Safety (ORS)
Office of the Vice President for Research

Contents

Introduction

Laboratory fume hoods minimize chemical exposure to laboratory workers. They are considered the primary means of protection from inhalation of hazardous vapors, mists and particulate matter. It is, therefore, important that all potentially harmful chemical work be conducted inside a properly functioning fume hood.

A fume hood structure is basically a cabinet, with an open side (or sides) for access to the interior of the hood. A transparent, movable sash, allows the user to restrict or enlarge the fume hood opening. The hood is connected, via ductwork, to an exhaust fan, usually located on the roof of the building in which the hood is located. The exhaust fan draws air from the room in which the hood is in through the hood opening and out through the ductwork. A fume hood is an integral part of the building air handling system.



The speed of the air moving through the hood opening is known as face velocity.
This laboratory worker guide is intended to help identify fume hood types and outline exposure control practices in relation to the fume hood.

Hood Types

There are many types of hoods, each with its own design and function. To identify which hood type is present in your lab, a list of definitions describing hood features and their advantages and disadvantages is provided below.

Constant air volume principle

Conventional hood

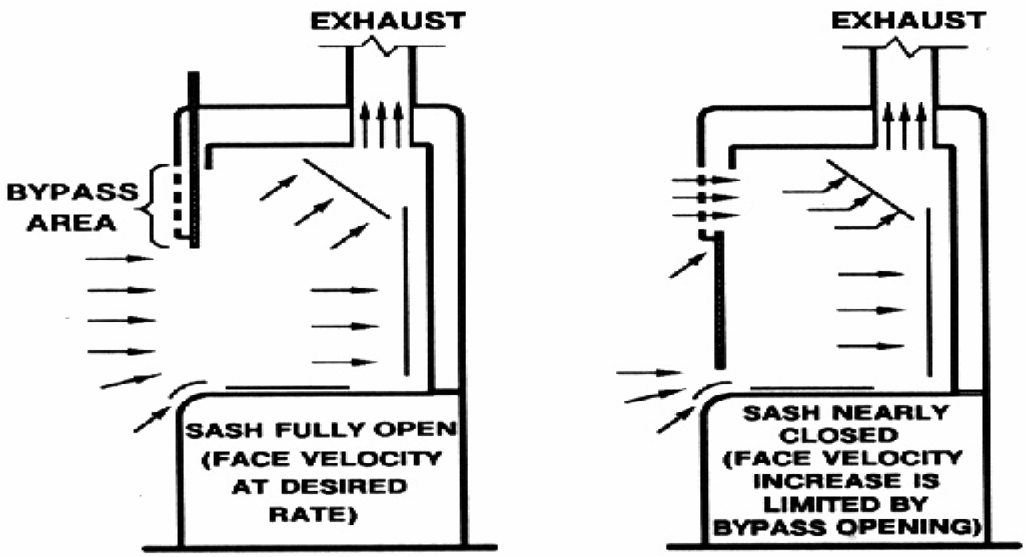
This term is used to describe a constant air volume (CAV) hood, an older, traditionally less elaborate hood design used for general protection of the laboratory worker. Because the amount of exhausted air is constant, the face velocity of a CAV hood is inversely proportional to the sash height. That is, the lower the sash, the higher the face velocity. CAV hoods can be installed with or without a bypass provision which is an additional opening for air supply into the hood.

Conventional hood without a bypass

Some conventional hoods do not have a provision for a bypass. Essentially, they consist of an enclosed cabinet with a connection for an exhaust duct and a movable sash on the front.

Conventional bypass fume hood

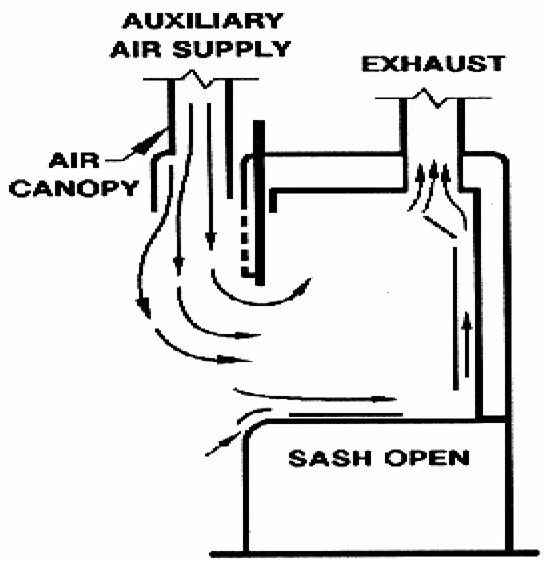
The bypass fume hood is an improved variation on the conventional fume hood. The bypass is located above the sash face opening and protected by a grille which helps to direct air flow. The bypass is intended to address the varying face velocities that create air turbulence leading to air spillage. The bypass limits the increase in face velocity as the sash nears the fully closed position, maintaining a relatively constant volume of exhaust air regardless of sash position.



Auxiliary air hoods

This fume hood, sometimes referred to as a makeup air fume hood, was developed as a variation on the bypass fume hood and reduces the amount of conditioned room air that is consumed. The auxiliary fume hood is a bypass hood with the addition of direct auxiliary air connection to provide unconditioned or partially conditioned outside makeup air. Auxiliary air hoods were designed to save heating and cooling energy costs, but tend to increase the mechanical and operational costs

due to the additional ductwork, fans, and air tempering facilities. In general, installation of this type of hood is discouraged since the disadvantages usually outweigh the benefits.



Variable air volume principle

Variable air volume (VAV) hoods differ from constant air volume (CAV) hoods because of their ability to vary air volume exhausted through the hood depending on the hood sash position. VAV hoods reduce the total quantity of supply and exhaust air to a space when not needed, thereby reducing total operating costs.

Variable air volume (VAV) hood

A VAV hood maintains a constant face velocity regardless of sash position. To ensure accurate control of the average face velocity, VAV hoods incorporate a closed loop control system. The system continuously measures and adjusts the amount of air being exhausted to maintain the required average face velocity. The addition of the VAV fume hood control system significantly increases the hood's ability to protect against exposure to chemical vapors or other contaminants. Many VAV hoods are also equipped with visual and audible alarms and gauges to notify the laboratory worker of hood malfunction or insufficient face velocity.

Specialty Lab Exhaust Systems

Walk-in hood

A walk-in hood is a hood which sits directly on the floor and is characterized by a very tall and deep chamber that can accommodate large pieces of equipment. Walk-in hoods may be designed as conventional, bypass, auxiliary air, or VAV. If you have a walk-in hood, contact ORS for operating protocol and inspection procedures.

Fume exhaust connections: "snorkels"

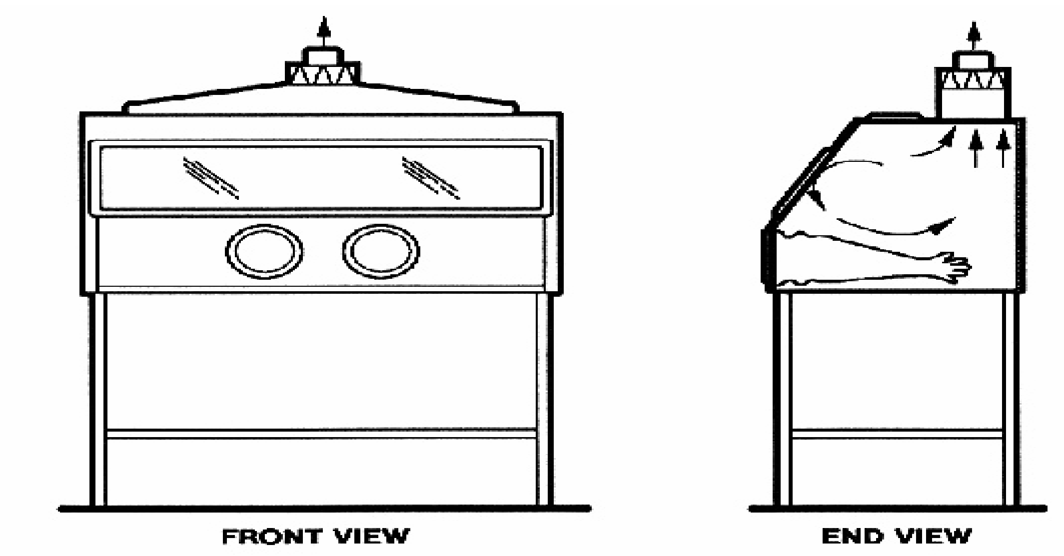
Fume exhaust duct connections, commonly called snorkels, elephant trunks or flex ducts, are designed to be somewhat mobile allowing the user to place it over a small area needing ventilation. However for optimal efficiency, these connections must be placed within six (6) inches of an experiment, process, or equipment. These funnel-shaped exhausts aid in the removal of contaminated or irritating air from a point source to the outside.

Canopy hoods

Canopy hoods are horizontal enclosures having an open central duct suspended above a work bench or other area. Canopy hoods are most often used to exhaust areas that are too large to be enclosed within a fume hood. The major disadvantage with the canopy hood is that the contaminants are drawn directly past the user's breathing zone.

Glove boxes

Glove boxes are used when the toxicity, radioactivity level, or oxygen reactivity of the substances under study pose too great a hazard for use within a fume hood. The major advantage of the glove box is protection for the laboratory worker and the product.



Perchloric acid and radioisotope fume hoods

Perchloric acid hoods have wash-down capabilities to prevent the buildup of explosive perchlorate salts within the exhaust systems. Both perchloric acid and volatile radioisotope work require specific fume hood use protocols. If you have questions or concerns about working with perchloric acid or volatile radioisotopes within a fume hood contact ORS for further guidance at 491-5581(Evanston) or 503-8300(Chicago).

Fume Hood Design Definitions

Flammable and corrosive material storage cabinets

Flammable and corrosive cabinets typically comprise the bottom supporting structure of the fume hood. They can be vented or non-vented enclosures used primarily for storage of flammable or corrosive materials. If vented, the flammable storage cabinet is connected to the hood exhaust. The corrosive storage cabinet should be designed with a protective lining and secondary containment to inhibit chemical corrosion. It is recommended that these storage cabinets be vented either through the hood or through their own dedicated exhaust.

Sash

Sash is the term used to describe the movable glass panel that covers the face area of a fume hood. Sashes can be vertical, horizontal, or a combination of the two. Many hoods are installed with a vertical sash stop, which stops the sash at approximately a 14 inch work level. Sash stops should never be removed, overridden, or modified. It is recommended that all lab work in a properly functioning fume hood be performed at the sash stop level or lower whenever possible.

Alarms, sensors, controls, and gauges

Many of the newer VAV hoods are installed with alarms, sensors, controls, and gauges. These features are included to provide lab personnel with a constant reading of fume hood performance. If the face velocity falls below an acceptable range the hood sensors will trigger an alarm to notify lab personnel. Low velocity alarms activate when the sash has been raised to a height at which the hood can no longer exhaust a sufficient amount of air, the building air exhaust system is not working properly, or there has been a power outage. When a low velocity alarm is activated, no hazardous chemical work should be performed until the exhaust volume is increased. Additionally, laboratory workers should not attempt to stop or disable hood alarms. NU's Physical Plant office should be notified for adjustment of air handling system exhaust and fume hood maintenance.

Air foil (Sill)

The air foil or sill, located at the front of the hood beneath the sash, creates a smooth air flow, minimizing turbulence of the air entering the hood. The recessed work area is directly behind the sill. All work should be done at least six (6) inches into the recessed area.

Air jambs

The air jambs are vertical sills or side posts at the front of the hood. These are tapered to promote smooth air flow into the hood.

Baffles

The baffles are movable panels located on the back wall of the hood that create slots in which air is exhausted. The pattern of the air moving into and through the hood is determined by the setting of the baffles. Physical Plant should adjust the baffles according to the specific gravity of the chemicals used in the hood. Once the baffles are set, they should not be re-adjusted by laboratory workers.

Operating Performance

Location

The location of the hood affects its efficiency. Ideally, fume hoods should be located in an area of minimal traffic. When a person walks by a fume hood, turbulence can be created causing contaminants to be drawn outside the hood. Also, if the air diffuser is located directly above the fume hood, air turbulence may be created causing contaminants to escape into the room. The air flow into the room has an effect on the fume hood. All doors and windows should be kept closed to maintain the negative pressure of the lab with respect to the outside corridor. This ensures that any contaminants in the lab will be exhausted through the fume hood and not escape into the hallway.

Face velocity

Face velocity is a measurement of the average velocity at which air is drawn through the face of the fume hood. Face velocities too high or to low can be detrimental to the performance of the fume hood. The acceptable range of the average face velocity may vary between 60-100 feet per minute (fpm) depending on hood type and hazard.
If non-carcinogenic materials are being used the acceptable face velocity for minimally hazardous materials is 50 fpm. Currently, all fume hoods are certified for work with hazardous chemicals if the air velocity is between 80 and 120 fpm. At velocities greater than 125 fpm face velocity, studies have demonstrated that the creation of turbulence causes contaminants to flow out of the hood and into the user's breathing zone.

Air flow indicators

Small pieces of tinsel are taped to the bottom corner of the sash. Inward movement of the tinsel indicates air is being drawn into the hood. Air flow indicators do not determine face velocity. They only indicate that air is being exhausted through the fume hood.

Inspection of Fume Hoods

When installed, fume hoods should be inspected in accordance with the American Society of Heating, Refrigerating and Air-Conditioning Engineers ASHRAE 110 to ensure proper containment. ASHRAE 110 is the industry standard tracer gas mannequin method. . It is the responsibility of the Office of the University Architect or Facilities Management to arrange for testing and initial certification of a new hood. An air balancing specialist is hired to ensure that containment meet design criteria and that supply and exhaust air flow are in proper proportion to establish a negative pressure differential between the lab and the outside corridor. Exhaust flow must be greater than supply to create air movement from the hall into the lab to contain airborne contaminants.

The Occupational Safety and Health Administration standard 29 CFR 1910.1450 – Occupational Exposures to Hazardous Chemicals in Laboratories.OSHA 29 CFR 1910.1450 (1)(c)(iii) states related to fume hood inspections:

> *"A requirement that fume hoods and other protective equipment are functioning properly and specific measures that shall be taken to ensure proper and adequate performance of such equipment"*

Ideally, a random sample of chemical hoods can be tested for leakage and proper capture integrity. A tracer gas such as sulfur hexafluoride is delivered into the hood and measurements of concentration are collected around the hood to determine gas escape. A mannequin is placed at the face of a hood to simulate an operator's presence.

ORS performs fume hood inspections on an annual basis. Ten percent of all VAV hoods on a single system are tested and averaged to determine the overall efficiency for all VAV hoods on that system. All conventional hoods and specialty hoods are inspected individually. After initial post-installation checks, ORS will annually inspect fume hoods for the following:

- average face velocity of the hood with the sash fully opened
- sash height at which the average face velocity is 100 fpm
- smoke test to determine air flow patterns and leakage
- placement of airflow indicators in hood
- survey hood condition for spills, airflow blockage, and disabled sash stops

If the fume hood is not functioning properly contact ORS for an immediate assessment.

Safe Work Practices

The health and safety of laboratory personnel and building occupants must be the primary goal of laboratory management. Properly functioning fume hoods help achieve this goal with respect to the hazards of chemical vapors and other harmful airborne substances. It is important to remember that a fume hood is not a storage area. Keeping equipment and chemicals unnecessarily in the hood may cause airflow blockage.

- Substitute toxic chemicals with less hazardous materials whenever possible.
- Keep fume hood exhaust fans on at all times.
- Perform all work six inches inside the hood.
- Never place your head inside the hood.
- Keep the hood sash closed as much as possible at all times to ensure the optimum face velocity and to minimize energy usage.
- Keep lab doors and windows closed to ensure negative room pressure to the corridor and proper air flow into the hood.
- Do not store chemicals in the hood.

- Keep the slots of the baffle free of obstruction.
- Do not use the hood exhaust as a waste disposal mechanism (e.g., for evaporation of chemicals).
- Avoid rapid movements in front of the hood including opening and closing the fume hood sash rapidly and swift arm and body movements in front of or inside the hood. These actions may increase turbulence and reduce the effectiveness of fume hood containment.
- Do not override or disable mechanical stops on the sash
- Train and educate employees regarding specific hazards and include work methods that help reduce contaminant exposure.
- Have a general awareness of the operation of your hood and be aware of any differences in visual or audible cues that may imply a change in function.

Fume hood exhaust fans may shut down due to unexpected failure or for periodic fan maintenance. Scheduled exhaust fan outages will be announced by Facilities. When exhaust fans are shut down or face velocities are low, procedures must be shut down and all chemical containers capped.

References

ACGIH Committee on Industrial Ventilation. 2004. “Industrial Ventilation: A Manual of Recommended Practice, 25th edition.” American Conference of Governmental Industrial Hygienists, Inc., Cincinnati, OH.

American Industrial Hygiene Association. 2003. “American National Standard for Laboratory Ventilation.” ANSI/AIHA Z9.5 Fairfax, VA.

Associated Air Balance Council. 2002. “National Standards for Total System Balance, 6th edition.” Associated Air Balance Council, Washington, D.C.

Committee on Prudent Practices for Handling, Storage, and Disposal of Chemicals in Laboratories. 1995. “Prudent Practices in the Laboratory, Handling and disposal of Chemicals.” National Academy Press, Washington, D.C.

DiBerardins, Louis J., Baum, Janet S., First, Melvin W., Gatwood, Gari T., Groden, Edward F., Seth, Anand K. 2001. “Guidelines for Laboratory Design: Health and Safety Considerations, 3rd edition.” John Wiley and Sons, Inc., New York, NY.

Gershey, E.L., Wilkerson, Amy, Joao, R.V., Volin, C.E., Reiman, J.S. 1996. “Chemical Hood Performance: Standards, Guidelines, and Recommendations.” Chemical Health & Safety, November/December.

Plog, Barbara A., Niland, Jill, Quinlan, Patricia J. 2002. “Fundamentals of Industrial Hygiene, 5th edition.” National Safety Council, Itasca, IL.