Tennessee TECH

Environmental Health and Safety

A GUIDE TO LABORATORY FUME HOODS

I. Purpose

a. Chemical fume hoods are a recognized engineering control and play an important role in laboratory safety. These devices must be properly designed, installed, maintained and used for optimum control of hazardous substances. These guidelines reflect federal and state health and safety regulations and policies. The guidelines do not stand alone, but must be incorporated with other applicable standards into the design and construction of a fume hood. In this way, those who use and maintain chemical fume hoods will be ensured of an adequate level of protection from the possible harmful effects of laboratory chemicals.

II. Scope

a. This guide shall address chemical fume hoods used to control hazardous substances in the laboratory. This plan does not address biosafety cabinets, glove boxes, histology grossing tables, clean benches, bench-top exhausts, and similar local exhaust ventilation.

III. Introduction

a. Laboratory fume hoods are a type of ventilation system where the primary function is to exhaust chemical fumes, vapors, gasses, dust, mist and aerosol. Fume hoods also serve as physical barriers between reactions and the laboratory, offering a measure of protection against inhalation exposure, chemical spills, run-away reactions and fires.
b. A typical fume hood has a box like structure with a moveable sash window. Experimental procedures are performed within the hood which is consistently and safely ventilated, usually by means of an extract blower and ductwork. Chemical fumes are exhausted and diluted many times over in the atmosphere and have a negligible effect to human health.
c. The hood functions by maintaining a relatively negative pressure in the interior of the hood to prevent any contaminant from escaping while drawing air in through the hood opening at a consistent rate. A suitable hood face velocity (the speed at which air is drawn into the hood) is of importance to the safe and effective operation of a fume hood.
d. While excessive face velocities can often result in turbulence and reduce containment, insufficient velocities can also compromise hood performance.
e. In general, a hood's face velocity is recommended to be between 0.3 m/s (60 fpm) and 0.5 m/s (100 fpm). Most hoods are commonly sized for a minimum face velocity at full sash opening; but as means to conserve energy some hoods size the minimum face velocity of the hood at half-sash opening creating new low flow fume hoods, which are now present in the market.

IV. Roles and Responsibilities

a. Laboratory Personnel (including students in classes)
    i. Review and follow all relevant safety standard operating procedures.
    ii. Keep work areas safe and uncluttered.
    iii. Review and understand the hazards of materials and processes in their research/class operations prior to conducting work.
    iv. If the fume hood is not working properly the individual must immediately stop work and report the malfunction to the supervisor.

b. Principle Investigator/Faculty/ Laboratory Supervisor
    i. The Principal Investigator (PI)/Faculty/Laboratory Supervisor has responsibility for the health and safety of all laboratory personnel and students working under their authority or within their research facilities.
    ii. Know the applicable health and safety rules and regulations, training and reporting requirements, and standard operating procedures associated with chemical fume hood use.
    iii. Notify Facilities Services via a work order request as soon as possible and stop work when fume hoods are not operating properly.

c. EHS
    i. Administer and oversee the implementation of the *Guide to Laboratory Fume Hoods*.
    ii. Conduct annual inspection of fume hoods.

V. Laboratory Design

a. Fume hoods should be located so that persons exiting the lab do not have to pass in front of the hood.
    i. Potentially dangerous portions of experiments are usually conducted in a fume hood. Many lab fires and explosions originate in fume hoods. A fire or explosion in a fume hood located adjacent to a path of egress could trap someone in a lab. Also, turbulence from passing traffic can adversely affect hood performance.

b. Windows in labs containing fume hoods must be closed.
    i. Breezes coming in through open lab windows can adversely affect the proper functioning of a hood. Turbulence caused by these wind currents can easily bring the contaminated air inside the hood out into the lab. Note that hood face velocities are only about 1 mile/hr.

VI. Fume Hood Basics

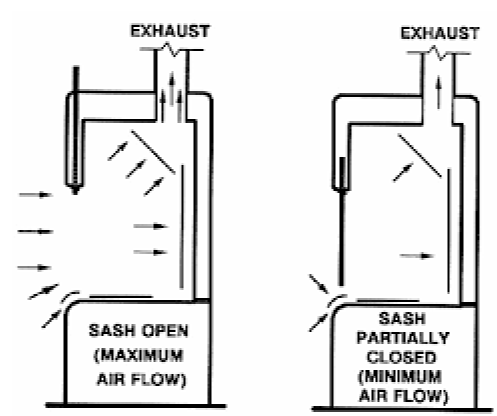
a. A chemical fume hood is a partially enclosed workspace that is exhausted to the outside. When used properly, hazardous gases and vapors generated inside the lid are captured before they enter the breathing zone. This serves to minimize the exposure to airborne contaminants. The common parts of a fume hood and their major functions are:
    - Hood Body-The visible part of the fume hood that serves to contain hazardous gases and vapors.
    - Baffles-Moveable partitions used to create slotted opening along the back of the hood body. Baffles keep the airflow uniform across the hood opening, thus eliminating dead spots and optimizing capture efficiency.

- Sash-By using the sash to adjust the front opening, airflow across the hood can be adjusted to the point where capture of contaminants is maximized. Each hood is marked with the optimum sash configuration. The sash should be held in this position when work involving the fume hood is being performed and closed completely when the hood is not in use.
- Airfoil-Found along the bottom side edge airfoils streamline airflow into the hood, preventing the creation of turbulent eddies that can carry vapors out of the hood. The space below the bottom airfoil provides source of room air for the hood exhaust when the sash is fully closed.
- Work Surface-the area under the hood where chemicals are placed for use.
- Exhaust Plenum-an important engineering feature, the exhaust plenum helps to distribute airflow evenly across the hood face
- Face- the imaginary plane running between the bottom of the sash to the work surface. Hood face velocity is measured across this plane.

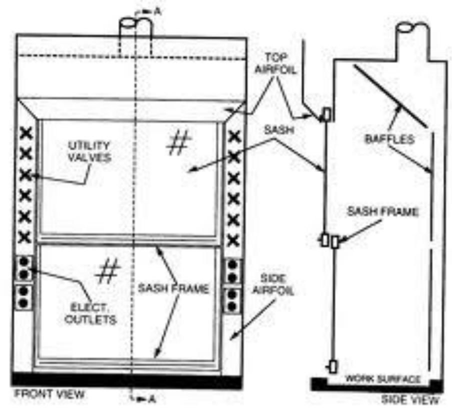
VII. Fume Hood Types

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.

a. 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.



b. Walk-in Hood/Floor Mounted Fume Hood- Used for applications which require large apparatus. As the name implies, these hoods are floor mounted without any work surface. This facilitates the transfer of equipment and materials into, and out from the hood. Walk-in hoods require a specific written operating protocol.



c. Fume exhaust connections: "snorkels"- 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.
d. Canopy hoods- 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.
e. Glove boxes- 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. However, some glove boxes/glove box designs cannot be used with volatile chemicals.
f. Perchloric acid and volatile radioisotope hoods- This hood type has wash-down capabilities to prevent the buildup of explosive perchlorate salts within the exhaust systems. Perchloric acid and volatile radioisotope work require specific fume hood use protocols.
g. Ductless Fume Hood- Utilize activated carbon filtration to adsorb chemical vapors and fumes. These hoods recirculate air to the laboratory, and are growing in popularity because of energy savings. One disadvantage is that these hoods can only be used with certain chemicals.
h. Not Fume Hoods- Biological safety cabinets, laminar flow clean benches, and glove boxes (see information about glove boxes in (e)) are sometimes mistaken for fume

hoods. These devices utilize particulate filters which do not remove chemical vapors. With specific rare exceptions, they should not be used for work involving chemicals.

VIII. Fume Hood Safety

a. To ensure safety and proper fume hood performance, follow these guidelines:
    i. Confirm that the hood is operational. Make sure the switch is in the "on" position and the airflow is working properly. To test the airflow hold a tissue or other light weight paper up to the opening of the hood. The paper should be pulled inward.
    ii. A laboratory fume hood should have a minimum of 2.5 linear feet of hood space per person.
    iii. Equipment and other materials should be placed at least six inches behind the sash.
        1. This will reduce the exposure of the person to chemical vapors that may escape into the lab due to air turbulence.
    iv. Work with the sash at least at optimum height or as far down as practical. Some fume hoods have arrows. The arrows on these fume hoods indicate optimum height. When the fume hood is not in use, pull the sash all the way down.
    v. Do not keep loose papers, paper towels, or tissues in the hood. These materials can be drawn into the blower and adversely affect the performance of the hood.
    vi. Never place your head inside the hood.
    vii. Do not block the baffle area of the fume hood. Elevate large equipment two inches off the base of the fume hood to allow proper ventilation around the equipment.
    viii. DO NOT use the fume hood as a storage cabinet for chemicals. Excessive storage of chemicals and other items will disrupt the designed airflow in the hood.
    ix. Use extreme caution with ignition sources inside the fume hood.
    x. Avoid cross drafts and disruptive air currents on front of the fume hood. A person walking past a fume hood can create competing air currents at the hood face, causing vapors to flow out. Other sources of competing air currents such as open windows and fans should be avoided while using the fume hood.
    xi. Clean up spills in the fume hood immediately.
    xii. Wear personal protective equipment, as appropriate.
    xiii. Have a general awareness of the operation of your hood and be aware of any differences in smell, visual or audible cues that may imply a change in function.
    xiv. In case of an emergency, notify the appropriate personnel.

IX. Inspections

To ensure that any contaminants in the lab will be exhausted through the fume hood and not escape into the hallway fume hood test are performed. The face velocity, average velocity at which the air is drawn through the face to the hood exhaust, is measured by using an anemometer. The ideal average face velocity is 100 feet per minute (fpm) for most operations. Ideally, no measurements should be plus or minus 20% of the average.

a. Fume hoods should also be tested in the following circumstances:
    i. Annually;
    ii. When an employee request an inspection;
    iii. When a procedural change requires a hood upgrade;

    iv. After a major repair.

b. Fume hoods that are newly installed shall be tested prior to use by an independent contractor using the ANSI/ASHRAE Standard 110 Method of Testing Performance of Laboratory Fume Hoods.
    i. Documentation of this test must be sent to Environmental Health and Safety (EHS) prior to using the fume hood.
c. Deficient Hoods:
    i. Chemical fume hoods that do not meet minimum performance standards shall be tagged out of service by Environmental Health and Safety (EHS).
        1. Lab workers present at the time of inspection/testing shall be notified of hoods that fail.
    ii. A work order shall be submitted by the responsible person or a designated individual in the lab space.
    iii. The Department Chair shall be notified immediately of the failure by EHS.

X. Maintenance

a. In the event that scheduled maintenance is to be done on a fume hood the faculty member, lab supervisor, or department head should be notified of the day and time of work to be done in advance.
    i. The notification will instruct lab personnel to shut down all processes and discontinue all activities in the fume hood if necessary.
b. When the maintenance is completed, Facilities Services must notify faculty member, lab supervisor, or department head the when the work is complete and the exhaust systems are operating normally.

XI. Power Failure

a. In the event of a power failure to the fume hoods, lab personnel should follow the following plan:
    i. Shutdown all processes and discontinue all activities in the fume hood;
    ii. Contain or remove all hazardous materials;
    iii. DO NOT use the hoods;
    iv. If toxic fumes have entered the room evacuate the building and call 911.

XII. References

NFPA 45 Section 6-4.5
OSHA 29 CFR 1910.1450
ANSI/AIHA Z9.5-2003
National Research Council: Prudent Practices in the Laboratory, Handling and Disposal of Chemicals
University of Tennessee Knoxville, Department of Environmental Health and Safety: Safety Manual
University of California Santa Barbara: Chemical Fume Hood Guide
Centre College: Fume Hood Guidelines
Northwestern University: The Chemical Fume Hood Handbook
Esco: A Guide to Laboratory Fume Hoods