Biosafety Cabinets and Fume Hoods Supplemental Material (OHS_BIO304)

Introduction

Welcome to the Biosafety Cabinets and Fume Hoods Training Supplemental Material for OHS_BIO304. This information is for anyone that will be conducting work and/or research that requires a Biosafety Cabinet, Fume Hood, or Clean Air Station.

Fume Hoods

Overview

Long ago, alchemists conducted experiments in the fireplace hearth to avoid being overcome by heat, smoke and foul smelling vapors. Today, we use a state-of-the-art fume hood, which comes in traditional and low flow varieties.

The traditional types include the conventional, bypass and auxiliary air hoods, which differ in how the air enters the hood with a face velocity between 80 to 100 feet per minute (fpm).

The primary purpose of laboratory fume hoods is to keep toxic or irritating vapors out of the general laboratory working area. A secondary purpose is to serve as a shield between the worker and the equipment being used when there is the possibility of an explosive reaction, or to protect the specimen.

Fume hoods are comprised of the hood itself and a sash, which is the front panel of the fume hood that can be opened and closed to maximize access and minimize airflow. 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 airflow into the room has an effect on the fume hood. All doors should be closed to maintain the negative pressure of the lab with respect to the corridor. This ensures that any contaminants in the lab will be exhausted through the fume hood and not escape into the hallway.

There are different types of Fume Hoods on campus at UAB. However, Ductless Fume Hoods are strongly not recommended.

Fume Hood Design Definitions

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.
- It is highly recommended that these storage cabinets be vented either through the hood or through their own dedicated exhaust.

Types

Conventional Hoods

Represent the original and most simple of the hood design styles. With a conventional hood, the volume of air exhausted is constant, regardless of sash height. Thus, the face velocity increases as the sash is lowered.

Bypass Hoods

Have an added engineering feature and are considered a step up from conventional hoods. An air bypass incorporated above the sash provides an additional source of room air when the sash is closed.

Auxiliary Air Hoods

Have attached, dedicated ducts to supply outside air to the face of the bypass hood. The main advantage of an auxiliary air hood is the energy savings realized by reducing the amount of heated or air-conditioned room air exhausted by the hood.

Variable Air Volume (VAV) Hoods

VAVs are the most sophisticated hood types, requiring technically proficient design, installation and maintenance. The primary characteristic of VAV hoods is their ability to maintain a constant face velocity as sash height changes.

Ductless Fume Hoods

A conventional hood design, but are self-contained to recirculate air back into the lab after filtration occurs. These hoods use either High Efficiency Particulate Air (HEPA) filters or Activated Carbon Filtration (ACF) technology to remove contaminants from the hood air. Their use is limited to nuisance vapors and dusts that do not present a fire or toxicity hazard.

High-Performance Chemical Fume Hoods

Also known as low-flow chemical fume hoods, were designed to operate with a lower intake face velocity for use with chemicals or radiological agents.

Specialty

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 variable air volume.

Snorklers

Fume exhaust duct connections, commonly called snorklers, elephant trunks or flex ducts, are designed to be somewhat mobile allowing the user to place it over the area needing ventilation.

Canopy Hoods

Canopy hoods are horizontal enclosures having an open central duct suspended above a work bench or other areas.

- 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 heat, odor and contaminants can be drawn directly past the user's breathing zone.
- The capture zone for a canopy hood is only a few inches below the opening and is best used for capturing water vapor or heated air.

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 worker and the product.
- Two commonly sought out specialty types include Radioisotope and Perchloric hoods.
- Radioisotope hood systems are ideally made from welded stainless steel to ensure against absorption of radioactive materials. In order to comply with most licensing requirements, radioisotope hoods require a face velocity of 125 fpm.
- Perchloric acid hoods have wash-down capabilities to prevent the buildup of explosive perchlorate salts within the exhaust systems.

Hood Considerations

All the above fume hood designs and systems have their particular shortcomings, but the traditional hoods with a higher face velocity can be somewhat forgiving if the sash is above design height for a limited time.

The low flow hoods are not so forgiving even with the most recent improvements and fail containment because they are more vulnerable to traffic, placement, number of hoods and sash position.

Parts

Sashes

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 combination of the two.

Alarms

Many of the newer VAV hoods are installed with alarms, sensors, controls, and gauges.

Hoods usually go into alarm mode either because 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 hood alarms, no chemical work should be performed until the exhaust is increased. Additionally, lab workers should not attempt to stop or disable hood alarms.

Positioning the Fume Hood

The location of the fume hood affects its efficiency.

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 airflow into the room has an effect on the fume hood. All doors should be closed to maintain the negative pressure of the lab with respect to the corridor. This ensures that any contaminants in the lad will be exhausted through the fume hood and not escape into the hallway.

Face velocity is a measurement of the average velocity at which air is drawn through the face to the hood exhaust. The acceptable range of the average face velocity is 60-100 feet per minute (fpm).

If non-carcinogenic materials are being used, the acceptable face velocity for minimally hazardous materials is 60 fpm. The ideal average face velocity is 100 fpm for most operations.

If using a carcinogen, reproductive toxin, or acutely toxic material it is recommended that the face velocity range from 60 to 125 fpm.

MORE IS NOT ALWAYS BETTER! At velocities greater than 125 fpm, studies have demonstrated that the creation of turbulence causes contaminants to flow out of the hood and into the user's breathing zone.

Testing

Periodic Fume Hood Testing

Routine performance testing shall be conducted at least annually or whenever a significant change has been made to the operational characteristics of the hood system.

A hood that is found to be operating with an average velocity more than 10% below the designated average velocity shall be labeled as out of service or restricted and corrective actions shall be taken to increase the flow.

Out of Service Notice

When taken out of service it shall be posted with a restricted out-of-service notice. The restricted use notice shall state the requisite precautions concerning the type of materials permitted or prohibited for use in the hood.

Fume Hood Tracer Gas Testing

The benchmark velocity is established by ANSI/ASHARE 100 Fume Hood Testing Requirements.

- All new fume hood installations require AI (as installed) testing and old new hoods requires AU (as used) testing.
- These requirements also standards for permanent air flow monitors and proper standards for permanent air flow monitors and proper air sill installation when hazardous materials are used inside the hood.
- A decrease in the average velocity below 90% the benchmark velocity and face velocity increases in excesses exceeding 20% of the benchmark shall be corrected prior to continued use.

Practices

Keep Safe

You should keep:

- The hood surface free of stored chemicals and paper towels/Kimwipes
- Instruments 2" above the hood surface to allow air flow under the instrument
- Work 6" behind the sash and do not let items block sash closure
- Items from blocking the back baffles.

- The sash **as low as possible and always between you and your experiment** when working in the hood.
- The sash closed when not working in front of the hood.

Proper Workplace

- Work slowly and remove your arms slowly to reduce the creation of eddy current that may disrupt the containment ability of the hood
- Work at least 6 inches back from the face of the hood. A stripe on the bench surface is a good reminder.
- Always use splash goggles and wear a full face shield if there is possibility of an explosion or eruption.
- Never use a fume hood as a canopy hood to draw away heat. This will create airflow disruptions.
- Never over pack a fume hood; Air must be able to flow around objects.
- Never use the fume hood to store chemicals. This precludes the hood from being used.
- Never stick you face or body head into a fume hood

Low vs. Standard Flow

Discussion Point

Once VAV hoods were developed, engineers started to look for ways to further decrease the amount of air used by fume hoods. The growing green movement further fueled this. As a result, a sub class of VAV hoods was developed that took advantages of computer modeling to engineer more efficiently coupled fume hoods that required less air for the same containment capability. The physics of air capture is such that while these fume hoods were better able to capture vapors, they were more sensitive to cross drafts in rooms. Thus a person walking by a fume hood or shutting a door in a room, or a misplaced air diffusor, or about a thousand other possible sources of turbulence impacts the ability of a low flow hood to contain vapors. Never the less there are appropriate uses for these fume hoods.

The flow rate of a fume hood directly impacts the expense necessary to run a fume hood. When many fume hoods are placed into a space, the cost of exhausting air and conditioning makeup air can be considerable.

Thus over time ways have been sought to minimize the cost associated with running fume hoods. Whole no total agreement is established, 100 FPM has become the basic face velocity flow rate considered appropriate for a fume hood to contain the work inside the fume hood when using flow rather than tracer gas an evaluating factor. This face velocity is called the standard velocity.

Work in the 1990s lead to the development of the HOPEC style fume hood which has a deeper body than the standard fume hood. This plus improvements in computer modeling allowed the design of the so called “low flow hood”. This hood was designed to reduce the required air for containment from 100 FPM to as low as 40FPM while still maintaining containment of the work inside the cabinet. A flow rate of 60FPM has become an unofficial standard for low flow hoods. Below 60 FPM cross drafts negatively impact low flow hoods. These hoods are meant to be evaluated using tracer gas and smoke rather than face velocity.

The deployment of low flow hoods is best when the number of fume hoods to be installed in a space exceed the amount of makeup air normally required for the laboratory itself. If the amount of air that must be discharged from a fume hood does not meet or exceed the amount that must exhausted from a space thorough the normal room exhaust, it will not save any air to use a low flow hood. Hence, the more expensive hood will offer no additional value and may offer poorer performance and require design compromises in terms of the placement of equipment in the laboratory.

Biological Safety Cabinets (BSC)

Types

In varying degrees, a laminar flow biological safety cabinet is designed to provide three basic types of protection:

- Personnel protection from harmful agents inside the cabinet
- Product protection to avoid contamination of the work, experiment, or process
- Environmental protection from contaminants contained within the cabinet

Classifications

Classification	Application
Class I	Personnel and environmental protection only
Class II	Product, personnel, and environmental protection

Class II – Type A BSCs

New NSF Classification, Adopted 2002	Previous NSF Classification	General Description
A1	Class II, Type A	70% air recirculated; 30% exhausted from a common plenum to the room 75 LFPM intake May have biologically contaminated positive pressure plenum
A2	Class II, Type A/B3	70% air recirculated; 30% exhausted from a common plenum to the room 100 LFPM intake Biologically contaminated plenum under negative pressure or surrounded by negative pressure
B1	Class II, Type B1	40% air recirculated; 60% exhausted from cabinet Exhaust air pulled through dedicated exhaust duct into facility exhaust system 100 LFPM intake All biologically contaminated plenums are negative to the room

		or surrounded by negative pressure plenums
B2	Class II Type B2	0% air recirculated; 100% exhausted from cabinet Exhaust air pulled through dedicated exhaust duct into facility exhaust system 100 LFPM intake All contaminated ducts are under negative pressure or surrounded by directly exhausted negative pressure ducts or plenums

Air Cleanliness

Air Cleanliness, Federal Standard No, 209E	
Class100	Particle count not to exceed a total of 100 particles per cubic foot of a size 0.5 micron and larger.
Class 10,000	Particle count not to exceed a total of 10,000 particles per cubic foot of a size 0.5 micron and larger, or 65 particles per cubic foot of a size 5.0 micron and larger.
Class 100,000	Particle count not to exceed a total 100,000 particles per cubic foot of a size 0.5 micron and larger, or 700 particles per cubic foot of a size 5.0 micron and larger

Protection

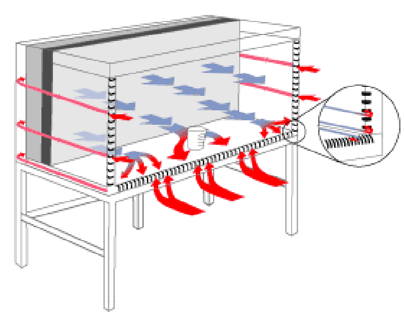
Class II Protection	From Particulates	From Vapors and Gases
Type A1 **Type A2**	Personnel, work area (products) and environment	If exhausted to room: none; not for use with vapors and gases

		If exhausted to facility exhaust system, protects personnel If exhausted to a treated facility exhaust system protects personnel, the work area and the environment
Type B1	Personnel, work area (products) and environment	Offers more protection to personnel and the work area the closer the vapor source is located toward rear of work area (Offers protection to the environment if exhausted to treated system)
Type B2	Personnel, work area (products) and environment	Offers protection to personnel (Offers protection to environment if exhausted to treated system)

Benches

Laminar Clean Flow

The laminar flow clean bench is a workbench or similar enclosure, which has its own filtered air supply.



In recent years, the use of the clean bench, laminar flow cabinet or laminar flow hood has spread from research and manufacturing to other fields such as aerospace, bioscience, pharmaceutical production and food processing. Today, laminar flow clean benches are used in a variety of applications throughout medical research laboratories, hospitals, manufacturing facilities and other research and production environments.

Clean Bench Function

The laminar flow clean bench is a workbench or similar enclosure, which has its own filtered air supply. The clean bench is recommended for work with non-hazardous materials where clean, particle-free air quality is required. The clean bench is recommended for work with non-hazardous materials where clean, particle-free air quality is required.

The clean bench provides product protection by ensuring that the work in the bench is exposed only to HEPA-filtered air.

- It does not provide protection to personnel or to the ambient environment.
- It is not designed to contain aerosol generated by the procedure; the user is exposed to these aerosols.
- The clean bench provides product protection by ensuring that the work in the bench is exposed only to HEPA-filtered air.
- It does not provide protection to personnel or to the ambient environment. It is not designed to contain aerosols generated by the procedure; the user is exposed to these aerosols.

Discussion Point

BSCs vs. Fume Hoods

A fume hood is designed to remove chemical vapors, fumes, mists, or particles from the workplace and to safety dilute with enough air so that upon discharge from the building they do not present a hazard to the environment. Some fume hoods may employ wash down systems, filtration systems, particle trapping electrostatic systems, or other means of scrubbing the air stream prior to discharge. This works well for nonliving materials. Biological materials grow and reproduce so that while the concentration of a biological material such as a bacteria or virus may be reduced in log concentration by air dilution, it may only take a single viron or bacteria to infect a plant, animal, or human outside of the work area. As such, a special type of fume hood called the Bio-Safety Cabinet is used that can trap and contain biological organisms and prevent them from reaching the worker and the environment. Some BSC residing in special facilities such as BSL3/4 ABSL3/4, or AGBSL-3/4 may even employ a flame system that burns the air before discharge from a building. A point to remember is that sometimes chemicals must be used in BSC. In these situations a fully vented BSC must be used.

For further assistance or information contact the Department of Occupational Health and Safety (OH&S) at 205-934-2487 or visit their website.

Want to Learn More?

OH&S has many training courses available to all UAB active employees and students. This includes topics such as in depth radiation training, biosafety, bloodborne pathogens, chemical safety, controlled substances, building life safety, hazardous and medical waste, universal waste, PPE, hazard communication, etc.

We have a decision tree to assist you in choosing the right course to match the knowledge/skills you may need at work every day as well.

If you have any questions or comments, please feel free to contact OH&S.