

# Chemical Fume Hood Guide Design, Construction, Health and Safety

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## I. Introduction

The Department of Risk Management & Safety (RMS) has adopted the following guidelines for the design, installation, renovation, maintenance, and dismantling of chemical fume hoods on the UNLV campus and UNLV affiliated facilities.

These guidelines reflect federal, state, local, and University 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.

Regulations and technology are constantly changing and these guidelines may not reflect current best practices and regulatory requirements; therefore RMS shall be consulted whenever new fume hoods are to be installed or when existing hoods need to be modified or replaced. 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.

A laboratory fume hood is a ventilated enclosure where hazardous materials can be handled safely. The purpose of the hood is to contain contaminants and prevent their escape into the laboratory. This is accomplished by drawing (by air flow) contaminants within the hood's work area away from the user thereby preventing and minimizing inhalation and contact with hazardous materials.

To create airflow into the hood, an exhaust blower "pulls" air from the laboratory room into and through the hood and exhaust system. A baffle, airfoil, and other aerodynamically designed components control the patterns of air moving into and through the hood.

## II. Construction, Installation, and Renovation

Listed below are the guidelines to be followed as part of the fume hood construction, installation, or renovation process. These guidelines are divided into nine categories: Laboratory Design, Fume Hood Construction and Installation, Ductwork, Exhaust Fan, Exhaust Stack, Plumbing, Electrical, Utility Service Fixtures, and Sashes.

### 1. Laboratory Design

Fume Hoods must be located away from heavy traffic aisles and doorways so that persons exiting the lab do not have to pass in front of the fume hood. The potentially dangerous portion of an experiment is usually conducted in a fume hood. Many lab fires and explosions originate in fume hood and a fume hood located adjacent to a path of egress could trap someone in the lab.

There must be two exits from rooms where new fume hoods are to be installed. If this is not feasible, the fume hood must be situated on the side of the room furthest from the door. A fire or chemical hazard, both of which often start in a fume hood, can render an exit impassible. For this reason, all labs with fume hoods are required to maintain two unblocked routes of egress.

- Fume hoods must not be situated directly opposite occupied work stations. Materials splattered or forced out of a hood could injure anyone seated across from it.
- Fume hoods should be so located within the laboratory to avoid cross currents at the fume hood face due to heating cooling, or ventilation supply or exhaust diffusers. Cross currents outside a hood can nullify or divert air flow onto a hood, negatively affecting its capture ability.
- Sufficient makeup air must be available within the laboratory to permit fume hoods to operate at their specified face velocities. A fume hood exhausts a substantial amount of air. Therefore, additional makeup air must be brought onto the room to maintain a proper air balance.
- Windows in labs that have fume hoods must be fixed closed. Breezes coming in through open lab windows can adversely affect the proper functioning of the hood. Turbulence caused by these wind currents can easily bring the contaminated air inside the hood back into the laboratory.
- Safety devices such as deluge showers, eye wash stations, fire extinguishers, and fire blankets should be located convenient to the fume hood operating personnel.
- Fume hoods shall not have an on/off control accessible in the laboratory, unless the lab has an alternate exhaust ventilation system or the exhaust is being filtered through a charcoal or HEPA filter. Fume hoods are an integral part of the entire laboratory's air balancing system which must be maintained. Labs must be maintained under positive pressure and when a fume hood is turned off the lab can develop positive pressure.

## 2. Fume Hood Construction and Installation

- Supply or auxiliary air hoods are unacceptable for new fume hoods installations. It is very difficult to keep air supply and exhaust of supply hoods properly balanced. In addition, the supply air is intemperate, causing discomfort for those working in the hot or cold air stream.
- Constant volume bypass fume hoods are recommended. These hoods permit a stable air balance between the lab's ventilation system and the fume hoods exhaust by incorporating an internal bypass feature. This allows a constant volume of air to be exhausted through the hood regardless of sash position. Variable volume systems may be acceptable if properly designed.
- Portable, non-ducted fume hoods are not allowed except for limited uses as approved by RMS. Non-ducted fume hoods utilize filters which may be overwhelmed in the event of a spill. Breakthrough can also occur as the contaminant is dislodged with the sudden changes in air flow velocity associated with turning the blower on and off. In addition, an adequate level of protection cannot be assured for different classes of chemicals.
- Interior fume hood surface should be constructed of durable, corrosion resistant, nonporous, noncombustible, fire resistant materials such as stainless steel or special composite or polymer material. Corrosive materials can damage many types of materials,

shortening fume hood life. In addition, some materials, when exposed to direct flame, emit noxious and toxic fumes.

- The work surface inside the fume hood must be of the recessed type. With a recessed type work surface, spills can be effectively contained by the retaining lip.
- Plastic or fiberglass hood are unacceptable. Although some plastic and fiberglass containing construction materials may be noncombustible, when involved in a fire they generate large quantities of dense, potentially toxic smoke. This smoke presents a hazard to both building occupants and fire fighters.
- An airflow indicator must be provided at the fume hood.
- Hood shall operate at an acceptable sound level so that it does not pose a hearing loss hazard or be an annoyance.
- There should be a horizontal bottom airfoil inlet at the front of the hood. The airflow at the front of the hood assures a good sweep of air across the floor toward the back of the hood. This minimizes the generation of turbulent eddy currents at the entrance to the hood.
- A baffle with adjustable horizontal slots should be present at the back and top of the fume hood interior. Baffles assist in maintaining a unidirectional airflow.
- Baffles should be at adjusted in such a way that less than a +10 variation in face velocity measured with the sash in its maximum open position can be obtained.
- Average air velocity at the hood face must be at least 80 linear feet per minute (fpm), with a minimum of 60 fpm at any measured point. If regulated carcinogens are to be used, an average air velocity of 100 fpm should be maintained with a minimum of 80 fpm at any measured point.
- Where feasible, chemical fume hoods should be capable of switching to emergency power in case of a power failure.

### 3. Ductwork

a. If gang ducting of fume hoods is necessary, the system must be properly designed with final approval from RMS and Facilities Management. Perchloric and radioactive material hoods shall have individual exhaust systems.

b. Design criteria for fume hood duct construction include:

- minimum 18 gauge, Type 316 stainless steel. Coated galvanized steel may be considered under circumstances.
- heliarc inert gas with Type 316 welded seams
- follow the Sheet Metal and Air Conditioning Contractors National Association (SMACNA) Round Industrial Duct Construction Standards for duct supports and reinforcement using stainless steel material.
- follow SMACNA 2000 HVAC Duct Construction Standards using type 316 stainless steel for exhaust stack on roof.

c. Fire controltype dampers should not be utilized in fume hood exhaust systems.

d. Duct velocities should maintained between 16002000 linear feet per minute (fpm) to minimize noise, static pressure loss, and blower power consumption within a duct system.

e. Slope all horizontal ducts down towards the fume hood (Guideline: 1/8" to the foot). Liquid pools, which result from condensation, can create a hazardous condition if allowed to collect.

f. New duct installation should be tested at negative pressure, 1 1/2 times its operating pressure. Tests should show zero leakage.

#### 4. Exhaust Blower and Stack

- New exhaust blowers should be oriented in an upblast orientation. Any other type of fan orientation increases the work load required from the fan.
- The exhaust blower should be located at the roof of the point of final discharge to provide a negative pressure in that portion of the duct system located within the building.
- Hood exhausts in the roof should be located away from air intakes to prevent re-entrainment of exhaust fumes.
- Fume hood exhaust stacks shall be of adequate height (at least seven feet above the roof or at two feet above the top of a parapet wall, whichever is greater) to prevent or minimize reentry of contaminants or to comply with air pollution regulations. Discharge must be directed vertically upward.
- Discharge from exhaust stacks should have a velocity of at least 3,000 fpm. A sufficient discharge velocity is necessary to adequately disperse contaminants. Provide air cleaning on exhaust as needed.

Exhaust stacks shall be color coded as follows:

Green: Regular Chemical Hood  
Yellow: Perchloric Acid Hood  
Magenta: Radiological Hood  
Blue: Biosafety Hood

#### 5. Plumbing

- All Plumbing utilities must have a shutoff valve or cock adjacent to the hood.
- If remote control fittings are used for hood utilities, the extension rod shall be solid four sided stainless steel with a Monel coupling and set screw.
- Hot or cold water supplies must be connected to non-potable industrial water system. If industrial water is not available in the building, then a reduced pressure type back flow device shall be used on each water system. A single device may serve several hoods.

#### 6. Electrical

- Electrical outlets must be outside the hood. The atmosphere inside a fume hood may contain flammable gases or vapors that can ignite, resulting in a fire or explosion. For this reason, any activity including plugging into and unplugging from an electrical outlet - which may produce a spark, must be performed outside the hood.
- Lighting fixtures should be of the fluorescent type. Fluorescent bulbs give off less heat than conventional bulbs. They help maintain a safe and comfortable work area inside the hood.
- Light fixtures should be sealed and vapor tight, UL listed and protected by a transparent impact resistant shield. The potential for flammable or combustible atmospheres requires explosion proof electrical equipment.

## 7. Utility Service Fixtures

- Utility service includes connections to gases, air, water, and vacuum.
- Should be installed to allow the connection of service supply lines either on the hood itself or the work surface supporting the hood.
- Service valves shall be accessible for maintenance.
- Service valves shall be corrosion resistant if located inside the hood.
- All service fixture controls shall be controlled from the outside of the hood.
- All service fixture controls shall be color coded and shall be clearly identified.

## 8. Sashes

a. Sashes may either be horizontal, vertical, or a combination, and should have the capability to completely close off the hood face.

b. Sashes should be made of safety glass:

- laminated safety glass for standard use when internal temperature is anticipated to be less than 1600 F.
- Tempered safety glass when high internal temperatures are anticipated that will result in sash surface temperatures greater than 1600°F.

Where hydrofluoric acid is used, sashes will be made of plastic or Lexan with a flammability rating of 25 or less when tested in accordance with ASTM E16276.

c. Horizontally sliding sash panels may not be less than twelve inches, nor more than fifteen inches in width. Such sashes may offer extra protection to lab workers as they can be positioned to act as a blast shield.

## III. Special Use

1. Perchloric Acid is a strong oxidizer which, in contact with organic materials, can form an explosive reaction product. For this reason, special construction materials are required for laboratory fume hoods in which substantial quantities of perchloric acid are frequently used. For additional information or consultation contact RMS at extension 54226.

- Laboratory fume hoods designated for use with perchloric acid shall be identified by a label indicating suitability for use with perchloric acid procedures.
- All exposed hood and duct construction materials shall be suitable for use with perchloric acid inorganic, nonreactive, acid resistant and relatively impervious.
- The work surface in the hood shall be water tight and dished or furnished with a raised bar to contain spills and wash down water.
- The fume hood and exhaust ducting design shall be provided with a water spray (wash down) system. The baffle must be removable to allow for

- periodic cleaning and inspection.
- Each perchloric acid fume hood must have an individually designated duct and exhaust system. The duct system should be straight, vertical and as short as possible.
- Use only an acid resistant metallic fan.
- Do not use lubricants, caulking materials, gaskets or other materials in the fan that are not compatible with perchloric acid. Use fluorocarbon type grease.
- The fan motor must be located outside of the airstream.

## 2. Radiological Fume Hoods

- Facilities Maintenance personnel shall contact the person responsible for the lab to schedule service, and shall NOT enter a laboratory or area restricted for purposes of radiation safety unless accompanied by the Authorized User or Radiological Safety Office personnel. Written Radiological Safety Officer (RSO) approval shall be posted on the hood by the user prior to servicing.
- All radiological hoods shall vent separately to the outside of the building.
- The RSO shall provide a list of fume hoods used for radiological materials.
- Maintenance personnel are to receive basic radiation safety instruction from the Radiological Safety Officer prior to work in active laboratories.
- The RSO shall monitor fume hoods at the request of the authorized user or Facilities Maintenance personnel PRIOR to scheduled repair or maintenance, and provide written approval to be posted on the hood.
- The authorized user of radioactive materials shall control radioactive materials used in hoods as follows:

Radioactive materials shall be secured against unauthorized removal, and all surfaces decontaminated and surveyed to assure that no contamination remains when unattended. This is to assure that no radiation hazard is present during routine, nonscheduled maintenance activities.

If radioactive materials are unattended for any reason without direct supervision by the user or trained assistants, the room shall be locked to prevent unauthorized entry.

The authorized user or his assistants shall promptly notify the RSO of any spill, accident, or any operation which may have contaminated the hood or released any contamination.

- The user shall provide documentation of his or her radiation and contamination surveys of the hood to the RSO. The user may directly supervise work without RSO approval, and then assumes responsibility for radiation safety.
- All radiological fume hoods and exhaust blowers shall be labeled – “CAUTION – Radioactive Material” and exhaust stacks shall be stripped magenta.

## 3. Iodination Mini Hoods

The Radiation Safety Officer shall be contacted before an iodination mini hood is installed. Iodination mini hoods must be located within an already operative laboratory fume hood.

Each mini hood must be equipped with a charcoal filter.

The mini hood should be compatible with the laboratory fume hood with respect to size and airflow.

Air flow through the arm portals should be maintained at 150 linear feet per minute.

Plexiglas construction is recommended.

#### IV. Testing, Servicing, and Dismantling

During routine servicing and repair or dismantling of a laboratory fume hood the potential exists for exposure to hazardous substances that had been used or stored in the hood. To guard against this, certain protective measures, appropriate to the specific situation, should be implemented before work begins.

##### 1. Fume Hood Evaluation in the Field

Evaluation of new or refurbished laboratory fume hoods shall be performed by the installer prior to releasing the fume hoods for use. Tests shall be performed by qualified personnel to verify proper operation of the fume hoods.

Average face velocities shall be checked by RMS once per calendar year.

- Verify that the building makeup air system is in operation, the doors and windows are in normal operating position, and that all other hoods and exhaust devices are operating at design conditions.
- Check room conditions in front of the fume hood using a thermal anemometer to verify that the velocity of cross drafts does not exceed 20 percent of specified average fume face velocity. Any cross drafts that exceed these values shall be eliminated before proceeding with the fume hood test.
- With the sash open 18 inches, measure the face velocity at nine different points across the fume hood face. Readings should be taken at equal distances across the face of the hood. Average air velocity at the hood face must be 80 to 150 linear feet per minute (fpm) with a minimum of 60 fpm at any measured point.
- Fume hoods with acceptable face velocities will be allowed to continue operation.
- Deficient fume hoods shall be labeled with appropriate signage (See Caution Notice, Forms Section). The principal investigator will be informed that the fume hood is deficient and should not be utilized pending repair by Facilities Management.
- Fume hoods with inadequate face velocities will be reported to Facilities Management for repair. Facilities Management personnel



shall follow the procedures listed in the Servicing and Dismantling Section of this policy. Upon completion of the repair work, Facilities Management will notify RMS. RMS will then evaluate the face velocity of the hood to assure optimum conditions are being met. A label will then be placed in the hood indicating that the hood is certified for use.

## 2. Procedures Prior to Servicing or Dismantling

- a. Laboratory personnel must: remove all equipment in the hood that may impede or impair access. Remove all chemicals and radioactive materials in the hood that may pose a hazard. If necessary, decontaminate the interior of the hood as appropriate.
- b. If necessary, don protective clothing (i.e. goggles, respirator, coveralls, gloves, arm guards).
- c. If the fume hood needs to be turned off, notify laboratory workers and post a Caution Notice on the hood. A designated person from the laboratory is responsible for ensuring that the procedures mentioned above have been done. Upon completion of the necessary decontamination procedures, the responsible party must fill out the appropriate form and attach it to the front of the fume hood.

## 3. Fume Hood Service Procedures

The following procedures are to be followed by anyone who must service any part of a fume hood system at UNLV. (Service includes mechanical work, sheet metal work, painting and electrical work.)

- a. Locate the fume hood blower or motor on the roof to be serviced and the room in which it is housed.
- b. Communicate to lab personnel the need to service the fan or hood and obtain permission to shut down the hood. If lab personnel are not available, contact the department office to obtain permission to shut down the hood. **DO NOT TURN OFF WITHOUT NOTIFYING AND RECEIVING PERMISSION FROM AN AUTHORIZED PERSON.**
- c. Fill out a Caution Notice and fix it to the hood sash (copy attached, Forms Section). Then shut down the fan. Note: Information on the tag should include:
  - date of shut down
  - expected duration of shut down
  - reason for shut down
  - your name
  - your supervisors phone number
- d. When service is completed, restart the fan and remove the notice from the hood(s).

## V. References

Air Movement and Control Association, Inc. (AMCA)

American Conference of Governmental Industrial Hygienists (ACGIH), Industrial Ventilation Manual, 25th (2004) Edition American Society of Heating, Refrigerating and Air Conditioning Engineers

(ASHRE), Fundamental Handbook American Society of Testing Materials (ASTM) E 162

National Fire Protection Association (NFPA), Exhaust Systems for Air

Conveying of Materials, NFPA 912004

National Fire Protection Association (NFPA), Fire Protection for Laboratories Using Chemicals, NFPA 452004 Occupational Safety and Health Administration, Occupational Exposures to Hazardous Chemicals in Laboratories, 29CFR 1910.1450