Selection, Installation & Testing Guidelines for New & Modified Chemical Fume Hoods

The purpose of this document is to provide guidelines for the selection, installation and testing of chemical fume hoods (CFHs) in UVA owned and operated facilities. Also included within this document are suggestions for the optimal placement of CFHs, general room ventilation characteristics and other recommended design elements pertinent to achieving optimal CFH performance.

Scope

All UVA teaching, research and clinical laboratory work areas in which chemicals or other potentially hazardous materials are used and/or stored.

Definitions

AFV	Average Face Velocity, the average speed or rate of air flow measured in the plane of the sash opening, generally measured in feet per minute.
AM	As Manufactured. Operating specifications confirmed by performance tests done at the manufacturer's facility.
CFD	Computational fluid dynamics, uses numerical analysis and data to analyze fluid flows (one method to visualize complex and turbulent air flow).
CFH	Chemical Fume Hoods
CFM	Cubic Feet per Minute
CV	Constant Volume, continuous air flow. CV chemical fume hoods provide a relatively constant air volume exhausted from the CFH, regardless of sash position (face velocity increases as sash is lowered).
EHS OH	Environmental Health and Safety Occupational Health group, specialists in occupational health, industrial hygiene, ventilation, and exposure monitoring.
FPM	Feet per Minute
HVAC	Heating, Ventilation, Air Conditioning
LEV	Local exhaust ventilation, or extraction/fume control of airborne contaminants generated in the workplace.
LPM	Liters per minute
PPM	Parts per million
SME	Sash Movement Effect, real time tracer gas leakage is measured when the chemical fume hood sash is opened and closed and/or during a walk-by simulation
VAV	Variable Air Volume, a type of ventilation system that varies airflow. A VAV chemical fume hood operates with controls that adjust the volume of air flow based on the position of the sash or occupancy conditions, keeping the face velocity constant while saving energy.

Exclusions: This guideline does not apply to the following:

1. Biological safety cabinets, laminar flow benches or other filtered enclosures/containment devices. Refer to the EHS Biosafety webpage for guidance.)
2. Building exhaust systems/HVAC systems
3. All other enclosures and local exhaust ventilation devices (e.g., enclosures for analytical balances, special mixing stations, evaporation racks, welding hoods, slot exhaust hoods, canopy hoods, and ductless chemical fume hoods, and paint booths)

CFH Selection Criteria

1) As Manufactured ASHRAE 100 Testing:

When considering CFHs for purchase, it is important to ensure that the models under consideration have been tested by the manufacturer in accordance with the most current version of *ANSI/ASHRAE 110 Standard Method of Testing Performance of Chemical Fume Hoods*. Testing in this manner is referred to as "As Manufactured" testing, as the manufacturer will typically have this test performed at the manufacturer's test facility. The test should be performed by a qualified 3rd party contractor at no cost to the purchaser. Test results should be available for review by EHS OH staff prior to purchase.

Special considerations for low face velocity: CFH are generally designed to provide a minimum average face velocity (AFV) between 85 and 100 FPM, with no single reading greater than +/- 20% from the AFV, at the minimum operating sash height of 18-inch vertical sash opening. If lower face velocities (resulting in lower volumetric flow rates) are proposed for energy conservation purposes or required by a research application, CFHs shall be tested per ASHRAE 110 at the proposed face velocity. Currently, there are no standards that recommend face velocities below 60 FPM. EHS OH may recommend additional testing criteria and stricter performance ratings based on a risk assessment of the research needs of the building or the specific research application(s) in consultation, as needed, with the Laboratory Director and Space Manager.

Types of Chemical Fume Hoods

- <u>Low vs Standard Flow Chemical Fume Hoods</u>

So called "Low Flow/High Performance" or "Low Flow Hoods" are designed to achieve better containment at lower air flows than standard CFHs. The deployment of low flow hoods is most appropriate when there are multiple CFHs installed in a single space. If the amount of air that must be discharged from a CFH does not meet or exceed the amount that must be exhausted from a space through the normal room exhaust, it will not save any air to use a low flow hood. Existing CFHs may also be retrofitted (by approved contract vendors) to achieve better containment performance at lower air flows.

- <u>Floor Mounted Chemical Fume Hoods (sometimes referred to as walk-in hoods)</u>

Sashes may be double vertical sliding, two track horizontal sliding, or a combination of vertical and horizontal sliding sashes. Performance testing must include all accessories such as tables, shelves, tubing racks, etc. Contact EHS OH for guidance when selecting this equipment.

- <u>Distillation Fume Hoods</u>

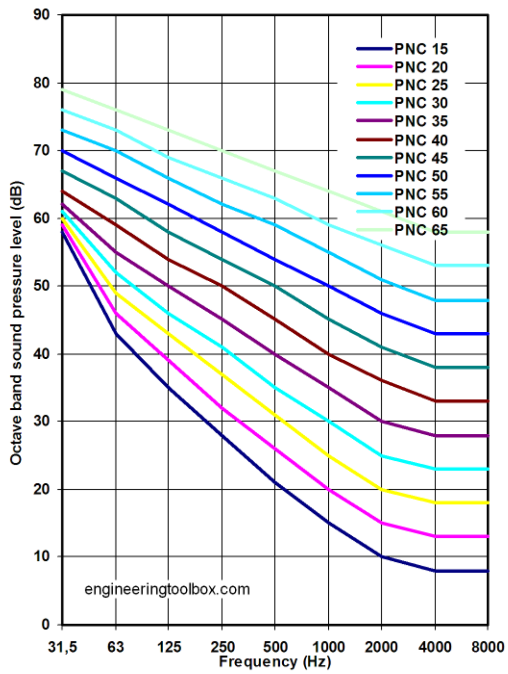
These CFHs have two sashes that operate independently, allowing for an opening at the top or bottom of the CFH and with releasable sash stops that allow no more than 80 percent of the top sash open with the bottom sash closed (40 percent of maximum sash opening).

- <u>Special Use CFH</u>

Additional safety features exist for Radioisotope and Perchloric Acid Fume Hoods. Contact EHS OH for additional information regarding any proposed installation or modification to these systems.

Additional CFH Selection Considerations:

- Horizontal Sashes: If horizontal sashes are used, sash panels (horizontal sliding) should be no more than 12 to 14 inches in width. The narrower panels allow users to reach around the panel and use them as a barrier.
- On-Off fan switches: CFHs should not have an on/off fan switch located in the laboratory since exhaust fans should run continuously. Exceptions may be granted to facilities where use is limited and/or seasonal, and full lock and tag out of the CFH is possible.
- Airflow Monitor & Alarms: The CFH shall have an airflow display monitor with a low flow audible and visible alarm that can be calibrated to alarm when air flow drops to an unsafe level. The monitor should indicate airflow in a quantitative manner with a minimum accuracy of ± 10 percent of the specified AFV or its equivalent. If the CFHs monitor is being installed on a VAV system, the airflow monitor will need to come from the VAV supplier so that it can be properly calibrated to the specific VAV system. The monitor display and alarm conditions shall be clearly visible in the installed location. The airflow indicator shall be calibrated during initial commissioning tests and when required by the manufacturer thereafter.
- Noise: System design must provide for control of exhaust system noise (a combination of fan-generated and air-generated noise) in the laboratory. Systems should be designed to achieve an acceptable Sound Pressure Level (SPL) frequency spectrum (room criterion) as described in the Noise Manual.[1] Acceptable SPL may vary depending on the intended room use. A Noise Criteria (NC) curve of 35 - 40 is generally adequate for a standard laboratory (equivalent to 45-50 dBA). The chart below describes the sound pressure levels across the frequencies significant to hearing.



- **https://www.engineeringtoolbox.com/nc-noise-criterion-d_725.html**

[1] The Noise Manual by EH Berger, AIHA, 5th Ed.

General Room Ventilation and Installation Considerations

- Room air currents at the CFH should not exceed 20% of the average face velocity to ensure CFH containment. Makeup air should be injected at low velocity through an opening with large dimensions to avoid creating jets of airflow at the hood face.
- Diffusers should be located at least 5 feet from the hood and located to the side rather than in front of the hood. Increase the distance and decrease the volume from supply diffusers near the CFH as much as practicable. Fabric 2 x 4 diffusers and radial perforated diffusers provide equivalent performance. High velocity directional diffusers or linear slot diffusers are not appropriate for labs in general. Discharge temperature can further affect hood performance and should be considered.
- Location of CFH should be:
    - Away from activities or facilities which produce air currents or turbulence. Away from high traffic areas, air supply diffusers, doors, and operable windows.
    - At least 10 feet from any door or passageway, to avoid air currents that can pull contaminants out of the hood.
    - CFHs should not be located adjacent to a single means of access to an exit.
- Both vertical and horizontal cross drafts should be < 50% of the AFV (for example, < 45 FPM for a 90 FPM AFV).
- CFH sash openings should not be located opposite workstations where personnel will spend much of their working day, such as desks or microscope benches.
- An emergency irrigation station should be within 10 seconds (or 50 feet) of any CFH.

Testing of New and Modified CFH after Installation
To ensure proper operation of new and modified CFHs, 'As-Installed' (AI) testing per current ANSI/ASHRAE 110 shall be completed by a third-party contractor prior to use. Contractors should be approved by EHS OH staff with the opportunity to witness the onsite testing and verify test results.

Conditions for As-Installed ASHRAE 110 Testing
Since a CFH is part of a laboratory's overall ventilation and can affect airflow performance, best practice suggests the following should be completed prior to As-Installed (AI) testing. If not completed in advance of AI testing, re-testing may be required:

- Testing, adjusting and balancing of the building ventilation systems
- Calibration and tuning of building ventilation control systems
- The facility is ready for occupancy.
- Test any controls that are provided at the CFH (e.g. unoccupied cycle override, alarm override, emergency purge, etc.)
- The full period of As-Installed testing will be conducted with the building ventilation system operating as designed.
- Additional tests or challenges (e.g., walk-by test if CFH is located near sources of turbulence) may be recommended at the suggestion of EHS IH staff.

Additionally, for VAV systems:

- The minimum flow requirement for a VAV fume hood is generally 25 CFM per square foot of work surface (or 375 CFH air changes per hour), but can be lower, provided a risk assessment is conducted and determined acceptable by EHS OH.
- The VAV response should achieve 90% of steady state airflow within 5 seconds (from closed sash to operating height) without dropping below 25% of design air flow for any length of time.
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Retesting may be triggered by:

- Relocation of an existing CFH
- A significant modification of the room ventilation system
- Installation of a door or throughway next to a CFH
- Any modification that may change exhaust air flow characteristics of the CFH
- Damage to CFH that requires significant repair (e.g., fire)

If uncertain, please contact EHS OH to determine the need for testing.

The contractor's test report shall be reviewed, and results accepted by EHS OH before hoods can be certified by EHS as safe to use. Failure to meet performance requirements is cause for rejection of the CFH and may require modification of the laboratory environment or adjustment of the ventilation systems.

Reference Documents

1. ANSI/ASHRAE 110-2016 Standard for Testing Performance of Fume Hoods
2. National Fire Protection Association NFPA 45 – Fire Protection for Laboratories Using Chemicals
3. ANSI/AIHA Z9.5 Laboratory Ventilation Standard
4. The Noise Manual by EH Berger, AIHA, 5^{th} Ed.
5. EPA Performance Requirements for Laboratory Fume Hoods
6. NIH Fume Hood Testing Protocol