Fume Hood Safety

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A laboratory fume hood is a three-sided enclosure with an adjustable front opening. It is designed to capture, contain, and exhaust hazardous fumes generated inside its enclosure. Fume hoods accomplish this by exhausting air through the hood face to the outside of the building. By doing so, fumes are drawn away from the worker's breathing zone. Because exposure to volatile chemicals constitutes one of the top health and safety hazards to laboratory workers, a fume hood operates as a principle safety devise in a laboratory setting.

Face Velocity

Several governmental and industry organizations have adopted fume hood safety standards. These standards are designed to measure a fume hoodís ability to contain fumes. They are based on a measurement of the speed at which laboratory air enters a fume hood's face opening, i.e. face velocity. The intent of these standards is to designate face velocities that are high enough to contain fumes but not so high as to cause air turbulence between a hood's face and a worker. Below is a list of some standards organizations and the face velocities they require:

OSHA (Federal Occupational Safety and Health Administration)

Appendix A 4. (g) Quality. recommends, "...airflow into and within the hood should not be excessively turbulent...; hood face velocity should be adequate (typically 60-100 lfm)..."

Cal/OSHA (California Occupational Safety and Health Administration)

California Title 8, 5154.1 requires 100 linear feet per minute with a minimum 70fpm at any one point, except for hoods with carcinogens, which require 150fpm and a minimum of 125fpm.

National Research Council

Prudent Practices in the Laboratory, Handling and Disposal of Chemicals, recommends face velocities between 80 and 100fpm. 120fpm is recommended for substances with

very high toxicity or where outside influences adversely influence hood performance. Face velocities approaching or exceeding 150fpm should not be used.

NFPA (National Fire and Protection Agency)

Section 6-4.5 states, "Face velocities of 0.4 m/sec to 0.6 m/sec (80 fpm to 120 fpm) generally provide containment if the hood location requirements and laboratory ventilation criteria of this standard are met."

ANSI/AIHA (American National Standards Institute / American Industrial Hygiene Association)

Standard *Z9.5-1992* Section 5.7 requires that, "Each hood shall maintain an average face velocity of 80-120 fpm with no face velocity measurement more than plus or minus 20% of the average."

S.E.F.A (Scientific Equipment & Furniture Association)

SEFA 1.2-1996 Section 5.2, "Government codes, rules and regulations may require specific face velocities. A fume hood face velocity of 100 fpm is considered acceptable in standard practice. In certain situations face velocity of up to 125 fpm or as low as 75 fpm may be acceptable to meet required capture velocity of the fume hood."

N.I.H. (National Institutes of Health)

National Institutes of Health Fume Hood Containment Testing states, "Face velocity measurements shall meet an air velocity profile of 100 fpm plus or minus 10 fpm with the sash fully open."

NIOSH (National Institute for Occupational Safety and Health)

NIOSH recommends face velocities of 100 to 150 fpm

Knutson, G. *Fume Hood 2000, Laboratory Hood Testing and Evaluation*. Presentation given at the Fume Hoods 2000 Seminar. April 21, 1999

ACGIH (American Conference of Governmental Hygienists)

I*ndustrial Ventilation A Manual of Recommended Practice* recommends 80 - 100 fpm face velocity with a full open sash depending on quality of supply air distribution and uniformity of face velocity.

Fume Hood Testing

Face velocity has been accepted as an adequate measure of a fume hood's performance for many decades. It has become such an established method, that it is the only performance standard established by the various standards organizations listed above. It is also the only performance test that is likely to be performed after a fume hood is installed. However, many current studies have argued for more thorough testing of fume hood containment capabilities.

ASHRAE, The American Society of Heating, Refrigerating, and Air-Conditioning Engineers, has created the *ASHRAE 110-1995 Method of Testing Performance of Laboratory Fume Hoods*, a protocol for fume hood testing. This protocol does not specify a performance level fume hoods should meet; It simply provides a more thorough protocol for fume hood performance testing than has historically existed. This protocol allows occupational safety organizations, such as those listed above, to adopt new performance standards to this more thorough method of testing.

The ASHRAE 110 is a three part test that includes measurements of face velocity, air-flow visualization, and tracer gas containment. This exhaustive test protocol goes beyond face velocity measurement to test the ability of a fume hood to contain and exhaust fumes. Air flow visualization requires the generation of smoke streams at designated points within a fume hood. It provides a visual understanding of the air flow currents that exist within the hood. The tracer gas containment test releases a large volume of gas at a prescribed location in a hood. A mannequin is positioned in front of the hood face with a monitoring device affixed in its breathing zone. The monitoring device tests for the presence of the tracer gas outside the hood.

The ASHRAE 110 offers a direct method of measuring a fume hood's ability to contain the fumes produced within its enclosure.

Face Velocity as a Testing Method

Face velocity is just one of the the three tests called for in the ASHRAE 110; yet face velocity is often the only test performed once a fume hood is installed. There are several reasons for this. The full ASHRAE 110 is expensive. The cost of the recommended tracer gas, sulfur hexafluoride, and the equipment that tests for this gas can approach $20,000. The full test is also quite time consuming to complete. It can take a couple hours to test each hood. Large organizations with hundreds of hoods could require months of testing. Face velocity is also the only item required to be tested by most regulatory organizations. For these reasons, face velocity tests are often the only tests performed on installed fume hoods.

Many studies regarding fume hood safety have indicated that face velocity is not the best measure of a fume hood's ability to contain hazardous substances. They argue that factors other than the speed at which air enters the fume hood opening are significant in

determining a fume hood's ability to contain hazardous fumes. Some of these significant factors are:

- The location of the fume hood in the laboratory setting.
- The laboratory's supply air location and distribution.
- The amount of equipment stored within the hood

Studies have shown that a significant number of hoods that are able to meet face velocity tests are not able to pass containment tests such as the ASHRAE 110. Many of these studies recommend that face velocity tests be replaced with containment testing in order to improve worker safety in the laboratory.

This site presents links that argue against face velocity as an effective means of testing fume hood containment abilities. It also presents information on alternatives in fume hood containment testing that are less expensive than the *ASHRAE 110-1995 Method of Testing Performance of Laboratory Fume Hoods*.