ASHRAE 110 Standard:
Containment Assurance or a False Sense of Security?

By Dan Frasier, PE

The foreword of the ANSI/ASHRAE 110-1995 Standard, "Method of Testing Performance of Laboratory Fume Hoods," defines the standard as "a reproducible method of testing laboratory fume hoods."[1] An analogy is included to clarify the purpose by comparing it to "a method for measuring airflow; it prescribes how the flow should be measured, not how much it should be."

Essentially, this standard was intended as a repeatable process for evaluating containment. It was never meant to be used as a hood-certification method, as has recently occurred for some low-flow constant volume (CV) hoods. Any implication that a "passed" test ensures safety or endorses a hood is an abuse of the original intent of the standard. In fact, the ASHRAE 110 test method does not define safety, nor does it offer an assurance of containment.

For years, containment of fumes and reduction of airflow through fume hoods were considered mutually exclusive. Constant-volume models with full-open sashes dictated the capacity of many building HVAC systems. Engineers and manufacturers have made many attempts to reduce system capacity, using such ideas as auxiliary-air hoods, mechanical sash stops, and variable-air-volume (VAV) designs. These ideas have met with varying degrees of acceptance among designers, users, facilities managers, and hood vendors.

Containment, however, is the one issue of vital interest to everyone in the fume hood "community." A hood is supposed to protect users by drawing sufficient and properly patterned air through the face of the hood.

Low-flow CV hoods

Constant-volume, low-flow fume hoods have become a hot topic among designers, engineers, planners, users, and vendors. Reportedly, these hoods require lower airflows and face velocities than recommended by the most widely accepted industry standards. Manufacturers' claims about the performance of their low-flow CV hoods have persuaded some consulting engineers to design HVAC systems that use lower flows.

At first glance, it's an appealing package: low flows, simplicity, and maybe even design savings over traditional CV systems and VAV approaches. Available containment data seem to show that the hoods can do it all. The allure of simplicity and presumed savings is causing many to overlook the critical issue: safety. In addition, those advocating low-flow CV hoods may not have a complete understanding of hood users and their work habits.

Laboratory designers have sound reasons to exercise extreme caution regarding low-flow CV hoods. Fume hoods are intended as the primary safety device for protecting people from chemicals in the laboratory. Constant-volume hoods that use ASHRAE 110 test results as a "stamp of approval" give the industry a false sense of security since the following three critical issues are not accounted for:

- People move, and their movements challenge containment.
- Containment ability should not decrease when sash stops are overridden.
- Industry standards and research caution against undesirable face velocities.

User movement
As mentioned above, ASHRAE 110 has been used recently in a way it was never intended to be used: to determine the lowest possible face velocity at which a hood will "pass" tests described in the standard, with "pass" values defined independently. The ability to "pass" an as-manufactured (AM) test at a face velocity of 60 ft/min (fpm) or less means that the hood contained acceptably in nearly perfect static conditions. This does not ensure containment when a moving operator is present.

Many designers seem to believe that acceptable performance under the 110 tracer gas test guarantees hood safety. Unfortunately, the limitations of the standard allow manufacturers to use the results of gas containment tests to "prove" that their hoods or systems perform well. The frightening fact is this: Many industry experts agree that even fume hoods that have "passed" tracer gas containment tests at low velocities are not safe in operation at this level[2,3,4,5].

Lab designers must understand, and account for, operator movement and relevant lab applications. Failure to account for these significant factors can give users a sense of false security. It is dangerous to select a life-safety product that has been tested to operate at a very low threshold of safety in less demanding conditions than will occur in actual use.

This strategy is like buying a smoke detector that is rated "just barely passed" compared with one that passed with a comfortable margin of safety. The goal of these life-safety devices is to protect people at the most critical moment: when a moving operator is actually working at the hood or when an actual fire is sensed in the space.

Sash stop overrides
Sash stops were created to protect hood operators from exposure to fumes, but also to allow for reduced flows through hoods. Most sashes open to a maximum height of ~30 in. once the sash stop has been overridden. Traditionally, stops have been installed at around 18-in. above the work surface – sometimes higher and, less often, lower.

When a hood operator overrides a sash stop, it is often called "misuse," even if the researcher needs to raise the sash for an experiment setup. Labeling this activity as "misuse" may raise the operator's awareness of poor practices, but the label does not negate the designer's responsibility to provide appropriate containment during the entire cycle of setup, experiment, and take-down.

In addition, some designers and vendors seem to believe that setup is an infrequent activity. In reality, procedures may require sashes to be raised above the stops many times each day, since some experiments require regular activity or monitoring. Every time the sash is raised for experimental procedures, the user challenges containment and is at risk for exposure – especially during setup and take-down when accidents are most probable[3].

The recent promotion of reduced sash openings raises two major safety issues. The first involves maximum hood airflows calculated when the sash is at the stop vs. a full-open sash. Establishing a maximum flow based on a face velocity of 60 to 80 fpm with the sash at the stop can result in face velocities well below 40 fpm with a full-open sash. CV systems lack controls to adjust airflow according to the sash position; therefore, the higher the sash is opened, the lower the face velocity.

ASHRAE 110 addresses the use of sash stops with the following statement: "When the design documents describe a condition other than full-open sash, the user may operate the hoods with the sash opened beyond the design condition, resulting in a lower face velocity than design. This could reduce the protection provided by the hood. The hood should be tested with the sashes full open to determine the misuse of the hood[1]." In other words, the full-open sash should be evaluated as a mode of hood operation.

The second issue concerns sash stops placed too low for ease of use. The lower the sash stop, the more likely users are to override it, since restricted access is inconvenient. If maximum airflow is pegged to lower-than-conventional sash heights, the full-open face velocity will be even less than the 40 fpm described in the previous paragraph. This approach fails to meet desirable safety objectives.

Face velocities

It is true that no specific face velocity can guarantee containment. Nevertheless, numerous published industry standards stress the importance of acceptable values for proper containment. The most commonly recommended containment value in the industry is 100 fpm. Recommended face velocities from various standards and guidelines are shown in Table 1. Standards cited in the table range from 60-125 fpm.

Standard / Guideline	Face Velocity
ANSI/AIHA Z9.5, p.13, section 5.7	average 80-120 fpm
Federal Register – OSHA, p.484	typically 60-100 lfm
NFPA 45 p.45-26, section A-6-4.5	0.4 m/sec to 0.6 m/sec (80 fpm to 120 fpm)
Prudent Practices p.178	80-100 fpm, toxic = 100-120 fpm
SEFA 1.2/1996 p. 7, Section 5.2	100 fpm, 75 to 125 fpm may be acceptable
NIH Design Guidelines, Mechanical, D-138	100 fpm +/- 20 fpm

Table 1. Recommended face velocities in widely accepted standards and guidelines range from 60-125 fpm.

A report given at the 2000 Spring Seminar of the Los Angeles Chapter of ASHRAE summarized tracer gas containment tests for more than 1,600 hoods. In these tests, fewer than 50% of hoods operating at <80 fpm provided adequate containment, whereas hoods with higher face velocities displayed a marked improvement. Eighty-six percent of hoods rated at 80-120 fpm showed adequate containment, as did 89% of hoods at 120-150 fpm and 97% of hoods at >150 fpm[8].

The dramatically lower percentage of hoods showing acceptable containment when velocities were <80 fpm is worth noting, especially considering that the tracer gas testing was conducted in a static situation, without moving users.

It is true that commissioning hoods in the field involves more than simply setting a hood for a specific face velocity. Nevertheless, the idea that face velocity guidelines are passé is inconsistent with substantial research data and articles, a few of which are referenced below.

In conclusion, the 110 Standard is a valuable measuring stick for hood performance. However, its current misuse could lead to lab designs that are ultimately unsafe when containment is most critical: when people actually use the hoods. Key points to consider:

- Researcher movement should be factored into the design and commissioning process.
- Raising a sash is a research requirement and should not put the user into a proven danger zone.
- The extensive industry research on airflow, face velocity, and containment has a proven value in defining safety in the laboratory environment[2,3,4,5,6,7].

When ASHRAE 110-1995 test results are misused as product endorsements, people who normally exercise a high degree of discernment may overlook the body of existing research and may design life-safety systems that pose a risk of inadequate containment. While the industry works to design an improved testing method that includes dynamic activities, I encourage building designers to exercise caution and discretion so that safety is not sacrificed for simplicity and presumed savings.

References

1. American Society of Heating Refrigerating and Air-Conditioning Engineers, Inc. ANSI/ASHRAE 110-1995. "Method of Testing Performance of Laboratory Fume Hoods," 1995.

2. Haugen, R. "The Low Constant Volume Cupboard: How Low is Safe?" *International Labmate*, Feb. 1995, pp. 30-33.

3. Miller and Williams, "The Laboratory Fume Hood: Safety Considerations." *American Laboratory*, June 1986.

4. Zboralski, J. "The Effects of Face Velocity on Fume Hood Containment Levels." Hamilton Info-Bank Technical Paper No. 90.01, Feb. 1990.

5. Ljungquist, B. "Some Observations on Aerodynamic Types of Laboratory Fume Hoods." Ventilation '91 Conference proceedings, pp. 569-571.

6. American National Standard for Laboratory Ventilation, ANSI/AHIA Z9.5-1992, p.13. Face Velocity: "Each hood shall maintain an average face velocity of 80-120 fpm with no face velocity measurement more than +20% off the average."

7. Scientific Equipment & Furniture Association (SEFA). "Laboratory Fume Hoods Recommended Practices," SEFA 1.2-1996, p. 7. "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."

8. Smith, T. (Exposure Control Technologies Inc.), "Performance Testing of Laboratory Hood Systems," ASHRAE Spring Seminar 2000, Los Angeles. (Report based on testing a total of 1,671 hoods.)