Technical Paper : Lowered Face Velocity Challenge on EFD-4B1 (Customized ASHRAE Test)

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INTRODUCTION

Fume hood is one of the primary safety devices in the laboratory. A well designed fume hood , when properly installed and maintained, can offer a substantial degree of protection to the user.

Testing of fume hood is critical, as user safety is of prime importance and cannot be compromised. Fume hood testing should be able to test the efficiency of hood containment. ASHRAE 110 testing is one of the fume hood standard testing, which can determine the hood's containment ability qualitatively and quantitatively. This method, first published in 1985 and extensively revised in 1995, consists of face velocity testing, flow visualization testing and tracer gas containment testing to evaluate the performance of a fume hood.

At Esco, we design fume hoods which meet and exceed the ASHRAE standard requirements, by having a target of approaching the task keeping user free from the potentially toxic fumes. Using the methods of the face velocity test as defined in ASHRAE 110, a series of tests were conducted on Esco Frontier Duo Fume Hood with different face velocities.

TEST PROCEDURES

ASHRAE consist of the following tests and each test has a distinct purpose, which fulfils a safety criteria.

1. Face velocity measurement

Face velocity is the average air flow speed at the sash opening of fume hood into the work chamber. The measurement is expressed in m/s or fpm. Face velocities will often provide information concerning fume hood ability to properly control containment.

Face velocity shall be taken at full sash opening. Opening will be divided into equal square grids no greater than 300 x 300mm (12" x 12") and the face velocity measurement is taken in the center of the square. Measurement is taken at 1 reading per second and averaged over 60 secs by an air velocity transducer, connected to DAQ board.

Face velocity should be 0.5m/s (100fpm) with a deviation of 20% at all points on the face of sash opening. In this test, we lowered the face velocity to a value of 0.4m/s and 0.3m/s.

2. Cross draft measurement

Cross draft is the air flow disturbance in front of fume hood. High cross draft in front of fume hood might effect the hood containment efficiency. Cross draft is caused by door or windows opening and closing, traffic movement in front or nearby the hood, and air diffusers.

Cross draft shall measure at the center position and 1.5m (5 ft) in front of the fume hood and the reading shall not exceed 0.15m/s.

3. Smoke visualization test

Smoke visualization test is a qualitative test inspecting the hood's ability on captures and contains gas and vapors, by visualizing the air flow patterns at the inner work chamber and around the corner of fume hood. Sash shall be fully opened and the work chamber shall be empty when conducting test. The smoke visualization test consist of 2 parts:

a. Local visualization challenge

A stream of smoke shall discharged from the smoke tube along the work surface and interior walls of the hood at 6" behind the sash opening plane, along and beneath the airfoil, and on top of sash opening, and. drag an 8" diameter circle on the back of the hood.

Purpose of local visualization is to observe hidden eddies and vortex around the corner or dead zone in the fume hood. Smoke shall flow into fume hood smoothly and observe the lazy flow areas. No smoke shall escape from hood.

b. Gross visualization challenge

Fog generator is used to release large volumes of smoke in a short period of time. The air flow patterns in the work chamber is observed and the time of clearance (after generation has ceased) is recorded. No smoke shall escape from hood.

4. Tracer gas containment test

Tracer gas containment test is a quantitative test to measure the hood's containment ability. It is a critical test simulating an actual size worker working in front of the fume hood. A mannequin is used in the test and tracer gas detector is placed at the mannequin's breathing zone to simulate human breathing zone. The breathing zone shall be 66.4mm (26") height from the work surface. By releasing heavy tracer gas sulfur hexafluoride(SF6) at a rate of 4.0LPM at 150mm / 60" behind the sash opening, it simulates a fume hood under harsh usage. Detector is be able to capture any leakage of SF6 at a range of 0.01ppm during the experiment.

a. Static test

Test is carried out in 3 positions: center, 300mm (12") from the left wall and 300mm (12") from the right wall for each sash opening. Mannequin shall be centrally located in front of the tracer gas ejector. Gas is released and detector is monitored for 5 minutes for tracer gas leakage. The test is repeated with sash opening at 100%, 50% and 25% for each ejector location.

The maximum SF6 leakage shall not exceed 0.10ppm.

b. Sash movement effect

Test is carried out in 3 positions: center, 300mm (12") from the left wall and 300mm (12") from the right wall for each sash opening. Mannequin shall be centrally located in front of the tracer gas ejector. Sash is moved from 0% to 100% sash opening position, paused for 2 minutes then moved to 0%sash opening position again. The test is repeated 3 times and maximum SF6 leakage shall be recorded.

The maximum SF6 leakage shall not exceed 1.0ppm.

c. Face hood surface scan

Test is carried out in 3 positions: center, 300mm (12") from the left wall and 300mm (12") from the right wall. Sash is adjusted to 100% sash opening and tracer gas detector is held at the sash opening plane, 1 inch away from the edge of opening. Detector probe is moved slowly around the edge and seek for leakage of SF6 at the ash opening plane. Movement shall be repeated 3 times at each location.

The maximum SF6 leakage shall not exceed 0.10ppm.

RESULTS & DISCUSSIONS

1. Results for smoke visualization:

Method	0.5m/s	0.4m/s	0.3m/s
Local Visualization Challenge	Good	Good	Good
Gross Visualization Challenge (Smoke clearance time)	Good (<3 sec)	Good (<4 sec)	Good (<5 sec)

EFD-4B1 Customized performance was excellence. At lower inflow velocities of 0.4m/s and 0.3m/s, smoke flows into the hood smoothly without any eddies observed. No smoke escape is observed in gross visualization test.

Figure 1. Local visualization challenge at 0.3m/s. Smoke flows into hood smoothly without turbulence.

Figure 2. Gross visualization challenge at 0.3m/s. Smoke cleared within 6 secs and no smoke escaping from work chamber.

2. Results for tracer gas containment test

Maximum SF6 Leakage Detected (in ppm)					
Method	**Ejector Position**	**Sash Opening**	**0.5m/s**	**0.4m/s**	**0.3m/s**
Static Test	Center	100%	0	0	0.03
		50%	0	0	0
		25%	0	0	0
	Left	100%	0	0	0
		50%	0	0	0
		25%	0	0	0
	Right	100%	0	0	0.03
		50%	0	0	0
		25%	0	0	0
Sash Movement Effect	Center	100%	0	0	0
		50%	0	0	0
		25%	0	0	0
	Left	100%	0	0	0
		50%	0	0	0
		25%	0	0	0
	Right	100%	0	0	0
		50%	0	0	0
		25%	0	0	0
Face hood surface scan	Center	100%	0	0	0.03
	Right	100%	0	0	0.01
	Left	100%	0	0	0.02

Above results indicate the SF6 leakage detected when conducting tracer gas containment test. At face velocities of 0.5 m/s (100fpm) and 0.4 m/s (80fpm), no leakage was detected in all test. At the face velocity of 0.3m/s (60fpm), no leakage was detected during sash movement test, but minor leakage were observed for static test at sash fully open position and face hood surface scan.

Conclusion

Fume hoods that comply with the requirements of the ASHRAE 110 standard ensure end users' safety during test experiments. Esco Fume Hoods are not only certified to the ASHRAE standard, they are also proven to be safe in operation at lower face velocity conditions.

NSF Standard 49 Biological Safety Cabinets • Animal Containment Workstations • Fume Hoods • Clean Benches

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