Certification Guidelines

FLOW SCIENCES, INC.

2025 Mercantile Drive

Leland Industrial Park

Leland, NC 28451

(800) 849-3429

FAX (910) 763-1220

www.FlowSciences.com

TABLE OF CONTENTS

Contents

Always consult with on-site Industrial Hygiene or Safety Officer for recommended face velocity levels before beginning any certification procedures.

Introduction

The contents of this document are intended to aid customers and certification professionals with proper installation and efficiency tests of Flow Sciences enclosures. The topics discussed include installation tips, recommendations for filter leak tests, HEPA filter replacement and efficiency information.

Certification Outline

1. Verify Installation and Location
2. Set Face Velocity Alarm
3. Set Operating Velocity
4. Small Volume Smoke Visualization
5. Large Volume Smoke Visualization (Optional)
6. HEPA filter challenge
7. SF6 (Optional)

Enclosure Installation

The location of the enclosure installation is an important factor in the functionality and performance of the hood. Apply the following guidelines when setting up your Flow Sciences hood.

Cross drafts and shearing can have a detrimental effect on the ability of the enclosure to contain hazardous materials **(See figure 1 & 2)**. The system should not be located in a high traffic area, such as near a door or directly underneath a non laboratory grade HVAC diffuser. Before getting started verify that the velocity of cross drafts does not exceed 30 linear feet per minute (lfpm) (.15 m/sec). The enclosure must be installed as recommended in the manual.

The appropriate manuals for installing the fan and enclosure are shipped with each unit. A replacement manual can be obtained by registering at www.flowsciences.com and clicking the "View Our Downloads" tab or by contacting Flow Sciences' Technical Department at (800) 849-3429. The air from the fan should be directed away from the enclosure, walls, ceiling or any flat surface that may deflect the air across the front access area. **Figure 3** illustrates proper cross draft measurement locations.

Fig. 1. *Example of Shearing*

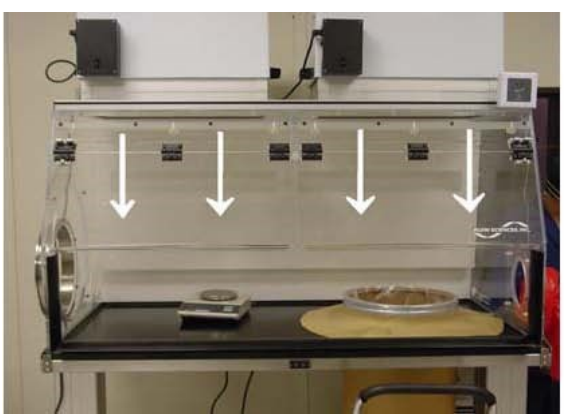


Fig. 2. *Example of Cross Draft*

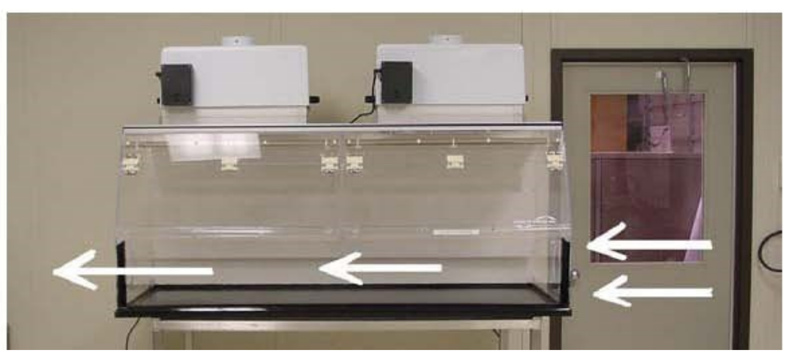
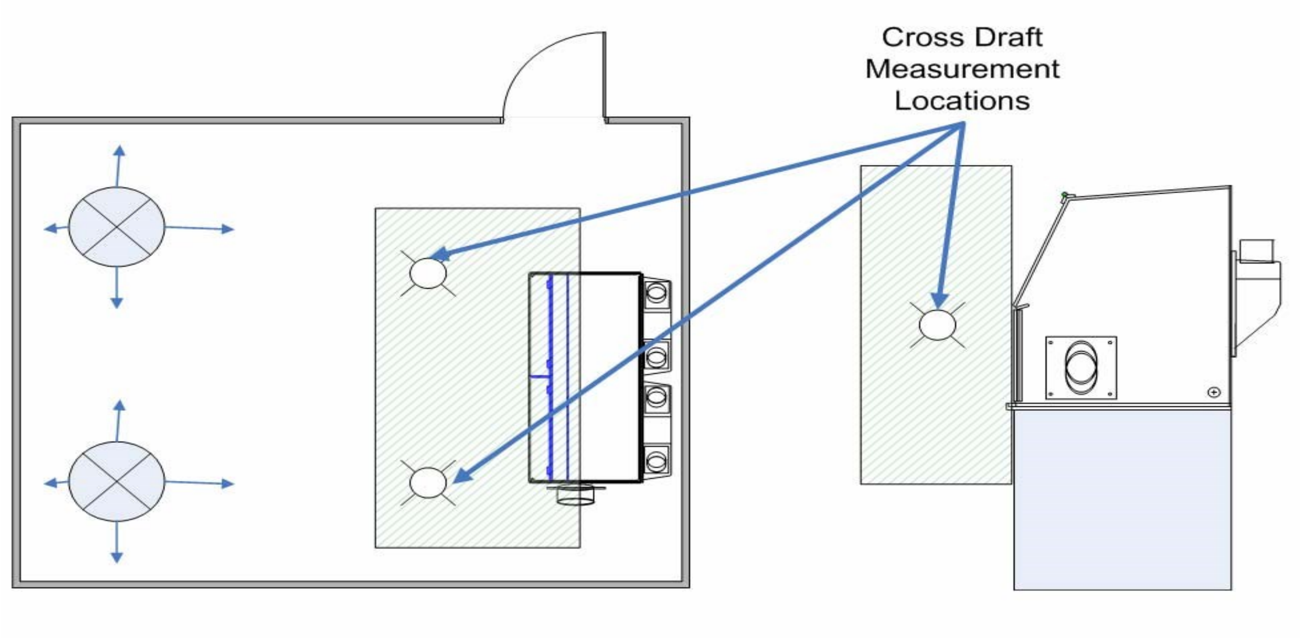


Fig.3. *Cross Draft Measurements*



ASHRAE -110

ASHRAE-110 is the factory acceptance test (FAT) Flow Sciences uses to test the containment efficiency of all enclosures. The ASHRAE-110 test method consists of three components: 1) an average face velocity measurement, 2) a smoke visualization test, and 3) a tracer gas test. **Table 1** (page 11) shows an ASHRAE test report sample.

Alarm Calibration

Prior to setting the enclosure's operating velocity the alarm set point should be established and the alarm calibrated.

The Flow Sciences FS1650 Face Velocity Alarm is designed to continuously monitor air flow through Flow Sciences' Enclosures. Once the FS1650 is installed and properly calibrated, this device provides both a visual and audible alarm to alert the end user to abnormal air flow conditions in the enclosure.

The flow alarm is designed to be mounted either integrally on the exterior of the enclosure or on an adjacent surface with adhesive strips provided with the unit. The module is connected by cable to the flow sensor, which is snapped into the base or side airfoil on the enclosure. A green light indicates normal flow conditions. If the flow deviates a programmed amount from the ideal conditions a red indicator light signals low flow. After a pre-set period of time at these conditions, an audible alarm sounds. The audible alarm can be silenced by pressing the acknowledge button (ACK) on the face of the alarm.

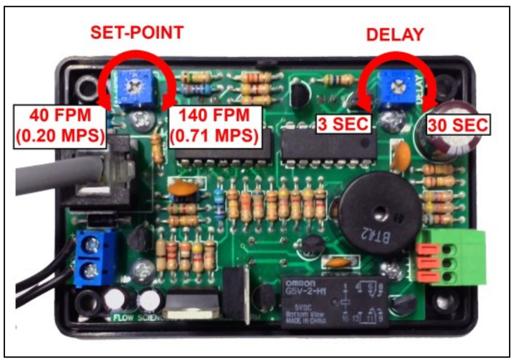
Alarm Set-Up

To begin, allow the fan to warm up by running it approximately 15 minutes prior to setting the alarm. Next, verify that the glass bead on the air flow sensor is perpendicular to the airfoil as shown in **figure 4**. Make sure that the two filament leads connecting the glass bead are extended and not touching each other or bent over. This could give false velocity readings and compromise the alarm accuracy.

Figure 4

Flow Sciences recommends the face velocity alarm be set at 20% below the operational face velocity. Therefore, if 75 lfpm (.38 m/sec) is the desired velocity, a face velocity less than 60 lfpm (.30 m/sec) would force the alarm to trip. Begin alarm calibration by first removing the four screws located on the face of the alarm**.** Next, maximize the delay to 30 seconds by adjusting the delay screw **(shown in figure 5)** all the way to the right **(optional-consult safety personnel).** By doing so, quick disturbances in the face velocity will not trigger the alarm. Set the face velocity to 20% of the desired velocity (i.e. 60 lfpm). Afterwards, adjust the set point screw **(shown in figure 5)** until the red and green light toggle between each other. This sets the alarm so that a consistent (30 seconds) face velocity of less than 60 lfpm (.30 m/sec) would turn the alarm red and sound the audible alarm.

Figure 5



Face Velocity

Establishing the appropriate face velocity is one of the most important factors in the overall performance of the hood. The vented enclosures from Flow Sciences are engineered to operate between 60 to 100 lfpm (.30 -.50 m/sec). The factory recommended face velocity is **75 lfpm +/- 5 lfpm (.38 m/sec).** All enclosures from Flow Sciences have been tested in accordance with the ASHRAE 110-1995 protocol. All enclosures exceed the SEFA standard of 50 ppb SF6. Additional independent surrogate testing has been conducted on selected types of enclosures; please contact your FSI representative for details.

75 lfpm +/- 5 lfpm (.38 m/sec) is the factory recommended setting however the face velocity should be set in accordance with your site safety requirements. The anemometer is to be held perpendicular to the plane of the front access area with the tip placed at the center of the plane as shown in **figure 7**. The fan speed may be adjusted by a set screw on the side of the fan box **(refer to figures 16 and 17).**

It is recommended that an approximate 1.0 ft^2 grid pattern be formed by equally dividing the face opening into vertical and horizontal dimensions. Considering that most face openings are close to 12" high, simply measure 12" from edge and measure in center. Using a calibrated anemometer, velocity readings should be taken in the center of the grid space **(refer to figure 6 and 7).** According to ASHRAE 110 operating procedures, at least four face velocity readings should be taken over a minimum of five seconds for each grid. Care should be taken to stand to the side while taking any measurement so as not to disturb air flow.

It is critical to measure directly in the center of the face opening plane as off center measurements can be inconsistent. Refer to **figures 6-9** for proper alignment as studies have shown that one inch inside or outside the face opening plane can alter the true reading by 10-15%.

Fig. 6. *Anemometer Placement*

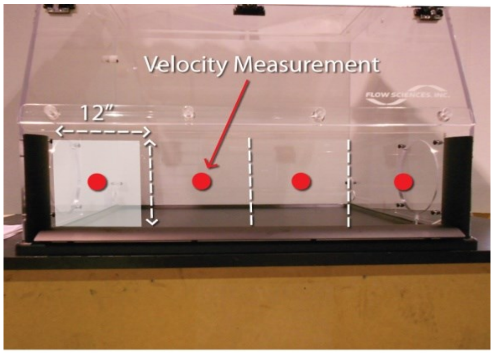


Fig. 7. *Anemometer Placement (Cont.)*

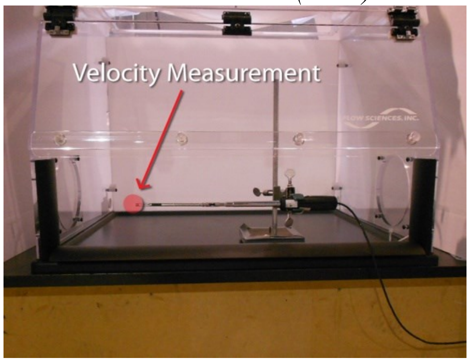


Fig. 8. *Anemometer Directly in Center*

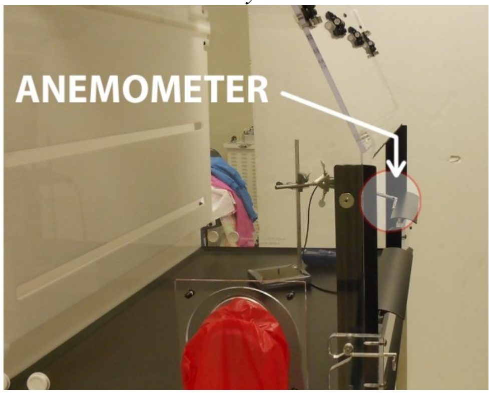
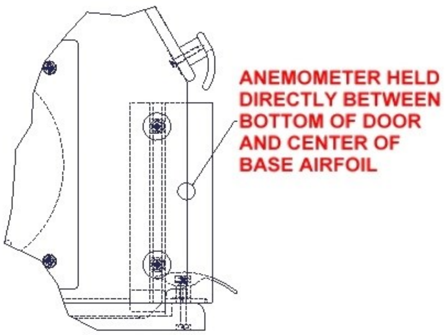


Fig. 9. *Anemometer Directly in Center (Cont.)*



Face Velocity for Hybrid Enclosures (Draft shield)

The hybrid isolator has a draft shield with glove ports to minimize contact between the operator and any hazardous chemical, or API's (active pharmaceutical ingredients) they may encounter. With the draft shield installed the recommended face/slot velocity should be set between **100-150 lfpm (0.5-0.76 m/s)** Adding the draft shield, decreases the area of the face opening and the face velocity is increased to maintain CFM requirements.

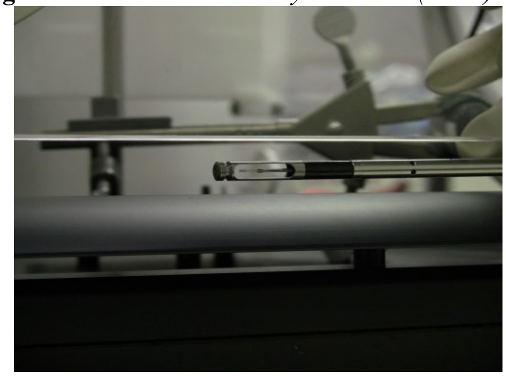
Anemometer placement should be performed in a similar manner to the standard vented enclosures. With the decrease in height, it is easier to judge the exact center. Flow Sciences recommends that the slots above and below the draft shield be set between 100-150 lfpm (0.5-0.76 m/s). The area of the lower opening is typically slightly smaller than the top and the velocity is greater than the upper opening by as much as 10 lfpm (0.051 m/s). **See Figures 10-13.**

Fig. 10. *Anemometer Placement (Hybrid)*

Fig. 11. *Anemometer Placement (Cont. Hybrid)*

Fig. 12. *Anemometer Directly in Center*

Fig. 13. *Anemometer Directly in Center (Cont.)*



Face Velocity for Dual Variable Speed Fan

The dual variable speed fan has the ability to set the enclosure at two separate face velocities. This is accomplished with the use of two variable speed controllers mounted internally inside the fans electrical box **(refer to figure 17)** and a proximity sensor **(refer to figure 18).** In the case of an enclosure with a draft shield and a dual variable speed fan the face velocity can be set and certified with both draft shield in place or removed. One variable speed controller is labeled "HIGH" for high CFM to be used without the draft shield and the other is labeled "LOW" for low CFM to be used with the draft shield in place. The proximity sensor identifies whether or not the draft shield is in place and communicates with the fan to adjust to the face velocities that set during certification.

It is important when using draft shields with glove ports to measure the face velocity with gloves installed but do not allow gloves to block face opening or effect face velocity.
Balancing Multiple Fans

Flow Sciences offers many enclosures that require multiple fan units to generate the appropriate CFM requirements. Example of this are shown in **figures 12 and 13**. Extra care is to be taken when setting the face velocity for this type enclosure. We recommend that each fan be adjusted to within 5% of each other. This minimizes interior turbulence and increases the overall efficiency of the unit.

To begin, adjust all fan speeds to maximum and take an initial reading of the face velocity. This is accomplished by turning the variable speed control shown in **figure 16 and 17**. Depending on the desired face velocity, each fan may need to be turned down considerably. Try to maintain consistency between the adjustments of each fan. When the face velocity approaches the desired level, check the entire face opening for flow uniformity.

Fig. 14. *Multiple Remote Fans*

Fig. 15. *Multiple Top Mount Fan Housing*

Fig. 16. *Remote Fan Housing (newer fan housings are white)*

Fig. 17. *Top Mount Fan Housing*

Fig. 18. *Dual Variable Speed Fan*

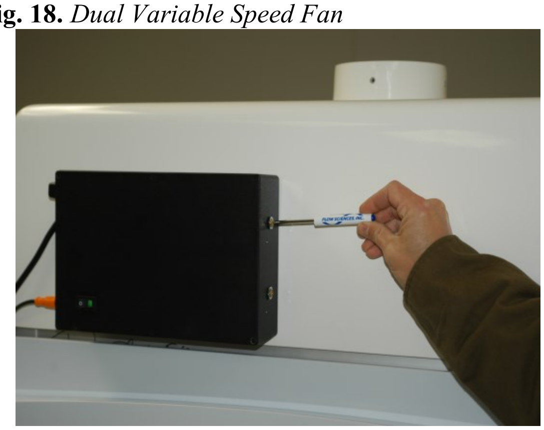
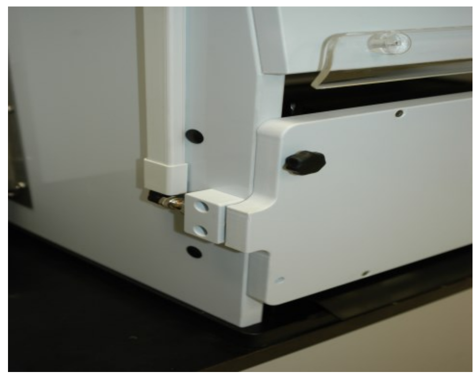


Fig. 19. *Proximity Sensor (Draft shield)*



Once the face velocity seems consistent across the face opening, verify that each fan is pulling equal volumes of air. This can be accomplished by comparing the plenum slot velocities. As shown in **figures 20 and 21**, hold anemometer perpendicular to the face opening of a plenum slot and record readings. Afterwards, measure the same slot on the next plenum. These velocity measurements should be within 5% of each other.

In many laboratories, air can be quite turbulent due to many variables. This turbulence can sometimes cause the enclosure face velocity to be inconsistent. It is here that measuring slot velocities becomes very important. When the face velocity is inconsistent, always refer to slot velocities to even air flow. **If these slot velocities are not similar (one fan is pulling more air), a vortex is created within the enclosure leading to decreased performance and making the face velocity extremely difficult to set.**

Fig. 20. *Measuring Slot Velocities*

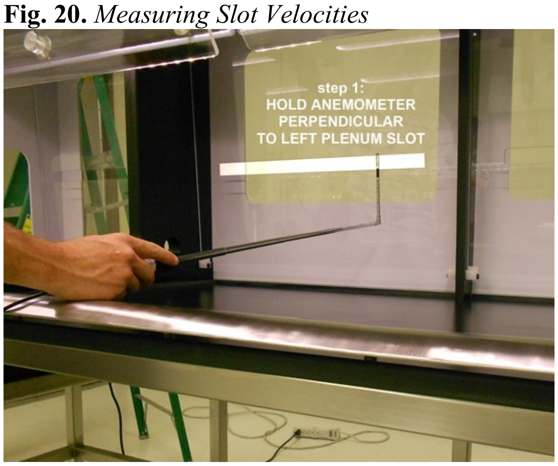
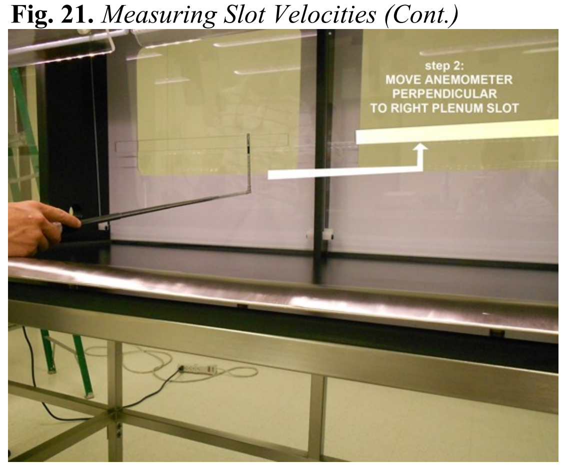


Fig. 21. *Measuring Slot Velocities (Cont.)*



If it is necessary to operate the enclosure outside of the manufacturer guidelines, please contact Flow Sciences Technical Department for further guidance at (800) 849-3429.

Thimble Connection

When connecting a fan directly in line with house exhaust duct work, **a thimble must be used for proper removal of contaminants. This connection has an air gap that prevent complications that result from having competing fans in the duct work. Figures 22a and 22b** shows the appropriate set up. Flow Sciences recommends that the face velocity be set prior to connecting the thimble. Once the desired face velocity has been achieved, the thimble connection can be attached. It is recommended that the house exhaust be 10-15% greater than the enclosure fan CFM. For example, if the enclosure fan is pushing 250 CFM (.118 m^3/sec), then the house exhaust should be pulling 275-288 CFM (.130-.135 m^3/sec). This prohibits any resistance between the two fan units. A simple way of checking the thimble installation is to **hold a smoke stick near the inlet of the thimble. The smoke should rush into the thimble with no reversions.**

After the thimble connection has been installed, verify that the face velocity has not changed. It is often seen that the additional force of the house exhaust fan creates a negative pressure which could slightly increase the face velocity. Refer to the face velocity section and adjust accordingly.

Fig. 22a. *Thimble Connection for Top Mount Enclosures*

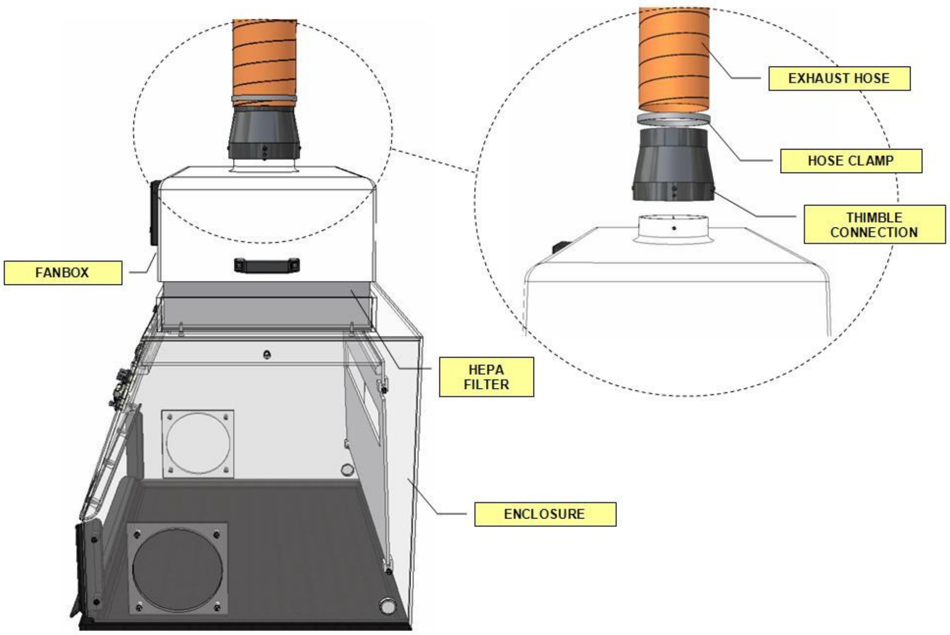


Fig. 22b. *Thimble Connection for Remote Fan Housing*

Verify Alarm Function

After the alarm set point has been set, adjust fans to the operational face velocity (i.e. 75 lfpm). To verify alarm functionality, simply open front door(s) and, depending on size of doors, the alarm should sound. For more information and troubleshooting tactics, refer to the face velocity alarm manual included with every enclosure.

Fig. 23. *Acceptable Face velocity (Green)*

Fig. 24. *Unacceptable Face Velocity (Red)*

Flow Visualization

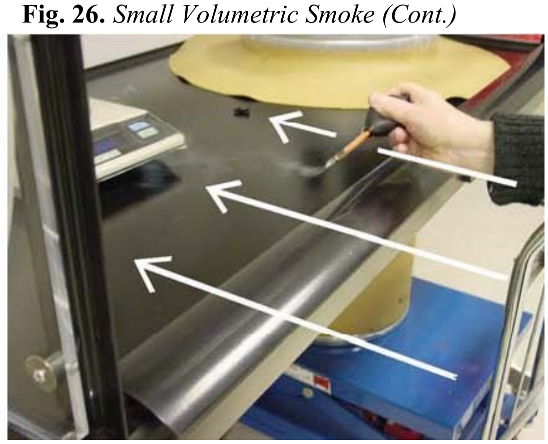
This test is a visualization of a hood's ability to contain powders and vapors. This test consists of both a small and large volume challenge to the enclosure. The objective of this test is to render a visual observation of the enclosure as it is typically used.

Small Volumetric Smoke

A smoke stick can be used to visualize local air flow within the enclosure. A stream of smoke can be discharged from the stick along both walls and the floor of the enclosure in a line parallel to the enclosure face **(shown in figure 25)** and 6 inches behind the face of the unit **(shown in figure 26)**. If there is visible smoke flow out of the front of the enclosure the system should be rechecked to ensure that the enclosure and fan housing are properly installed and that sheer or cross drafts are not affecting the containment performance.

Fig. 25. *Small Volumetric Smoke*

Fig. 26. *Small Volumetric Smoke (Cont.)*



Large Volumetric Smoke (Optional)

The large volumetric challenge must be administered with a smoke generator capable of filling the enclosure with smoke. The smoke must be released 6 inches inside the face opening and blown through a diffuser as to minimize interference with normal airflow. **Refer to figures 27 and 28**. A release from the enclosure that is steady and visible would constitute a failure.

Fig. 27. *Large Volumetric Smoke*

Fig. 28. *Large Volumetric Smoke (Cont.)*

Tracer Gas (Optional)

A tracer gas test is optional for certification and should only be performed if the system is connected to the house exhaust system. The tracer gas used during this portion of ASHRAE is to be commercial or reagent grade Sulfur Hexafluoride (SF6). It should be supplied from a cylinder capable of maintaining 30 psig with a release rate of 4.0 liters per minute (Lpm). **Figure 30** shows an example of the tracer gas ejector. When performing a tracer gas test, make sure the unit is **connected to house exhaust** as HEPA filters will not contain these gases.

According to ASHRAE-110, the tracer gas discharge nozzle is to be placed 6 inches from the face opening. Typical enclosures should be measured at three locations: left, center, and right. Smaller enclosures may only need two locations, as ASHRAE suggests the right and left side should be measured 12 inches from the inside wall of the enclosure. **Figure 29** shows the proper set-up including the detector probe positioned in the mouth of the mannequin and 3 inches from the plane of the sash. It also shows the detector probe located 26 inches above the work surface. Flow Sciences uses the Scientific Equipment and Furniture Association (SEFA) standard of 50 ppb as the maximum tracer gas detection limit.

Fig. 29. *Tracer Gas Set-Up*

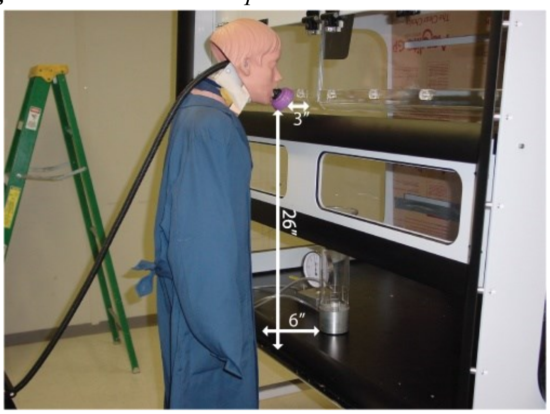
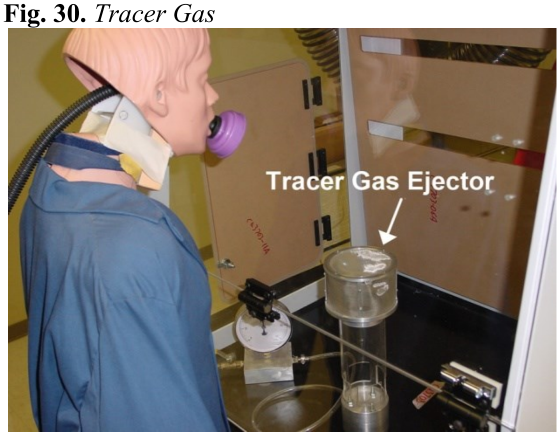


Fig. 30. *Tracer Gas*



Safety considerations suggest that a scheduled inspection and documentation be set up for each enclosure at least annually. Flow Sciences includes a maintenance log with every enclosure for this purpose. It is located in the back of each user manual. Optional testing can include tracer gas (SF6) and/or surrogate powder testing, at the discretion of the safety department. An inspection notice should be adhered to the enclosure indicating when the enclosure was tested, what the face velocity was, and that the enclosure was operating properly.

Table 1. *ASHRAE Test Report Example*

Laboratory Enclosure Performance Results										
Date			Enclosure Type				CQ #			
Lab Report #			CFM @ avg FV				Model #			
Inspector			Face Velocity (Max)				Serial #			
Sales Contact			Category				Company			
			DIMENSIONS (in)							
Enclosure work area:	Width:		Height:		Depth:		Enclosure Volume:			
Face Opening	Width:		Height:		Number:		Face opening Area:			
Draft shield	Width:		Height:		Number:		Turnover Rate (ACM):			
	Width:		Height:		Number:		Area of slots:			
Plenum Slots	Width:		Height:		Number:		Face opening/ slot:			
	Width:		Height:		Number:		Slot speed (70):			
Base Slot	Width:		Height:		Number:		Temperature (F)			
Comments:							Humidity			
							Slot Ratio			
			SMOKE VISUALIZATION TEST RESULTS							
Low Volume Rating:		sec			High Volume Clearance Time:				sec	
Comments (1):										
Comments (2):										
Comments (3):										
			HOOD FACE - VELOCITY TRAVERSE RESULTS							
Operating Range 60-80 LFPM.										
				SIDE 1						
	Enclosure	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8	Col 9	Col 10
Average:										
Standard Deviation:										
Variability:										
Minimum Reading:				Maximum Reading						
			Tracer Gas							
	TRACER GAS TEST						TRACER GAS TEST			
Average				ppb	Average				ppb	
Minimum				ppb	Minimum				ppb	
Maximum				ppb	Maximum				ppb	
	Left	Center	Right			Left	Center	Right		
Comments:	Front					Back				

Filter Leakage Test

Aerosol Challenge

Each Flow Sciences HEPA filter undergoes a stringent quality assurance test to verify the filter efficiency is within acceptable parameters. The test data document is included with the filter. To confirm the in-place efficiency of the unit and HEPA filter, many companies elect to perform a final certification of the HEPA filters. This proves that the HEPA filters were installed correctly and were not damaged prior to using the enclosure with potent powders.

The final HEPA certification should be a total leak test performed after installation. The aerosol used during this test should be a polydispersed aerosol such as POLY-ALPHA OLEFIN (PAO) or Dioctyl Phthalate (DOP). The following sections of this document will describe how to perform HEPA leak tests.

Vented Enclosure with Remote Fan/Filter Assembly

After the correct installation has been verified, the aerosol challenge can begin. Flow Sciences recommends that an aerosol be introduced into the enclosure as shown in **figure 31**. To assist with proper air/PAO uniformity, it is beneficial to inject the aerosol through a diffuser.

Turn the aerosol generator to the on position, introducing adequate aerosol. Refer to **table 2** for theoretical upstream concentrations. Another option to using the theoretical concentration is to measure the upstream concentration and make this the 100% baseline (As shown in **figure 33**). When gathering the upstream 100% baseline, it is essential to position the probe in a place where the most accurate representation of air to aerosol mixture is found. For this reason, the photometer probe should be located approximately 30 inches down the flex duct. To avoid ruining the entire flex hose, it is recommended to make a sample port close to the end of the duct. Following the test, this section can be cut off and discarded.

Fig. 31. *Aerosol Challenge*

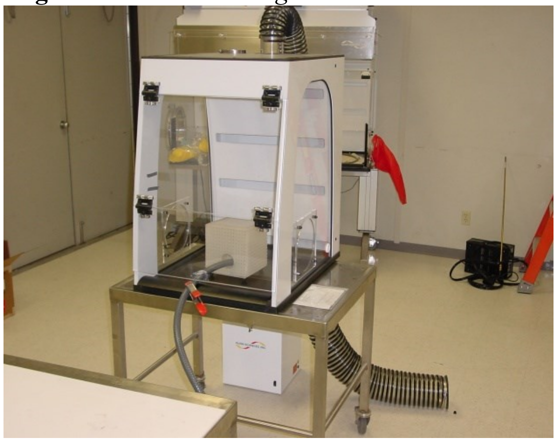


Fig. 32. *VBSE Test Set-Up*

Many photometers do not offer the probe extension shown in **figures 33 and 34**. This 3/8" (9.5 mm) diameter copper tube and fitting was purchased separately and can be found at most hardware stores. The tube should be approximately 3 feet in length. The ATI photometer used by Flow Sciences has 1/8" pipe thread, but the threads should be verified prior to purchasing as different model photometers use different threads.

With the 100% baseline concentration established, measure the downstream concentration as a percentage of the upstream. **See figure 34** for sample location. Considering a known upstream concentration (in percentage form) and the known filter efficiency (99.99%), perform a total leak test to determine the percentage of breakthrough. An aerosol detection of over .01% would constitute a failure.

Fig. 33. *Upstream measurement*

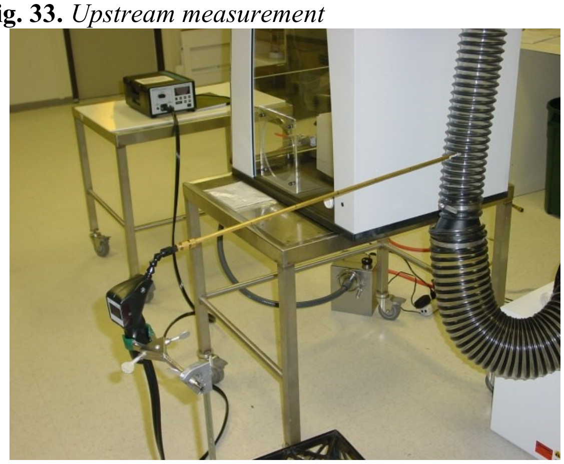
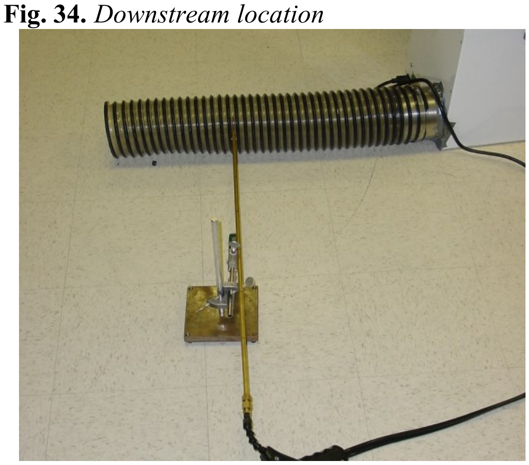


Fig. 34. *Downstream location*



The following diagram gives a representation of complete aerosol challenge.

Fig. 35. *Diagram of Aerosol Challenge*

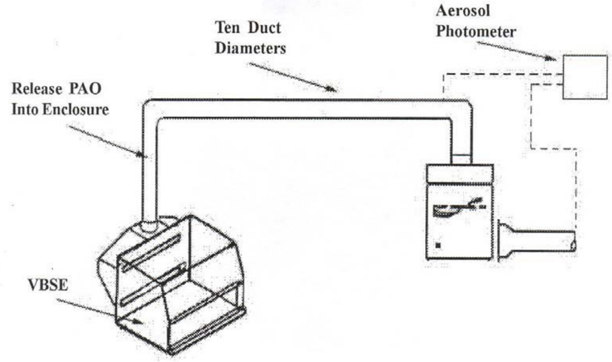


Table 2. *Theoretical Concentrations*

Theoretical Concentration Based on CFM 13500 * # Nozzles/CFM (Based on ATI 4B Lite)							
Pressure (PSI)	Nozzles	CFM	µg/L	Pressure (PSI)	Nozzles	CFM	µg/L
20	1	100	**135**	20	1	450	30
20	1	150	**90**	20	1	500	27
20	1	200	**68**	20	1	550	25
20	1	250	**54**	20	2	600	45
20	1	300	**45**	20	2	650	42
20	1	350	**39**	20	2	700	39
20	1	400	**34**	20	2	750	36

Top Mount Enclosures

Single HEPA Bag Out Filtration

A variation of the VBSE style enclosure is the Top Mount Series**.** This series incorporates the use of a rear and top plenum to direct air flow laterally through the back and out the top of the enclosure through a HEPA filter.

To assist with the certification of FSI enclosures, FSI has provided the theoretical upstream concentration of PAO to air mixture for different CFM ranges **(Table 2)**. This is based on Air Techniques International (ATI) aerosol generators. For example, if your aerosol generator is operating at 20 psi, generating aerosol from one nozzle and your enclosure is pulling 400 CFM of air, the upstream concentration would be 34µg/l. Program the photometers internal reference to include this concentration.

Another option is that the certifier can verify the upstream concentration by first injecting the aerosol through a diffuser into the enclosure as shown in **figure 37**. Allow the aerosol to run for approximately five minutes to ensure adequate mixing of the aerosol. Next, establish the 100% baseline concentration by inserting the photometer probe (3/8") into the test port on the side of enclosure **(Figure 38).** This port is located above the plenum and is ½ inch in diameter. It is important to make sure the photometer intake is in the most accurate location. This is typically beneath the center of the primary (bottom) HEPA filter **(Figure 43).** After the 100% baseline has been established, measure the downstream concentration at the fan exhaust port **(Figure 39).** Considering a known upstream concentration (in percentage form) and the known filter efficiency (99.99%), perform a total leak test to determine the percentage of breakthrough. A PAO detection of over .01% would constitute a failure.

Dual HEPA Bag-In/Bag-Out (BIBO)

Fig. 37. *Downstream Measurement Location*

Flow Sciences offers a series of enclosures with BIBO housings so that the primary (bottom) filter can be replaced without exposure to the operator using a specially designed bag with integrated glove sleeves. To perform an aerosol challenge on this type enclosure, the proper installation should first be verified. **Note: With proper visual inspection of the secondary safety filter Flow Sciences only requires the primary filter be checked after installation**.

The first step to testing the BIBO enclosures is to establish an upstream concentration measurement. **Table 2** provides a theoretical upstream concentration of PAO to air mixture for different CFM ranges. Be sure that only one aerosol generator nozzle is open and operating at 20 psi when referring to this table. As another option the certifier can verify the upstream concentration by first introducing the aerosol through a diffuser, inside the enclosure as shown in **figure 37**. Allow the aerosol to run for approximately five minutes to ensure adequate mixing of air and aerosol (PAO). Next, establish the 100% baseline by inserting the photometer probe (3/8”) into the test port on the side of the enclosure **(Figure 38).** This port is located above the top plenum and is 3/4" inch in diameter. It is important to make sure the photometer intake is in the most accurate location. This is typically beneath the center of the primary (bottom) HEPA filter**.** After the 100% baseline has been established, insert the probe into the 3/4 inch hole above the primary filter (use duct tape with a small slit in the center to minimize background interference) and measure the downstream concentration as a percentage of the upstream **(Figure 38)**

Considering a known upstream concentration (in percentage form) and the known filter efficiency (99.99%), perform a total leak test to determine the percentage of breakthrough. Flow Sciences recommends that several quadrants be measured and averaged downstream of the primary HEPA filter. Please refer to **figure 39**. An average PAO detection of over .01% would constitute a failure.

Fig. 38. 100% *Upstream Baseline*

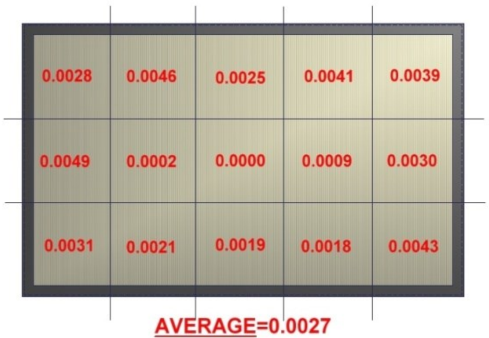
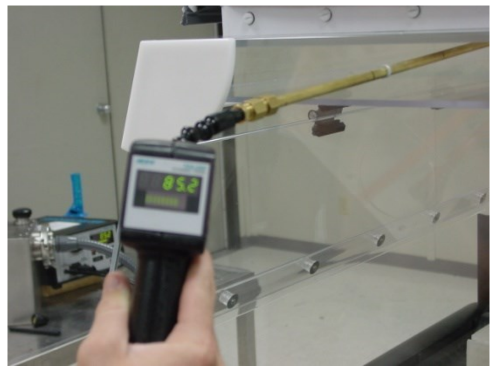


Fig. 39. *Example of Upstream Concentration*



Flow Sciences does not require testing of the secondary HEPA filter provided a visual inspection showed no damage to the pleats or seals. However, if the certifier or customer feels it is appropriate, please use the following guidelines.

If the secondary filter is challenged, the aerosol test should begin by testing the secondary HEPA filter. The following instructions are assuming the test would be administered after the enclosure was completely set up. If the enclosure has not been completely installed, please set up filters according to the following paragraph.

Prior to PAO injection, the primary filter must first be removed. This is done by removing the primary filter cover located on the front of the bag-in/bag-out unit **(Figure 40).** Next, remove the tension on the primary filter by lifting the four compression springs on the left and right of the BIBO housing. Afterward, unroll the yellow BIBO bag and slide the primary filter forward using the handle. The bag should remain attached via strap during this operation. Flow Sciences recommends the primary filter to be slid approximately six inches (152 mm) outside the face of the BIBO housing as shown in **figures 41 & 42**. This allows adequate space for the 100% upstream concentration of the secondary filter.

Fig. 40. *Removing Filter Cover*

Fig.41. *Slide Primary Filter Forward*

Fig. 42. *Approximately 6 inches*

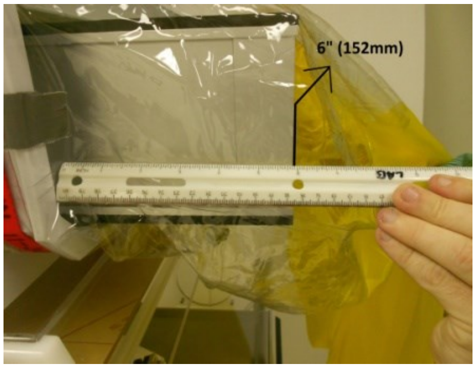
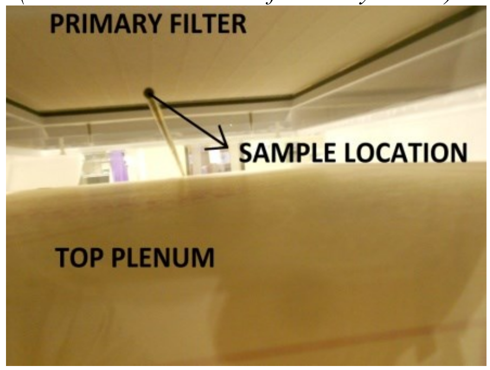


Fig. 43. *Photometer Probe(center of HEPA) (100% Concentration of Primary ONLY)*



Once again, the first step to testing the BIBO enclosures is to establish an upstream concentration measurement. **Table 2** provides a theoretical upstream concentration of PAO to air mixture for different CFM ranges. Be sure that only one aerosol generator nozzle is open when referring to this table. If chosen, the certifier can verify the upstream concentration by first introducing the aerosol through a diffuser, inside the enclosure as shown in **figure 37**. Similar to the primary filter, let the aerosol run for a few minutes to equally distribute. Gather the 100% baseline concentration by inserting the photometer probe in the ½" hole located on the sides of the enclosure. Be sure to locate the photometer probe behind the removed primary filter as shown in **figure 44**. Tests indicate that this sample location is most accurate. After attaining the baseline concentration, measure the downstream concentration by measuring the exhaust port on the fan **(Figure 45).** Once again, a detection of over .01% would constitute a failure.

Fig.44. *Testing Secondary Filter (100% Concentration of Secondary ONLY)*

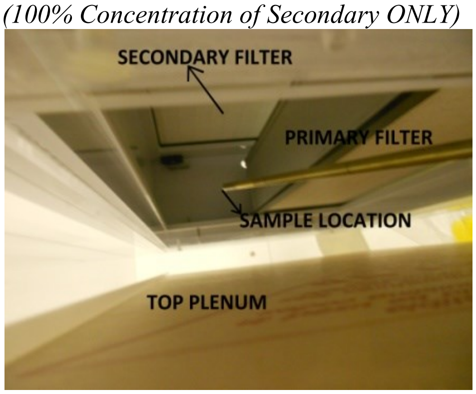
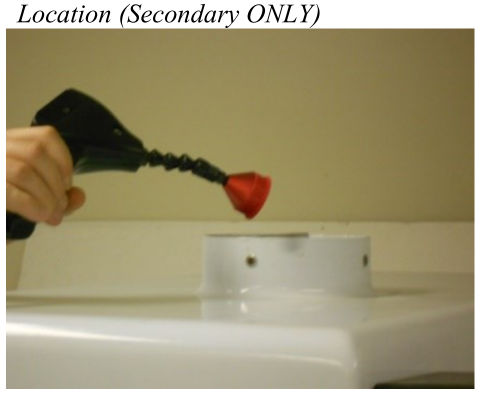
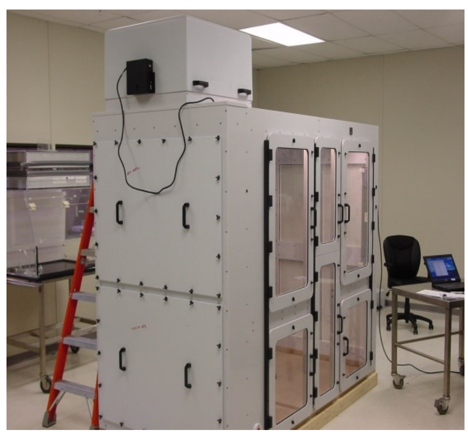


Fig. 45. *Downstream Concentration Location (Secondary ONLY)*



Lateral Flow Unit

Fig. 46. *Lateral Flow*



Flow Sciences offers a variety of custom enclosures. Many use the same type filtration as those previously mentioned and can be tested in the same manner. However, lateral flow units do require a slight variance in the testing protocol.

Face Velocity Alarm and Setting Internal Air Flow

The first step for the certification of a lateral flow unit is to set the internal air velocity at the predetermined level for activating the face velocity alarm. The alarm should be set 20% below the operating range and the recommended internal velocity is a setting between 50-70 lfpm (.25-.36 m/s). Therefore at an operating velocity of 50 lfpm the alarm would be set at 40 lfpm.   Once the alarm is calibrated the internal velocity should be increased to the operating range and record the pressure differential if the unit is equipped with a MiniHelic gauge. In order to measure the velocity an internal grid parallel to the inlet HEPA should be established and measurements taken in the center of each grid with the doors closed. Take the average of the readings in this grid. A large ring stand or similar device is helpful for taking these measurements. Once the internal velocity is achieved the pressure differential should be recorded if the unit is equipped with a minihelic gauge.

There are two options for interior verification of the filter installation; an aerosol challenge of the HEPA's or measuring the interior with a Particle Counter. One or both of these methods may be selected based on the project requirements and requirements of the owner.

Aerosol Challenge

The Lateral Flow units follow similar guidelines to the vented enclosures, insert aerosol upstream and measure downstream. The biggest difference is sample locations due to the unique shapes and sizes of these systems. An example of a large lateral flow enclosure is shown in **figure 46**. As the name implies, the air passes laterally from right to left. Intake air passes through HEPA filters and then exits the enclosure through HEPA filters followed by the exhaust fan.

For this type enclosure, begin testing the primary HEPA filters by introducing the aerosol into the HEPA filters. As the aerosol is being injected into the enclosure, another person should measure the interior concentration from the inside. As seen in **figures 47 and 48**, a flashlight was held with the aerosol injector so that the person measuring the downstream concentration could follow along. This is more of a filter scan rather than total leak test. These HEPA filters are also 99.99% efficient so the same acceptance criteria should be enforced.

Fig. 47. *Filter Scan (Intake)*

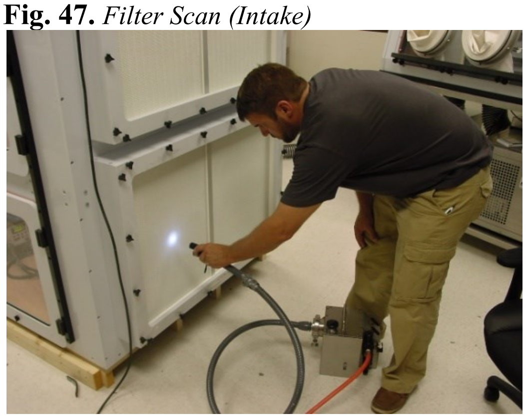
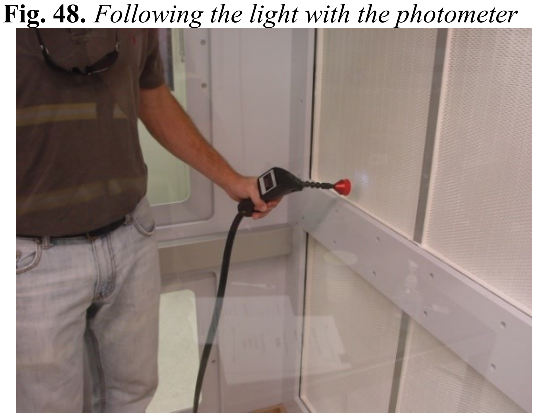


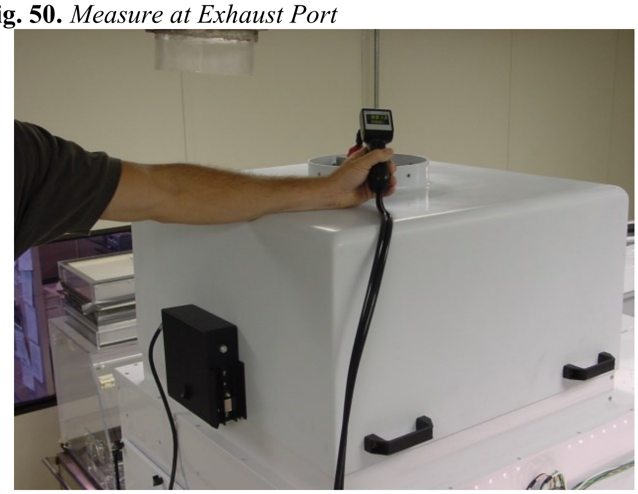
Fig. 48. *Following the light with the photometer*



After the intake HEPA filters have been tested, test the exhaust HEPA filters. This is done by injecting the aerosol through a diffuser inside the enclosure and measuring the concentration at the exhaust port of the fan unit as shown in **figure 49 and 50**.

Fig. 49. *Inject Aerosol Inside Enclosure*

Fig. 50. *Measure at Exhaust Port*



Particulate Verification Test

Many lateral flow units are designed not only for personnel protection but for product protection as well. The work and manipulation of many substances require a clean environment. One method to test the cleanliness is to perform particle counts within the contained environment.

Prior to performing particle counts, verify the cross sectional velocity is set appropriately. To do so, we recommend making an imaginary grid in the center of the enclosure as shown in **figure 51.** Take velocity readings directly in the center of each grid and then calculate the average. Once set, particle counts can be taken using the same imaginary grid. It is recommended to set the particle counter on a ring stand, close all doors, and after waiting a few minutes, take each measurement. This allows the particles that have entered through the doors to escape, avoiding any false contamination. Further, it is important to take particle counts with the counter placed directly into the air flow.

Fig. 51. *Imaginary Grid*

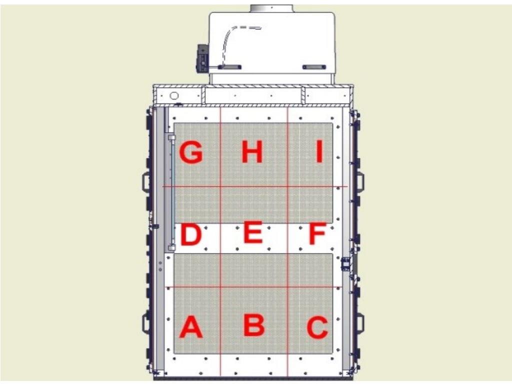


Fig. 52. *Particle Counter Facing Airflow*

When concluding a pass/fail, be sure that the particle counter is set to the appropriate unit of measure or converted properly. Typically, Flow Sciences uses the Federal Standard 209E guidelines as means of cleanliness. The enclosure shown below had to perform better than a FS209E class 100 meaning no more than 100 .5µm particles per cubic foot. The results from this test are shown in **Table 3** and correspond with the grid shown in **figure 51.**

Table 3 shows the data collected with this unit. Run 1 was taken with doors open as a baseline for the test. It was concluded that the enclosure was successfully within class 100 with an average of 13.1 (.5µm/1ft^3), just over class 10.

Table 3. *Summary of Particle Counts*

0.5µ / 1m^3						
Location	**Run # 1**	**Run # 2**	**Run # 3**	**Run # 4**	**Run # 5**	**After 10 minutes**
A	4910	110	60	30	60	70
B	4990	10	0	0	0	0
C	3750	30	0	0	0	0
D	3280	30	10	10	0	10
E	4370	20	0	0	0	0
F	7180	20	10	0	10	0
G	2690	10	0	0	0	40
H	3010	20	20	0	10	80
I	3010	10	0	10	0	40
Average	4132.2	28.9	11.1	5.6	8.9	26.7
Average After 2 Minute Clearance Time (Runs 3-6)						**13.1 0.5m/1 m^3**

It is the intent of this document to assist with the testing and certification of Flow Sciences products. If additional information is necessary, please register at www.flowsciences.com to view specific unit specifications. You can also contact our technical support team at (800) 849-3429.