

ASHRAE Atlanta 2015 - Seminar 11

Upgrading Ventilation in Existing Laboratories

Upgrade Traditional Chemical Fume Hoods to Improve Containment Performance and Reduce Energy Consumption

consumption

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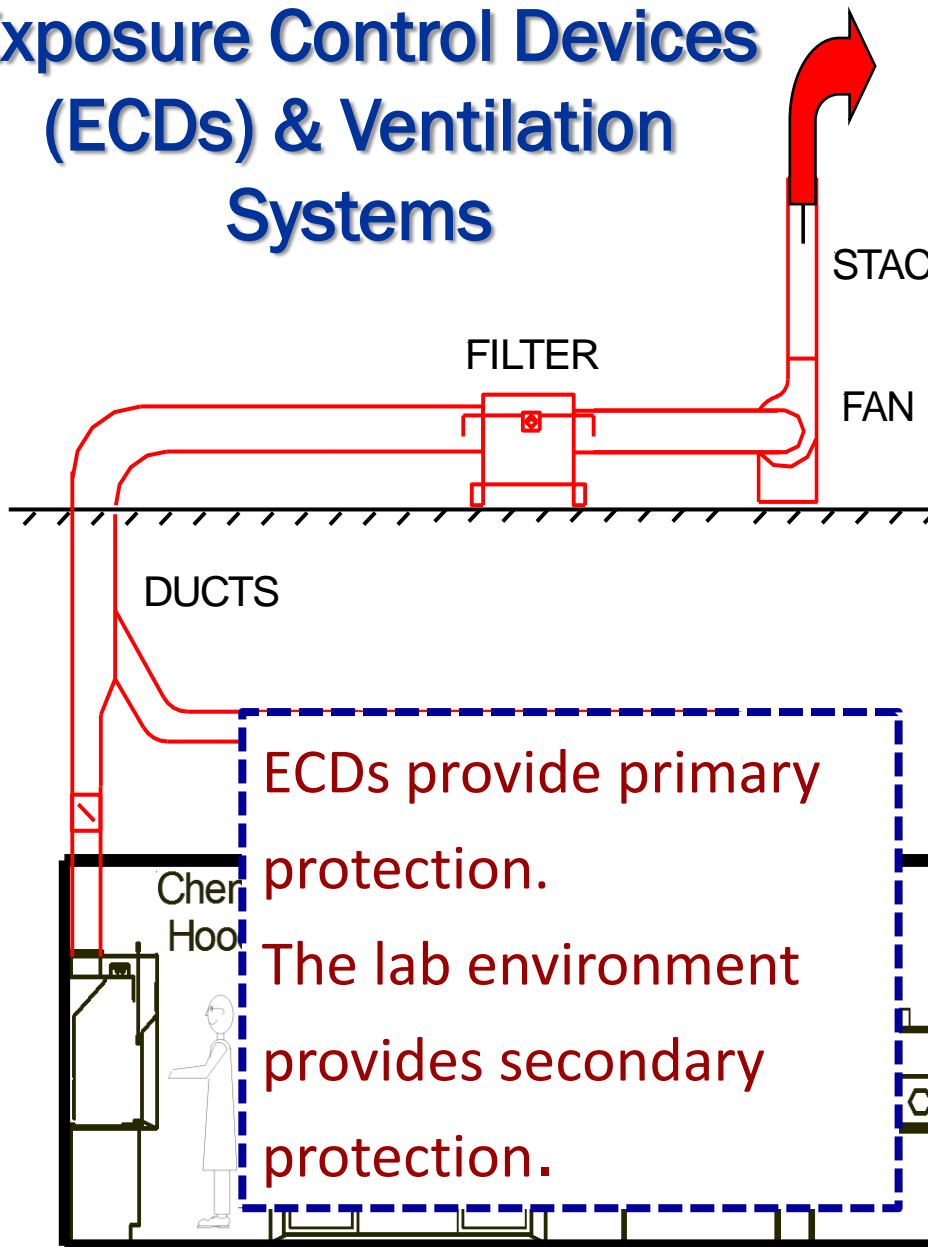
Introduction & Objectives

- Plan renovation projects where energy conservation pays for improved ventilation and safety.
- Plan renovation projects that add today's BAS technology to existing mechanical equipment, enhancing access to information needed to manage safety, energy use and mechanical maintenance.
- Extend the capacity of existing primary systems by upgrading constant volume labs to VAV.
- Reduce the potential for chemical exposure in labs by bringing today's aerodynamic design concepts to existing fume hoods.

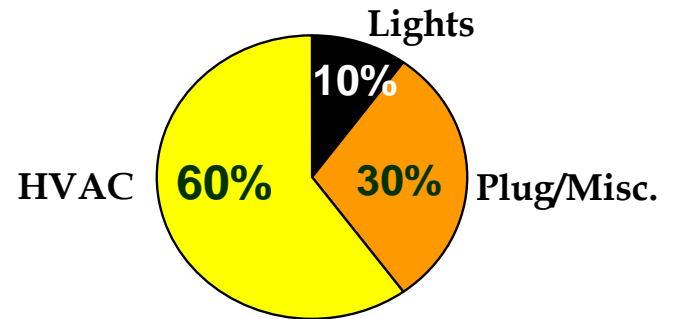
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Exposure Control Devices (ECDs) & Ventilation Systems



- Laboratory Utilities \approx \$5 to \$20 per sq. ft.



- Lab HVAC \approx \$3 to \$9 per cfm-yr
- As much as 50% of energy can be wasted by inefficient and ineffective HVAC
- Excess flow can be due to poor design and operation of fume hoods and high air change rates
- 15% - 30% of fume hoods may not meet ANSI standards for performance and many labs do not maintain proper air balance



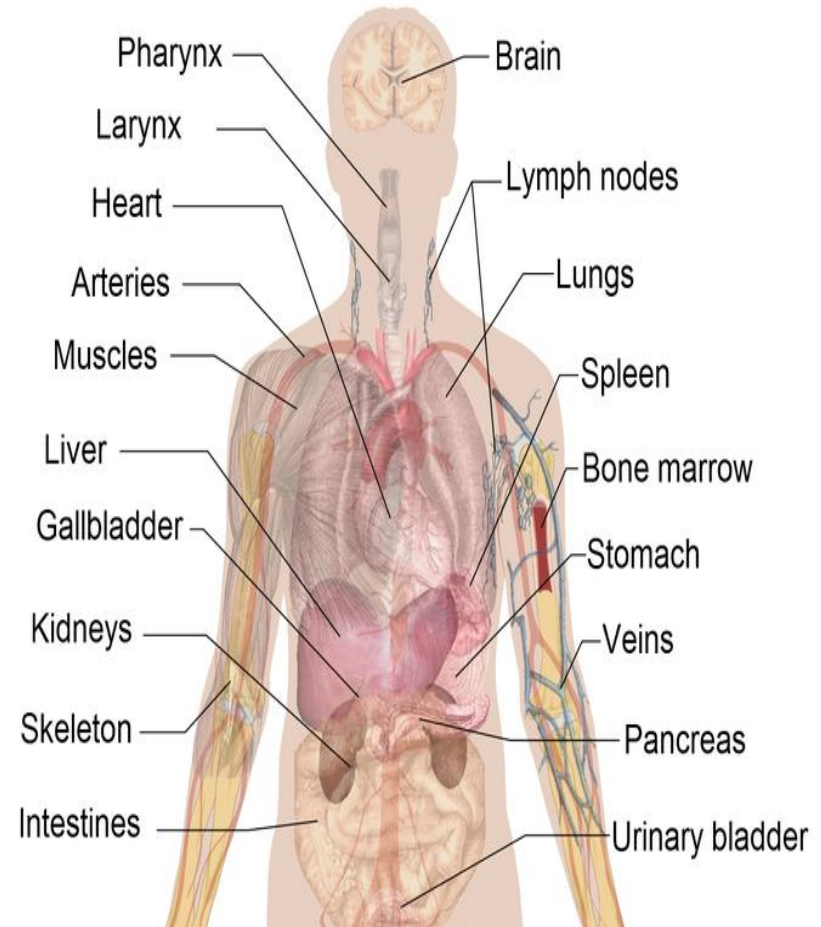
Potential for Adverse Health Effects from Airborne Hazards in Labs

Inhalation Hazards

- Types of Materials
- Toxicity
- Generation Rate
- Concentration
- Duration of Exposure

Physical Hazards

- Dermal Exposure
- Fire & Explosion



$$\text{Dose} = \text{Concentration} \times \text{Duration of Exposure}$$

Purpose of a Laboratory Fume Hood

Protect People

Contain, Capture and Exhaust Airborne Hazards



Evaluating Fume Hood Safety & Performance

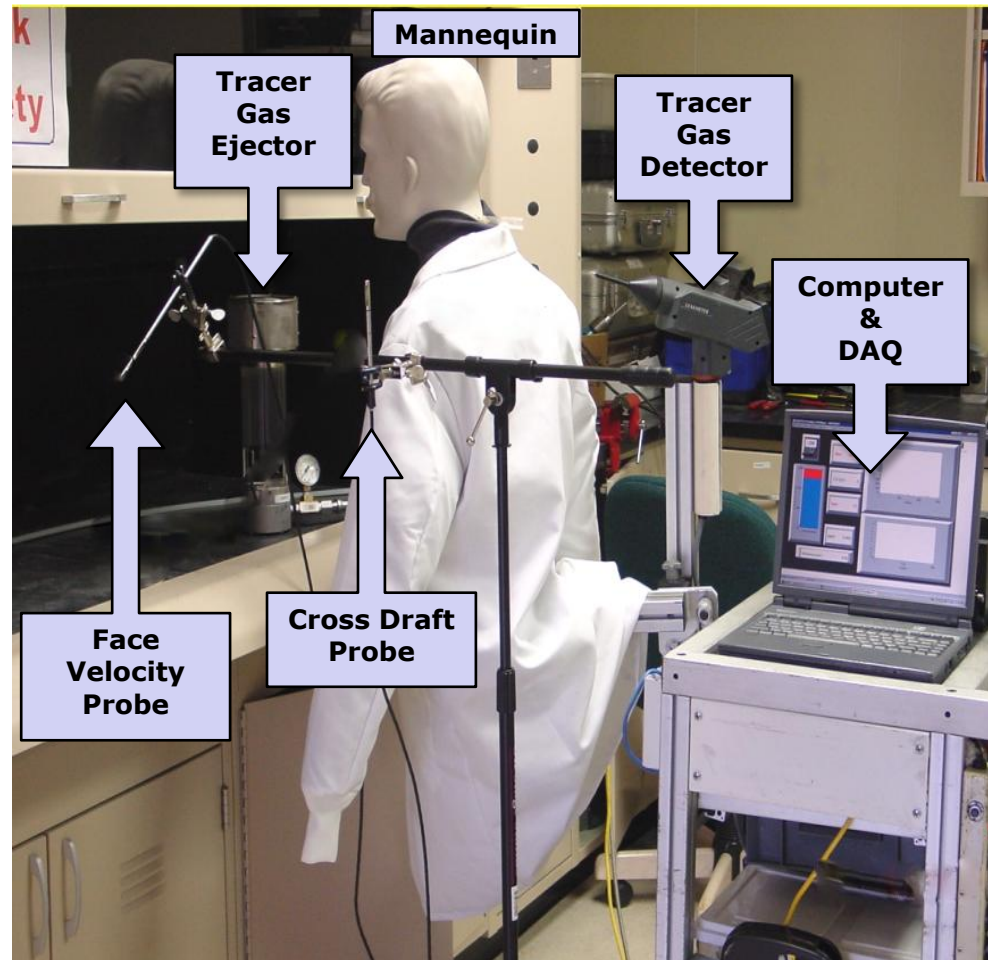
ANSI/ASHRAE 110 “Method of Testing Performance of Laboratory Fume Hoods”

Evaluate Operating Conditions

- Hood and Lab Inspection
- Face Velocity Measurements
- Cross Draft Velocity Tests
- VAV Response and Stability

Evaluate Performance (Containment)

- Flow Visualization Smoke Tests
- Tracer Gas Containment Tests



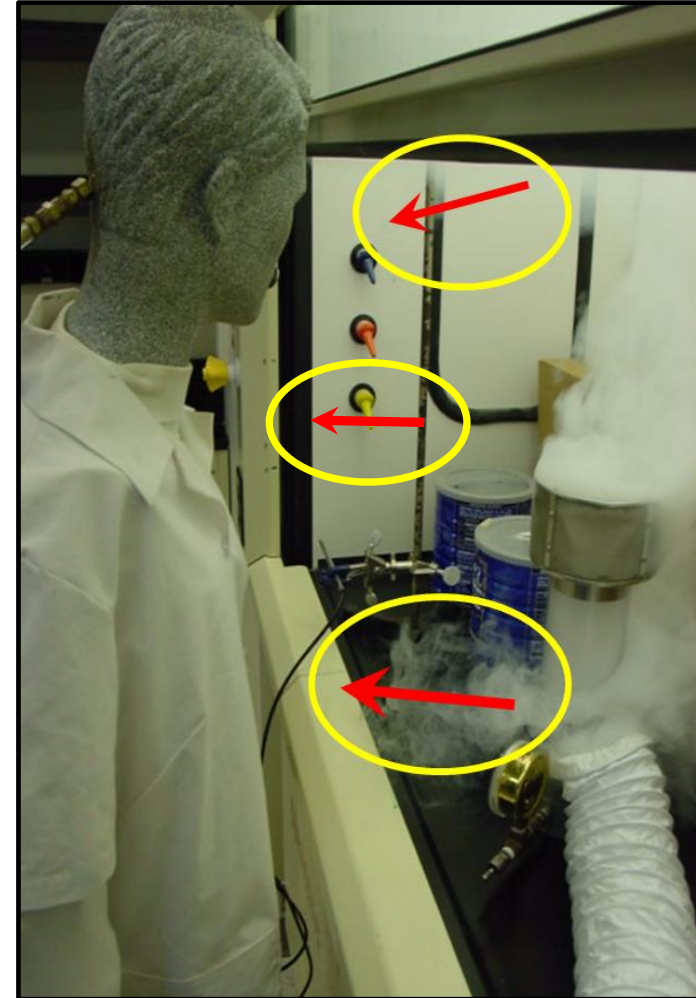
Laboratory Hood Safety & Performance

Results of more than 30,000 ASHRAE 110 Tracer Gas Containment Tests

Demonstrate 15% - 30% Failure

Primary Factors Affecting Performance

- Hood design - 20%
 - Lab Design
 - System Operation
 - Work practices - 25%
- } 55%

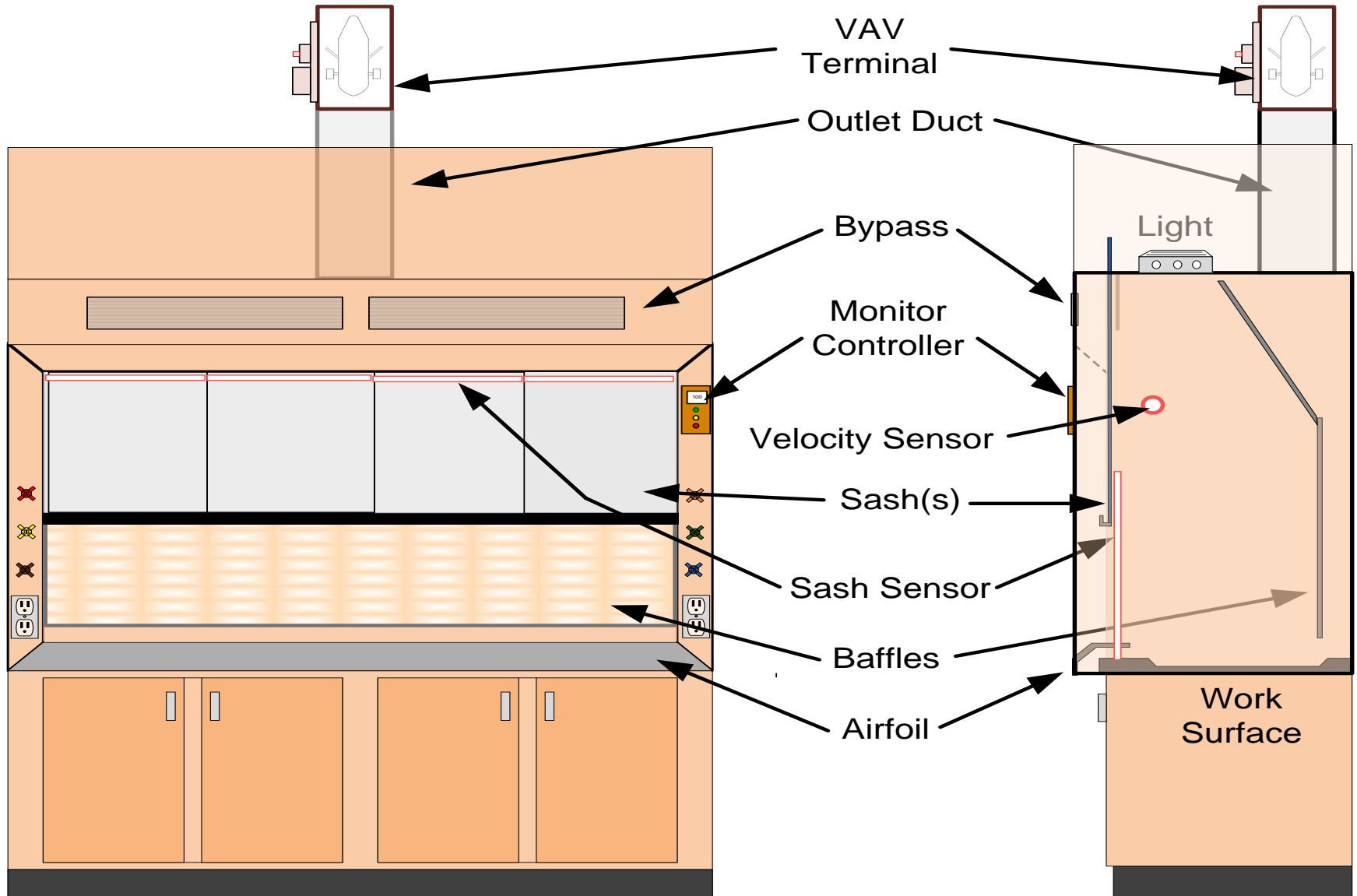


Laboratory Fume Hoods

- **Bench-Top**
 - Traditional Bypass
 - Auxiliary Air
 - Low Velocity / High Performance
 - VAV - Restricted Bypass
- **Distillation**
- **Floor Mounted (Walk-in)**



VAV Fume Hood Components



Bench-Top Fume Hood

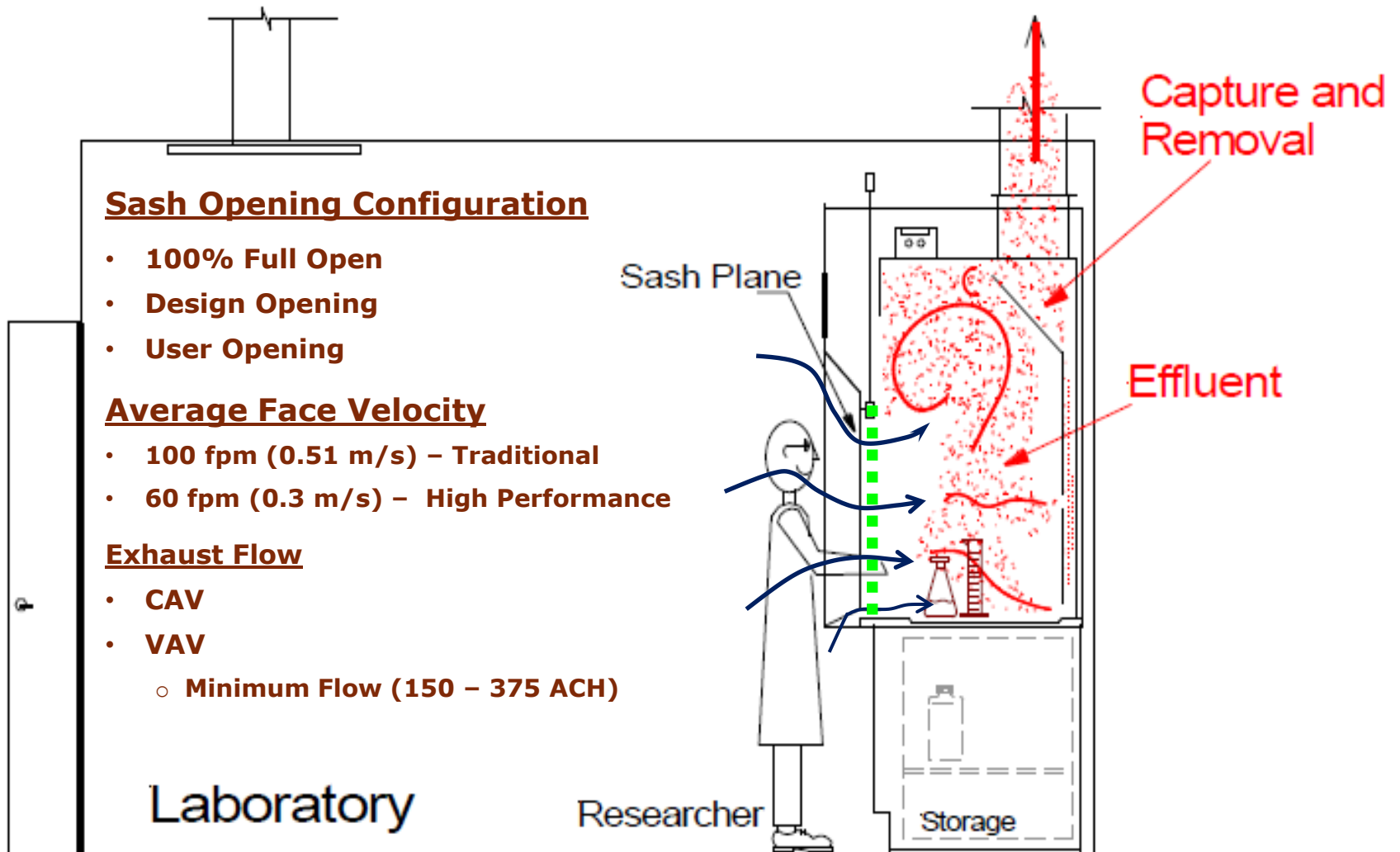
Vertical Sash Opening



Horizontal Sash Opening



Fume Hood Operation and Specifications



“High Performance” Fume Hoods

- Containment at Full Open Sash
- Face Velocity: 60 - 70 fpm
- Equivalent or better containment than Traditional Fume Hoods @ 100 fpm
- Safe & Proven Technology
- Numerous Hood Manufacturers
 - Lab Crafters
 - Fisher Hamilton
 - Kewaunee Scientific
 - Labconco
 - Air Master
 - Others



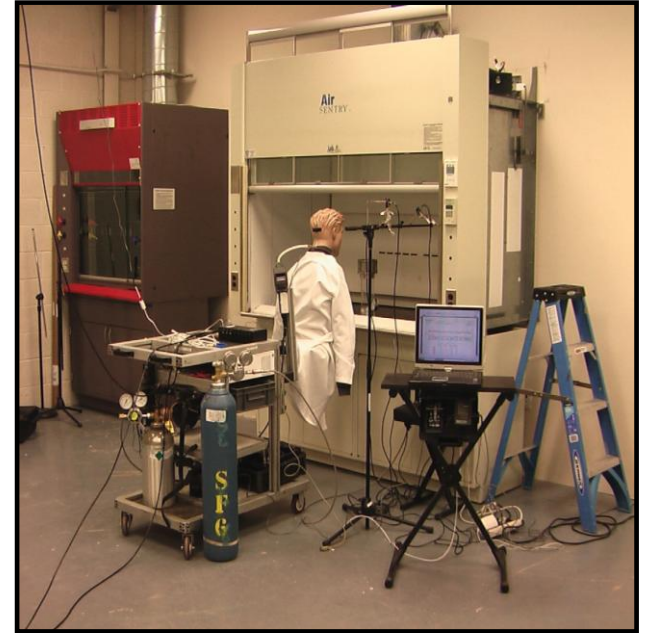
**EPA SHEMD
Laboratory Fume Hood List
March 2009**

STANDARD LABORATORY FUME HOODS** (cont.)				
Manufacturer	Details	Model No. when Tested	Width	Model No. as of March 2009
LABCONCO http://www.labconco.com/scripts/AdvSearch.asp?Cat20ID=4				
Protector PVC	bench top PVC acid digestion hood, bypass airflow, vertical sash	72824	4'	4882400
			6'	7282400
Protector XL	bench top hood, bypass airflow	9750600	6'	same
Protector Xstream	bench top hood, bypass airflow	9840600	6'	same
Protector XL Distillation	floor mounted walk-in distillation hood, bypass airflow	9660601	6'	same
LAB CRAFTERS http://www.lab-crafters.com/fumehoods/sentryn.html				
Air Sentry	bench top hood, vertical sash	HBASC6	4'	HBASC4
			5'	HBASC5
			6'	HBASC6
Air Sentry	low bench (distillation) hood,	HLASC5	4'	HLASC4

- U.S. EPA Tested & Approved

Evaluation of HP Fume Hood Performance

- **Manufacturer Prototype Tests**
- **Factory Acceptance Tests (As Manufactured)**
 - EPA, NIH, GSK, Merck, UNC, Duke, etc.
- **Extensive Field Tests by ECT, Inc.**
 - UCI Low Flow Hood Study
 - State of Wisconsin Equivalent Hood Study



Fume Hood Modifications and Upgrades

- Kewaunee
- Fisher Hamilton
- Labconco
- Jamestown
- Flowsafe
- AirMaster



Retrofit-Upgrade Traditional Fume Hoods

Upgrade
Critical
Components

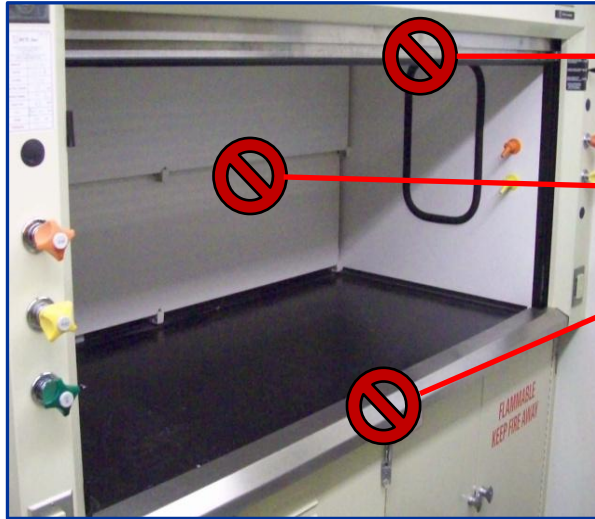
- Airfoil Sill
- Sash Handle
- Baffle

- Renew/Refurbish Inefficient Hoods
- Improve Safety & Containment
- Reduce Flow and Energy Use



Fume Hood Retrofit Kit

Traditional Fume Hood



Vortex Displacement
Sash Handle

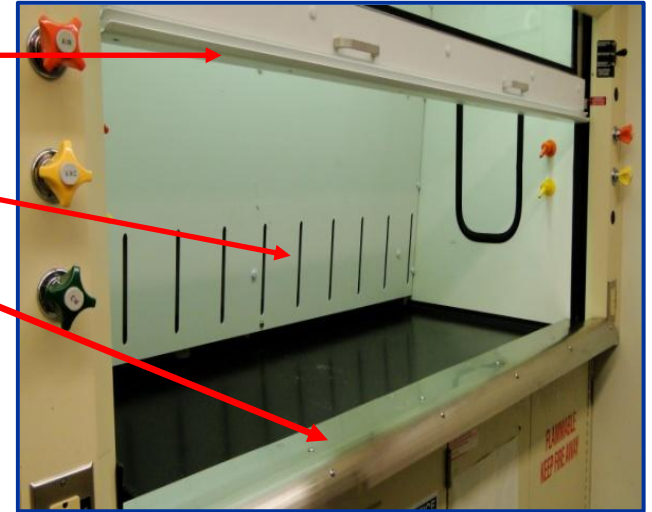
Bifurcated Baffle

Aerodynamic Airfoil Sill

Long Life, LED Lights

Accurate Fume Hood Monitor

Traditional Fume Hood
w/Performance Upgrades



- 40% Less Flow and Energy
- Equivalent or Better Containment
- CAV and VAV Fume Hoods
- Easy Installation (< 3 hrs. per hood)
- Quick Payback (2-5 years)

Upgrade & Retrofit Fume Hoods

Before



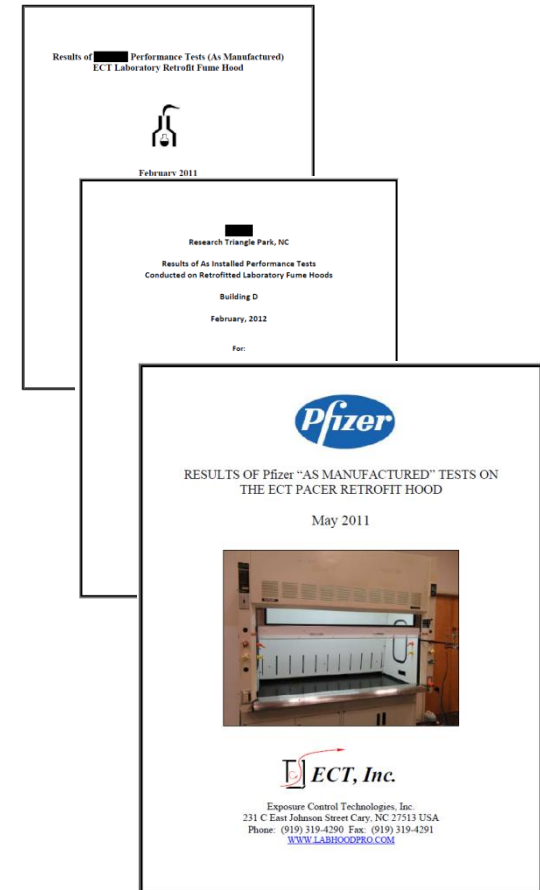
After



Safe & Sustainable Technology

Fume Hood Retrofits – Verified Performance

- Thousands of AM, AI and AU Tests
- Test Protocols
 - ASHRAE 110
 - EPA
 - NIH
 - PWGSC
 - Pfizer & GSK

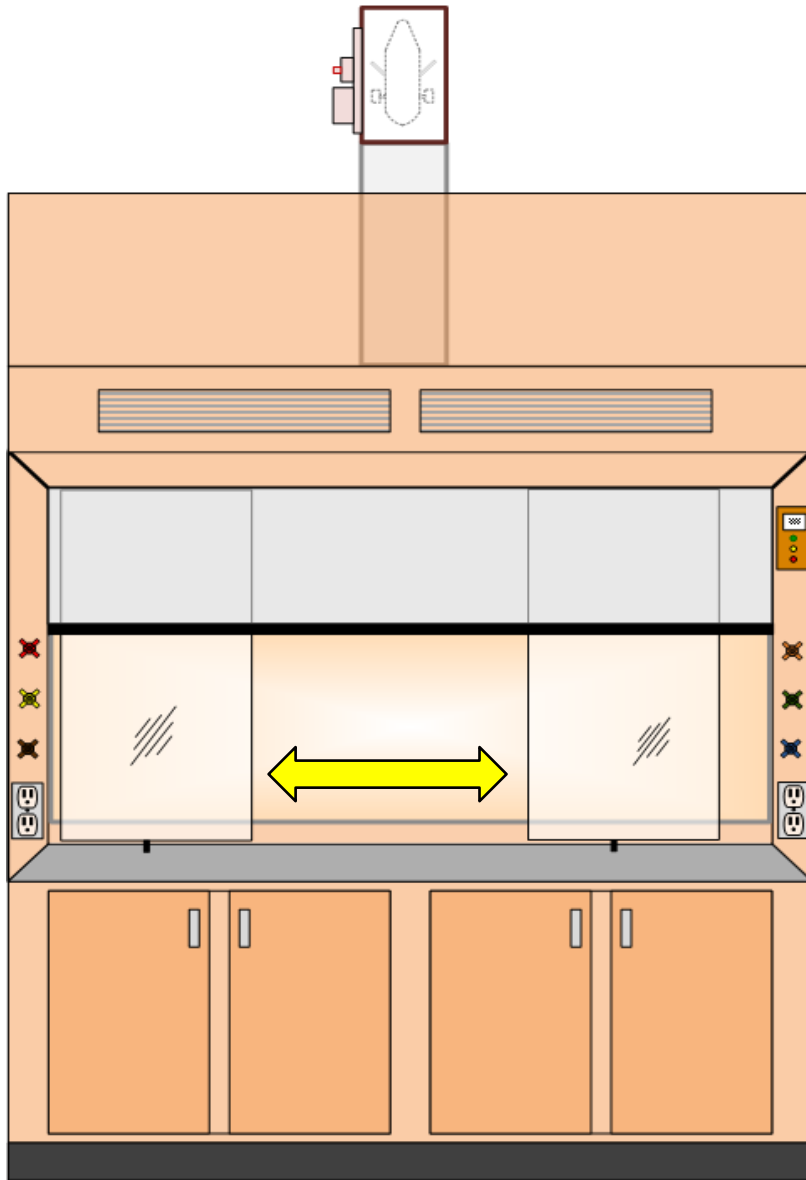


Candidates for Fume Hood Retrofit

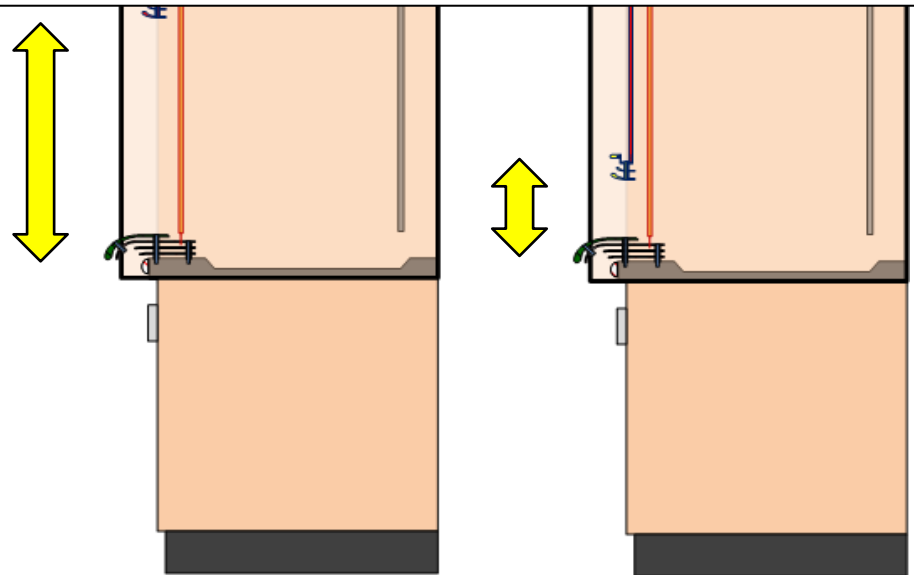
- Traditional Bypass and Auxiliary Air Bench-Top Fume Hoods
- CAV or VAV
- Vertical, Horizontal and Combination Sash
- Good Integrity



Fume Hood Retrofit - Combination Sash



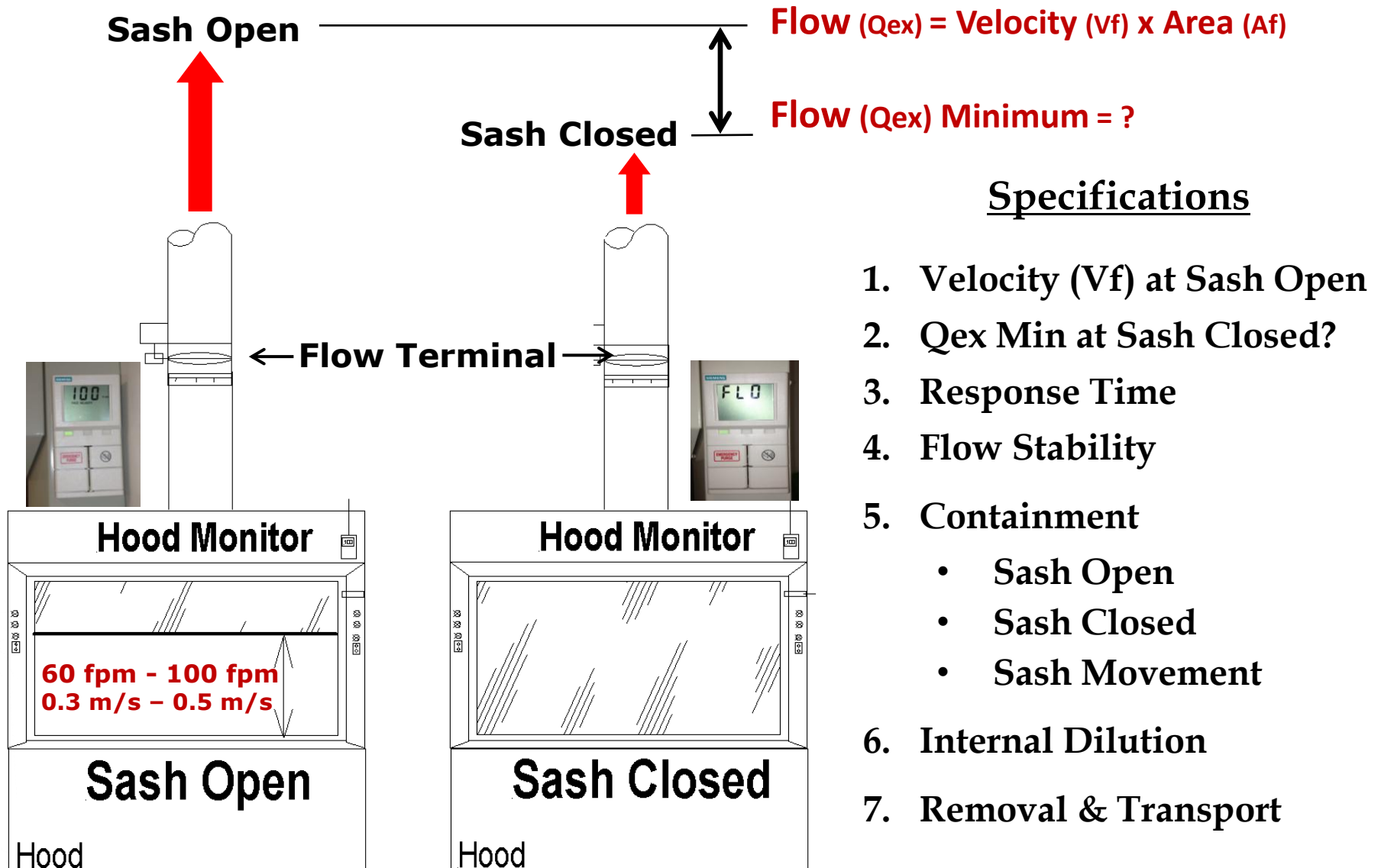
- Vertical to Combination Sash Upgrade
- Install Horizontal Panel (s)
- Reduce Flow by 40%
 - Reduce Face Velocity - 100 fpm to 60 fpm
- Equivalent or Better Containment
- 40% Less Energy Consumption
- CAV and VAV Compatible



Replace or Retrofit Fume Hoods

- **Replace with High Performance Fume Hood**
 - New hoods typically cost \$1,500/ft to purchase plus installation
 - Requires disconnecting all controls and services, demolition, removal of old hood, installation of new hood and reconnection of components and services
 - Hood and surrounding area must be cleared
 - Significant inconvenience, disruption and downtime (~ 3 days)
- **Retrofit Existing Fume Hood**
 - Approximately \$6,000 installed with new monitor
 - No disruption of controls of services
 - Only the hood must be cleared and downtime less than 1/2 day
 - Less than 30-50% of the cost of replacement

VAV Fume Hood Flow Modulation



Specifications

1. Velocity (V_f) at Sash Open
2. Q_{ex} Min at Sash Closed?
3. Response Time
4. Flow Stability
5. Containment
 - Sash Open
 - Sash Closed
 - Sash Movement
6. Internal Dilution
7. Removal & Transport

Flow Monitors and VAV Controls

- **Hood Monitors (Flow Measuring Device)**

- Flow
- Velocity
- Pressure

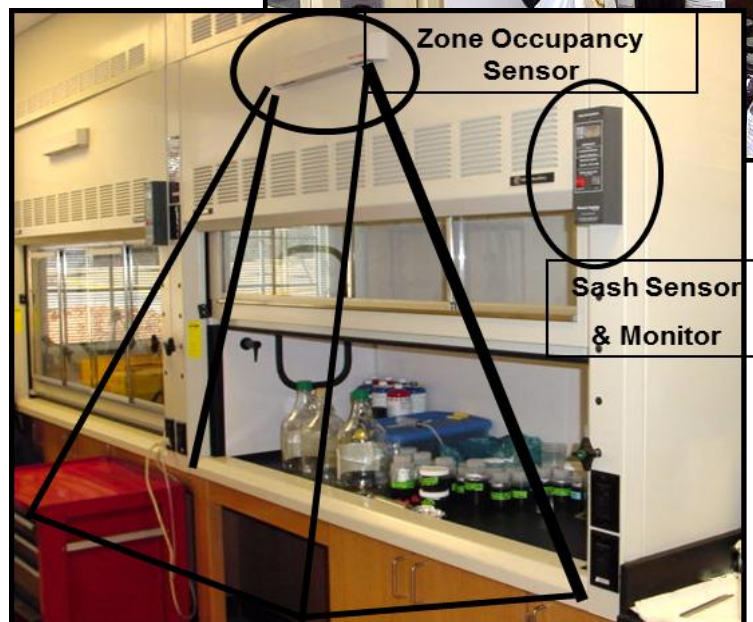
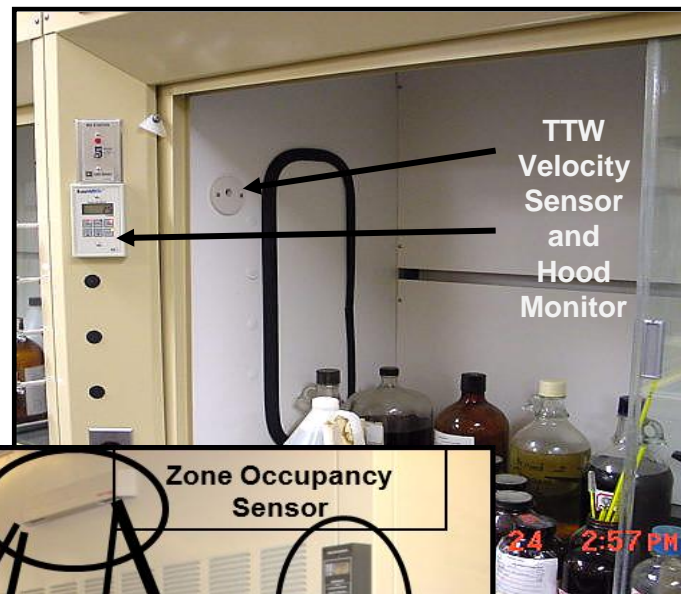
Monitors are required on all fume hoods

- **Flow Control Types**

- Through the Wall Velocity
- Sash Position
- Occupancy
- Manual

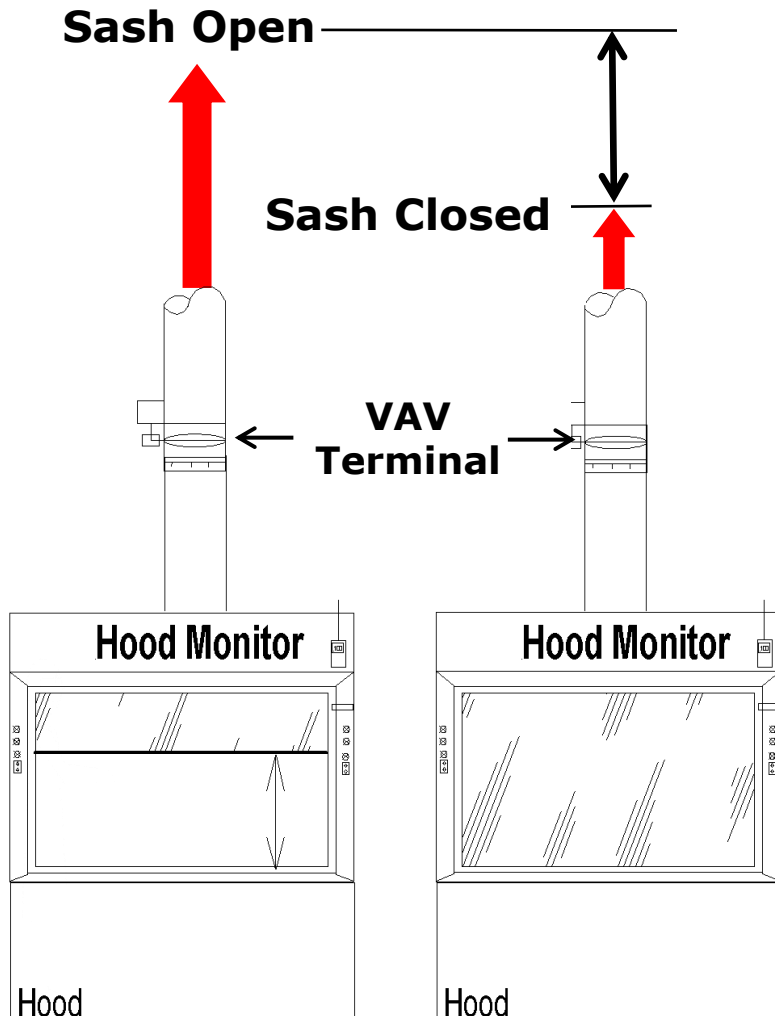
- **VAV Modes**

- Two State
- Full VAV
- VAV Hybrid

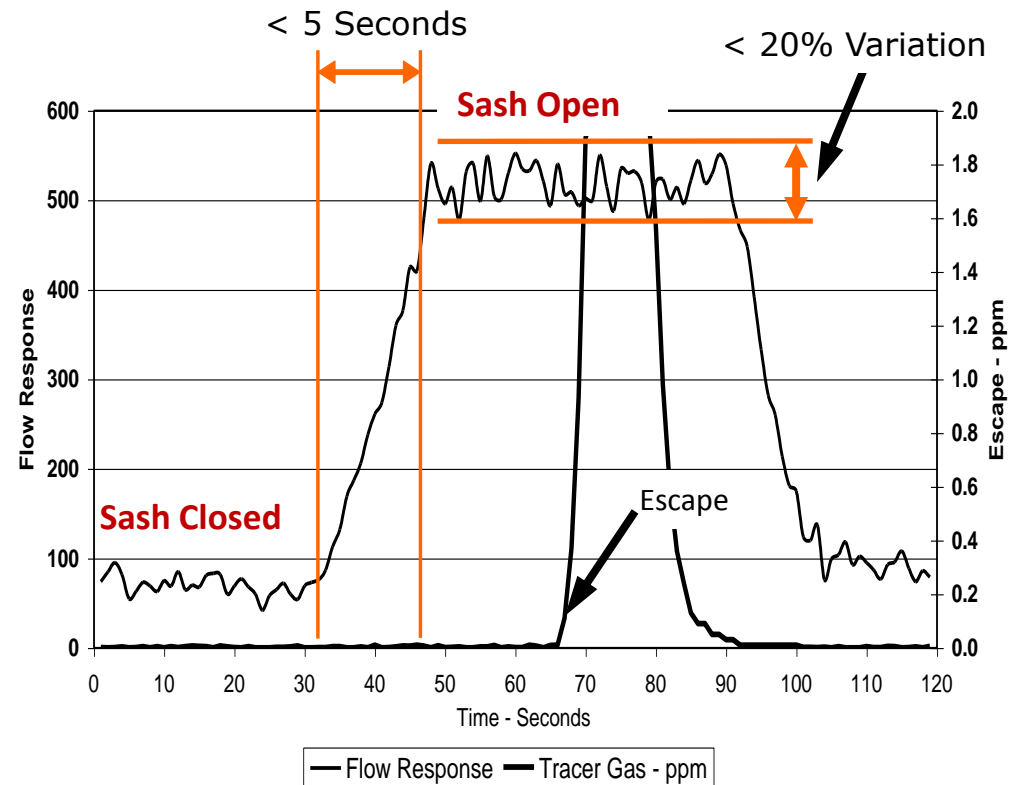


VAV Flow Response and Stability

- Min and Max Flow
- Response Time
- Flow Stability



VAV Response To Sash Movement



Minimum Flow Specs for VAV Fume Hoods

- Containment
- Dilution
- Removal

1990s - EPA – 50 cfm / ft of Wh

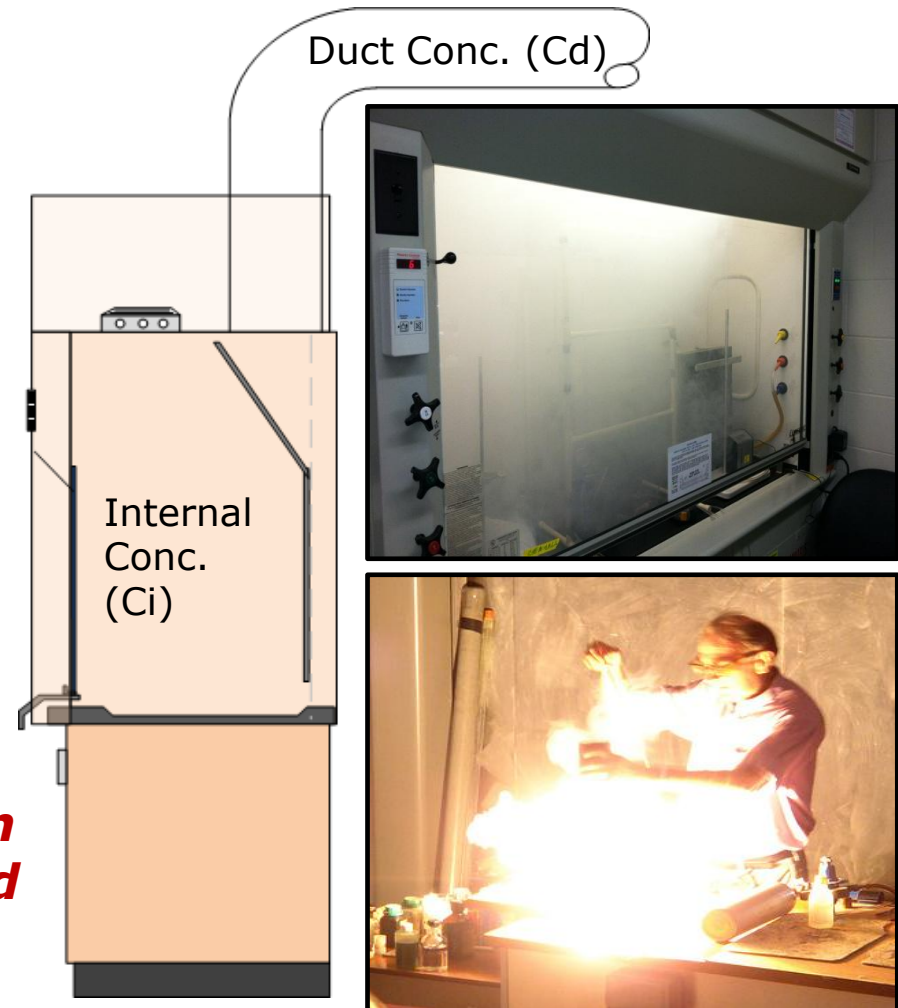
2004 - NFPA 45

- 25 cfm / sq. ft. ws
- 2010 - Defers to ANSI Z9.5

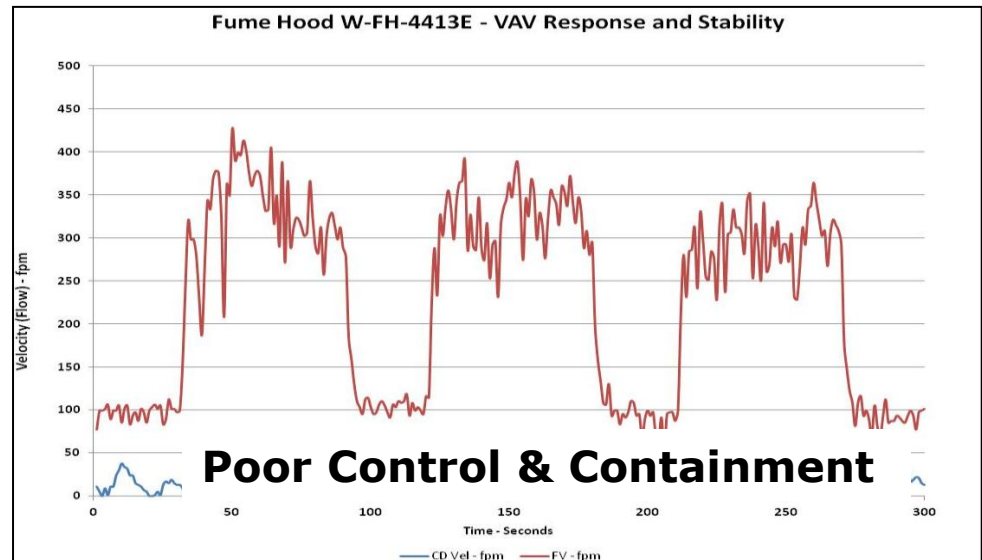
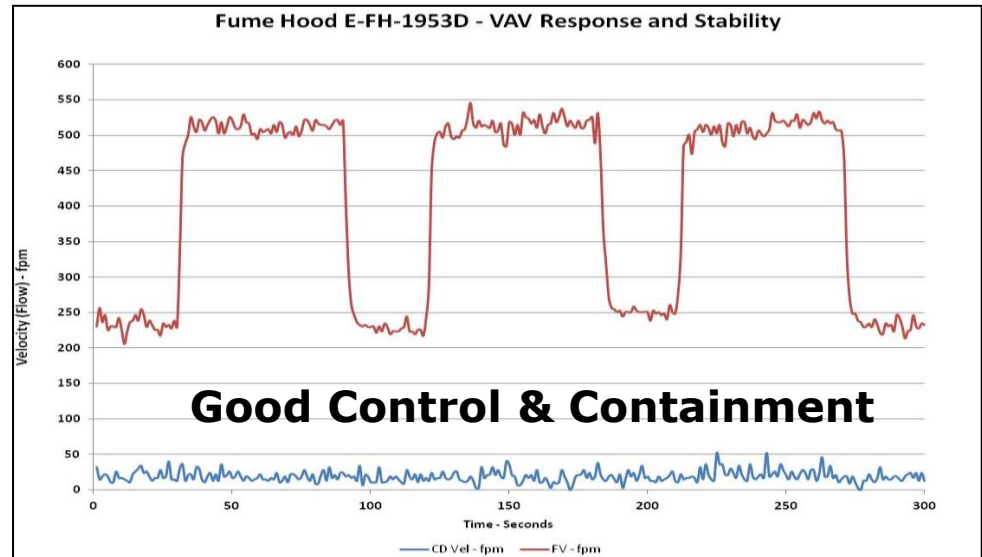
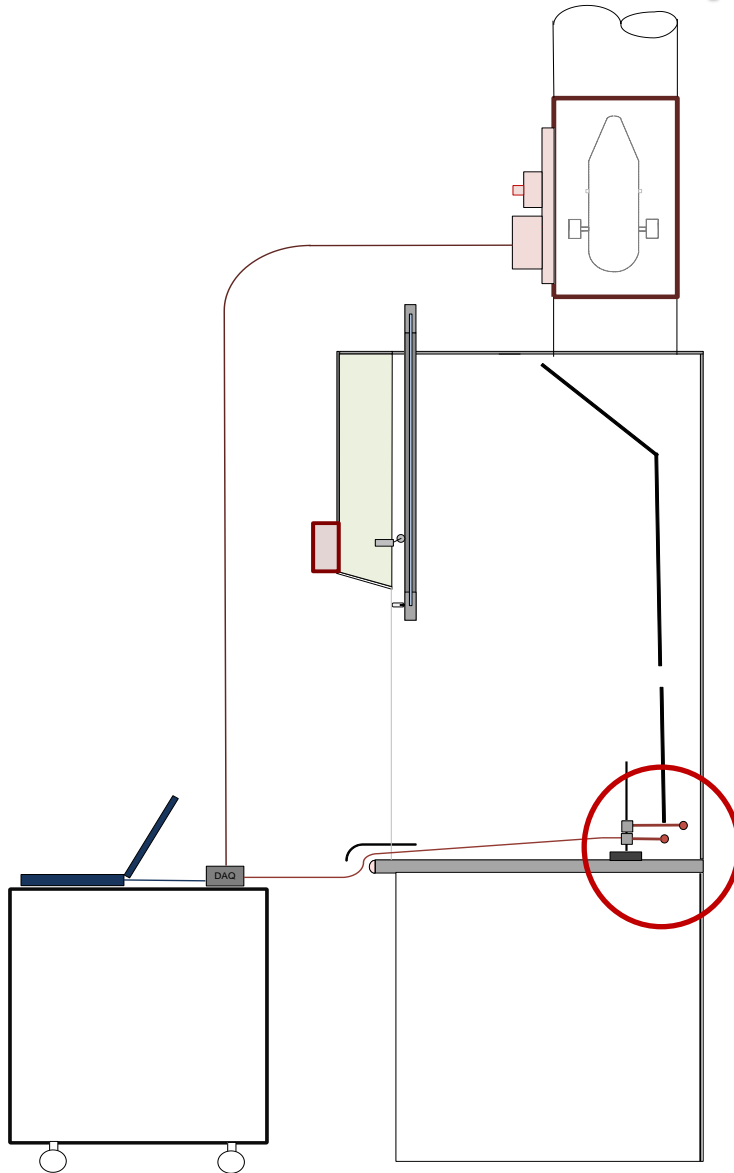
2012 - ANSI Z9.5 (must be appropriate)

- Internal ACH (150 ACH to 375 ACH)
- 150 ACH ~ 10 cfm / sq. ft. ws
- 375 ACH ~ 25 cfm / sq. ft. ws

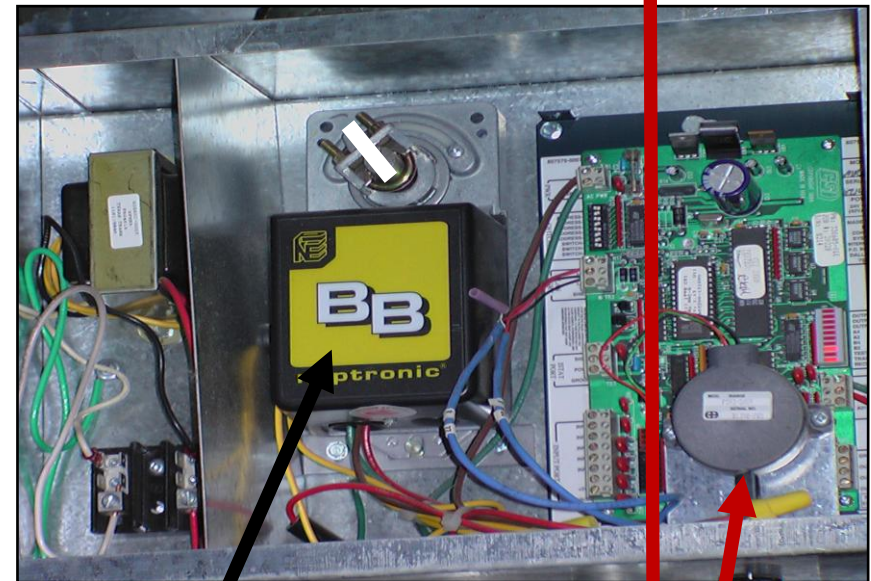
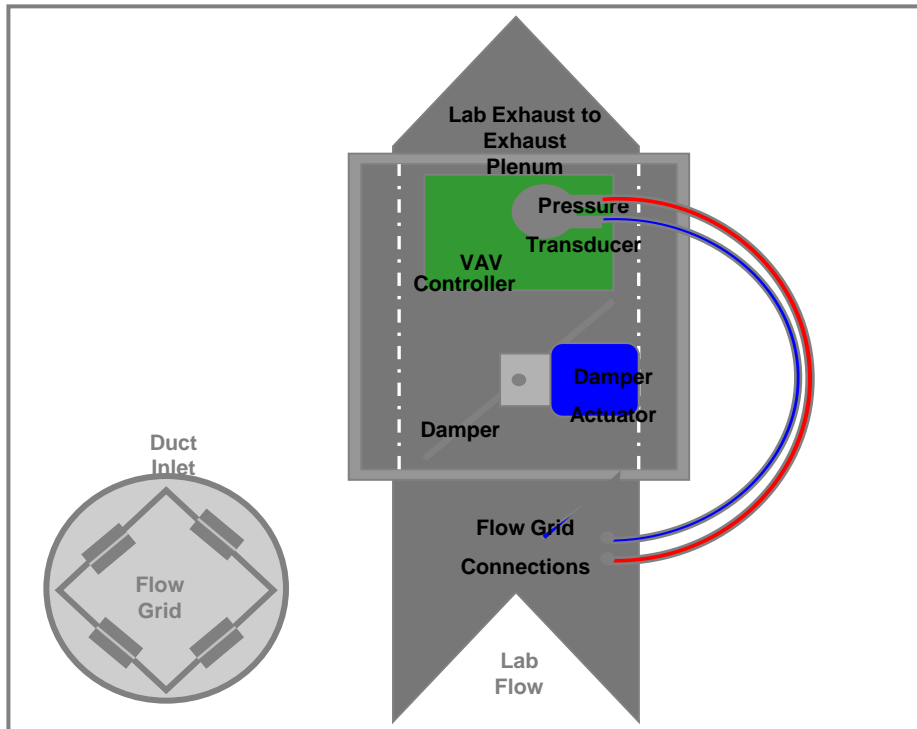
Caution: Exhaust Flow depends on the Hood, the System and the Application



VAV Flow Response and Stability



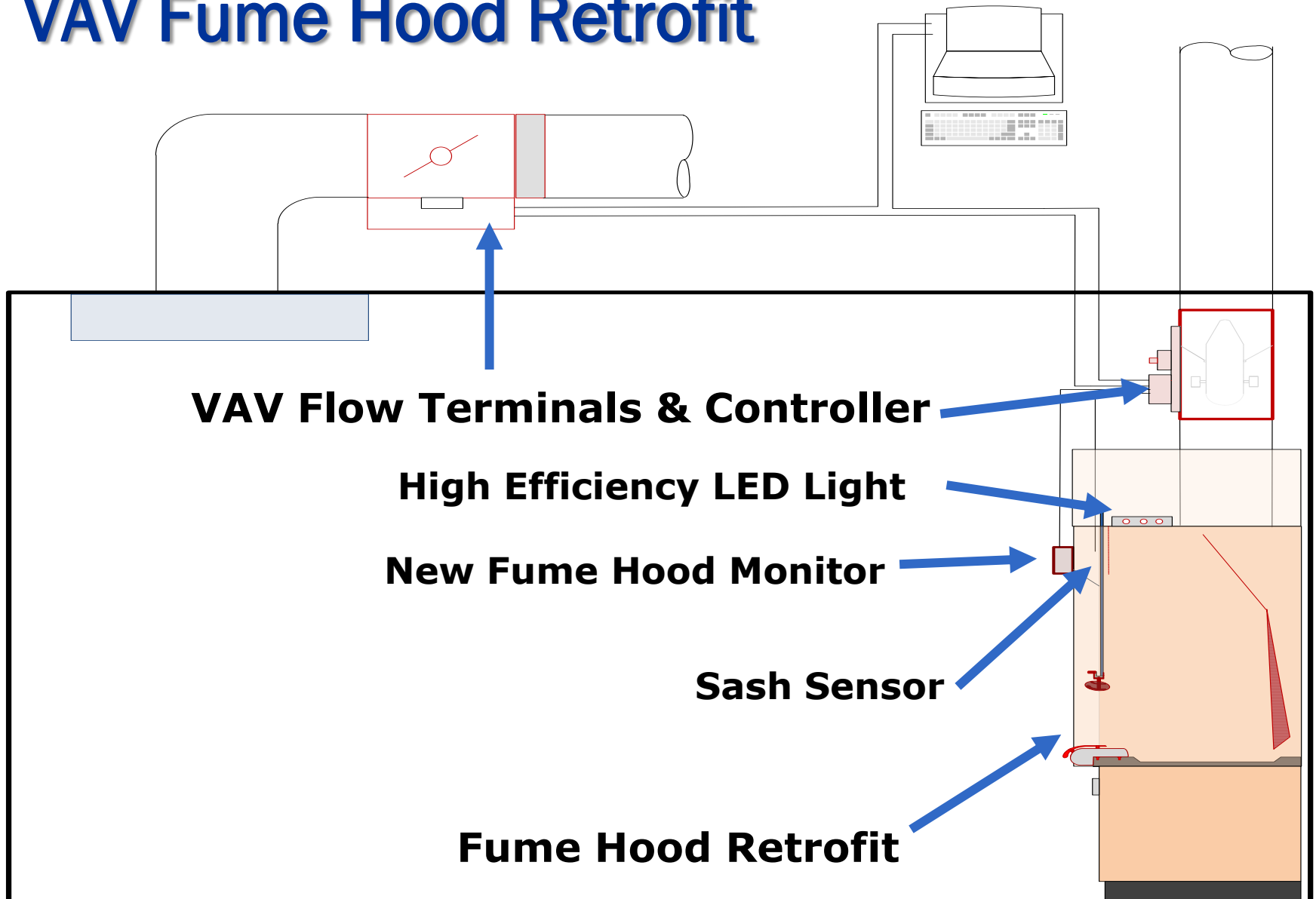
VAV Retrofit & Component Upgrades



Upgrade
Damper
Actuator

Upgrade
Pressure
Transducer

VAV Fume Hood Retrofit



Comparison of Fume Hood Retrofit, Replacement and VAV Conversion

Fume Hood Retrofit	Flow Before Retrofit cfm	Flow After Retrofit cfm	Flow Reduction cfm	\$ Savings	% Savings	Estimated Cost \$	Payback yrs
	1000	600	400	\$2000	40%	\$6,000	3.0

Replace with High Performance Fume Hood	Flow Before Retrofit cfm	Flow After Retrofit cfm	Flow Reduction cfm	\$ Savings	% Savings	Estimated Cost \$	Payback yrs
	1000	600	400	\$2000	40%	\$16,000	8.0

Fume Hood CAV to VAV Conversion	Sash Open	Sash Closed - cfm	Flow Reduction cfm	\$ Savings	% Savings	Estimated Cost \$	Payback yrs
	1000	250	563	\$2813	56%	\$25,000	8.9

Fume Hood Retrofit + VAV Conversion	Sash Open - cfm	Sash Closed - cfm	Reduction cfm	\$ Savings	% Savings	Estimated Cost \$	Payback Yrs
	600	200	663	\$3313	66%	\$29,000	8.3

- Sash Open – 25%
- Sash Closed – 75%
- \$5 per cfm-yr
- VAV Upgrade Includes Exhaust and Supply Components
- Fume Hood Replacement includes major disruption and downtime.



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Questions?