Welcome to the Webinar!

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- We can read your comments under the “chat tab” (conversation)
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- We will take questions during the Q&A session

Low Flow (High Performance) Fume Hood Study

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UNIVERSITY of CALIFORNIA · IRVINE

University of California, Irvine

Large research university

$16M annual utilities budget

Lab buildings consume 2/3 of campus energy

Many energy initiatives to reduce carbon footprint

Campus Energy $avings Challenge
Recipe for Success
Team Synergy

Safety Management

Engineers

Supportive Users/ Researchers

Visionary & Supportive Upper Management

Patience

Facility Managers

This Initiative

Do Low Flow (High Performance) Fume Hoods Provide Equivalent Protection to Traditional Fume Hoods in “Real World” Conditions?

Low Flow Fume Hoods & Energy $avings Challenge

Balance energy savings & safety

Maximize Energy Savings

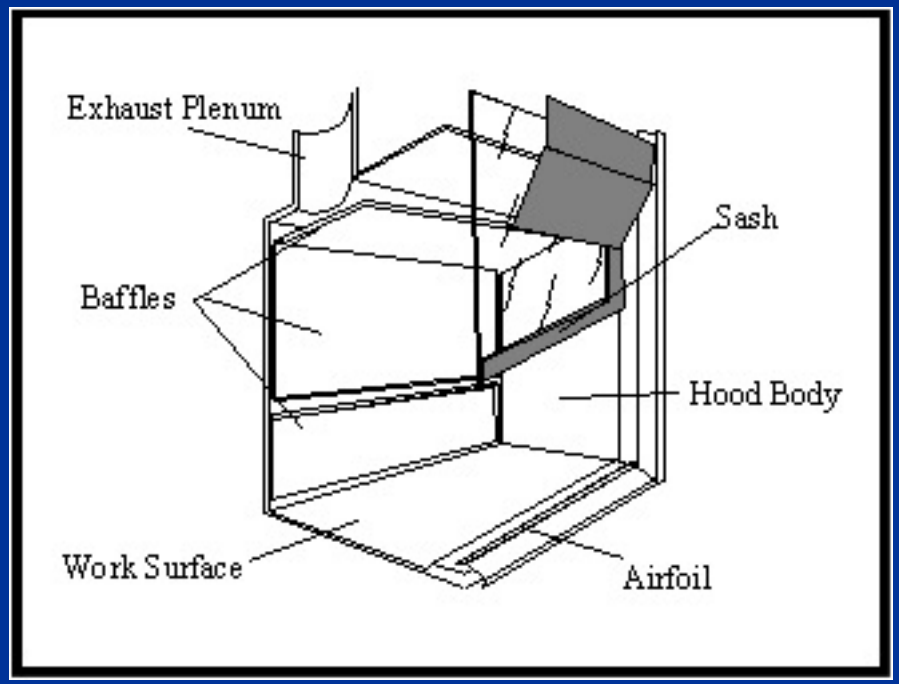
Without Compromising Safety

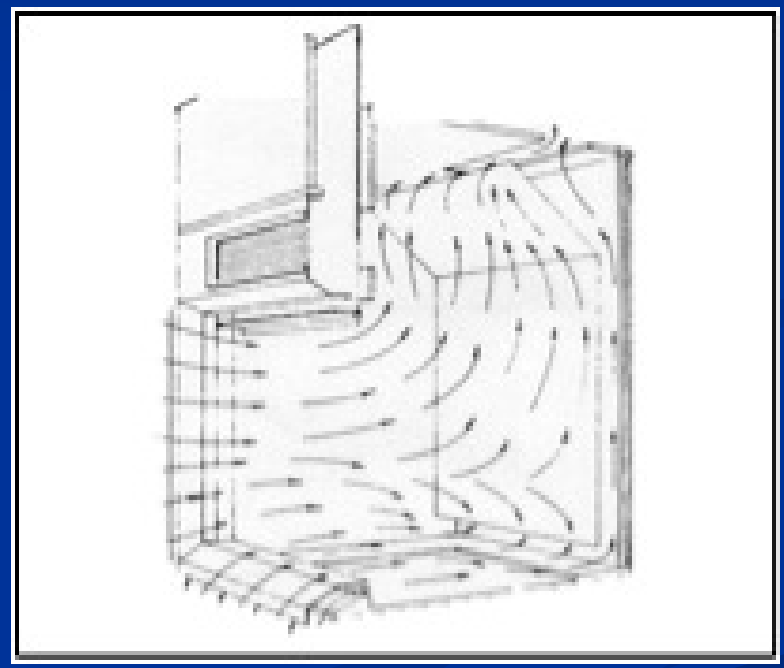
Agenda

- Hood Design
- Regulations & Variances
- Partnering with Cal-OSHA
- Study Objectives & Methodology
- Results & Conclusions
- Cost and Energy Savings
- Next Steps & Lessons Learned

Traditional Hood Design

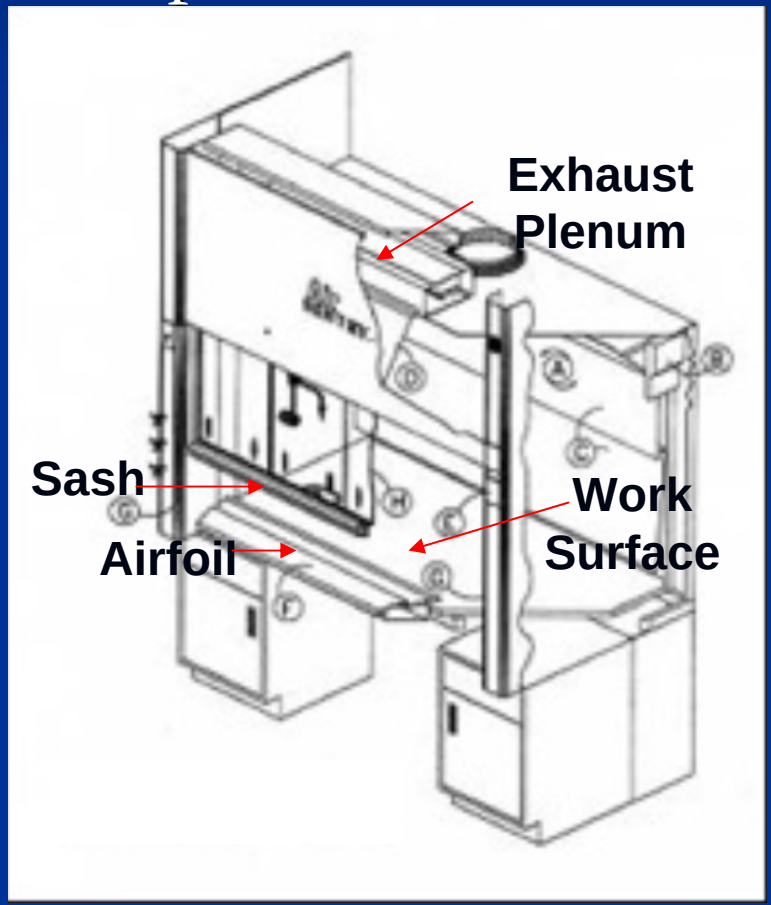
- Components & Air Flow

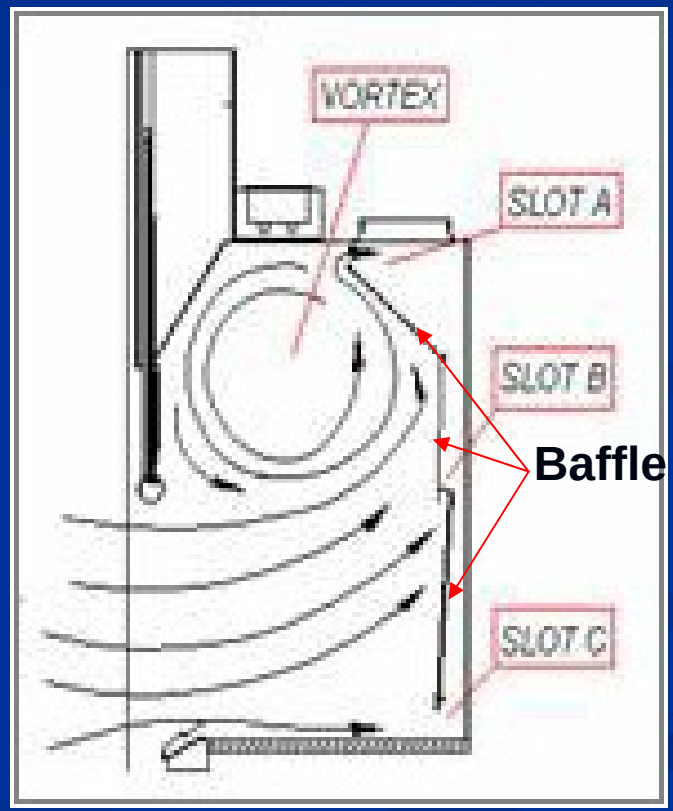




Low Flow Fume Hood Design

- Components & Air Flow





Increased Hood Depth

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Fume Hood Regulations

- Federal OSHA Standard
  - Face velocity not specified
  - 13 Carcinogens exception
- Cal-OSHA Standard
  - 100 fpm face velocity
- Low flow fume hoods allowed in 49 states

Cal-OSHA Variances

- Genentech, Inc. – December, 2001
  - 80 fpm face velocity
  - Containment tests
    - ASHRAE 110
    - Prior to initial use, repeat annually
    - 0.05 ppm acceptance concentration of tracer gas (“as manufactured”)
  - Test Record retention 5 yrs -tracer gas tests, face velocity measurements, alarm condition and actions to correct

Cal-OSHA Variances

- San Diego State University – May, 2006
- National Food Laboratory, Dublin, CA – May, 2006
  - 80 fpm face velocity (40 fpm max. cross draft)
  - Containment tests
    - ASHRAE 11O, Human-as-Mannequin (HAM)
    - Prior to initial use; annually for 1st 3 years, triennially thereafter
    - 0.05 ppm acceptance concentration of tracer gas (“as manufactured”) initial, then 0.1 ppm (“as used”)

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Partnering with Cal-OSHA

- Met to establish relations & partnership
- Discussions re: test methodology & variance process
- Observation of testing by Cal-OSHA
- Discussions re: experimental & permanent variance requests

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Study Objectives

1. Can low flow fume hoods operating at less than 100 fpm provide equal or better protection than a traditional fume hood operating at 100 fpm?

2. What is the minimum velocity and operating conditions where satisfactory performance can be confidently provided?

Study Objectives

3. What factors affect performance?
   - average face velocity
   - turbulence of face velocity
   - cross draft velocity
   - pedestrian walk-bys
4. Compare HAM tests to ASHRAE 110 static mannequin tests

Baseline Room Conditions

- Room pressure – monitored & maintained
- Test and balance of lab
- ASHRAE 110 containment tests
- Measured existing cross drafts
- Tested hoods in same position in one room with same HVAC system/ ductwork
  - To minimize outside variables

Test Protocol – "Real World"

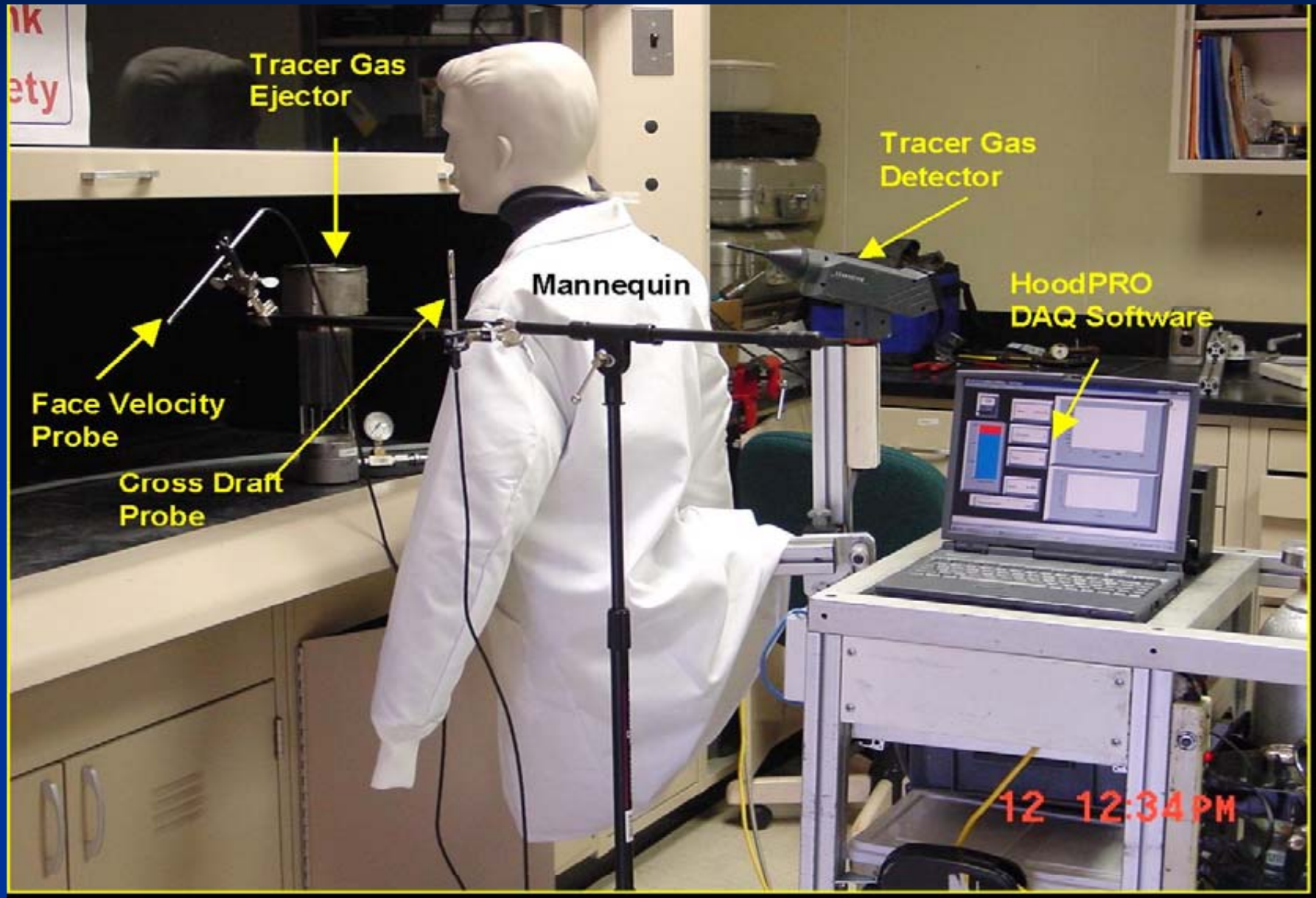
- Three average face velocities
  - 60, 80 & 100 fpm
- Two vertical sash configurations
  - 100% full open and 18 inches open
- Obstructions in the hoods to simulate presence of lab apparatus
- Pedestrian walk-bys
- Cross draft of 50 fpm at 45°

Obstructions in Hood

Test Procedures

- Measurement of face velocity
- Measurement of cross draft velocities
- Visualization of airflow patterns
- Measurement of tracer gas containment
  - Static ASHRAE 110 Mannequin
  - Human as Mannequin (HAM)

ASHRAE 110 – Static Mannequin



HUMAN AS MANNEQUIN – HOOD LOADED

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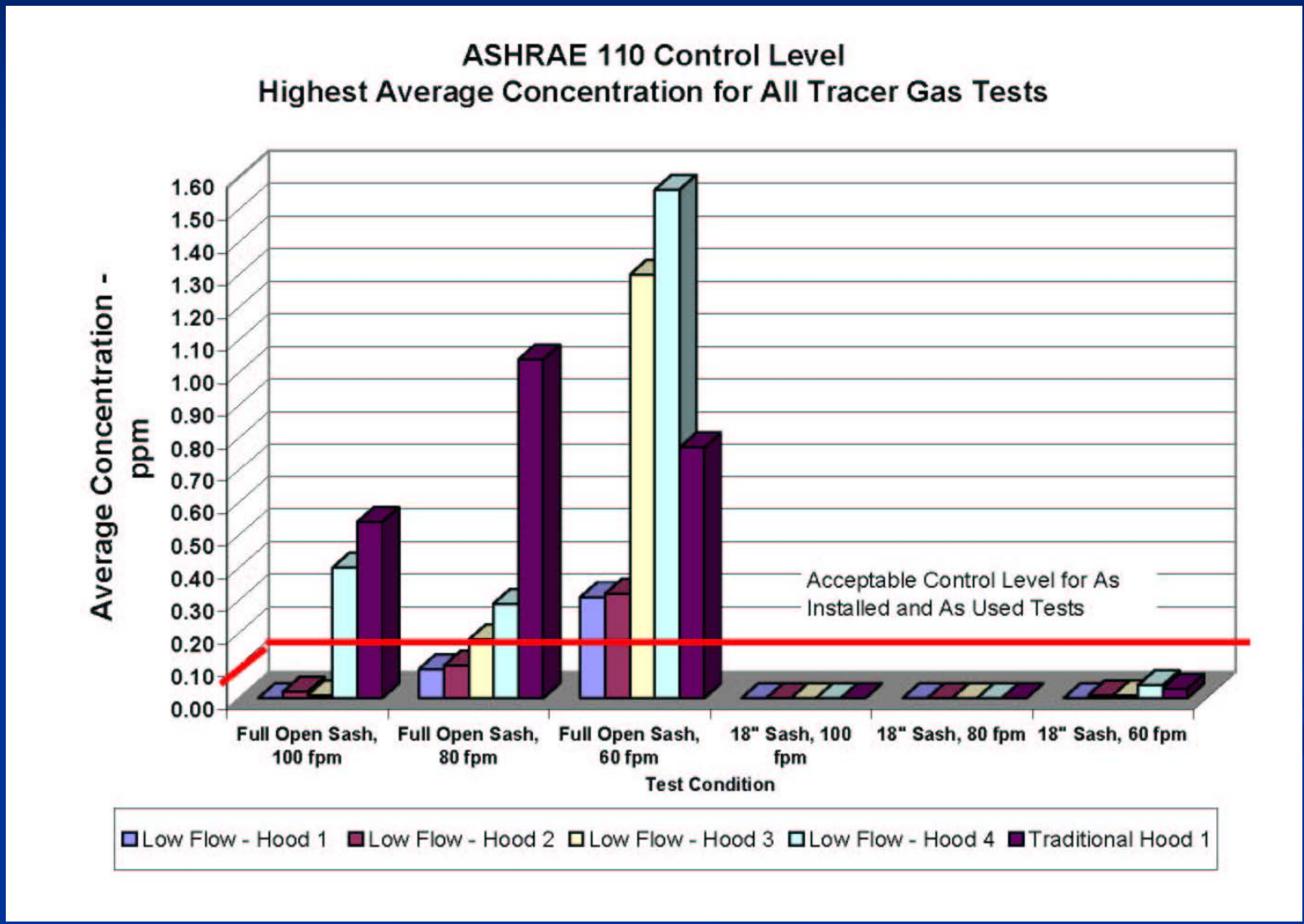
Number of Tests with Average Tracer Gas Concentrations ≥ 0.1 ppm

Hood	Full Open 100 fpm	Full Open 80 fpm	Full Open 60 fpm	18" Open 100 fpm	18" Open 80 fpm	18" Open 60 fpm	Total Tests Avg Conc. ≥ 0.1 ppm
Low Flow - Hood 1	0	0	1	0	0	0	1
Low Flow - Hood 2	0	1	2		0	0	3
Low Flow - Hood 3	0	2	5	0	0	0	7
Low Flow - Hood 4	1	0	4	0	0	0	5
Traditional - Hood 1	2	2	3	0	0	0	7
Total Tests Avg Conc. ≥ 0.1 ppm	3	5	15	0	0	0	23
Percent of Total Tests	0.7 %	1.2 %	3.6 %	0.0 %	0.0 %	0.0 %	5.5 %

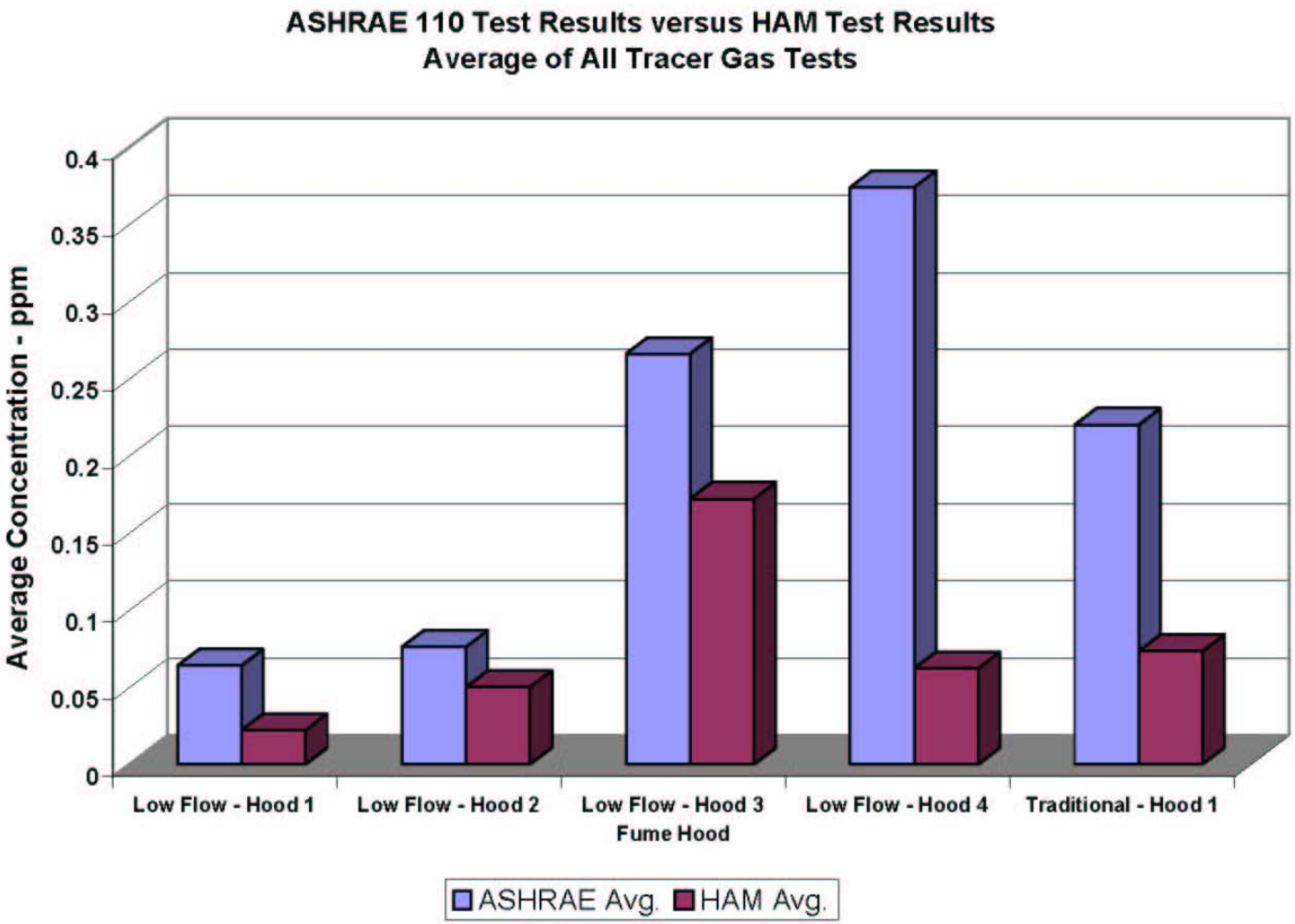
Highest Average Concentration for Tracer Gas Tests:

Maximum 5-minute average tracer gas concentrations per condition



ASHRAE 110 Tests vs HAM Tests:

5-minute average tracer gas concentrations
at full open & 18” sash openings combined



ASHRAE 110 Tests vs HAM Tests

		Test Challenge Condition			
		Baseline Tests	**Walk-by Tests**	**Cross Draft Tests**	**Total**
ASHRAE 110	Tests ≥ 0.1 ppm	**2**	**1**	**8**	**11**
	Highest Average Conc. ppm	**0.28**	**0.13**	**1.56**	
HAM	Tests ≥ 0.1 ppm	**0**	**2**	**10**	**12**
	Highest Average Conc. ppm	**0**	**0.16**	**0.55**	

Study Conclusions
Face Velocity & Sash Height

- All hoods - performed best at 18” sash height
  - All tracer gas results were well under 0.1ppm “as used” ASHRAE criteria
  - At 100, 80, and 60 fpm
- All low flow hoods performed better than standard hood at 80 & 100 fpm full open sash

Study Conclusions
Factors Affecting Performance

- Continuous cross draft (50 fpm) most impactful at 45 ° to hood
- Walk-by drafts were less impactful
- Hood placement critical to avoid cross drafts
- ASHRAE 110 test more challenging than HAM

Study Conclusions Minimum Recommended Face Velocities

Low flow hood sash - 18” open

- LFH-1 60 fpm
- LFH-2 60 fpm
- LFH-3 60 fpm*
- LFH-4 60 fpm

*With attention & control of room air cross drafts

Study Conclusions Minimum Recommended Face Velocities

Low flow hood sash - full open*

- LFH-1 80 fpm
- LFH-2 80 fpm
- LFH-3 100 fpm
- LFH-4 100 fpm

* Fully open sash not recommended

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Fume Hood Energy Savings

Low Flow Fume Hoods Can Provide Significant Energy Savings

Flow & Cost Assumptions

- Air flow through the hood drives the flow in the room.
- 72” fume hood opening, 24” depth
  - Constant Air Volume assumed 18” working height (9 square feet of opening)
  - Minimum flow is 25 CFM per square foot of work surface (300 CFM)
- Sash management
  - Good Sash Mgmt - 40/60 split of Perfect & Bad
  - Poor Sash Mgmt -10/90 split of Perfect & Bad
- One CFM costs $5 per year

Flow & Cost Comparison

HVAC System Type and Fume Hood Equipment	Flow at 100 fpm nominal face velocity Annual Cost at $5 per CFM	Flow at 80 fpm nominal face velocity Annual Cost at $5 per CFM	Flow at 70 fpm nominal face velocity Annual Cost at $5 per CFM
Constant Air Volume	900 CFM $4500	720 CFM $3600	630 CFM $3150
Variable Air Volume (VAV)	Good: 682 CFM/$3410 Poor: 851 CFM/$4255	Good: 568 CFM/$2840 Poor: 686 CFM/$3430	Good: 511 CFM/$2555 Poor: 604 CFM/$3020
VAV with ZPS	Good: 492 CFM/$2460 Poor: 558 CFM/$2790	Good: 470 CFM/$2350 Poor: 539 CFM/$2695	Good: 462 CFM/$2310 Poor: 530 CFM/$2650
VAV with ASC	361 CFM $1,805	343 CFM $1,715	335 CFM $1,675
VAV with Perfect Sash Management	343 CFM $1,715	331 CFM $1,655	325 CFM $1,625

Energy Summary

- Low flow hoods save significant energy, particularly in constant volume systems
- Good sash management (with VAV) is the most effective method of reducing flow, regardless of hood type
- Low flow hoods may be a good solution in buildings with limited HVAC capacity

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Next Steps

- Experimental variance request
  - Exposure monitoring to verify hood containment (2 labs in 2 buildings)
- Permanent variance request
  - Will request for several UCI buildings
- Ideally, allow use UC-wide – a stretch
- Support regulatory change for use in CA
- Looking for funding – send money!

Permanent Variance
Plan to Request

- Low flow hoods at 70 fpm & 18” sash
  - Manufacturer recommends 60 fpm
  - Study results – hoods contained well at 60 & 80 fpm
  - Allows safety factor for HVAC variation
  - Contingent on exposure monitoring results

Question

Do Low Flow (High Efficiency) Fume Hoods Provide Equivalent Protection to Traditional Fume Hoods in "Real World" Conditions?

Answer

Yes.

- Identify the best application and intended use
- Proper hood placement to avoid cross-drafts
- Commission hood with ASHRAE 110 test
- A tool in energy saving tool box

Webinar Q&A

- Use chat box to send questions to “all participants”, preface your question with “Question to Panel”
- If you cannot write in your question, “raise hand” and we will un-mute you to talk
- If you want to view the panel:
  - At top right corner – click on panel, then click on video

Thank You!

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