

Welcome to the Webinar!

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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



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 Savings Challenge

Balance energy savings & safety

**Maximize
Energy
Savings**



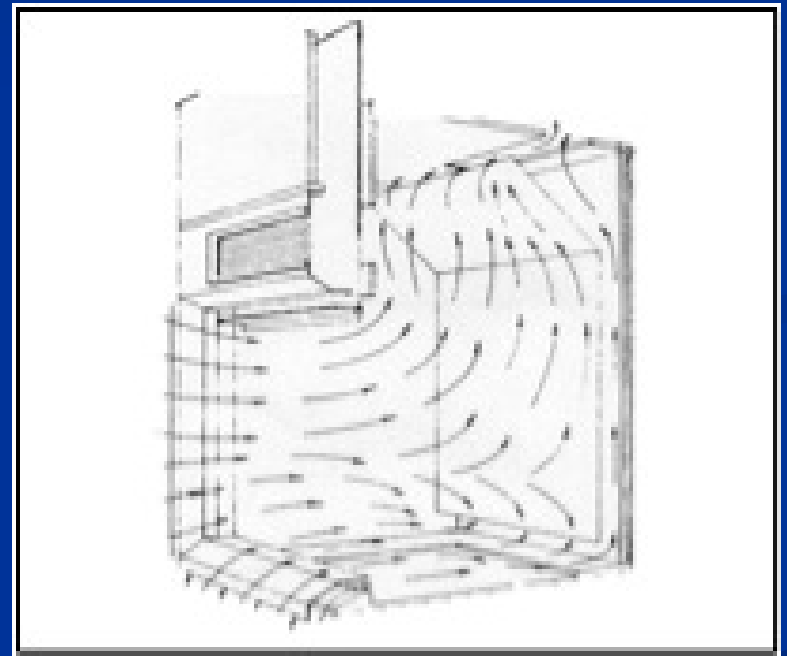
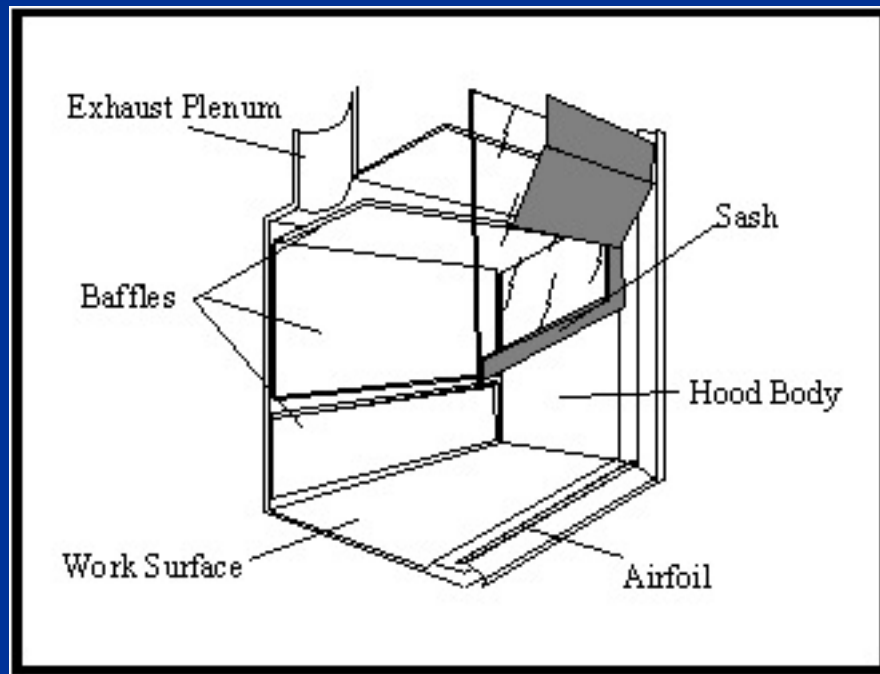
**Without
Compromising
Safety**

Agenda

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

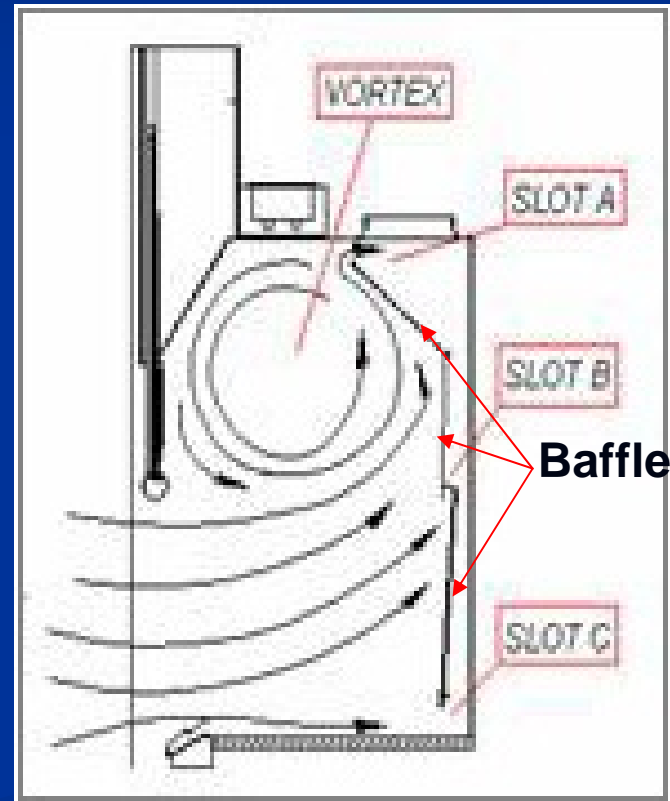
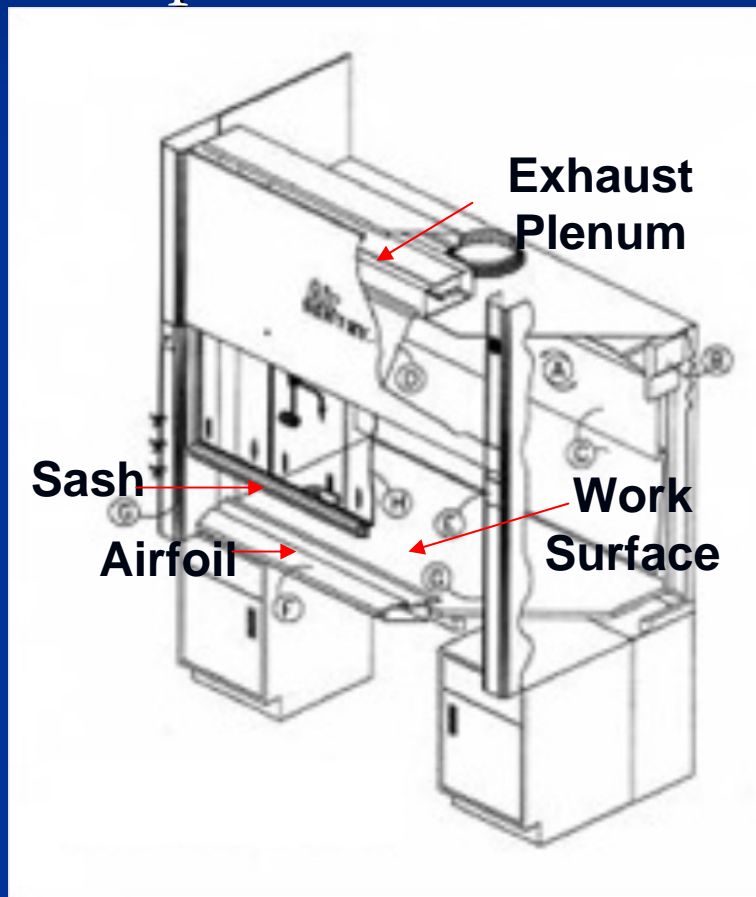
Traditional Hood Design

■ 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 110, 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°

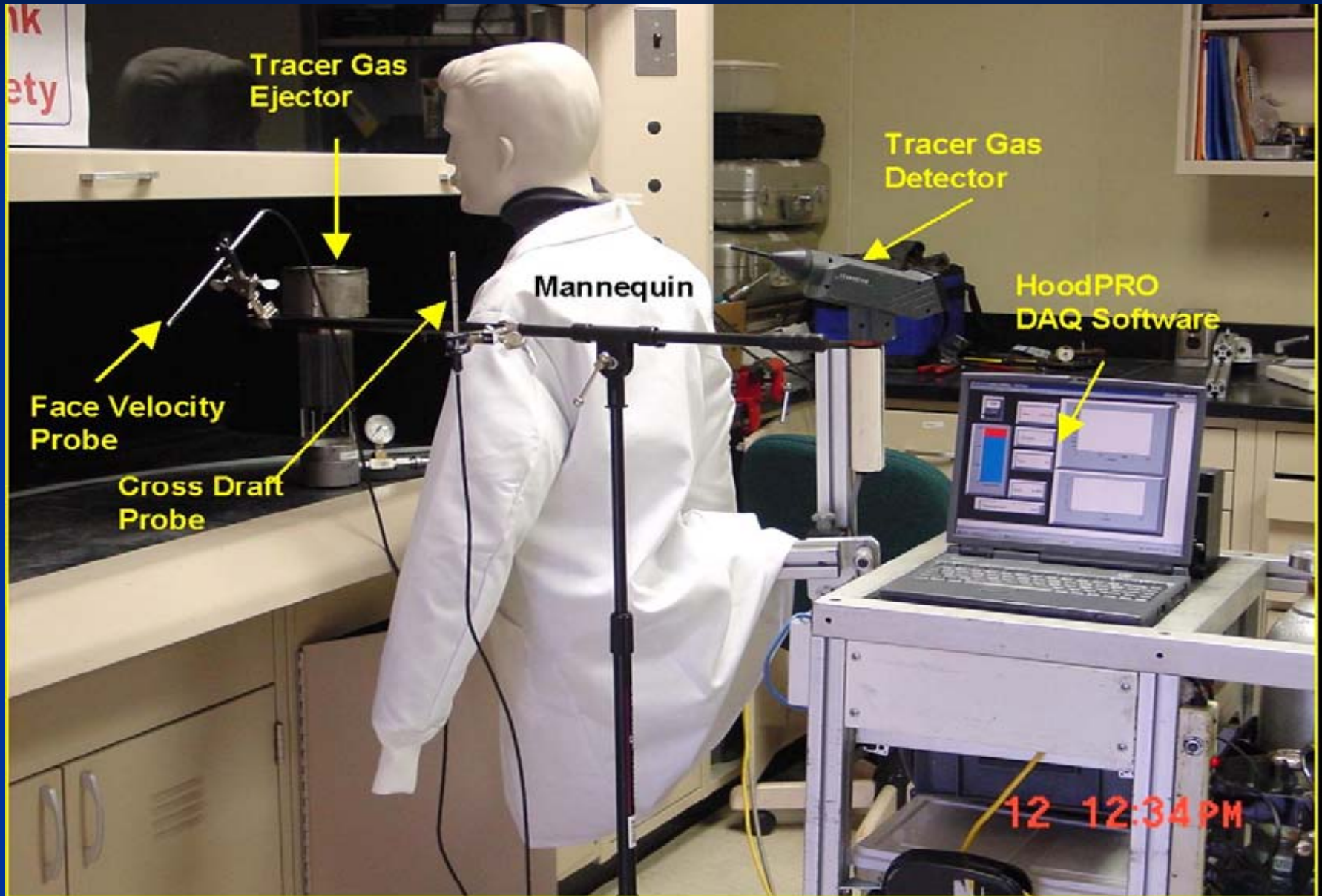
Obstructions in Hood



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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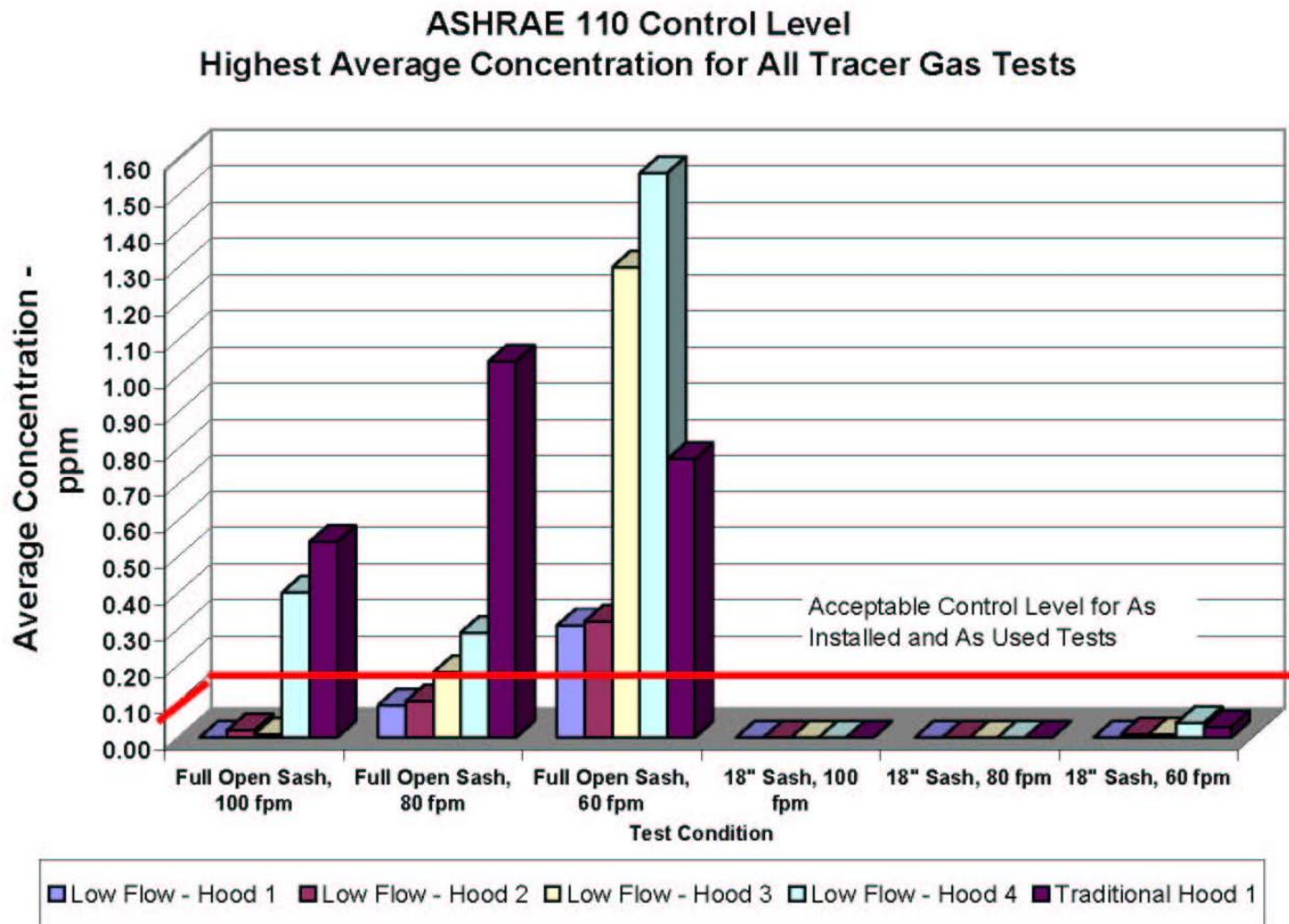
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Number of Tests with Average Tracer Gas Concentrations ≥ 0.1 ppm

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	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%

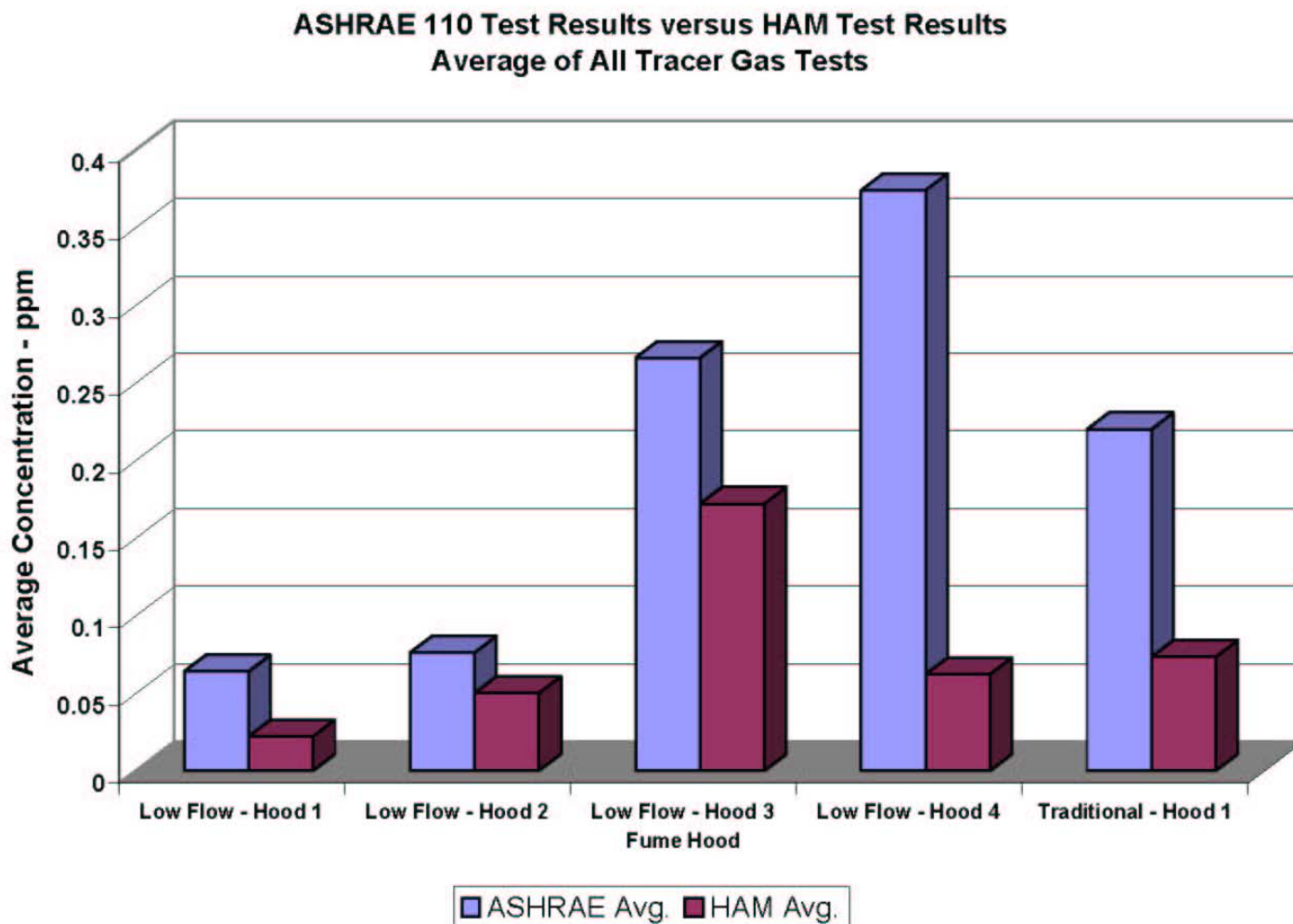
Highest Average Concentration for Tracer Gas Tests:

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 \geq 0.1 ppm	2	1	8	11
	Highest Average Conc. ppm	0.28	0.13	1.56	
HAM	Tests \geq 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”
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Thank You!



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