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Emerging Laboratory Efficiency Technologies and Techniques: LBNL Demonstration Experiences

Emerging Laboratory Efficiency Technologies and Techniques: LBNL Demonstration Experiences

- Track Title: Specialty Buildings
- Session Title:
  Technologies and Strategies for Energy and Water Reduction in Laboratories
- Session Number:
  SESSION 4
- Date and Time:
  August 17, 2010 8:30 AM – 10:00AM

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Emerging Laboratory Efficiency Technologies and Techniques: LBNL Demonstration Experiences

Introduction

- Fix what's broken:
  Aerosol Ductwork Sealing*
- Verify air balance:
  Lab HVAC Test & Tune-up*
- Investigate new technology:
  Centralized Demand Controlled Ventilation (CDCV)*

* See Labs21 Technical Bulletin for more information.

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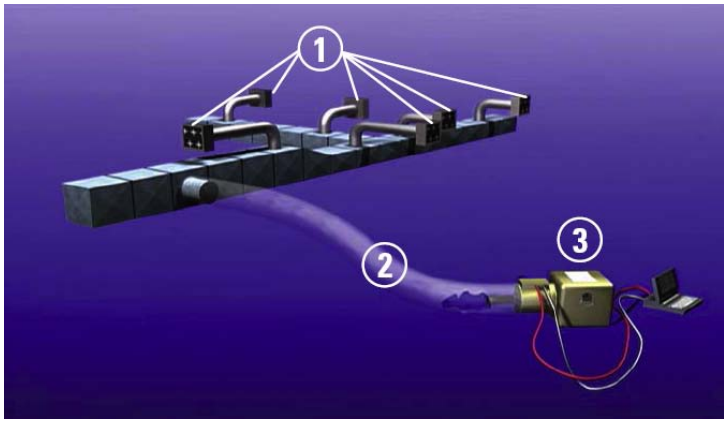
Fix what's broken:

Aerosol ductwork sealing

Benefits and features…



- Seals holes up to 3/8" across
- Vinyl polymer is safe
- No lingering odors or off-gassing
- Does not coat ductwork
- Cleaning ductwork not required before sealing
- Cleaning after sealing generally does not hurt seals
- Sealant remains rubbery
- Lasts >10 years

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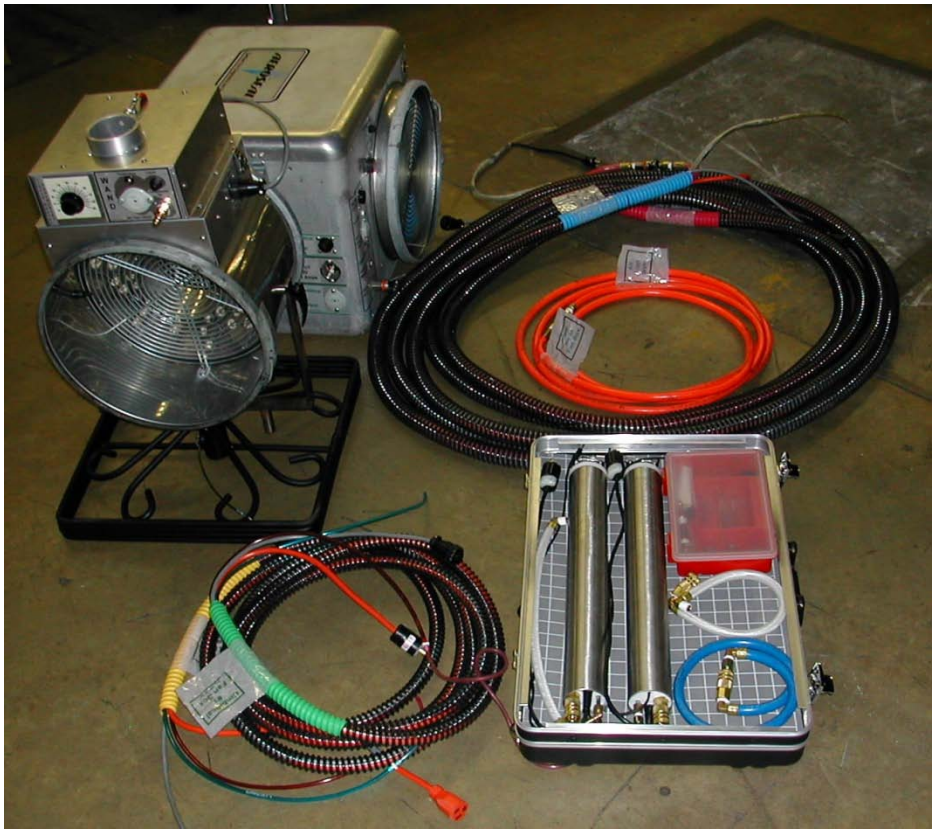
Aerosol Sealing System



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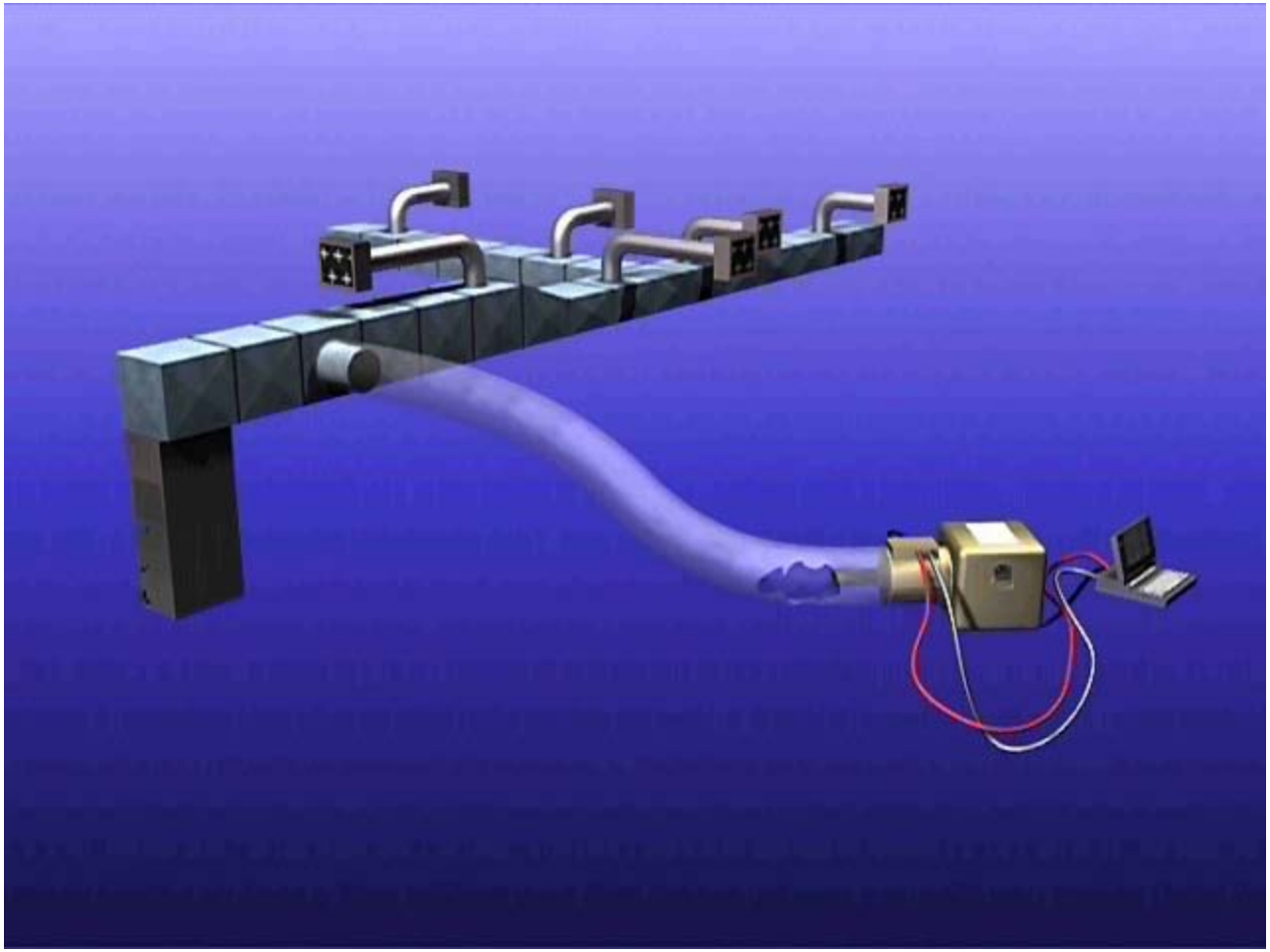
Aerosol Sealing Setup…

Direct injection on above-ceiling trunk duct. Red tube directs compressed air from control box to the wand thru an air dryer, while the "umbilical cord" brings electrical power, sealant material, compressed air, and control/measurement signals from the fan box to the control box.

Aerosol wand in operation…

Sealant spray pattern from injection wand

Aerosol sealing apparatus in action…



Aerosol Sealing Results

Buildup of polymer sealant

Aerosol Sealing Challenge at B70

Supply and exhaust registers located well above floor

Extensive leakage noted…

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Aerosol Sealing Challenge at B70…

Various methods used for blocking supply registers…

Aerosol Sealing Results

Certificate of Completion

Duct Sealing Performed for:
Bldg SEVENTY General Exhaust
LBNL
Berkeley,CA 94720
(111)111-1111

Overall Sealing Results

When we arrived,
YOUR DUCTS HAD:

2278 CFM of Leakage, equivalent to a
432 Square Inch Hole

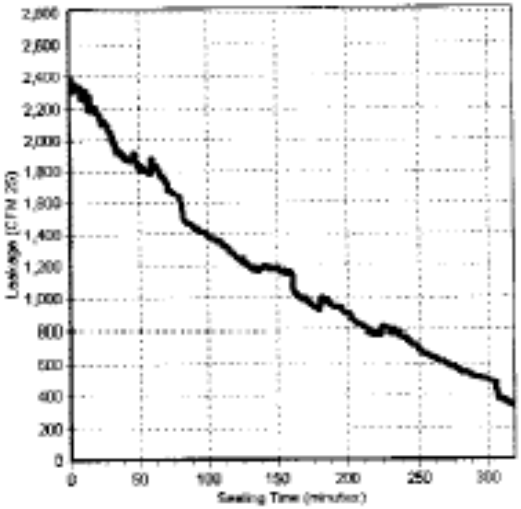
After we finished,
YOUR DUCTS HAVE:

335 CFM of Leakage, equivalent to a
64 Square Inch Hole

This corresponds to a **85% Reduction** in Duct Leakage

Note: Duct leakage results are calculated in cubic feet per minute (CFM) measured at a standard reference pressure of 25 pa (0.10 in. water).

Aerosol Sealing Profile



Your Heating and Cooling Capacity Improvement for Duct Sealing is
22%
based upon measured leakage reduction and original register flow

AEROSEAL.
Certified Duct Diagnostics & Sealing

Aeroseal Technician: Mark Modera
Aeroseal Equipment Serial #: 990
Friday, December 23, 2005

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Aerosol Sealing Results…

Section (Bldg 70)	Date	Pre-seal	2-min	Final	Post-Seal	Inj Time	%
		cfm25	cfm25	cfm25	cfm25	minutes	sealed
3rd Floor Annex Return	**11/6/2005**	30.7		15.6	14.5	27	53%
3rd Floor Annex Supply	**11/6/2005**	721	722	835	804	37	-12%
2nd Floor Annex Supply	**11/16/2005**	403	543	31	30.6	35	92%
1st Floor Corridor	**11/20/2005**	2373		134	135	171	94%
2nd Floor Corridor	**11/30/2005**	2805		717	919	240	67%
1st Floor Cold	**12/3/2005**	3087	1777.2	796	851	189	72%
2nd Floor Cold	**12/4/2005**	2007	1361.7	262	309	137	85%
1st Floor hot	**12/10/2005**	1040			273	138	74%
2nd Floor Hot	**12/11/2005**	1318			346	119	74%
Exhaust	**12/23/2005**	2277			335	319	85%
Total		15310			3198	1349	79%
Assuming avg leak press of 0.5" H2O		40212			8400		
%Leak at avg leak press of 0.5" H2O		35%			7%		
To keep the same total flow into zones, should be able to reduce fan flow to							80681
%reduction in fan flow							30%
%reduction in fan power							65%

>12% electrical savings in first month!

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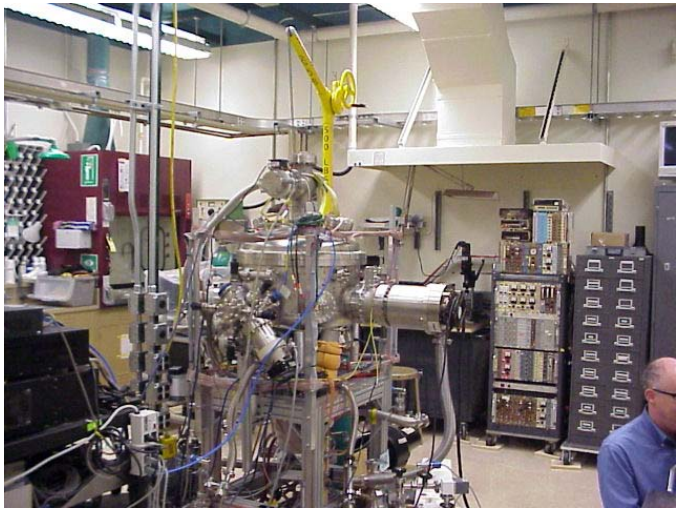
Verify air balance:
Laboratory HVAC Test & Tune-up

1. Review and reestablish basic design criteria
2. Engage EH&S support
3. Prepare Lab Test and Tune
4. Walk site
5. Determine air change rate (ACH)
6. Test fume hoods
7. Tune fume hoods
8. Results
9. Next steps



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1. Review and reestablish basic design criteria…

Ensure current design criteria promote both mission safety and energy efficiency

LBNL design criteria:

- Laboratory air change rate: 1 CFM/sq ft of floor area
- Fume hood face velocity set-point: 100 FPM average
- Laboratory differential pressure: -0.02” w.g.

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2. Engage EH&S support

Provides conduit to knowledge and authority…

- ✓ Discuss key areas of interest and concern
- ✓ Explain operational requirements
- ✓ Learn about known problems and deficiencies
- ✓ Identify obvious energy waste indicators with EH&S staff

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3. Prepare Lab Test and Tune…

Examine the "usual suspects…"

- ✓Review drawing archive
- ✓Study EMCS history
- ✓Compared meter data & trends

Inform researchers for safety and "buy in"…

- ➢Schedule time and stick to it!
- ➢Practice routine, refine, and adapt as necessary
- ➢Provide feedback of results

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4. Walking the site …

- What do you expect to see?
- What looks wrong or is missing?
- What are your *assumptions*?
- What *combination* of effects would add up to this result?
- What are the possible causes?
- What are the energy and operational impacts?

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5. Determine air change rate…

Monitor lab differential pressure

- ✓ Record ΔP continuously during tune-up process and sash position changes

Resolve air flow rates

- ✓ Record three sets of airflow data: as-found condition; sashes fully open; sashes fully closed (or min.).
- ✓ Calculate room area and volume: use laser measuring/dimensioning device *without regard to furnishings.*
- ✓ Compute supply/exhaust offset volume (exhaust volume should exceed supply).

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5. Determine air change rate…

Calculate air change rate

- ✓ Use room total exhaust volume flow, i.e., combine fume hood and general exhaust airflow.
- ✓ Compute rate for both sashes fully open and sashes fully closed (or minimum position) per:
  - ➢ CFM per sq ft (lab area).
  - ➢ Air changes per hour (ACH) (Exhaust airflow volume per cubic foot lab-space volume per hour; (CFM x min/hr)/CF= #/hr) .
- ✓ Record findings.

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6. Test fume hoods

Catalog lab fume hood data

- ✓ Obtain fume hood data from EH&S.
- ✓ Note building and room number.
- ✓ Photograph as-found conditions.
- ✓ Record number, type, and size of hood.
- ✓ Sketch lab layout with locations of fume hood(s), supply register outlets, and general exhaust inlets.
- ✓ Compare with database provide by EH&S; note discrepancies.
- ✓ Record findings.

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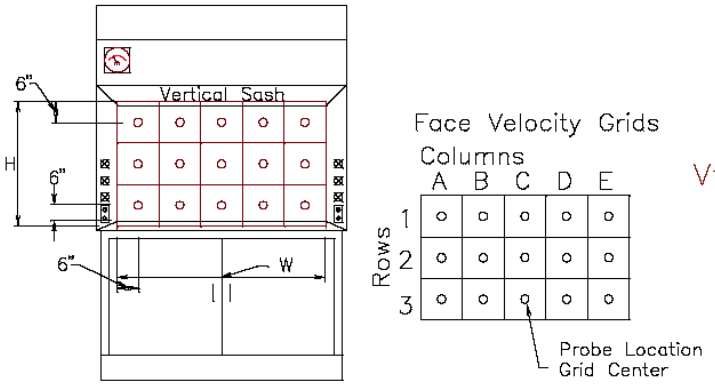
6. Test fume hoods…



Courtesy Exposure Control Technologies, Inc.

Face velocity measurements

Measure face velocity & record supply & general exhaust flow rates and lab ΔP at:

- ✓ **Fully open sash: with nine-point grid**
- ✓ **Sash open to 18 inches: with six-point grid.**
- ✓ **Sash open to 6 inches (or minimum): with three-point grid.**
- Vf ✓ **Record findings.**

7. Tune fume hoods

Face velocity adjustments

- ✓ Ensure lab ΔP is monitored during tune-up with local instrument.
- ✓ Position sash to 18 inches open.
- ✓ Adjust average face velocity to 100 FPM.
- ✓ Recheck and record general supply and exhaust airflow volume.

7. Tune fume hoods…

Install sash stop

- ✓ Position sash to 18 inches open, install sash stop.

Affix signage

Signage to include:

- "Operating Point"
  horizontal arrow at 18 inches, next to sash stop.
- "Close sash when leaving hood"
  vertical arrow point downwards.
- "Sash opening for set-up ONLY"
  vertical arrow pointing upwards.

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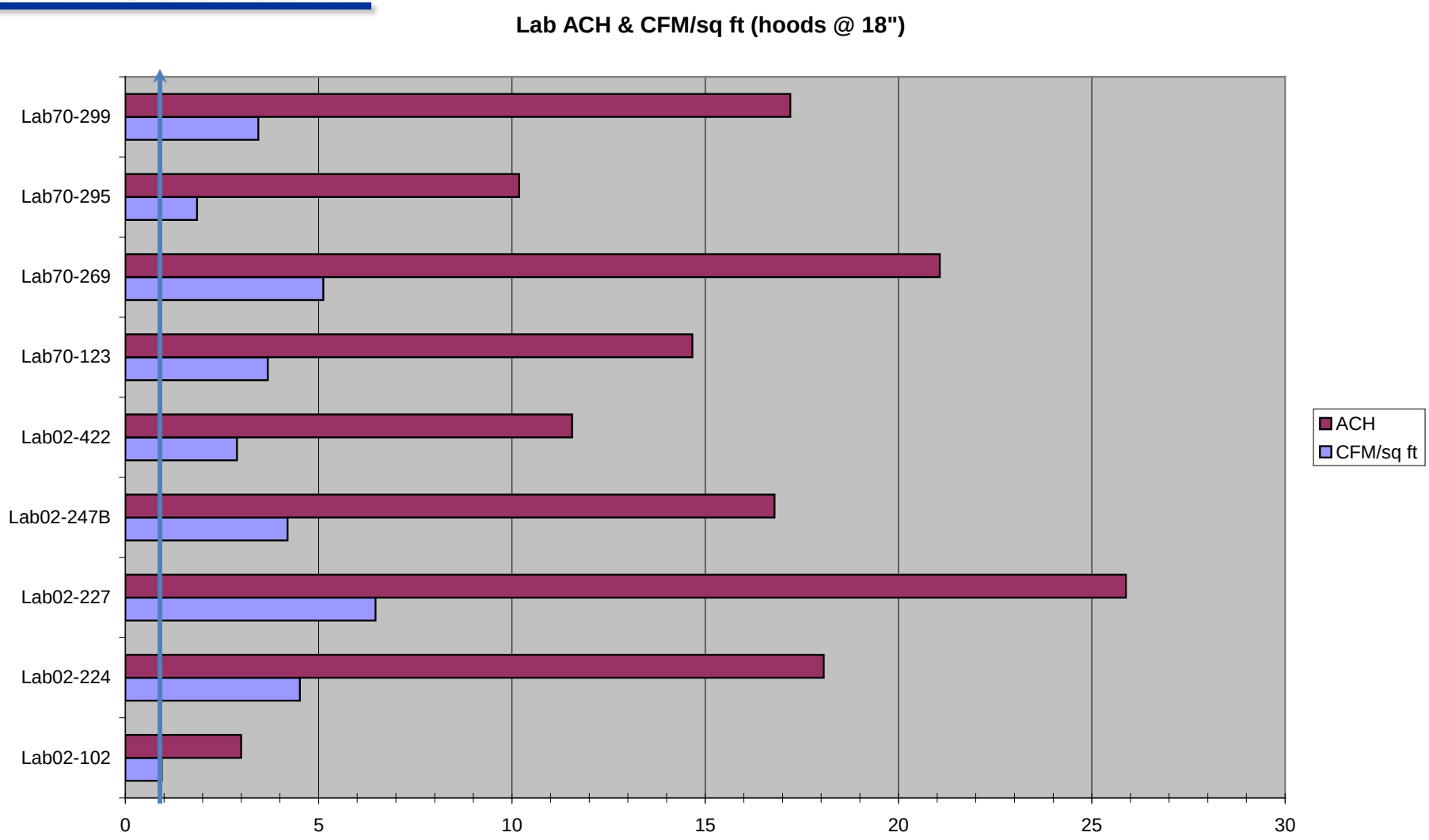
8. Results…



LBNL Standard: 1 CFM/sq ft

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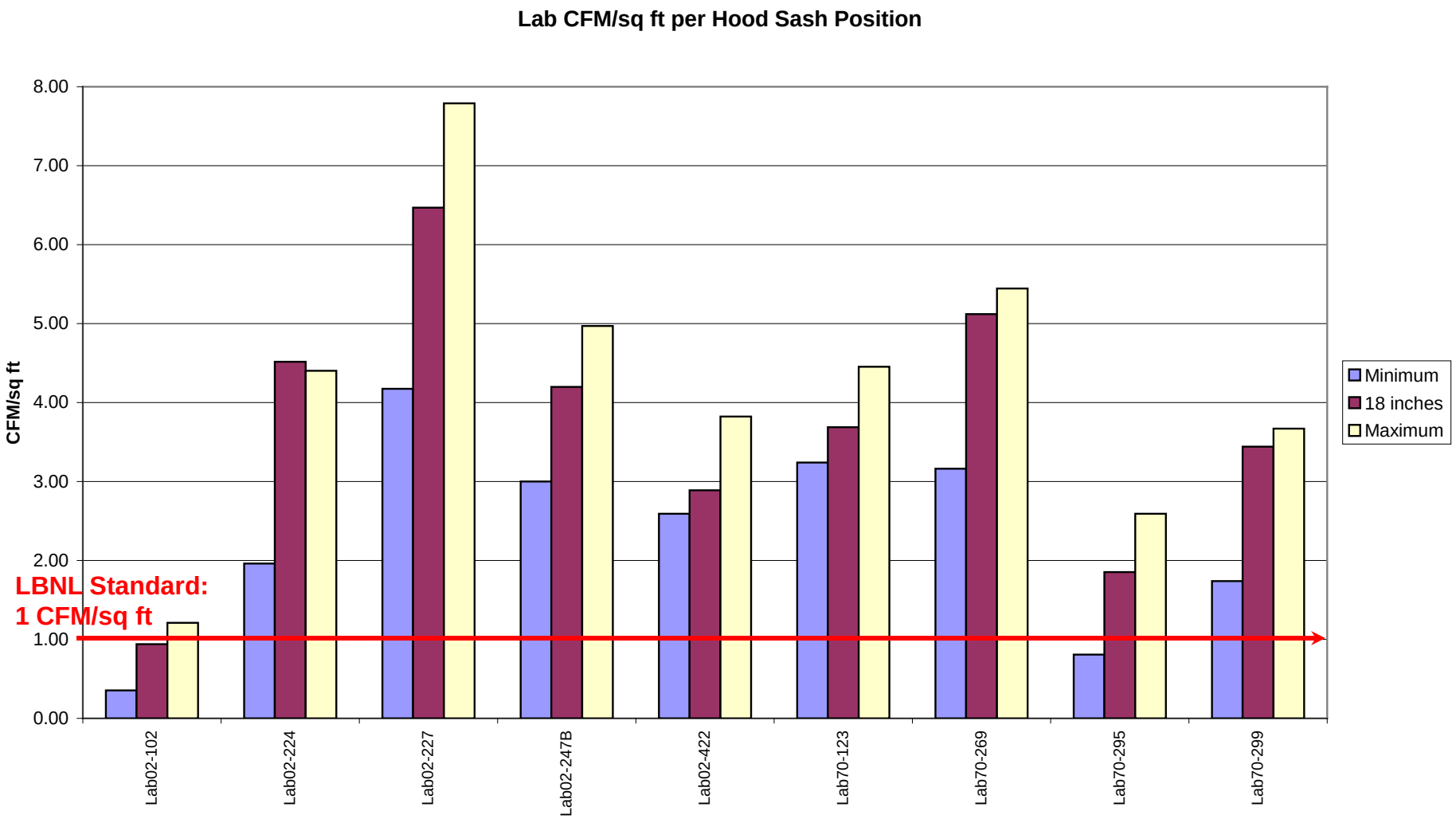
8. Results…



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8. Results…the Bottom Line

Case #1 Reduce fume hood face velocity

- ✓ Save 721 CFM x $4-$7 CFM/yr = $2,884 - $5,047/yr
- ✓ Payback: $600/ Lab Test & Tune-up = 2.5 to 1.5 months

Case #2 Reduce general exhaust volume

- ✓ Save 594 CFM x $4-$7 CFM/yr = $2,376 - $4,158/yr
- ✓ Payback: $600/ Lab Test & Tune-up = 3 to 1.7 months

Case #3 Reduce both…

- ✓ Save 974 CFM x $4-$7 CFM/yr = $3,896 - $6,818/yr
- ✓ Payback: $600/ Lab Test & Tune-up = 1.8 to 1 month(s)

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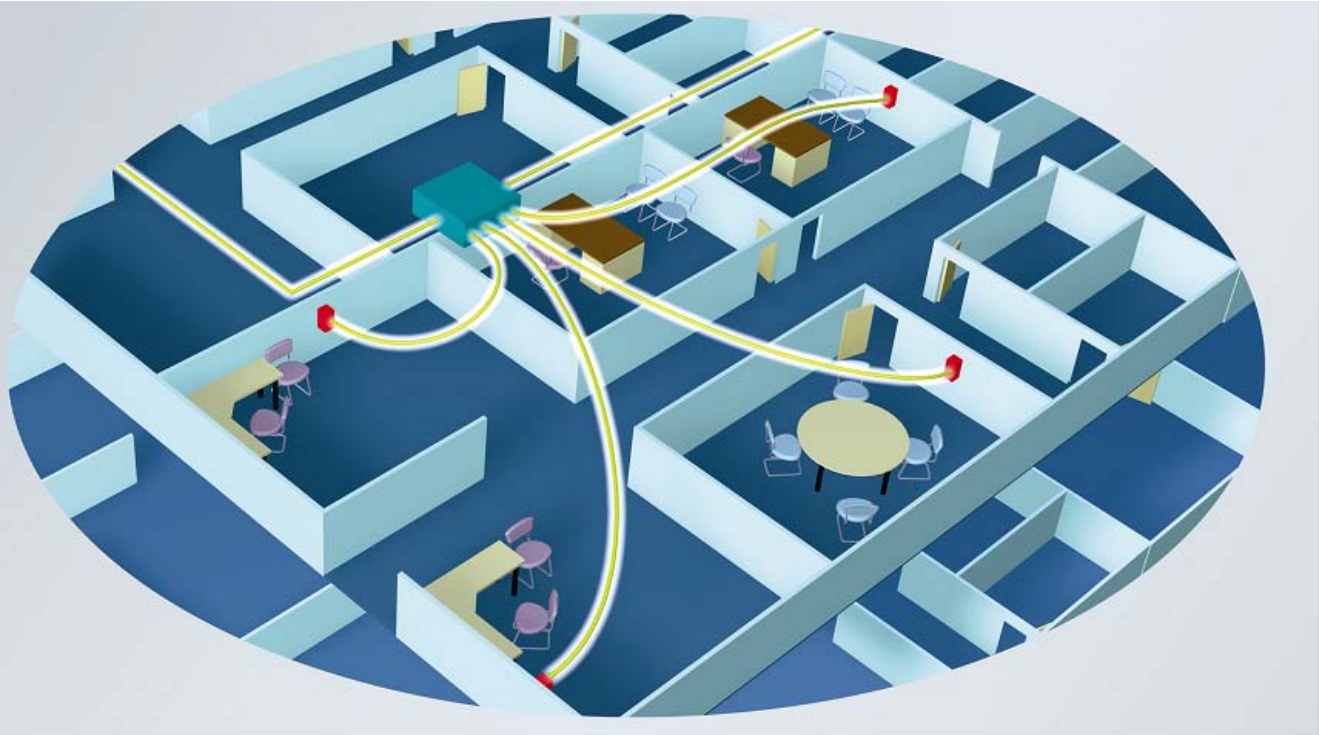
Investigate new technology:

Centralized Demand Control Ventilation (CDCV)



CDCV Overview:

Optimizing lab air change rate at UC Irvine…

- Often set at a "constant rate" 24/7.
- Recommended range 4 to 12 air changes per hour.
- Usually excessive during low-level process activity or non-occupancy.
- Explore possibility of "set back" based on lab pollutant concentration…
- Perform spill test to measure operation.

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UCI Spill Test Methodology

- 500 ml of acetone
- Baseline and CDCV measurement
- Photoionization detector - 10.6 eV lamp
  - MiniRae 2000 instrument
  - Calibrated by factory
- CDCV ventilation activation level: 0.5 ppm
- CDCV polling interval time: 14-17 minutes

Croul Hall spill locations

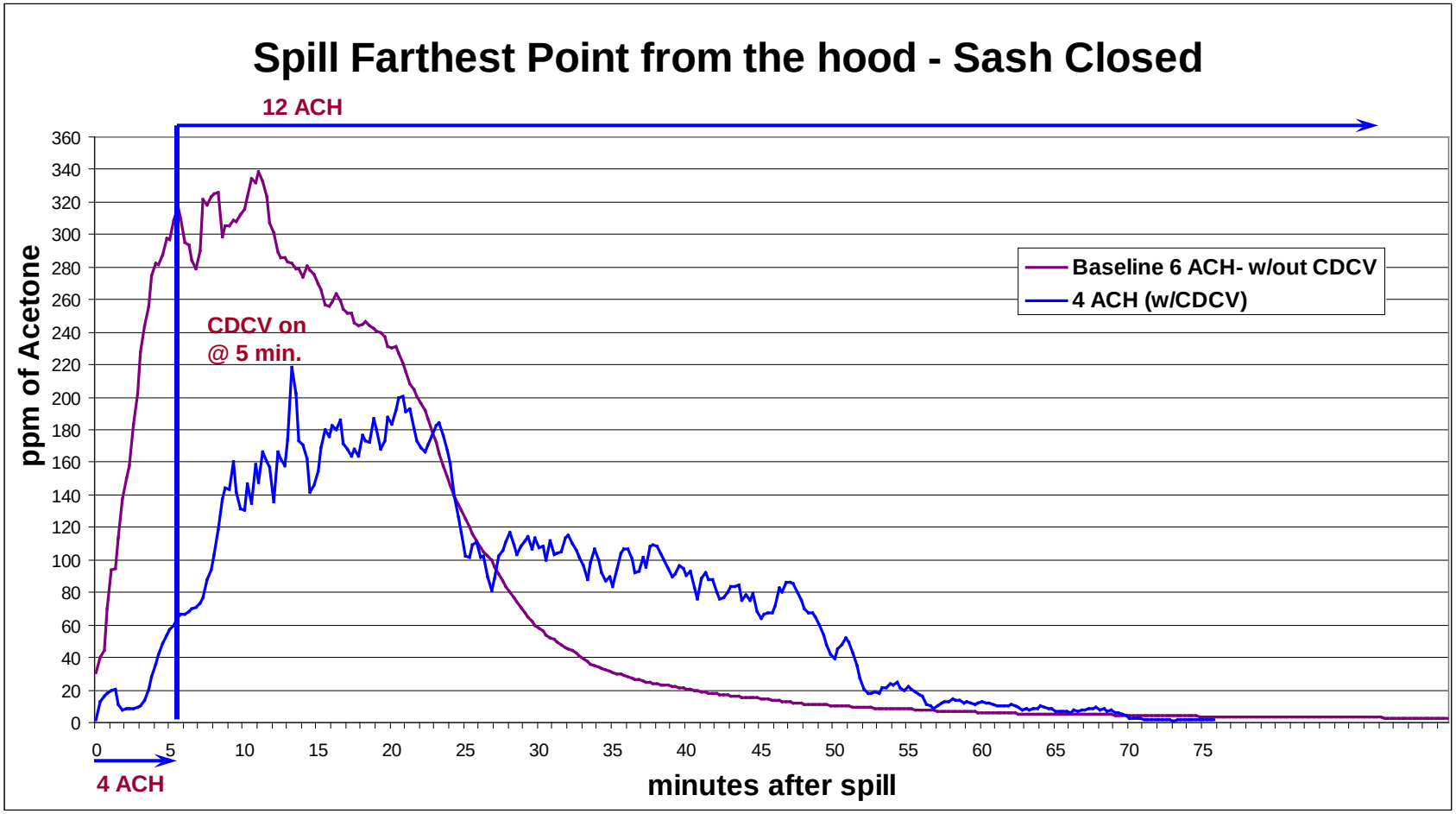
Farthest point from the hood

In front of the hood

Benchtop

Air Contaminant Monitoring Results:

Spill Farthest Point from Hood - Sash Closed



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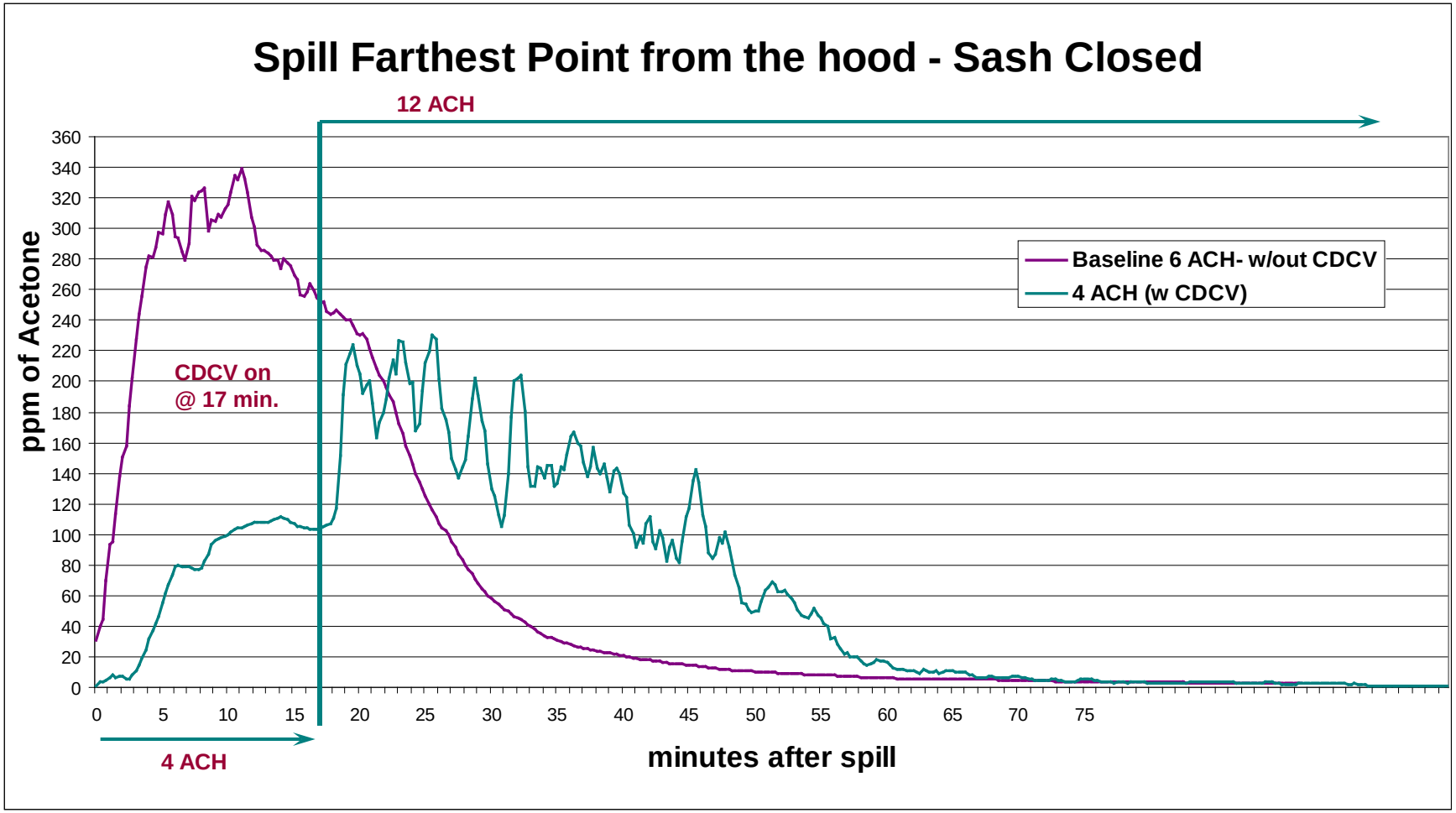
Air Contaminant Monitoring Results:

Spill Farthest Point from Hood - Sash Closed



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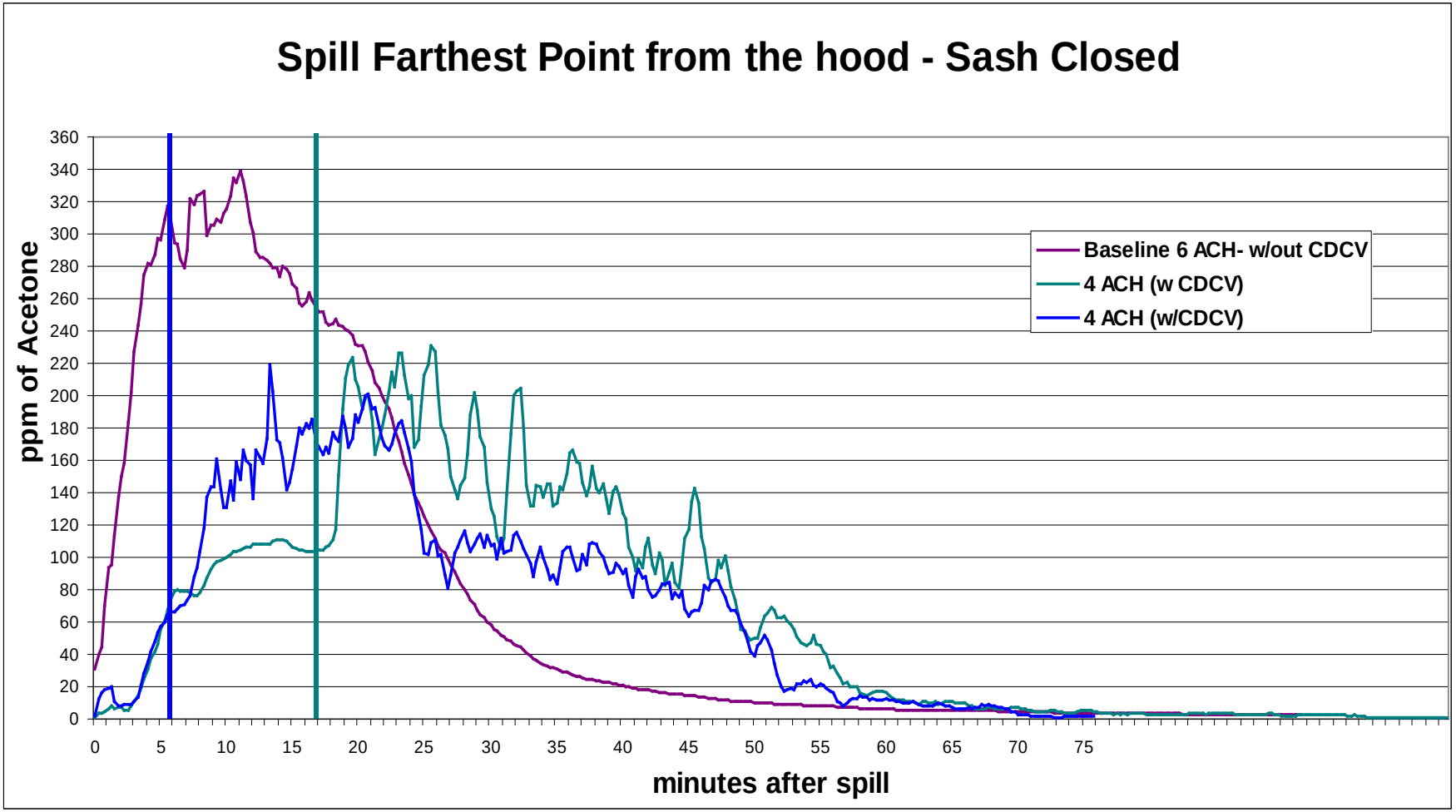
Air Contaminant Monitoring Results:

Combined Results



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Spill Results: Summary

Event	Pre-spill ACH	Post-spill ACH	Minutes post- spill ventilation increased	*Peak Conc. (ppm)	Clearance Time (min.)
Baseline Spill w/o CDCV	6	6	n/a	339	73
Spill 1 w/CDCV	4	12	5	219	70
Spill 2 w/CDCV	4	12	17	227	76

*** MiniRae 2000**

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Post spill safety review:

- CDCV system…
  - Responsive to spills.
  - Effective for sensing acetone levels used.
  - Lowers peak concentration in open areas.
- Polling time could delay detecting spill.
  - Consider polling interval during risk assessment.
- No significant difference in clearance time.
  - Scrutinize sensor sensitivity and potential saturation.
- Current sensor suite does not detect all chemicals.
  - Base sensor selection on risk assessment.

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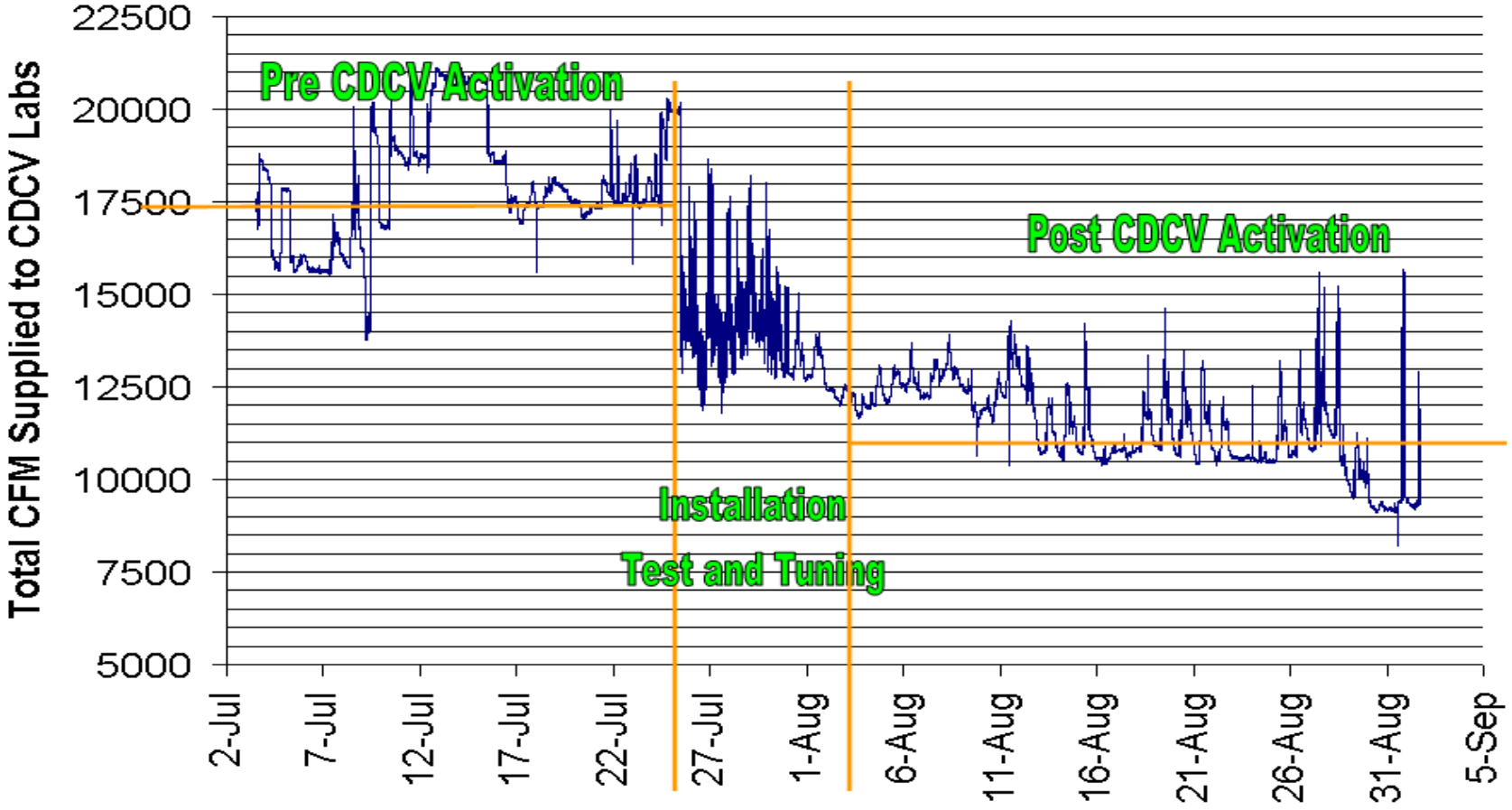
Croul Hall Air Change Rate Reduction



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CDCV System Savings & Payback at UCI

- Observed ~6,100 CFM reduction.
- Reduced chiller, boiler, and fan energy.
- Annualized estimated savings = $22,000.
- System Installation Cost approx. $125,000.
  - ✓ Extra cost for deferred maintenance.
  - ✓ Retro-commissioning required additional time and cost.
- Anticipated payback: 2-5 years.
- Future sensor calibration and other costs unknown; service contract included.

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Important technology considerations:

- CDCV Energy Management System…
  - Not meant to be a life safety system.
  - Provides IAQ info.
  - Promotes MBCx.

- CDCV system benefits can…
  - Reduce lab energy use.
  - Minimize impact of fugitive emissions from poor lab practice.
  - Notify EH&S staff of spill.
  - Evaluate maintenance issues.

- CDCV system suggested additions…
  - Employ instant messaging to facility staff of system problems.
  - Consider emergency exhaust ventilation override button.
  - Provide visual display outside lab.

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Questions?

For More Information

Lawrence Berkeley National Laboratory
A-Team
Energy Efficient Building Design Applications

http://ateam.lbl.gov

Geoffrey C. Bell, P.E.
510.486.4626
gcbell@lbl.gov

Environmental Energy Technologies Division