Better Buildings
U.S. DEPARTMENT OF ENERGY

Maximizing Energy Savings in Laboratories

Moderator: Bill Tschudi, Lawrence Berkeley National Laboratory
Panelists: Chuck McKinney, Aircuity, Inc.
Tom Smith, Exposure Control Technologies, Inc.
Phil Wirdzek, International Institute for Sustainable Laboratories

U.S. DEPARTMENT OF ENERGY

Preliminary Results of Ultra-Low-Temperature Laboratory Freezer Demonstration

Study conducted by for the Better Buildings Alliance Laboratories Team

by Navigant Consulting

Table of Contents

U.S. DEPARTMENT OF ENERGY

Introduction: Purpose of the Demonstration

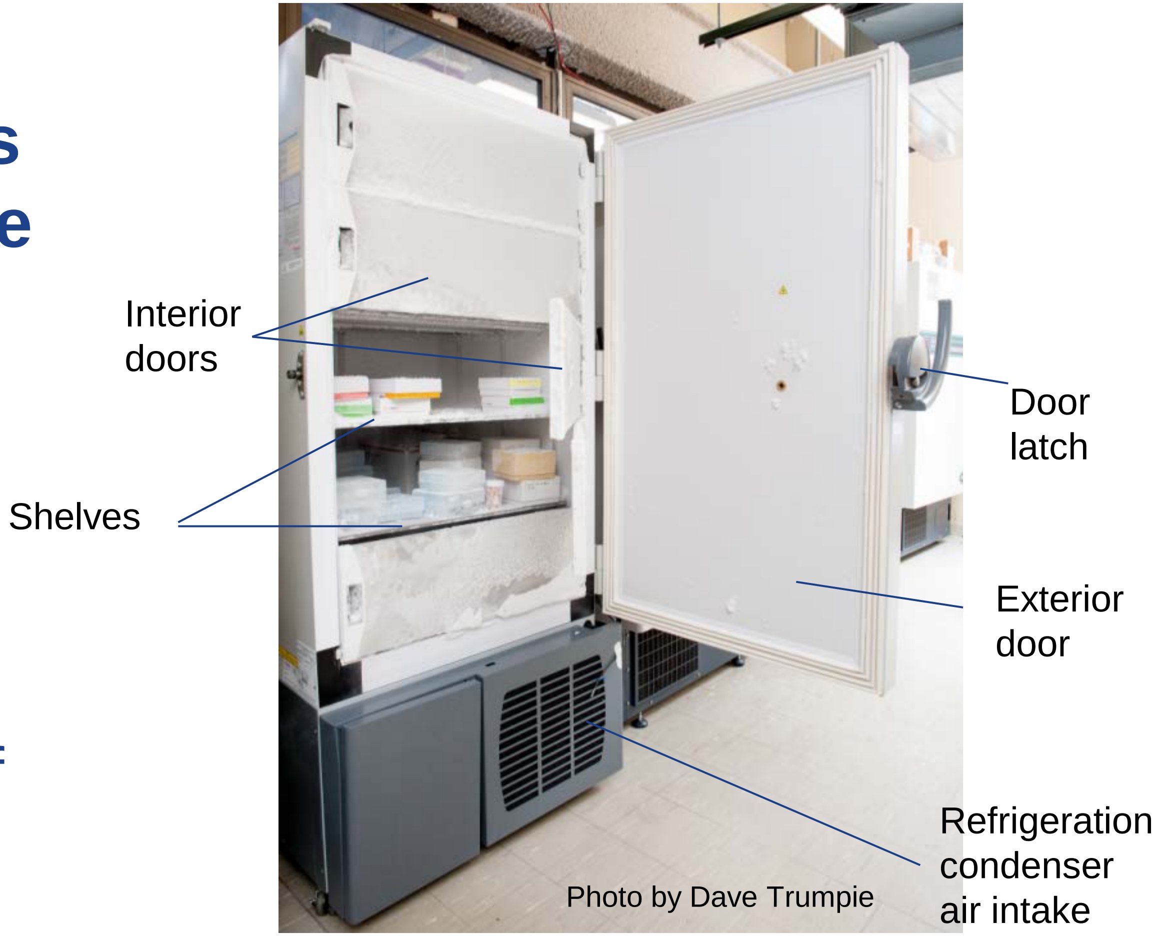
The purpose of the field study was to demonstrate energy savings that can be achieved in the field with high-efficiency ULTs.

- Goals included:
  - Examine the effect of field conditions on ULT energy use
  - Provide more information to purchasers seeking energy-efficient products
  - Support DOE and BBA efforts to increase market penetration of high-efficiency ULTs

Introduction: Equipment Description

We examined ULTs with characteristics most representative of the market.

- Air-cooled condensing
- Upright configuration
- Cabinet volume of ~20-30 ft^3



Typical ULT

Methodology: Choosing ULTs for Demo

We selected three ULTs to evaluate in the demonstration that we believed represented high-efficiency products.

- The selected demonstration ULTs:
  - Were within the top 25% of the market in terms of efficiency, based on existing manufacturer and field data*
  - Were manufactured within the last two years
  - Incorporated advanced technologies such as vacuum-insulated panels and/or alternative refrigeration system designs

*We were unable to verify the operating conditions and test protocols that the testers or manufacturers used in generating the existing data.

Methodology: ULTs Included in Demo

We evaluated each demonstration ULT at one host site alongside one or more "comparison" ULTs.

Table 1: Details of ULTs Included in the Demonstration

Unit #	Description	Brand/Model Number	Year of Manufacture	Host Site
Demo-1	Demo ULT #1	Stirling Ultracold SU780U	2013	University of Colorado at Boulder - MCDB Lab
Demo-2	Demo ULT #2	New Brunswick HEF U570	2012	University of Colorado at Boulder - iPhy Lab
Demo-3	Demo ULT #3	Panasonic VIP+ MDF-U76VC	2013	Michigan State University
Comp-1	Comparison ULT #1		2010	University of Colorado at Boulder-MCDB Lab
Comp-2	Comparison unit #2		2009	University of Colorado at Boulder - iPhy Lab
Comp-3	Comparison unit #3		2013	Michigan State University
Comp-4	Comparison unit #4		2012	Michigan State University

Methodology: Data Collection

We used instrumentation to collect data for each ULT.


Photo by Dave Trumpie

Energy Use: Power Meter

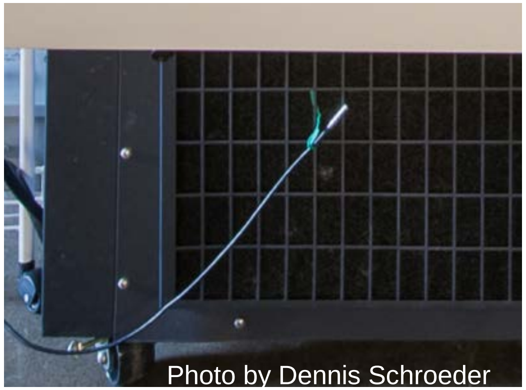


Photo by Dennis Schroeder

External Temperature: Temp. Sensor

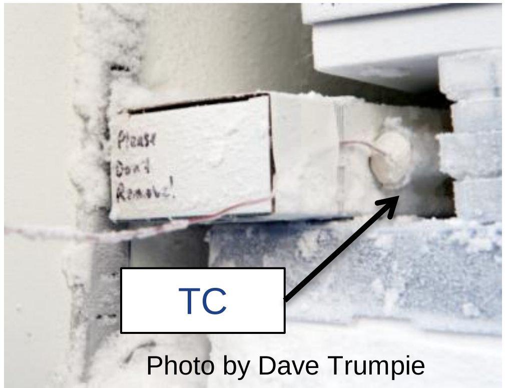


Photo by Dave Trumpie

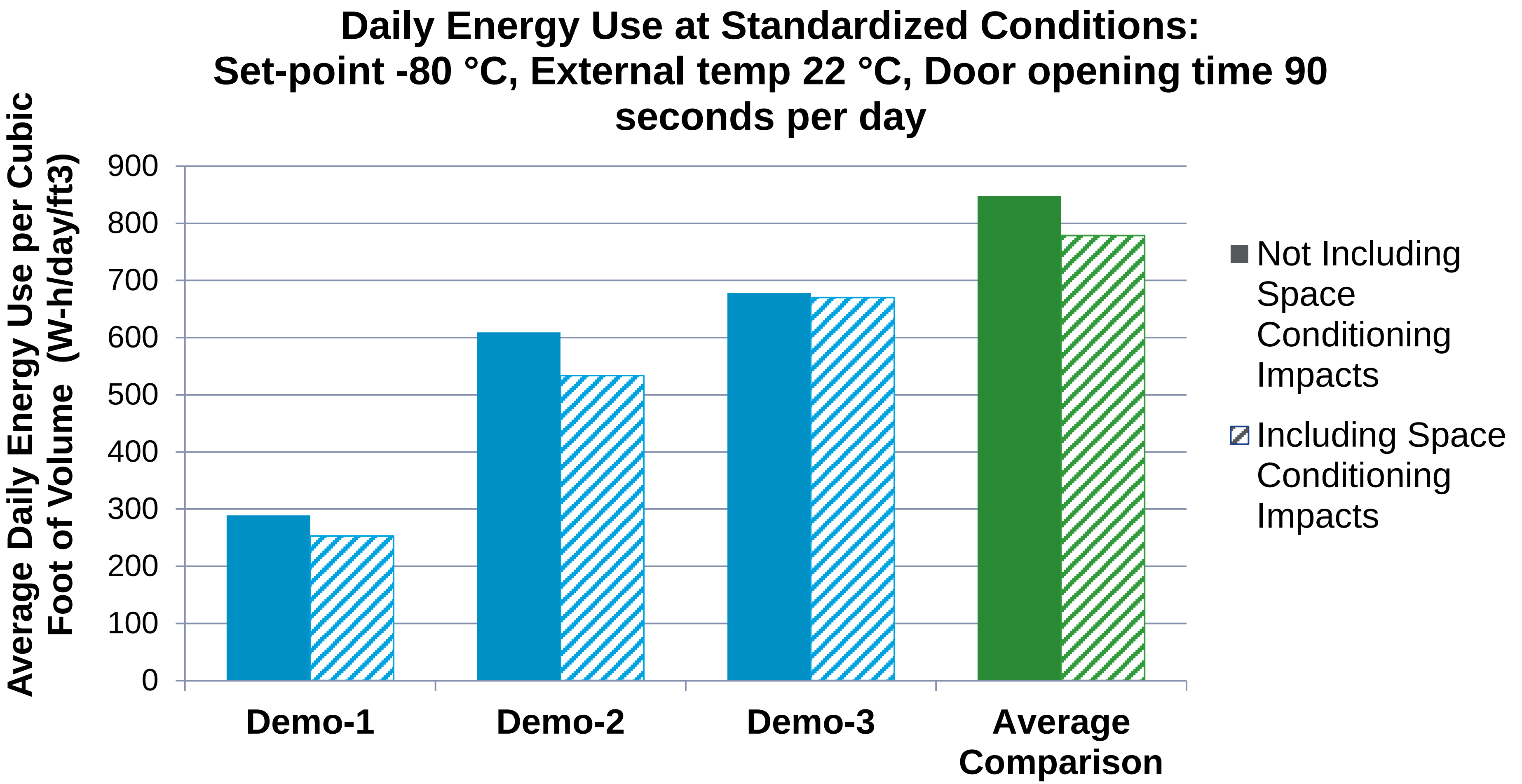
Internal Temperature: Type T Thermocouple


Photo by Dave Trumpie

Door Openings: Magnetic State Logger

Results: Energy Savings (Preliminary)

We observed that the demo ULTs used less energy than the average comparison ULT.



Results: Economic (Preliminary)

We conducted a simple payback analysis for each demo ULT vs. an average comparison ULT.

Table 4: Results of Simple Payback Analysis

Unit	Percent Energy Savings*	Annualized Energy Savings (MWh)*	Annualized Cost Savings ($)**	Estimated Payback Period (years)†
Demo-1	66%	5.6	$580	3
Demo-2	28%	1.7	$180	9
Demo-3	20%	1.6	$164	15

*Energy savings are normalized to the same volume in cubic feet. Does not include space conditioning impacts.
**Assuming an average U.S. electricity price of 10.34 cents per kWh (data from Energy Information Administration)
†Based on 30% discount for both demo and comparison ULTs. Actual prices and payback periods may vary due to distributor discounts.

Conclusions (Preliminary)

The study demonstrated energy savings that were achieved in the field with the demo ULTs.

- Demo ULTs saved between 20% and 66% energy versus the average comparison ULT on a per-cubic-foot basis
- Simple payback analysis estimated payback periods of ~3 to 15 years, depending on the ULT, available discount, and electricity rate.
- We could not draw conclusions about long-term reliability, whole-cabinet temperature performance, or characteristics of other products not included in the study.

Next Steps

Next steps include disseminating the results and supporting future deployment activities.

- Detailed results of the demonstration will be published in a report and made available on the BBA website.
- We plan to develop and deploy additional resources to help increase market penetration of high-efficiency ULTs through the HIT (High Impact Technology) Program.

Thank you!

Contact:

Rebecca Legett
Navigant Consulting
415-399-2156
rebecca.legett@navigant.com

U.S. DEPARTMENT OF ENERGY

International Institute for Sustainable Laboratories

Building Relationships with I2SL

For Sustainable Laboratories And Related High-Technology Facility Design, Engineering, and Operation

Better Building Summit

May 7, 2014

Laboratory Buildings – I2SL Building on Labs21

"Labs embody the spirit, culture, and economy of our age…what the cathedral was to the 14th century and the office building was to the 20th century, the laboratory is to the 21st century."

Don Prowler, FAIA
1950-2002
Professor of Architecture,
Building Climatology, and Sustainability Principles

National Renewable Energy Laboratory
Science and Technology Facility

International Institute for Sustainable Laboratories

I^2SL TODAY

- Labs21 and the International Institute for Sustainable Laboratories (I^2SL)
- Recent Developments
- I^2SL Today
  - Global Community
  - Initiatives
- 2014 I^2SL Annual Conference
- Working with Others

International Institute for Sustainable Laboratories

Laboratories for the 21st Century (Labs21®) – I^2SL Partnership

- Labs21 is dedicated to improving the energy and environmental performance of U.S. laboratories
- Co-sponsorship (1999)
  - U.S. Environmental Protection Agency (EPA)
  - U.S. Department of Energy (DOE)
  - I^2SL (2006)
- I^2SL program network now includes well over 8,000 individuals

I^2SL Vision and Mission

- Vision
  - To enable a global network of collaboration to move laboratories and other high-technology facilities into balance with the natural world, available resources, and a flexibility that maintains and exceeds the technological standards necessary to meet their purposes over time.
- Mission
  - Building upon Labs21 to educate, share, and promote the development of sustainable high-performance facilities worldwide.

I^2SL

International Institute for Sustainable Laboratories

Recent Developments

- EPA shifted Labs21 program responsibility to I^2SL
- I^2SL Becomes a Membership-Based Organization with Chapters
- Labs21 Tools and Case Studies available on I^2SL Websites
- Labs21 Annual Conference renamed to I^2SL Annual Conference
  - 2014 I^2SL Annual Conference September 22-24 Orlando, Florida

International Institute for Sustainable Laboratories

I^2SL Expands Labs21 Mission

I^2SL and Labs21

- Quarterly e-Newsletters, Monthly Webinars and Annual Conferences
- Global Community which Helps Shape the I^2SL Program of Activities
- Topical Working Groups
- Technical Assistance and Support
- Professional Training, Education and CEUs

International Institute for Sustainable Laboratories

Training/Certifying High-Tech Operations and Management Professionals

- Laney College, an NSF Center of Excellence in Oakland, CA, and I^2SL have identified knowledge, skills, and abilities gaps in existing training
- These gaps have been discussed at the last few Labs21 Annual Conferences
- I^2SL and Laney issued a survey to validate findings and to identify processes to assess next steps

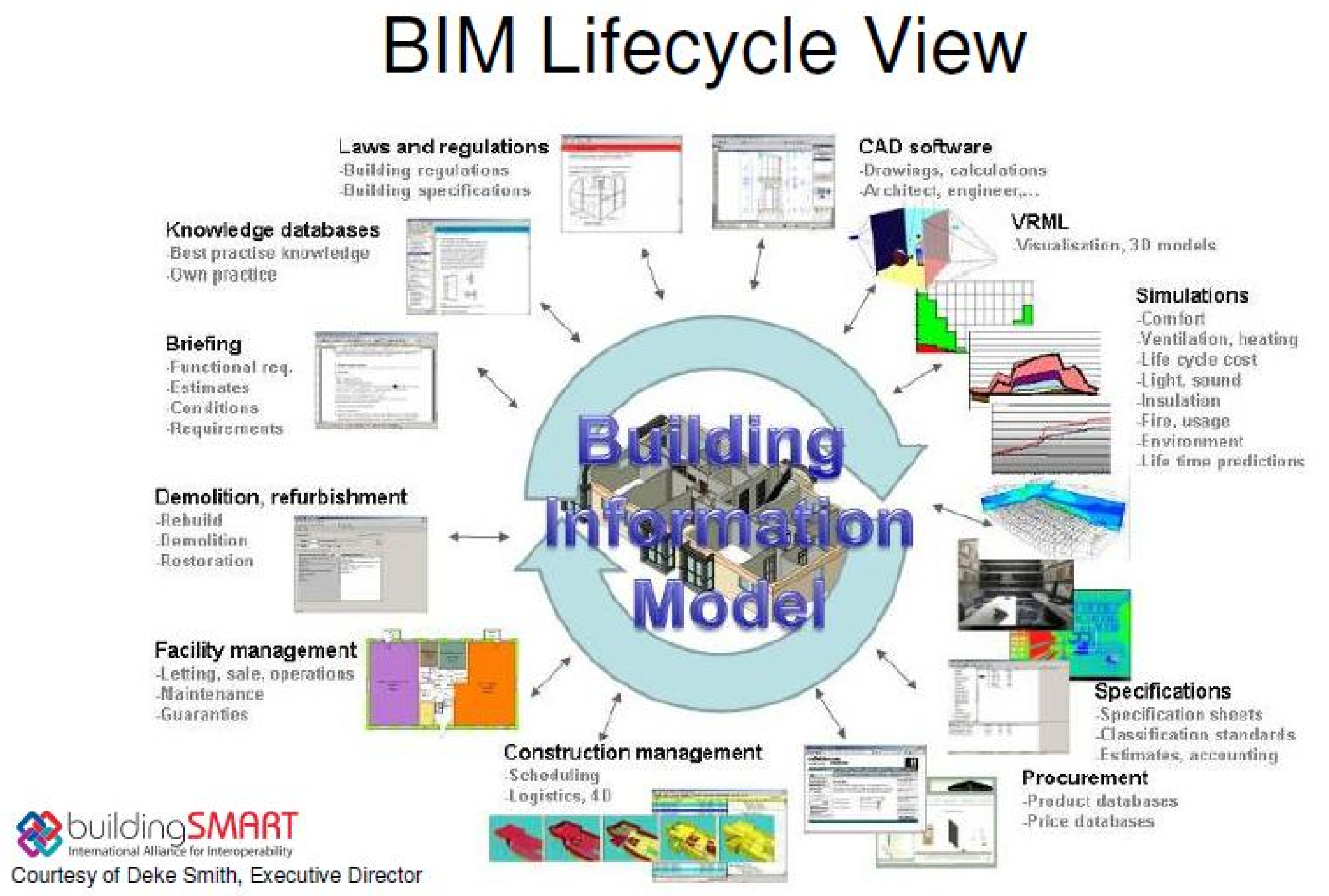
International Institute for Sustainable Laboratories

BIM for Operations and Management

- I²SL, National Institute of Building Sciences, and International Facility Management Association survey released in fall 2012
- Results encourage operations and management tools for BIM platform
- Survey summary article to be published in *Lab Design Newsletter*, *Building Operations Management* magazine, and *Journal of Building Information Modeling*
- Meeting at 2013 I²SL Annual Conference to present and discuss current client BIM projects incorporating operations/management

International Institute
for Sustainable Laboratories

With Tools for Life Cycle Performance



Continuous Performance Improvement Program (CPIP)

- Co-Chaired by University of Minnesota with I^{2}SL
- Two functioning sub-working groups
  - User behaviors and lab equipment procurement (UofCO and UC Irvine)
  - Existing Operating Standards and Building Systems Information Sharing
- Planned meeting at 2014 I^{2}SL Annual Conference

I2SL
International Institute for Sustainable Laboratories

Metering and Sub-Metering

Communicating for Results

- Understanding the value of sub-metering laboratory spaces
- How the practice can support management and sustainability goals.
- Reviews new tools created to help owners and laboratory personnel understand the value of energy management
- Why information modifies user behaviors.

International Institute for Sustainable Laboratories

3rd Party Energy Efficiency Project Financing - High Tech

- To increase 3rd party financing in Federal laboratories and high-tech buildings
- Incorporate energy conservation measures (ECMs) that include both whole building integrated design and user processes
- Help Federal agencies understand what integrated ECMs are possible and what a successful project incorporates
- Federal agencies must have the confidence that their energy service provider understands their mission needs and will enhance their performance
- Energy service providers must demonstrate their understanding of the mission requirements of laboratories and high-tech processes

International Institute for Sustainable Laboratories

Energy Programs at R&D Universities

- I^2SL has been asked to undertake a modest effort to develop a compendium of energy efficiency programs for laboratories undertaken by 10 tier-one research universities in the United States
- The compendium of case studies is intended to document the schools' efforts, identify common themes and applications of the programs, and highlight innovative approaches that may have been undertaken
- I^2SL expects to invite other schools to provide their information to help build this database and make it available to I^2SL Members

International Institute for Sustainable Laboratories

2012 Competition

Student Design Competition Promotes Systems Integration

International Institute for Sustainable Laboratories

GET STARTED

Phil Wirdzek
President and Executive Director
I^{2}SL
703.425.1258

info@i2sl.org
www.i2sl.org

International Institute for Sustainable Laboratories

Lab Ventilation Optimization Process (LVOP)

A Cost Effective Process to Achieve

Safe, Energy Efficient & Sustainable Lab Buildings

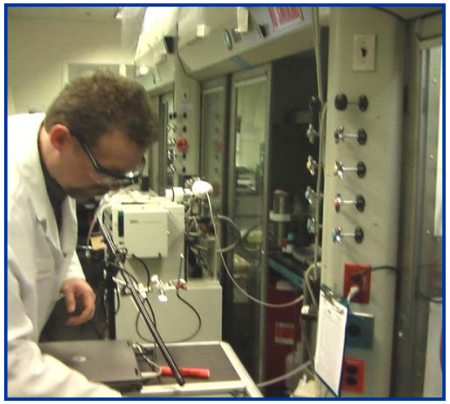
Thomas C. Smith

ECT, Inc.

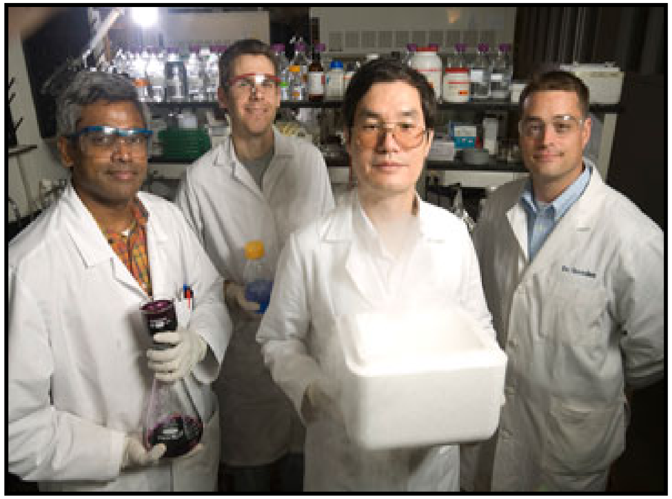
919-319-4290
www.exposurecontroltechnologies.com
tcsmith@labhoodpro.com

Goal: High Performance Laboratories

- Chemistry Labs
- Radiological Labs
- Nanotechnology Labs
- Biology Labs (BSL 2-4)
- Animal Vivariums
- Cleanrooms



- **Safe**
  - Compliant with Codes & Standards
- **Productive (Flexible)**
- **Energy Efficient**
- **Sustainable**



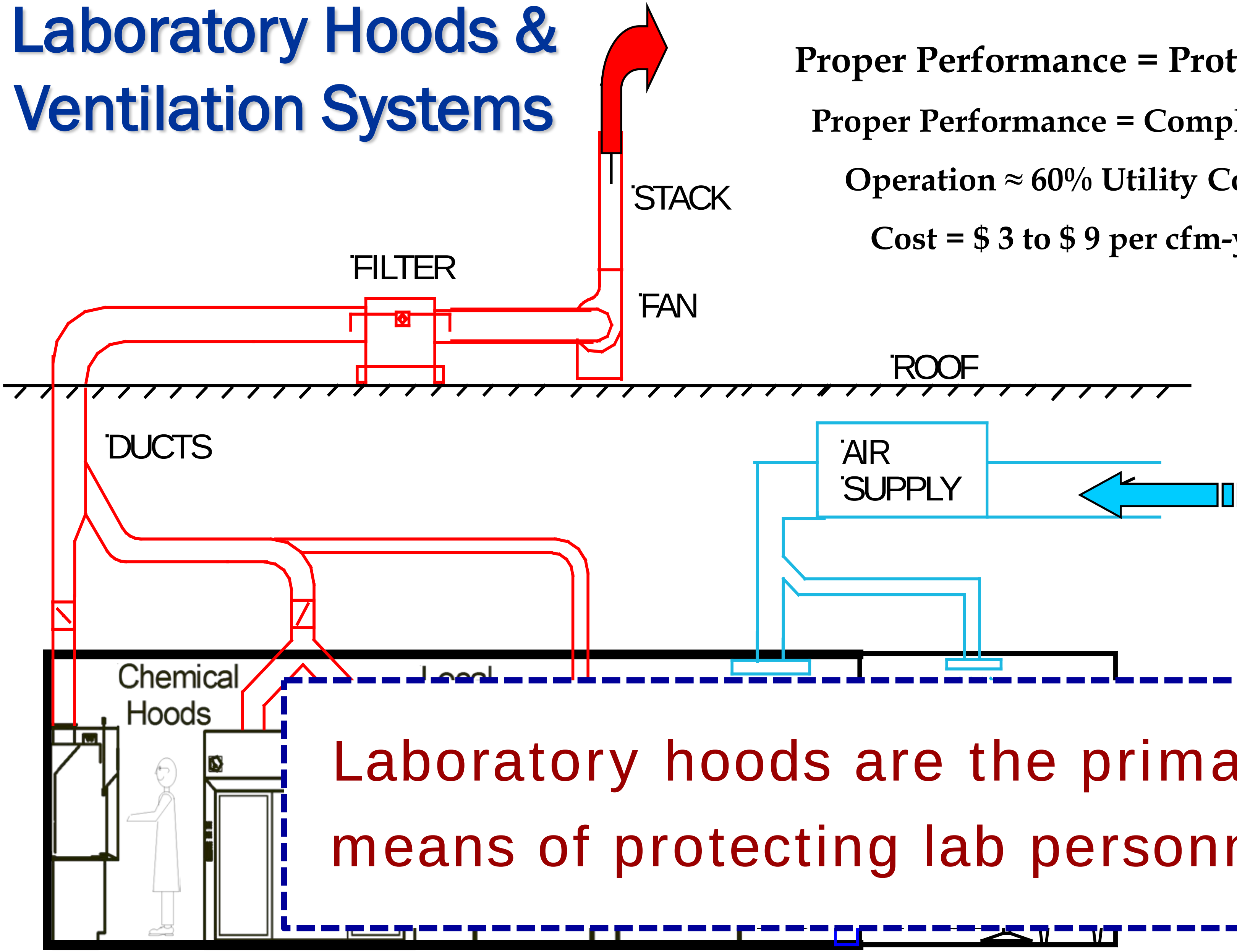
Laboratory Hoods & Ventilation Systems

Proper Performance = Protection

Proper Performance = Compliance

Operation ≈ 60% Utility Costs

Cost = $ 3 to $ 9 per cfm-yr

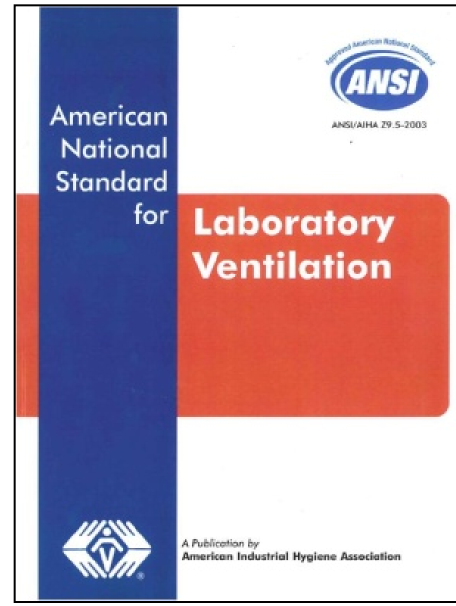


Laboratory hoods are the primary means of protecting lab personnel

ANSI/AIHA –Z9.5 - 2012
American National Standard for Laboratory Ventilation

AIHA
Protecting Worker Health

- **Newly Revised & Published September 2012**
- **Minimum Requirements and Best Practices**
  - Protect People
  - Ensure Dependable Operation
  - Operate Energy Efficient Labs
- **Recommendations & Specifications for New and Renovated Laboratories**
  - Hood Design & Operation
  - Laboratory Design
  - Ventilation System Design
  - Commissioning and Routine Testing
  - Work Practices and Training
  - Preventative Maintenance



The American Society of Safety Engineers

Airflow Specifications for Laboratories

Minimum Flow and Range of Modulation Required to Meet the Functional Requirements of the Lab

Demand for Ventilation

- **Safety**
  - Hood Exhaust Flow
  - Laboratory Pressurization
  - Dilution (ACH)
- **Comfort & Productivity**
  - Temperature
  - Humidity
- **Occupancy & Utilization**

Demand Based Optimization

Opportunities to Improve Safety and Reduce Energy

Modify Systems to Meet Demand

- Remove or Hibernate Unnecessary Hoods
- Modify Inefficient Hoods
- Replace & Retrofit Traditional Fume Hoods
- Upgrade CAV & Dysfunctional VAV Controls
- Optimize Temperature & Humidity Controls
- Install Demand Control Ventilation
- Reduce / Reset System Static Pressure
- Optimize Exhaust Fan and AHU Operation
- Implement Energy Recovery

Modify Inefficient Hoods

- Poorly Designed
- Under Utilized or Ineffective
- Typically Operate Continuously
- Large Energy Wasters

Replace or Upgrade Laboratory Fume Hoods

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



Upgrade-Retrofit Traditional Fume Hoods

Upgrade Critical Components

- Airfoil Sill
- Sash Handle
- Baffle

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

Upgrade & Retrofit Fume Hoods

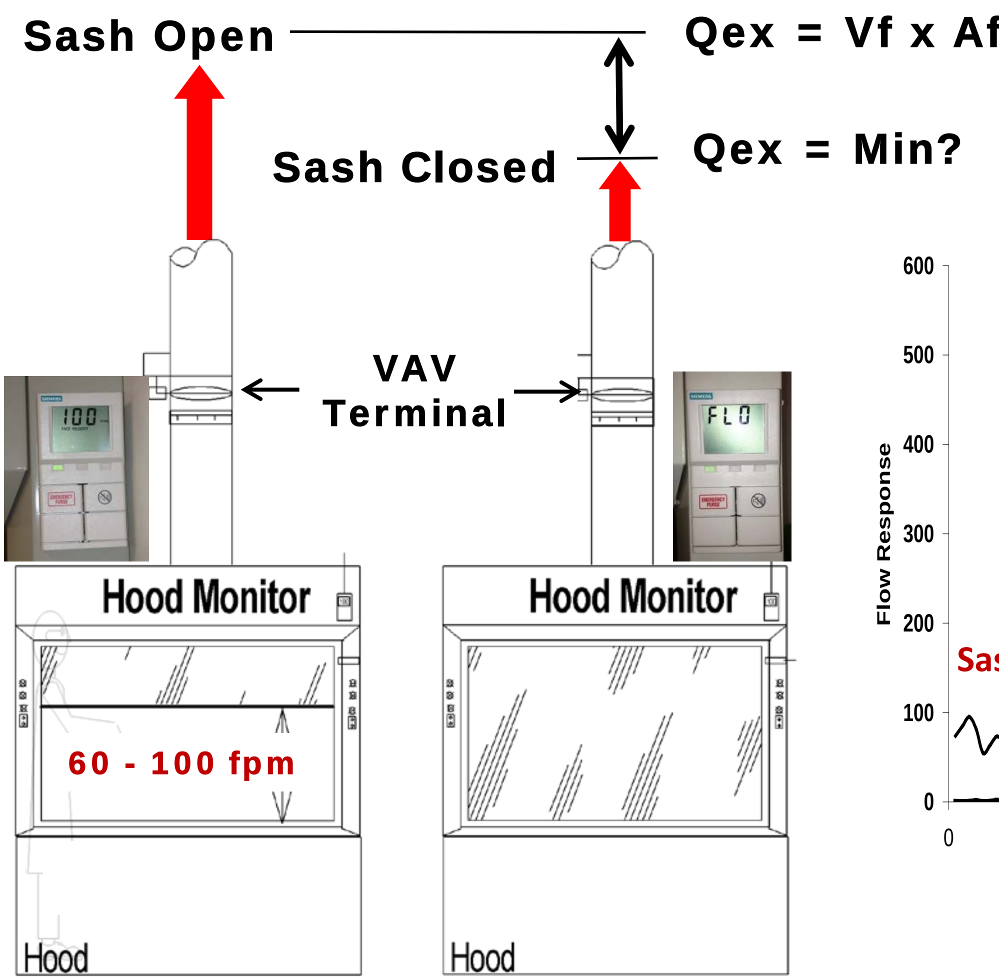
Before

After

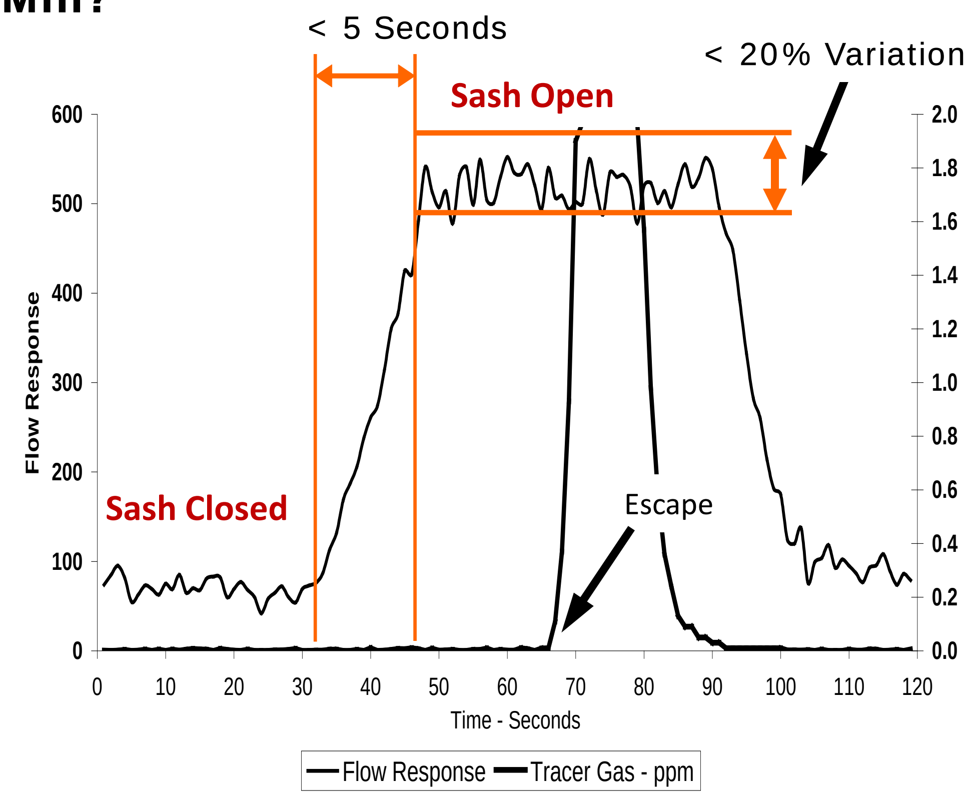
Safe & Sustainable Technology

Fume Hood Operating Specifications

- Min and Max Flow
- Response Time
- Flow Stability
- Containment
- Dilution



VAV Response To Sash Movement



Minimum Exhaust Flow for Fume Hoods

- Containment
- Dilution
- Removal

1990s - EPA – 50 cfm / ft of Wh

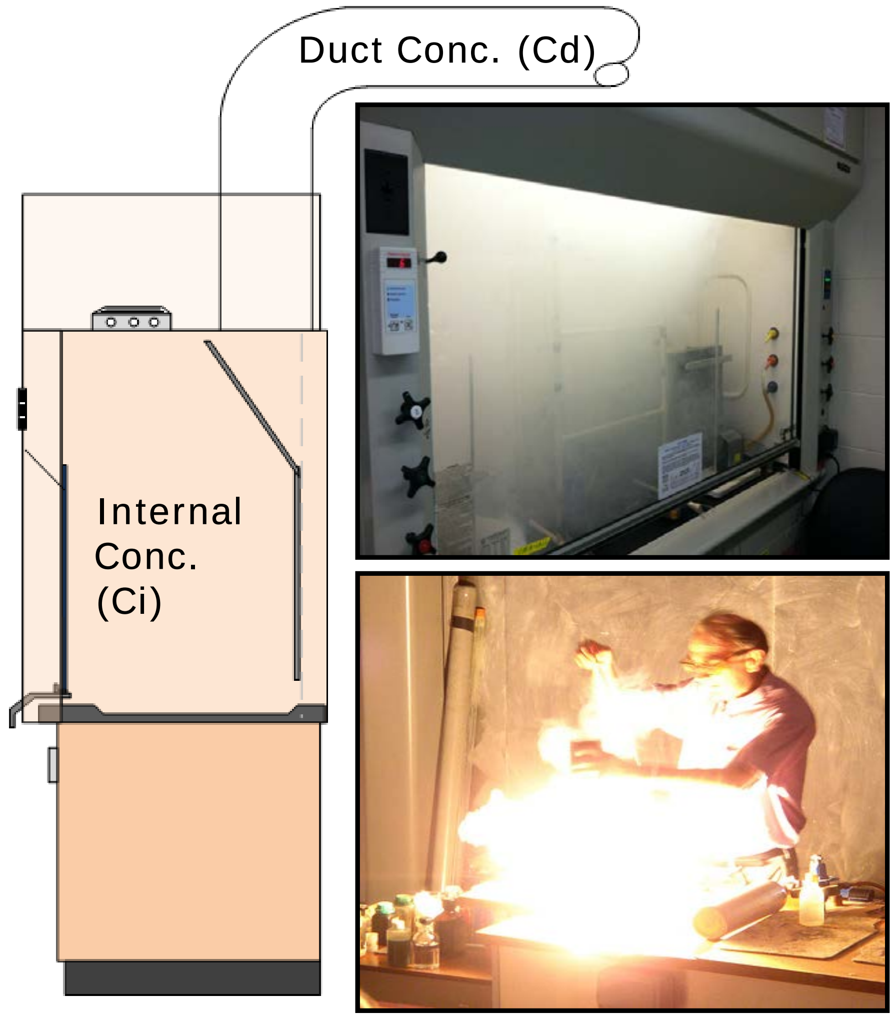
2004 - NFPA 45

- 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: Minimum Flow is Hood & System Dependent



Control Bands for Minimum Exhaust Specifications

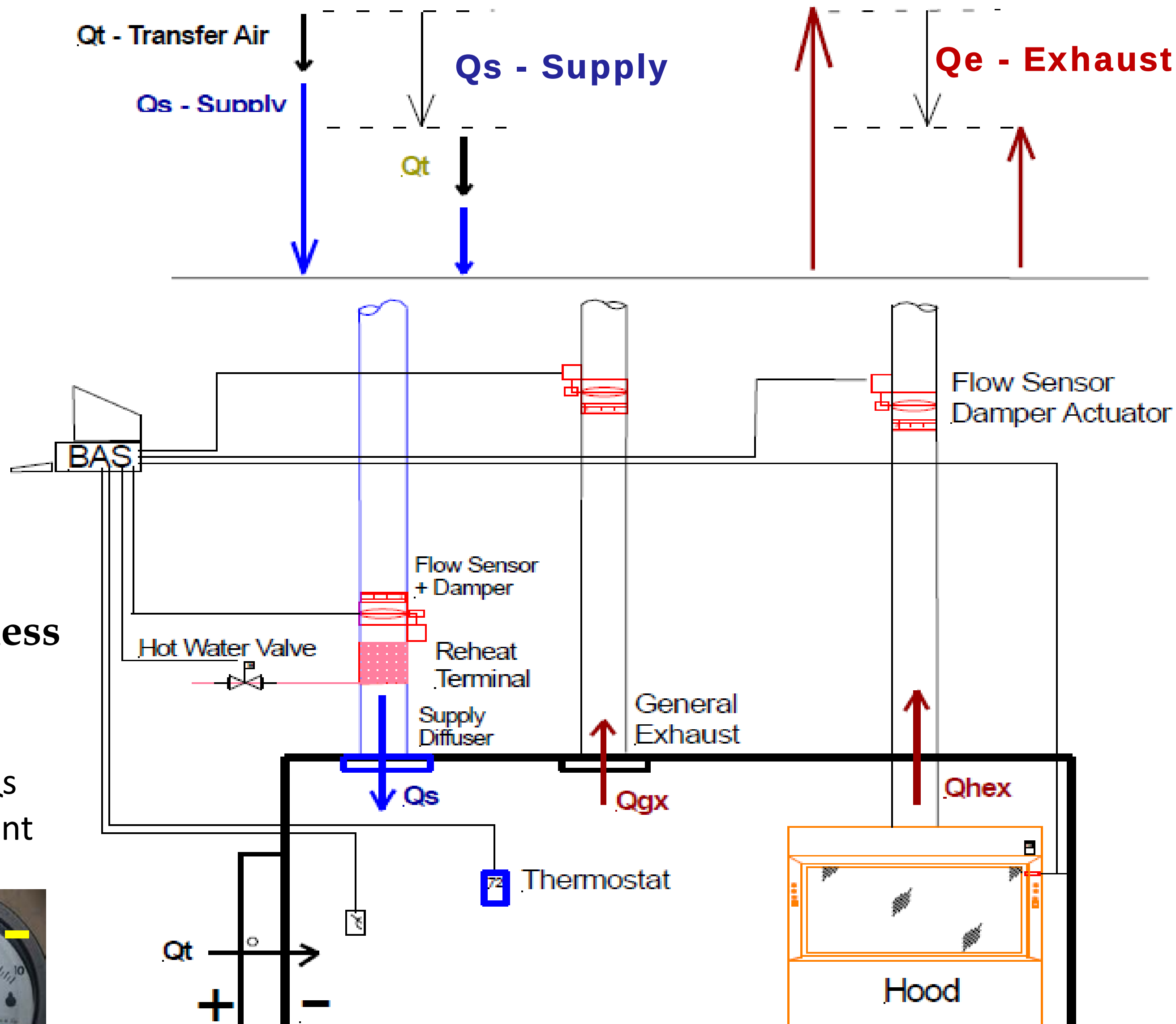
Fume Hood Control Band Parameters

- **Flammability**
  - Lower Explosion Limit (LEL)
- **Airborne Hazard (LOC)**
  - OSHA – Global Harmonized Standards
- **Generation Rate**
  - Vapor Pressure
  - Quantity
  - Heat / Energy
- **Corrosives**
  - Type & Quantity
  - Process/Heat
- **Generation Location**
- **Hood Dilution Factor**

Control Band	VAV Flow Reduction
1	Minimum Flow for Containment
2	Investigate Further
3	Maintain Design Flow
4	Operate as CAV (no reduction)

Laboratory Operating Specifications

- Operating Mode
- Min and Max Flow
- Temperature Control
- Room Pressure
- **Dilution (ACH)**
- Air Change Effectiveness



Qt = Qe – Qs

Qt = Constant

Room Pressure

Laboratory Operating Specifications

Lab Control Band Parameters

- Chemical Hazard Rating
- Chemical Generation Source Location(s)
- Chemical Generation Potential
- Duration of Chemical Generation
- Exposure Control Devices (ECD)
- Housekeeping - Lab Practices
- Ventilation Effectiveness (Sweep)

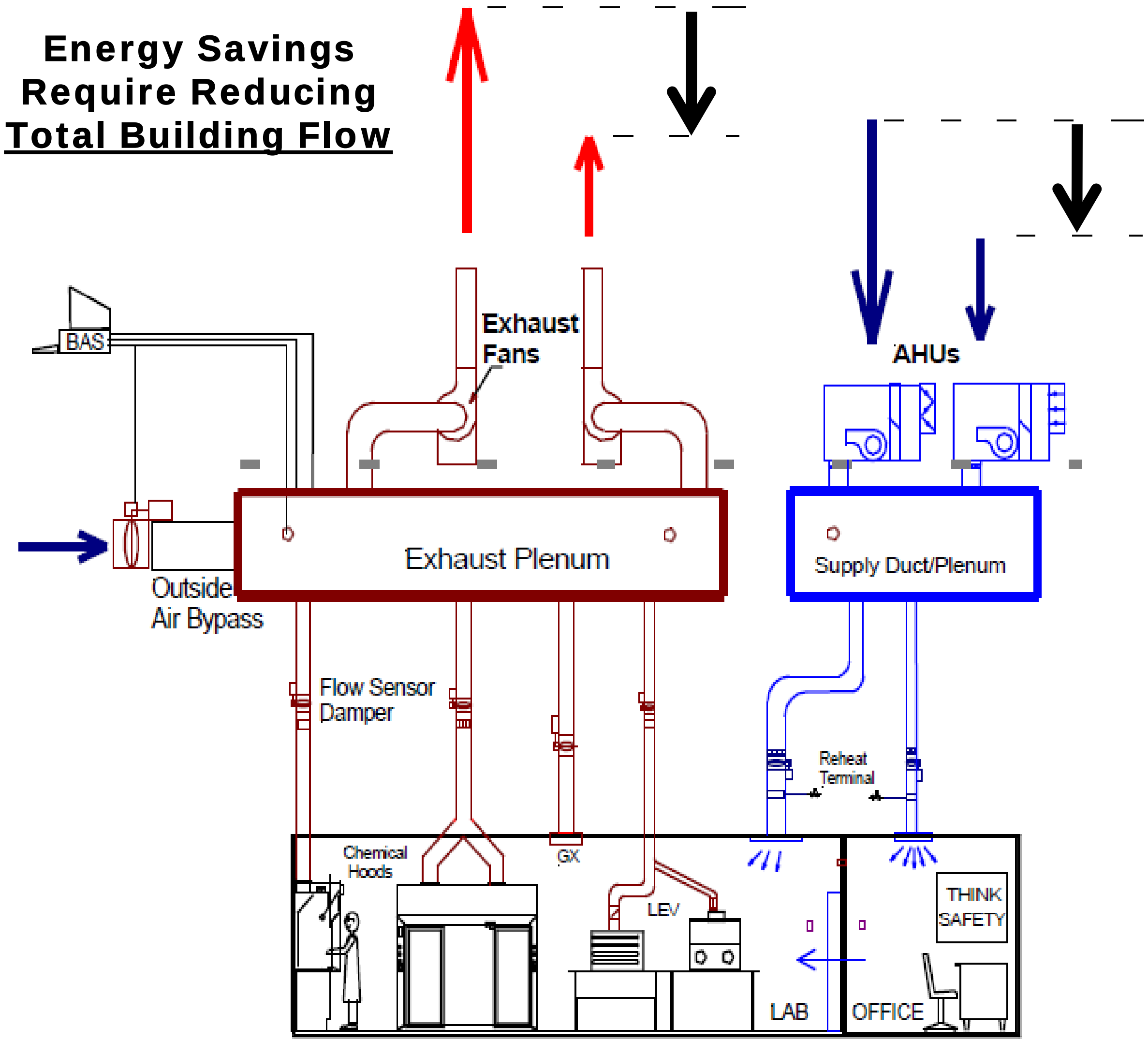
Control Bands for Laboratory Airflow Specifications

- Parameters, Weighting, and Scorecard Adjusted for Research
- Specify ACH & Risks of Recirculating Lab Air
- Evaluate Lab Construction, Pressurization, Need for Monitoring

Survey Score	Control Band	ACH	Recirculation of Lab Air	Lab Pressurization
0-5	**1**	< 4	Possible	Neutral
6-11	**2**	4-6	Filtered or DCV	< -0.005” w.g.
12-21	**3**	6-8	Investigate	< -0.01” w.g.
22-31	**4**	8-10	No	< -0.05” w.g. Critical w/ Monitor
>31	**5**	> 10	No	= > -0.05” w.g. Critical w/Anteroom & Monitor

System Operating Specifications

- AHUs and Ex. Fans
- Manifolds
  - Redundancy
  - Emergency Power
- Max and Min Flows
- System Static Pressure
- Duct Transport Velocity
- Exhaust Stack Discharge
- Control Capabilities
  - VAV Diversity
  - VAV Sensitivity

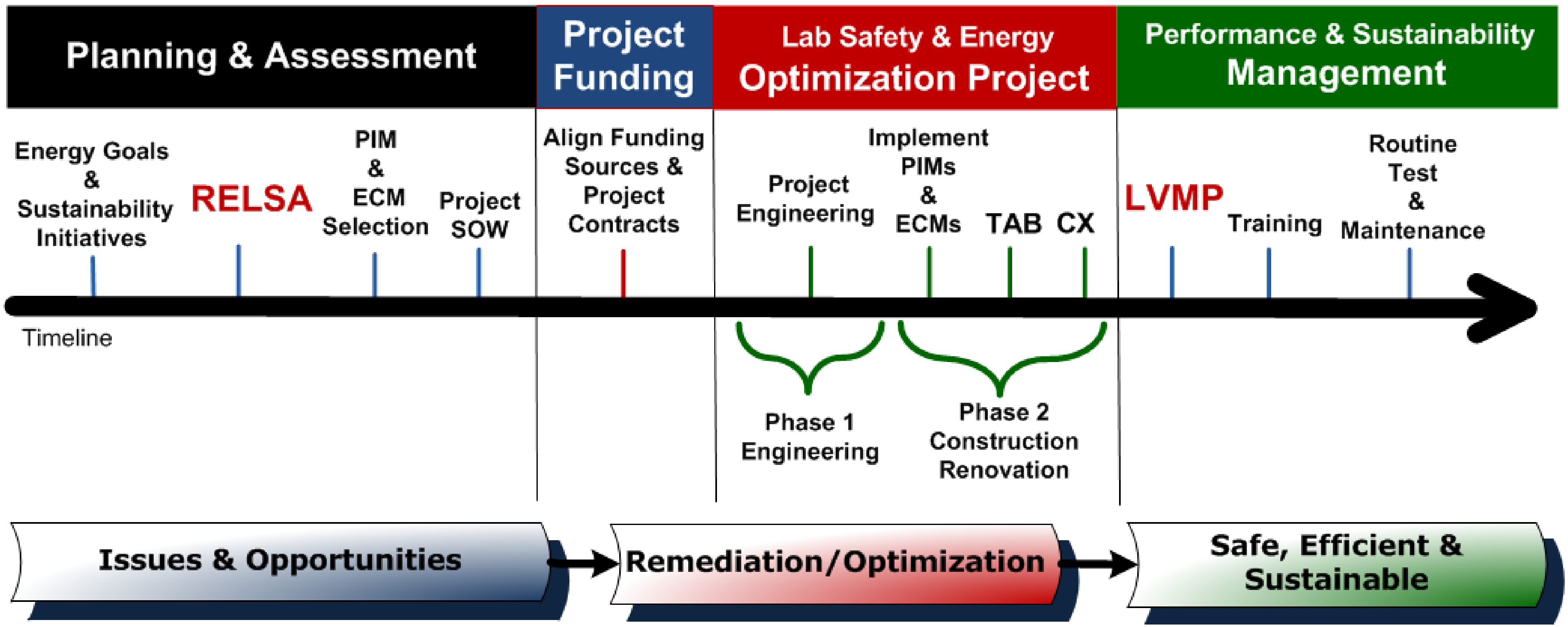


Lab Ventilation Optimization Process (LVOP™)

- **Rapid Energy & Lab Safety Assessment (RELSA™)**
  - Quick, Low Cost, Low Risk Audit
  - Evaluate Safety & Code Compliance
  - Identify Performance Improvement Measures (PIMs)
  - Prioritize Energy Conservation Measures (ECMs)
  - Determine Benefits, Energy Reduction, Cost and Payback
- **System Renovation & Upgrade Project**
  - Engineer & Implement PIMs and ECMs
  - **Retrofit Laboratory Hoods and Upgrade Systems**
  - TAB & Commission Systems
  - Benchmark Operation
- **Lab Ventilation Management Plan (LVMP)**
  - Maintain Safe, Efficient & Effective Operation
  - Ensure Compliance – Conduct Routine Test and Maintenance
  - Protect Return on Energy Investment

Lab Safety & Energy Optimization Projects

LVOP – Roadmap to Safe, Energy Efficient & Sustainable Laboratories



RELSA = Rapid Energy & Lab Safety Assessment

SOW = Scope of Work

PIM = Performance Improvement Measure

ECM = Energy Conservation Measures

TA = Technical Assistance Vendor

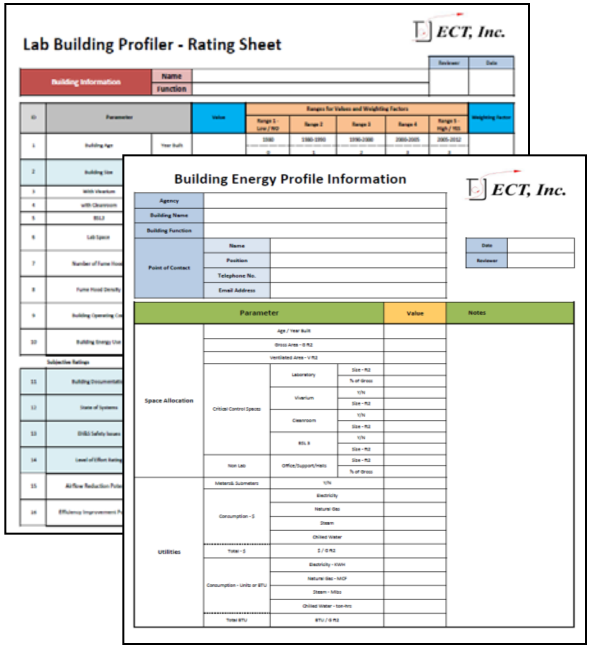
TAB = Test, Adjust and Balance

Cx = Commissioning Tests

LVMP = Lab Ventilation Management Program

Lab Safety & Energy Assessment (LS&EA)

- **Facility and Building Evaluation**
  - Select & Prioritize Best Projects First
- **Key Metrics & Weighting Factors**
  - Size & Space Allocation
  - Energy Use & Operating Costs
  - State of the Systems
  - Energy Reduction Potential
- **Lab Profile Report**
  - Building Classification
  - Assessment of Energy Reduction
  - Estimated Project Costs & Payback



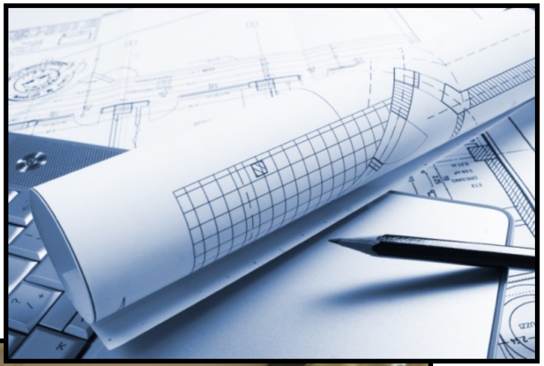
Attribute	Lab Building Profile Category				
• **State of the Systems** • **Energy Reduction Potential** • **Project LOE & Complexity** • **Return on Investment (Payback)**	Class A	Class B	Class C	Class D	Class E

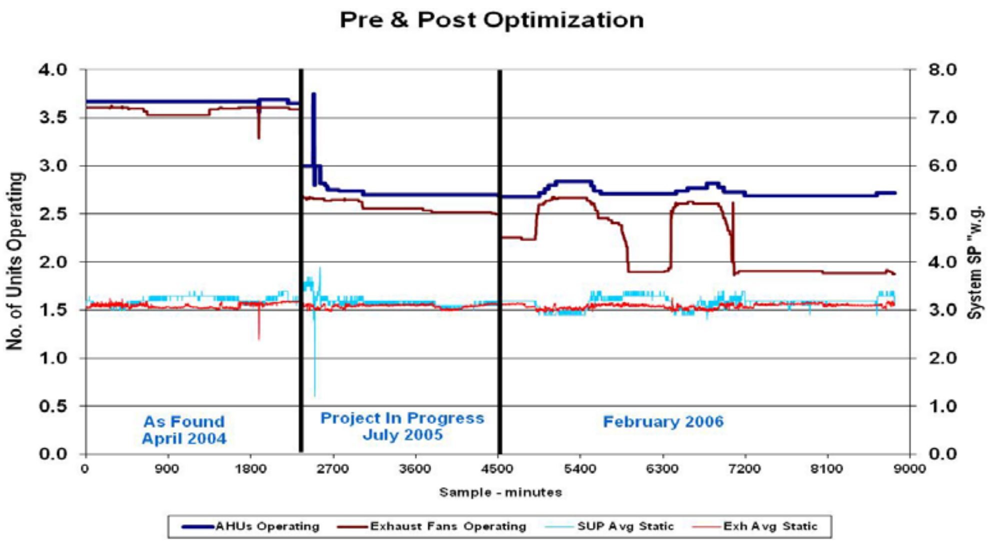
LS&EA Building Profile & Project Prioritization

Profile	Building	Total Annual Utility Cost	% Utility Reduction	Annual Savings $	Investment to Realize Savings $	Payback Period
A	Bldg D	$1,950,000	24	$468,000	$1,404,000	3
B+	Bldg A	$800,000	16	$128,000	$512,000	4
B	Bldg F	$600,000	21	$126,000	$567,000	5
B	Bldg E	$980,000	16	$156,800	$784,000	5
B-	Bldg B	$450,000	9	$40,500	$202,500	5
C-	Bldg C	$300,000	7	$21,000	$189,000	9
	Totals	$5,080,000	19	$940,300	$3,658,500	4

Lab Safety and Energy Optimization Project

- **Phase 1 – Project Engineering**
  - Determine Operating Specifications
    - **Control Band Hoods & Labs**
  - Design Upgrades & System Modifications
  - Develop TAB & Cx Plans
- **Phase 2 – Upgrade/Renovation Project**
  - Implement Selected PIMs & ECMs
  - Verify Performance and Energy Savings





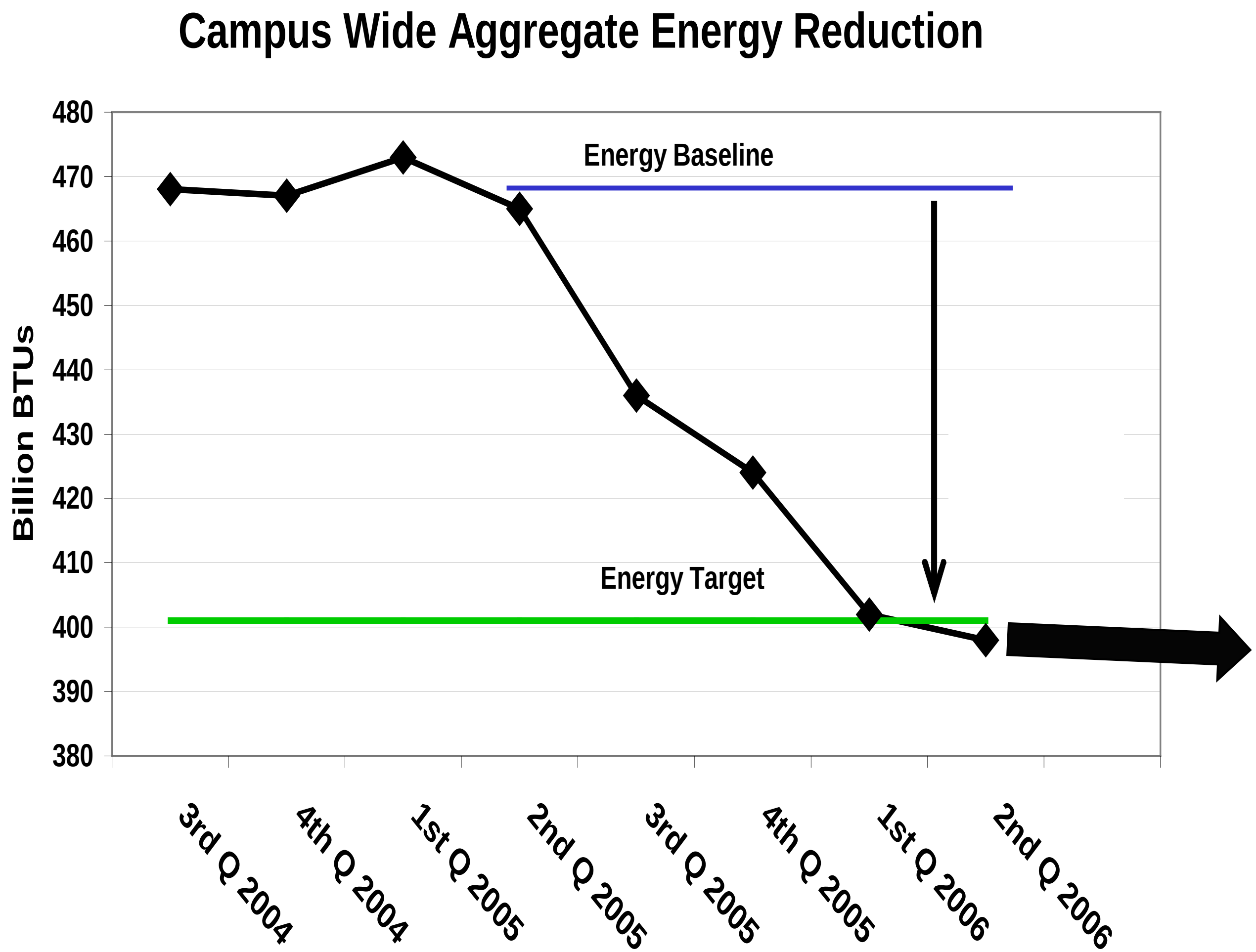
Building Profile and Project Optimization Tasks

	Attribute	Building Profile				
Profile	State of the Systems Building Operating Cost Energy Reduction Potential Energy Project Complexity (LOE)	A	B	C	D	E (New)
	ROI - Project Payback	< 3	< 5	< 10	> 10	N/A
Project Phase & Task						
Planning	RELSA & TA Study	X	X	X	X	
Safety & Energy Optimization Project	Minor Engineering	X	X			
	Major Engineering			X	X	
	Component Repair Maintenance	X	X	X	X	
	Retrofits & Component Upgrades		X	X	X	
	Component Replacement			X	X	
	New Equipment Installation				X	
	TAB	X	X	X	X	
	CX	X	X	X	X	
Sustainability Program	LVMP	X	X	X	X	X
	Training	X	X	X	X	X
	Routine T&M Services	X	X	X	X	X

Demand Based Optimization - Success

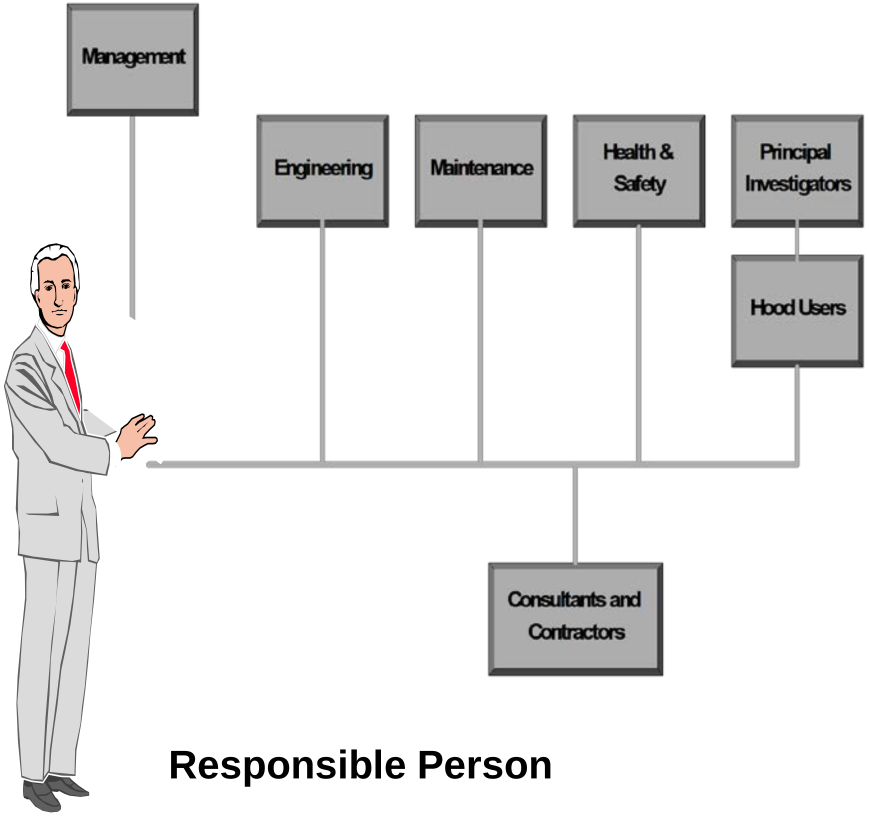
Building	Baseline Airflow cfm	Annual Operating Cost $	Final Airflow cfm	Flow Reduction cfm	% Flow Reduction	Annual Cost Savings $ @ $4.50/cfm-yr	GHG Reduction tons/yr
Gov 1 (5 bldgs)	773,000	3,478,500	518,000	255,000	33%	1,147,500	15,300
Gov 2 (1 bldg)	66,000	297,000	37,000	29,000	44%	130,500	1740
Gov 3 (1 bldg)	71,000	319,500	56,000	15,000	21%	67,500	900
Gov 4 (2 bldgs)	144,000	648,000	101,000	43,000	30%	193,500	2580
Gov 5 (1 bldg)	51,000	229,500	35,000	16,000	31%	72,000	960
Gov 6 (1 bldg)	47,000	211,500	33,000	14,000	30%	63,000	840
Biotek 1 (1 bldg)	11,000	49,500	7,000	4,000	36%	18,000	240
Pharma 1 (4 bldgs)	628,000	2,826,000	470,000	158,000	26%	711,000	9,720
Pharma 2 (1 bldg)	168,000	756,000	120,000	48,000	28%	216,000	2880
University 1 (1 bldg)	394,000	1,773,000	332,000	62,000	16%	279,000	3780
University 2 (1 bldg)	180,000	810,000	135,000	45,000	25%	202,500	2760
Summary	2,533,000	$11,398,500	1,844,000	693,808	29%	$3,100,500	41,700

Safe Sustainable Energy Use – Protect ROI



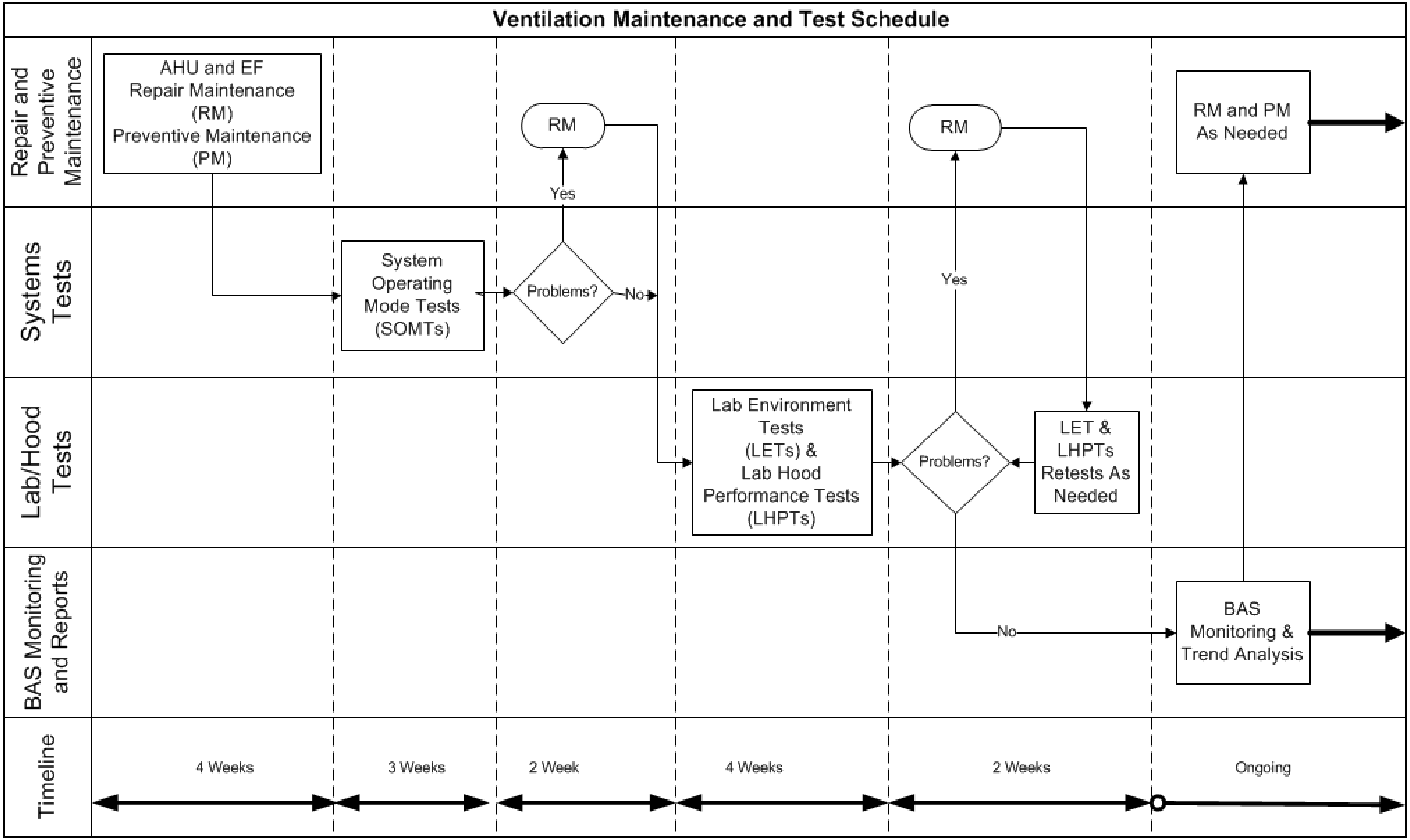
Laboratory Ventilation Management Plan (LVMP)

- **System Management and Sustainability Plan**
  - Organization and Responsibilities
  - Effective Collaboration/Integration
  - SOP's for Testing and Maintenance
  - Metrics, Monitoring & BAS Utilization
- **Ventilation Design Standards**
  - Commissioning Guidelines
- **Management of Change**
- **Personnel Training**
- **Required By ANSI Z9.5-2012**



Responsible Person

Ventilation Maintenance and Test Schedule



Training of Personnel

- Lab Personnel
- Facility Maintenance
- Building Operators

Lab Ventilation Optimization Process (LVOP)

- **Safe**
- **Energy Efficient**
- **Sustainable**

Thomas C. Smith

ECT, Inc.

Exposure Control Technologies, Inc.
919-319-4290
www.exposurecontroltechnologies.com
tcsmith@labhoodpro.com

LAZARE RESEARCH BUILDING

Laboratory Ventilation Optimization Project

University of Massachusetts UMASS. Medical School

umassmed.edu

Project Goals

1. Reduce air change rates in the high bay laboratories to 4.5 air changes per hour while maintaining a high degree of indoor air quality
2. Reduce air change rates in the Animal Holding Areas to 8 air changes per hour while maintaining a high level of indoor air quality
3. Reduce fume hood face velocity to 70 fpm while improving hood performance
4. Avoid interruptions to ongoing research
5. Maintain Pressure Relationships Between Adjacent Spaces
6. Implement Laboratory Ventilation Management Plan

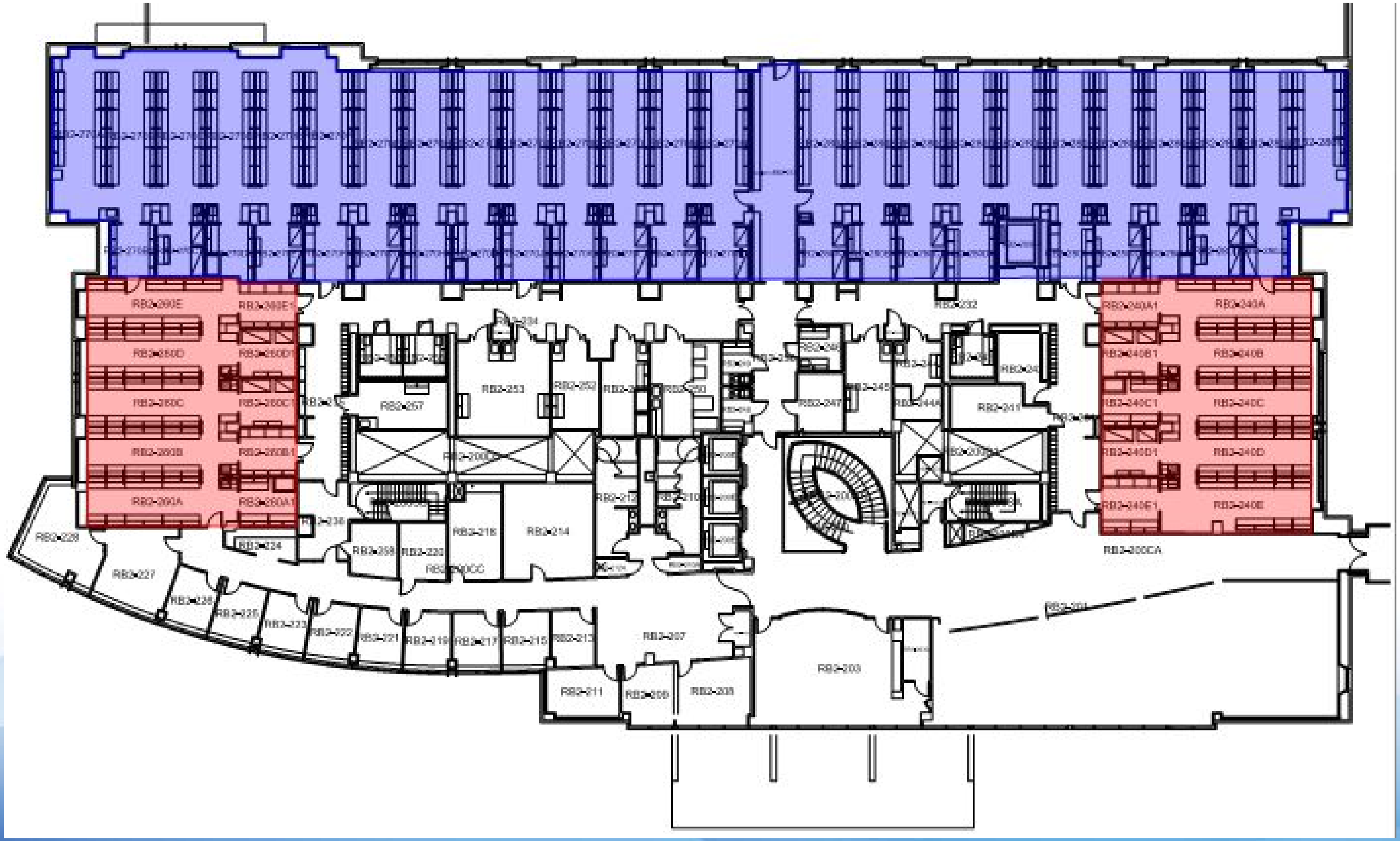
Project Team

National Grid:	Fran Boucher Michael Horton
NSTAR:	John Kibbee
Andelman & Lelek:	Michael Andelman Alison Farmer
UMass Med:	John Baker Mark Armington Melissa Lucas David MacNeil EH&S
Aircuity:	Jim Robichaud Chuck McKinney
Exposure Control Technologies:	Thomas Smith

Project Milestones

Fall 2009:	National Grid Approaches UMass with their "Health and Safety First" approach to Laboratory Energy Projects
Summer 2010:	Laboratory Ventilation Optimization Project (LVOP^{TM}) completed by Exposure Control Technologies
Fall 2010:	Energy Conservation Measures (ECM's) evaluated by Andelman & Lelek. Minimum project requirements defined.
Fall 2013:	Project Start
Spring 2014:	Project Completion

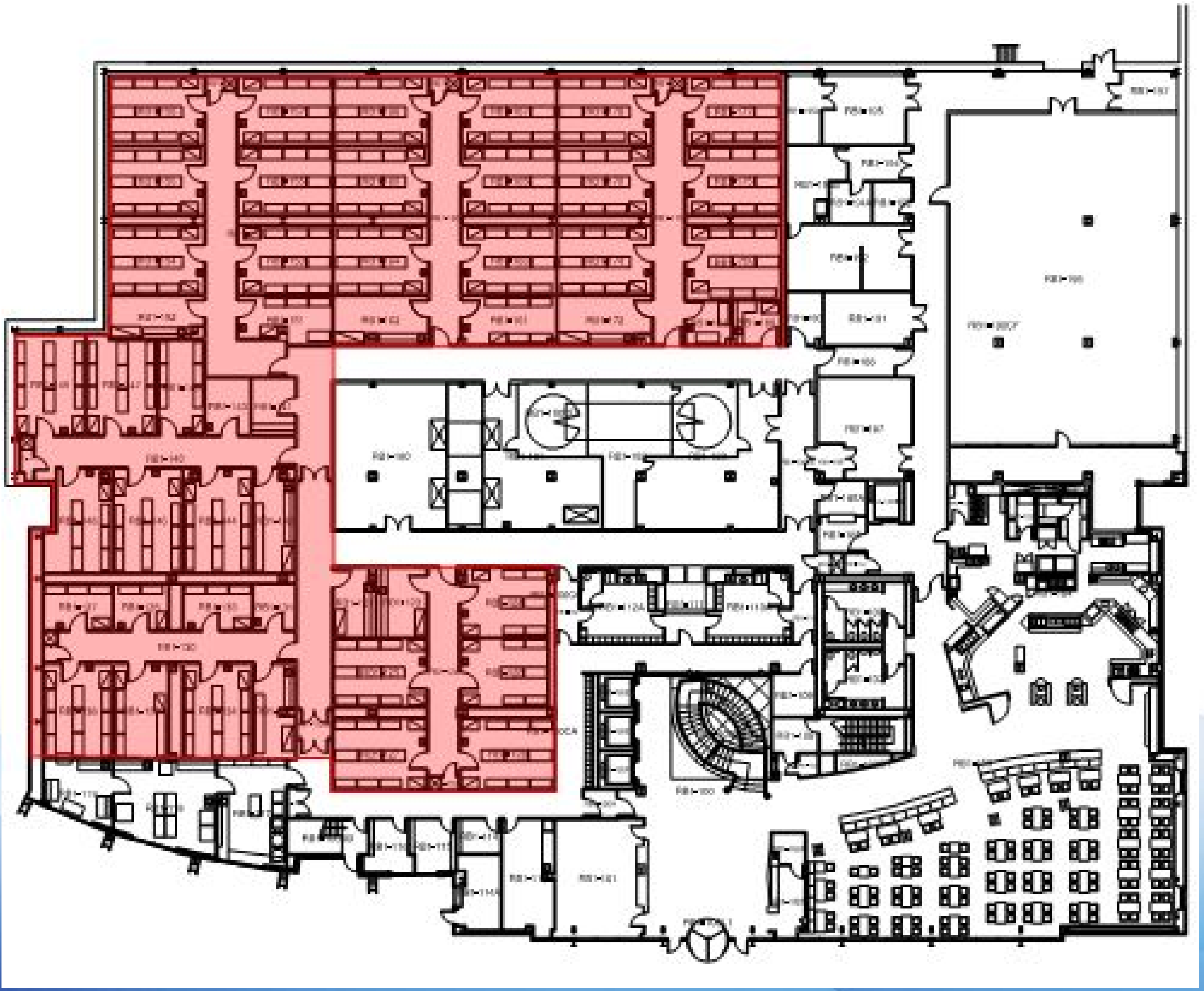
Typical Lab Floor 2 -9



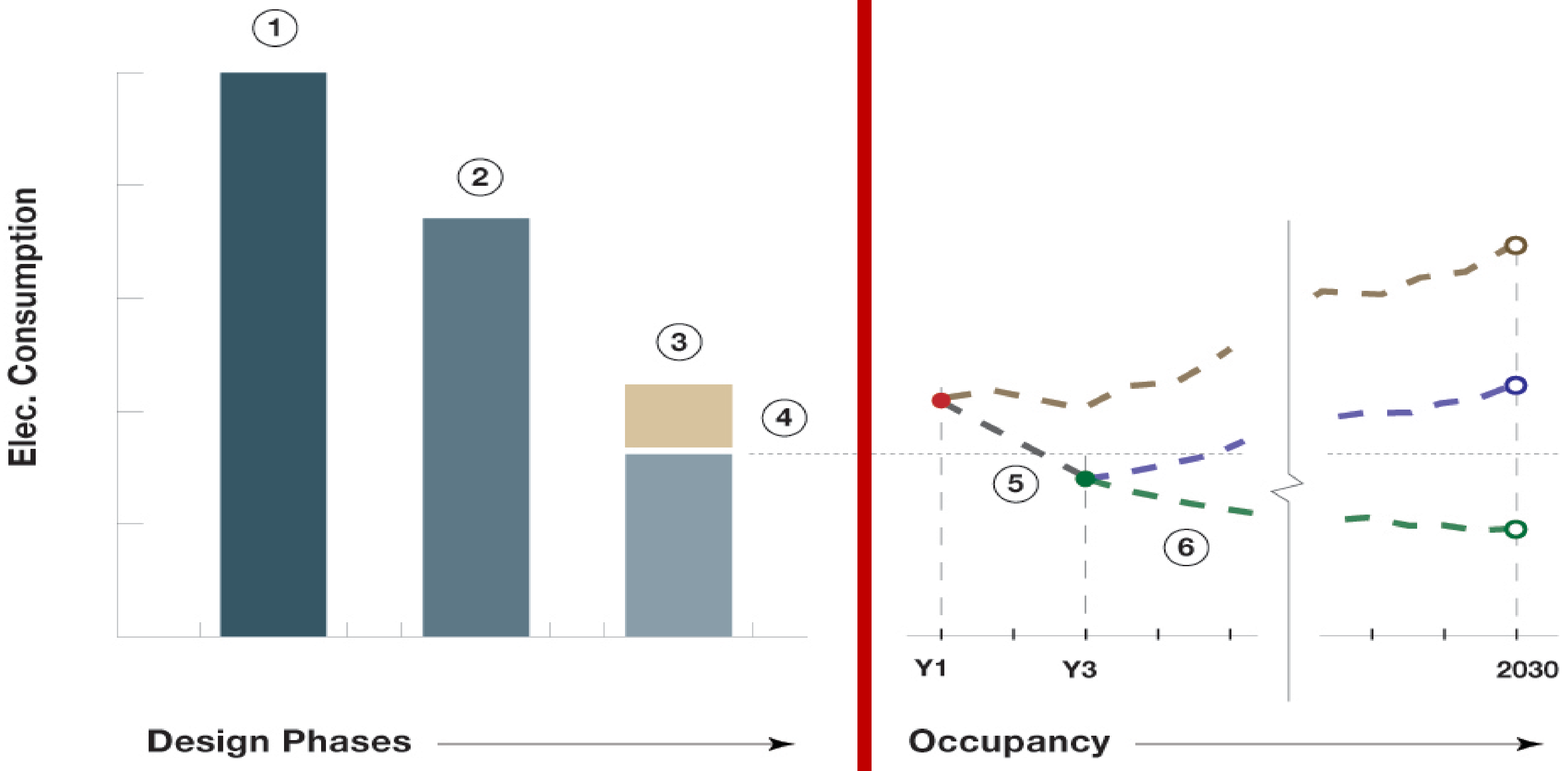
University of Massachusetts UMASS. Medical School

umassmed.edu

Vivarium Animal Holding Rooms



University of Massachusetts
UMASS. Medical School
umassmed.edu



PEUI

EUI

University of Massachusetts Medical School
umassmed.edu

LVOP Results and ECMs

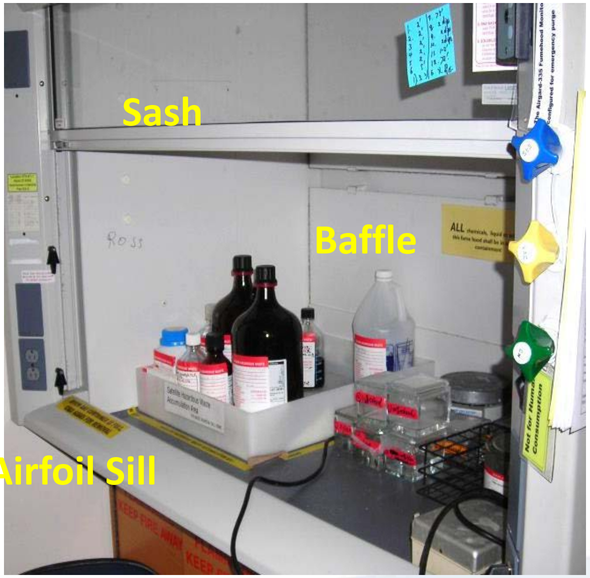
Results during initial investigation indicated:

- Many labs under positive pressure
- Excess Supply
- Greater than 12 ACH
- Greater than 17% error in flow reported by Terminals to BAS

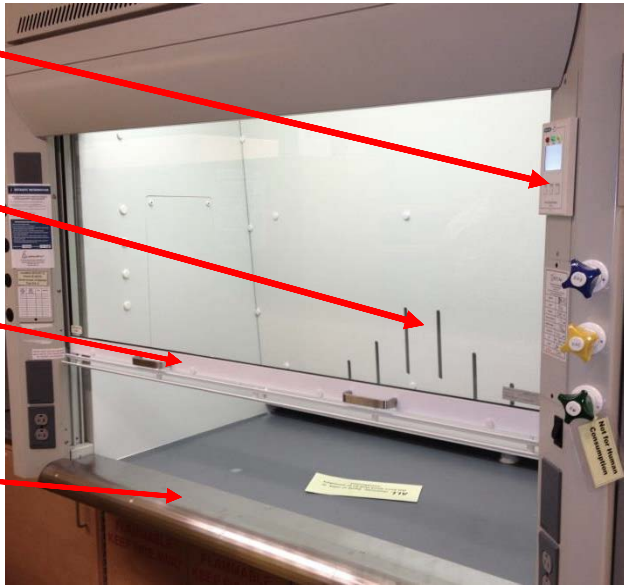
ECM#1a:	Cleaning of Exhaust Boxes and Returning to Original Design Values
ECM#1b:	Install Fume Hood Retrofit Kit
ECM#2:	Demand Controlled Ventilation System – Laboratory
ECM#3:	Demand Controlled Ventilation System – Vivarium

Fume Hood Retrofit

Traditional Fume Hood



Traditional Fume Hood w/Performance Upgrades



<u>109 Fume Hoods</u>

85 5-ft Constant Air Volume Fume Hoods (450 CFM to 315 CFM)

24 6-ft Variable Air Volume Fume Hoods (775 CFM to 545 CFM)

30% Reduction in Exhaust Flow

Improved Containment

Installation = 2-3 hrs. each.

University of Massachusetts UMASS. Medical School
umassmed.edu

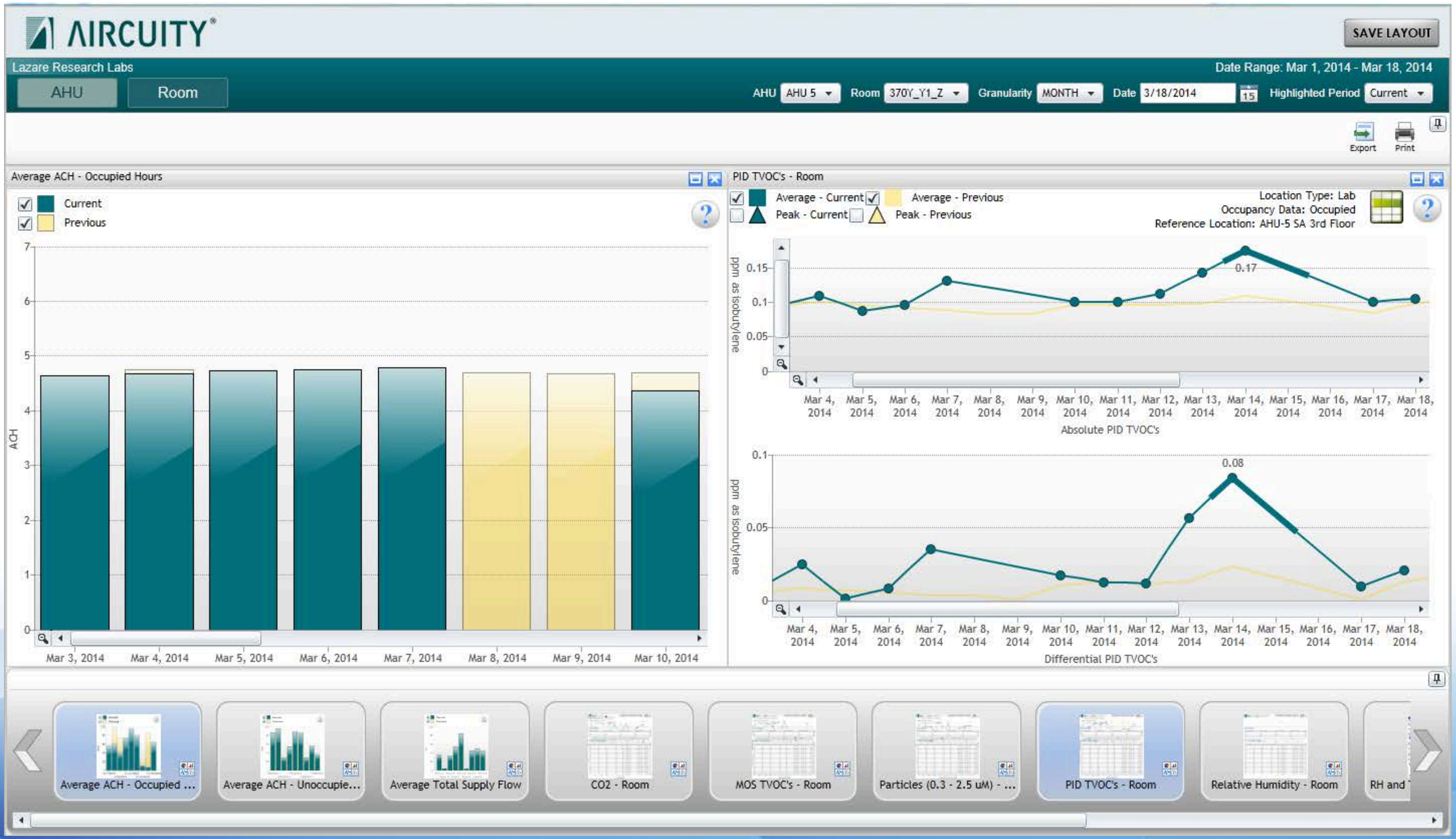
5th Floor

Zone	Area	Ceiling Height	Volume	Supply Box Size	Supply Box Min	Original Airflow CFM	Original Airflow ACH	New Airflow CFM	New Airflow ACH		Exhaust Box Size	Exhaust Box Min	Original Exhaust CFM	Original Exhaust ACH	New Exhaust CFM	New Exhaust ACH	Zone Pressure
560A,A1,B	792	9	7128	14	335	900	7.6	500	4.2		14	335	1100	9.3	400	3.4	
560C,D,E,E1	1126	9	10134	19	845	900	5.3	750	4.4		16	440	600	3.6	650	3.8	
560B1	122	8.5	1037	8	105	550		550			8	105	550		550		
560C1 (Hood)										315							
560D1	122	8.5	1037	8	105	550		550			8	105	550		550		
								2350		315					2150		-4.89%
570A,B,B1,C,D	1628	9	14652	[illegible]	845	[illegible]	[illegible]	1100	4.5		[illegible]	[illegible]	[illegible]	[illegible]	1000	4.1	
570E,F,F1,G,H	1525	9	13725	19	845	1700	7.4	1000	4.4		19	845	1000	4.4	900	3.9	
570I,J,J1,K,L	1461	9	13149	19	845	1700	7.8	1000	4.6		19	845	1400	6.4	900	4.1	
570M,N,O,O1,P	1462	9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4.1	
570Q,R,S,T	1115	9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4.2	
570U,U1,V,W,X	1705	9	15345	19	845	1700	6.6	1100	[illegible]		19	845	1400	5.5	1000	3.9	
570Y,Y1,Z	797	9	7173	14	335	900	7.5	550	4.6		14	335	900	7.5	450	3.8	
570C1 (Hood)										315							
570D1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		550			[illegible]	[illegible]	[illegible]		550		
570E1	122	8.5	1037	8	105	550		550			8	105	550		550		
570G1 (Hood)										315							
570H1	122	8.5	1037	8	105	550		550			[illegible]	105	550		550		
570I1	122	[illegible]	[illegible]	[illegible]	105	[illegible]		550			[illegible]	105	[illegible]		550		
570K1	122	8.5	1037	8	105	550		550			8	105	550		550		
570L1 (Hood)										315							
570M1	122	8.5	1037	8	105	550		[illegible]			[illegible]	[illegible]	[illegible]		550		
570N1	122	8.5	1037	8	105	550		550			8	105	550		550		
570P1	122	8.5	1037	8	105	550		550			8	105	550		550		
570Q1 (Hood)										315							
570R1	122	8.5	1037	8	105	550		550			8	105	550		550		
570S1	122	8.5	1037	8	105	550		550			8	105	550		550		
570V1	122	8.5	1037	8	105	550		550			8	105	550		550		
570W1	122	8.5	1037	8	105	550		550			8	105	550		550		
570X1 (Hood)										315							
								13250		1575					12450		-5.85%
540A,A1,B,C	1120	9	10080	19	845	1100	6.5	850	5.1		19	845	800	4.8	750	4.5	
540D,E,E1	856	9	7704	14	335	800	6.2	500	3.9		14	335	900	7.0	400	3.1	
540B1	122	8.5	1037	8	105	550		550			8	105	550		550		
540C1 (Hood)										315							
540D1	122	8.5	1037	8	105	550		550			8	105	550		550		
								2450		315					2250		-4.69%
Total Airflow						23700		18050					21500		16850		
Average ACH							7.3		4.5					6.4		3.9	

"...ACH rates cannot simply be lowered below original design specifications without consideration of the engineering and safety implications of the change"

-Journal of Chemical Health & Safety

Diagnostic and Reporting tools



University of Massachusetts
UMASS. Medical School
umassmed.edu

Project Summary

➢ Fume Hood Face Velocity Reduction:	100 to 70 fpm
➢ Fume Hood Air Flow Reduction:	12,000 CFM
➢ Laboratory Air Change Rate Reduction:	10.2 to 4.5
➢ Laboratory Air Flow Reduction:	64,000 CFM
➢ Vivarium Air Change Rate Reduction:	13.4 to 10.8
➢ Vivarium Air Flow Reduction:	5,600 CFM
➢ Total Project Cost:	$1,751,416
➢ Annual Savings:	$518,319
➢ NGRID/Nstar Utility Rebates:	$1,049,744
➢ Payback after rebate:	1.4 years

UMASS. University of Massachusetts Medical School
umassmed.edu

Lessons Learned

- **Do your homework!**
  - Understand your mechanical system capabilities
  - Measure and record current baselines
  - Understand current lab utilization
- **Communicate!**
  - …with all constituents
  - …before, during & after the project
- **Follow Thru!**
  - Lab Ventilation Mgmt Plan

Questions?

University of Massachusetts Medical School
UMASS.
umassmed.edu