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· August 15-18, 2010 · Dallas, Texas ·
· Dallas Convention Center ·

High Performance Laboratories

Safe, Energy Efficient, Sustainable

EXPOSURE CONTROL SYSTEMS

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CRITICAL CONTROL ENVIRONMENTS

- Chemical and Rad Labs
- Biology Labs (BSL_{2-4})
- Nanotechnology Labs
- Animal Vivariums
- Clean Rooms
- Isolation Suites

High Performance Laboratories

- Safe
- Productive (Flexible)
- Dependable
- Energy Efficient
- Sustainable

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Primary Objective:

Lab Safety
and
Personnel Protection

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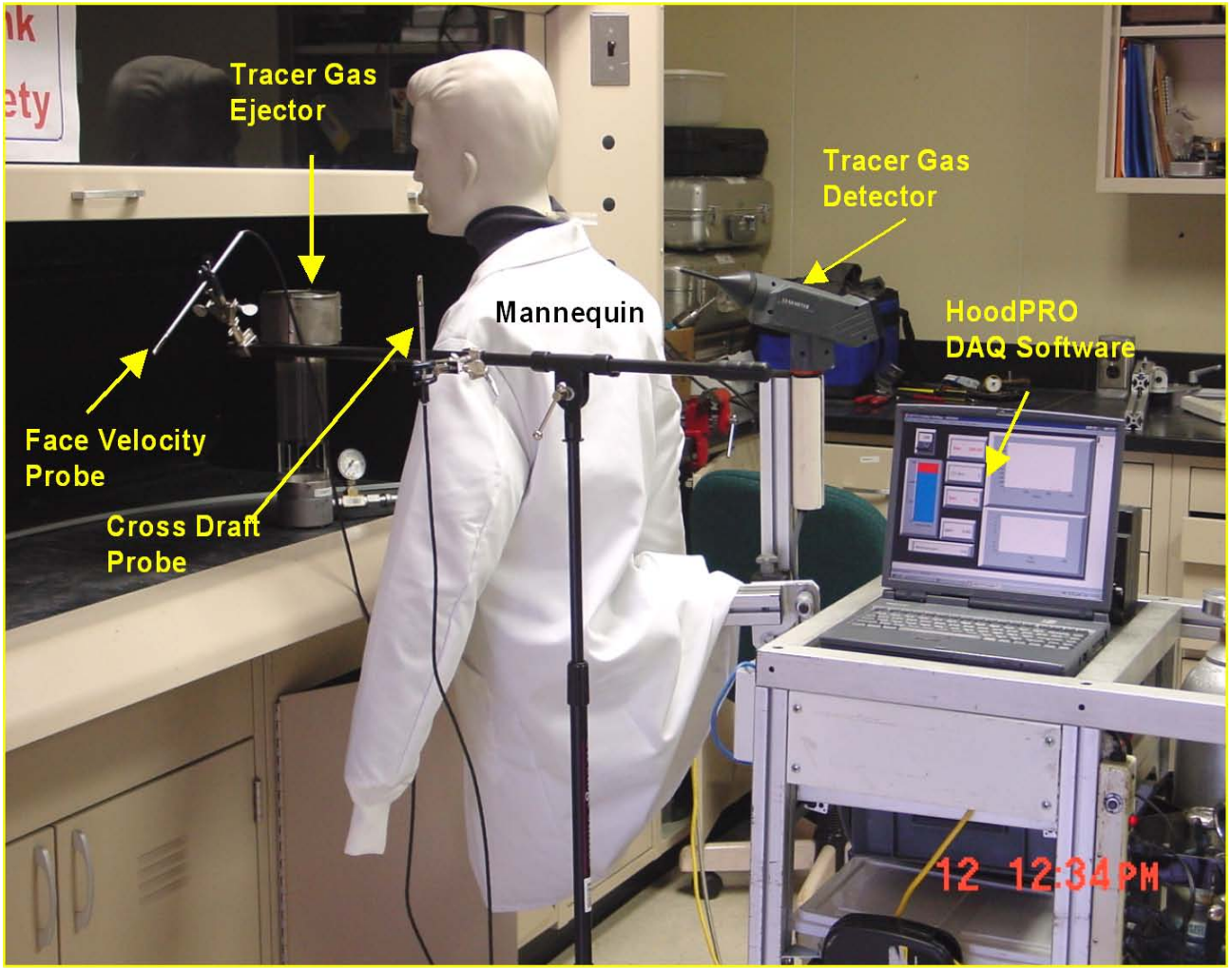
LABORATORY HOOD TEST SYSTEM



Evaluate Operating Conditions, Containment and Factors Affecting Performance

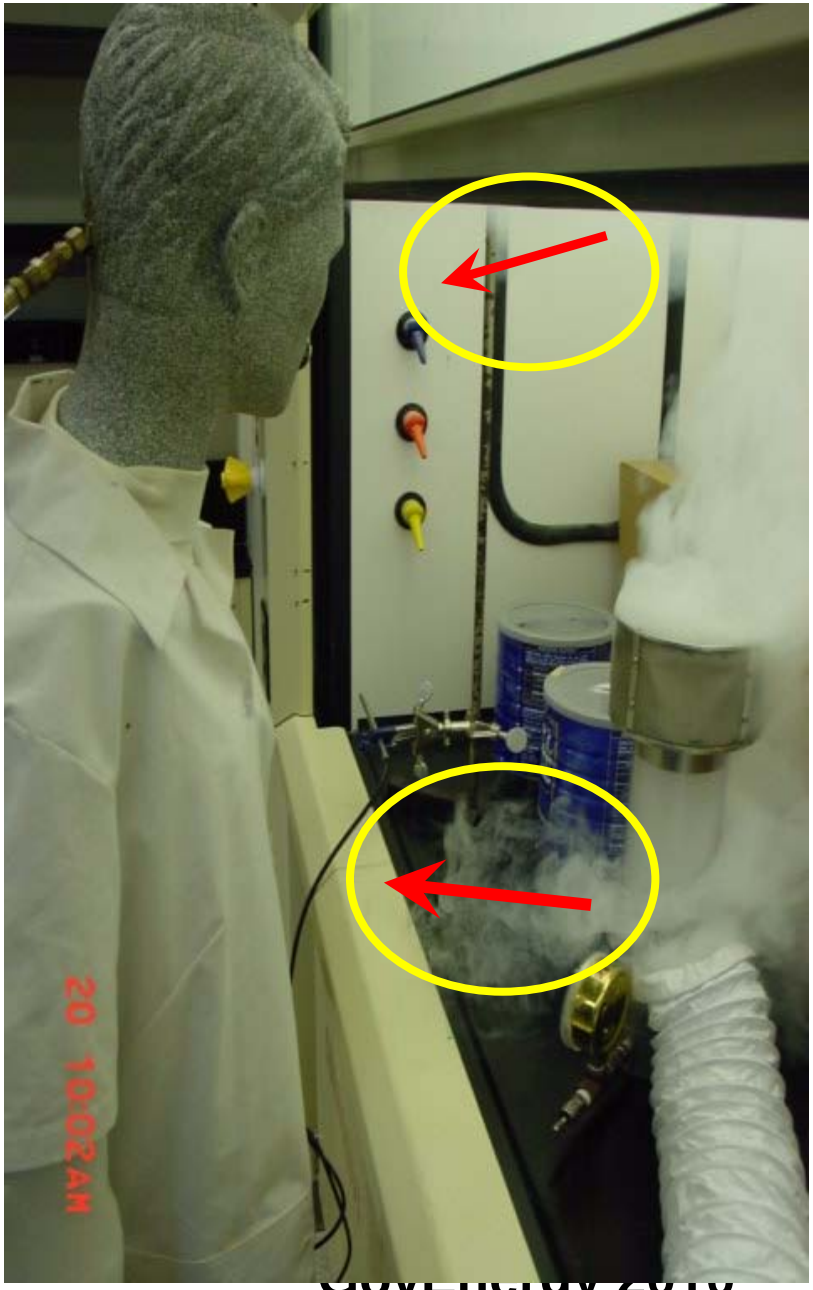
Laboratory Hood Safety

Tracer Gas Containment Tests

> 15% Failure

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

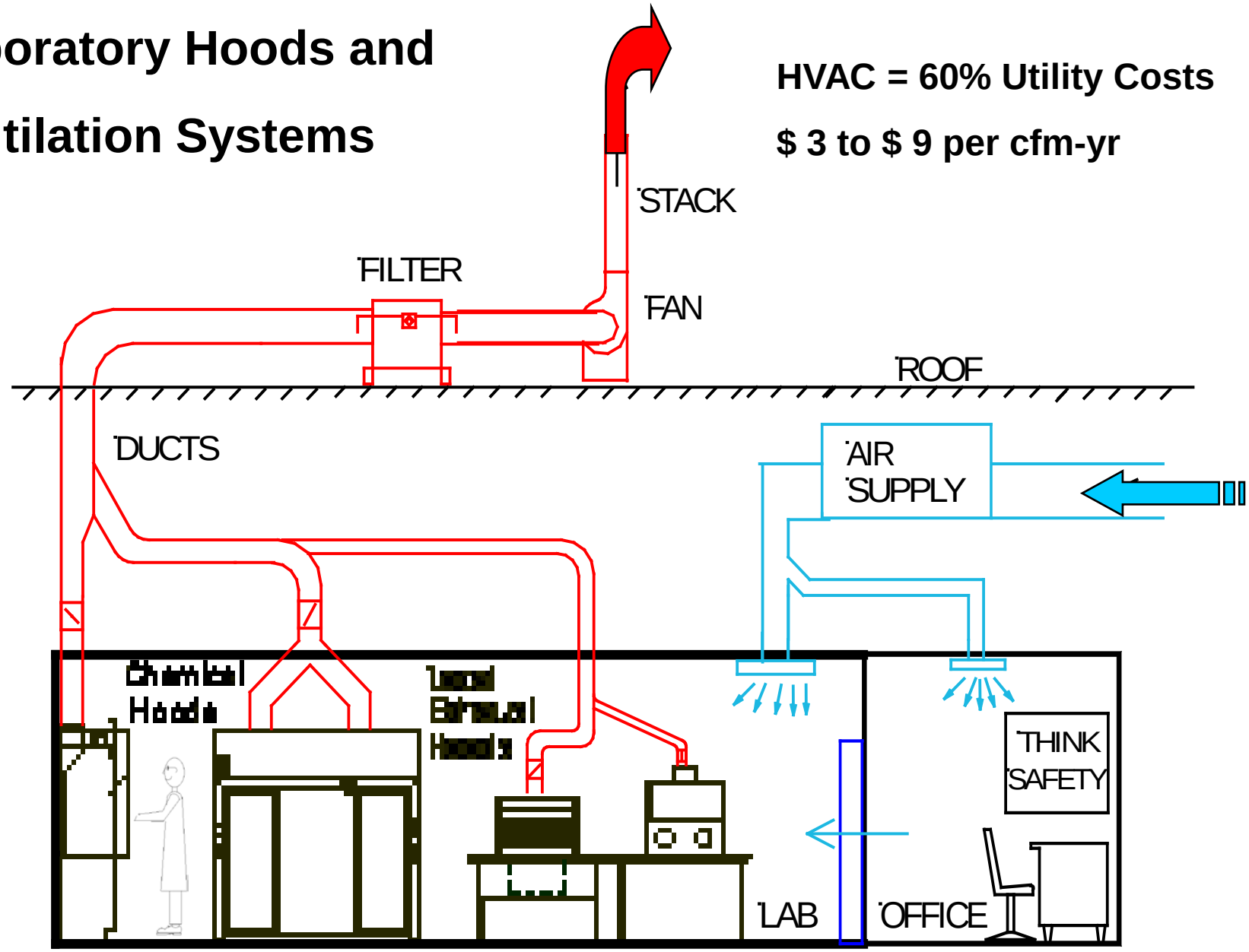
55%



Laboratory Hoods and Ventilation Systems

HVAC = 60% Utility Costs

$ 3 to $ 9 per cfm-yr



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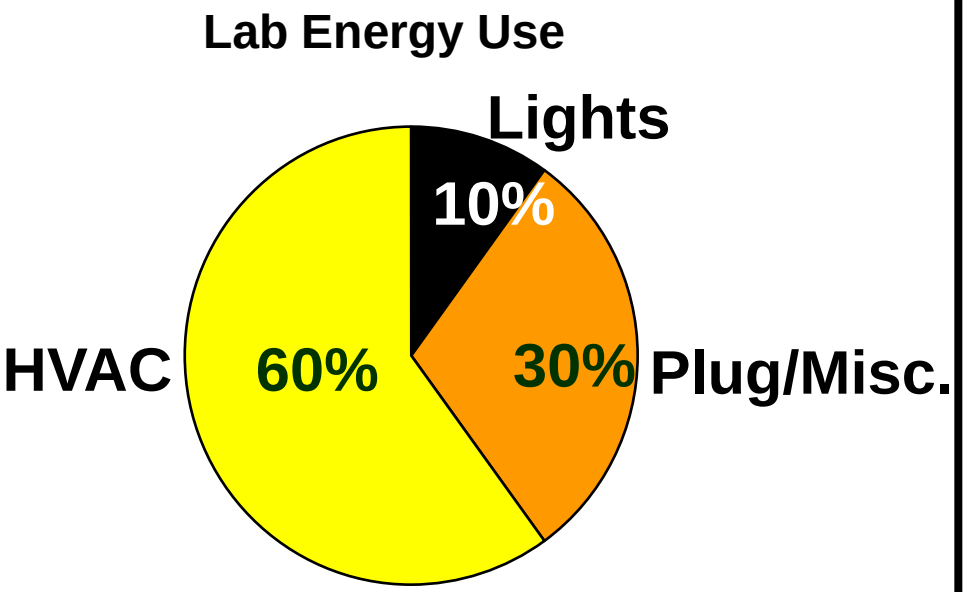
UTILITY COSTS FOR LABORATORIES

Laboratories are far more expensive to operate than commercial buildings.

Equivalent Annual Energy of One 6ft. CAV Fume Hood

- Three 2500 sq. ft. houses
- Fifty 100 watt light bulbs
- 1500 gallons of gasoline
- 80 tons CO^2 emissions

Facility Type	Average Utility Cost
Commercial	$ 1 / ft^2
Hospital	$ 3 / ft^2
Laboratory	$ 7 / ft^2
Specialty Labs & Cleanrooms	≥ $ 15 / ft^2



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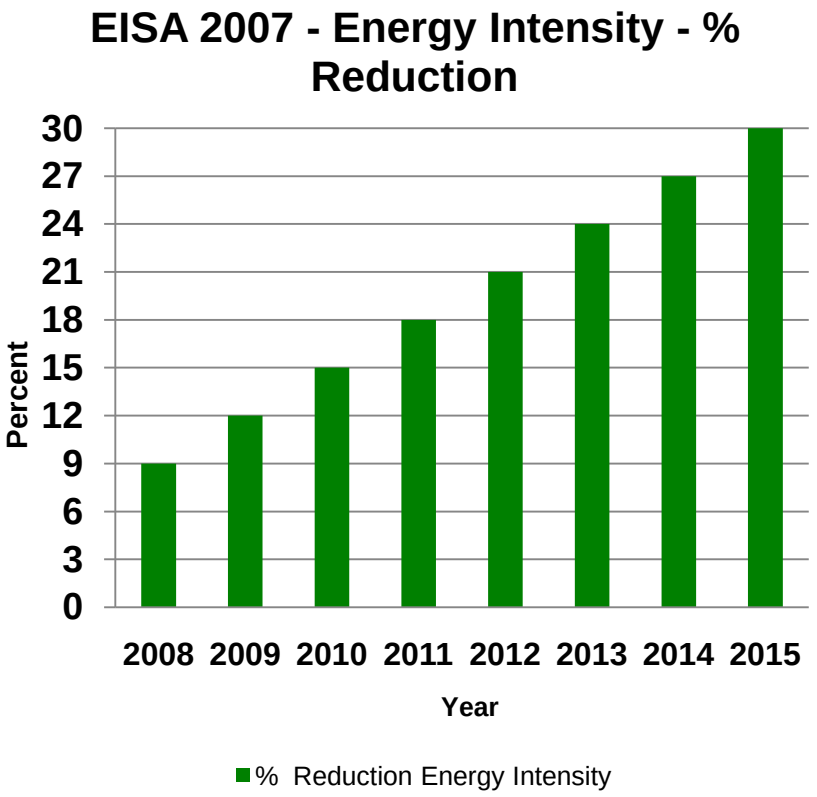
EPAct 2005 and EISA 2007

- Energy Policy Act
  - Metering by 2012
- Energy Independence Security Act
  - Energy Reduction Goals
  - Energy Intensity (BTU/ft^2)
  - 30% Reduction by 2015



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SUMMARY OF OBJECTIVES

- Ensure Safety
- Improve Reliability
- Minimize Operating Costs & GHG Emissions

Safety & Reliability

Energy Use

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Demand Based Optimization

Reduce energy use by modifying the laboratory systems to meet and track the varying demands for ventilation.

- Safety
  - Hood Exhaust Requirements
  - Laboratory Pressurization
  - Laboratory Airflow (Dilution / Extraction)
- Comfort (IAQ)
  - Temperature
  - Humidity
- Occupancy

Opportunities to Improve Safety and Reduce Energy Consumption

Current Operation vs. Current Demand

- Laboratory Hoods Types
- Fume Hood Face Velocity and Minimum Flow
- Lab ACH and Air Change Effectiveness
- Cooling and Heating Loads
- Temperature Control
- Occupancy and Hood Use
- Exhaust Discharge and Plume Dispersal

Energy Reduction must not Jeopardize Lab Safety or Hood Performance

Opportunities to Improve Safety and Reduce Energy Consumption

Modify Systems to Meet Current Demand

- Remove Unnecessary Hoods from Service
- Hibernate Hoods and Labs (Short Term Vacancies)
- Retrofit Hoods (Better Performance, Less Flow)
- Improve VAV Controls (Better Accuracy, Precision, Reliability)
- Improve Sequences of Operation
- Upgrade & Install High Efficiency Equipment

REMOVE / TURN OFF UNNECESSARY HOODS

Canopy Hoods

- Heat Removal Only
- Limited to No Protection
- Very High Airflow Rates
- Large Energy Waster

Operating Cost = $9000 per year

Remove Unnecessary Hoods

Vented Cabinets

- **Misapplied**
- **Limited to No Protection**
- **Large Energy Waster**

12 Vented Book Cases in one lab building @ 200 cfm each = $12,000 per year

High Performance Fume Hoods

Install, Replace or Retrofit

20% - 40% Flow Reduction

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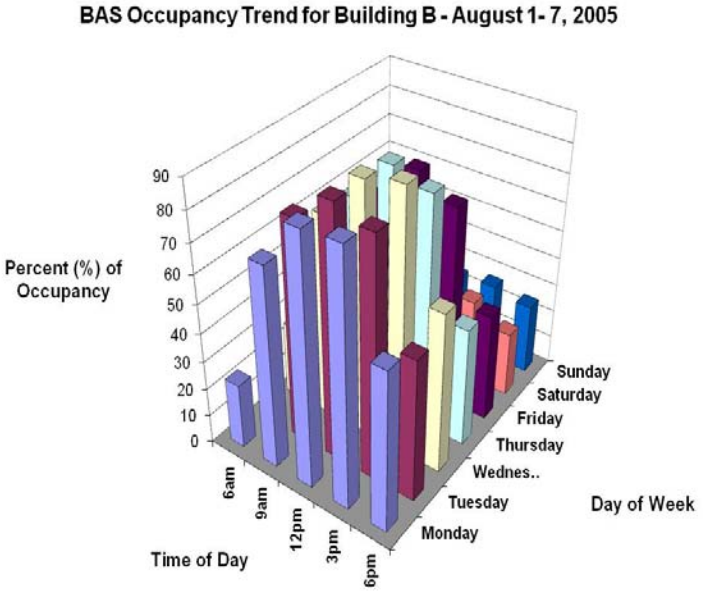
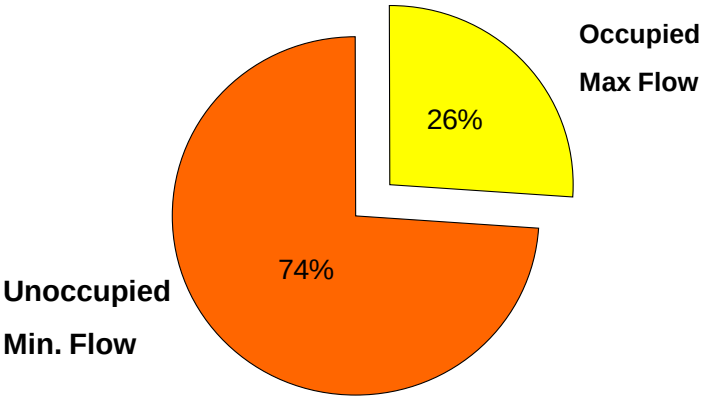
Lab Occupancy & Airflow Demand

- Lab Time vs. Analytical Time
  - Experiments in Lab
  - Analysis in Office
- Nights, Weekends, Holidays
- VAV vs. CAV



Reduce flow and use less energy during periods of reduced activity.



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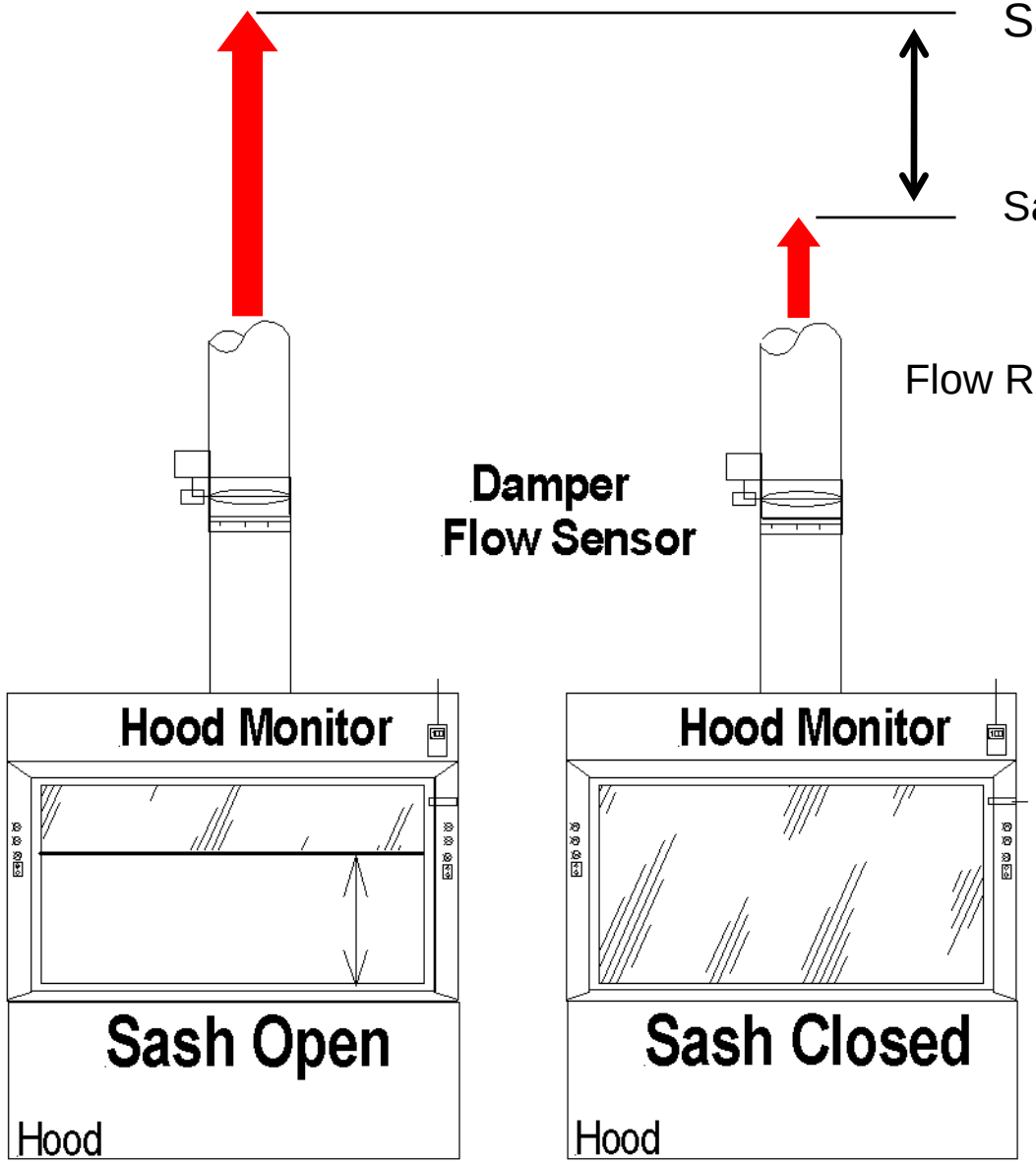
VAV Fume Hood – Exhaust Modulation

Sash Open - Qex = Vf x Af

Sash Closed - Qex = Constant

Flow Reduction = Energy Reduction



What is the Required face velocity and minimum safe flow?

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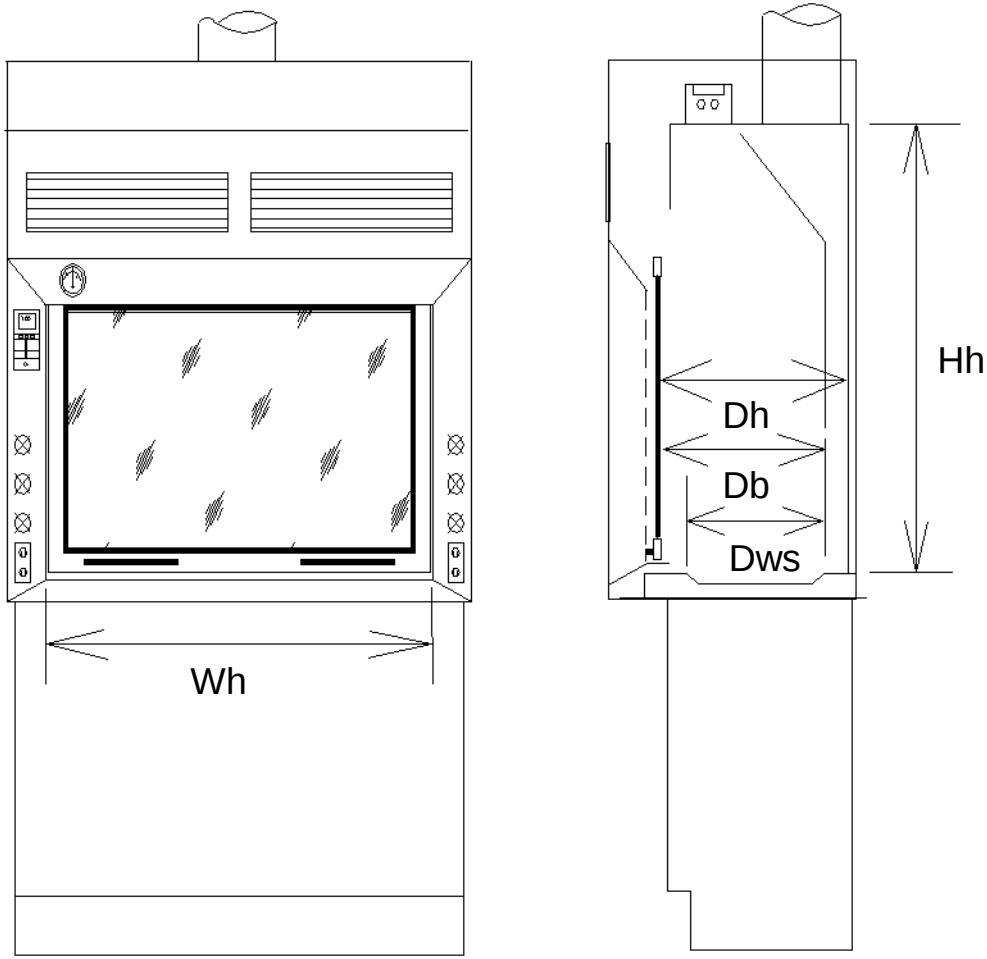
Minimum Flow Specifications

Internal Concentrations << Lower Explosion Limit (LEL)

- **NFPA 45**
  - **2004 - 25 cfm / sq. ft. of work surface**
  - **2010 - Defers to AIHA Z9.5**
- **AIHA Z9.5**
  - **150 – 375 ACH**
  - **150 ACH ~ 10 cfm / sq. ft. of work surface**



$$Vh = Db \times Wh \times Hh$$

$$ACHh = \frac{Qe}{Vh} \times 60$$

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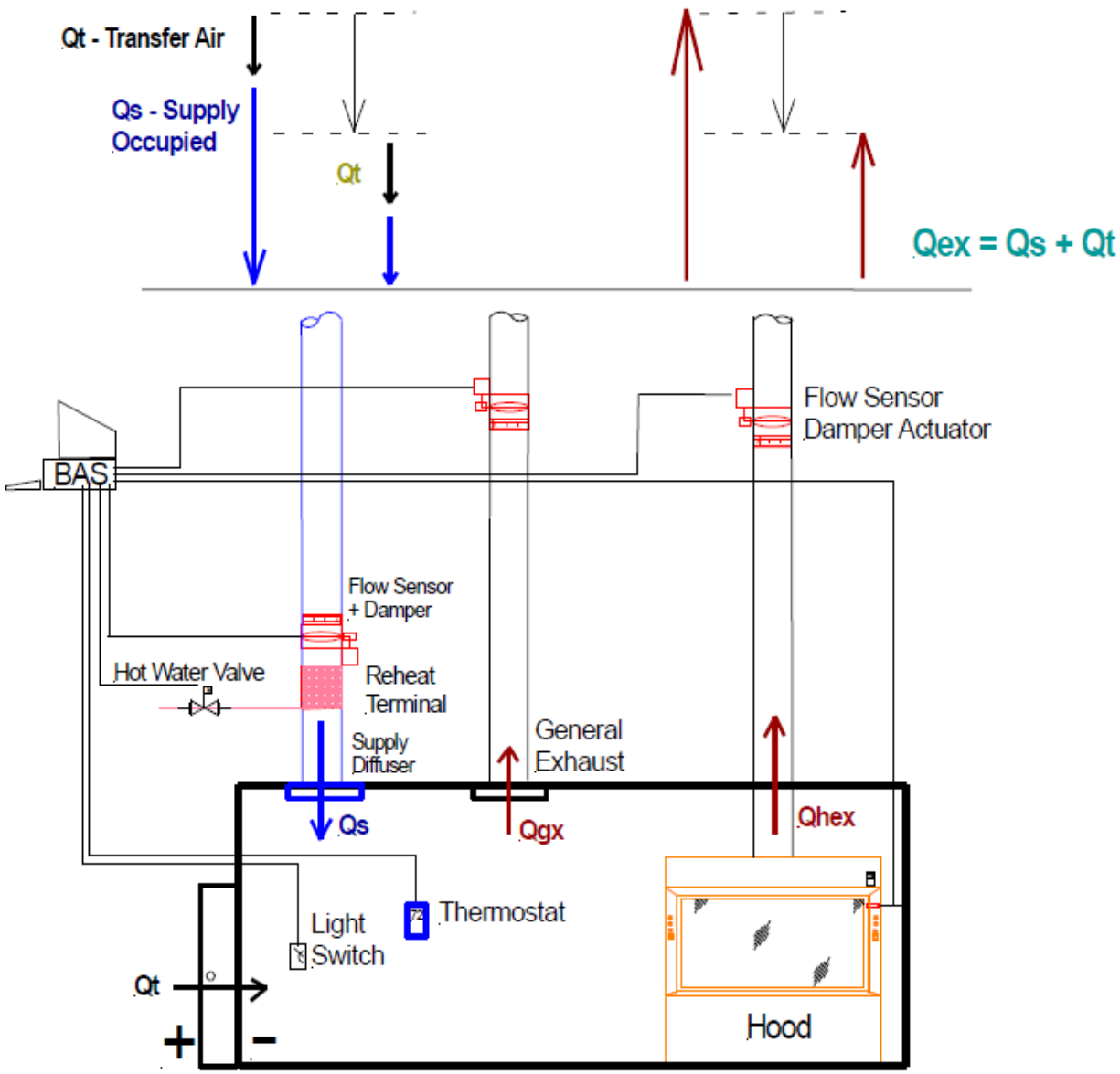
Laboratory Operating Specifications

- Min and Max Flow
- Offset Volume
- Differential Pressure
- VAV Response
- Conditioning Loads
- Air Distribution
- Air Change Effectiveness



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Airflow and Pressurization

- Minimum Airflow
  - Indoor Air Quality
  - Dilution - ACH
  - Comfort and Temperature Control
- Lab Pressurization
  - Negative (-) for secondary containment
  - Positive (+) to minimize infiltration
- Offset Flow Volume (Transfer Air)
  - Difference between supply and exhaust
  - Typically 100 cfm per door

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Lab Temperature Control

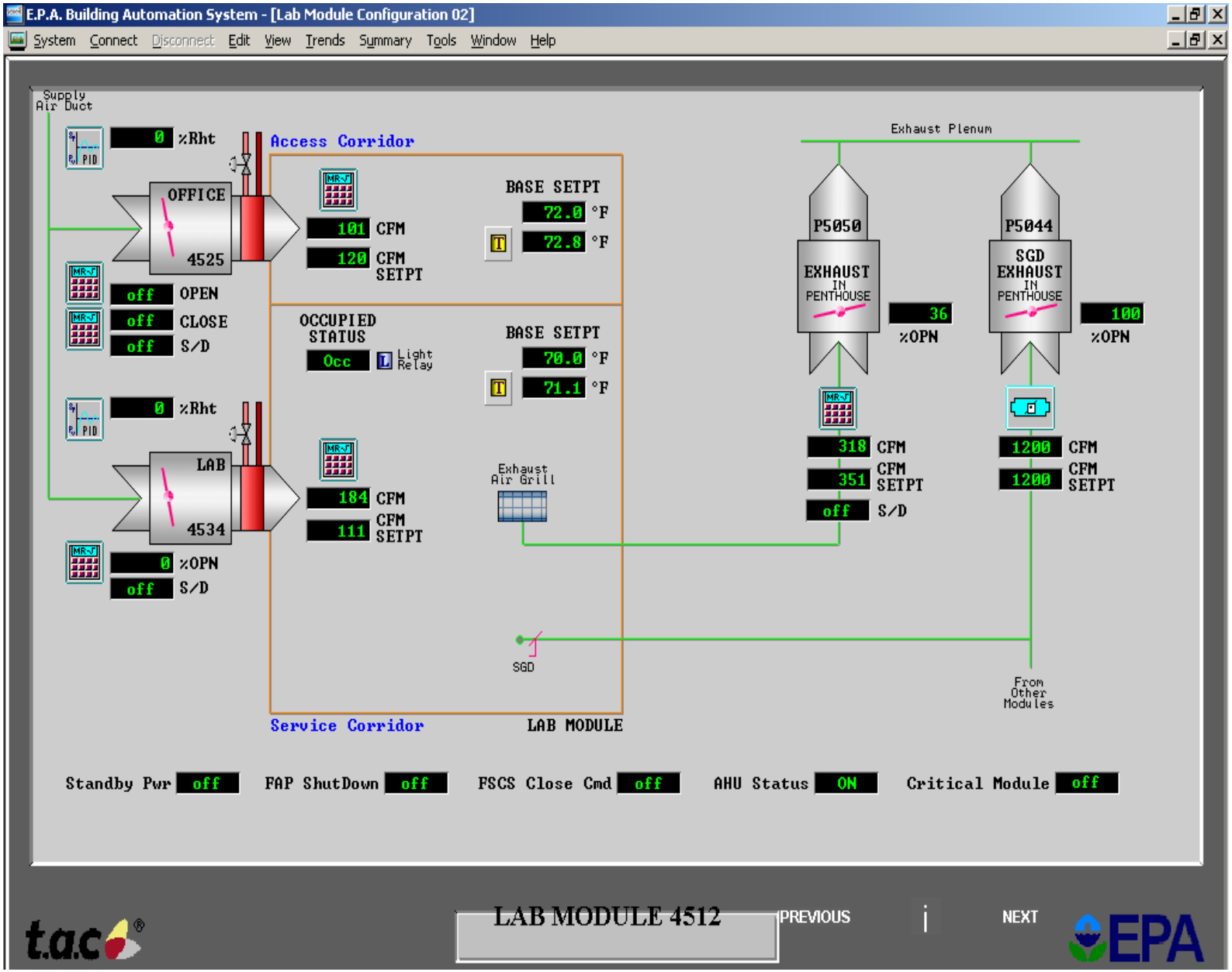
Discharge Temperature & Space Temperature

- Reheat Control
- Thermostat Location
- Sensor Calibration
- Diffuser Type and Location
- Room Air Patterns

Eliminate Simultaneous Heating and Cooling

Sensor & Monitor Calibrations

- Face Velocity
- Flow
- Pressure
- Alarm Points



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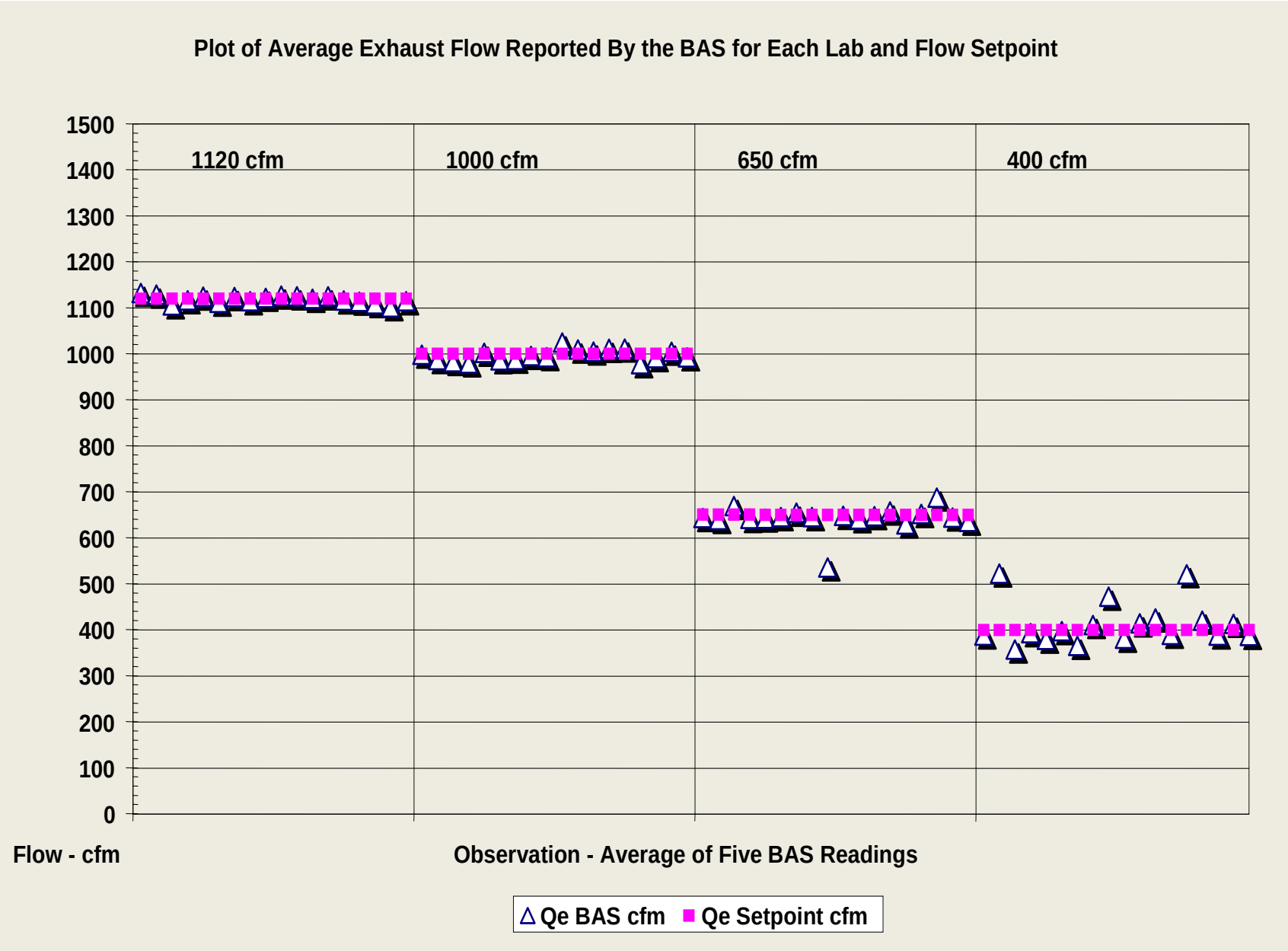

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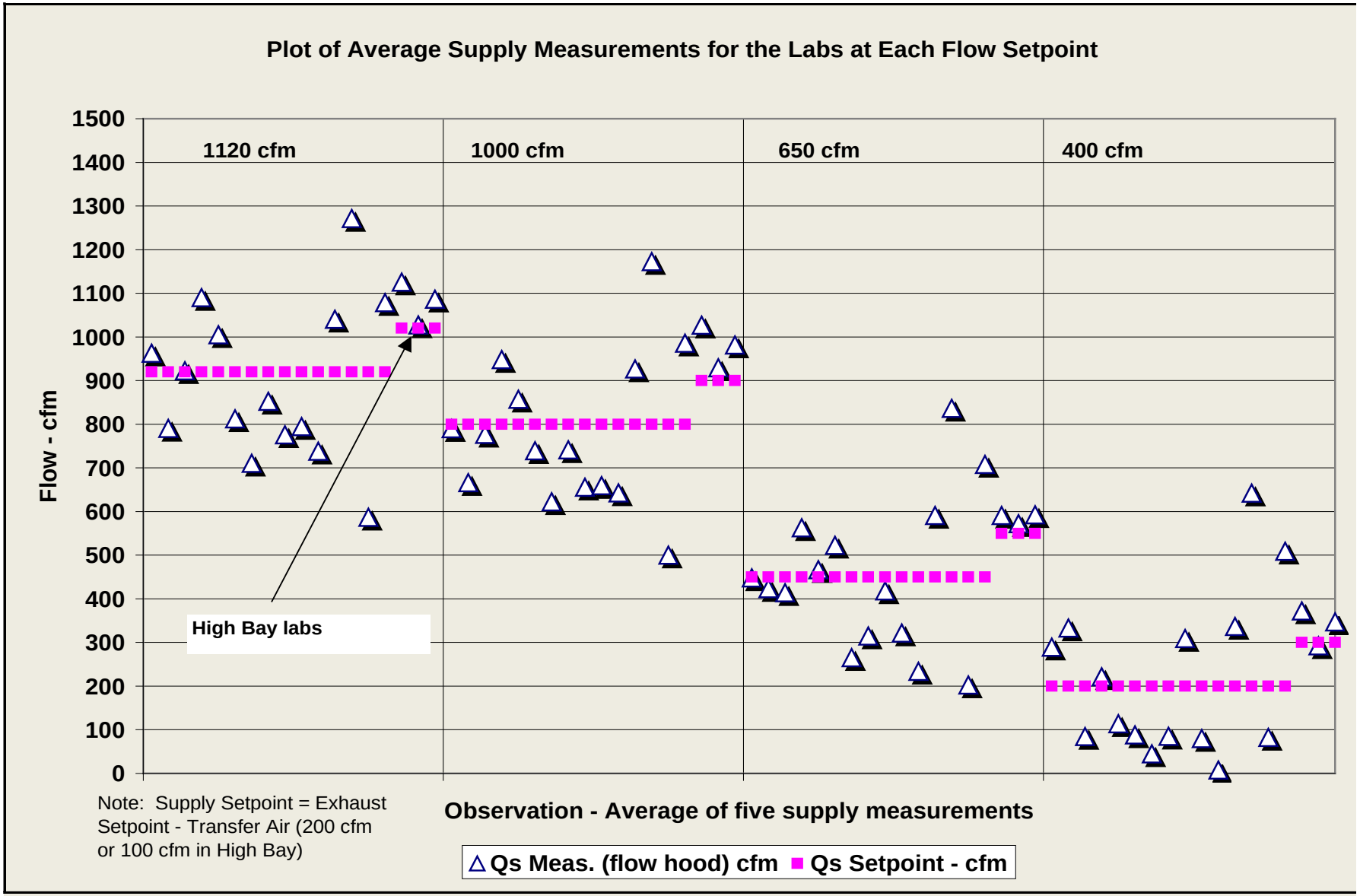

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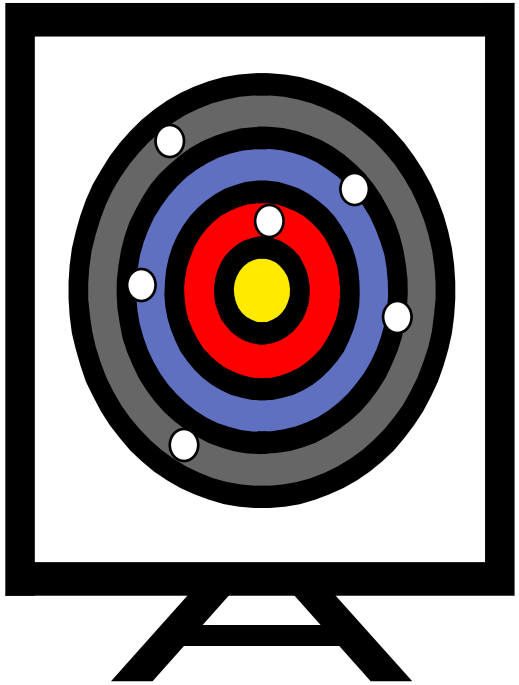
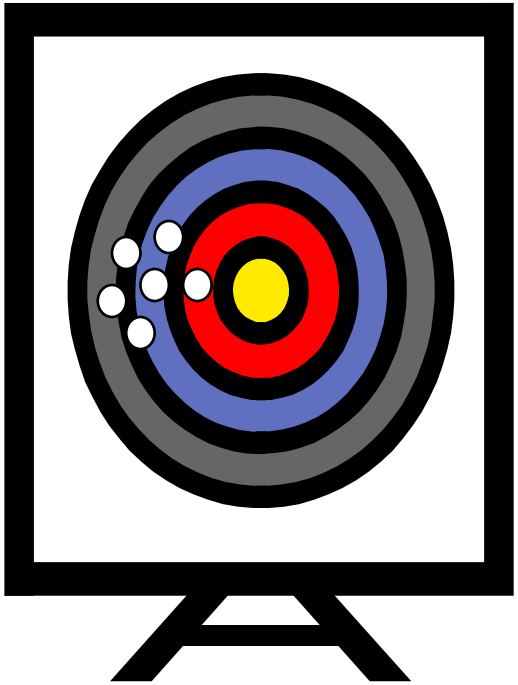
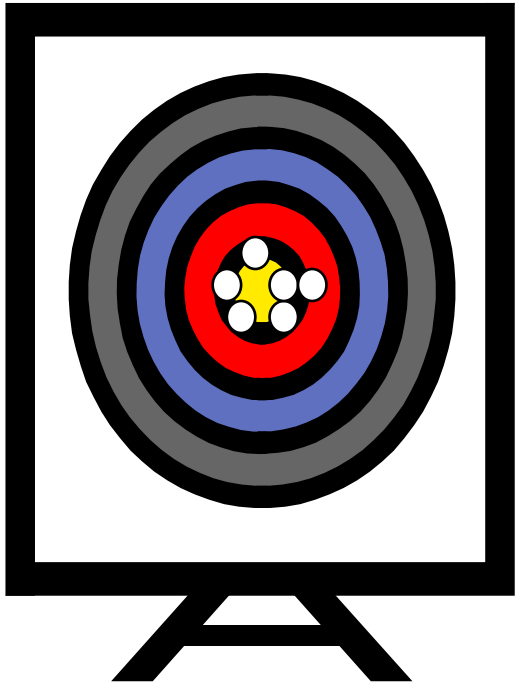
Accuracy and Precision



Not Accurate and Not Precise



Precise but not Accurate



Accurate and Precise

<u>EPA RTP</u>

Flow Sensors (Pre LVOP) = 20% to 65% Error

Flow Sensors (Post LVOP) = 5% Error

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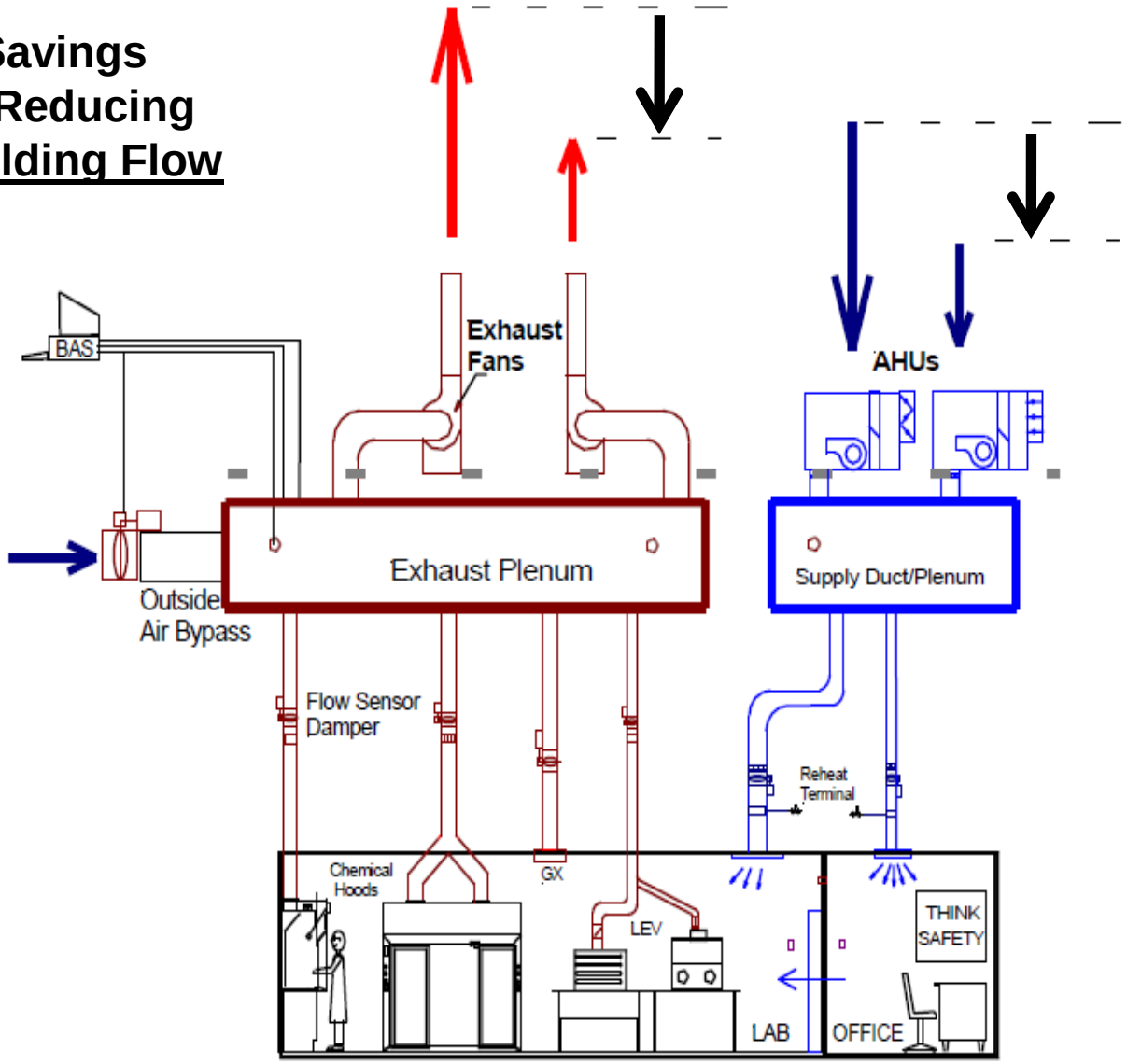
Establish System Operating Specifications

Energy Savings Require Reducing <u>Total Building Flow</u>

- **Max and Min Flows**
- **AHUs and Ex. Fans**
- **Control Capabilities**
- **Static Pressures**
- **Duct Velocities**
- **Exhaust Stack Discharge**



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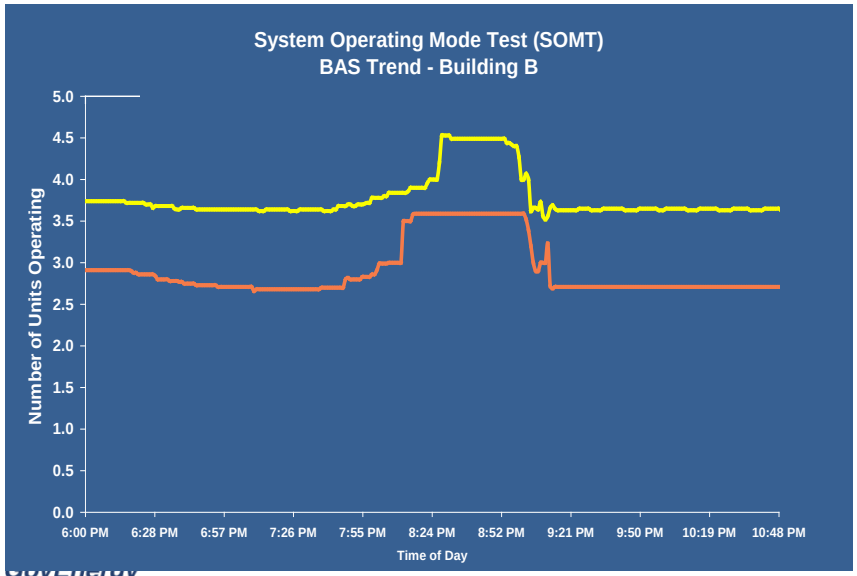
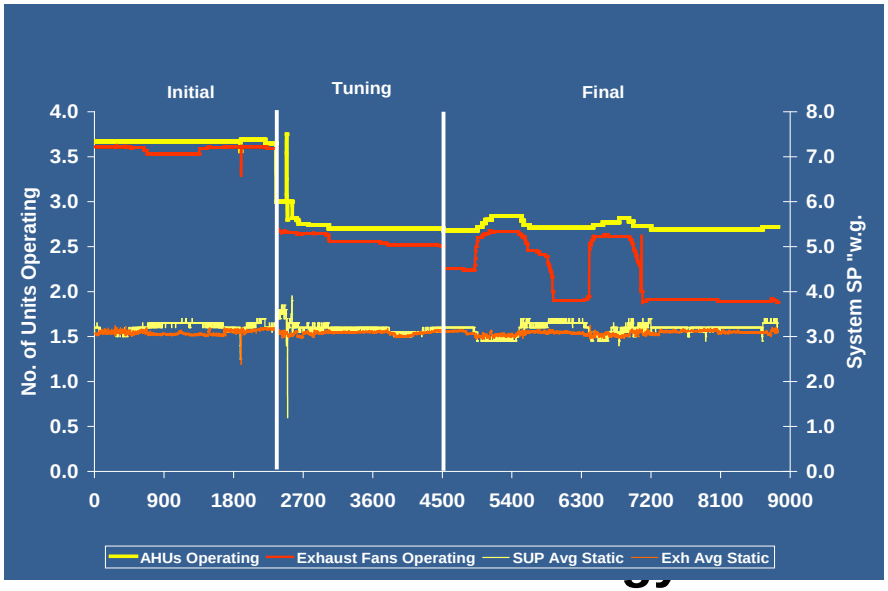
Evaluating Operation and Performance

- VAV Response and Stability
- System Operating Mode Tests (SOMT)
- SPORT – Static Pressure Reduction
- Re-Entrainment Investigations
- Monitoring Based Commissioning
- Trend Analysis and Continuous M&V

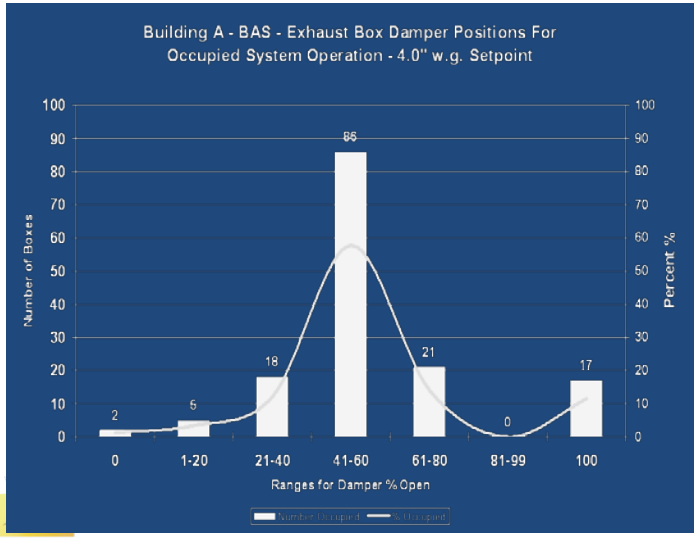




Static Pressure Optimization and Reduction Tests (SPORT)

Reduce System Static Pressures

- Evaluate Duct Layout
- Measure Static Pressure Profile (Distribution)
- Identify Minimum Required Static Pressure
- Optimize Static Pressure Set Points
- Verify Performance over Range of Operating Modes



System	Old Static Pressure Setpoint	New Static Pressure Setpoint	% Reduction
Air Supply	2.9	1.7	**40%**
Exhaust	3.1	2.6	**16%**

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Modify and Upgrade Systems

- Install High Efficiency Equipment
  - VFDs
  - VAV Systems
  - Energy Recovery
- Upgrade System Components
  - VAV terminals
  - Fume Hoods
  - Sensors and Monitors
- Repair Dysfunctional Equipment
  - Thermostats
  - Reheat Valves
  - Dampers and Actuators

Opportunities to Improve Safety & Reduce Energy Use

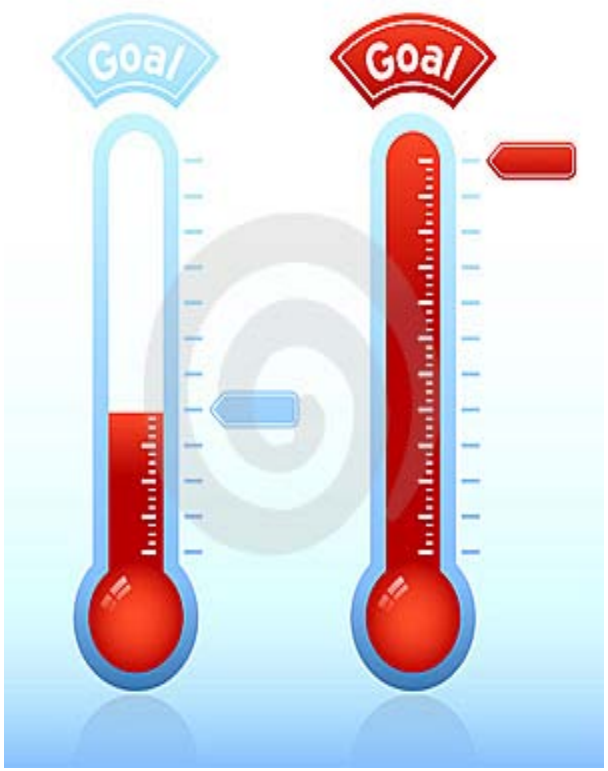
- Plan and Set Goals
- Assess Current Demand
- Evaluate Current Operation
- Modify Systems
- Manage and Maintain Efficient Operation

Demand Based Optimization Programs For R&D Facilities

- Rapid Energy and Lab Safety Assessment™ (RELSA™)
- Lab Ventilation Optimization Project™ (LVOP™)
- Hospital Ventilation Optimization Project™ (HVOP™)
- Lab Ventilation Management Program (LVMP)

Strategic Planning

- Facility Mission
- Functional Requirements
- Health and Safety Requirements
- Energy Reduction Goal
- GHG Emission Reduction Goal
- Available Funds / Budgets
- Timeframes

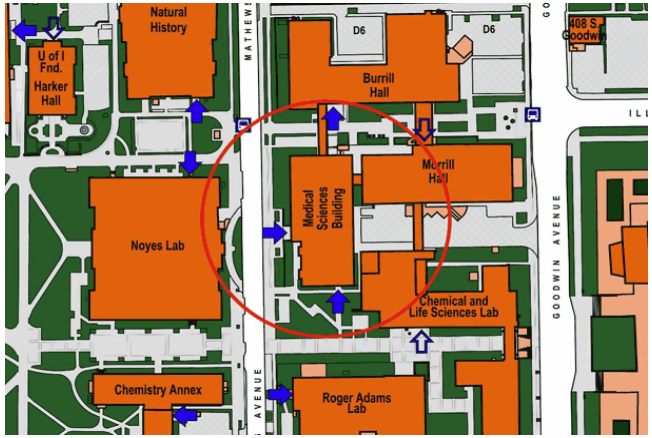


Energy / Safety Task Force

- Management
- Facility Engineering
- Energy Management
- Facility Maintenance
- Environmental Health & Safety
- Space Planning & Asset Management
- R&D Lab Representatives
- Laboratory Specialist

Building Information & Analysis

- Asset Valuation
- Space Allocation/Utilization
  - Labs
  - Office
  - Support Spaces
- Utilities and Operating Costs
- Labs, Hoods, and Systems
  - Age, Type, Capabilities
- Systems Engineering
  - Functional Capabilities Assessment
  - Financial Costs and Benefits Analysis



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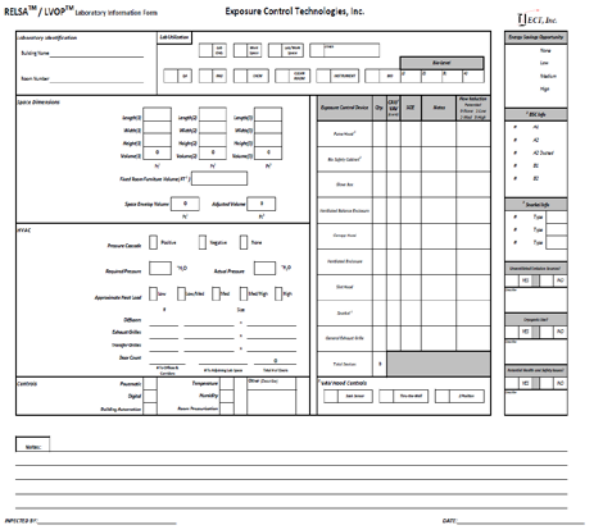
Rapid Energy and Lab Safety Assessment
(RELSA™)

- **Single Building Assessment**
  - Survey Labs, Hoods and Ventilation Systems
  - Assess Demand and Quantify Opportunities
  - Assess Level of Effort and Recommend Options
- **Multiple Building - Campus Assessment**
  - Survey Labs and Ventilation Systems in all Bldgs.
  - Assess Demand and Quantify Opportunities
  - Prioritize and Rank Bldgs.
  - Assess Level of Effort and Recommend Options (ROI, IRR)

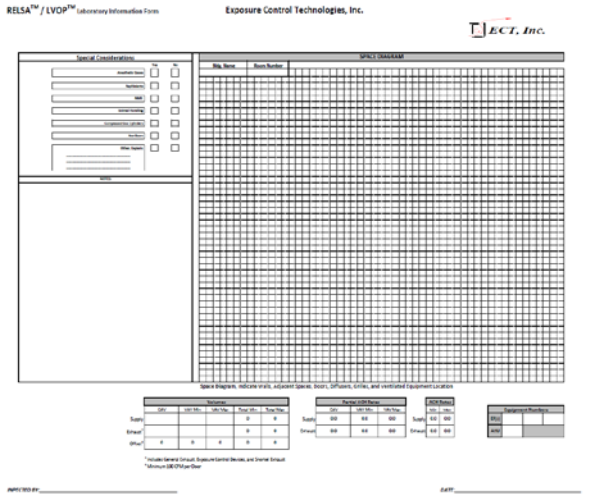
Rapid Energy and Lab Safety Assessment (RELSA™)

- Survey of Laboratories
- Survey of Ventilation Systems
- Identification of Opportunities
- Quantification and Prioritization
- Findings and Recommendations


RELSA™ / LVOP™ Laboratory Information Form

Exposure Control Technologies, Inc.

ECT, Inc.


RELSA™ / LVOP™ Laboratory Information Form

Exposure Control Technologies, Inc.

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RELSA BUILDING PRIORITIZATION

Building	Potential Flow Reduction - cfm	Level of Effort Required	% Probability	Numeric Ranking
B2	31000	Fairly Easy	100	1
B7	92750	Hard	75	2
B1	18200	Fairly Easy	59	3
B6	24000	Fairly Easy	54	4
B5	6400	Fairly Easy	21	5
B3	10500	Moderately Hard	17	6
B8	9100	Moderately Hard	15	7
B4	4100	Fairly Easy	13	8
	196050			

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LVOP Implementation Phases

- Phase 1 – Detailed Building Assessment (Study)
  - Functional Requirements (Demand)
  - Required Operating Specifications
  - Operational Benchmark
- Phase 2 – Optimization and Energy Reduction Project
- Phase 3 – Operations Management & Sustainability Plan

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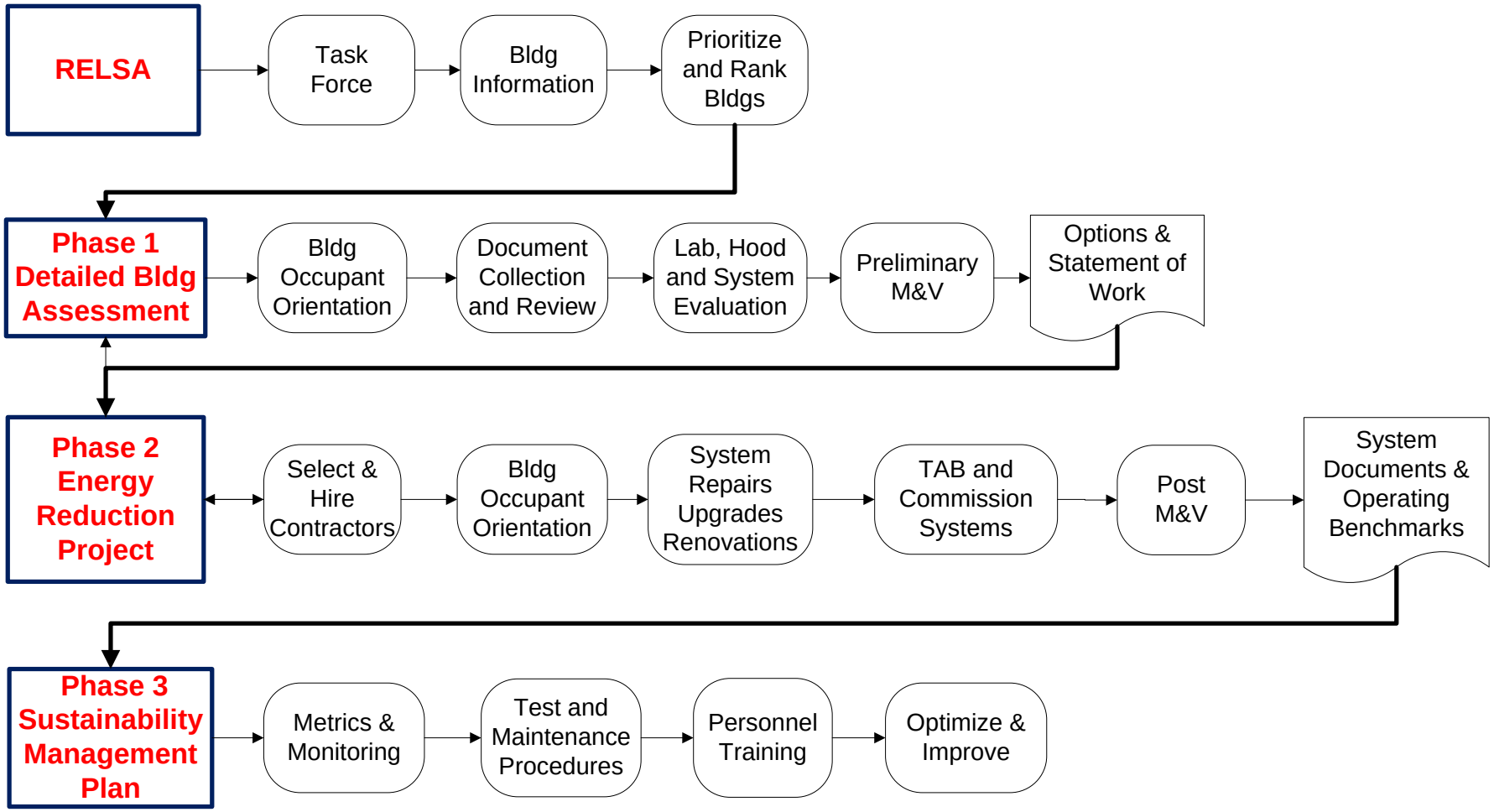
LVOP - Energy Reduction Process



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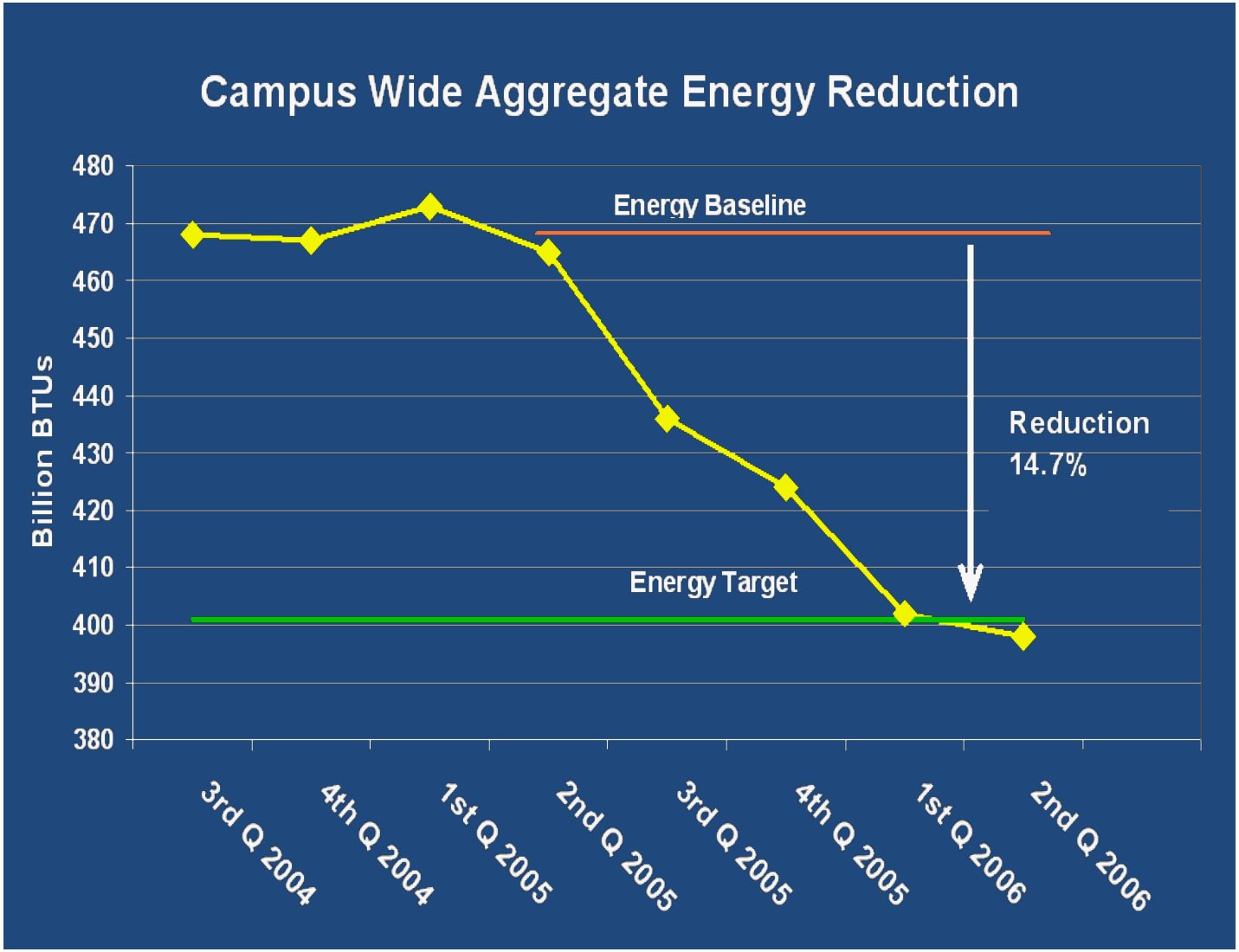
The Laboratory Ventilation Optimization Project (LVOP)

- Team Approach
- Evaluate Labs, Hoods, Hazards and Processes
- Determine Required Operating Specifications (Demand)
- Benchmark System Operation & Energy Use
- Repair, Renovate and Upgrade Systems
- Calibrate & Tune Sensors and BAS
- TAB and Commission Systems
- Implement System Management Tools

Demand Based Program - Energy Reduction



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LVOP ™ SUCCESS

Building	Baseline Airflow cfm	Final Airflow cfm	Flow Reduction cfm	% Flow Reduction	$ Annual Savings @ $5/cfm-yr	Carbon Reduction mtons
EPA 1 (5)	773,000	518,000	255,000	32%	1,275,000	15,300
EPA 2	66,000	37,000	29,000	44%	145,000	1,740
EPA 3	71,000	56,000	15,000	21%	75,000	900
EPA 4	144,000	101,000	43,000	30%	215,000	2,580
EPA 5	51,000	35,000	16,000	31%	80,000	960
EPA 6	47,000	33,000	14,000	30%	70,000	840
Biotek 1	11,000	7,000	4,000	36%	20,000	240
Pharma 1 (4)	628,000	466,500	161,500	28%	807,500	9,720
Pharma 2	168,190	120,347	47,843	28%	239,215	2,880
Totals	**1,959,190**	**1,373,847**	**585,343**	**30%**	**2,926,715**	**35,160**

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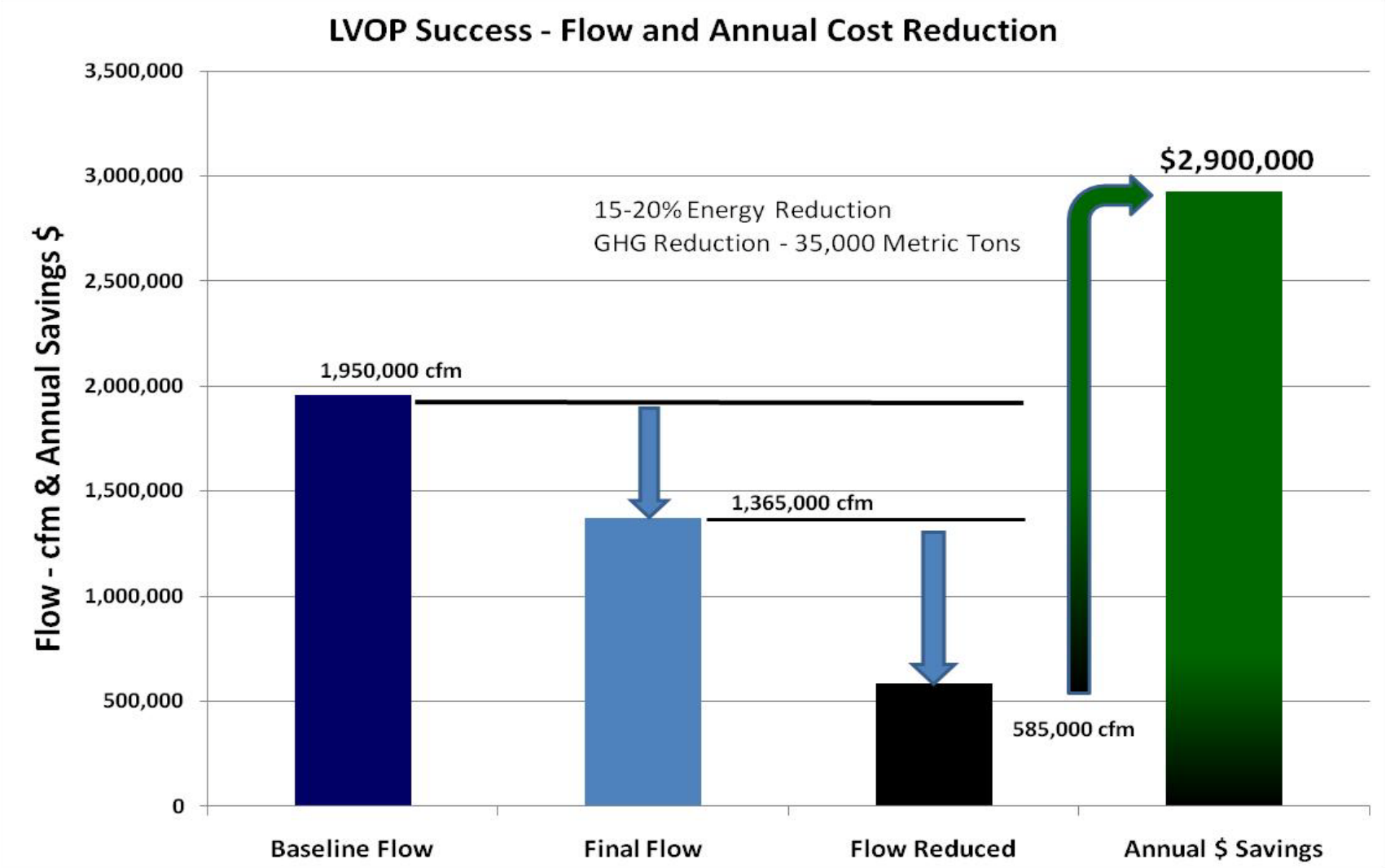
Demand Based Optimization



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LVOP ™ Proven Results

16 Research Lab Buildings

Costs Reduced / Avoided (Annual)

- $2,900,000

Energy and Carbon Emission Reduction (Annual)

- 4.6 MegaWatts
- 35,000 Metric Tons CO_2

Competitive Return on Investment

Simple Payback = 1 to 5 years

Internal Rate of Return ~ 25-35%

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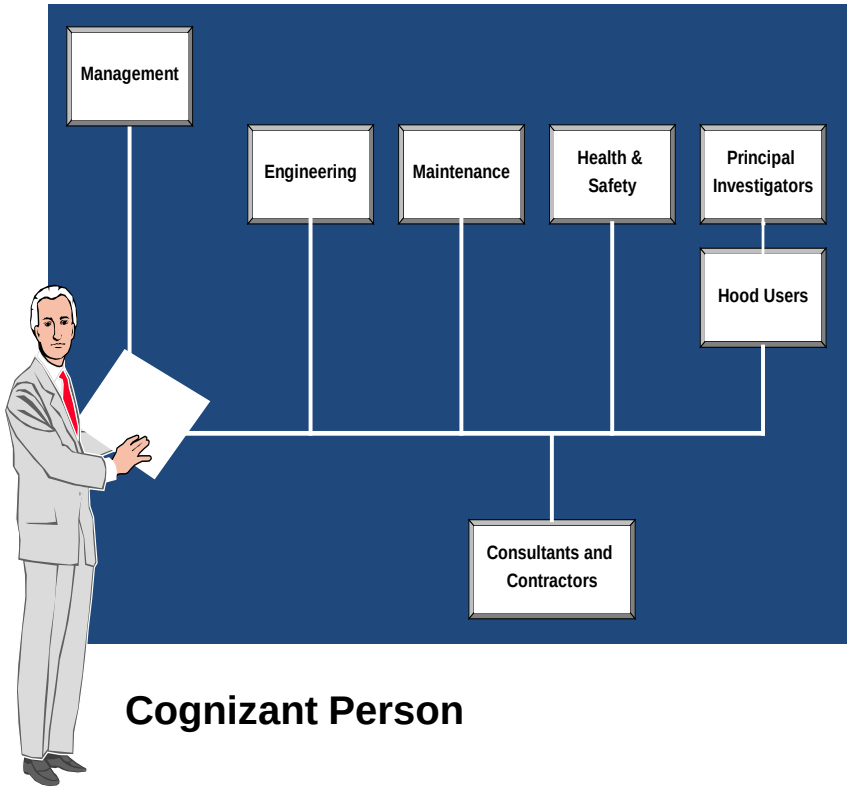
Laboratory Ventilation Management Program (LVMP)

- System Management and Sustainability Plan
  - Organization and Responsibilities
  - SOP's for Testing and Maintenance
  - Metrics and Monitoring
  - Continuous Commissioning
- Management of Change
- Personnel Training



LVMP – Personnel Training

- Hood Users and Lab Managers
- Test and Maintenance Personnel
- Facility Engineers
- Building Operators
- Management

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ENSURE PROPER HOOD USE AND SASH MANAGEMENT

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Benefits of LVOP & Demand Based Optimization

- Known Ventilation Requirements
- Safe And Dependable Operation
- Accurate Information for System Management
- Improved Flexibility and System Capabilities
- Reduced Energy Use and Lower Operating Costs
- Replicable/Scalable Process – Applicable to Any Lab Building

Demand Based Optimization Programs

RELSA

↓

LVOP

↓

LVMP

- Safe
- Energy Efficient
- Dependable
- Sustainable

END

QUESTIONS?

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