Smart Labs Ventilation Management Program

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Why Focus on Laboratory Buildings?

- Laboratories use significant energy – typically 3 to 4 times more energy than an average office building
- Case examples indicate cost-saving opportunities of 20-40%
- Statutory requirement: Federal building efficiency requirements in Section 431 of EISA 2007 and E.O. 13834

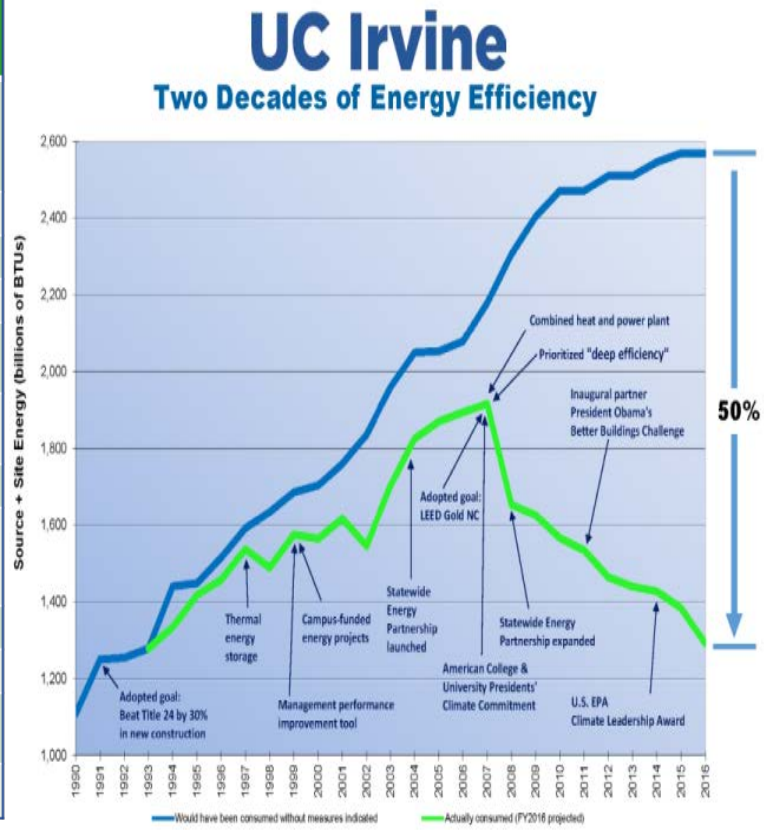
Laboratory Statistics	Nationwide*	Federal Govt**	DOE**
Laboratory Square Footage % of Total	1%	6%	36%
Laboratory Energy Usage % of Total	3%	16%	70%
Laboratory Energy Cost Annually	$5B	$700M	$33M
Potential Laboratory Energy Savings (20-40%)	$1 – 2B	$140 – 280M	$7 – 13M

* Values estimated based on the Commercial Buildings Energy Consumption Survey (CBECS) and study completed by Lawrence Berkeley National Laboratory entitled, "Characterizing the Laboratory Market"
** Values estimated based on federal agency data compiled for FEMP's Federal Comprehensive Annual Energy Performance Data
***Zero Energy University Campuses: A 2018 Progress Update on Reaching Campus Energy Goals, NREL, https://www.nrel.gov/docs/fy18osti/71822.pdf

UCI Smart Labs Initiative

Laboratory Building		BEFORE Smart Lab Retrofit		
Name	Type	Estimated Average ACH	VAV or CV	More efficient than code?
Croul Hall	P	6.6	VAV	~ 20%
McGaugh Hall	B	9.4	CV	No
Reines Hall	P	11.3	CV	No
Natural Sciences 2	P,B	9.1	VAV	~20%
Biological Sciences 3	B	9.0	VAV	~30%
Calit2	E	6.0	VAV	~20%
Gillespie Neurosciences	M	6.8	CV	~20%
Sprague Hall	M	7.2	VAV	~20%
Hewitt Hall	M	8.7	VAV	~20%
Engineering Hall	E	8.0	VAV	~30%
Averages		**8.2**	**VAV**	**~20%**

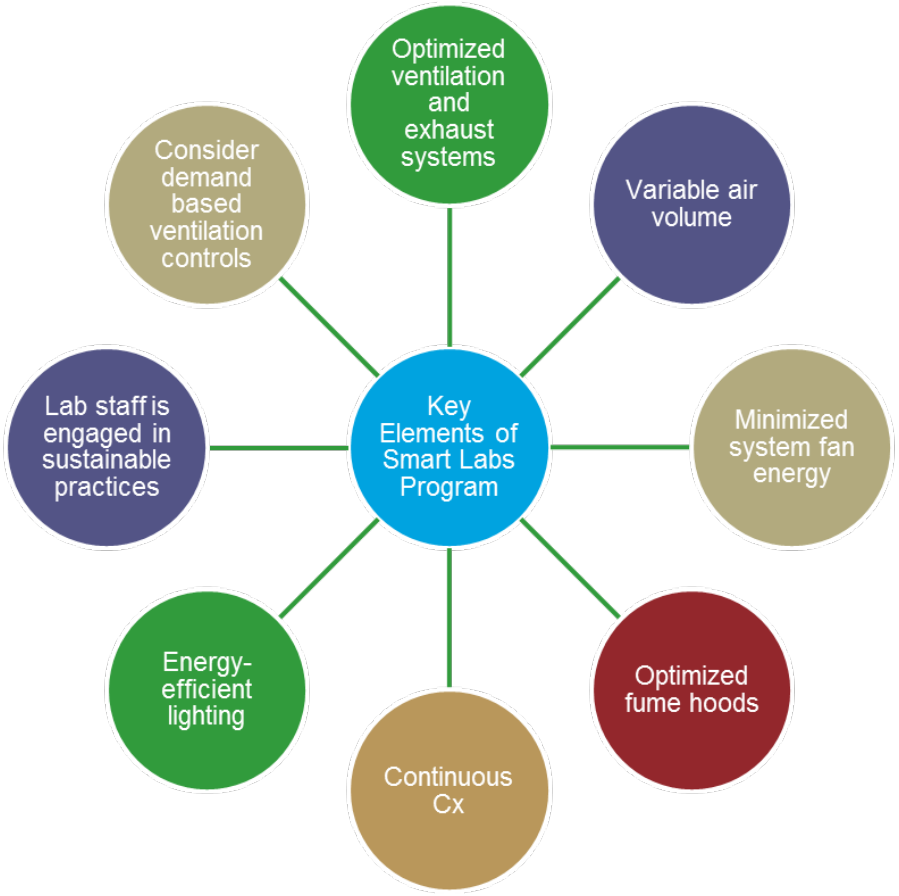
Type: P = Physical Sciences, B = Biological Sciences, E = Engineering, M = Medical Sciences



AFTER Smart Lab Retrofit		
kWh Savings	Therm Savings	Total Savings
40%	40%	40%
57%	66%	59%
67%	77%	69%
48%	62%	50%
45%	81%	53%
46%	78%	58%
58%	81%	70%
71%	83%	75%
58%	77%	62%
59%	78%	69%
57%	**72%**	**61%**

What is a Smart Labs Program?

A Smart Labs program enables safe and efficient world class science by designing and operating safe and efficient laboratories through optimization of ventilation and exhaust systems, minimization of fan energy, and implementation of smart building controls.



DOE's Better Buildings Smart Labs Accelerator

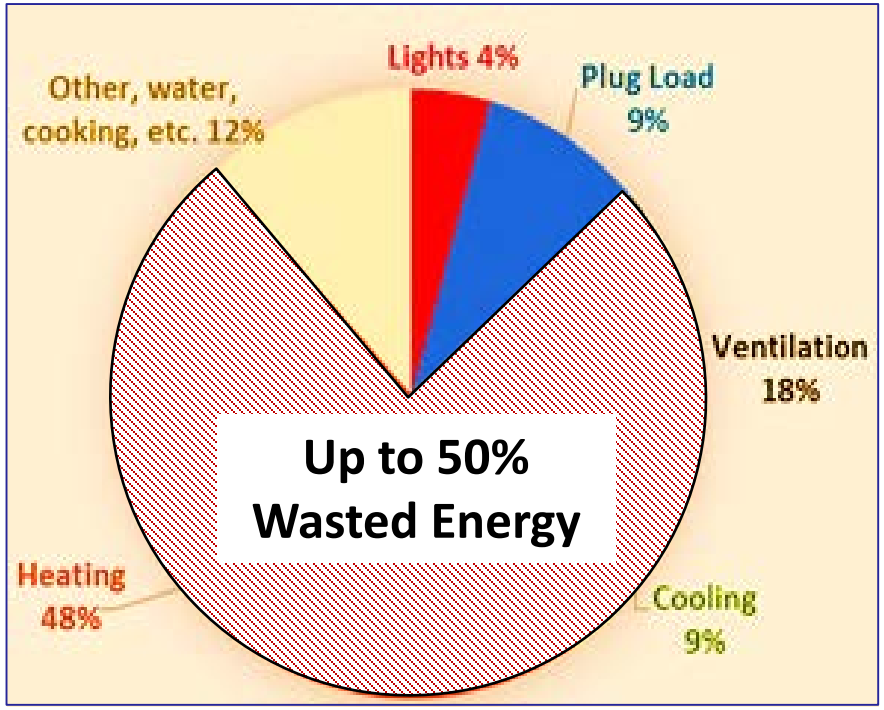
Accelerator Goal:	**At least 20% energy reduction over portfolio of laboratory buildings in 10 years or less**
Accelerator Sub-Goal:	At least 5% energy reduction in one laboratory by the end of the accelerator
Timeframe:	March 2017 – February 2020
Number of Partners:	17 organizations 2 affiliate partners
End Result:	Showcase projects of partners success, Smart Labs Toolkit, website, training

Smart Labs Accelerator Partners

Laboratory Ventilation Management Program

Labs are expensive and complicated

- Contruction = $250/ft^2 to $4000/ft^2
- Energy = 150 kBTU/ft^2 to 1,000 kBTU/ft^2
- Annual Energy Cost = $3 to $10/ft^2



- Airflow ≈ 45% to 85% Energy Use
- Airflow ≈ $3 to $9 per cfm-yr.

Energy is wasted by excess airflow, inefficient systems and improper modulation of Flow

Improperly designed and aging labs can adversely affect research and safety

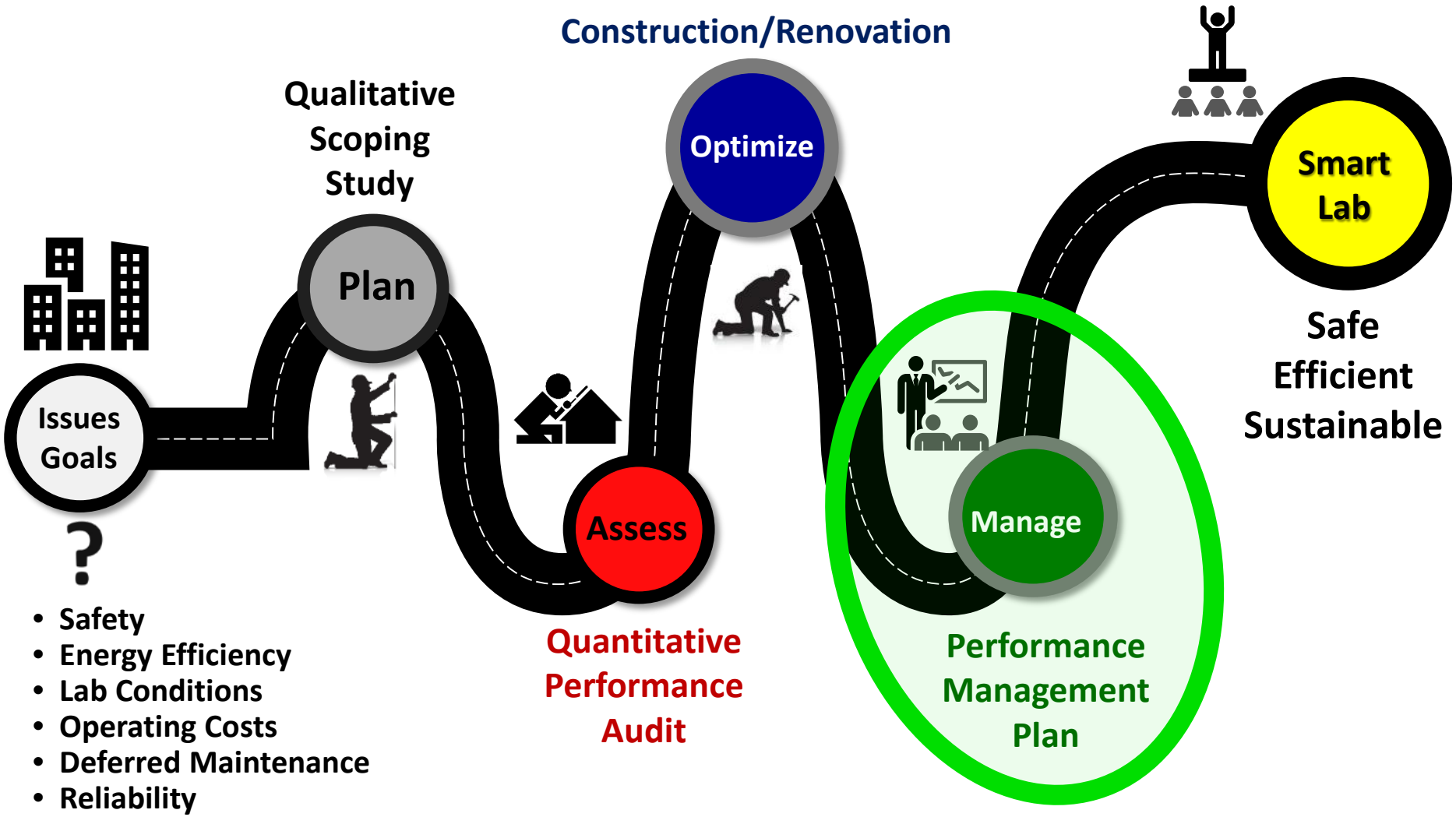
- Inefficient and costly
- Poor control of environmental conditions
- Failure to meet occupant needs
- Negatively affect recruitment and retention
- Increase risk and potential for liability
- Increase Deferred Maintenance Issues

Building System	DM Costs	Percentage costs of the total DM costs
HVAC	$132,917,184	35%
Electrical	$79,750,310	21%
Exterior Systems	$49,369,239	13%
Interior Systems	$41,773,972	11%

Organizations can improve safety, reduce risk and provide workplaces that better facilitate success.

- Attract & retain top talent
- Ensure safety
- Minimize waste
- Improve sustainability
- Maximize resilience
- Accommodate change
- Mitigate risk
- Enhance return on investment

Smart Labs™ provides a roadmap to success

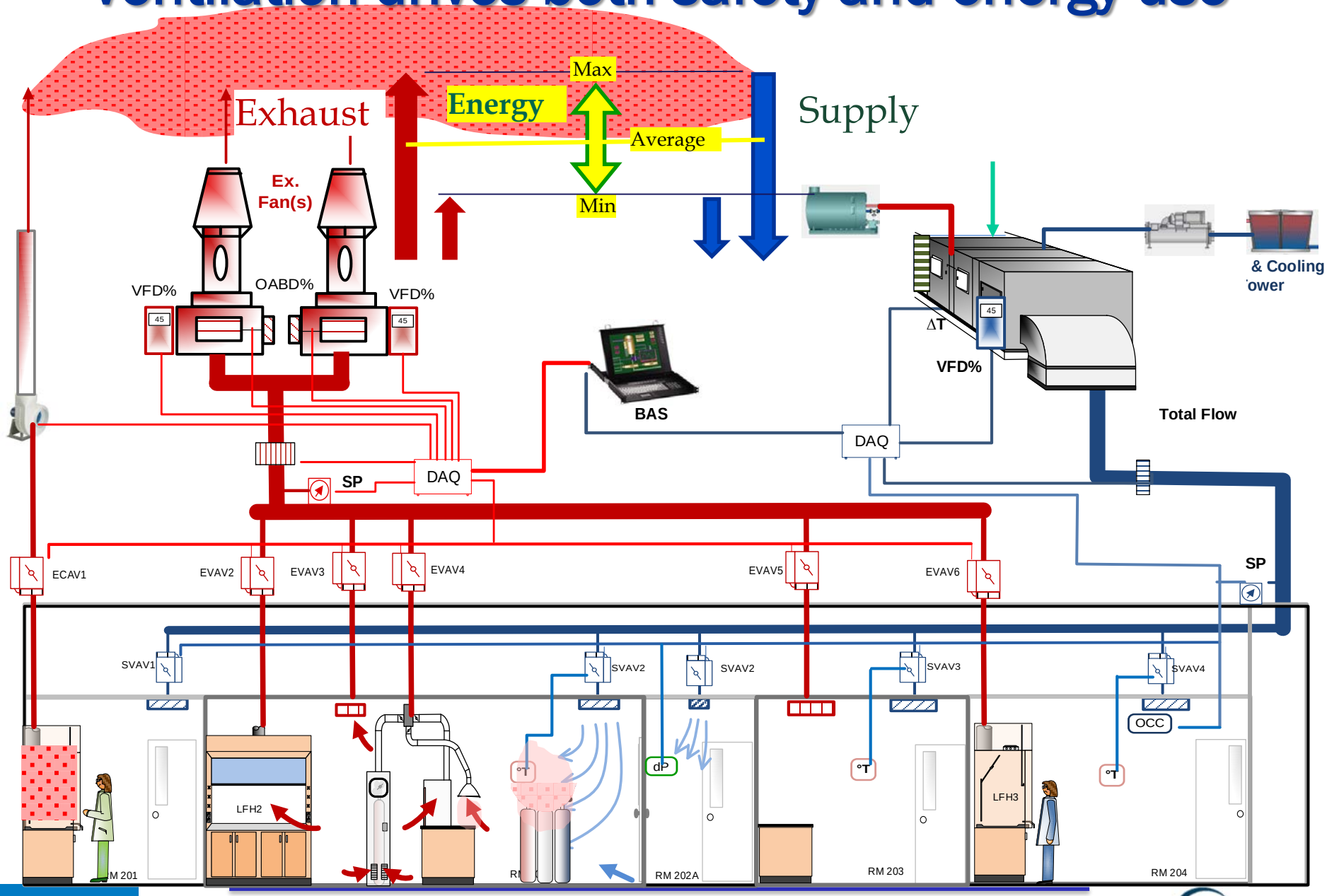


Success requires a combination of efforts

- **Design and Mechanical Attributes**
  - High performance fume hoods
  - Variable Air Volume Systems
  - High efficiency mechanical systems
  - Building information and control systems
- **Management and Leadership**
  - Occupant Information and Floor Plans
  - Ventilation Safety Demand Assessment
  - System Diagrams and Airflow Specification
  - Airflow Management Program (AMP)
  - LVMP Manager / Coordinator

Lab Ventilation Management Plan

Ventilation drives both safety and energy use



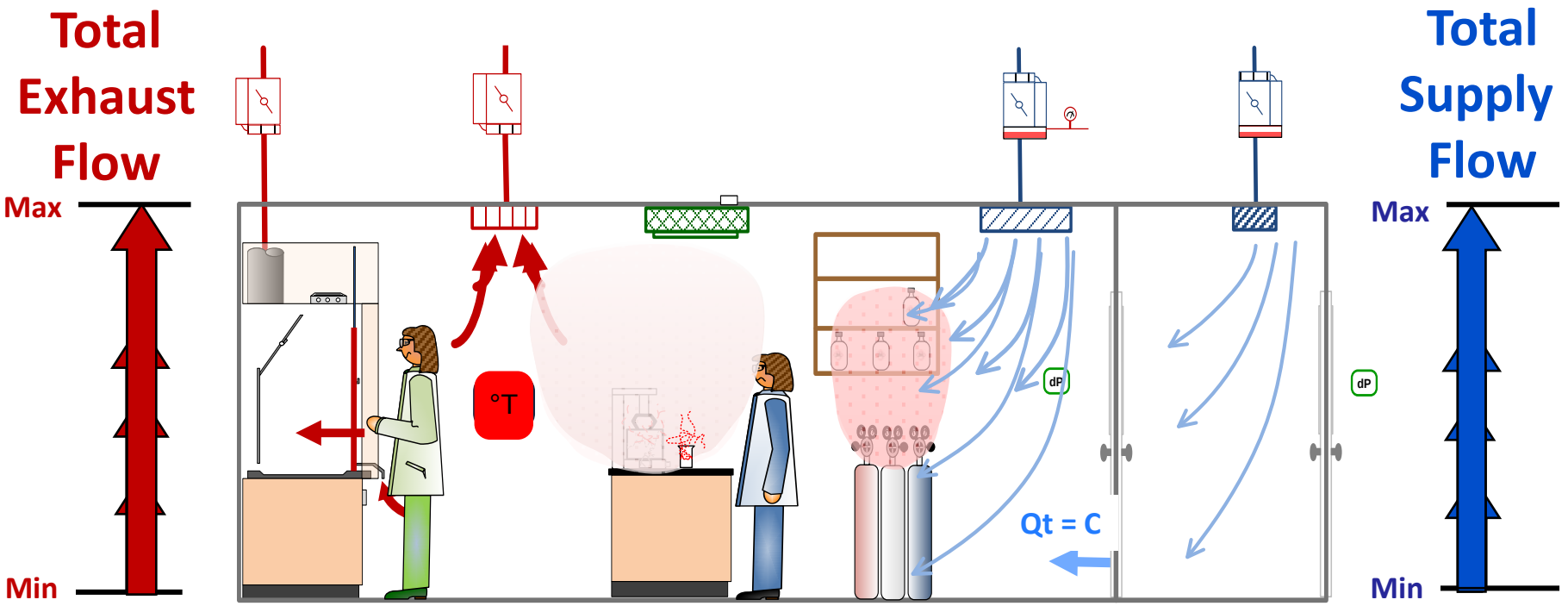
The Demand for Ventilation establishes the design and operating requirements

- **Safety (Risk)**
  - Fume Hood Flow
  - Contaminant Removal (ACH)
  - Isolation (Lab Pressurization)
- **Comfort & Productivity**
  - Temperature
  - Humidity
- **Occupancy & Utilization**

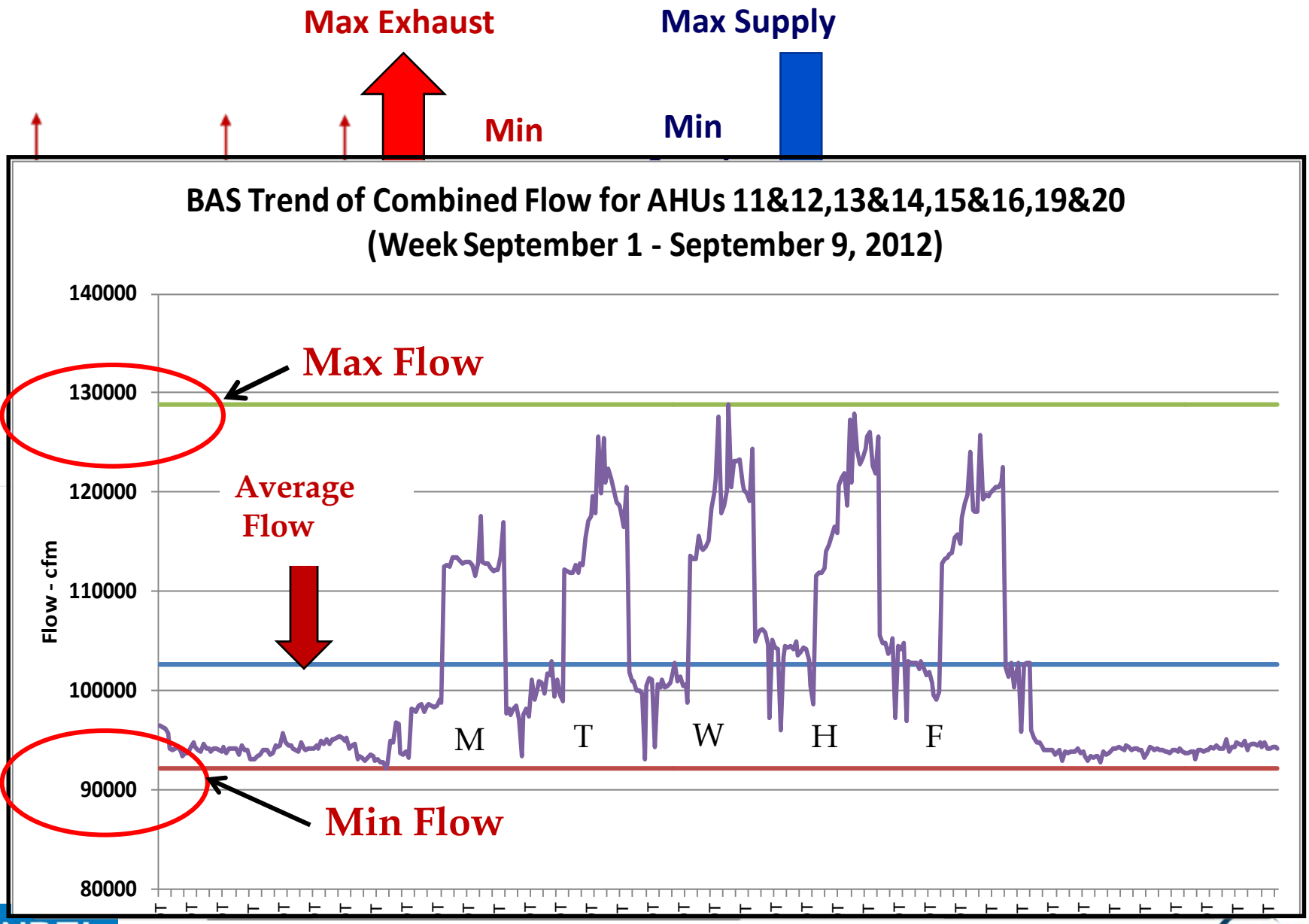
Minimum flow and range of modulation required to meet the functional requirements of the occupants

Variable Air Volume (VAV) controls modulate flow to the demand for ventilation

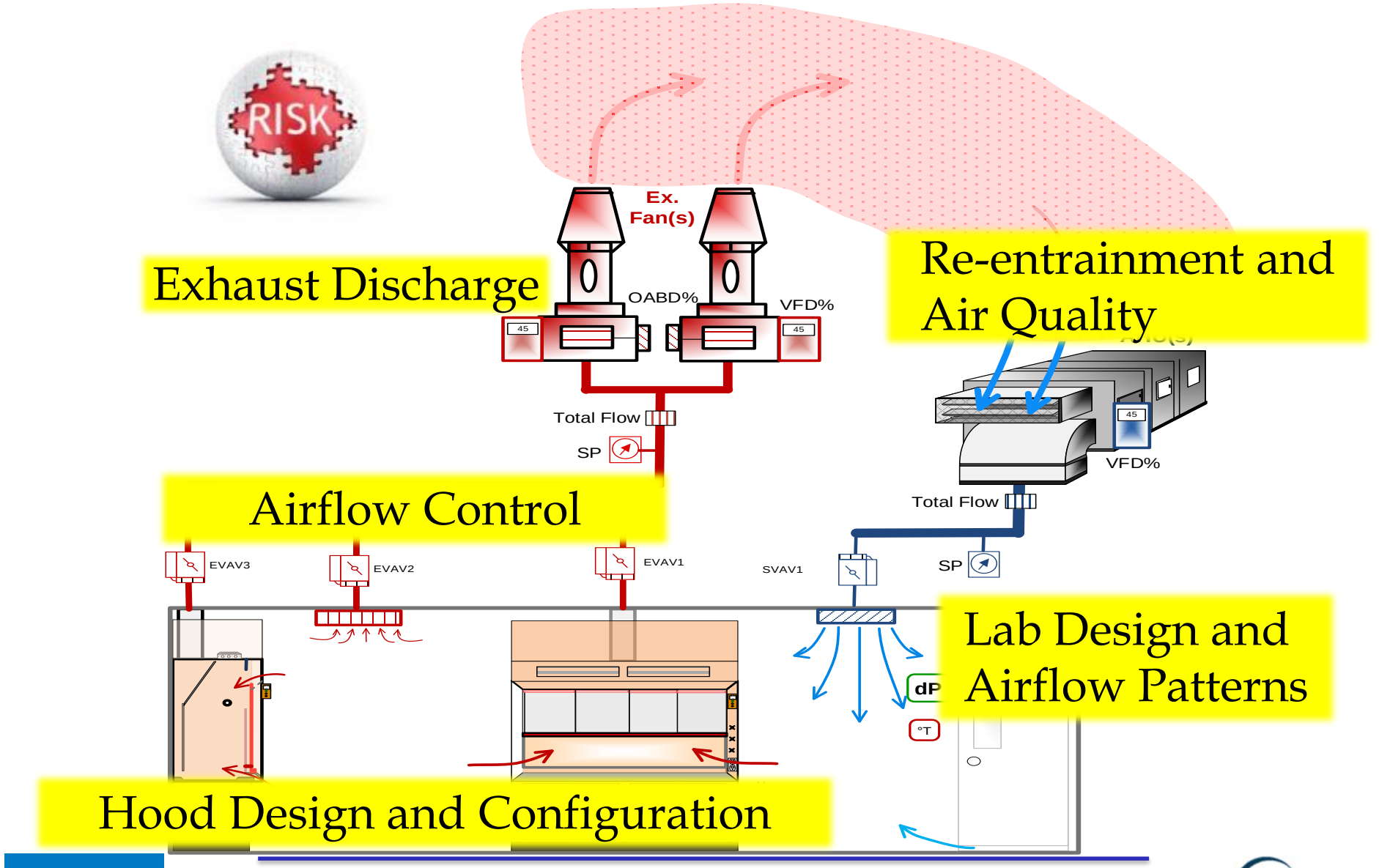
- Unoccupied – Sashes Closed – Min. Conditioning Required
- Occupied – Sashes Closed – Max Conditioning Required
- Occupied – Sashes Open – Min Conditioning Required
- Occupied – Sashes Open – Max Conditioning Required



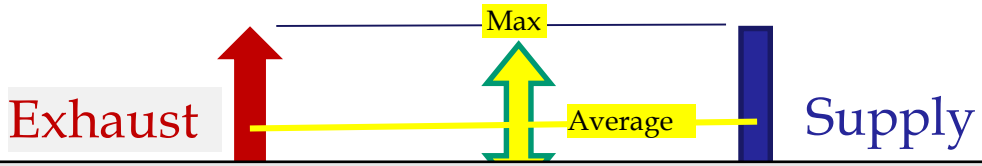
Building Flow Should Modulate to Meet Demand



Many factors affect system performance and risk



Identifying and monitoring key metrics are critical to managing performance

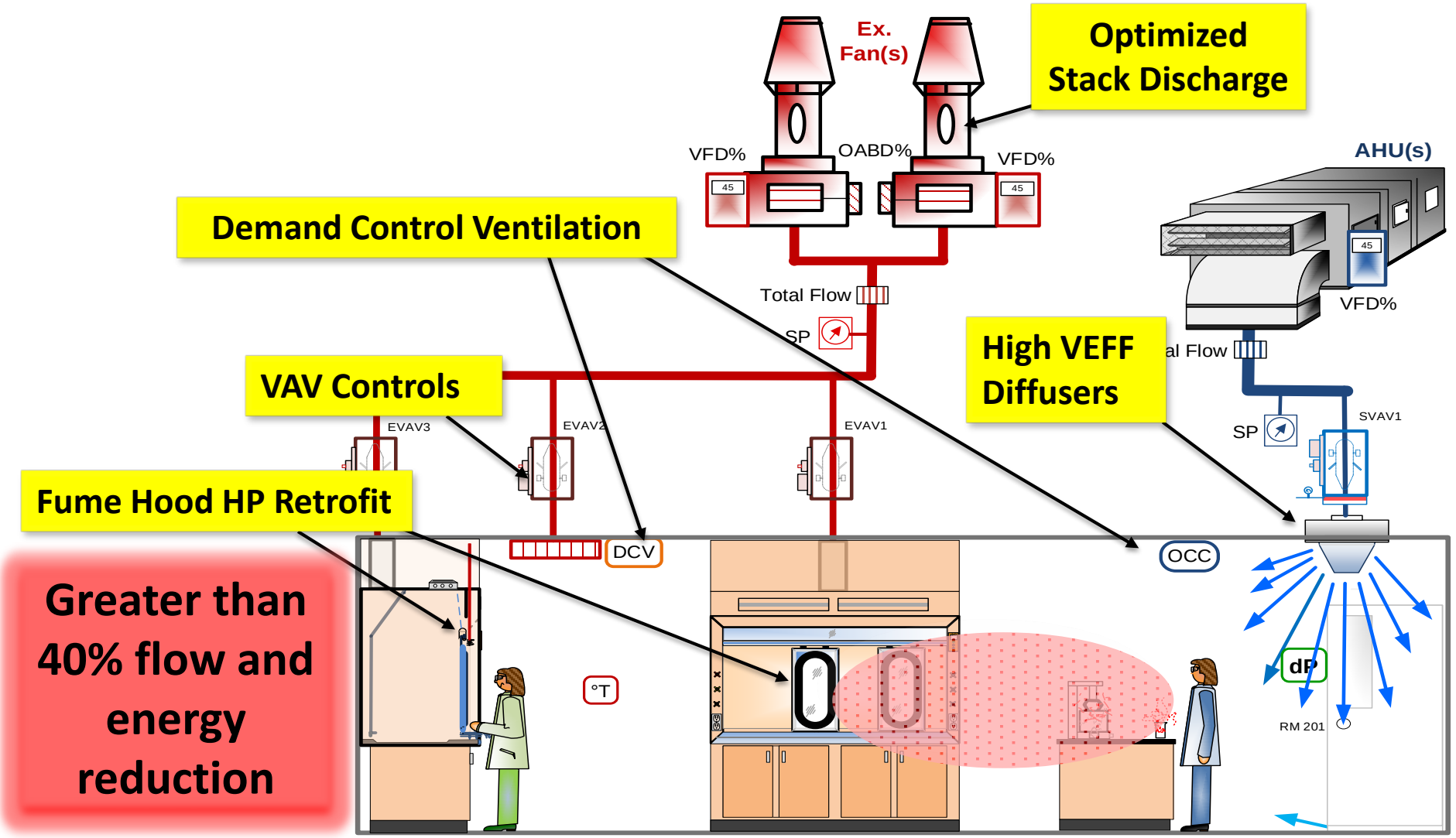


Demand ⇒ Operation ⇒ Energy

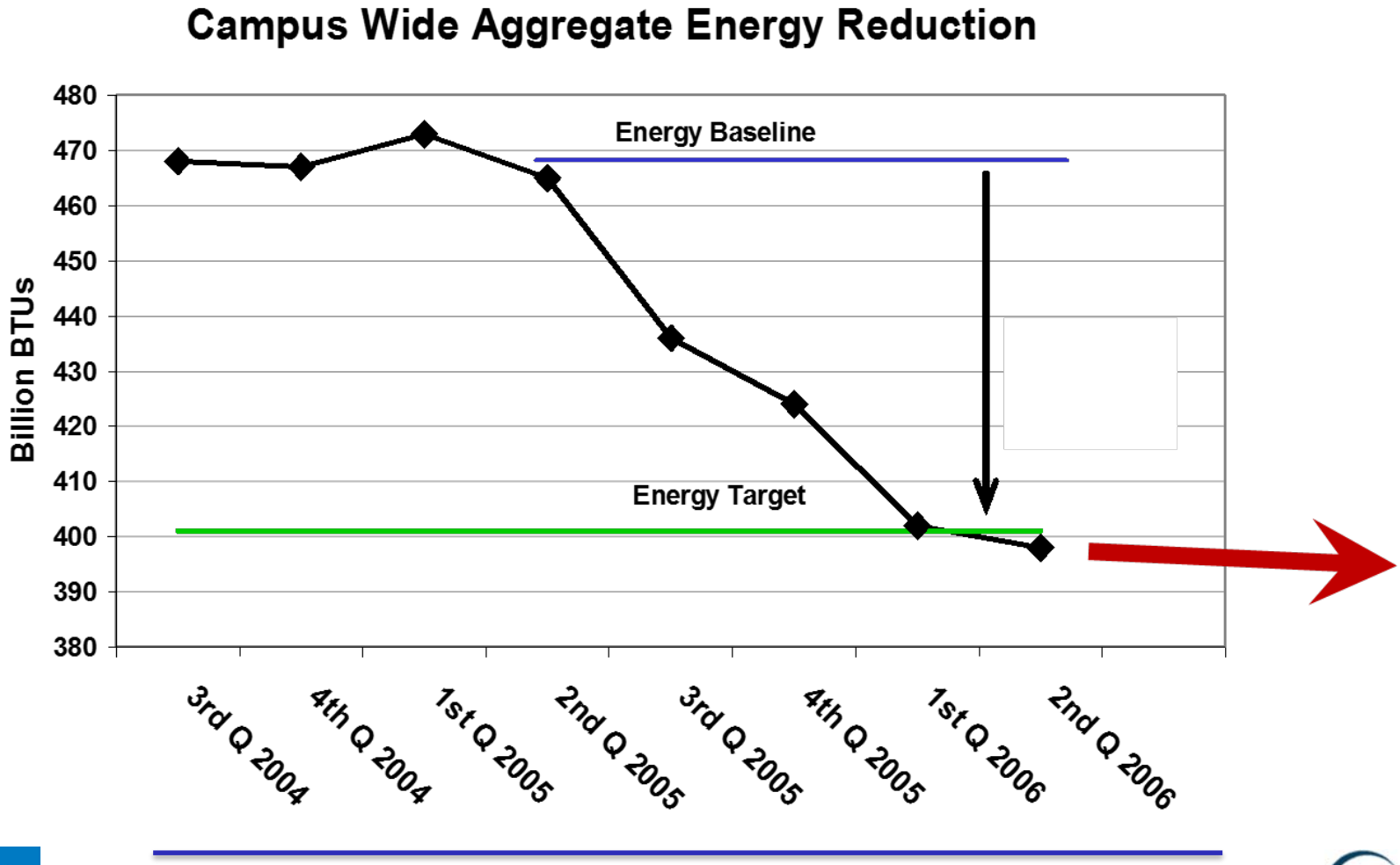
Energy		Airflow		Efficiency
BTU/ft^2	→	$\$/ft^2$	→	cfm/ft^2 → $\$/cfm$

Maximum savings are achieved by optimizing airflow and system efficiency

New technologies can be deployed to improve safety and energy efficiency

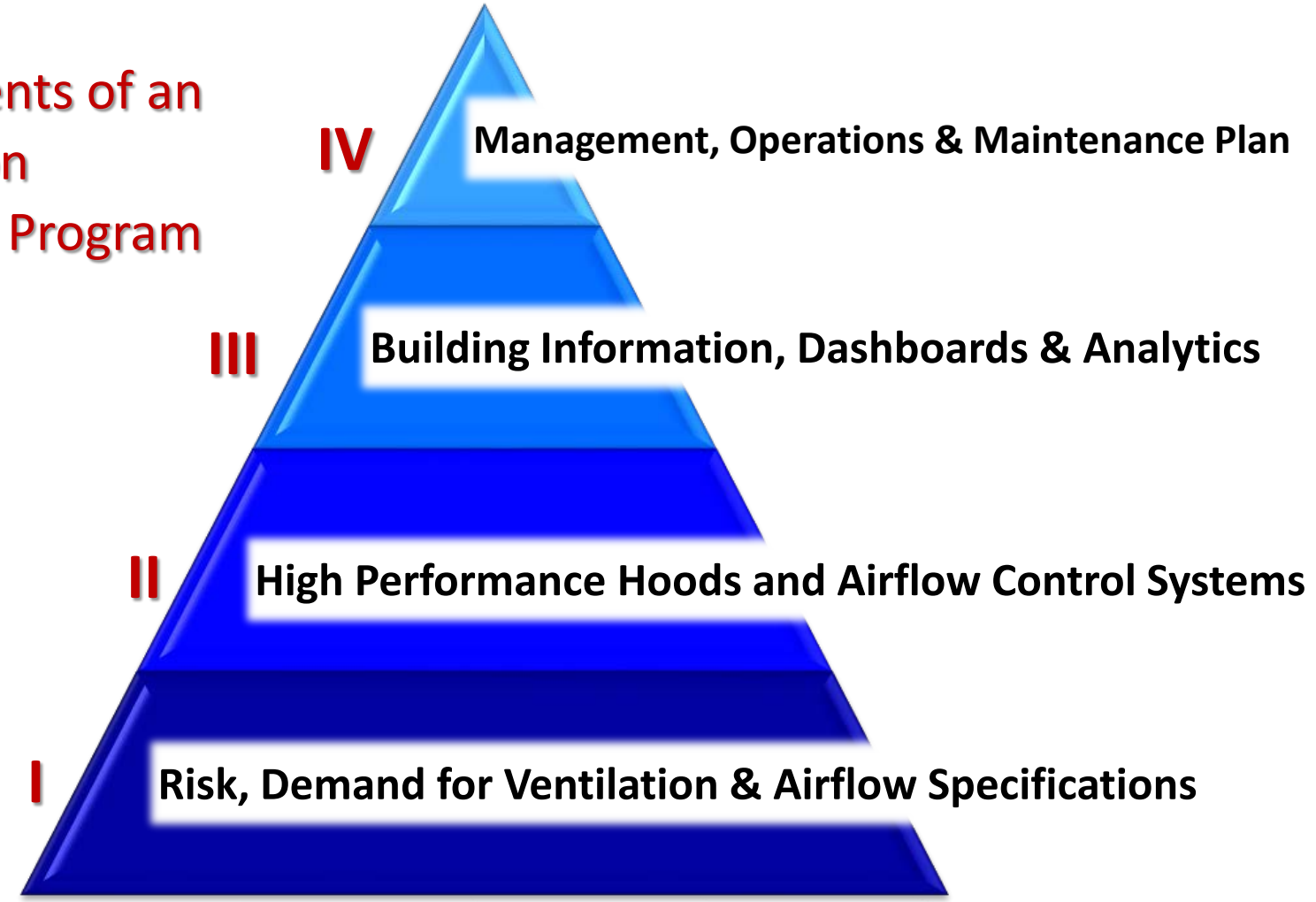


Efficiency can be improved, energy can be reduced, but can it be maintained?

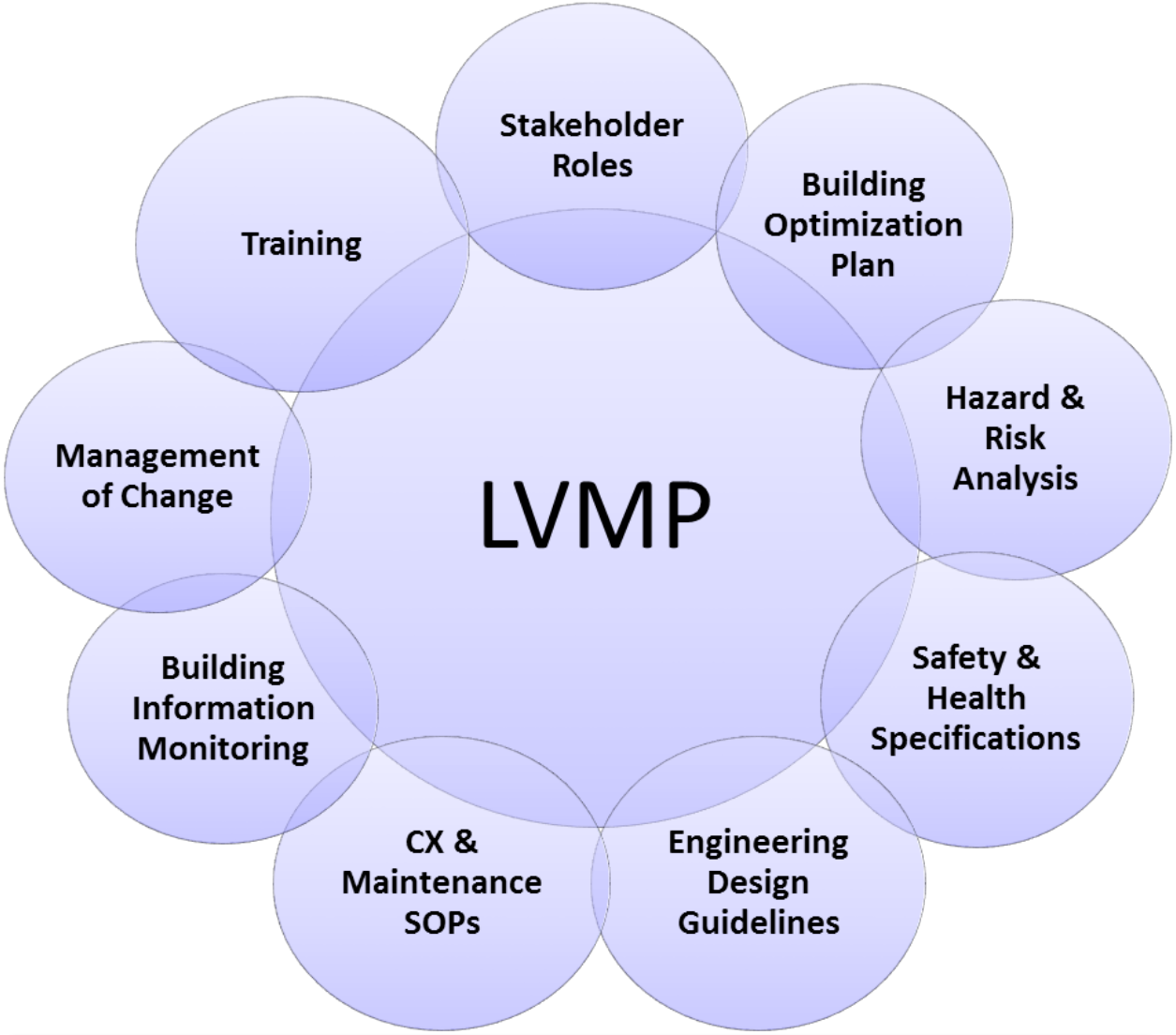


A Lab Ventilation Management Program provides the structure to achieve and maintain safe, energy efficient and sustainable facilities

Key Components of an Lab Ventilation Management Program (LVMP)



A Lab Ventilation Management Program is comprised of multiple elements

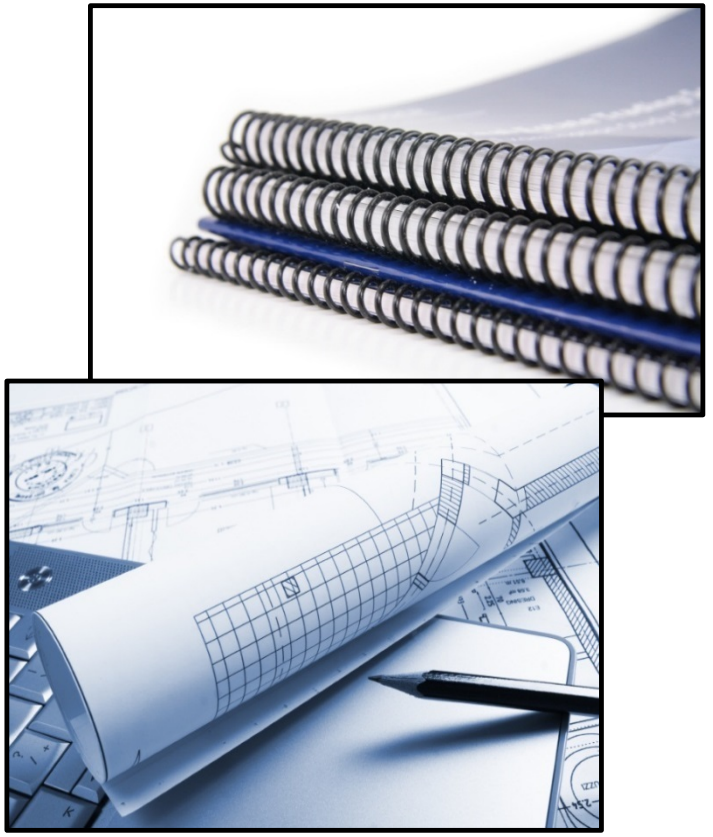


Leadership and a coordinated team effort are critical to success

- **Stakeholder and LVMP Team (In-house and Contractors)**
  - Facilities and Energy Engineers
  - Environmental Health and Safety
  - Lab Staff Representatives
  - HVAC Systems Engineer
  - Laboratory Hood Specialist
  - Building Controls Operator
  - Mechanical Maintenance
  - TAB Contractor
  - Commissioning Contractor
- **LVMP Manager/Coordinator**

The program delivers building operating manuals and training to achieve and maintain performance

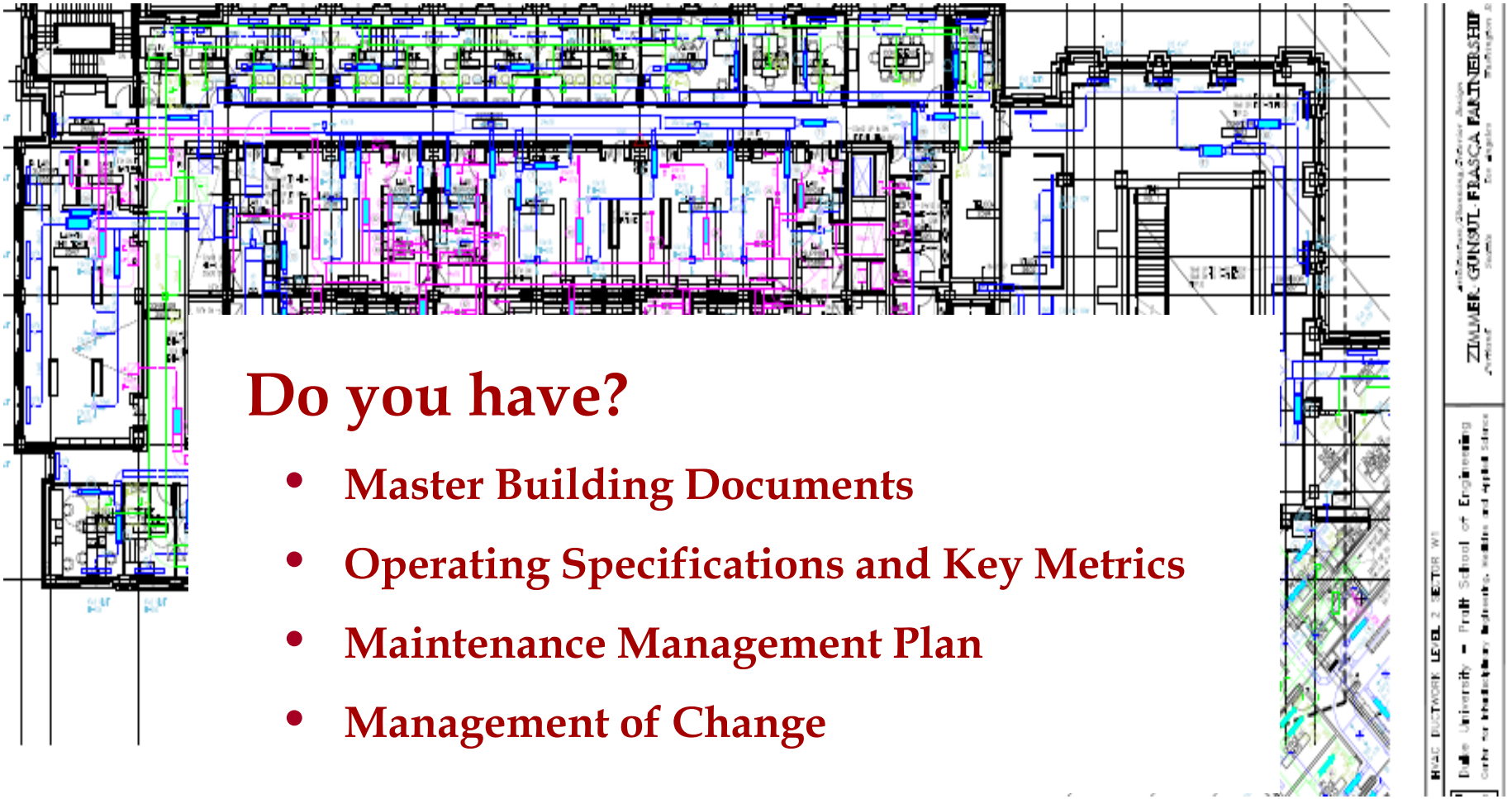
- Equipment Inventories
- System Line Diagrams and Drawings
- Lab Ventilation Risk Matrix
- Airflow Specifications
- Effective Controls and Sequences
- Key Performance Indicators and Metrics
- Proper Procedures and Guidelines
  - Routine Tests & Maintenance Tasks
  - Schedules and Management of Change
- Training for Stakeholders



Protect Return On Investment

What is the state of the building information and drawings?

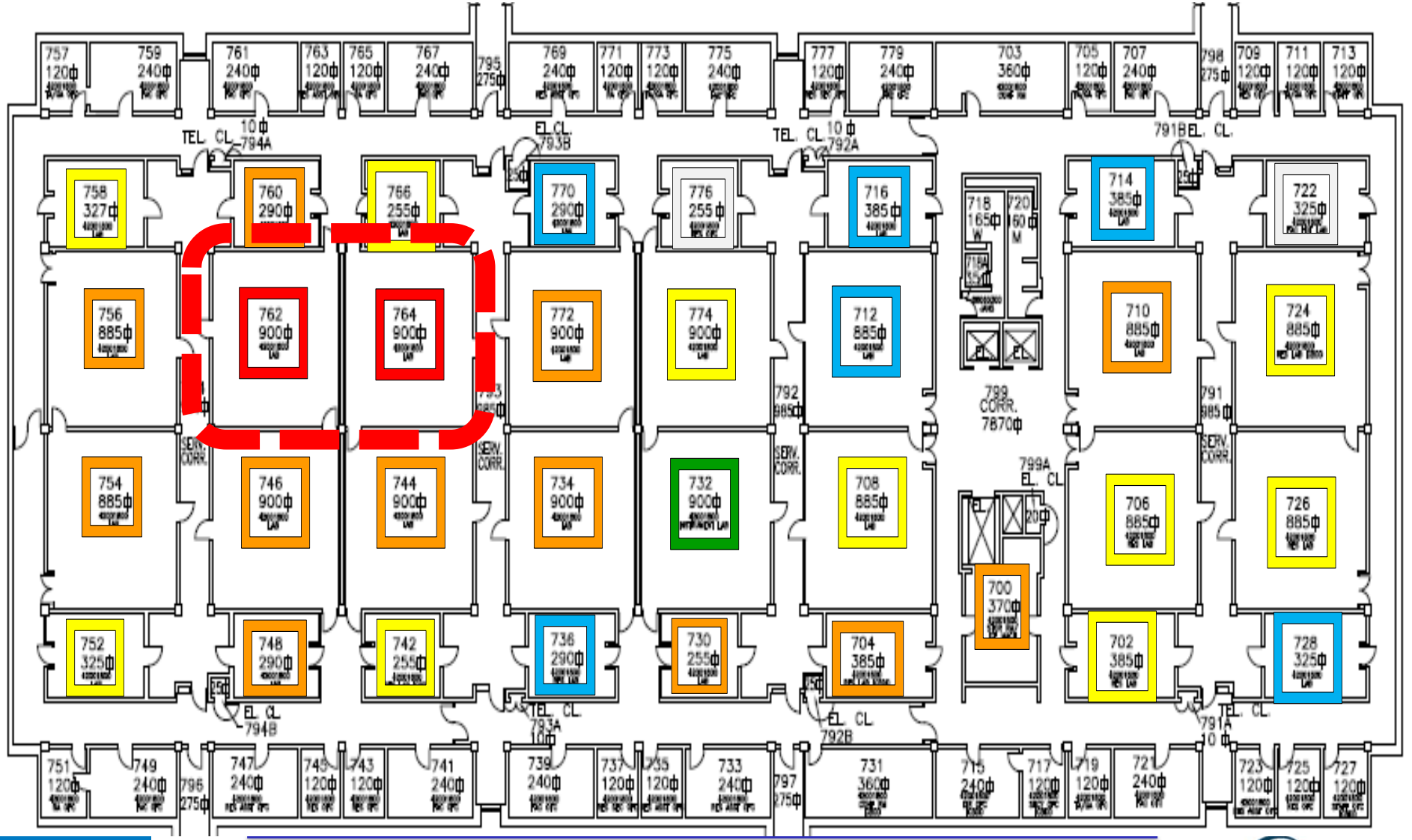
✓ Complete? ✓ Clear? ✓ Accurate?



Do you have?

- Master Building Documents
- Operating Specifications and Key Metrics
- Maintenance Management Plan
- Management of Change

A Risk Assessment can differentiate spaces to identify airflow requirements and priorities



An Airflow Spreadsheet provides specifications to meet the Demand for Ventilation

Room Information								Supply		Transfer Flow	Exhaust						Resultant ACH	
											Hood ID	Open Area - ft2	Qex for Exhaust Devices		Room Exhaust Flows			
													Qex at FV	Sash Closed - Unoccupied	Max/Min based on Exh Devices, dP, Cond., or ACH			
Room #	Room Name	Area (ft^2)	Height (ft)	Volume (ft^3)	Room Type	Heat Load Label	Control Band #	Room Flow @ Max (cfm)	Room Flow @ Min (cfm)	Greater of Door and 10% Max Exh (cfm)					Room Max Flow (cfm)	Room Min Flow (cfm)	Max ACH	Min ACH
728	Research Lab	325	9.0	2925	Stg	N	2	193	193	100	FH - CAV	7.9	792	146	293	293	6	6
											FH - CAV	7.9	792	146				
					Lab	N	4	1433	1433	150	FH - CAV	7.9	792	792	1583	1583	28	28
													792	792				
					Lab	N	1	3797	3797				792	792	4222	4222	19	19
													792	792				
											FH - CAV	7.9	792	792				
											FH - CAV	18.5	1847	1847				
734	Research Lab						4	5231	5231	575	FH - CAV	7.9	792	792	5806	5806	27	27
											FH - CAV	7.9	792	792				
											FH - CAV	7.9	792	792				
											FH - CAV	7.9	792	792				
											FH - CAV	7.9	792	792				
												.5	1847	1847				
736	Research Lab	290	14.5	4205	Lab							.3	1729	470	747	747	11	11
												55		277				
742	Research Lab	255	14.5	3698	Lab	L	3	1433	1433	150	FH - CAV	7.9	792	792	1583	1583	26	26
											FH - CAV	7.9	792	792				
744	Research Lab	900	14.5	13050	Lab	N	4	5231	5231	575	FH - CAV	7.9	792	792	5806	5806	27	27
											FH - CAV	7.9	792	792				
											FH - CAV	7.9	792	792				
											FH - CAV	7.9	792	792				
											FH - CAV	7.9	792	792				
											FH - CAV	18.5	1847	1847				
746	Research Lab	900	14.5	13050	Lab	N										06	27	27
											FH - CAV	18.5	1847	1847				

Space Information

ECDs

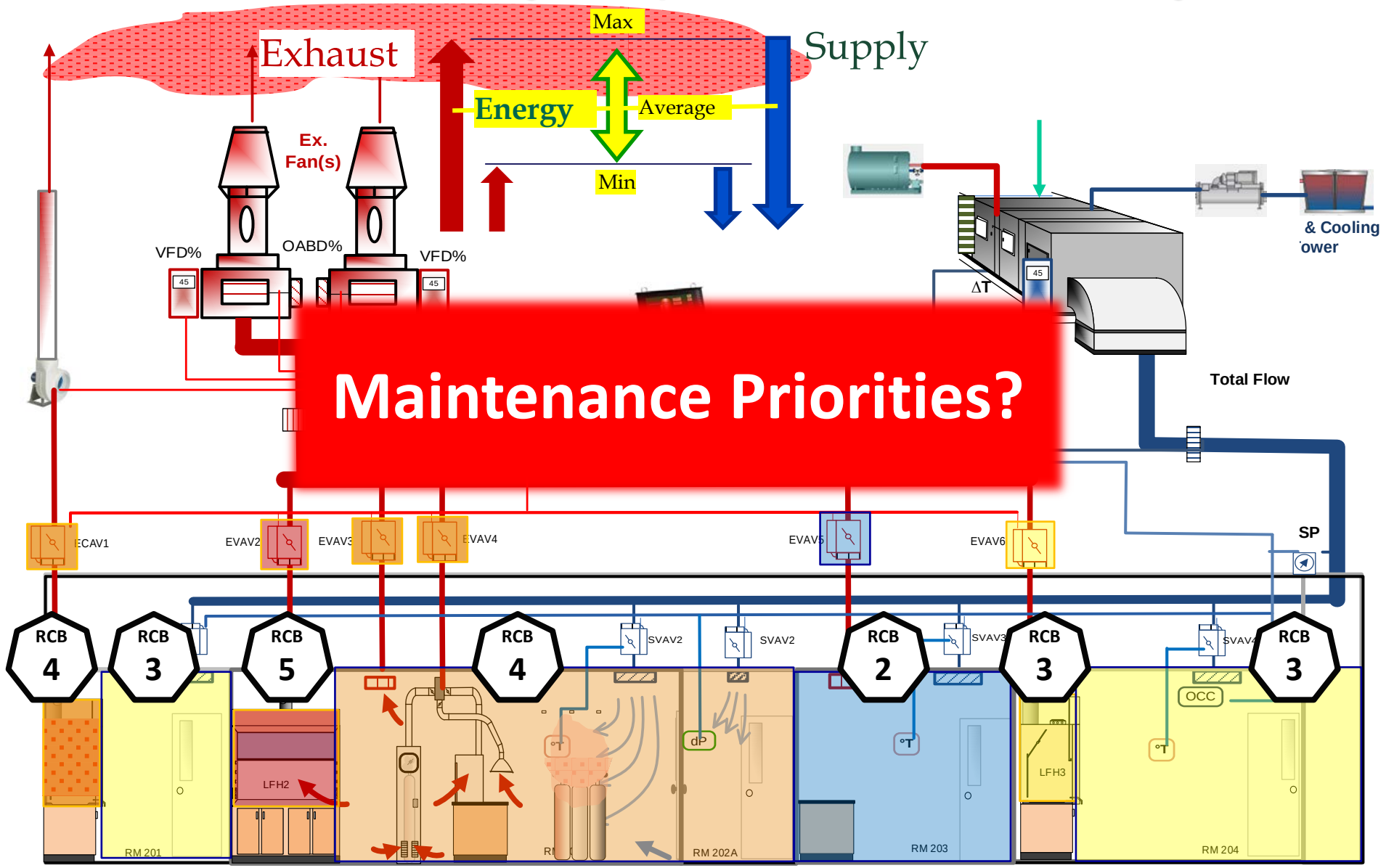
Risk Levels

Airflow Specifications

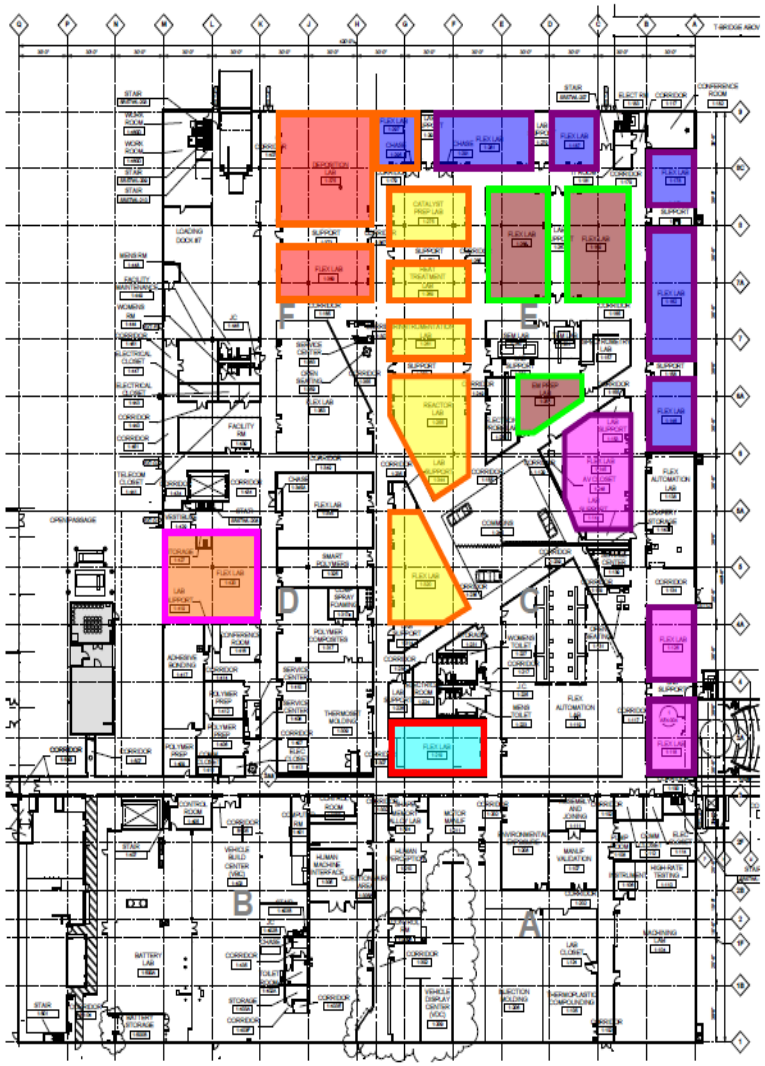
Min and Max Supply Flow

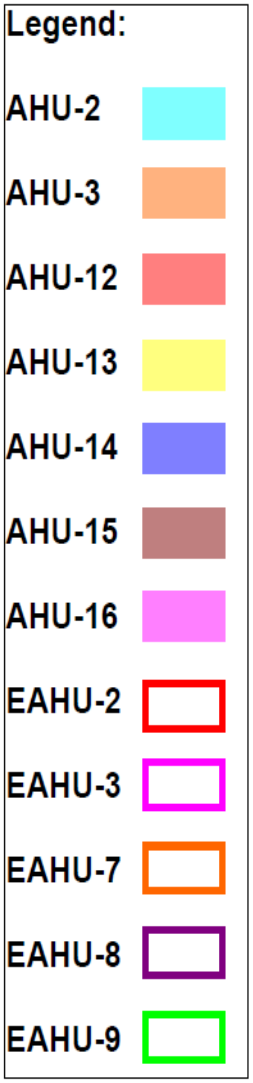
Min and Max Exhaust Flow

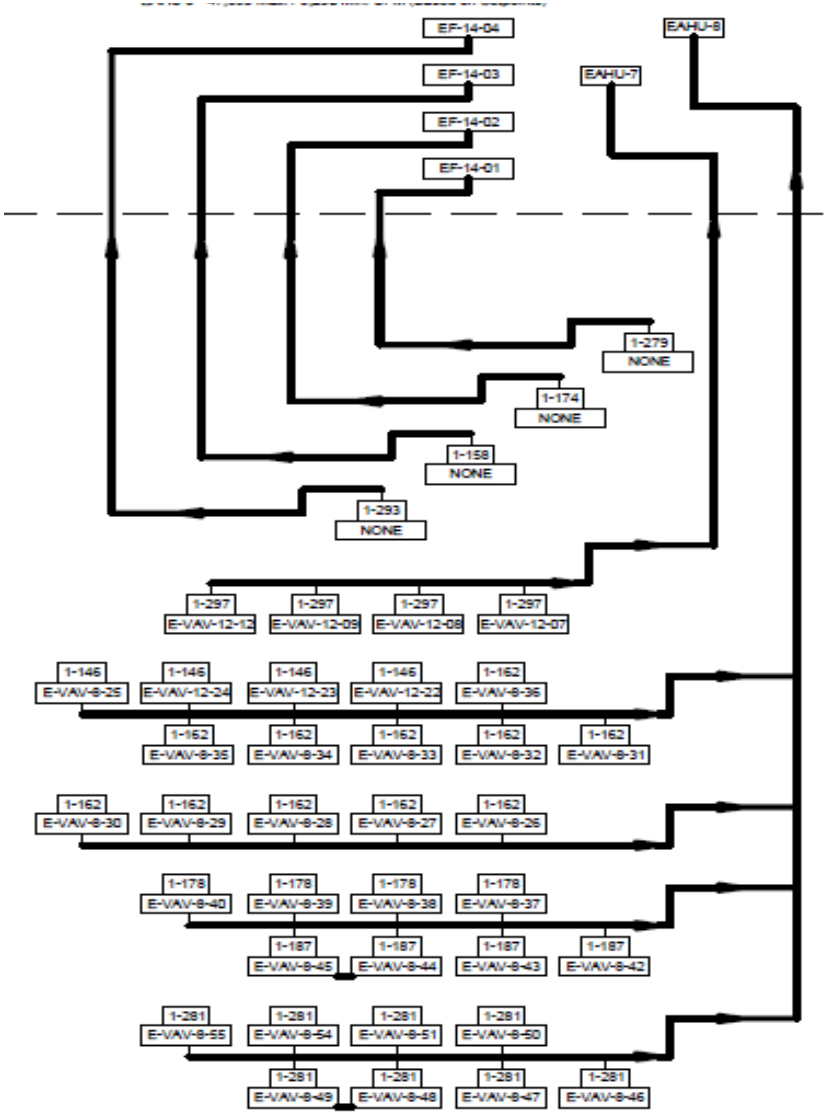
Sustainability Requires Maintainability



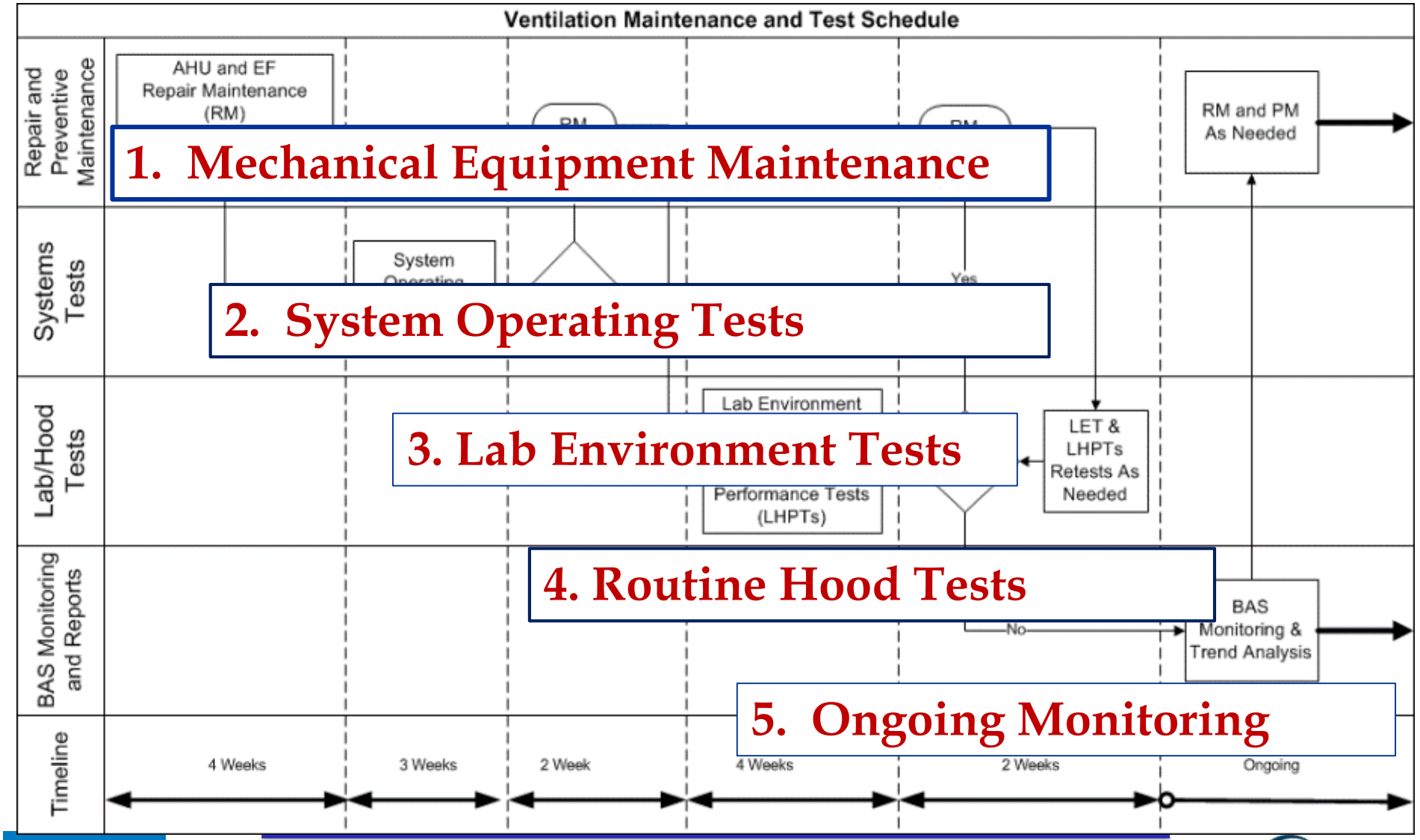
System Information and Line Diagrams Facilitate Management and Operations



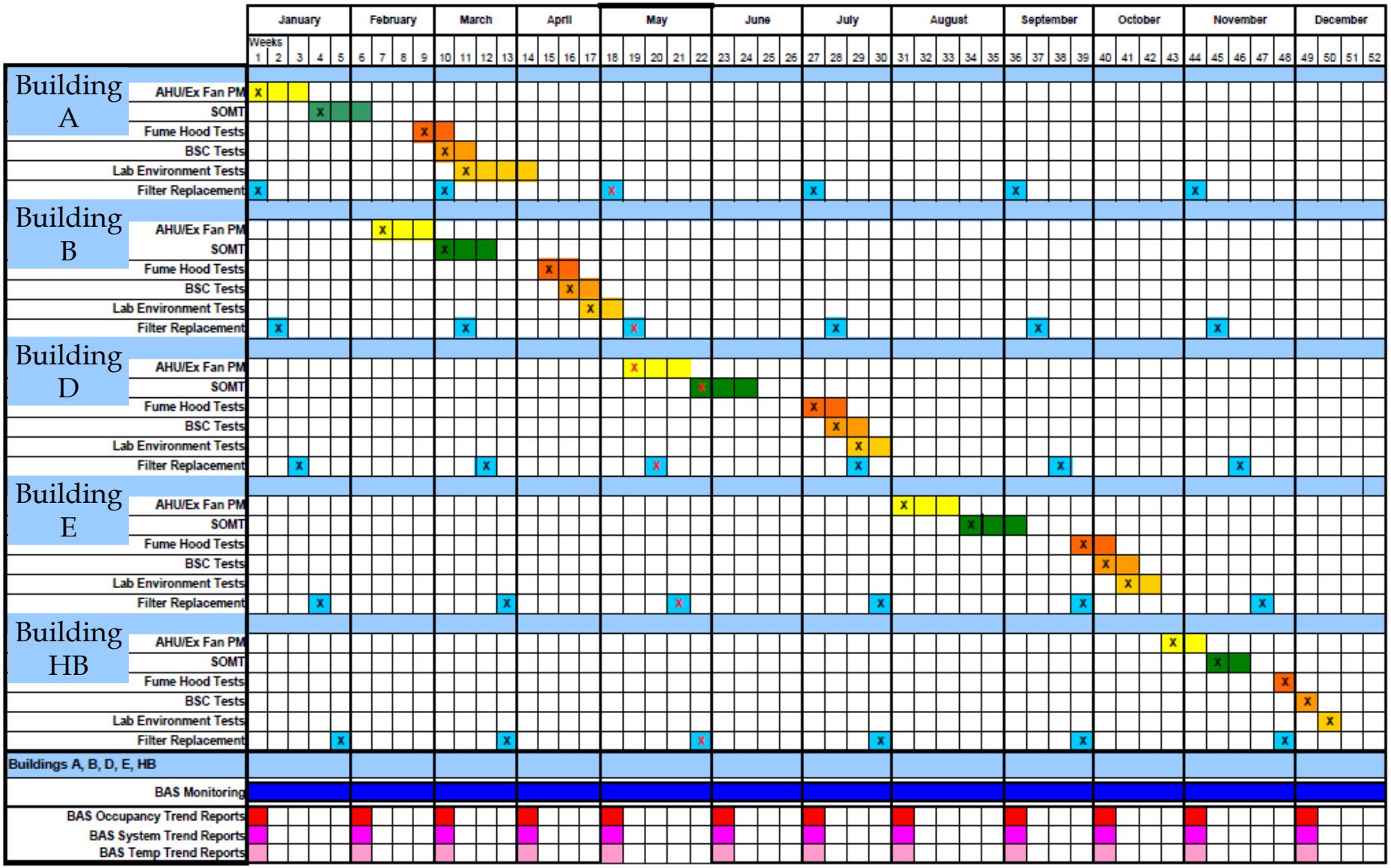




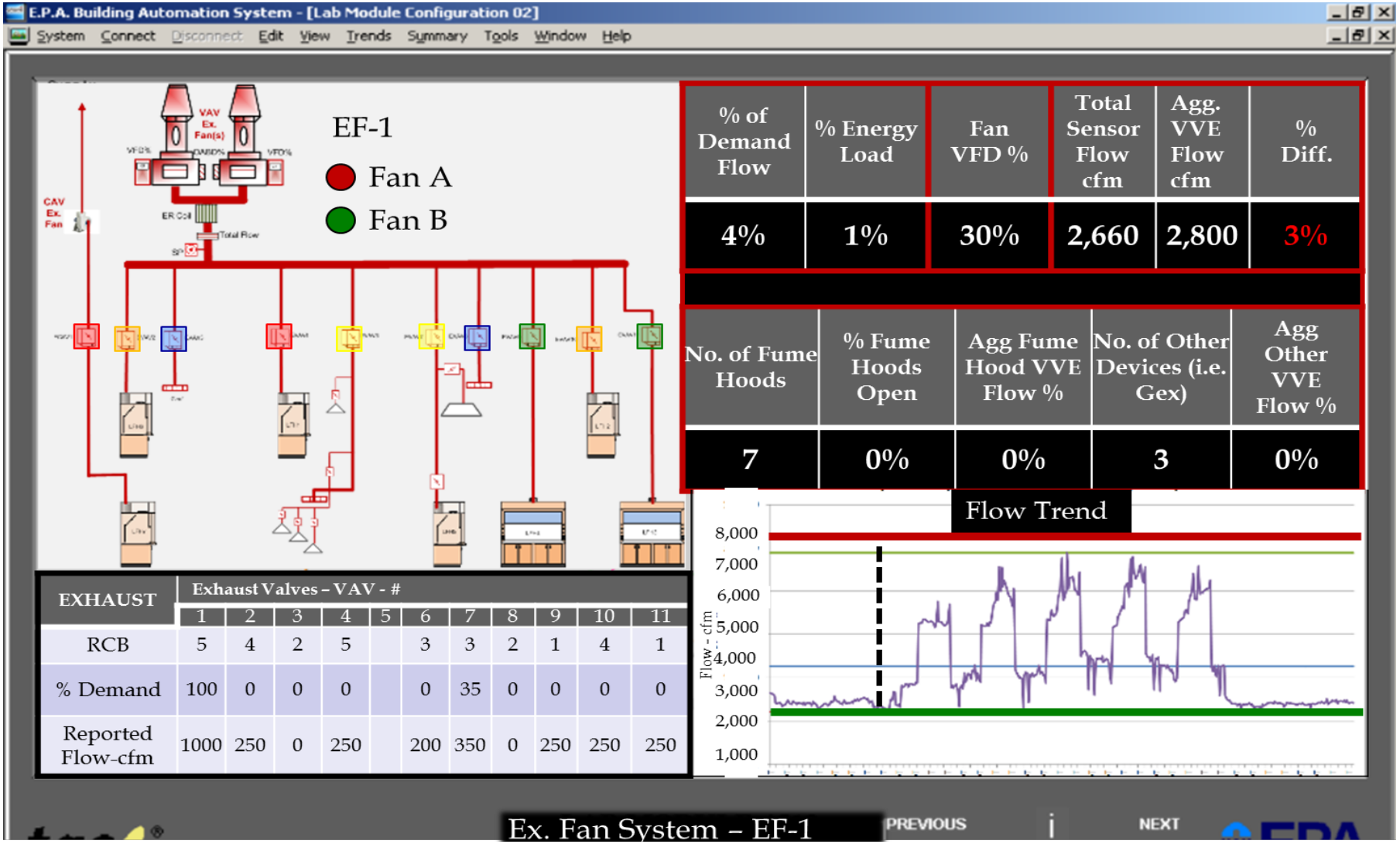
Routine test and maintenance tasks are optimized to maintain performance and minimize operating costs



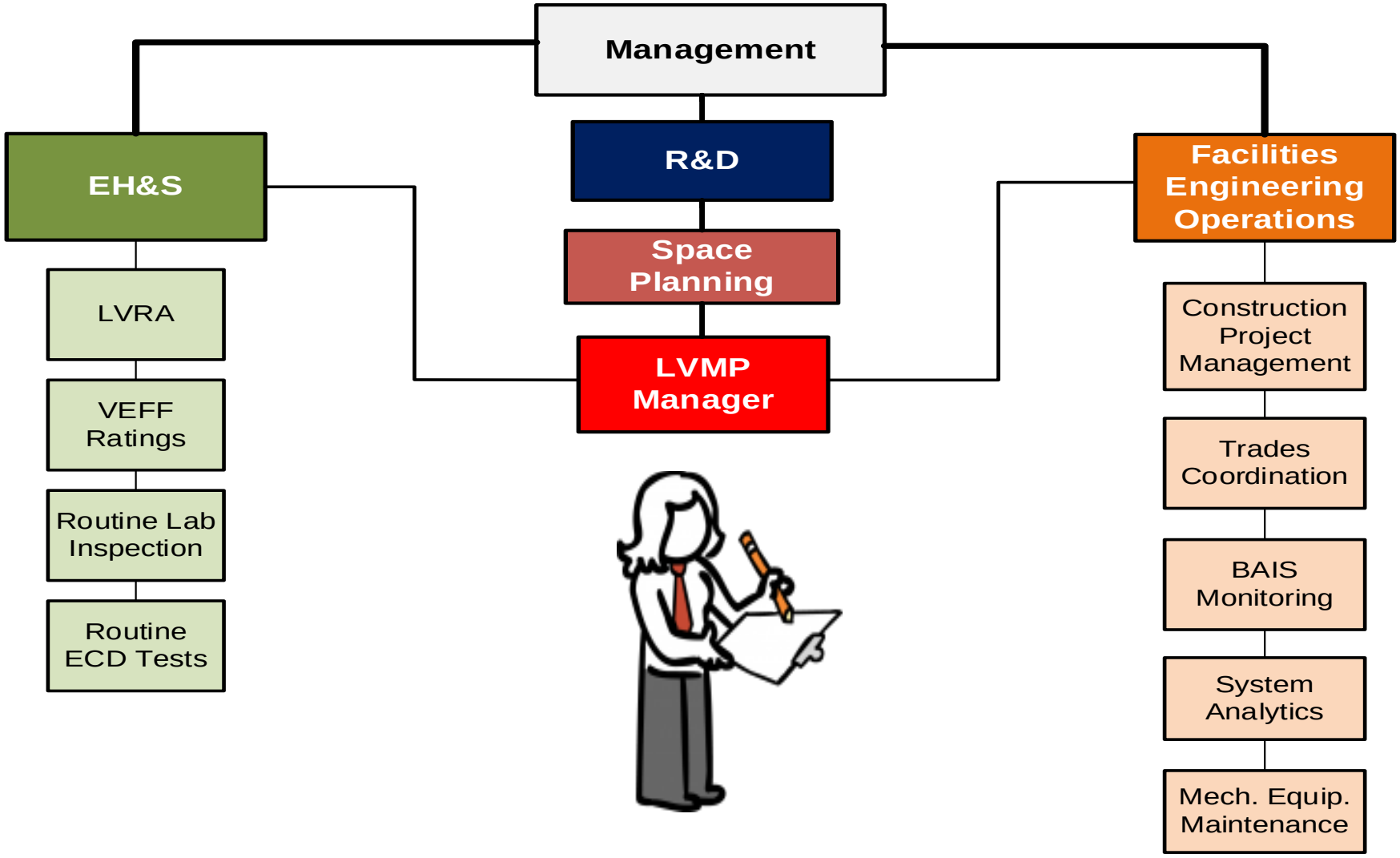
LVMP Multi-Building Task Coordination



Building Information Dashboards enable more effective management and improved sustainability



The LVMP Manager integrates and coordinates the efforts of key stakeholders



Smart Labs™ includes training for all stakeholders

- Program Managers & Supervisors
  - Facilities Engineering
  - Operations and Maintenance
  - EH&S
  - Lab Management

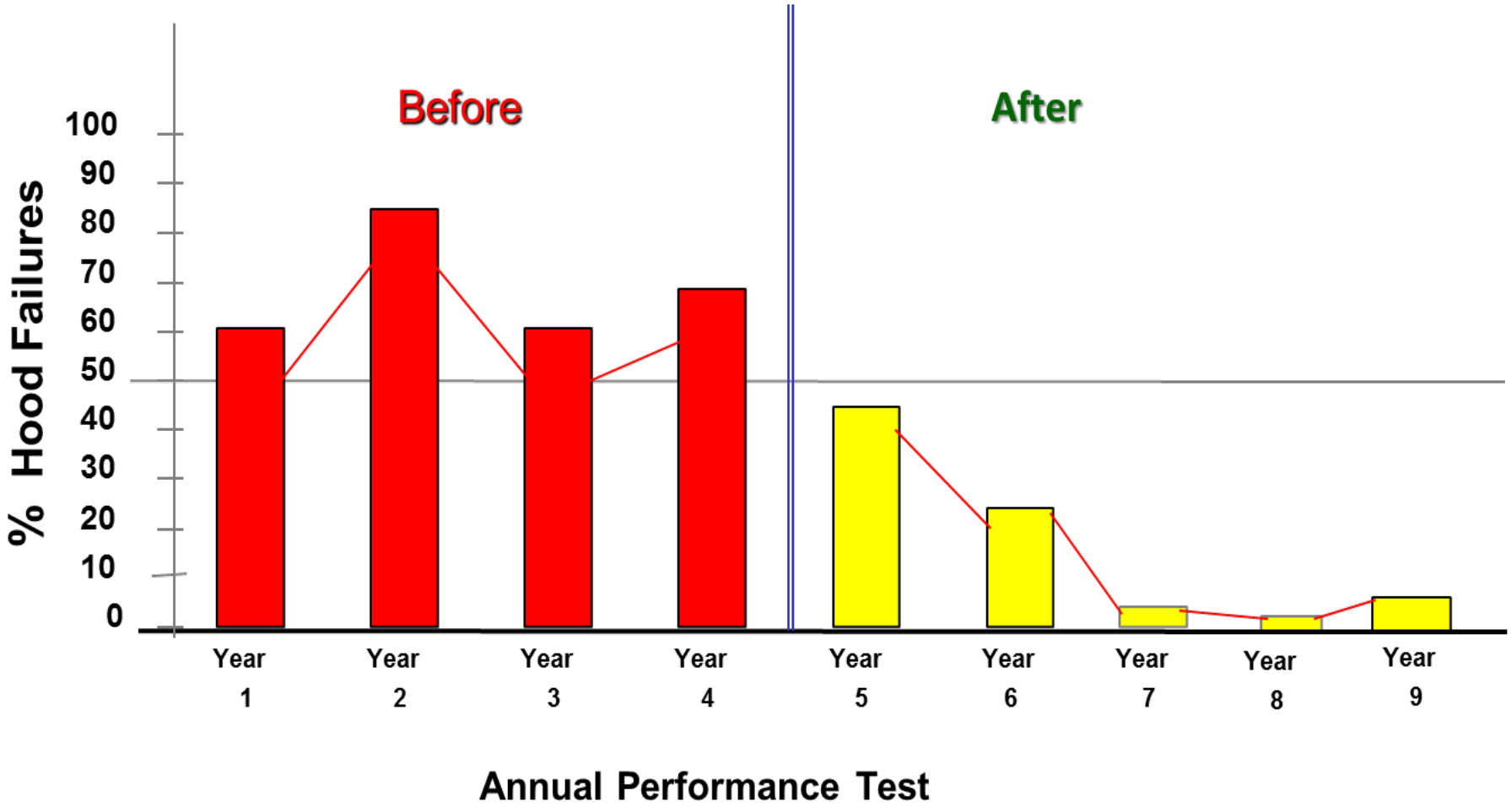
LVMP Manager Coordinator

- Maintenance

- Building Operators

- Lab Personnel

The LVMP improves performance, mitigates risk and maximizes sustainability




The right flow in the right place at the right time!™
3Flow™

Thank You!

Questions

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