

ASHRAE WILL GIVE YOU THE WORLD

T
E
A
C
H

Give Back to ASHRAE



LEARN

This ASHRAE Distinguished Lecturer is brought to you by the
Society Chapter Technology Transfer Committee

Complete the Distinguished Lecturer Event Summary Critique



❖ CTTC needs your feedback to continue to improve the DL Program

- ✓ Distribute the DL Evaluation Form to all attendees
- ✓ Collect at the end of the meeting
- ✓ Compile the attendee rating on the Event Summary Critique
- ✓ Send the completed Event Summary Critique to your CTTC RVC and ASHRAE Headquarters



Forms are available at:

www.ashrae.org/distinguishedlecturers

VOLUNTEER!



BECOME A FUTURE LEADER IN ASHRAE – WRITE THE NEXT CHAPTER IN YOUR CAREER

ASHRAE Members who attend their monthly chapter meetings become leaders and bring information and technology back to their job.

YOU ARE NEEDED FOR:

- ❖ Membership Promotion
- ❖ Research Promotion
- ❖ Student Activities
- ❖ Chapter Technology Transfer Technical Committees



Find your Place in ASHRAE! Visit www.ashrae.org

The Siemens logo, which is the word "SIEMENS" in a bold, teal, sans-serif font, set against a white rectangular background.

SIEMENS

A photograph showing several people wearing yellow hard hats and light blue shirts, looking down at a large set of blueprints or technical drawings on a table. One person is pointing at a specific area on the drawing with a yellow marker.

Methodical Approach to Sustainability in Laboratories

ASHRAE Distinguished Lecture Series

Jim Coogan
Siemens Building Technologies

ASHRAE, St. Louis Chapter
November, 2014

Agenda

Sustainability and energy use in labs

Structure of a long-range program

Assessment Phase

Technical Solutions

- Air flow reductions
- Thermal process efficiency
- Optimized air movement

Information Management

Maintaining Operation

Context: Institutions Commit to Sustainability

Reduce energy use
on campuses

Growing list of
presidents committed

- 12 in 2006
- 400 in 2007
- 684 in 2014

Started in US; now includes other nations

Accountable through public reporting

Reference:

<http://www.presidentsclimatecommitment.org/>



Context: Standards and Technology Advance

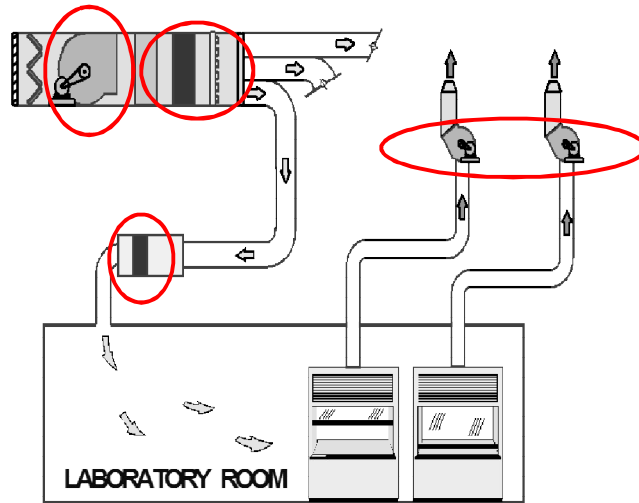
Lab Ventilation, ANSI Z9.5, standard
allows lower flow rates in fume hoods
New hood designs contain better
Ventilation effectiveness studies
Sensing and control technologies for
better ventilation, not more ventilation
Data collection and analysis tools “document
reliable operation”, as required by Z9.5
Design tools for exhaust dispersion

What is sustainable?

Preserving our environment
over the long term
Many environmental issues;
energy, indoor environment
are near the top
Design and construction are
important steps
In the long run, operation
consumes energy



HVAC Energy Use in Labs



Page 9

Copyright © 2014. All rights reserved.

Reducing Energy Use

1. Use less air
2. Improve heating and cooling processes
3. Move air more efficiently

How do you cut air flow safely?

Page 10

Copyright © 2014. All rights reserved.

Many strategies and devices

- Install VAV hood control
- Install Low Flow fume hoods
- Improve hood entrance and access
- Run a sash closing campaign
- Sense contaminants and ventilate on demand
- Reassess minimum ventilation flow for rooms
- Set back flow rates in unoccupied periods
- Cool with water instead of air
- Install sash closers
- Reduce minimum flow rates on closed hoods
- Improve exhaust dispersion



Page 11

Green Lab Program

Component	Assessment	Technical Solutions (FIMS)	Information Management	Service Solutions
Potential Customer Deliverables	<ul style="list-style-type: none"> • Qualification Assessment/Survey • Lab Safety • Lab Energy • Complete Performance Report (Energy & Safety) • Analytical Tool • Safety/Compliance Recommendation • Energy Conservation Recommendation • Confirm Design/Operational Baseline 	<ul style="list-style-type: none"> • CV to 2 pos CV • CV to VAV • Occupancy Monitoring • Low-Flow, High Performance Fume Hoods • Fume Hood Sash Management • Lab Ventilation Rate Management • Exhaust System Management • Equipment De-Commissioning • Etc... • New Baseline Monitor/Control: 	<ul style="list-style-type: none"> • Historian • Green Dashboard • Mobile Solution • Real-Time Monitoring • Data Trending • Data Archiving • Reporting • Alarm Information • Remote Notification 	<ul style="list-style-type: none"> • Historian • Calibration Services • Chemical Fume Hood Testing • Bio-Safety Cabinet Certification • Re-entrainment Testing • Room Pressurization Testing • Validation Protocol Development and Execution • SOP Development • Continuous Commissioning
Customer Value	<p>Assess:</p> <ul style="list-style-type: none"> • Regulatory compliance and safety • Energy efficiency • Current operational baseline 	<ul style="list-style-type: none"> • Enhance and ensure regulatory compliance • Enhance energy consumption and efficiency 	<p>Manage:</p> <ul style="list-style-type: none"> • Total facility operation with monitoring, reporting, and data archiving capabilities 	<p>Maintain:</p> <ul style="list-style-type: none"> • Protect investment • Maximize compliance • Maximize energy efficiency (based on new baseline)

Page 12

Copyright © 2014. All rights reserved.

Green Lab Program: Assessment

Component	Assessment	Technical Solutions (FIMS)	Information Management	Service Solutions
Potential Customer Deliverables	<ul style="list-style-type: none"> • Qualification Assessment/Survey • Lab Safety • Lab Energy • Complete Performance Report (Energy & Safety) • Analytical Tool • Safety/Compliance Recommendation • Energy Conservation Recommendation • Confirm Design/Operational Baseline 	<ul style="list-style-type: none"> • CV to 2 pos CV • CV to VAV • Occupancy Monitoring • Low-Flow, High Performance Fume Hoods • Fume Hood Sash Management • Lab Ventilation Rate Management • Exhaust System Management • Equipment De-Commissioning • Etc... 	<ul style="list-style-type: none"> • Historian • Green Dashboard • Mobile Solution • Real-Time Monitoring • Data Trending • Data Archiving • Reporting • Alarm Information • Remote Notification 	<ul style="list-style-type: none"> • Historian • Calibration Services • Chemical Fume Hood Testing • Bio-Safety Cabinet Certification • Re-entrainment Testing • Room Pressurization Testing • Validation Protocol Development and Execution • SOP Development • Continuous Commissioning
Customer Value	<p>Assess:</p> <ul style="list-style-type: none"> • Regulatory compliance and safety • Energy efficiency • Current operational baseline 	<p>New Baseline Monitor/Control:</p> <ul style="list-style-type: none"> • Enhance and ensure regulatory compliance • Enhance energy consumption and efficiency 	<p>Manage:</p> <ul style="list-style-type: none"> • Total facility operation with monitoring, reporting, and data archiving capabilities 	<p>Maintain:</p> <ul style="list-style-type: none"> • Protect investment • Maximize compliance • Maximize energy efficiency (based on new baseline)

Assessment Phase

Qualification Assessment

- Lab Safety – evaluate overall compliance to latest codes and standards
- Lab Energy – identify improvement measures

Reporting

- Energy and safety performance reports
- Energy conservation recommendations

Green Lab Program: Tech Solutions

Component	Assessment	Technical Solutions (FIMS)	Information Management	Service Solutions
Potential Customer Deliverables	<ul style="list-style-type: none"> Qualification Assessment/Survey Lab Safety Lab Energy Complete Performance Report (Energy & Safety) Analytical Tool Safety/Compliance Recommendation Energy Conservation Recommendation Confirm Design/Operational Baseline 	<ul style="list-style-type: none"> CV to 2 pos CV CV to VAV Occupancy Monitoring Low-Flow, High Performance Fume Hoods Fume Hood Sash Management Lab Ventilation Rate Management Exhaust System Management Equipment De-Commissioning Etc... New Baseline Monitor/Control: Enhance and ensure regulatory compliance Enhance energy consumption and efficiency 	<ul style="list-style-type: none"> Historian Green Dashboard Mobile Solution Real-Time Monitoring Data Trending Data Archiving Reporting Alarm Information Remote Notification 	<ul style="list-style-type: none"> Historian Calibration Services Chemical Fume Hood Testing Bio-Safety Cabinet Certification Re-entrainment Testing Room Pressurization Testing Validation Protocol Development and Execution SOP Development Continuous Commissioning
Customer Value	<p>Assess:</p> <ul style="list-style-type: none"> Regulatory compliance and safety Energy efficiency Current operational baseline 	<p>Manage:</p> <ul style="list-style-type: none"> Total facility operation with monitoring, reporting, and data archiving capabilities 	<p>Maintain:</p> <ul style="list-style-type: none"> Protect investment Maximize compliance Maximize energy efficiency (based on new baseline) 	

Chemical Fume Hood



Fume hood protects lab workers by containing gases, vapors, etc. from the work

HVAC system replaces exhaust with conditioned supply air

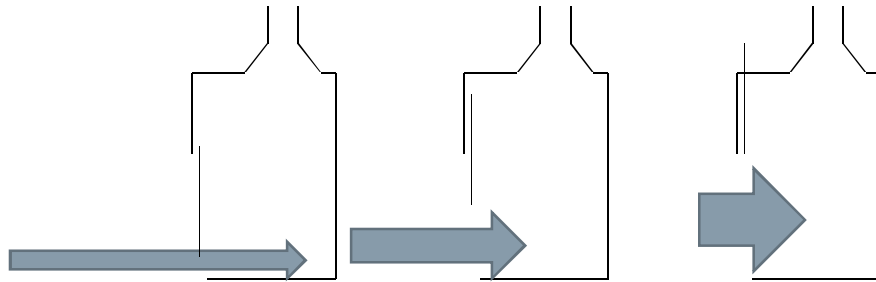
Control Hood Flow for Safety and Energy Management

Constant volume hood

draws the same flow all the time; velocity changes

Variable volume hood

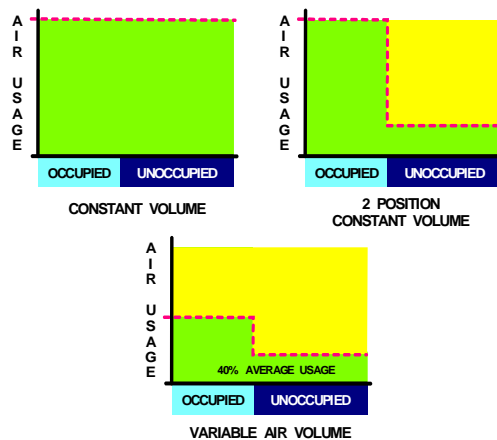
varies the flow for constant velocity



Page 17

Copyright © 2014. All rights reserved.

Energy Conservation Potential



Page 18

Copyright © 2014. All rights reserved.

Fume Hood Technology and Industry Changes

Fume hoods are
#1 safety device and
#1 driver of conditioned air

Low-flow fume hoods use
less air to do the same job

Automatic sash positioning
systems

New Z9.5 allows lower
minimum flow



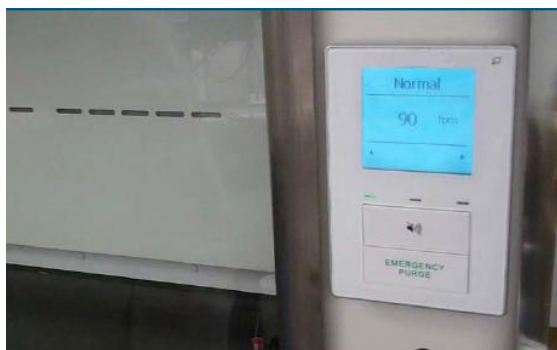
Page 19

Copyright © 2014. All rights reserved.

Sash Management

Involve the occupants in conservation;
Not just another engineering measure.
Many components to program, including:

- Alert guard after hours
- 'Beeps' to lab user
- Reports to lab manager



Page 20

Copyright © 2014. All rights reserved.

Automatic Sash Positioner

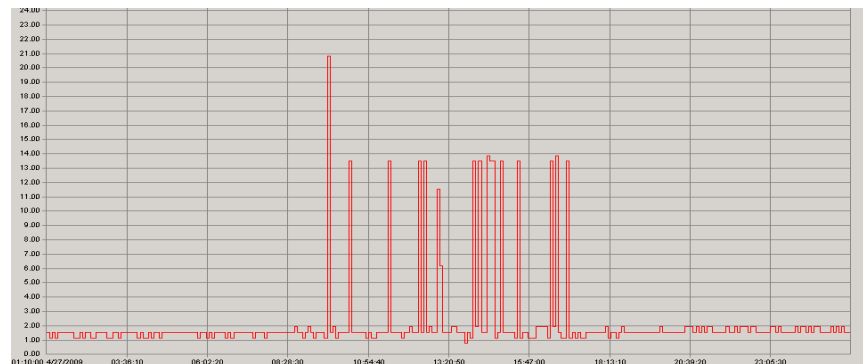
Automatic Sash Positioning systems address BOTH safety and energy savings concerns

ASPs close the sash when no user is present
“Sash closer” vs. “ASP”

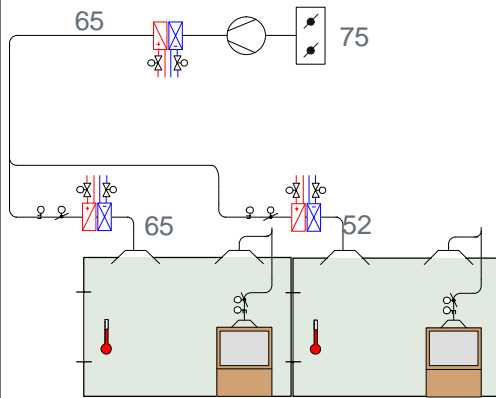


Automatic Sash Positioner

1 day of operating data



Decouple Cooling and Ventilation



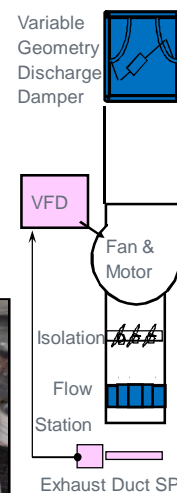
Send partly conditioned outside air to terminals
 Avoid cooling at AHU and reheating at room
 One high load does not set the AHU temp
 Supports “free cooling” concepts
 Can be fan coil, chilled beam or air terminal with cooling coil

Page 23

Copyright © 2014. All rights reserved.

Variable Geometry Exhaust Discharge Damper

Reduce load on exhaust fans
 Let fan flow vary with building exhaust instead of constant flow with OA bypass
 Apply VSD to exhaust fan
 Maintain plume momentum with variable outlet damper



Page 24

Copyright © 2014. All rights reserved.

Lab Building Exhaust Optimization

Standard approach

- Run fans at prescriptive 3000 fpm discharge

Engineered approach

- Study location of outlets, inlets, wind, contaminants
- Calculate required discharge momentum and velocity in worst case

Dynamic approach

- Measure changing conditions: weather, contamination, ...
- Adjust discharge with requirements



Green Lab Program: Information

Component	Assessment	Technical Solutions (FIMS)	Information Management	Service Solutions
Potential Customer Deliverables	<ul style="list-style-type: none"> • Qualification Assessment/Survey • Lab Safety • Lab Energy • Complete Performance Report (Energy & Safety) • Analytical Tool • Safety/Compliance Recommendation • Energy Conservation Recommendation • Confirm Design/Operational Baseline 	<ul style="list-style-type: none"> • CV to 2 pos CV • CV to VAV • Occupancy Monitoring • Low-Flow, High Performance Fume Hoods • Fume Hood Sash Management • Lab Ventilation Rate Management • Exhaust System Management • Equipment De-Commissioning • Etc... • New Baseline 	<ul style="list-style-type: none"> • Historian • Green Dashboard • Mobile Solution • Real-Time Monitoring • Data Trending • Data Archiving • Reporting • Alarm Information • Remote Notification 	<ul style="list-style-type: none"> • Historian • Calibration Services • Chemical Fume Hood Testing • Bio-Safety Cabinet Certification • Re-entrainment Testing • Room Pressurization Testing • Validation Protocol Development and Execution • SOP Development • Continuous Commissioning
Customer Value	<p>Assess:</p> <ul style="list-style-type: none"> • Regulatory compliance and safety • Energy efficiency • Current operational baseline 	<p>Monitor/Control:</p> <ul style="list-style-type: none"> • Enhance and ensure regulatory compliance • Enhance energy consumption and efficiency 	<p>Manage:</p> <ul style="list-style-type: none"> • Total facility operation with monitoring, reporting, and data archiving capabilities 	<p>Maintain:</p> <ul style="list-style-type: none"> • Protect investment • Maximize compliance • Maximize energy efficiency (based on new baseline)

Information Management: Laboratory Performance Reporting

True performance occurs during operation;
requires supervision

Reports designed to
confirm function,
identify deficiencies

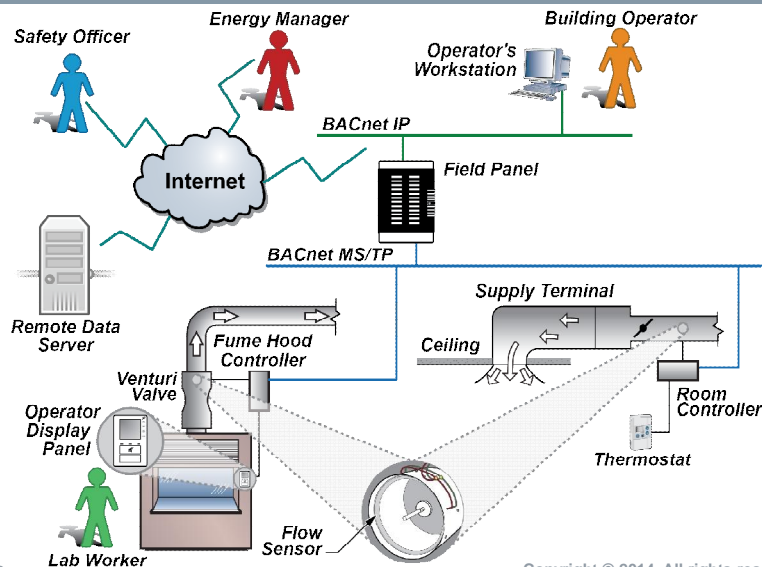
Report designed to evaluate energy opportunities

Nodes	% of Satisfactory Temperature	% of Satisfactory Directional Airflow	% of Satisfactory Ventilation
1 Lab K311	100.00	100.00	99.16
2 Lab K319	92.64	99.92	99.00
3 Lab K321	99.00	99.99	99.16
4 Lab K366	100.00	99.92	99.37
	94.38	99.72	99.12
	94.38	99.72	99.12

Reference:

- J. Coogan, ASHRAE IAQ 2013 Proceedings, Information Tools to Manage and Improve Laboratory Ventilation Systems

Information Infrastructure for Sustainable Laboratory



Information Management: Hood Comparison Report

Quickly identify which fume hoods

- Not functioning
- Left open too often

Lab Facility Fume Hood Comparison

Organization: State of Indiana Forensics and Life Sciences Lab
Node: Indiana Forensics & Health Lab [Other meters]
Path: Indiana Forensics & Health Lab

Fume Hood Performance	Performance Criteria	
Nodes	Target Ratio Met (+/Yes; 0/No)	Satisfactory Exhaust Volume
		%
1 Lab N211 Hood 2	1.00	99.24
2 Lab N219 Hood	1.00	99.97
3 Lab N221 Hood 1	0.00	99.90
4 Lab N221 Hood 3	1.00	99.72
5 Lab N230 Hood 2	1.00	99.53
6 Lab N230 Hood 4	1.00	91.60
7 Lab N232 Hood 1	1.00	98.49
8 Lab N232 Hood 2	1.00	99.32
9 Lab S220 Hood 1	1.00	0.00
10 Lab S233 Hood 1	-	-
11 Lab S239 Hood 1	1.00	99.89
12 Lab S253 Hood 1	1.00	92.41
13 Lab S344 Hood 1	1.00	94.85
14 Lab S344 Hood 2	1.00	99.22
15 Lab S366 Hood 1	1.00	97.01
16 Lab S367 Hood 1	1.00	96.94
-	-	91.28
-	0.68	91.28

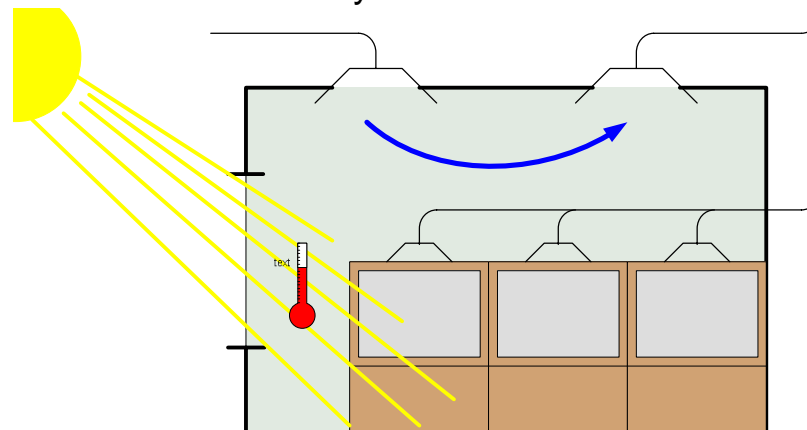
Page 29

Copyright © 2014. All rights reserved.

Lab Energy Drivers

Energy drivers = airflow drivers

3 drivers for chemistry lab are well known



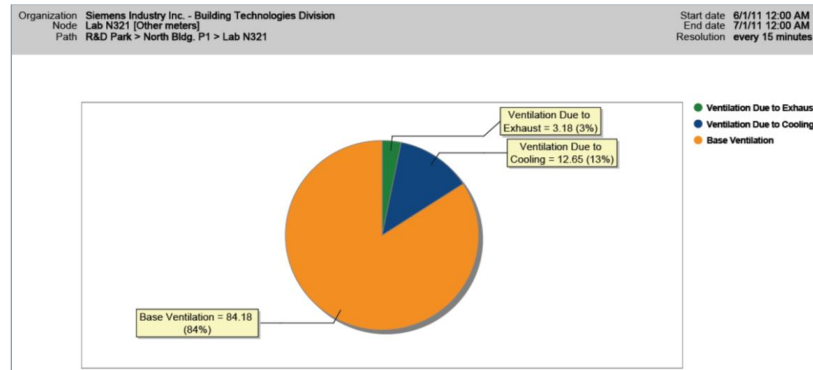
Page 30

Copyright © 2014. All rights reserved.

Information Management: Lab Air Flow Driver Report

Lab Facility Air Volume Driver Report

- Knowing which of the three factors is principally driving the air volume is the first step in determining how to reduce the airflow.



Using the Lab Energy Driver Report

Energy driver report distinguishes
between improvement options

Driven by Exhaust Devices, consider:

- Are they used?
If not, consider decommissioning
- Are they left open?
Apply sash management or automatic sash closers
- Are they often closed?
Evaluate minimum flow considering current guidelines

Using the Lab Energy Driver Report

Driven by Room Ventilation, consider:

- Evaluate ACH with current industry trends
- Implement UNOCC ventilation
- Measure contaminants to vary ventilation (DCV)

Driven by Thermal Load, consider:

- Re-locate heat sources
- Reduce lighting
- Replace old freezers

Green Lab Program: Service

Component	Assessment	Technical Solutions (FIMS)	Information Management	Service Solutions
Potential Customer Deliverables	<ul style="list-style-type: none"> • Qualification Assessment/Survey • Lab Safety • Lab Energy • Complete Performance Report (Energy & Safety) • Analytical Tool • Safety/Compliance Recommendation • Energy Conservation Recommendation • Confirm Design/Operational Baseline 	<ul style="list-style-type: none"> • CV to 2 pos CV • CV to VAV • Occupancy Monitoring • Low-Flow, High Performance Fume Hoods • Fume Hood Sash Management • Lab Ventilation Rate Management • Exhaust System Management • Equipment De-Commissioning • Etc... • New Baseline 	<ul style="list-style-type: none"> • Historian • Green Dashboard • Mobile Solution • Real-Time Monitoring • Data Trending • Data Archiving • Reporting • Alarm Information • Remote Notification 	<ul style="list-style-type: none"> • Historian • Calibration Services • Chemical Fume Hood Testing • Bio-Safety Cabinet Certification • Re-entrainment Testing • Room Pressurization Testing • Validation Protocol Development and Execution • SOP Development • Continuous Commissioning
Customer Value	<p>Assess:</p> <ul style="list-style-type: none"> • Regulatory compliance and safety • Energy efficiency • Current operational baseline 	<p>Monitor/Control:</p> <ul style="list-style-type: none"> • Enhance and ensure regulatory compliance • Enhance energy consumption and efficiency 	<p>Manage:</p> <ul style="list-style-type: none"> • Total facility operation with monitoring, reporting, and data archiving capabilities 	<p>Maintain:</p> <ul style="list-style-type: none"> • Protect investment • Maximize compliance • Maximize energy efficiency (based on new baseline)

Service and Maintenance

Assure continuous regulatory and/or accreditation compliance

- Calibration Services
- Chemical Fume Hood Testing
- Bio-Safety Cabinet Certification
- Room Pressurization Testing
- Validation Protocol Development & Execution
- SOP Development
- Continuous Commissioning

Summary

Sustainability occurs in operation

In labs, it means reducing energy use

While maintaining function:

- Better ventilation, not more
- Monitor verify performance
- Actively manage operation
- Engage occupants in conservation

Establish a program for maintenance
and improvement

Questions?



Jim Coogan, PE
Jim.Coogan@Siemens.com

