



Cornell University
Environmental
Health and Safety

Laboratory Ventilation Management Program

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2/8/2016



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1. Introduction

This Laboratory Ventilation Management Plan (LVMP) provides guidance for balancing the safety value of ventilation in the laboratories on the Ithaca and Geneva Cornell campuses with the financial and “carbon” costs associated with the energy required to supply this air. On these campuses, laboratory spaces use a disproportionate amount of the University’s energy and carbon budget (nearly 50% of the energy’s heating and cooling load for 33% of the campus floor space). This is largely due to the demands of laboratory ventilation; in particular the energy required to condition air to maintain temperature requirements in the laboratory. Therefore optimization of laboratory ventilation is a key element in reaching the goal envisioned in Cornell’s Climate Action Plan of a climate neutral campus by 2035. The purpose of this LVMP is to delineate the laboratory ventilation program’s scope and provide procedural guidance for anyone who is affected by or has responsibility for the ventilation of laboratories at the University. These stakeholders are outlined below.

For the purposes of this plan, “laboratory ventilation” refers to the once-through movement of air through spaces that is used to maintain the quality of a laboratory environment where hazardous chemicals are used. Specialized ventilation systems which serve high hazard operations are excluded from this program; however, managers of these systems are encouraged to include energy conservation as a key element in the facility’s operations.

Questions about the details of this plan should be referred to the Cornell Chemical Hygiene Officer or Laboratory Ventilation Specialist.

2. Objectives

The overriding aim of the lab ventilation program is to maintain the safety and health of lab workers while contributing to the energy reduction goals of the entire campus. Based on benchmarking with other research campuses, our overall target is to reduce the laboratories’ normalized carbon footprint by at least 20% from 2010 to 2020. This is accomplished by assessing chemical usage in existing labs, ventilation effectiveness and housekeeping in existing labs and identifying the ones that can be ventilated at a 25% airflow rate reduction. It will also be accomplished with the existence of design standards for new construction and renovation that utilize a variety of strategies. Experience at Cornell University Ithaca has shown that up to 80% of laboratories outside chemistry-specific research laboratories can operate safely at the moderate ventilation rate. This determination must be made on a lab by lab basis and reassessed periodically, generally every three years or when research operations change significantly.

3. Relevant Requirements

External Requirements

There are few regulatory requirements that address laboratory ventilation issues and none in a way that prescribes specific criteria. The OSHA Laboratory Standard (29 CFR 1910.1450 Subpart Z Appendix A) contains the most detailed information about the components of a ventilation system for chemical hygiene purposes, including the quantity of the general ventilation rate. But it does not provide airflow rate requirements. Therefore, this document outlines a working partnership between Cornell’s laboratory workers and administration, the Facilities Services Energy and Sustainability Department, and the Department of Environmental Health and Safety which supports the safe and sustainable operation of laboratory ventilation systems. It is an integrated management plan for the design, use, monitoring, and maintenance

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of the ventilation systems in campus laboratories.

This program is based on two American National Standards Institute standards developed by the American Industrial Hygiene Association: ANSI Z9.5 for Laboratory Ventilation and ANSI Z10 for Occupational Health and Safety Management Systems. The first of these standards outlines the mechanical and management elements required for the appropriate use of laboratory ventilation to protect worker health and safety. The second standard describes the elements of a management system which support the ongoing improvement of the program over time by providing the Key Performance Indicators outlined in Chapter 8, which monitor the plan's performance (see Figure 1).

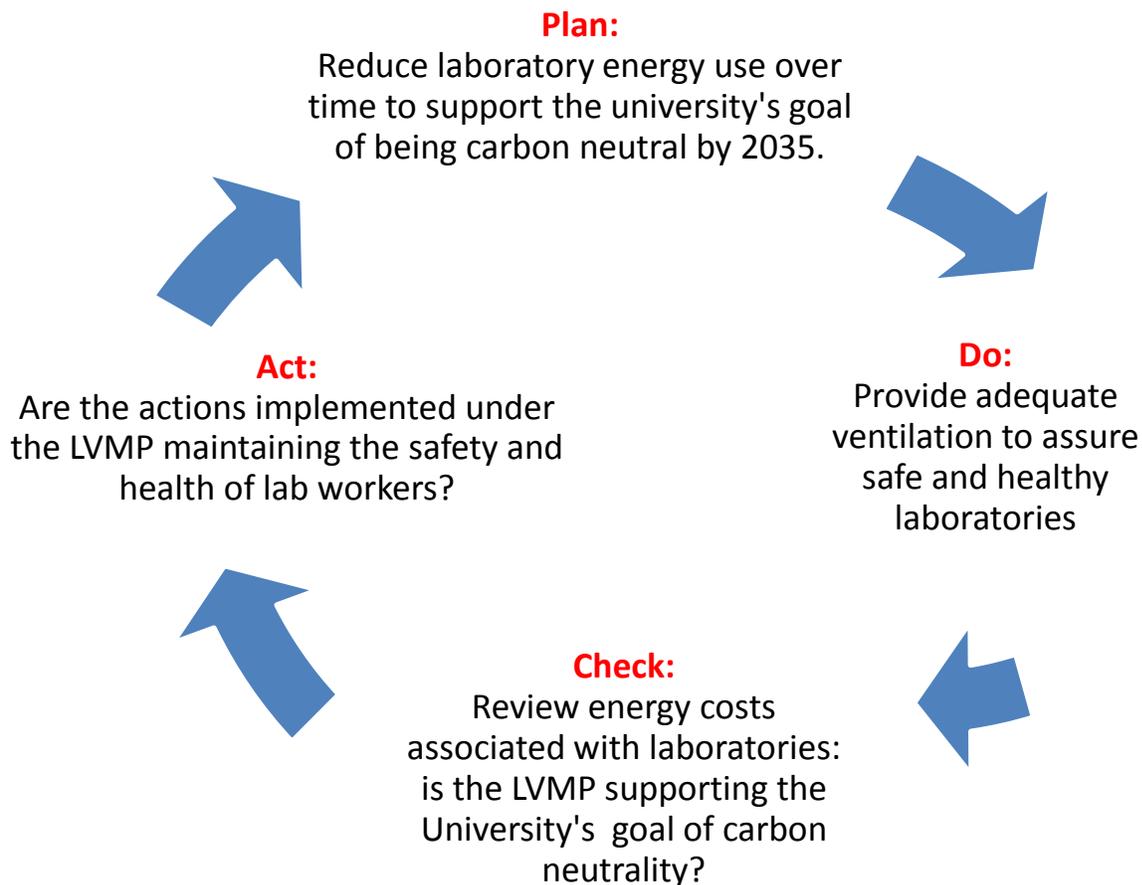


Figure 1: Overview of Laboratory Ventilation Monitoring Process

Internal Requirements

The University's Health and Safety Policy 8.6 is the governing policy that states Cornell's commitment to, and describes the departmental and individual responsibilities for, maintaining the safety of everyone in the Cornell community. In order to comply with this policy, the

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laboratory ventilation optimization outlined in this plan will be managed within the constraint of supporting safe laboratories that carry out the teaching, research and service missions of the University.

In order to achieve its Climate Action Plan (CAP) goal of reaching carbon neutrality by 2035 and to cost effectively reduce energy use as part of ongoing cost reduction efforts, Cornell University is “implement(ing) a broad program of energy conservation on the Cornell campus.” The CAP notes that laboratory spaces use a disproportionate amount of the University’s energy and carbon budget. This is largely due to the heating and conditioning demands of laboratory ventilation; therefore optimization of laboratory ventilation is a key part of reaching this goal. This issue is also a core element of the Green Development Actions identified by the Climate Action Plan, which include implementing “low energy use standards for new buildings...to reduce the need for future energy and maintenance costs.”

4. Stakeholders

The strategy for this program recognizes that laboratory ventilation encompasses both a wide variety of stakeholders and widely varying laboratory ventilation system designs, conditions, uses, and effectiveness around campus. The system described in this management plan will maintain the health and safety of lab occupants while optimizing the ventilation rates to meet the sustainability goals of the University,

The stakeholders involved in this program are organized into four broad groups according to their involvement with the laboratory ventilation operations. The breakout of responsibilities and tracking indicators for these groups is outlined below. Tracking indicators measure the activities of the various stakeholders group as they fulfill their role.

	Stakeholder Groups	Role
1	Laboratory workers, supervisors and administration	Directly involved in laboratory operations and planning
2	Infrastructure, Properties and Planning, and Environmental Health and Safety staff	Provides facility support and institutional oversight of laboratory work on campus
3	External authorities such as OSHA, EPA and AIHA committees	Sources of external safety and health standards for campus laboratory practices
4	Campus Community	Establishes and tracks energy usage and carbon budgets for laboratory operations on campus

Scope for Laboratory Workers, Supervisors and Administration

For the purpose of the lab ventilation program, “lab occupants” includes employees and students in several subgroups. The first involves individuals who are directly impacted by the decisions made about the ventilation provided to a specific lab or group of labs because they work with hazardous chemicals in the laboratory. Other members of this group are Laboratory Supervisors and Principal Investigators who are the first line managers of specific spaces. These people direct the choices of chemicals used in their labs, where equipment is placed and how work will be performed. They also supervise the training of employees and students. A third subgroup in

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Group 1 is department chairs, deans and departmental safety representatives, who allocate and monitor use of lab space.

Scope for Infrastructure, Properties and Planning (IPP) and EHS

This group is comprised of support staff from IPP and Environmental Health and Safety who make observations and recommendations about the design and operation of specific lab ventilation systems. This group includes EHS staff that conduct fume hood commissioning and certifications, risk assessment and review of ventilation adequacy. They provide recommendations about laboratory equipment selection and placement, and provide general safety training for lab occupants. Facilities Services includes those who provide the design of laboratory spaces and facility maintenance, mechanical support and operational budget management. The Energy Management Office staff within IPP is the group responsible for identifying, promoting and implementing energy conservation opportunities in campus laboratories. It provides continuous laboratory systems monitoring and maintenance with improved energy usage in mind.

This LVMP builds upon current practices by these stakeholders. The Hood Housekeeping Score and Control Banding of the entire laboratory room indicators are the two elements added to current practice of this group.

Scope for External Authorities and Peers

This group encompasses external groups who do not manage laboratory ventilation systems at Cornell, but provide technical standards for minimum performance and best practices. They are concerned about the health and safety of laboratory workers and the potential climate impacts and energy costs associated with lab operations. These groups include professional technical committees, government regulators and agencies such as the Department of Energy. In addition to providing minimum performance requirements and best practices, these organizations look to Cornell as a model for best practices with regard to laboratory ventilation management.

Scope for Campus Community

This group includes the Campus Community and Public who are concerned about both the health and safety of laboratory workers and the potential climate impacts associated with campus laboratory operations. They are represented by the Cornell administration, which helps determine the type and conditions of work appropriate to be conducted through funding decisions and legal requirements.

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5. Roles and Responsibilities

The stakeholder groups outlined above have varying responsibilities with regard to laboratory ventilation. These responsibilities are outlined in this section, with indicators that will be used to track the success of these groups in meeting these responsibilities. The indicators are organized in a way to create a “balanced scorecard” that includes safety and sustainability indicators and assess both leading and lagging measures of performance. These indicators are more fully described in Section 8.

Laboratory Workers, Supervisors and Administration

Roles	Responsibilities	Tracking Indicator
Laboratory workers	Maintain good chemical housekeeping practices	Trend in Hood Housekeeping Score (HHS) as seen at the time of annual recertification and during EHS drop in visits
Laboratory workers	Properly use containment devices and understand the impact of laboratory ventilation in their work area on their work practices	HHS and EHS inspections results show improvement
Laboratory supervisor and/or principal investigator	Lead chemical hazard assessment of laboratory work; identify and implement less hazardous chemical operations when possible.	Trend in Control Band assignments for lab work over time
Laboratory supervisors and academic administration	Identify and implement opportunities to decommission hoods or reduce general ventilation flow-rate or plug-load	Number of hoods decommissioned or labs whose Control Banding assignment is lowered

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Infrastructure Properties and Planning (IPP) and Environmental Health and Safety

Roles	Responsibility	Tracking Indicator
IPP mechanics	Monitor face velocity of fume hoods	Number of hoods with face velocities outside 120% of recommended value
Energy Management staff and shops mechanics	Continuously commission laboratory ventilation systems and implement and track hood decommissioning	Trends in energy consumption of laboratory buildings
IPP and EHS staff	Observe hood housekeeping conditions during hood certification and other lab visits	Use of HHS to educate occupants about the proper use of fume hoods
IPP, EHS staff, Energy Management staff, building coordinators and Departmental Safety Representatives	In consultation with Laboratory Ventilation Specialist, approve opportunities for hibernating hoods (see section 7.3), reduced general ventilation flow-rates or fume hood face velocities	Reductions in laboratory ventilation rate implemented
EHS Laboratory Ventilation Specialist and Energy Outreach Coordinator	Provide education and outreach to lab occupants about safe and sustainable general ventilation and fume hood practices	Number of laboratory consultations to apply good ventilation practices to their lab
Energy Management staff	Maintain metrics database that converts building ventilation rates to financial and carbon costs	Decrease in financial and carbon operating costs of laboratory ventilation on campus
Campus Laboratory Planners and Designers	In consultation with facilities management and EHS, develop laboratory designs with ventilation operating costs in mind	Ventilation Control Band distribution and number of fume hoods installed relative to campus benchmarks
IPP Managers	Assign laboratory facilities to minimize ventilation requirements to support the work being conducted	Lab ventilation control bands appropriately reflect chemical use in labs
EHS staff	Conduct risk assessments of lab operations with ventilation effectiveness a central component	Appropriate ventilation rates assigned to lab spaces to maintain safety of occupants

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Professional Peers

Roles	Responsibilities	Tracking Indicator
Laboratory science peers, nationally and internationally	Review of ventilation program impacts upon science developed in Cornell laboratories	Adoption of similar practices by other campuses
IPP and EHS peers nationally	Establish external standards for best practices and performance with regard to laboratory safety and carbon emissions	Ongoing compliance with external standards

Campus Community

Roles	Responsibilities	Tracking Indicator
President and Provost	Assure that financial and carbon operating costs are included as part of laboratory facility planning	Upper level support of the CAP efforts over time
Cornell Sustainability	Track energy usage and carbon footprint of laboratories on campus	Metrics for success of energy conservation initiatives
Public	Understand and be publically involved with energy consumption within the county	Public interest in energy reduction efforts of the University

6. Training

Elements of each group's role in the laboratory ventilation program are included in departmental and Environmental Safety training programs. This Environmental Safety training program is currently being expanded in order to spread the awareness and knowledge of lab ventilation stakeholders more broadly.

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7. Operational Tools

Standard Procedures

The following section lists the operational procedures and documentation that organize the Laboratory Ventilation Program. Cross departmental policies and procedures are also provided with links to the appropriate websites.

7.1.1 Fume Hood Commissioning and Annual Inspection Procedure

This procedure outlines routine practices associated with fume hood installation and oversight by support staff.

7.1.2 Design and Construction Standards

This standard describes Cornell's expectations for laboratory ventilation design during laboratory construction and renovation. See Standard 230540 for Laboratories at <http://cde.fs.cornell.edu/toc.cfm>.

7.1.3 Carbon Dioxide Ventilation Effectiveness Protocol

This procedure describes the process for assessing laboratory ventilation effectiveness in specific laboratories in order to support a laboratory ventilation control banding assignment for the laboratory.

Job Tasks

The following section lists the daily job plans specific to individual activities.

7.2.1 Fume Hood Recertification

This job plan specifies requirements for testing and inspection of individual fume hoods on an annual basis. Specific assignments and results are managed by the Infrastructure Properties and Planning Maximo system.

7.2.2 Fume Hood Commissioning

Conducted by EHS this is the final verification of proper operation and inventorying of new fume hoods.

7.2.3 Fume Hood Maintenance

Fume hoods are to operate within the face velocity parameters recommended by Environmental Health and Safety. Those that are outside of this range, as indicated by the certification sticker on the fume hood, are to have a work order issued by the building coordinator if safety related or the Energy Management office if energy related to have the hood face velocity corrected.

Fume Hood Hibernation

Hoods which will not be used for chemical containment purposes for at least 3 months can be "hibernated" by request of the Facilities Control Shop, Energy Conservation and Controls Team (ECCT). This is initiated within the Maximo database system as a service request.

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7.4 Forms

Forms can be found at: <https://sp.ehs.cornell.edu/lab-research-safety/chemical-safety/lab-ventilation/Pages/default.aspx>

See Maximo database for performance information and history about individual hoods

See building control system for information about current room ventilation rates

8. Recordkeeping, Reporting & Monitoring

Key Performance Indicators

The key indicators measure the performance of the program by providing feedback loops that can be monitored and adjusted. The leading indicators for this program are Green Laboratories and Hood Housekeeping. The Green Labs concept is an initiative used to drive the choices of chemical usage toward less hazardous options and equipment placement within a room with the effectiveness of the ventilation in mind. Hood Housekeeping is a scorecard for fume hood usage made from observations by EHS staff and facilities maintenance staff. The two lagging indicators are measurements of actual energy usage as measured by the Energy Management staff after changes have been made. Chemical Safety Conditions is accomplished by monitoring improvements from a variety of tracking methods from other established EHS programs and feedback mechanisms.

Indicator Groups	Indicator	Oversight Department	Type of Indicator
Plan: Green Laboratories	Distribution of labs in Laboratory Ventilation Control Bands on campus	EHS Lab Ventilation Program	Leading Sustainability
Do: Hood Housekeeping	Improvements in Hood Housekeeping Score	EHS Lab Ventilation Program	Leading Safety
Check: Energy Use	Amount of energy used, and consequent carbon emissions, by Cornell labs on an annual basis	ECl and Sustainability Program	Lagging Sustainability

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Act: Chemical Safety Conditions	Improvement in laboratory safety observations, based on EHS audit scores, IAQ concerns, and hazmat responses	EHS Lab Ventilation Program	Lagging Safety
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Control Band Assignment

This rating system is based on the chemical usage and housekeeping of individual spaces. The rating is based on the control banding protocol outlined in the EHS procedure. This data will be used to identify trends in the intensity of laboratory chemical use over time. This will be stored on the Cornell EHS Sharepoint team-site and potentially in the Maximo database or Facilities Space Inventory. Although we recognize 4 bands that exist in labs that have single-pass airflow, the control banding assignment only involves the first 2. The following are examples of labs that do meet the criteria for reaching the moderate ventilation rates that are being used to meet energy conservation goals.

Ventilation Rates potentially higher than 8 ACH (occupied):

- 1) Ventilation systems that require higher rates due to environmental condition needs, such as clean rooms;
- 2) Labs where the stability of temperatures or humidity are important for the processes occurring in the space and will be negatively impacted with the ventilation rate reduction;
- 3) Small labs with a fume hood in which the general airflow rates are driven higher to meet the exhaust requirements of the hood (fume hood driven rooms);
- 4) Labs with high human or animal occupancy;
- 5) Labs whose chemical operations change so often that effective oversight of their ventilation is not possible with current EHS resources.

Ventilation Rates Lower than 6 ACH (occupied):

- 1) Low hazard/low volumes of chemicals in use;
- 2) Human occupancy and personal odor control is the main driver for ventilating the space;
- 3) Intermittent chemical sources that require single-pass air but do not constitute as a "significant chemical source";
- 4) Lab support spaces that meet the definition of a lab but where there is little or no lab work occurring;
- 5) Labs where the maintenance of temperature is the main driver, but where there is a fan coil unit or other less energy intensive technology to maintain space temperature.

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Laboratory ventilation control bands	General ventilation rate
Design-to ventilation	8 ach occupied / 4 ach unoccupied
Moderately ventilated	6 ach occupied / 3 ach unoccupied
Low laboratory ventilation provided	single pass air required, but ventilation rate is determined by specific operating schedules or other management practices
Specialized ventilation required	to be determined by engineering analysis

Hood Housekeeping (HHS)

During annual hood certification visits laboratory hood uses are assessed according to the scale below. This scale is based on best practices for safe and sustainable fume hood use. Trends in these scores will be used to design laboratory worker training and education efforts. This information is put into the Maximo database for each hood upon annual certification.

Hood Housekeeping Score (HHS)		Reason for concern
1	Hood decommissioned	None
2	Hood on, used for a single chemical process or well organized multiple purposes	None
3	Hood on, but empty or being used for storage	Sustainability
4	Hood on, crowded or used for competing multiple chemical uses	Safety
5	Hood on and contamination evident	Safety
The higher the Hood Housekeeping Score, the more serious the concern		

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Goals and Gap Analysis 2012

Stakeholder Perspective	Current Situation	Where you'd like to be over a specific time frame? (SMART Goals)	How the Gap can be filled	Change leader
Laboratory population	Little practical training about appropriate fume hood use is currently available	Development of an occupants "hood use review" – a form that occupants could fill out to determine when a hood is required for a specific chemical process GOAL: Such a form is available in July, 2013.	Develop "Hood Use Review" form. This should support culture shift where lab occupants participate in hazard review of their space and will support proper hood use instruction for lab population.	EHS
Laboratory population	Few fume hoods have undergone hood hibernation (temporary decommissioning).	Observations indicate that around 30% of hoods are not used for chemical processes. But are on when not needed; wasting ventilation air. GOAL: 20% of fume hoods on campus are in hibernation by 2015	Include this process in Facilities Customer Service.	Green Labs Program
Laboratory population	Green Chemistry principles are inconsistently applied across campus.	Broad application of Green Chemistry Principles within laboratories as outlined by EPA and ACS GOAL: 20% of labs adopt the <i>beyond benign</i>	Green Chemistry outreach program to laboratories with 4 key elements: solid waste, ventilation conservation, decreasing chemical hazards and	Green Labs Program

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		Green Chemistry Commitment by 2014	reducing plug-load	
Facilities and EHS support services	"Housekeeping" only communicated through lab inspection program with no follow-up. There is a corrective action issued to PI, but the frequency of inspections is low.	Hood Housekeeping ratings for hoods (to be collected in Maximo) GOAL: HHS System in place by July 2013:	Instruct Steve Phayre to rename column, provide Steve Palmer with rating system and anyone else who views the hood inventory	EHS / ECI partnership
Facilities Services	If the hood is found to be operating above 120 fpm it is a priority for adjustment	Fume hoods across campus that operate between 80-120 fpm. GOAL: Reduced number of fume hoods operate above 120 fpm each year	Instruct Steve Palmer and Rick Bishop that tickets are to be issued for hood above range	ECI outreach and EHS
Facility and EHS support services	Control banding system for labs needs further development and implementation	Control Banding is in common use and a general awareness exists of how it is accomplished among lab population GOAL: Form available by October, 2013	Need total development of the banding part of the LVM Program.	EHS
Energy Management Program and EHS	Many laboratories are currently ventilated at rates above the design standard of 8 ach occupied / 4 ach unoccupied	Survey operational laboratories for ventilation reduction opportunities	All buildings are identified for survey by March, 2013 (accomplished); 50% of buildings are adjusted by January, 2014 and reminder	Energy Management and EHS

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			are adjusted by January, 2015	
Facilities Services and EHS	Outdated Laboratory Design standard requirements	Update Laboratory Design standard to reflect best practices described in the Labs-21 program materials	Discussion with facilities engineering design section	EHS
External peer groups	Peer review of scientific program development upon submission of written work or presentation	Frequent opportunities for peer review via manuscripts, presentations, standards development, etc GOAL: 2 national presentations or papers on the Green Labs and/or lab vent program each year	Continue to seek outreach opportunities with appropriate groups, including American Chemical Society, AASHE ERAPPA, and Labs 21	Facilities Services and EHS
Campus community	Specific tracking of carbon footprint indicator directly tied to LVMP	Public messages describing Cornell's conservation efforts with regards to lab sustainability GOAL: Public recognition of lab role in achieving climate change	Incorporate metrics done by ECI, but calculate portion afforded specifically to lab vent.	Facilities Energy Management (ECI)

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8.5 Goals and Gaps 2014

Stakeholder Perspective	Current Situation	Goals	How the Gap can be filled	Change Leader
Laboratory population	Little practical training about appropriate fume hood use is currently available	Hood Housekeeping scoring system is easily available to lab staff GOAL: Score made available with lab inspection reports in December, 2014.	Create action items in lab inspection reports that includes HHS. This will support culture change that support lab occupant participation in hazard reviews of their space and proper hood use instruction.	EHS
Laboratory population	No lab community awareness of sustainability efforts with respect to lab ventilation.	General knowledge of lab ventilation energy usage on campus by end 2015.	Include sustainability in lab trainings, inspections and other communications with lab population. It is currently part of all introductory lab safety trainings.	Lab Ventilation and Green Labs programs
Laboratory population	Green Lab principles are inconsistently recognized across campus.	Broad application of Green Chemistry Principles. Sustainability of labs a common concern of lab population. GOAL: 10% of labs become Green Lab certified by end 2016	Green Lab outreach program to laboratories with 5 key elements: solid waste, ventilation and water conservation, decreasing chemical hazards and reducing plug-load.	Green Labs and Lab Ventilation Program

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