Upgrade to the modern vivarium: digitally enabled & super energy/water efficient

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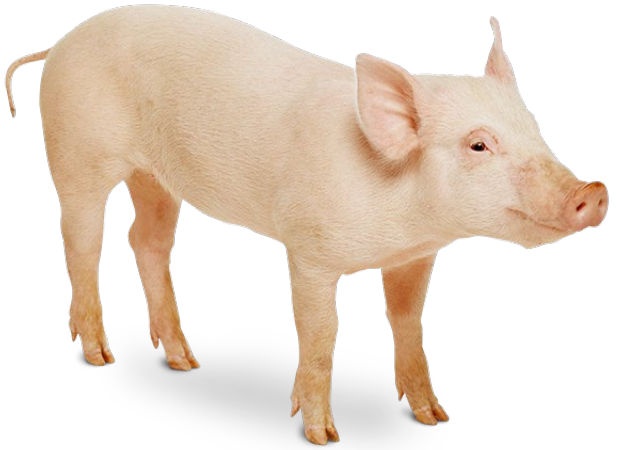
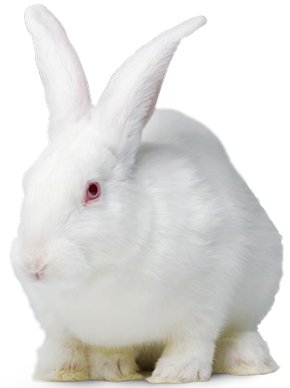
Edstrom part of AVIDITY Science

AIRCUITY® Creating Measurably Better Environments

Why Critical Monitoring in the Vivarium?





Why Critical Monitoring in the Vivarium?

Animal Welfare

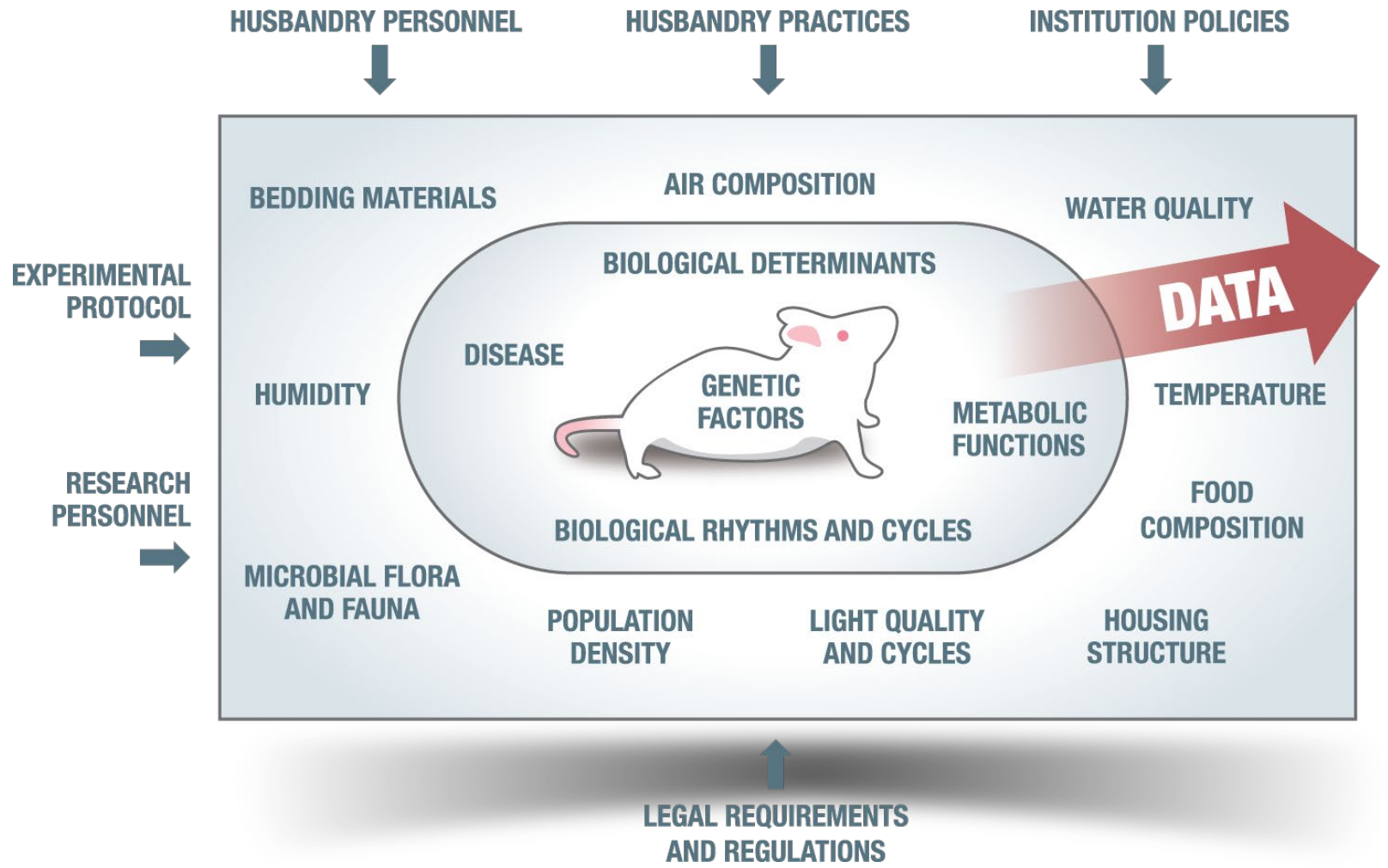
Research Integrity

Legal Responsibility

Physiological Response = Disease or Disorder

Behavioral Response = Stress Response

Factors Influencing Animal Physiology and Behavior



What needs to be monitored in a typical environment per *The Guide*?

- Temperature
- Humidity
- Light
- Air Flow
- Differential Pressure

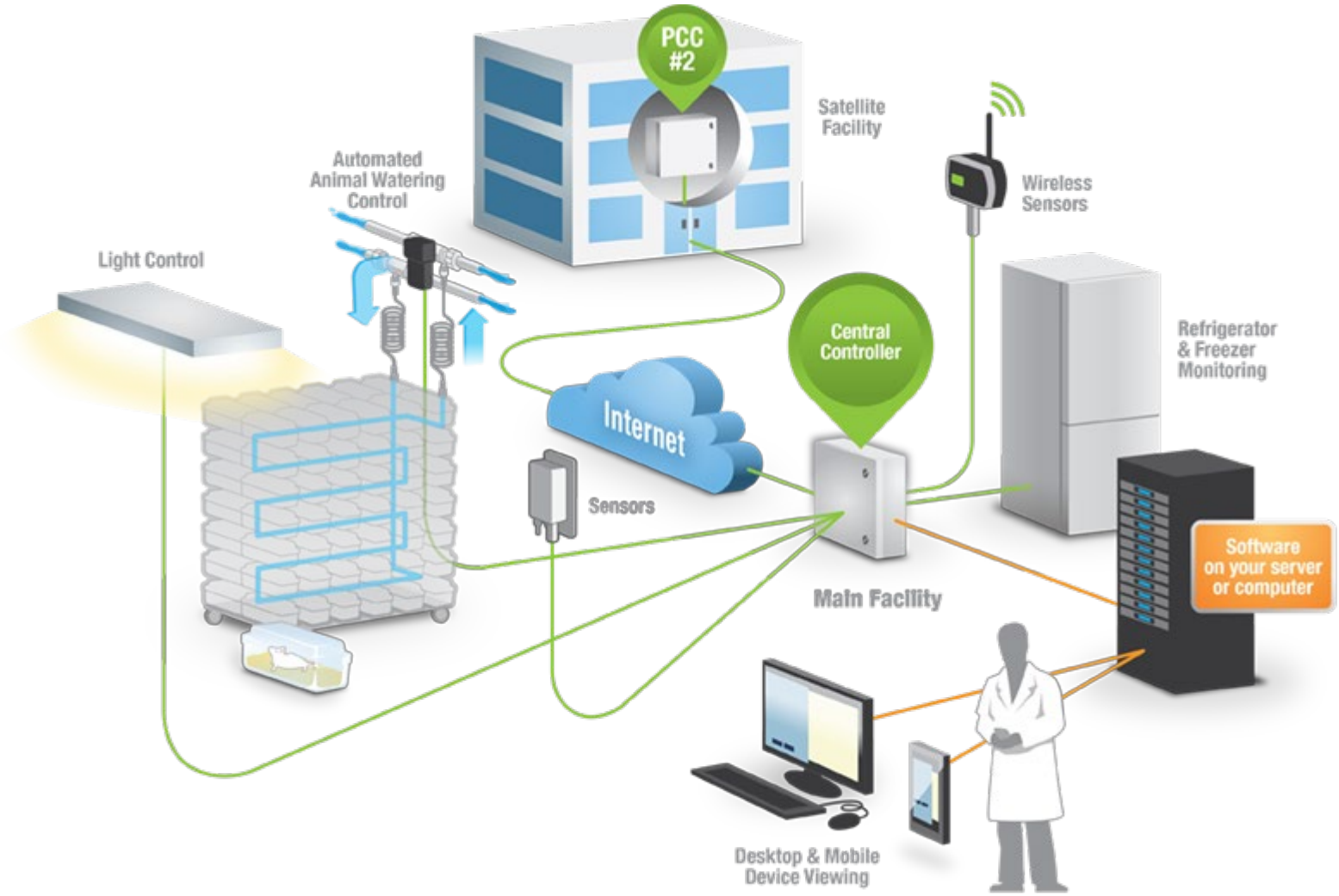
Ventilation, Air Quality, Pressure

- A properly ventilated space must provide appropriate air quality and a stable environment for the animals
- Needs to maintain a healthy and comfortable environment for the human workers
- Energy consumption is a major factor for environmental considerations and cost
  - The historically recommended rate of 10-15 is often more than necessary
  - Levels of CO2, ammonia, airborne pathogens, odors, chemical contaminants and particulate matter can be controlled with lower ACH.
  - Variable air exchange rates are becoming more widely acceptable and offer opportunities for energy savings resulting in ROI.
  - Centralizing the data point collection, reporting, alarming, and notifications specific to vivarium needs is important.

Vivarium Specific Monitoring v. Building Management System

Vivarium Specific	BAS/BMS
System and data “owned and managed” by animal care group.	System is primarily owned and managed by the campus or organization
Records and archives support specialized research studies &/or regulatory needs	General recording not meant to support research studies
Sensors located in animal rooms	Sensors located in ducts
Monitoring system is the automated, secondary "evaluation" mentioned in the Guide	Same system controls and monitors, false/drifting data point = incorrect environment
Access from any web enabled device	Access and Control typically limited to house security/ facilities groups.
Alarm and notification flexibility and controlled by vivarium staff	One alarm usually goes to one person in security or physical plant area

Campus Solution



Vivarium Solutions

Maintain and Healthier Environment and Save Energy

What is Airside Efficiency?

Next generation sensing platform

Energy & environment information

Not a building control system - Integrates with building/lab controls

Simplifies building sensing

More reliable concept w/ less sensors

Reduces & out sources maintenance

Unique, proven technology

650+ systems installed, 750+ sold

30,000 rooms/areas sensed

Energy savings for many facilities

80+ Vivarium systems installed & 300+ Laboratory systems installed

- Dynamic control of air changes

Offices, Healthcare, Education, Assembly

- DCV, Differential enthalpy, dew point sensing

A high IEQ and energy savings are simultaneously delivered.

The macro environment is often way over ventilated.

2X

Often ACH is more than twice what is needed when cages are clean

$15k/yr

Based on annual usage of 3,000 CFM

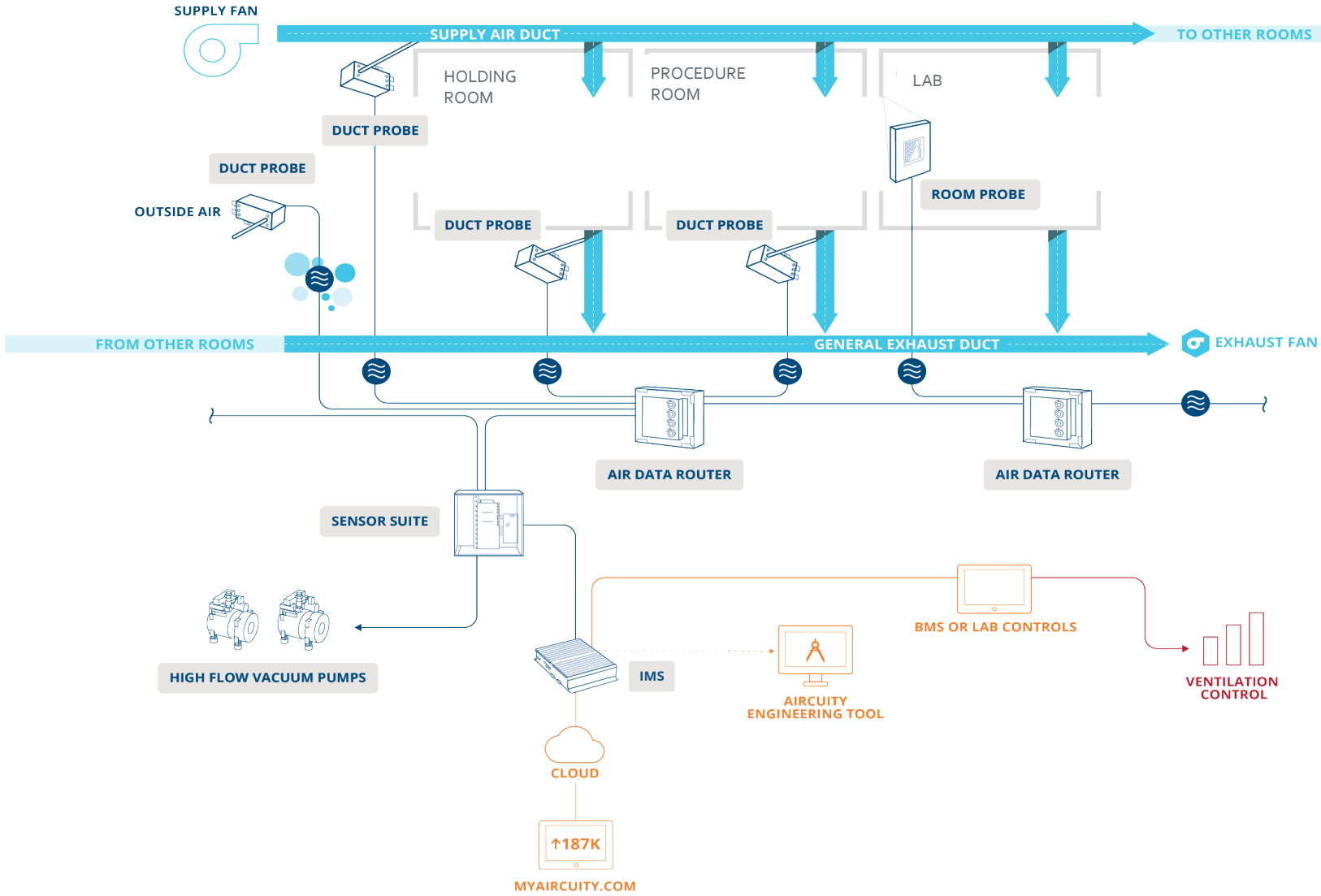
With airside efficiency the amount of particles is understood, helping to minimize allergy risk and ammonia build up is limited.

Sensor & Hardware Assurance

Reporting

Monitoring

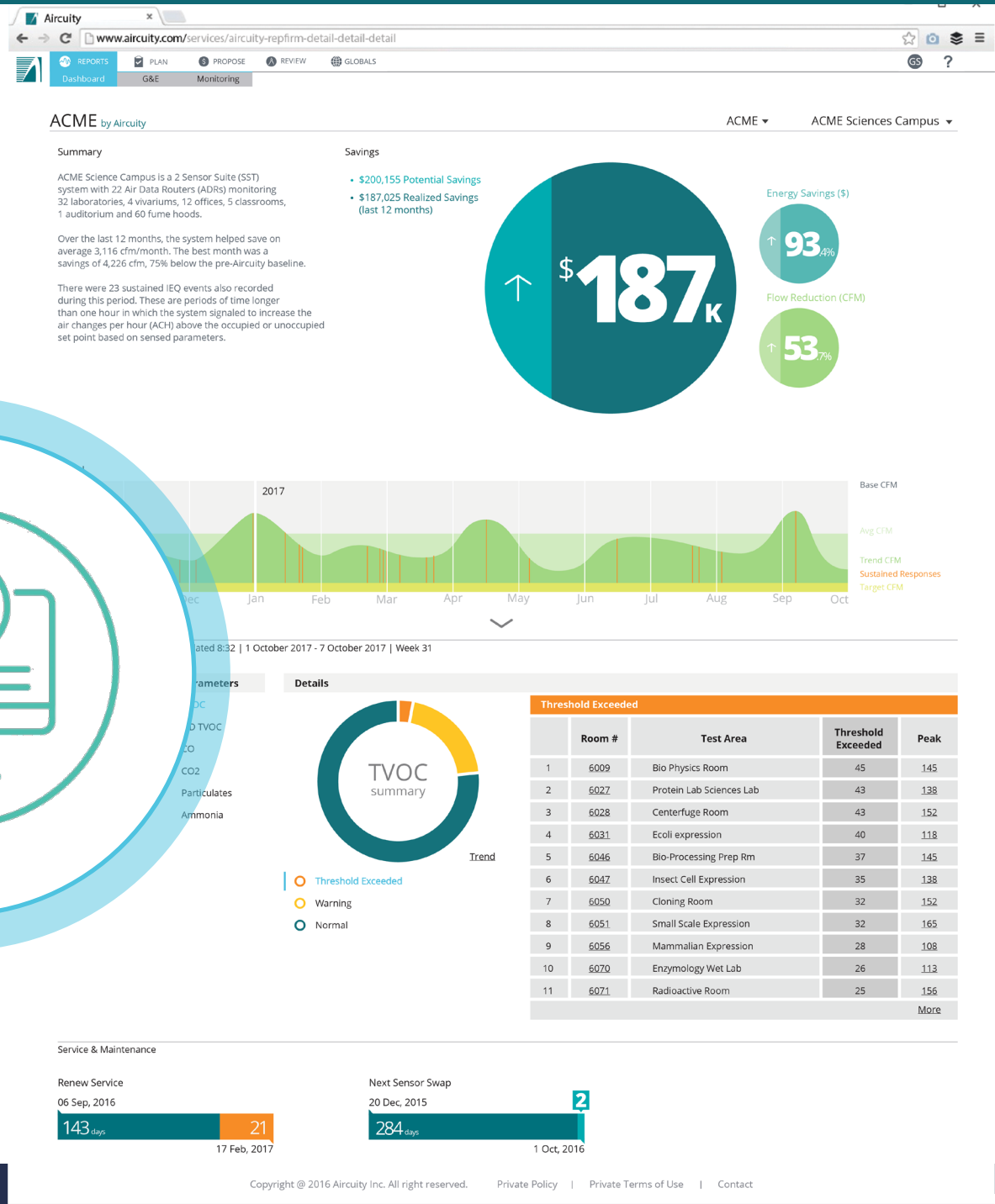
Enablement Tools


SUPPLY FAN
SUPPLY AIR DUCT
TO OTHER ROOMS
HOLDING ROOM
PROCEDURE ROOM
LAB
DUCT PROBE
DUCT PROBE
ROOM PROBE
OUTSIDE AIR
DUCT PROBE
DUCT PROBE
FROM OTHER ROOMS
GENERAL EXHAUST DUCT
EXHAUST FAN
AIR DATA ROUTER
AIR DATA ROUTER
SENSOR SUITE
HIGH FLOW VACUUM PUMPS
IMS
BMS OR LAB CONTROLS
AIRCUITY ENGINEERING TOOL
VENTILATION CONTROL
CLOUD
↑187K
MYAIRCUITY.COM

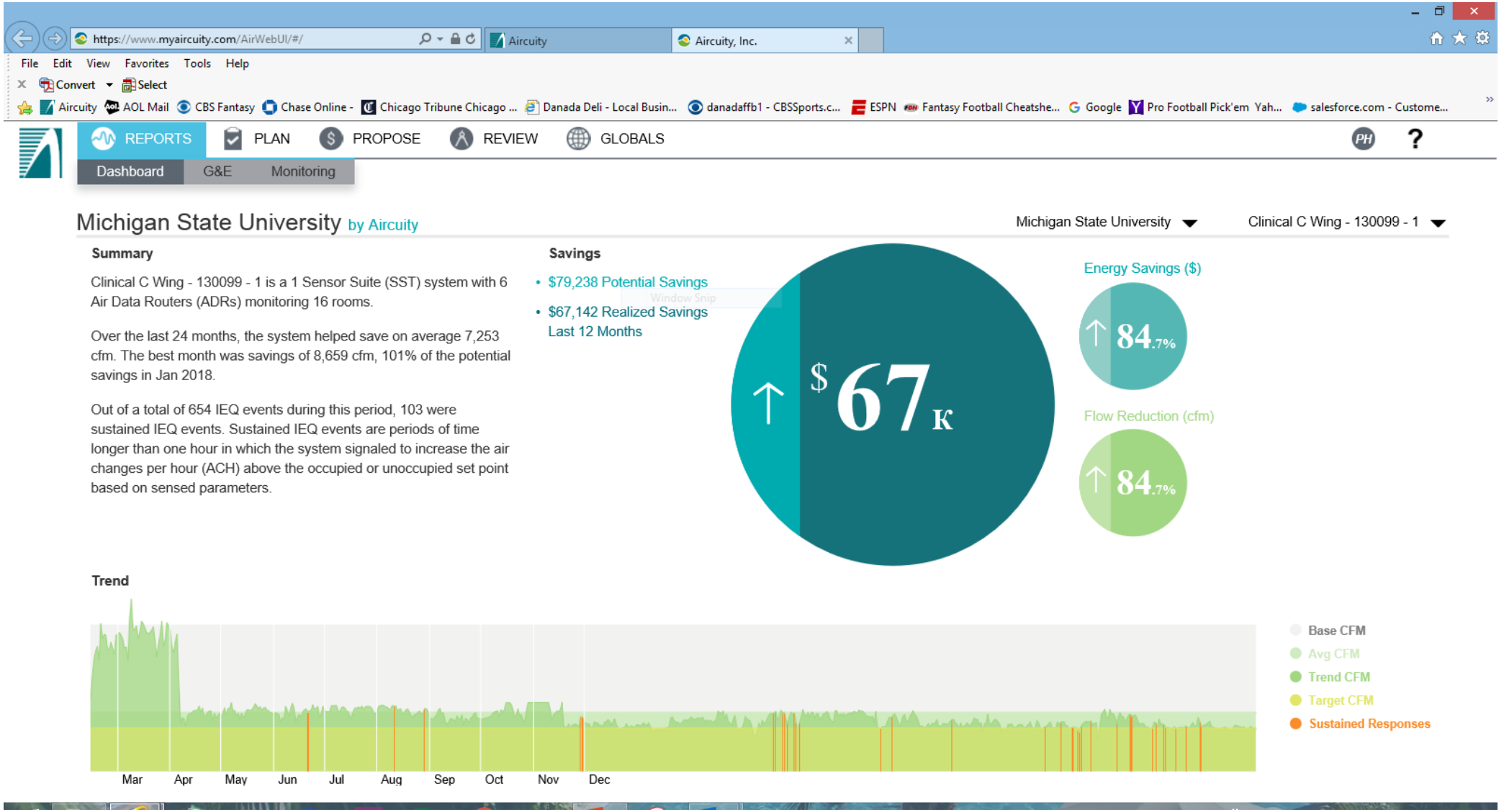
Reporting

Dynamic insight beyond spreadsheets or traditional reports

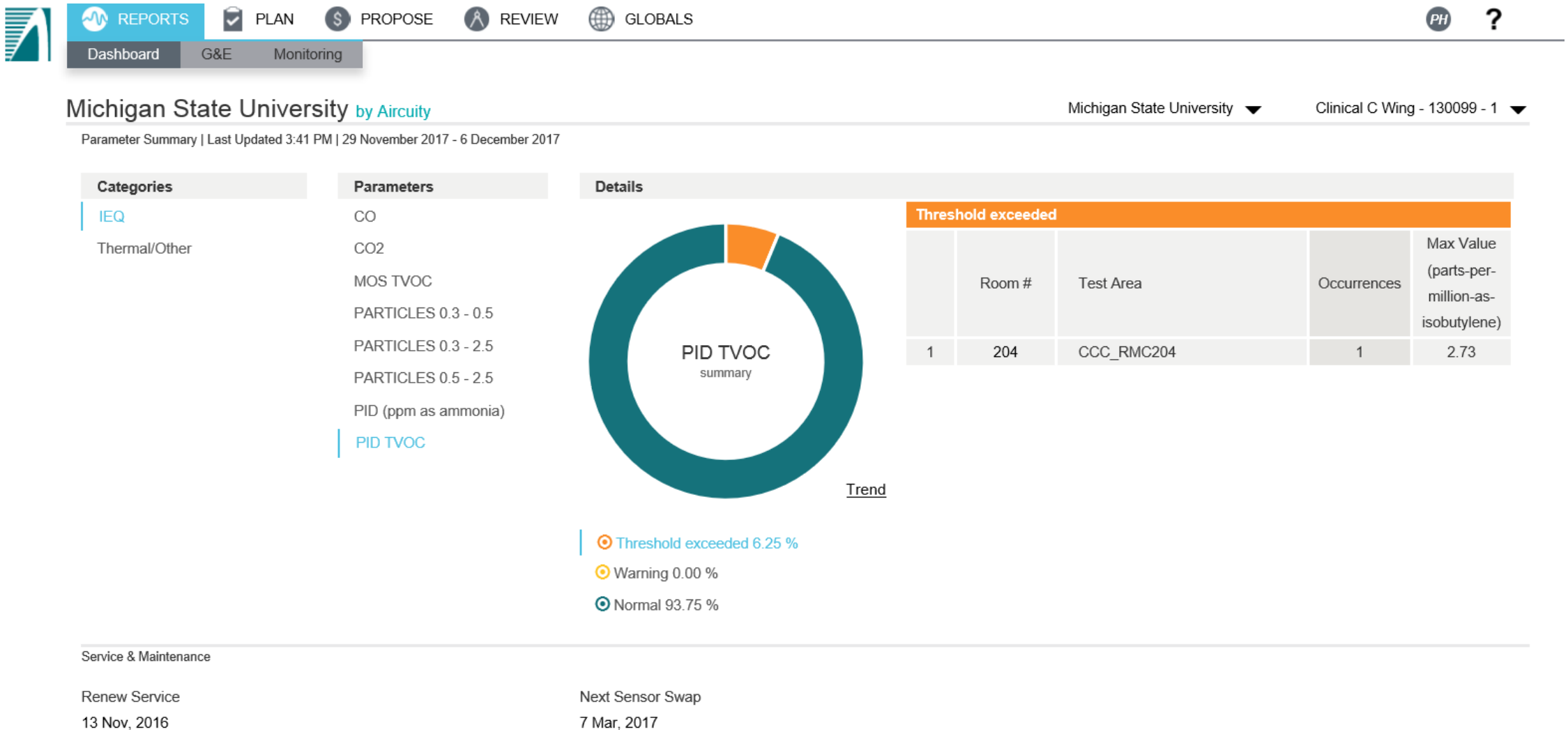
- ✓ Energy Data
- ✓ Ventilation Performance
- ✓ IEQ Information
- ✓ Operational Performance



Midwest University Vivarium Energy Savings



Vivarium - TVOC Event Information



DVM: Airside efficiency will help you

- Ensure proper environmental conditions
  - Notify you if IEQ conditions go out of range
    - ✓ Health related: ammonia & potential allergens
    - ✓ Comfort related: temperature & humidity
  - Provide guidance on cage change frequency
  - Document comfort and IEQ conformance for accreditation and research purposes
  - All while saving energy…

The undulating precast concrete façades use light, reflection, and shadow to catch the sun as it plays across each building’s surface….

....transforming the exterior into a dynamic display that changes depending on time of day and sun angle.

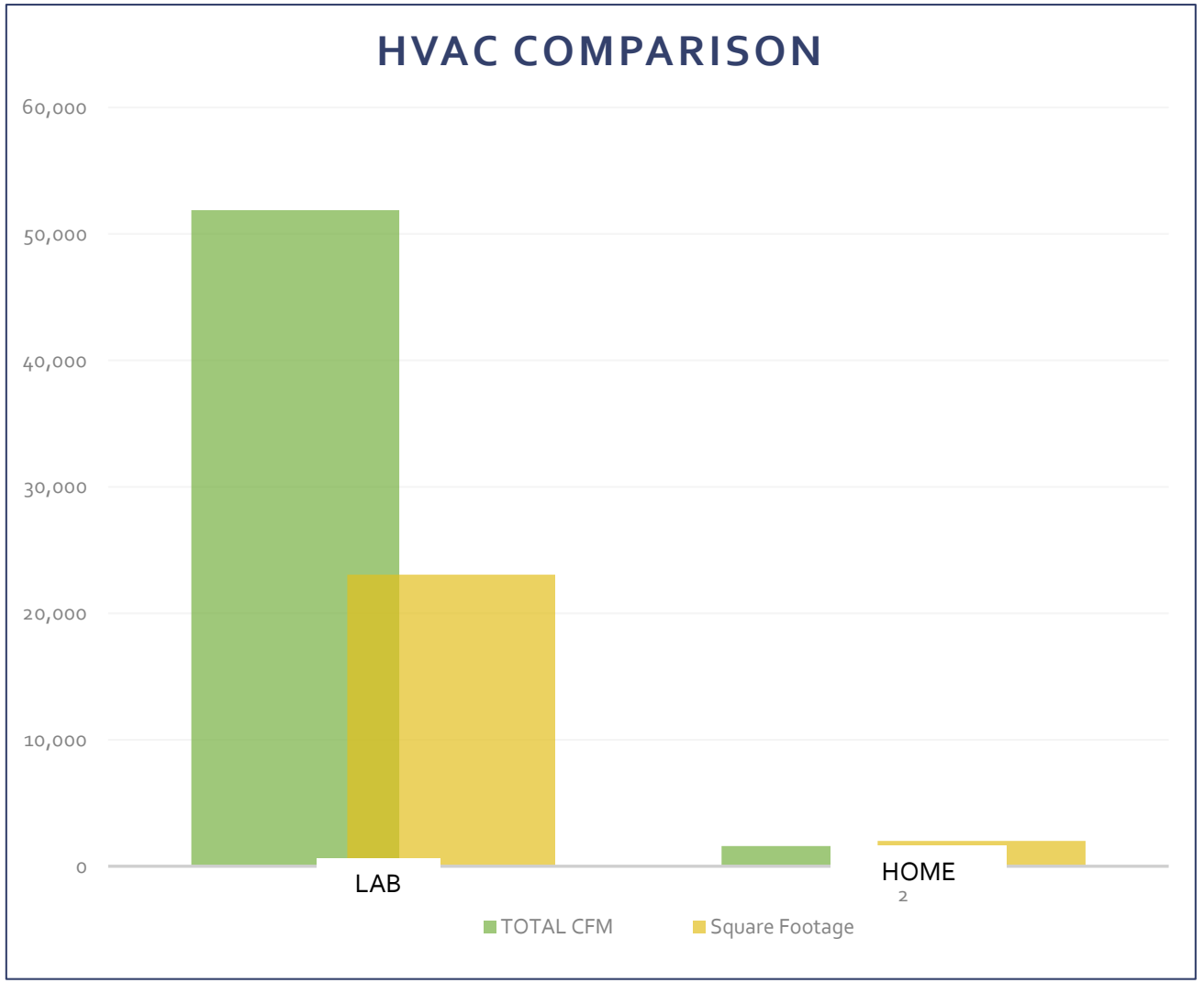
Health and Biomedical Science

- What drove University of Houston to implement airside efficiency in the vivarium?

1. Construction cost
   - Eliminate one air handler and instillation cost
2. Long term energy cost savings.

SR2 vs Average home HVAC

	Lab	Home
TOTAL CFM	51,876	1,600
Square Footage	23,056	2,000
Total homes based on square footage	11.528	1
TOTAL Homes that could be cooled	33	1



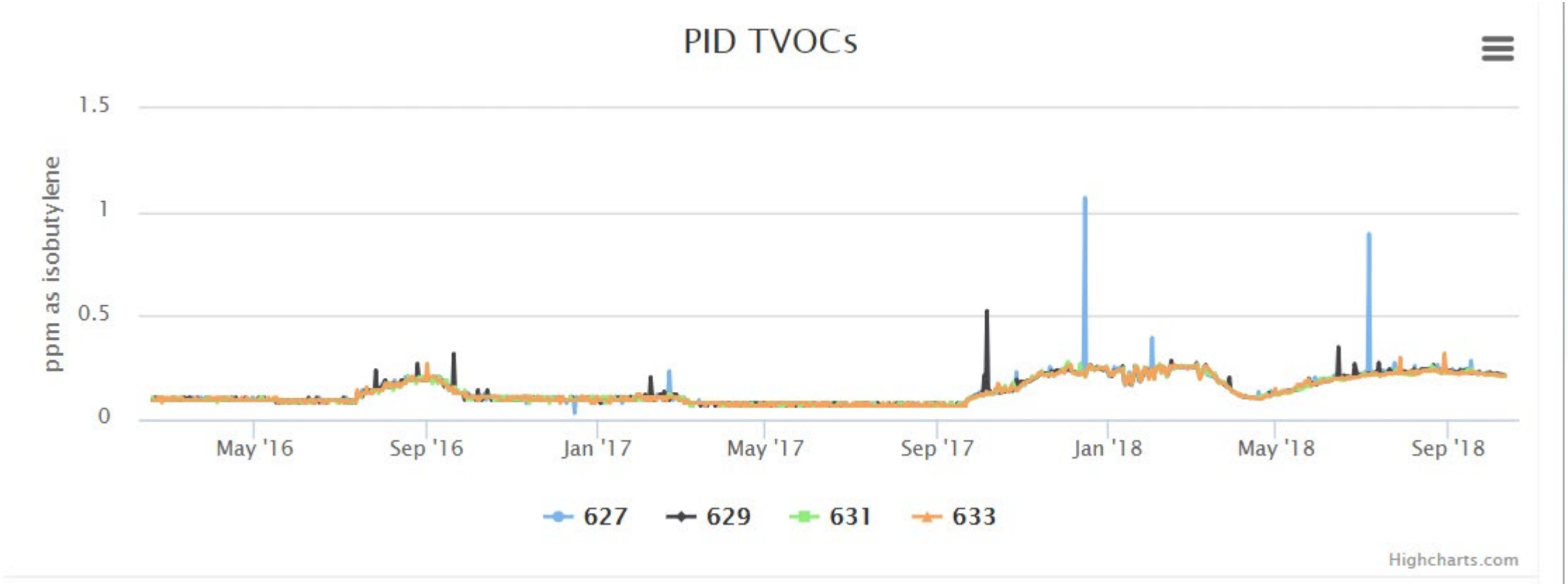
Why 10-15 air Changes per hour?

First air flow recommendations

- 1938
- recirculating air ventilation system providing at least 20% fresh air per change
- 11 ACH was necessary to reduce odors to a “satisfactory” level in a rudimentary animal room housing rats and guinea pigs.
- **Munkelt F**. 1938. Odor control in animal laboratories. Heating Piping and Air conditioning **10**:289-291.

Ammonia

OSHA says the Odor Threshold is between 5 and 50 ppm.

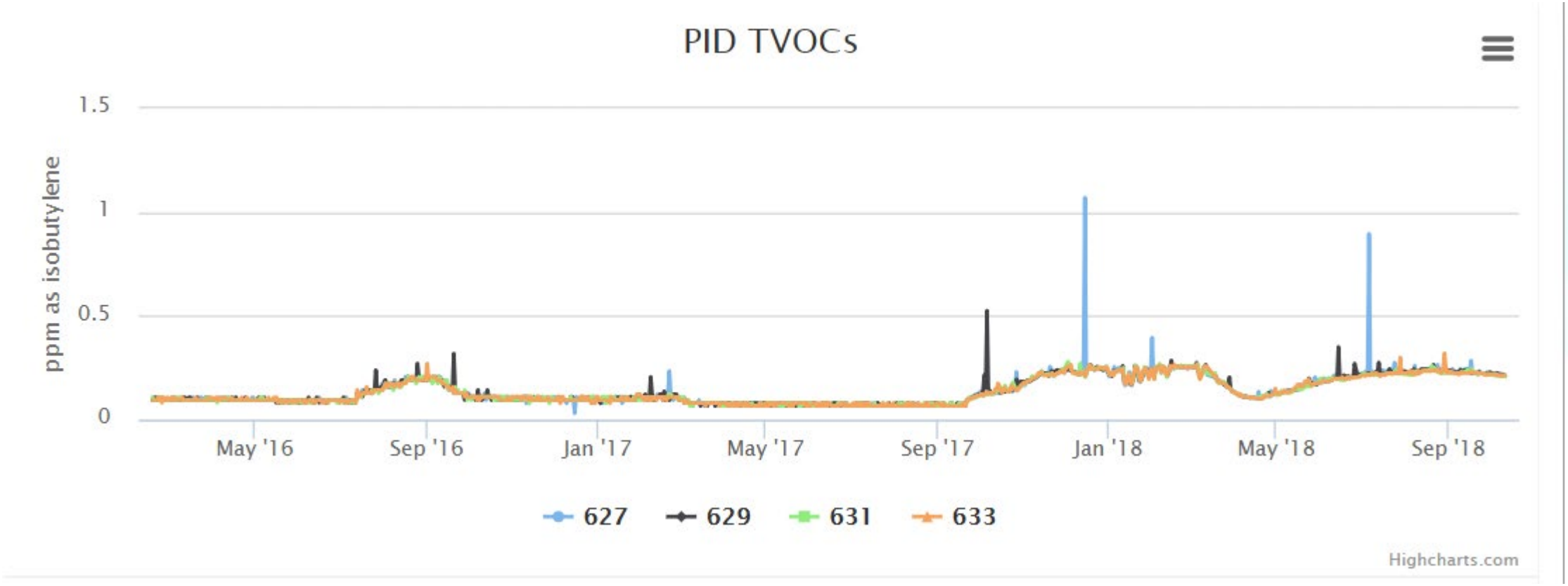


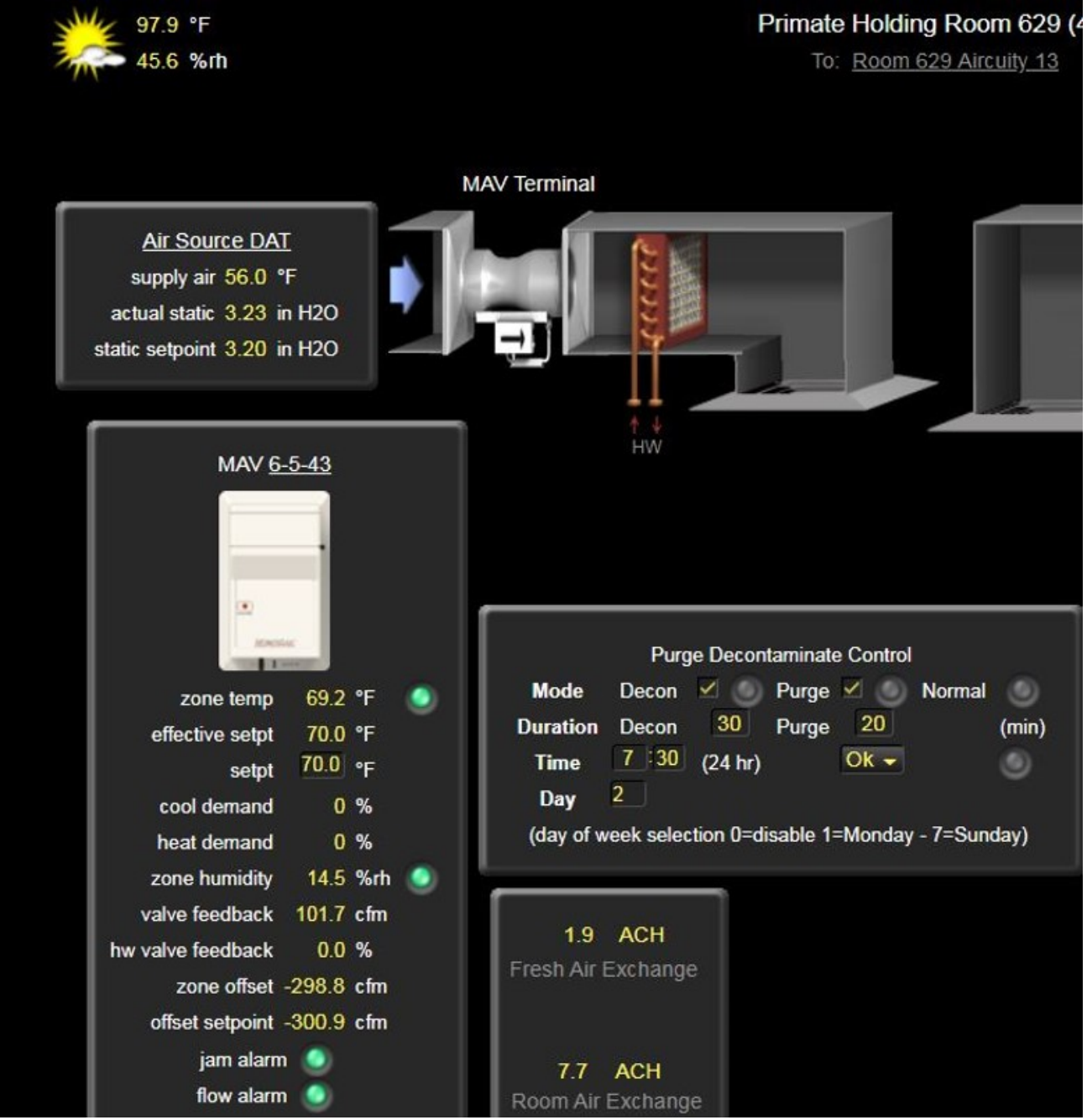
Total volatile organic compounds

- below DCV flushing threshold
- **99% of the time**
- <0.4ppm

Ammonia

OSHA says the Odor Threshold is between 5 and 50 ppm.





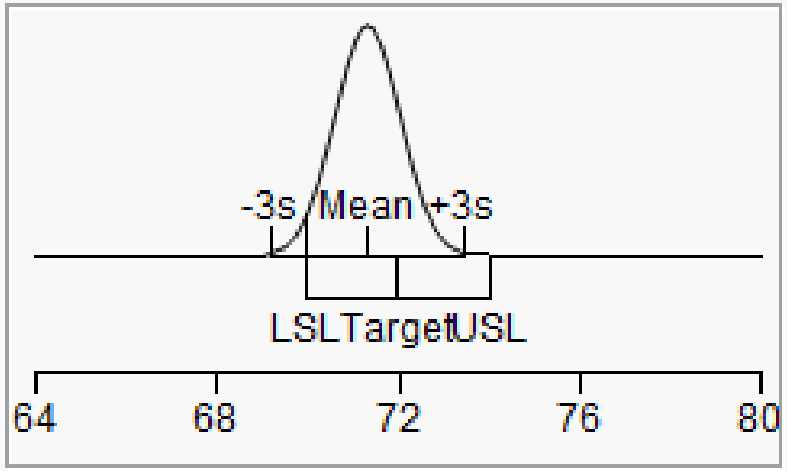
1.9 Fresh Air Exchanges

3 Air changes per hour

Capability Analysis

Specification	Value	Portion	% Actual
Lower Spec Limit	70	Below LSL	3.2424
Spec Target	72	Above USL	1.1256
Upper Spec Limit	74	Total Outside	4.3680

Long Term Sigma



Sigma = 0.71925

Capability	Index	Lower CI	Upper CI
CP	0.927	0.918	0.936
CPK	0.609	0.601	0.617
CPM	0.671	0.665	0.677
CPL	0.609	0.601	0.617
CPU	1.245	1.232	1.258

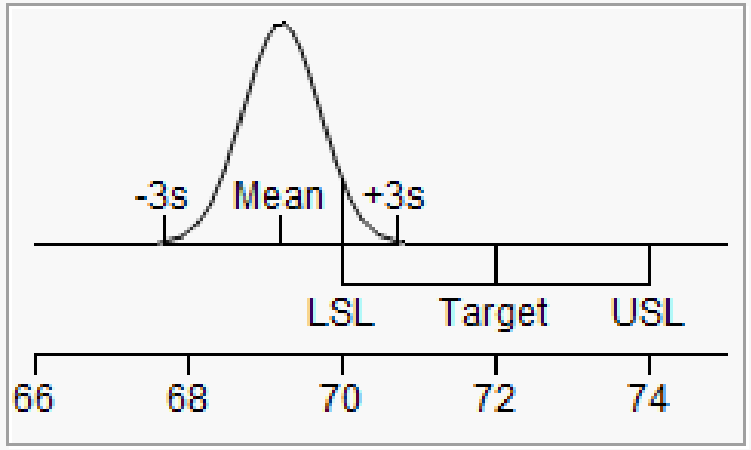
Portion	Percent	PPM	Sigma Quality
Below LSL	3.3847	33846.754	3.327
Above USL	0.0094	94.1090	5.234
Total Outside	3.3941	33940.863	3.326

10 Air changes per hour

Capability Analysis

Specification	Value	Portion	% Actual
Lower Spec Limit	70	Below LSL	96.0952
Spec Target	72	Above USL	0.0000
Upper Spec Limit	74	Total Outside	96.0952

Long Term Sigma



Sigma = 0.50257

Capability	Index	Lower CI	Upper CI
CP	1.327	1.314	1.339
CPK	-0.527	-0.534	-0.520
CPM	0.235	.	0.235
CPL	-0.527	-0.534	-0.520
CPU	3.180	3.149	3.211

Portion	Percent	PPM	Sigma Quality
Below LSL	94.3062	943061.86	-0.081
Above USL	0.0000	0.0000	.
Total Outside	94.3062	943061.86	-0.081

3.9 ACPH savings per year

- $4.60/cfm
- 40,000 ft^2
- 10 ACPH = $93,519.00
- 15 ACPH = $170,173.92

AAALAC International Perspective on Performance Standards

Gary L Borkowski, DVM, MS, DACLAM
Senior Director

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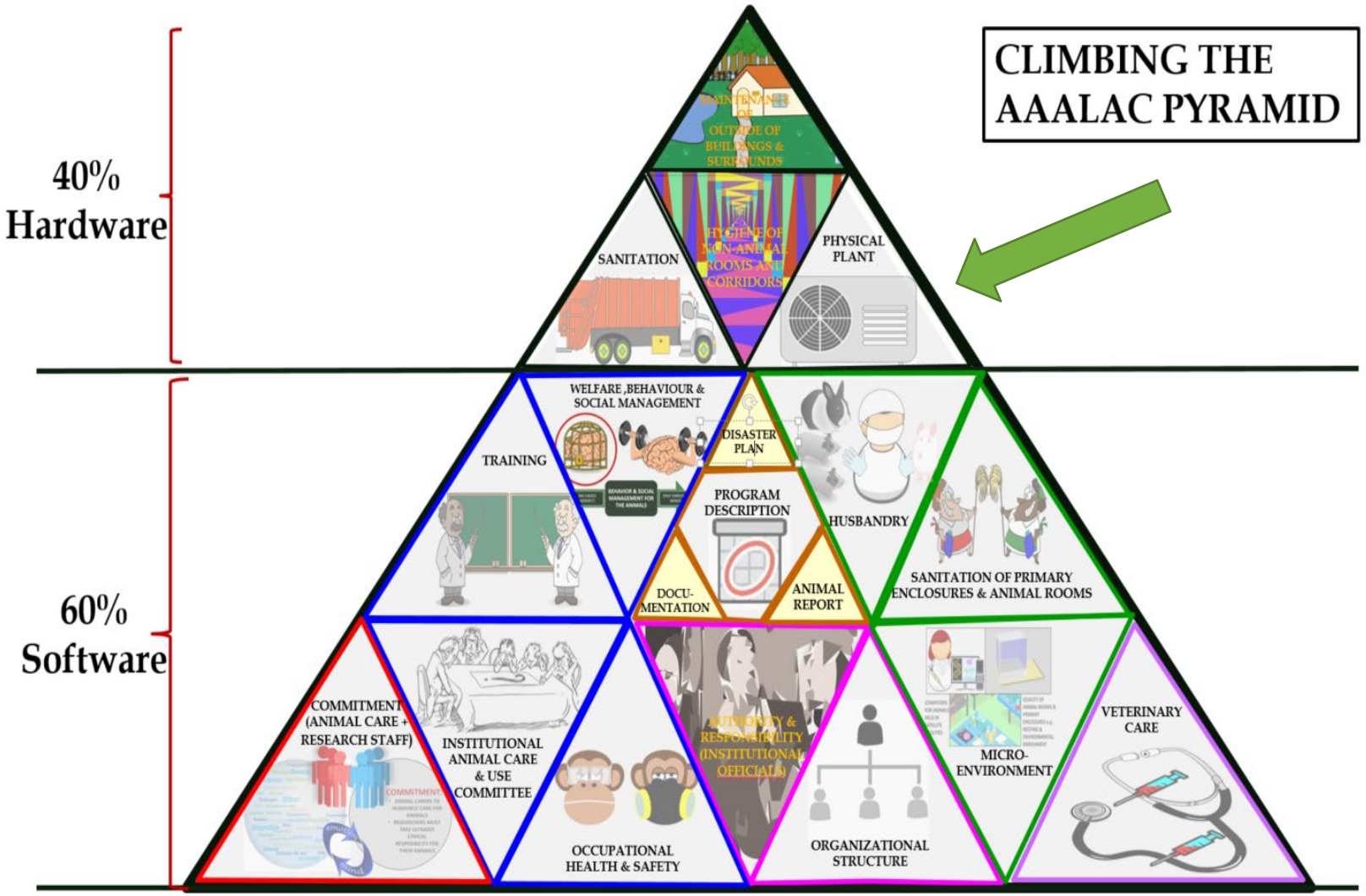
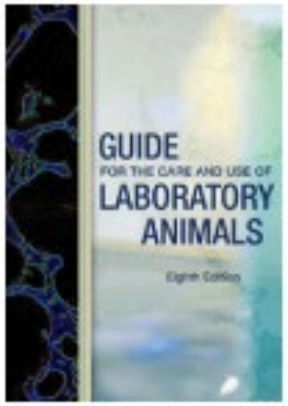
By the conclusion of this presentation, attendees will have:

- An improved appreciation of how AAALAC utilizes Performance Standards (PS)
- An understanding of how to develop and apply and update PS
- Gained an understanding of *The Guide* HVAC expectations and options for animal facilities


CLIMBING THE AAALAC PYRAMID
40% Hardware
60% Software
MAINTENANCE OF OUTSIDE OF BUILDINGS & SURROUNDS
HYGIENE OF NON-ANIMAL ROOMS AND CORRIDORS
SANITATION
PHYSICAL PLANT
WELFARE ,BEHAVIOUR & SOCIAL MANAGEMENT
TRAINING
DISASTER PLAN
PROGRAM DESCRIPTION
DOCU-MENTATION
ANIMAL REPORT
HUSBANDRY
SANITATION OF PRIMARY ENCLOSURES & ANIMAL ROOMS
COMMITMENT (ANIMAL CARE + RESEARCH STAFF)
INSTITUTIONAL ANIMAL CARE & USE COMMITTEE
OCCUPATIONAL HEALTH & SAFETY
AUTHORITY & RESPONSIBILITY (INSTITUTIONAL OFFICIALS)
ORGANIZATIONAL STRUCTURE
MICRO-ENVIRONMENT
VETERINARY CARE

Outline

- Overview
- Performance Standards
- Program Description
- *Guide*
- Conclusions

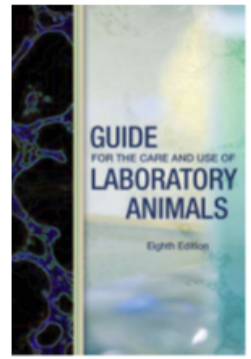


Kahoot

- 2 ways to play:
  - Computer – https://kahoot.it
  - Mobile device – download app

- To Play
  - Enter PIN (shown on next screen)
  - Enter nickname
  - Pick answer/shape (on your device) that matches right answer (on the screen)

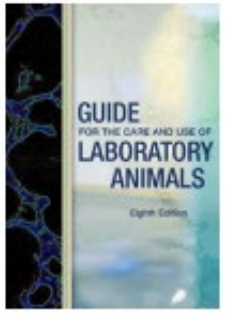
The *Guide* on Performance Standards

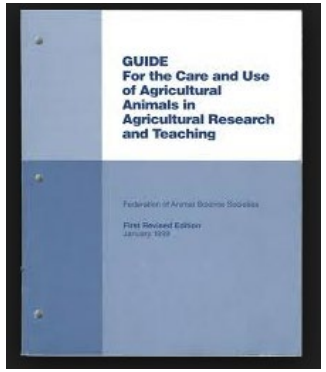


"*Performance standard* means a standard or guideline that, while describing a desired outcome, provides flexibility in achieving this outcome by granting discretion to those with responsibility for managing the animal care and use program, the researcher, and the IACUC."

P6

Performance Standards (PS)





- P7 - Ideally, engineering and performance standards are balanced, setting a target for optimal practices, management, and operations while encouraging flexibility and judgment, if appropriate, based on individual situations (Gonder et al. 2001).

Performance standards define the outcome in detail and provide measurable criteria for assessing whether the outcome is achieved. As noted in the 2011 *Guide*, the performance approach "requires professional input, sound judgment, and a team approach to achieve specific goals." Research in laboratory animal management and science provides new information which should be used to update the performance standards used at an institution.

AAALAC encourages institutions to make animal care and use determinations based on regulatory and funding requirements, overlaid with a performance approach that enhances animal welfare and quality science.

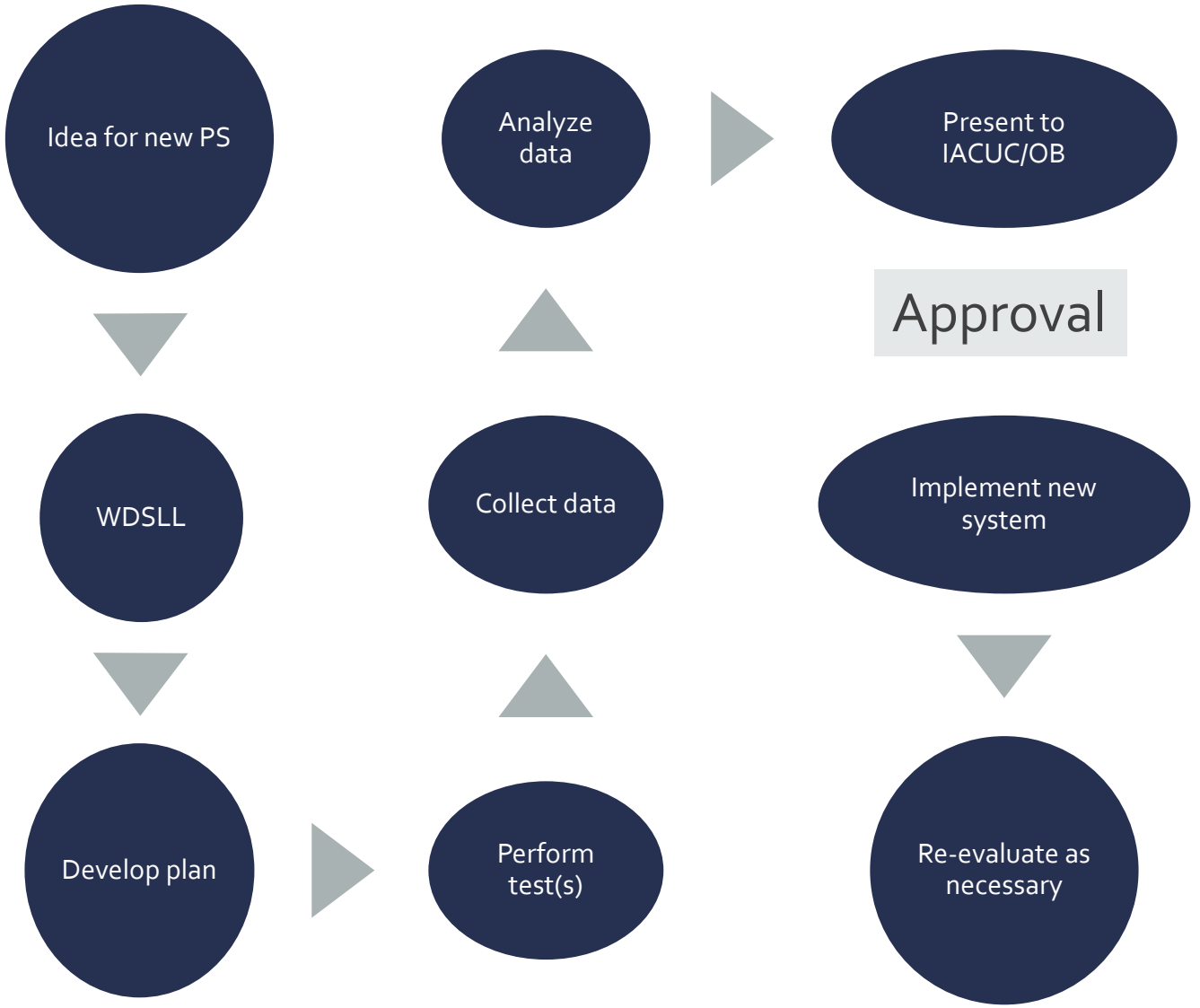
From: Frequently Asked Questions
A. AAALAC International's Assessment Process
1. AAALAC International's 3 Primary Standards
2. AAALAC International's Application of Performance Standards

How do I set and use PS

- With the advent of new scientific information and new technology, there are situations where new methods or procedures not described in the *Guide* may be available and result in equal or greater welfare for the animals involved.
- In all cases where practices deviate from *Guide* standards, AAALAC expects each IACUC/OB to establish an ongoing, documentable, site specific, data driven approach for approval and monitoring of exceptions to the *Guide*.

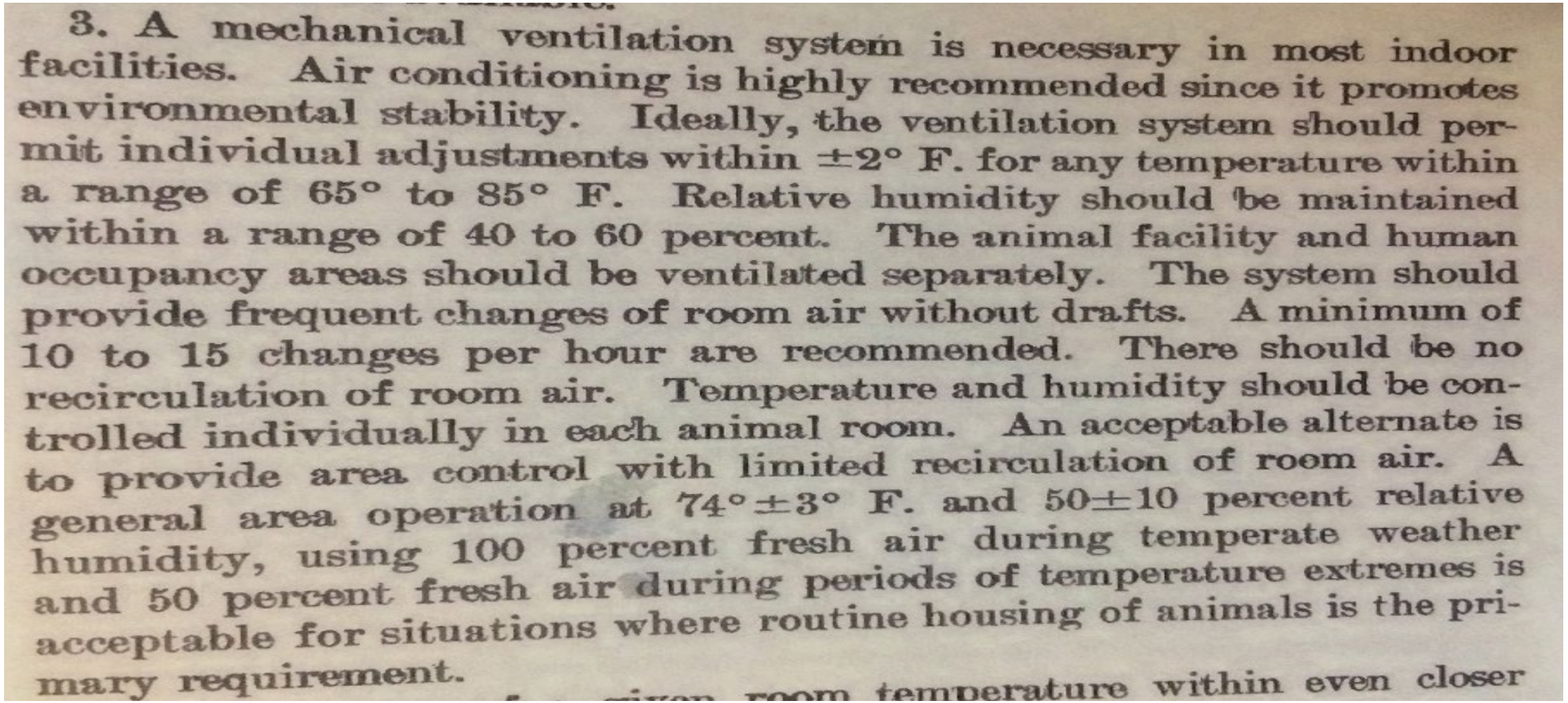
From: Program-wide IACUC/OB exceptions FAQ

Performance Standard Flow Diagram



What Does Success Look Like?

1963 Guide - Where did we start?



3. A mechanical ventilation system is necessary in most indoor facilities. Air conditioning is highly recommended since it promotes environmental stability. Ideally, the ventilation system should permit individual adjustments within ±2° F. for any temperature within a range of 65° to 85° F. Relative humidity should be maintained within a range of 40 to 60 percent. The animal facility and human occupancy areas should be ventilated separately. The system should provide frequent changes of room air without drafts. A minimum of 10 to 15 changes per hour are recommended. There should be no recirculation of room air. Temperature and humidity should be controlled individually in each animal room. An acceptable alternate is to provide area control with limited recirculation of room air. A general area operation at 74°±3° F. and 50±10 percent relative humidity, using 100 percent fresh air during temperate weather and 50 percent fresh air during periods of temperature extremes is acceptable for situations where routine housing of animals is the primary requirement.

room temperature within even closer

Ventilation & Air Quality – The *Guide* (p46)

- 10-15 ACH…acceptable guideline…
- Modern HVAC systems (e.g. VAV) allow ventilation rates to be set in accordance with heat load and other variables.
- These systems offer considerable advantages with respect to flexibility and energy conservation…

HVAC – The *Guide* (p.139)

- Essential to provide environmental and space pressurization control
  - Temperature
  - Relative humidity
  - Pressurization
- Should be designed for:
  - Reliability
  - Ease of maintenance
  - Energy conservation
  - Meet requirements for animals
  - Flexible & adaptable

Guide – p139

- “Constant-volume systems have been most commonly used in animal facilities, but variable-volume (VAV) systems may offer design and operational advantages, such as allowing ventilation rates to be set in accordance with heat loads and other variables.”

- “These systems offer considerable advantages with respect to flexibility and energy conservation.”

Overview/Executive Summary

Appendix 11: Heating, Ventilation and Air Conditioning (HVAC) System Summary

Summarize the heating, ventilation and air conditioning (HVAC) systems for each animal facility, ***including all satellite facilities***. Include ***all animal holding rooms*** (including satellite holding rooms), surgical facilities, procedure rooms, and support spaces integral to animal facilities (e.g., cage wash, cage and feed storage areas, necropsy, treatment).

Location/Building/Facility:	

In the text box below, provide a general description of the mechanical systems used to provide temperature, humidity and air pressure control. Include details such as:

- the source(s) of air and air recirculation rates if other than 100% fresh air
- treatment of air (filters, absorbers, *etc.*)
- design features such as centralized chilled water, re-heat coils (steam or hot water), individual room vs. zonal temperature and relative humidity control, the use of variable air volume (VAV) systems and other key features of HVAC systems affecting performance
- features that minimize the potential for adverse consequences to animal well-being (such as re-heat coils that fail closed or that are equipped with high-temperature cut-off systems), and
- how room temperature, ventilation, and critical air pressures are monitored and maintained in the event of a system or component failure, including notifying appropriate personnel in the event of a significant failure that occurs outside of regular working hours and/or other management systems used to respond to alerts or failures.

PD – Detailed Information

Appendix 11: Heating, Ventilation and Air Conditioning (HVAC) System Summary

In the Table below, provide room-specific information requested. For each room within this location, indicate use, including the species for animal housing rooms. *Measurement of air exchange rates and verification of relative pressure within animal housing rooms (excluding rooms housing aquatic species only) and cage washing facilities must be completed* ***within the 12 months preceding completion of this Program Description.*** Air exchange rates may be important to maintain air quality in other areas; *however, measurements may be left at the discretion of the institution.* Information may be provided in another format, providing all requested data is included. **[*Note*: Please remove the examples provided in the Table below.]**

Room No.	Specific Use	Temperature Set-Point (define units)	Electronic / Emergency Monitoring of Temperatures (Y/N)	Alert/Alarm Temperature Ranges (if applicable; define units)	Humidity Control (Y/N)	Relative Pressure	Air Exchange Rate (per hour)	Date Verified / Measured
		(settings to be verified)					(values to be measured)	
10	Surgery	72°F	N	NA	Y	+	15	4/2014
12							2	4/2014
13							0	4/2014
14							0	4/2014
150	Treatment Room	70°F	N	NA	Y	-	10	4/2014
175	Necropsy	70°F	N	NA	Y	-	15	4/2014
200	Cage Wash	70°F	N	NA	Y	-	15	4/2014
210	Feed Storage	65°F	Y	>70°F	Y	+	10	4/2014
A100	Swine Room	70°F	Y	65-75°F	N	N/A	variable fan	4/2014
A-12	Pole Barn	NA	N	NA	N	N/A	climate dependent	4/2014

11. **HVAC Summary.** Summarize the heating, ventilation and air conditioning (HVAC) systems for each animal facility, including all satellite facilities. Include all animal holding rooms (including satellite holding rooms), surgical facilities, procedure rooms, and support spaces integral to animal facilities (e.g., cage wash, cage and feed storage areas, necropsy, treatment).

From Instructions

[Create additional rows by pressing TAB in the bottom-right box.]

Copy and repeat the Description and Table for each location, including all satellite housing locations.

Thank you!

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