What is the Big Deal About Demand Ventilation?

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Do you know?

- Flip a button to occupied from unoccupied?
- You clap and the ventilation comes on?
- What about....

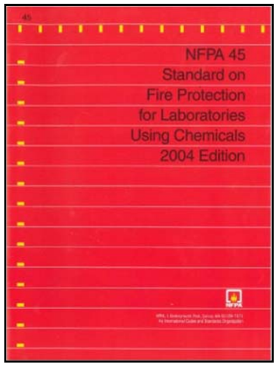
  Siri, “Turn on the laboratory ventilation to 10 ACH between 8-10am today”
- What about money?
- What about energy conservation/sustainability?
- What about maintaining IAQ?

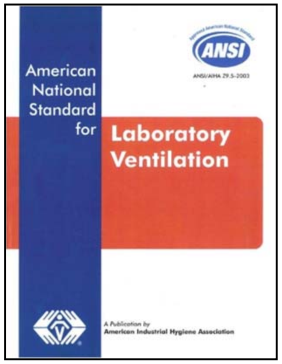
Background

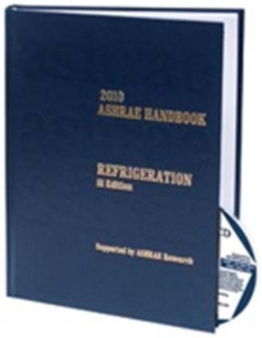
- Traditional
  - Set Volumetric, CFM (i.e. 15 to 20 CFM/person)
- Demand Controlled Ventilation (DCV)
  - CO_2 sensors (90's)
  - Pressure
  - Multiple sensors (CO, CO_2, PID, SVOC, particulates, LEL, etc)(early 00's)

Industry Recommendations on ACH Rates

- No codes other than ASHRAE 62.1
  - At best for Univ/college labs: 1.2 ACH fresh air
- Most fixed ACH values are being dropped:
  - NFPA 2010: 8 Occ / 4 Unocc rates were removed
  - ANSI Z9.5 does not advocate for any fixed rate:
    - An air exchange rate (air changes per hour) cannot be specified that will meet all conditions. Furthermore, air changes per hour is not the appropriate concept for designing contaminant control systems.
- Occ/Unocc Control scope is being limited
  - 2011 ASHRAE Handbook, Lab chapter 14:
    - …There should be no entry into the laboratory during unoccupied setback times and occupied ventilation rates should be engaged possibly one hour or more in advance of occupancy to properly dilute any contaminants.
- Active/Demand Based Control is in main stream:
  - 2011 ASHRAE Handbook, Lab chapter 14:
    - Reducing ventilation requirements in laboratories and vivariums based on real time sensing of contaminants in the room environment offers opportunities for energy conservation. This approach can potentially reduce lab air change rates down safely to as low as 2 air changes per hour when the lab air is "clean"...

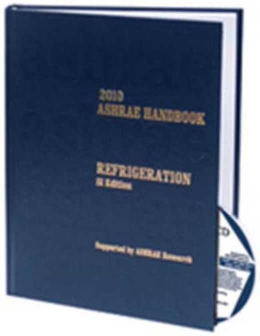






Industry Recommendations on ACH Rates

- More comments on ACH rates & DBC:
  - 2011 ASHRAE Handbook, Lab chapter 14:
    - 6 to 12 air change per hour range may not be appropriate for all laboratories.
    - Minimum ventilation rates be established on a room-by-room basis considering hazard of materials, operation and procedures to be performed.
    - As the operation, materials and level of hazard of a room change an increase or decrease in the minimum ventilation rate should be evaluated.
    - Active sensing of the air quality in individual laboratories is an alternative approach for dealing with the variability of appropriate ventilation rates, particularly when energy efficiency is important or when less may be known about the hazard level.



What is traditional ventilation?

- Ventilation is the process of "changing" or replacing air in any space to control temperature or remove any combination of moisture, odors, smoke, heat, dust, airborne bacteria or carbon dioxide, and to replenish oxygen.
- Ventilation includes both the exchange of air with the outside as well as circulation of air within the building. It is one of the most important factors for maintaining acceptable indoor air quality in buildings. Methods for ventilating a building may be divided into mechanical/forced and natural types. (ASHRAE)

Typical Components of Traditional

- Ductwork, fans, heat exchangers, boilers, chilled water, condensers, sensors (temperature), outside air, return air, filters, etc.
- There are several different methods for achieving cooling or heating.
  - Geothermal
  - Heat Pumps
  - Chillers/Boilers
  - Others

Traditional Ventilation

Advantages

- Low upfront cost (on per ton basis)
- Easy installation, depending on application
- Constant volume

Disadvantages

- Wasted energy heating/cooling air for unoccupied areas
- No ability to change to condition, except for temperature
- High percentage use refrigerant based systems

What is demand control ventilation (DCV)?

- Demand control ventilation is recognized as being a method of ensuring a building is ventilated cost effectively while maximizing indoor air quality. Sensors are used to continuously measure and monitor ambient conditions in the conditioned space and provide real time feed back to the zone controller which adjusts the fan speed modulating the ventilation rate to match the specific use and occupancy of the building. (www.demandcontrolventilation.com)
- Ventilation provided in response to actual number of occupants and occupant activity

DCV Advantages/Disadvantages

Advantages

- 30-60% energy saving.
- Great return on investment
- Huge reduction in system operating costs
- Part of the bigger picture of looking after the environment.
- Improved IAQ
- Health benefits - decrease human fatigue, increase in productivity
- Existing systems can be upgraded

Disadvantages

- High upfront cost, requires variable air volume values for each zone or room being controlled
- Requires specialized equipment (sensors & VAV)
- Maintenance accessibility & cost

How can we use DCV?

- ASHRAE interpretation of ASHRAE standard 62-1989 January 26, 1997, states:

“...it is consistent with the Ventilation rate procedure that Demand Control be permitted for use to reduce the total outdoor air supply during periods of less occupancy....”

- This means individual zone ventilation control using CO_2 sensors can be applied to such critical areas as conference rooms, board rooms, cafeterias and other spaces with **<u>frequent changes in occupancy</u>**.

What space are suitable for DCV?

- Classrooms
- Offices
- Laboratories
- Conference rooms
- Board rooms
- Cafeterias
- Gymnasiums
- Spaces with frequent changes in occupancy

What would a DCV system look like?

- 1 central panel for 15-20 rooms
- Tubes from each room to the panel
- Vacuum pump
- Communication via internet and/or internal communication systems
- Refer to photo

The sensors?

- Carbon Dioxide
  - Dual Wavelength, Non-Dispersive, Infrared Sensor
  - 0-3000 ppm
- • Dewpoint
  - Dual Wavelength, Non-Dispersive, Infrared Sensor
  - -58 ambient DPT Deg F or 122 Deg F, whichever is less
- Temperature
  - Thermocouple
- Relative Humidity & Enthalpy
  - measurements are computed from dewpoint and drybulb temperatures. A local drybulb temperature sensor is additionally required via a room sensor, duct probe or outdoor air probe.

The sensors?

- • Airborne Particulates
  - PM 2.5
  - Optical Particle Counter
  - 100 - 10,000,000 particles pcf
- • Total Volatile Organic Compounds
  - Metal Oxide Semiconductor (MOS) or Photoionization Detector (PID) (<10.6eV)
  - 0-100 ppm
- • Carbon Monoxide

Maintenance

- Simplified due to central panel
- Service intervals 18-24 months

Case Study #1

- Beth Israel Deaconess Medical Center (Harvard)
  - Annual savings
    - Phase 1 = $270,000
    - Phase 2 = $640,000
  - ROI <1-yr

Case Study #2

- Global Financial Services Company
  - 103,000 sq.ft.
  - Original design
    - 210,000 CFM
    - 30,000 CFM Outside Air
  - Annual savings = $60,000/yr
  - Energy reductions
    - 125,000 kw-h (cooling)
    - 53,000 therms gas (heating)

In the academic environment

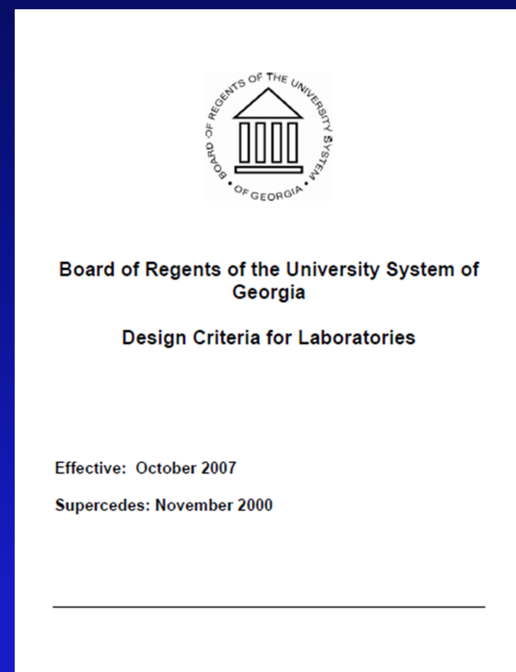
- Most campuses with laboratory buildings are the highest energy users, accounting for approximately 40-60% of total emissions
- Implementation of a multi-sensor type DCV can result in 1-3 ROI, assuming VAV systems are installed

What is the University System Doing?

- 4th Edition of the Laboratory Design for Laboratories

History

- 1^{st} USG Design Criteria published November 1998
- 2^{nd} – November 2000
- 3^{rd} – October 2007
- 4^{th} – to be published early 2012



Board of Regents of the University System of Georgia

Design Criteria for Laboratories

Effective: October 2007

Supercedes: November 2000

Who's Developed the Criteria?

- Various BOR/Institutional Staff
  - EHS
  - Engineers
  - Architects
  - Plant Operations Directors
  - Researchers
- Outside vendors, consultants, & manufacturers

Purpose of the Design Criteria

- Establish minimum design requirements for new construction & renovation lab projects
- Provide a safe work environment
- Prevent chemical exposures
- Minimize environmental impact through efficient energy design & operation

Overview of Existing Specifications

- Standard References

  (NFPA, ANSI/AIHA, ASHRAE, OSHA, ADA…)

- All projects must be endorsed by the institution's Facilities, Engineering Env. Health & Safety, involved academic units, etc…prior to submittal to the Board for approval

Existing Specifications (continued)

- Variance Process
- Fume Hood Minimization
  - Strategies to reduce number (i.e. micro-scale and virtual simulation)

Existing Specifications (continued)

- Negative air pressure in labs
- 6-10 air changes/hr
- Laboratory layout
- Airflow patterns
- Casework
- Service fixtures
- Floor drains are allowed in labs

Existing Specifications (continued)

- Laboratory fume hood systems;
  - Std bypass constant volume, variable air volume, or auxiliary
  - Ductless fume hoods prohibited
  - 3’ to 6’ Fume Hoods (avg 100 ft/min)
  - Non-bypass constant volume hoods are prohibited
  - Application (general, radiation, perchloric acid, & special use)
  - Location, submittals, components
  - Sash stops

Existing Specifications (continued)

- Laboratory fume hood systems (continued);
  - Installation
  - Performance/Documentation
  - (i.e. sound <63dB, fan speed <900 rpm, …)
- Test & Balance
- Hood Certifications
- Manifolded exhaust ducts
- Biological Safety Cabinets

Existing Specifications (continued)

- Emergency showers & eyewash stations
  - Certain drench hoses are not acceptable as defined in ANSI Z358.1
  - Flush water must be at least tepid (60-100°F)
- Gas cylinder storage
- Plus others

New specifications for 2012

- Definitions
  - High Performance Chemical Fume Hood
  - Life cycle costs (Net Present Value & Internal Rate of Return)
  - Significant renovation
  - Maintenance points

New specifications for 2012

- Utility exhaust stack to remain within least 10’ above the roof plain or adjacent structure and the stack discharge velocity will be between 3000 to 4000 FPM.
  - High density applications may require a computational fluid dynamics (CFD) analysis.

New specifications for 2012

- High performance hoods/VAV for all new laboratory science buildings or significant renovation
  - Variances (including life cycle and energy analysis) should be submitted to the Board of Regents if a conventional system (CAV) is desired.
- First Large High Performance Building in the university system completed in 2012 at Kennesaw State University
- Major renovation project completed at Georgia College & State University in 2012

New specifications for 2012

- Automatic sash closures should be strongly considered for all new chemical fume hoods
- Chemical Fume Hood certifiers shall provide proof of technical competence
- Emergency purge systems shall be considered in all laboratories

New specifications for 2012

- Type 304L stainless steel for fume hood exhaust ducting
- All joints will be welded and ground smooth, except for maintenance points and initial connections to each chemical fume hood

- Manifold materials will be based on best engineering practice and a risk assessment.
- All deviations from 304L (with welded joints) will be approved by the institution or the Board of Regents, as a variance.

New specifications for 2012

- 4 air changes per hour minimum for an unoccupied lab
- Higher ventilation rates may be required
- Occupancy can be determined by motion sensors, light switches, or other technology

New specifications for 2012

- High Performance chemical fume hoods will operate at a minimum 60 FPM.
- High hazard locations may require additional airflow.

New specifications for 2012

- All new laboratory facilities shall consider energy recovery systems.

- Life Cycle Cost (LCC) analyses should be considered for all laboratory building design alternatives and energy conservation options.
- Institution should incorporate into facility designs energy saving measures with the lowest LCC.

New specifications for 2012

And, there is more…

- Use most current ASHRAE 110 standard for fume hoods installed in new construction or renovations

- Annual performance verification with multiple challenge tests

Questions

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