AIHEC – VENT 2006

Recommended Methods to Evaluate Performance of Variable Air Volume Fume Hood Systems

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Safety is the Primary Objective
Lab Occupancy

- Unoccupied Min. Flow: 74%
- Occupied Max Flow: 26%
VAV Ventilation Systems

- Modulate flow to meet user demand
- Reduce energy use when unoccupied
- Provide Increased Flexibility
- Leverage System Capacity (Diversity)
Types of VAV Systems

- Two Position (Two State Control - TSC)
  - Occupied
  - Unoccupied

- Full VAV
  - Demand Based on Sash Opening Area

- Hybrid VAV with Night Setback
  - Occupied - Sash Position
  - Unoccupied – Sash Position and Time Based
Qex (Occupied)

Qex (Un-Occupied)

Flow Controller

Damper
Flow Sensor

Hood Monitor

Sash Open

Hood

BAS

Qex (Occupied)

Qex (Un-Occupied)

Flow Controller

Damper
Flow Sensor

Hood Monitor

Sash Closed

Hood

Sash Open

Hood

Qex (Occupied)

Qex (Un-Occupied)

Flow Controller

Damper
Flow Sensor

Hood Monitor

Sash Closed

Hood

Sash Open

Hood

BAS
VAV Sash Sensor Control

Sashes Closed
Minimum Flow

Exhaust Valve
Actuator

Sashes Open
Maximum Flow

Sash Sensors

Hood Monitor
VAV Response and Flow Stability Test

Flow Sensor

Method A

Data Logger

Method B

Velocity Probe in plane of bottom slot where Slot Velocity is proportional to Flow
Flow Response - Sash Movement

Not Repeatable
Flow Response - Sash Movement

Repeatable
Measure Flow, Face Velocity, Room Drafts and Containment

Tracer Gas Ejector

Tracer Gas Detector

Mannequin

Flow / Velocity

Cross Draft Probe

DAQ Software
VAV Response To Sash Movement

Escape Due to Slow Response Speed

~ 15 Seconds Escape

Tracer Gas - ppm

Flow Response

Time - Seconds

Flow Response, Tracer Gas - ppm
Escape Due to Flow Fluctuations

![Graph showing flow fluctuation and escape]

- **X-axis**: Time - Seconds
- **Y-axis 1**: BZ Conc. - ppm
- **Y-axis 2**: Flow - cfm

Graph highlights:
- **Flow Fluctuation**
- **Escape**
Factors Affecting Hood Containment

- Flow Volumes (Face Velocity)
  - Sash Open
  - Sash Closed

- Speed of Response

- Flow Stability
\[ Q_{ex} = Q_s + Q_t \]
Lab Environment Tests

- Flow Sensor Damper Actuator
- Air Supply
- Flow Sensor Damper Actuator
- Reheat Terminal
- Supply Diffuser
- Light Switch
- Thermostat
- General Exhaust
- Hood
- Sash Sensor Door Interlock

- dP
- dP
Differential Pressure & Temperature When Changing Flow Setpoints

Occupied
Offset ~ 200 cfm

Unoccupied
Offset ~ 50 cfm

Mode Change

Room Temperature (f)

Service Corridor
E-362 Office
Temp
Air Handler – Variable Frequency Drive
Exhaust Fans – Outside Air Bypass

Outside Air Bypass Inlet
System Operating Mode Tests - SOMT

- **Purpose**
  - Establish Operational Boundary Conditions
  - Full Occupied to Full Unoccupied

- **Procedure**
  - Initiate BAS Trends
  - Place all labs in unoccupied mode
  - Measure system flow and record operating parameters
  - Sequentially initiate occupied mode for each lab
  - Measure system flow and record operating parameters

- **Analyze and Record**
  - Exhaust Fan and Supply AHU (VFD, Flow, Amps, SPs, etc.)
  - Lab Flow Controllers (Flow, Damper%, etc.)
System Operating Mode Test (SOMT)
BAS Trend - Building B

Number of Units Operating

Time of Day

Un-Occupied
81,000 cfm

Occupied
117,500 cfm

No. AHUs Operating
No. Ex. Fans Operating
BAS Occupancy Trend for Building B - August 1- 7, 2005

Overall Average Occupancy = 41%
Max Occupancy = 71%
Min Occupancy = 18%
BAS Trends to Optimize System Operation

Initial | Tuning | Final

No. of Units Operating

AHUs Operating | Exhaust Fans Operating | SUP Avg Static | Exh Avg Static

System SP w.g.
Recommendations for Ensuring Proper Operation of VAV Hood Systems

1. Conduct a Comprehensive System Analysis
2. Determine Hood, Lab and System Operating Specifications
3. Conduct VAV Hood Tests
4. Conduct Lab Environment Tests
5. Conduct System Operating Mode Tests
6. Calibrate and Tune Sensors and Controls
7. Use the Building Automation System for Operations Management