2015 Annual Conference

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Seminar 40 – Energy Efficient Labs: Case Studies

Retrofitting and Upgrading Lab Exhaust systems from CV to VAV

Atlanta, Georgia

Learning Objectives

- Objective 1: What are the key design objectives when approaching a retrofit in a Lab Chemistry building?
- Objective 2: What are some of the challenging factors that come into play when dealing with CAV to VAV Lab HVAC systems?
- Objective 3: What are some systems used to monitor and manage your energy usage and show your results?

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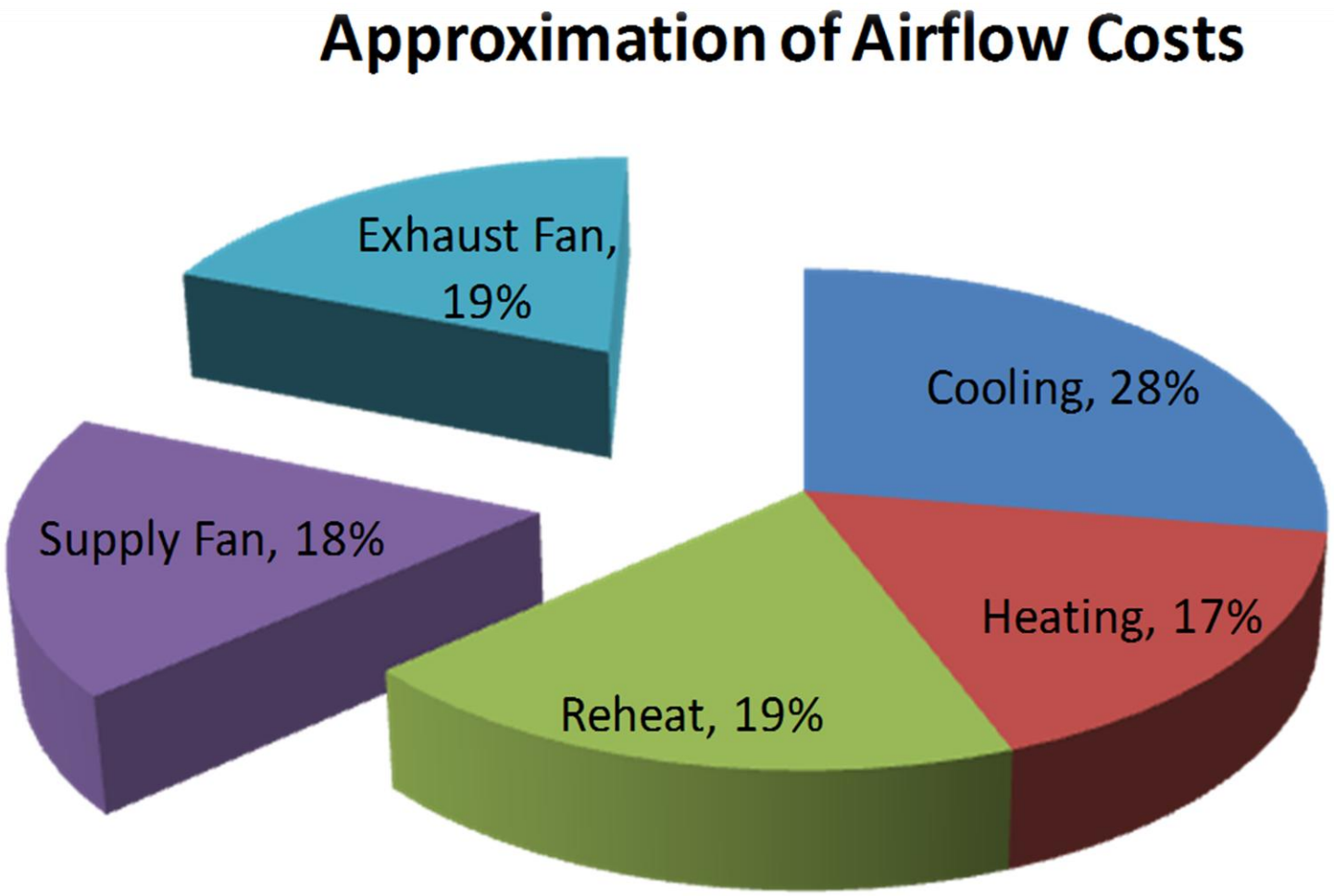
Acknowledgments

- TKO – Milt Kirkman
- AHA Consulting Engineers
  - Bob Andrews, PE
  - Roger Fournier

Seminar Description

Retrofitting and upgrading a lab building can be a daunting task on so many levels. Especially when that building is a key contributor to the campus research capabilities. This Case study of a 1973 vintage Chemistry building will look at some of the more interesting risks and challenges that a team of engineers had to face in order to meet the energy goals set out. Challenges like: Lab Occupancy, existing space and infrastructure limitations and most importantly, funding. We will step through the unique planning strategies used and review the outcome of a more energy efficient lab HVAC system that is safe, comfortable and achieved nearly $2 Million dollars in annual energy savings.

Why Focus on Research Buildings?



University of Pennsylvania

- Chem 73 – 6 floor building built 1973
- Location: Philadelphia, PA
- CV fume hoods on 3 floors individually exhausted
- Total building exhaust approx. 280,000 CFM

University of Pennsylvania

- **Goals**
  - Reduce energy cost - target total exhaust 80,000 CFM
  - Maintain occupancy and research during renovation
  - Flexibility of open lab spaces
- **Challenges**
  - CV fume hoods contained asbestos!
  - Occupied building
  - Horizontal AHU on each floor needs replacing

Mechanical Upgrade consisted of the following parts...

- **Lab Pressurization and Fume hood Containment**
- **Exhaust Fan Consolidation**
- Energy Recovery
- **Air Handling Units**

Will only talk through the items in bold

Lab Spaces

- CV to VAV Focus Points of retrofit...
  - **Fume hood capture and containment**
  - **Laboratory pressurization**
  - Comfort control
  - **Minimum ventilation control**
    - Demand Based ventilation
  - **Local and remote monitoring**

Fume Hood Capture and Containment

VAV Venturi Valve changes the airflow based on sash position and occupancy

FH Occupancy Sensor Determines if someone is in front of the hood and lowers face velocity when no one is present

Fume hood Monitor alarms if hood is unsafe or sash is too high, Note Sashes should be closed when not in use

Bypass Air blocked to allow fume hood to be variable flow

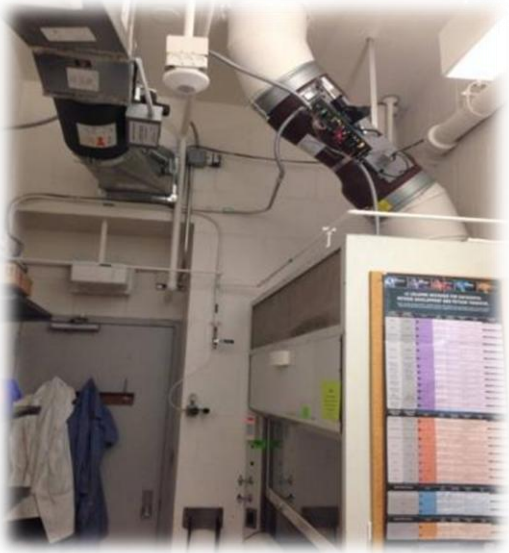
Sash Stops and sash sensors installed at 18". Alarm will sound when sash is raised higher than the stop. Do this for set up only

Side Sashes are permanently closed

Airfoil installed to pick up heavier than air particles

PENN Chem 73 Fume Hood Modifications

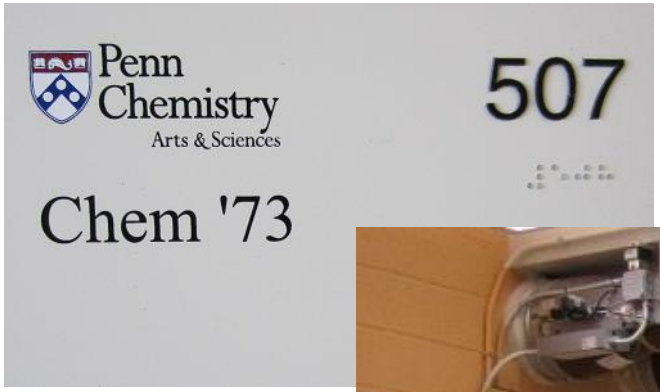
Lab Mechanical Retrofit



No Straight duct Run Requirements

Venturi Valves were ideal for retrofit because of pressure independence

New Lab Spaces



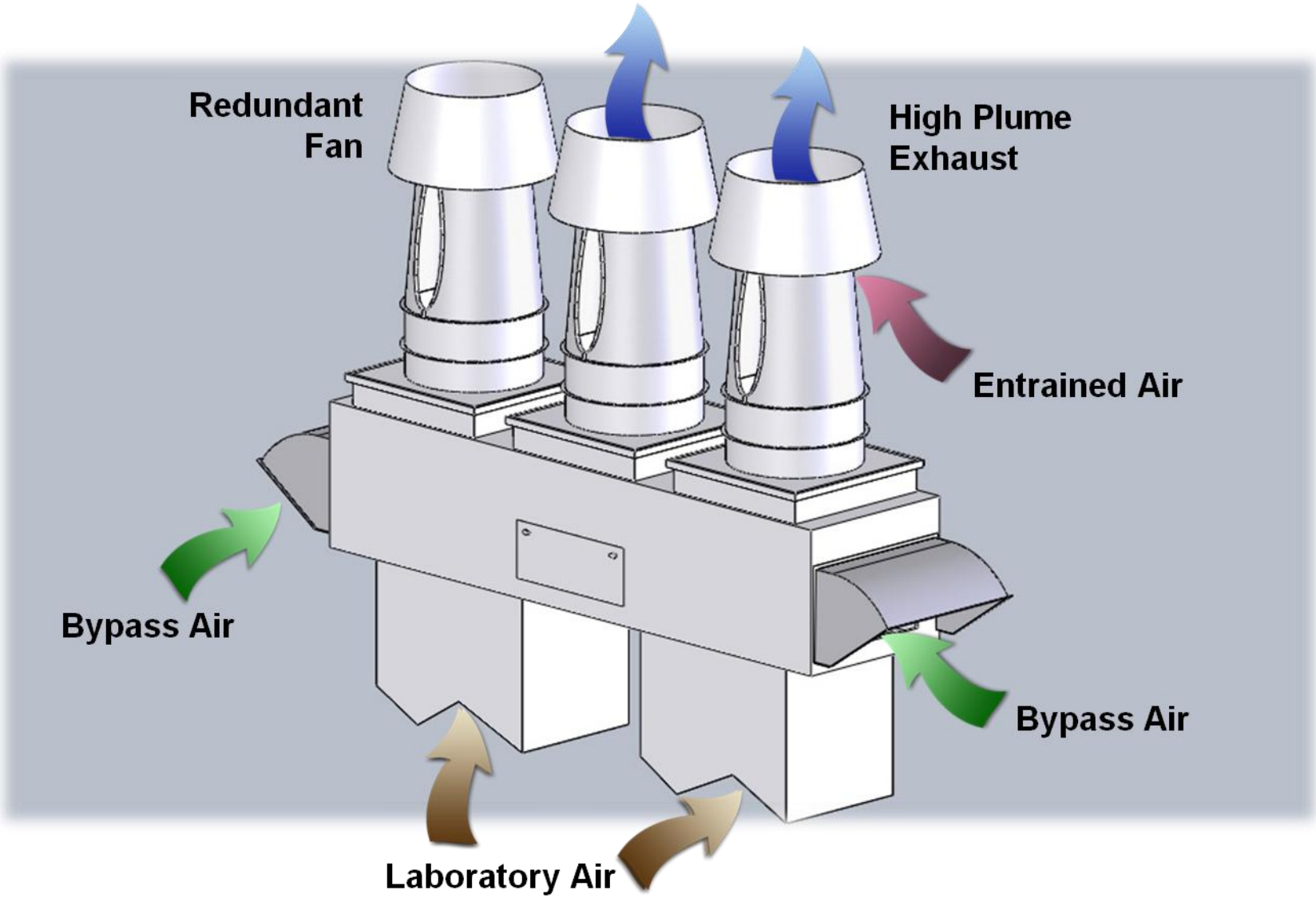
Existing Exhaust Fans

- Most Buildings built before 1990 had single fans per fume hood.
- Belt Drive
- High Stacks or worse low stacks
- Many Roof Mounted
- Vibration Isolation Required
- Access bad - maintenance often deferred

Proposed Centralized Exhaust

- ANSI Z9.5 issued in 1992
  - Belt must be inspected Monthly
  - 3000 Ft/min Stack velocity
- PENN Wanted Reduced Maintenance
- Wind Wake Models for campus wanted higher stack Heights and more dilution
- Energy Recovery required on most projects

Two Operating, One Standby



Mechanical Room - After

High Plume Exhaust Fans With Heat Recovery

New VAV AHU's

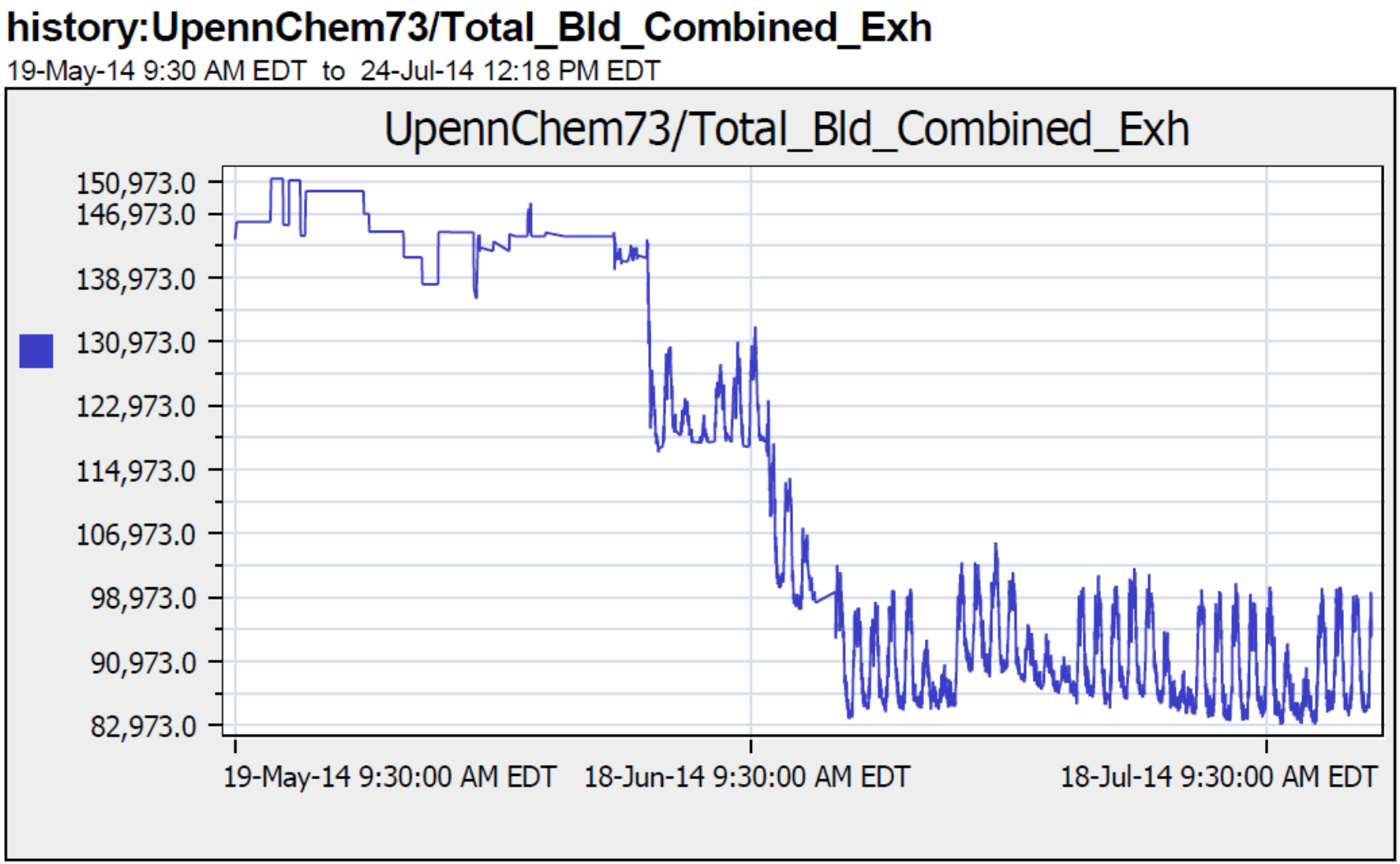
- Existing Constant Volume AHU's were generally in poor condition with old standard efficiency motors and poorly functioning controls

- Replace with new VAV AHU's with premium efficient motors and VFD's as well as new DDC controls

Chem 73

2nd Floor Existing CV AHU & 4th Floor New VAV AHU

CV - VAV Total Exhaust - Monitoring



University of Pennsylvania

- Engineering - 4 years to Plan / Design CV to full VAV project
  - SPP approx 4.1 years
- Existing building (CV) 280,000 CFM
- VAV system
  - ~ 80,000 CFM (Off Peak)
  - ~ 105,000 CFM (Peak)
- Total energy savings $1.8M Annually

Summary

- Reduces Annual Energy Costs - $1.8M
- Reduces Carbon Footprint/Emissions
  - Lab Buildings are the largest contributors on campus at 37% (50% Reduction of 37%)
- VAV Systems Respond to Space Occupancy Changes versus CV Full Out 24/7
  - Tighter Environmental Space Condition Control
  - Significantly reduces hot/cold calls
- Reduces Ongoing Maintenance
  - Eliminate problematic pneumatic controls and inefficient air compressors
  - Reduce fan belt replacement & unit down time
  - Also reduced the amount of Ambient noise inside labs

Questions?... Thank you for your time!

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