Welcome. Today’s webinar is being recorded and will be posted at:

- www.E3Tnw.org
- www.ConduitNW.org

You may submit questions at any time during the webinar. We’ll answer them during the Question & Answer session after the presentation.

The webinar will begin momentarily. Thank you for attending!
Demand-Controlled Ventilation for Commercial Kitchen Ventilation

Emerging Technologies Showcase

Don Fisher, PG&E Food Service Technology Center

Kim Erickson, Consortium for Energy Efficiency

February 13, 2013

Sponsored by BPA’s E3T Program
Applying Demand-Controlled Ventilation (DCV) to Commercial Kitchen Ventilation (CKV)

Don Fisher
PG&E Food Service Technology Center
925-866-5770
dfisher@fishnick.com
More than 3 Billion CFM...

...exhausted from Commercial Kitchens in the U.S.
...dominated by single-speed systems!
Hotel Kitchen at 3 p.m.
No appliance use but exhaust at 100%

Front Line

Back Line
No piece of equipment in the commercial kitchen generates more controversy than the exhaust hood!
Design Guide 1: Minimize design exhaust rate

– Group appliances according to effluent production and associated ventilation requirements.
– Use engineered UL-listed canopy hoods to increase effectiveness and reduce heat gain.
– Use proximity hoods where applicable.
– Side panels and end walls!

How low can you go?

Download at: www.fishnick.com
Strategy Depends On…

Appliance category and usage

VS.
Strategy Depends On…

Hood style and design
Wall Canopy with Displacement MUA

\[ C\&C = 4,100 \text{ cfm}, \text{two charbroilers cooking} \]
Proximity Hood with Displacement MUA

C&C = 1,250 cfm, two charbroilers cooking
• Design Guide 2: Optimize makeup air (MUA) delivery to kitchen
  – No short-circuit hoods!
  – Introduce replacement air at low velocity.
Four-Way Diffuser Set-Up
Eight-Foot Wall-Mounted Canopy Hood

1,400 SCFM to four-way
Eight-Foot Wall-Mounted Canopy Hood

and with low-velocity makeup air
No Four-Way Diffusers Near Hood!
CKV/HVAC Design Strategies

- Design Guide 3: Integrate the CKV system with the HVAC system
  - Maximize dining room outdoor air as replacement air for the hood/minimize local makeup air.
  - Consider using HVAC system to replace 100% makeup air.
  - Consider adding demand ventilation controls (DCV) to kitchen exhaust and integrate with MUA and/or HVAC outdoor air supply.
Full Speed!

- 6000 cfm
- 3000 cfm
- 3000 cfm
Half Speed
Winnipeg Hospital
(my first DCV-CKV project)

30 years ago
Design Approach

• Reduced exhaust and makeup air
• Side panels and glass back wall for single island canopy
• Filter blanks in sections not over appliances
• Air-to-air heat recovery to preheat makeup
• Two-speed system (3,000 feet/min duct velocity on high speed)
1,500 feet/min minimum
now
500 feet/min

NFPA 96
2001 Edition

Reference: 8.2.1.1
Errata No.: 96-01-01


1. In section 8.2.1.1 revise to read as follows:

8.2.1.1 The air velocity through any duct shall be not less than 152.4 m/min (500 ft/min).

Issue Date: January 10, 2002
Demand-Controlled Ventilation (DCV)
The Potential...

Estimated installed base of 10,000 DCV systems as this technology has slowly emerged over the last 25 years.

There are approximately 1,000,000 commercial foodservice establishments in the U.S. and Canada.
Assuming just two exhaust hood systems per facility, an estimated 2,000,000 exhaust hoods are in operation.

This represents a market penetration of only 0.5 percent.

The potential for DCV is huge!
DCV Strategies

• Controlled on a time-of-day basis
• Proportional to appliance energy use
• Controlled by:
  – Exhaust temperature
  – Sensing smoke or steam produced by cooking process
  – Measuring cooking surface temperature or activity
  – Direct feedback from cooking equipment (NAFEM Online Protocol)
  – Combinations of the above
Appliance Control

No load – low speed!

Two-speed fan interlocked with two-sided griddle
DCV Technologies

E3T Energy Efficiency Emerging Technologies
Variable Frequency Drives (VFDs)

- Essentially electronic motor starters that replace magnetic starters
- Add flexibility to direct-drive fans
- Cornerstone of a DCV system
- May be considered a separate value proposition from DCV
FSTC’s First Project – the PTK
Old Exhaust System (w/o EMS)

- Exhaust Fan 1 (4000 CFM)
- Exhaust Fan 2 (4500 CFM)
- Make-Up Air

<table>
<thead>
<tr>
<th>Time of Day</th>
<th>Average Energy Rate (kW)</th>
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<tbody>
<tr>
<td>12:00 AM</td>
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<tr>
<td>2:00 AM</td>
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<tr>
<td>12:00 AM</td>
<td>0.0</td>
</tr>
</tbody>
</table>
Old Exhaust System (with EMS)

Average Energy Rate (kW)

Time of Day

Exhaust Fan 1 (4000 CFM)  Exhaust Fan 2 (4500 CFM)  Make-Up Fan
New Exhaust System

$5,000 fan energy saving!
Total Daily Fan Energy

- Original System: $180 kWh/day
- Original System with EMS: $140 kWh/day
- Retrofit System with Controller: $40 kWh/day

$3250 savings @ $0.10/kWh

$4,875 @ $0.15/kWh
Our Second Case Study

The Mark Hopkins Hotel, San Francisco
Hotel Kitchen 3 p.m.
No appliance use...but exhaust at 100%

Front Line
Back Line
Case Study Protocol

- Document the reduction in exhaust and makeup fan power (kW) and consumption (kWh) attributed to DCV.

- Power transducers with continuous data logging were installed on all fan circuits.

- Percent speed reduction (and corresponding “cfm” reduction) calculated from power.

- Makeup air heating and cooling load savings, based on calculated airflow reductions, were estimated using an outdoor air load calculator.
Fan Power with and without DCV

Exhaust and Makeup Fan Power

- With DCV: 5.3 kW
- W/O DCV: 14 kW

Avg. Reduction = 8.7 kW

$10,000 fan energy saving!
Outdoor Air Load Calculator

Free download:
http://www.fishnick.com/ventilation/oalc/
### Without Melink Intelli-Hood Controls

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>Design Exhaust Ventilation Rate</td>
<td>19,500 cfm</td>
</tr>
<tr>
<td>Exhaust &amp; Makeup Fan Power</td>
<td>14 kW</td>
</tr>
<tr>
<td>Exhaust &amp; Makeup Fan Energy</td>
<td>336 kWh/d</td>
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### With Melink Intelli-Hood Controls

<table>
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<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>Reduced (Average) Exhaust Rate</td>
<td>13,750 cfm</td>
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<tr>
<td>Reduced (Average) Fan Power</td>
<td>5.3 kW</td>
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<tr>
<td>Reduced Fan Energy</td>
<td>127 kWh/d</td>
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### Energy Savings

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<th>Parameter</th>
<th>Value</th>
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<tr>
<td>Effective Exhaust Reduction</td>
<td>5,750 cfm</td>
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<tr>
<td>Makeup Air Heating Saving</td>
<td>11,826 therms</td>
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<tr>
<td>Average Demand Reduction</td>
<td>8.7 kW</td>
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<tr>
<td>Average Fan Energy Saving</td>
<td>209 kWh/d</td>
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### Cost Savings

<table>
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<th>Parameter</th>
<th>Value</th>
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<tr>
<td>Fan Energy Savings*</td>
<td>$9,910</td>
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<td>Makeup Air Heating Savings*</td>
<td>$9,460</td>
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<tr>
<td>Total Cost Savings with Melink Control</td>
<td>$19,370</td>
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<tr>
<td>Installed Cost of Intelli-Hood Controls</td>
<td>$15,000</td>
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**Payback** < 1 year

* based on $0.80/therm and $0.13/kWh
Our Third Case Study

Wall-mounted canopy hood and typical fan power profile for a campus dining facility
California DCV Case Studies

- Average Exhaust Fan Speed Reduction - 26%
- Average Total Fan Power Reduction - 57%

- Percentage [%]
  - Total Fan Power Reduction (%)
  - Exhaust Fan Speed Reduction (%)

Institutional Cafeteria
Casual Dining Restaurant
Hotel Main Kitchen (1)
Supermarket
University Campus Dining Facility (1)
University Campus Dining Facility (2)
Hotel Main Kitchen (2)
Hotel Main Kitchen (3)
Quick Service Restaurant (1)
Quick Service Restaurant (2)
Quick Service Restaurant (3)
Technical Feature:
ASHRAE Journal, February 2013

Future of DCV For Commercial Kitchens

By Don Fisher, P.Eng., Associate Member ASHRAE; and Rich Swierczyna, Associate Member ASHRAE; Angelo Keras
Caution

The CKV system must work effectively as a single-speed system before DCV is applied.
The Hood Tune-Up

The Hood Tune-Up

The Hood Tune-Up
Hood 2
End Panels Pass the Test!
Temp-Based DCV (in Toronto): Reduced MUA Heater Run Time by 40 Percent

Calculated savings:
Fan energy $1,680
MUA heating $4,900
Total $6,580
If a kitchen/dining facility has a total kitchen hood exhaust airflow rate greater than 5,000 cfm, then it shall have one of the following:

a) At least 50% of all replacement air is transfer air that would otherwise be exhausted.

b) Demand ventilation system(s) on at least 75% of the exhaust air. Such systems shall be capable of at least 50% reduction in exhaust and replacement air system airflow rates, including controls necessary to modulate airflow in response to appliance operation and to maintain full capture and containment of smoke, effluent and combustion products during cooking and idle.

c) Listed energy recovery devices with a sensible heat recovery effectiveness of not less than 40% on at least 50% of the total exhaust airflow.
The Future

• With the specification of a DCV system, there is no need to take chances with a design exhaust ventilation rate that is too low.

• Effective commissioning of a DCV system can maximize its performance.

• The CKV system must work effectively as single-speed system before DCV is applied.

• Until appliances communicate directly with the DCV system, the DCV technology application will not realize its full “return on investment” potential.

• And in the future, the DCV system should communicate/integrate with the energy management system.
Give a Hoot!

be energy wise

save energy, save money, save the environment.

E3T Energy Efficiency Emerging Technologies
Bi-National Efforts to Prove Out Commercial Kitchen DCV

Kim Erickson
Commercial Program Manager
Consortium for Energy Efficiency
• Background
• CEE CKV DCV Resources
  – Program Guide
  – Field Test Protocol
  – Field Test Clearinghouse
• Field Test Clearinghouse in Detail
  – Data
  – Timeframe
  – Participants
• Next Steps
CEE Background
CKV Background

Annual Savings Potential by Equipment Type

Potential Energy Savings (Billion Btu/year)

- Exhaust Hoods
- Prerinse Sprayers
- Hot Holding Cabinets
- Gas Fryers
- Gas Griddles
- Coffee Makers
- Electric Steamers
- Elec. Conv. Ovens
- Gas Conv. Ovens

Source: EPA ENERGY STAR Final Market and Industry Research Report, 2002
CEE CKV DCV Resources

Field Test Protocol

Program Guide

Clearinghouse

Photo courtesy of Halton

Available from: http://library.cee1.org/public-library/results/ckv%20dcv
Clearinghouse Data: Intended Use and Caveats

• Aiming for 50 studies
• Looking for trends
• Will share findings
• Will not make statistically significant conclusions
  – Sites are not random
  – Until we know the variability in the data, we have no idea how many sites we would need to make statistically significant conclusions
## Clearinghouse Status

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<th>Test End Date</th>
<th>Manufacturer</th>
<th>Model</th>
<th>Test City</th>
<th>Test State</th>
<th>Market Segment</th>
<th>Operating Hours Per Day</th>
<th>Climate Zone</th>
<th>Hood Style</th>
<th>Total Exhaust Hood(s) (inches)</th>
<th>Design Exhaust Airlow Rate (CFM)</th>
<th>Percentage average demand reduction from CKV system &amp; energy usage</th>
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**CEE™ Commercial Kitchen Ventilation (CKV) Demand Control Ventilation (DCV) Field Test Clearinghouse**
Get Involved

- Do and submit field tests
- Add your program to the list of interested partners
- Leverage the results in your programs and with your customers (once available)
For More Information

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925-866-5770

Kim Erickson
Consortium for Energy Efficiency
kerickson@cee1.org
617-532-0026
TBD
March 20, 2013 at noon Pacific time

More information about emerging technologies:
E3T database: www.E3Tnw.org
E3T Program: www.bpa.gov/energy/n/emerging_technology/
Conduit: www.ConduitNW.org