

# Demand Controlled Kitchen Ventilation (DCKV)

[Strategy]

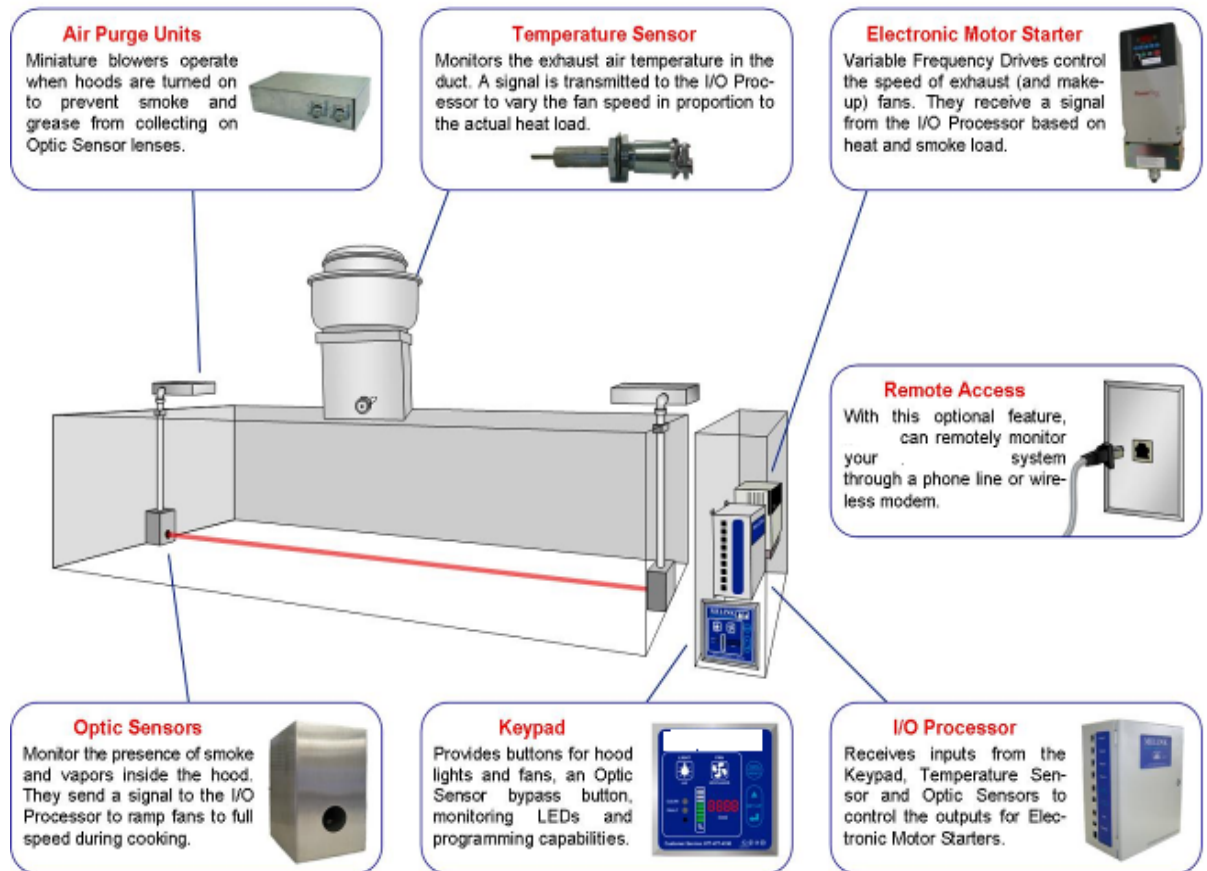
## BRIEF DESCRIPTION

DCKV equipment automatically varies kitchen ventilation by monitoring cooking activity to increase the exhaust airflow and makeup air when needed. DCKV equipment monitors cooking activity by measuring exhaust air temperature, and by sensing the infrared temperature of cooking surfaces and/or the presence of smoke/steam.

**Applications** Dining Facilities or other with cooking related activities

Desirable Characteristics:

- Relatively large exhaust hood (minimum of 5,000 CFM (2,360 L/s))
- Climate requiring significant heating and/or cooling of make-up air
- Relatively long operating hours of the restaurant's kitchen
- Medium to high utility costs.



## Design Notes

### Retrofit Requirements

- Installation of temperature and optical sensors
- Fan motors replaced if existing not compatible with Variable Frequency Drives (VFDs)
- Installation of VFDs

## Related Technologies

Similar concept to DCV used for Air Handling Units (AHUs), typically based on carbon dioxide levels

Bohlig, C., and D. Fisher. 2004. *Demand Ventilation in Commercial Kitchens: An Emerging Technology Case Study*. Report 5011.04.17, Food Service Technology Center.

Fisher, D. 2009. Energy efficiency in dining facilities. *IMCOM Energy Summit*. January 27-30. Chicago, IL.

Fuller, S., and S. Petersen. 1995. *Life-Cycle Costing Manual for the Federal Energy Management Program*. NIST Handbook 135. Gaithersburg, MD: National Institute of Standards and Technology (NIST).

Melink Corporation. 2014. Intelli-Hood: Demand Control Kitchen Ventilation, <http://melinkcorp.com/Products-and-Services/Kitchen-Ventilation-Controls/Melink-Intelli-Hood.aspx>

Smith, V. 2011. Low energy dining facilities concept. *Seventh Workshop and Industry Forum on Energy Efficient Technologies for Government Buildings*. January 26-28. Las Vegas, NV.

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[ENERGY AND environment]

## Energy Savings

### Heating Energy

- DCKV has the most savings in cold climates

### Cooling Energy

- DCKV has significant cooling energy savings, especially in humid climates

### Fan Motor Energy

- DCKV has significant fan motor savings

### Demand Charges

- Some demand charges result but difficult to quantify due to transient demand

## Guiding Principles

### Optimize Energy Performance (Energy Efficiency)

- Reduce the energy use by 30 percent compared to the baseline building performance rating per ASHRAE Standard 90.1-2007.

### Enhance Indoor Environmental Quality

- Reduces temperature fluctuations
- Reduces noise due to decreased need for exhaust

## Associated LEED Credits (NC 2009)

### EAc1: Optimize Energy Performance (1-19 points)

- Demonstrate a percentage improvement in energy performance compared to a baseline performance per ASHRAE/IESNA Standard 90.1-2007.

### EAp2 Minimum Energy Performance

- Reduce the environmental and economic harms of excessive energy use by achieving a minimum level of energy efficiency for the building and its systems.

**Product Images**



**Components**    **Optic Sensor, Temperature Sensor, Controller, VFDs, Keypad**

**Cost Range**

| Components | Cost          | Unit      |
|------------|---------------|-----------|
| Material   | \$14K - \$21K | 2-4 Hoods |
| Labor      | \$14 - \$32K  | 2-4 Hoods |

**Product Types**

**Temperature and Optical Sensor based controls**

- This type uses both temperature and opacity sensors to control exhaust fans and makeup air units
- Suitable for all cooking types

**Temperature only based controls**

- This type uses temperature only sensors to control exhaust fans and makeup air units
- Not suitable for exhaust containing steam or other vapors

## Demand Controlled Kitchen Ventilation (DCKV)

[PRODUCT AND Economics]

# Demand Controlled Kitchen Ventilation (DCKV)

## [Specifications]

### Vendors

#### **MeLink**

[www.melinkcorp.com](http://www.melinkcorp.com)

#### **Halton Company**

<http://www.haltoncompany.com/>

#### **CaptiveAire**

<http://www.captiveaire.com/>

#### **Greenheck Fan Corporation**

<http://www.greenheck.com/>

### Warranty Info

**Most manufacturers offer at least a 1 year warranty**

### Code Restrictions

**None**

**Note: [[Vendors. Warrantu omfp. And Code restrictions should be part of the “Product and Economics” section.]]**

# Demand Controlled Kitchen Ventilation (DCKV)

[CASE STUDY]

## Demand Controlled Kitchen Ventilation (DCKV)

### [CASE STUDY]

#### **Facility: Fort Lee, VA Bldg. 18028**

Bldg. 18028 is one of the larger dining facilities in the US Army. It has the capability of feeding 5,000 people during a normal meal time. The building is 65,500 sq ft in size. It is a two-story structure having a 16,100 sq ft kitchen on the first floor. Each floor of the two-story serving and dining space has an area of 24,700 sq ft with seating for 1,088 people per floor.



**Building 18028, a Large Two-Story Dining Facility.**

Two double-sided hoods in the kitchen are the subject of this study. These hoods control cooking emissions from ranges, skillets, ovens and kettles. Booth hoods are similar with each pair being 30 ft long by 4 ft wide.



**Building 18028 Main Kitchen – One Side of Hood 1.**



## Demand Controlled Kitchen Ventilation (DCKV)

### [CASE STUDY]

The main kitchen in Bldg. 18028 has two large double island-mounted canopy exhaust hoods. They are served by exhaust fans EF-1 and EF-2. MAU-1 is interlocked with EF-1 and MAU-2 is interlocked with EF-2. These two exhaust fans and MAUs were selected for the demonstration project. Also, two exhaust fans serve the pot washer area of the main kitchen. Air Handling Unit 5 (AHU-5) provides makeup air for these exhaust fans. Individual exhaust fans in the serveries account for the remainder of the exhaust flow rate (Table 1). The balance of the makeup air is from the AHUs, which provide occupancy ventilation air in the dining, kitchen, and storage areas.

**Table 1. Building 18028 Kitchen Ventilation Rates**

| System                               | Total Exhaust CFM | Total OA * | # Exhaust Fans | # Makeup Fans |
|--------------------------------------|-------------------|------------|----------------|---------------|
| Total Building Ventilation           | 66,460            | 72,830     |                |               |
| Total Kitchen and Served Ventilation | 63,290            | 47,450     | 21             | 14            |
| DCV Retrofit Systems                 | 30,240            | 24,200     | 2              | 2             |
| DCV Retrofit Systems % of Total CFM  | 48%               | 51%        |                |               |
| * Outside Air (OA)                   |                   |            |                |               |

### Approach

The DCV controls provided electrical and natural gas energy savings. The electrical savings are the result of reduced fan motor energy use and cooling energy savings that lowered the operation of the building's cooling equipment. The natural gas savings are the result of less outside airflow, which reduced the heating energy for warming this air. A total of 96,600 kWh of electrical energy and 5,600 therms of natural gas are estimated to be saved during a year operating period. This represents a total energy cost savings provided by the DCV controls of \$11,000 per year.

### Results: Fan Motor Electrical Savings

The use of DCV controls on these kitchen hood exhaust fans and MAU supply fans reduced electrical energy use by almost half. These dramatic savings result from the fact that fan horsepower varies by a cubic measure of the fan speed reduction. In other words, a reduction of fan speed to 80% equals a reduction of airflow to 80%, which equals a reduction in fan motor power of 51.2% ( $0.8 \times 0.8 \times 0.8$ ) of the initial power use. To get the actual electrical use at the lower fan speed, the fan belt loss and motor efficiency must be applied to the calculated fan motor horsepower. Table 2 lists the annual power savings and cost savings provided by the DCV controls based on motor wattage readings. The data in Table 2 show an annual cost savings of \$7,200 using an electrical energy cost of \$0.0748 per kWh.

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### [CASE STUDY]

**Table 2. Fort Lee Bldg. 18208 Fan Motor Electrical Power Savings.**

| Electrical User | kWh/day Saving | Days/yr | kWh/yr | Cost/kWh | Annual Cost Saving |
|-----------------|----------------|---------|--------|----------|--------------------|
| EF-1            | 73.9           | 365     | 26,974 | \$0.0748 | \$2,018            |
| MAU-1           | 37.7           | 365     | 13,761 | \$0.0748 | \$1,029            |
| EF-2            | 98.4           | 365     | 35,916 | \$0.0748 | \$2,687            |
| MAU-2           | 54.6           | 365     | 19,929 | \$0.0748 | \$1,491            |
| Total           | 264.6          | 365     | 96,580 | \$0.0748 | \$7,224            |

### Results: Heating and Cooling Energy Savings

The reduction in fan speed occurs during times when cooking levels are low. Reduced kitchen hood exhaust air results in a reduced amount of replacement air coming into the kitchen. Thus less outdoor air is needed to ventilate the kitchen, which saves heating energy in the winter and cooling energy in the summer. Table 3 lists the fan power and airflow rate savings. Note that exhaust airflow savings are greater than the MAU savings. This is because the reduction in exhaust air stems the flow of outdoor air into the building, both by infiltration and by inflow through the other building AHUs.

**Table 4. Fort Lee Bldg. 18208 Heating Energy Savings, Bldg. 18028.**

| Supply Air Unit | Airflow Savings, CFM | Heating Saving, kBtu | Heating System Efficiency | Annual Heating Saving, Therms | Cost/ Therm | Heating Cost Savings |
|-----------------|----------------------|----------------------|---------------------------|-------------------------------|-------------|----------------------|
| EF-1            | 5,422                |                      |                           |                               |             |                      |
| MAU-1           | 4,683                | 253,647              | 80%                       | 3,171                         | \$0.55608   | 1,763                |
| EF-2            | 4,083                |                      |                           |                               |             |                      |
| MAU-2           | 3,580                | 193,905              | 80%                       | 2,424                         | \$0.55608   | 1,348                |
| Infiltration    | 1,243                | 67,299               | 80%                       | 841                           | \$0.55608   | 468                  |
| TOTAL           |                      |                      |                           | 6,436                         | \$0.55608   | 3,579                |

**Table 5. Fort Lee Bldg. 18208 Cooling Electrical Energy Savings, Bldg. 18028.**

| Supply Air Unit | CFM   | Cooling Load Savings kBtu | Cooling Electrical kWh/yr | Cost/kWh | Cooling Cost Savings |
|-----------------|-------|---------------------------|---------------------------|----------|----------------------|
| MAU-1           | 4,683 | 15,756                    | 1,539                     | \$0.0748 | \$115                |
| MAU-2           | 3580  | 12,045                    | 1,176                     | \$0.0748 | \$88                 |
| Total           |       | 27,801                    | 2,715                     | \$0.0748 | \$203                |

lists the heating energy savings. The estimated natural gas energy savings totaled 644 million Btu (6,436 therms) per year. This amounts to a heating energy cost savings of \$3,600 per year. Table 5 lists the cooling energy savings. The reduced outside airflow saved an estimated 27.8 million Btu per

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### [CASE STUDY]

year in cooling energy. Using a Coefficient of Performance (CoP) of 3 this equals 2,700 kWh per year. The heating and cooling energy savings were estimated using the Outdoor Air Load Calculator.

**Table 3. Fort Lee Bldg. 18208 Estimated Air Flows Due to Fan Motor Speed Reduction, Bldg. 18028.**

| Ventilation Equipment | Pre-Retrofit kW | Assumed Pre-Retrofit VSD* % | Measured Airflow Rate CFM | Post-Retrofit kW | Average Post-Retrofit Calculated VSD% | Estimated Post-Retrofit Airflow Rate CFM | Airflow Savings CFM | Airflow Savings % |
|-----------------------|-----------------|-----------------------------|---------------------------|------------------|---------------------------------------|--|---------------------|-------------------|
| EF-1                  | 6.4             | 100                         | 16,881                    | 3.3              | 67.88                                 | 11,459                                   | 5,422               | 32%               |
| MAU-1                 | 3.4             | 100                         | 14,441                    | 1.9              | 67.57                                 | 9,758                                    | 4,683               | 32%               |
| EF-2                  | 8.9             | 100                         | 18,148                    | 4.8              | 77.50                                 | 14,065                                   | 4,083               | 23%               |
| MAU-2                 | 4.8             | 100                         | 14,193                    | 2.5              | 74.78                                 | 10,613                                   | 3,580               | 25%               |

\*Variable Speed Drive (VSD)

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### [CASE STUDY]

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| EF-1            | 5,422                |                      |                           |                               |             |                      |
| MAU-1           | 4,683                | 253,647              | 80%                       | 3,171                         | \$0.55608   | 1,763                |
| EF-2            | 4,083                |                      |                           |                               |             |                      |
| MAU-2           | 3,580                | 193,905              | 80%                       | 2,424                         | \$0.55608   | 1,348                |
| Infiltration    | 1,243                | 67,299               | 80%                       | 841                           | \$0.55608   | 468                  |
| TOTAL           |                      |                      |                           | 6,436                         | \$0.55608   | 3,579                |

**Table 5. Fort Lee Bldg. 18208 Cooling Electrical Energy Savings, Bldg. 18028.**

| Supply Air Unit | CFM   | Cooling Load Savings kBtu | Cooling Electrical kWh/yr | Cost/kWh | Cooling Cost Savings |
|-----------------|-------|---------------------------|---------------------------|----------|----------------------|
| MAU-1           | 4,683 | 15,756                    | 1,539                     | \$0.0748 | \$115                |
| MAU-2           | 3580  | 12,045                    | 1,176                     | \$0.0748 | \$88                 |
| Total           |       | 27,801                    | 2,715                     | \$0.0748 | \$203                |