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Exhaust Hood and Makeup Air Optimization

Demand-Controlled Ventilation Reduced Hood Energy Use by 33%

Between 2012 and 2013, the U.S. Army Engineer Research and Development Center, Construction Engineering Research Laboratory demonstrated the energy saving potential of installing DCV equipment in three dining facilities and one food court.

VARIABLE FLOW EXHAUST HOOD AUTOMATES AIR FLOW

Demand-controlled ventilation (DCV) technology monitors cooking activity and automatically modulates exhaust airflow using temperature and opacity sensors connected to a controller and variable frequency drives (VFD) on exhaust hood and makeup air unit (MAU) fan motors.

TYPICAL SAVINGS—60% ELECTRICITY AND 40% GAS

Findings included 33% average energy savings compared to the constant-volume fans, even though the latter were turned off at night 75% of the time. Simple payback was 7.3 years, assuming typical operation. With two kitchen hoods, payback was reduced to 5.7 years.

Technology Tested

MELINK® INTELLI-HOOD® SYSTEM

- Detection of active cooking with optical and temperature sensors inside the exhaust hood.
- Controller adjusts VFD motors to optimize air flow, increasing airflow to 100% when active cooking is detected, and reducing it to 50%–70% when idle.
- BACnet communication protocol interfaces with building automation systems (BAS).
- Ethernet communication for remote capabilities and firmware upgrades.
- Installed in nearly 10,000 hoods since 1997. Third-generation system, with improvements in installation, communication, diagnostic capabilities, and scalability.

STAINLESS STEEL SIDE PANELS

- Used in large hoods to direct and control exhaust flow and reduce the exhaust flow rate.

Best suited to:

- Large exhaust hoods found in facilities >10,000 ft^2.
- Exhaust volumes >5,000 CFM.
- DFAC main exhaust airflow hoods with a total motor size >5 horsepower (hp).
- Cooking area with dedicated MAU and constant airflow.
- Colder climates and areas requiring significant makeup air heating or cooling.
- Hoods with long operating hours.
- Areas with medium/high utility costs.

Limitations:

- Exhaust and MAU fans must have VFDs with VFD-rated motor.
- DCV controls require maintenance.
- May not be cost effective retrofit in some types of construction.

ABOUT ESTCP

The Environmental Security Technology Certification Program (ESTCP) is the U.S. Department of Defense's environmental technology demonstration and validation program. The program's goal is to identify and assess innovative technologies that address DoD's high-priority environmental requirements efficiently and cost-effectively.

ESTCP

Demonstration Sites: 3 Dining Facilities, 1 Food Court

DCV systems were installed on the main kitchen hoods in three dining facilities and one food court: the Samuel Sharpe Dining Facility at Fort Lee, Virginia (5,000-person capacity); the James R. Wolf Dining Facility at Fort Carson in Colorado Springs (600-person capacity); the US Air Force Academy Preparatory School, also in Colorado (240-person serving capacity); and the Base Exchange Food Court at the Ellsworth Air Force Base in South Dakota (a Burger King and a Charley's). Side-panels were added when hood performance could be enhanced by their presence. Energy use, electrical use, fan speed, MAU supply temperatures, and kitchen space temperatures were monitored before and after installation of DCV.

HOOD INSTALLATION COSTS*

Includes additional costs for coordination, additional measurements, and reporting. Totals do not include SIOH, which is 5.7% of the contractor cost.

	EQUIPMENT	LABOR
FORT LEE (4)	$14,129	$31,670
FORT CARSON (3)	$21,832	$27,165
AF ACADEMY (2)	$16,391	$22,550
ELLSWORTH AFB (2)	$14,673	$13,950

*Cost information is for reference only. Individual sites should do due diligence to determine local costs.

TYPICAL COST OF 3-HOOD SYSTEM*

Equipment $19,450
Labor $21,700
Total $41,150

*Cost information is for reference only. Individual sites should do due diligence to determine local costs.

Additional Resources

- **EW-201151 FINAL REPORTS AND TECHNOLOGY TRANSFER TOOLS**
  https://serdp-estcp.org/Program-Areas/Energy-and-Water/Energy/Conservation-and-Efficiency/EW-201151
- **TECHNOLOGY USED AT DEMONSTRATION SITE**
  Melink® Intelli-Hood® system melinkcorp.com. Stainless Steel Side Panels. Installed on hood sides to direct and control exhaust flow and improve performance.

NOTE: Before incorporating new technology, refer to Unified Facilities Criteria (UFCs) and other appropriate guidance to ensure compliance with current requirements. https://www.wbdg.org/ffc/dod/unified-facilities-criteria-ufc

Demonstration Results

ENERGY REDUCTION

- Average of 33% energy use reduction at the four sites. (Fans were turned off at night ~75% of the time; savings would be greater with continuous fan use.)
- Estimated typical savings—60% electricity and 40% gas.
- Typical savings of $3,188/yr for one hood.

INSTALLATION

- Access above the hood is critical for successful placement of cooking sensors. Access may be limited by low ceilings, hard ceilings, ductwork, piping, etc.

OPERATIONS & MAINTENANCE

- $200/yr to clean sensors.

USER SATISFACTION

- No change in satisfaction in Fort Lee; other sites did not provide feedback.

COST-EFFECTIVENESS

- Modeling across climate zones for a typical installation found Savings-to-Investment Ratio (SIR) and paybacks ranging from an SIR of 1 and payback of 8 years in Miami, Florida, to an SIR of 5 and payback of 2 years in Fairbanks, Alaska.
- Most economical when installed on main exhaust airflow hoods with a total motor size >5 hp and/or exhaust volumes >5,000 CFM. Not cost effective for small or infrequently used hoods, including food courts.
- Demonstration Sites SIR and Payback:
  Fort Lee: SIR 2.14; Payback 4.7 yrs.
  Fort Carson: SIR 0.79; Payback 13.2 yrs.
  USAFA: SIR 1.18; Payback 8.4 yrs.
  Ellsworth AFB: SIR 0.28; Payback 37.2 yrs.

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