Discharge Air Regulation Technique (DART)

"The energy savings are great, and the occupants are happy."

Mark Peppers, Project Manager, Design & Construction Services

PIER Buildings Program | ***Research Powers the Future*** | www.energy.ca.gov/pier

Wireless Control Converts Constant-Volume to VAV

A new, low-cost wireless control application called **Discharge Air Regulation Technique** (DART) is designed to economically convert constant-volume HVAC systems to VAV operation.

The DART system uses the latest wireless sensor network technology. Battery-powered wireless temperature sensors are installed in or near the discharge air diffusers (see photo at right). The sensors measure discharge air temperatures and regulate the highest or lowest zone temperature by varying the fan speed. There are no mechanical retrofits, and no need to get above the ceiling. Installation time is short, there is minimal disruption of the occupants, and no need for asbestos abatement, should it be present.

DART has a lower installation cost than conventional CV to VAV retrofits. Combined with the large fan, heating and cooling energy savings that are achieved, this results in a short payback period.

Product Overview

Energy Savings

- Reduces fan speeds at part load conditions.
- Typically reduces fan energy by 50% or more.
- Typically reduces heating and cooling energy by as much as 35%.

Operation/Maintenance

- Operation is automatic. Alarms can be sent via e-mail or pager.

Manufacturer: Federspiel Controls, LLC

Market: Commercial and Institutional HVAC systems

Availability: Federspiel Control, LLC (www.federspielcontrols.com)

Public Interest Energy Research | ***University of California*** | California State University

Field Demonstration

UC Santa Barbara -

Cheadle Hall and Phelps Hall

Three DART applications were installed at Cheadle Hall and Phelps Hall at UCSB. In Cheadle Hall, two applications each control a supply fan – return fan set, and the third DART system controls two supply fans on a common shaft in Phelps Hall. These fans have a total nameplate horsepower of 115, and a total supply airflow of 77,400 CFM. The systems in Cheadle Hall are dual-duct systems and operate 3,500 hours annually, and in Phelps Hall the system is heating and ventilating only, operating 5,850 hours per year.

Cheadle Hall

Phelps Hall

DART System Components

CPUC Partnership

The University of California/California State University (UC/CSU) and Investor-Owned Utility (IOU) Partnership Program has identified an incentive for this technology based on the energy saved per year. This is typically enough to pay for a significant portion of the installation cost. For more information please visit:

www.uccsuiouee.org

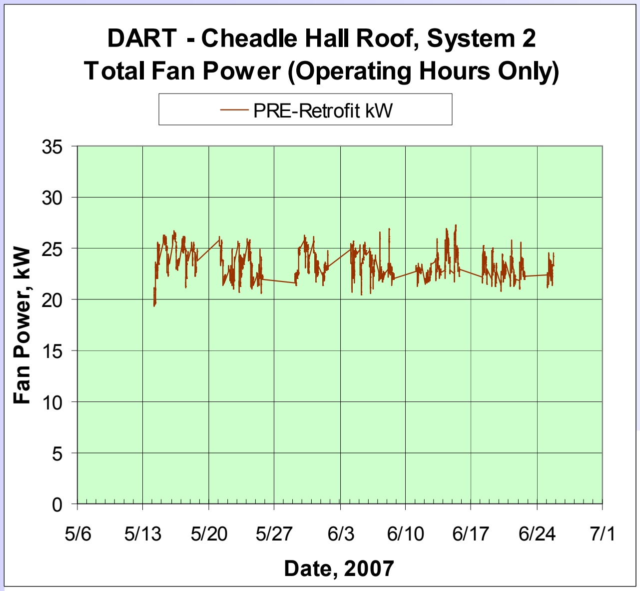
Installation Cost and Payback

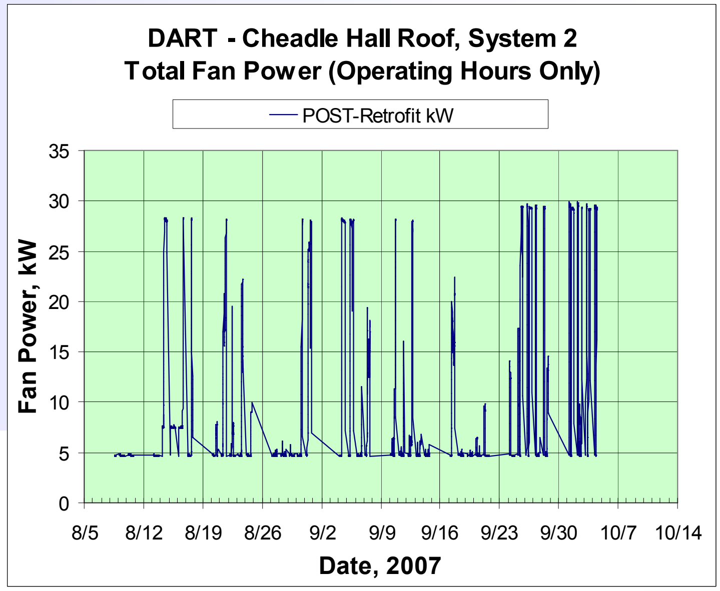
The installed cost of a DART control package at any particular facility depends on the horsepower of the supply and return fans, and the number of zones. Typical costs range from $10,000 to $30,000 per system. Energy savings depend on the fan motor loads (kW) at full speed, the initial variability of the HVAC system operation, and the number of operating hours in the year.

With the UC/CSU/IOP Partnership incentives, the investment will usually be returned in less than two years! Systems with more annual operating hours have the shortest payback periods.

Study Results

Energy performance data for five controlled fans (total of 115 hp) in the two buildings was collected for about 90 days between mid-May and early October, 2007. The estimated combined fan energy savings were about **58%**, which equates to annual savings of **187,000** kWh and $**21,500**. Calculated make-up air average CFM reductions yielded an additional savings of about $**13,900** per year from heating and cooling energy reduction. These savings are based on energy rates of $1.00/therm and $0.115/kWh.



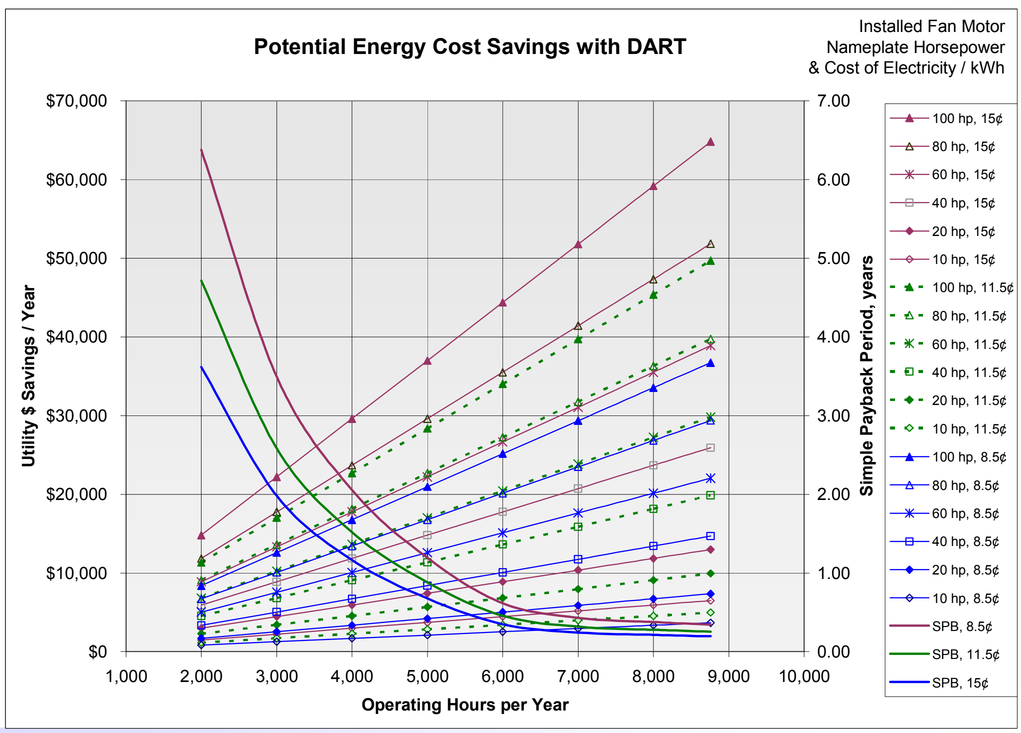


This nomograph below shows the approximate energy cost savings and the simple payback period for a DART retrofit. Starting with the number of annual operating hours for a system, go up from the horizontal axis to the line representing the total installed horsepower of the supply and return fans and your electricity cost. From this line, go to the left to find the energy cost savings. From the same number of operating hours, go up from the horizontal axis to the SPB curve for your electricity cost, then right to find the simple payback in years.

The graph is constructed using test data for fan systems with both heating and cooling. Heating-only or cooling-only systems will have less savings and longer SPBs.

The nomograph uses utility costs of 8.5, 11.5 and 15 ¢/kWh and $1.00 / therm, and Partnership incentives of 24 ¢/kWh and $1.00 / therm.

Without the Partnership incentives, the payback periods are 0.5 to 2 years longer.



Considerations

DART works by reducing the supply fan and return fan speeds at part-load conditions. When there is no load, the discharge air temperature is set equal to the zone temperature, so reducing the fan speed has no impact on the room temperature. At part-load conditions, the discharge air temperatures are somewhat higher or lower than the zone temperature, depending on whether the zone is being heated or cooled. Reducing the fan speeds while regulating the discharge air temperatures ensures that the heat transfer rate to the zone doesn't change. Reducing fan speeds results in fan energy savings. Heating and cooling energy savings are also achieved, based on the reduced airflow, reduced reheat or reduced mixing of hot and cold air.

The system uses low-power wireless sensing and control modules and the sensors can operate for four years on a set of AA lithium-ion batteries. VFDs are required on the supply and return fans. VFDs may also require the installation of inverter-duty motors.

Conclusion

DART converts constant-volume HVAC systems to VAV operation, reducing fan, heating and cooling energy load and cost. The electrical energy savings of DART are greater than most conventional constant-volume to VAV retrofits because DART achieves the same fan energy consumption as VAV with static pressure reset, and most VAV systems don't use static pressure reset.

DART is a web-enabled, wireless control system that achieves the following goals: ♦ Short installation time ♦ Minimal disruption of occupants ♦ Long battery life (up to 4 to 8 years) ♦ No need for asbestos abatement, should asbestos be present ♦ Browser-based human-machine interface (HMI) ♦ Standalone (without DDC) operation if necessary ♦ Remote monitoring and alarming ♦ Modular design that can be used to deploy other applications.

DART typically reduces fan energy use by 50%, and heating and cooling energy by as much as 35%. It is cost-effective, usually returning the investment in less than four years.

Availability

The DART control package is available directly from Federspiel Controls, LLC. Additional information about it can be found at http://www.federspielcontrols.com. The phone number is (510) 524-8480.

About PIER

This project was conducted by the California Energy Commission's Public Interest Energy Research (PIER) program. PIER supports public-interest energy research and development that helps improve the quality of life in California by bringing environmentally safe, affordable, and reliable energy services and products to the marketplace.

PUBLIC INTEREST ENERGY RESEARCH
"Research Powers the Future"

For more information see www.energy.ca.gov/research

Arnold Schwarzenegger, ***Governor***
California Energy Commission
Chairman: Jackalyne Pfannenstiel, *Vice Chair:* James D. Boyd
Commissioners: Arthur H. Rosenfeld, Jeffrey Byron, Karen Douglas

3.17.2008
Pub # ——