



## Discharge Air Regulation Technique (DART)

*“Cal Poly is delighted with the energy savings this system has produced, which far exceeded our expectation. Operation has been transparent to building occupants, with virtually no comfort complaints whatsoever.”*

Dennis Elliot, Sustainability Manager, Cal Poly San Luis Obispo

PIER Buildings Program

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### Wireless Control Converts Constant-Volume HVAC System 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. The pay-back period is short because of the large fan, heating and cooling energy savings that are achieved.



### 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](http://www.federspielcontrols.com))

Public Interest Energy Research

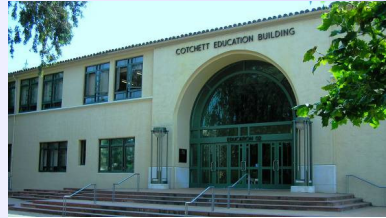
University of California

California State University





Mathematics and Science Building



Cotchett Education Building



Health Center

## Field Demonstration - California Polytechnic State University - San Luis Obispo

### Mathematics & Science Building, Cotchett Education Building, and Health Center

Three DART systems were installed in the Mathematics and Science building, the Cotchett Education building and the student Health Center at Cal Poly San Luis Obispo.

Each system controls a supply fan – return fan pair. These fans have a total of 48 nameplate horsepower, and a total supply airflow of 48,200 CFM. The systems in the Mathematics and Science building and the Education building are dual-duct systems, operating 3,440 and 5,000 hours per year respectively. The system in the Health Center is a terminal reheat system, operating 3,700 hours per year.

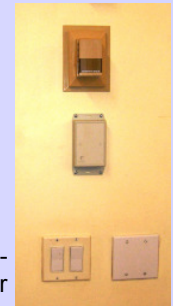


Web-to-Wireless Gateway (WWG) transmits sensor data to Federspiel Supervisory Controller (FSC)

### DART System Components



Wireless Control Module interfaces with existing control system



Zone Temperature Sensor

### IOU 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.uccsuioee.org](http://www.uccsuioee.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 per year.

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

## Study Results

Energy performance data for six controlled fans (total of 48 hp) in the three buildings was collected for about four months between mid-July and mid-November, 2008. The graph below shows typical daily fan energy consumption before and after DART was installed.

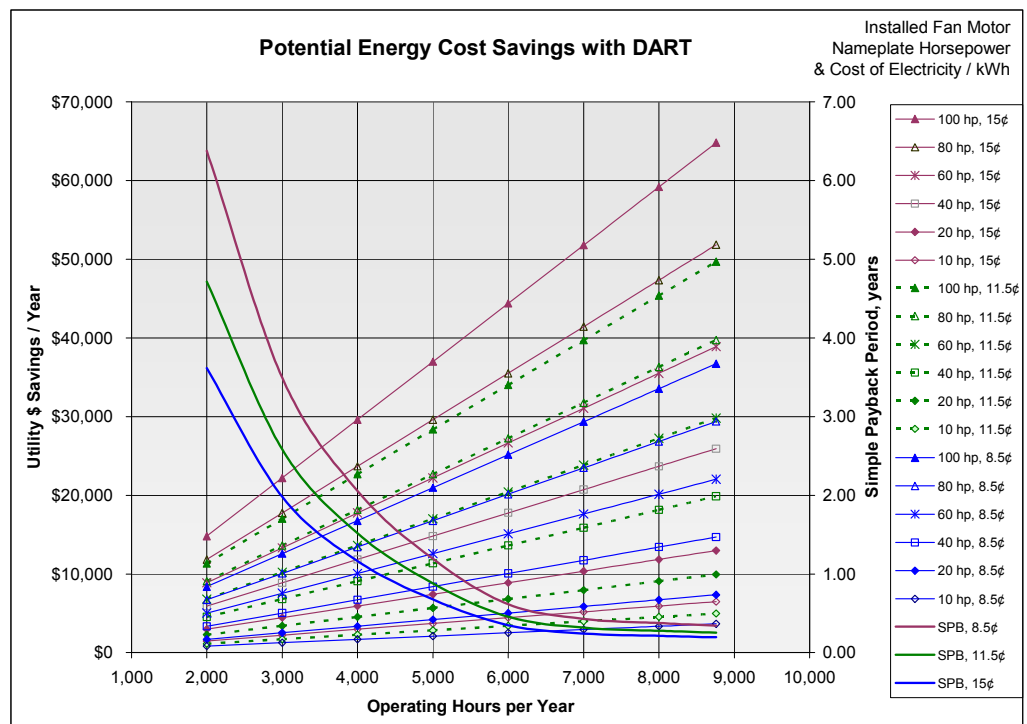
The estimated combined fan energy savings were about **62%**, which equates to annual savings of 58,800 kWh and \$5,600. Calculated make-up air average CFM reductions yielded an additional savings of about 7,500 therms of natural gas and 1,450 kWh from heating and cooling energy reductions, valued at \$7,100 per year (based on actual local energy rates of \$0.93/therm and \$0.095/kWh). With a total annual cost savings of \$12,700 and an installed cost of \$62,600, the simple payback period is 4.9 years. **Partnership Program incentives totaling \$22,000 reduce the net cost to \$40,700 and the SPB to 3.2 years.** In addition, these energy savings reduce production of CO<sub>2</sub> by 40 tons per year!

This nomograph 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 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 simple paybacks.

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 than indicated in the graph.*





## 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, and, with IOU Partnership incentives of \$0.24/kWh and \$1/therm saved annually, usually returns the investment in less than two years.

## Availability

The DART control package is available directly from Federspiel Controls, LLC. Additional information about DART 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.



For more information see [www.energy.ca.gov/research](http://www.energy.ca.gov/research)

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