BEST PRACTICES 2011

University of California, Irvine Rowland Hall HVAC Retrofit

This major university laboratory building goes beyond conventional upgrades to reduce fan energy by almost half. Sophisticated upgrades to fume hoods and laboratory air control valves, along with an innovative method for occupancy control, fine-tune air delivery to serve the users' needs.

Award Category

HVAC Design/Retrofit

Green Features

Changed constant air volume to VAV

Changed pneumatic controls to direct digital

Static pressure balance in office plenum

New lab air control valves

Occupancy and sash position control on fume hoods

New control sequence allows unoccupied setback of air change rates in offices

Annual Energy and Cost Savings

3487 MWh electricity

98,000 therms natural gas

640 kW total electrical demand reduction

1660 metric tons CO^2

$442,550

Size

232,000 ft^2

Cost

$4.1 million

Completion Date

December 2010

With 168 fume hoods in multiple labs and out-dated air delivery systems, Rowland Hall boasted the largest energy demand on the UC Irvine campus. Built in 1968, the six-story structure houses the School of Physical Sciences, with research and teaching laboratories, classrooms, and offices.

The building received new air handlers and exhaust fans during a seismic retrofit in 2007, but with old constant-volume supply and exhaust and pneumatic controls, the new equipment was already suffering maintenance problems, as it was sized for variable volume and running at full speed.

Constructed in 1968, Rowland Hall was in need of a massive replacement of air delivery systems. Photo: Matt Gudorf.

A full overhaul of the aging equipment became possible by leveraging rebates offered by the utilities that serve the campus through the UCOP Strategic Energy Partnership program, along with a bond financed by the University of California. An incentive payment of $922,000 was set aside once the campus submitted a scope of work, and the incentive was used, along with utility savings, to repay the bond.

Although the basic technological upgrades were nothing new, a focus on performance beyond energy efficiency, including maximizing occupant satisfaction and minimizing disruptions to research, allowed for huge savings with an exceptionally low impact.

To reap the full benefits of a new air delivery system, the campus studied the building's use patterns. Faculty often have unpredictable schedules, and offices may go days or weeks without being occupied, making occupancy-based HVAC controls an important efficiency measure. However, facilities staff had learned that implementing such controls in other campus buildings had come at the expense of occupant comfort. Until Rowland Hall, a basic approach was to widen the temperature band beyond the comfort range during unoccupied periods, an approach that typically causes delays in restoring comfortable temperatures once faculty return to their offices.

The retrofit saved 1660 metric tons of CO^2, meeting six percent of the campus's target reduction for 2014.

To solve this problem, Matt Gudorf, the Campus Energy Manager, proposed an alternative control sequence that would establish three low-flow modes based on thermostatic signals when offices are unoccupied. Below 68 °F, the heating damper is fixed at a ten percent flow. Above 74 °F, the cooling damper is similarly fixed to ten percent. Between 68 and 74 °F, both hot and cold air supply dampers are set to five percent. However, terminal unit controllers are not typically programmed to operate in this manner, so the campus worked with controls subcontractor Siemens to write and implement new code.

Such re-programming was uncharted territory, but the efforts paid off. Airflow to unoccupied offices was reduced by 85 percent while maintaining acceptable temperatures and high occupant satisfaction. Locking the mixing boxes at low-flow positions also extends equipment life by preventing the actuators from constantly modulating.

2011 BEST PRACTICES

Additional Awards

APPA Effective and Innovative Practices Award 2011

2011 Energy Efficiency Excellence Award, Large Commercial Category (SoCalGas)

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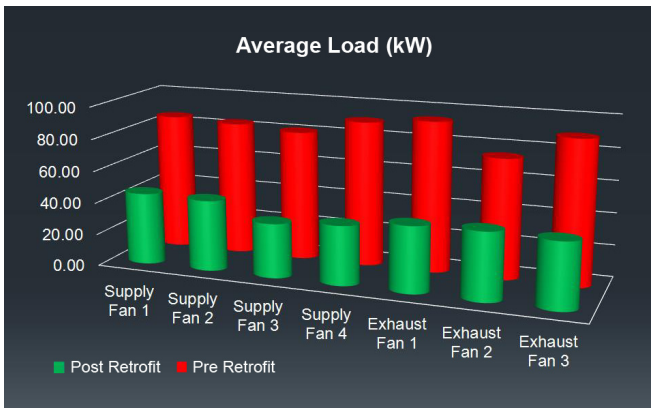
More Information

http://www.slideshare.net/matt_UCI/rowland-4453832

http://www.fm.uci.edu/news/energyaward_rowlandhall.html

In the labs, fume hoods were retrofit with new valves to provide full control, and with digital sensors to modify airflow according to sash position. Also added were "zone presence sensors," hood-mounted occupancy controls that provide savings when sashes are left open and unoccupied.

Adjustments to the air delivery system, including a complete air balance and static pressure adjustment to the office supply plenum, resulted in a demand reduction of 640kW. The demand dropped so significantly that one of the three building exhaust fans is now turned off. Prior to the retrofit, supply and exhaust fans ran at full speed, 24 hours a day, seven days a week. Post-retrofit, total annual fan electricity consumption was nearly halved, from 5.4 million kWh/year to 2.8 million kWh/year.



The system-wide retrofit reduced fan electricity by close to half. Image: Matt Gudorf.

The project demonstrated that a major laboratory retrofit is possible without disrupting research activities.

Most impressively, this savings was achieved while the building remained occupied. One key to success was the decision to place asbestos abatement under the responsibility of the general contractor. In past projects, the university hired asbestos removal and HVAC installation contractors separately, which often resulted in change-orders and delays. For the Rowland Hall project the campus office of Environmental Health and Safety provided color-coded diagrams of the entire building so that bidders could evaluate the level of asbestos access and removal prior to bidding, and were free to direct abatement as needed during the retrofit.

The campus provided a detailed work plan to ensure ongoing research and building staff would be accommodated. The winter holiday break was to be set aside for asbestos removal, and throughout the process, no lab could be out of commission for more than five days. Outside of these restrictions, the contractor was free to set work schedules.

LESSONS LEARNED

"You can push a project through in three months, but then you have to take the building offline," Gudorf explained. Instead, with a full year, the general contractor was given maximum control to coordinate directly with occupants and the abatement contractor. "This project was a proof of concept that you can do extensive retrofits with minimal disruption."

Keeping occupants informed, however, was critical. A town hall meeting prior to construction was held to set expectations about the work and the amount of time occupants would be required to be out of their office or lab.

According to Gudorf, the new occupancy control sequence was so successful that it will be implemented in future projects on campus, the first of which will be McGaugh Hall, a lab building for biological sciences.

Best Practices case studies are coordinated by the Green Building Research Center, at the University of California, Berkeley.

The Best Practices Competition showcases successful projects on UC and CSU campuses to assist campuses in achieving energy efficiency and sustainability goals. Funding for *Best Practices* is provided by the UC/CSU/IOU Energy Efficiency Partnership.