BEST PRACTICES 2007

Sacramento State Underfloor Air Distribution System

Sacramento State's first underfloor system integrates mechanical and telecommunication infrastructure into a single underfloor plenum. The readily adaptable system provides a convenient solution to cable management and will expedite future technology and space upgrades or reconfigurations.

Award Category

HVAC Design

System Features

Air stratification is encouraged to improve indoor air quality

Airflow controllability improves occupant comfort

Provides opportunities to reduce cooling and fan energy

Underfloor plenum houses communication wiring out of sight

Floor diffusers easily reconfigured

Improved space management flexibility

Variable frequency drives

Annual Energy Savings

182,000 kWh design energy calculations

Size

97,923 ft²

Cost

$26 million total building cost

Completion Date

May 2005

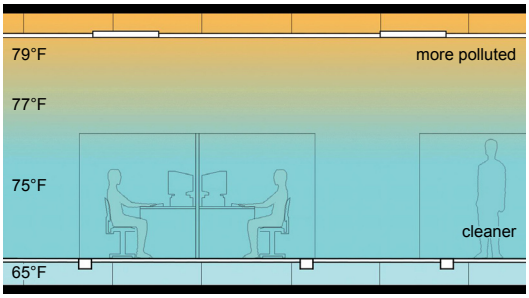
The Academic Information Resource Center (AIRC) consolidates communications, computing and media staff and services in one location on the Sacramento State campus. Miles of power and data cabling are needed to support these programs, prompting the university to install its first underfloor air distribution (UFAD) system. This type of air delivery system provides ventilation with the added benefit of a readily accessible service plenum suitable for housing cables.

Underfloor systems are steadily gaining traction as a compelling alternative to conventional overhead systems. UFAD design and operation differs substantially from ceiling-based systems, and requires different approaches to analysis and performance. However, when designed and applied properly, UFAD systems positively impact a range of common facilities management concerns including energy use, human health performance, and space management.

Underfloor plenum depths range from 8 to 18 inches, providing ample space for telecommunications infrastructure.

Several distinguishing features set underfloor systems apart from traditional overhead HVAC systems. Supply air is conveyed via an underfloor plenum rather than through ducts in the ceiling plenum. Air typically flows freely in the plenum to small floor diffusers positioned near occupants, or in rare instances to task/ambient outlets integrated into cubicle partitions. A raised access floor with removable floor tiles accommodates the supply plenum. These elements produce a very different thermal environment than that of a typical building, with great implications for occupant comfort and energy use.

Overhead systems are designed to completely mix the entire volume of air in a space, which ensures that fresh air reaches occupants and promotes temperature uniformity. UFAD design differs in that thermal stratification is encouraged under cooling operation. In this model, conditioned supply air is delivered at the floor level and travels to the ceiling return plenum as it warms. The goal of UFAD is to maintain a comfortable thermal environment in the occupied portion of the space while permitting stratification above head height where higher temperatures do not affect occupants.



UFAD encourages thermal stratification above head height. Image: Center for the Built Environment.

Delivering air directly into the occupied zone allows underfloor systems to operate at higher supply air temperatures than required by ceiling-based systems. In fact, supply air needs to be warmer to protect occupants' thermal comfort. UFAD systems typically supply air at 60 to 65°F, while overhead systems operate at 55 to 57°F. To further promote thermal comfort, diffusers are usually equipped with individual controls that allow occupants to adjust the airflow to match their personal preference.

Providing ventilation from the floor is an effective way to maintain high levels of indoor air quality. Contaminates and heat loads from office equipment and people are removed by the natural propensity of air to rise from floor to ceiling. Additionally, introducing air locally through diffusers increases air movement and prevents the feeling of air stagnation, which occupants often link to low indoor environmental quality.

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Team

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Electrical Engineer: Electrical Design Consultants, Inc.

Architect: Dreyfus & Blackford Architects

Contractor: McCarthy Building Companies, Inc.

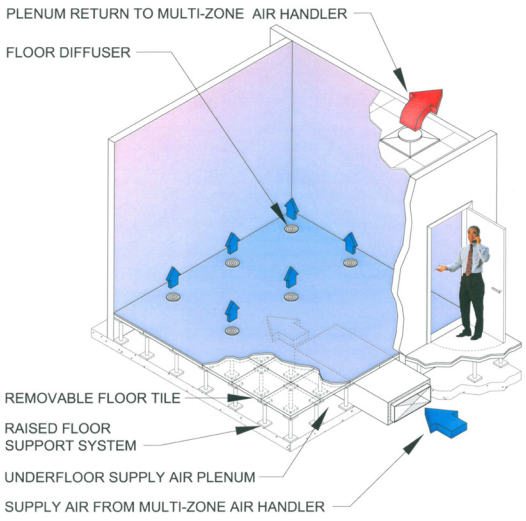
More Information

www.dreyfussblackford.com

www.cbe.berkeley.edu/underfloorair/default.htm

A properly designed and operating underfloor system has the potential to save energy relative to a conventional overhead system in addition to improving occupant comfort and indoor air quality. Depending on climate and operating conditions, the bulk of UFAD's potential savings lie in capitalizing on opportunities to reduce cooling and fan energy use.

Higher supply air temperatures produce cooling energy savings by extending the number of hours underfloor systems can operate in the economizer mode. Warmer supply air also saves cooling energy by allowing the chiller to operate at higher chilled water temperatures. Design energy calculations for Sacramento State's UFAD system show an annual savings of 32,000 kWh from reduced horsepower requirements at chiller pumps.



Underfloor system diagram. Image: Taylor Systems Engineering, Inc.

Underfloor systems save fan energy primarily by reducing static pressure requirements. The underfloor plenum infrastructure eliminates most branch ductwork found in conventional ceiling-based systems, which reduces static pressure and the associated fan horsepower required to move air though the system.

According to design energy calculations performed by the project engineer, the low-pressure design of the AIRC underfloor system reduces fan brake horsepower by 16 percent, saving about 150,000 kWh each year.

The AIRC is the first application of UFAD technology at Sacramento State. Photo: Nathaniel Martin.

While the system's energy performance is unverified due to partial utility metering capabilities at the building, Sacramento State has seen clear advantages to UFAD in the areas of telecommunications and space management. The raised-floor plenum allows extensive networks of cables to be organized out of sight, creating a visually clean building interior. Modular floor panels provide ready access to the wiring serving any workspace. Floor diffusers are easy to relocate, making the system highly adaptable to changes in the spatial layout of office furniture. Given the high cost of churn and likelihood of renovations, the flexibility afforded through UFAD will produce significant cost savings over the building's lifetime.

LESSONS LEARNED

Nathaniel Martin, Sacramento State's Energy Conservation Coordinator, describes the system's number one problem as "leaks, leaks and more leaks." Understanding the importance of sealing the underfloor plenum is critical, says Martin, because leaks significantly impact UFAD's ultimate energy and thermal comfort performance.

Best Practices is written and produced 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.