



Award Category

HVAC Design

System Features

Allows for operable windows

Adapted for coastal climate

Displacement ventilation in offices

Night flush strategy pre-cools building

Annual Energy Savings

248,000 kWh

2,700 therms

43% greater energy efficiency than Title 24 standards

Annual CO₂ Emissions Avoided

121,490 kg

Size

62,000 ft²

Cost

\$1.9 million HVAC cost

\$32 million total building cost

Completion Date

Scheduled for completion June 2008

University of California, San Diego Supercomputer Center Expansion

Occupants of the expansion project will enjoy a combination of tempered supply air and natural ventilation. The HVAC system is designed to accommodate occupants' desire for operable windows while remaining energy efficient. The expansion is projected to use 43% less energy than a Title 24 baseline building.

Engineers at UCSD teamed with Rumsey Engineers to create a climate-appropriate HVAC system that optimizes energy-efficiency and provides a comfortable indoor environment year-round. This system will provide the new Supercomputer Center office expansion with a combination of natural ventilation and filtered supply air delivered via a displacement ventilation system.

The design team's primary goals were to create an acceptable indoor environment; to keep costs comparable to a conventional HVAC system; and to realize higher energy-efficiency than a conventional system.

With 7.3 terabytes of total aggregate memory, the Supercomputer Center is one of America's largest data storage facilities. The Center also has 26 teraflops of computing power available for large-scale, data-intensive scientific research.

A detailed analysis of the site's climate was performed to gather information for the design process. Historical data from two typical weather years showed that for days over 79°F, the wind blows from the northwest 72% of the time. This information was used to optimize the natural ventilation strategy by positioning the building and locating operable windows to take advantage of the site's typical airflow pattern. Determining wind direction also revealed how saltwater might travel to the building, an important factor in locating outside air intakes to minimize the saltwater impact.

The potential for night cooling was determined by analyzing the daily variation between maximum and minimum temperatures in days over 70°F. With night cooling the HVAC system cools the building when energy costs are lower, with the goal of lowering the temperature of the building mass to prepare it to absorb more heat the next day. This technique shifts a portion of the building's peak cooling

load to off-peak periods, which can produce significant energy cost savings. The design team found moderate off-peak cooling potential and used the analysis to create an effective night cooling strategy.



Artist's rendering of the Supercomputer Center expansion. Image: EHDD Architecture.

The design team conducted energy modeling with EnergyPlus simulation software to test the HVAC design performance under several design variations. The variations included standard clear glazing; optimized, smaller shading devices; no external insulation in the vertical envelope walls; and lower gains from one occupant per office and one-half occupancy in core zones. The performance of the displacement ventilation system and night cooling strategy were also evaluated. Design documentation and usage schedules were followed closely in modeling simulations involving 77 independent thermal zones and over 700 surfaces. Internal gains in all zones were set to approximately .9 W/ft² for lights, 3.1 W/ft² for equipment, and 1.2 W/ft² for occupants.

Shading analysis was performed using ECOTECT software to determine the optimal shading dimensions, orientation, and spacing. External shading devices limit the internal heat gain resulting from solar radiation. This form of passive temperature control can allow for downsizing of mechanical systems due to

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More Information

[blink.ucsd.edu/Blink/
External/Topics/
Policy/0,1162,18846,
00.html](http://blink.ucsd.edu/Blink/External/Topics/Policy/0,1162,18846,00.html)

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the reduction in cooling loads. The final Supercomputer design includes horizontal sunshades on the southern exposure and vertical sunshades on the east and west exposures.

The HVAC system is designed to operate effectively in San Diego's coastal climate by filtering out saltwater droplets. Saltwater is extremely corrosive to HVAC coils and systems, and can affect indoor air quality if not properly managed. Each air handling unit (AHU) has a mist eliminator section with a media for removing moisture. The airflow then passes through a highly efficient MERV 11 filter, which captures 65% of airborne particles.



*View of the expansion project in relation to the existing Supercomputer Center (left).
Image: EHDD Architecture.*

Two-rooftop AHUs supply air to the interior via a three-mode system. On days with moderate temperatures, unconditioned air is supplied to the interior at a higher airflow rate of 1.5 cfm/sf, comparable to an economizer mode. On hot weather days, tempered air is supplied at 70°F and a lower airflow of 0.3 cfm/sf via a displacement ventilation system. On cold weather days, tempered air is supplied at 70°F and 0.3 cfm/sf. The design criteria for the building require that the indoor room temperature remain between 70-76°F. In the hottest days of summer, temperatures up to 80°F are allowed for the west facing exterior

rooms. In winter months, occupied rooms are maintained at about 70°F, and unoccupied rooms are setback.

The displacement ventilation system delivers low-velocity supply air to the offices through low sidewall grilles. As the air warms, it rises to the ceiling where it is discharged via grilles and windows. Displacement ventilation provides superior indoor air quality because odors and contaminants are expelled from the room with the rising exhaust air. In addition, supplying air through sidewall grilles directly into the occupied zone is more energy-efficient than a conventional overhead HVAC system which mixes air throughout the entire space.

Powering the completed expansion project and the existing Center will require combined total of almost five megawatts, which is enough energy to power 5,000 homes.

The displacement system provides further benefits to the building user. Equipped with occupant control of supply inlets, the system enables individual manipulation of the thermal environment. Studies have shown that providing user control features substantially increases worker comfort and productivity.

Heat is provided by hydronic radiators located in the perimeter spaces. The radiators are located at floor level, approximately four to five feet from building occupants. Each radiator is equipped with local thermostatic controls for improved occupant comfort.

At a projected cost of \$31 per ft² of conditioned space, the hybrid HVAC system is comparable to a conventional VAV system. In addition to the office space recognized under this Best Practice award, a 5,000 ft² data center facility designed for low energy consumption is also included in the building design. The data center will save over 1 MW each year. The Supercomputer expansion is scheduled for completion in June 2008.

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