Radiant Cooling and Heating Systems Case Study

Photo: D'Ambrosio Architecture + Urbanism

OVERVIEW

Location: Victoria, BC, Canada

Project Size: 16,275 ft^2

Construction Type: New Construction

Completion Date: 2012

Fully Occupied: 80%

Building Type: Office

Climate Zone: ASHRAE 5

RELIABLE CONTROLS HEADQUARTERS

The Reliable Controls Headquarters annex is a 4-story office building housing 80 employees. The 16,000 square foot building is LEED Platinum certified, designed to operate using 50% less energy than standard ASHRAE 90.1(1999) buildings.

The project was built as an expansion to accommodate the firm's research and development wing. The building integrates passive technologies and radiant space conditioning systems to considerably reduce the energy consumption of the building. The energy conservation measures, coupled with an extensive storm water management and soil erosion strategy, contributed to exceeding points for the LEED Platinum target and reduced the water consumption by 60%.

Planning and Design Approach

The building is a reflection of Reliable Controls' triple bottom-line ideals. Architect Franc D'Ambrosio drew inspiration from the company's state-of-the-art automation controls to devise a built form that functions seamlessly with its systems. Integrating passive technologies with the efficient mechanical systems provides a platform for the company's indoor environmental control products.

The landscape incorporates an extensive bioswale to regulate storm water runoff and a rainwater harvesting system provides for 80% of the water use. The notable water management system successfully reduces 54% stormwater runoff and 61% of the total potable water consumption as compared to the baseline.

Radiant System

The Headquarters extension uses a floor based radiant heating and cooling system for over 75% of the conditioned floor area. The radiant system uses embedded surface systems comprised of radiant topping slabs.

Two air source heat recovery heat pumps with supplemental condensing boilers deliver the hot and chilled water to the radiant systems and trickle vents (when necessary). During unoccupied hours, a water-to-water heat pump recovers heat from building exhaust, feeding radiant floor and trickle vents.

STATE OF CALIFORNIA ENERGY COMMISSION

nbi new buildings institute

CBE CENTER FOR THE BUILT ENVIRONMENT

Team/Owner Details

Owner: Reliable Controls Corporation

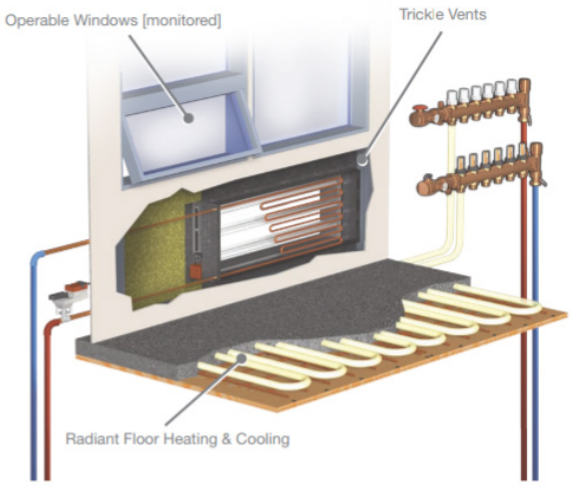
Architect: D'ambrosio Architecture + Urbanism

Structural Engineer: Read Jones Christoffersen Consulting Engineers

MEP Engineering: Integral Group, Avalon Energy Management

Landscape Architect: Murdoch de Greeff, Inc.

General Contractor: Campbell Construction Ltd.



Radiant slab for heating and cooling.
Photo: Reliable Controls

Ventilation - Supplemental Cooling

The building relies on passive ventilation and cooling through 57 trickle vents in the envelope, eliminating the need for a central forced air system. A Building Automation System (BAS) controls the modulating damper and heat/cool coils for each trickle vent. CO_2 based demand controlled ventilation is integrated with automated windows to enhance the ventilation performance of the system.

A wind tower drives summertime natural ventilation with modulating dampers that control louvers according to wind direction and intensity. In winter months, the ventilation air is drawn into the building by an extraction fan with heat recovery.

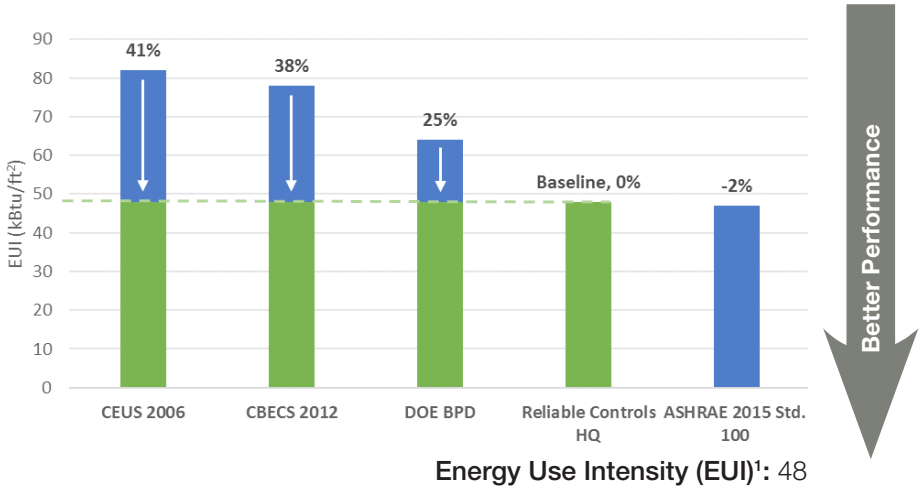
Trickle vents for passive ventilation.
Photo: Reliable Controls

"People should expect more of the built environment, both from an energy and environmental point of view, but also aesthetically."

–Franc D'Ambrosio, Architect

Building Energy Use

The Reliable Controls Headquarters has a whole building site Energy Use Intensity (EUI)[1] of 48 kBtu/ft^2. This low-energy use is 25-41% less than the average office EUI performance of the national CBECS[2] dataset, the California CEUS[3] dataset and offices in the same climate zone within the Building Performance Dataset (BPD)[4], as seen below. While those datasets include a mix of construction ages, the Headquarters' energy use is also on par with ASHRAE's best-practice energy efficiency standard 100 EUI target for this building type and climate zone.

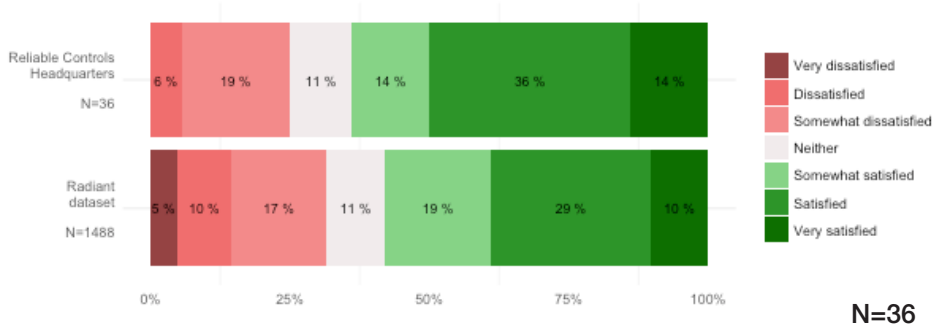


Energy Use Intensity (EUI)[1]: 48

Percent difference of office energy use intensity benchmarks compared to the Reliable Controls Headquarters measured performance.

Thermal Comfort Feedback

Overall, the thermal comfort of the occupants in the Reliable Controls Headquarters is relatively high as compared to the other radiant buildings in the studied dataset. 64% of the occupants reported that they were satisfied, 11% reported that they were neither satisfied nor dissatisfied and 25% reported that they were dissatisfied. For additional comparison, the average size of the satisfied group for all buildings surveyed by the Center for the Built Environment (CBE) is 40%.



N=36

Occupant thermal comfort feedback for the Reliable Controls Headquarters.

"The Reliable Controls Headquarters Annex is a demonstration of our collective commitment to sustainability and resilience, and effectively demonstrates leadership in our own field, showing we can work together to implement a reality that minimizes pollution, waste, and provides a lasting benefit to our community."

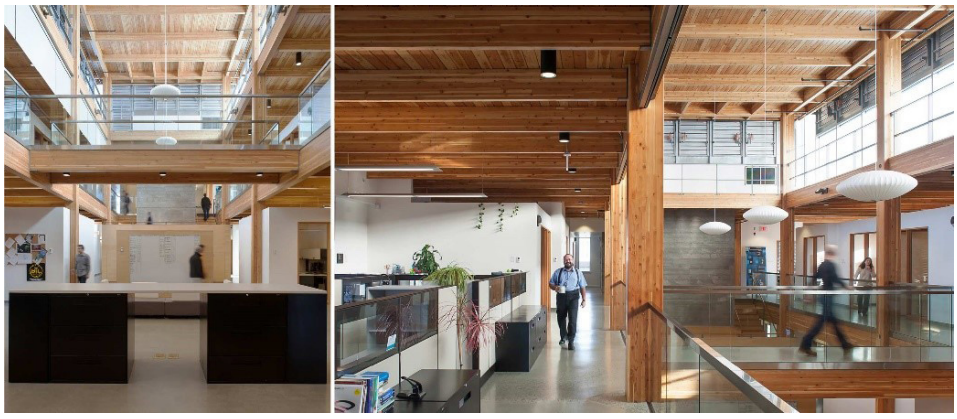
–Tom Zaban, EVP Sales & Marketing, Reliable Controls

[1] Energy Use Intensity (EUI) is a common metric to measure energy consumption in kBtu/square foot/year
[2] U.S. Energy Information Agency Commercial Buildings Energy Consumption Survey (CBECS)
[3] California Commercial Energy Use Survey (CEUS) 2006 http://www.energy.ca.gov/ceus/
[4] U.S. Department of Energy Building Performance Dataset (BPD)

Additional Efficiency Strategies and Features

Daylighting and Advanced Controls

The Headquarters extension enables 76% of the office spaces to receive daylight during occupied hours. Building Automation Controls integrate the HVAC, lighting, internal shading and security systems, allowing maximum occupant control. Individual access to the fully integrated controls is provided via LAN or wireless access from a computer or mobile device.



Daylit interior spaces.
Photo: D'Ambrosio Architecture + Urbanism

Role of Radiant in High Performance

Although a radiant system is not the sole driver of good energy performance, it can be an important part of an integrated approach from design and technology selection through to occupancy and operations. In California, low energy outcomes rely on strategies to address the HVAC system, which represents the highest proportion of commercial building energy use (32%).

This research found the majority of the study set buildings (96%) were pursuing high levels of LEED certification, where reduced energy is a requirement. This mirrors the findings in the largest database of ZNE buildings, where more than half of ZNE buildings in North America use a radiant system[5], and in a survey of 29 advanced ZNE and near ZNE buildings in California, where 11 include radiant systems[6]. The Reliable Controls Headquarters energy use is exemplary and the radiant system is part of the integrated approach that achieved that performance.

This case study is part of a project focused on energy and occupant factors within the larger study Optimizing Radiant Systems for Energy Efficiency and Comfort. Additional case studies and the full research findings on energy use and occupant perceptions of the indoor environment will be available in Fall 2017 at cbe.berkeley.edu/research/optimizing-radiant-systems.htm and at newbuildings.org. The larger study will include design optimization, cost assessment and savings opportunities and will be available on the CEC EPIC site in 2018 at energy.ca.gov/research/new_reports.html.

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[5] New Buildings Institute Getting to Zero Database http://newbuildings.org/resource/getting-to-zero-database/
[6] TRC and PG&E, ACEEE 2016 http://aceee.org/files/proceedings/2016/data/papers/3_636.pdf