

# VRF Zoning: A Flexible, Energy-Efficient HVAC System for Schools and Universities



White Paper

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A proven HVAC technology worldwide, **Variable Refrigerant Flow (VRF)** zoning systems are poised for dramatic growth in all areas of commercial construction because they provide precise zoned control that can contribute toward the achievement of LEED® certifications. This paper describes the major features and benefits of VRF zoning systems and how they are flexible, energy-efficient HVAC solutions ideally suited for elementary and secondary schools as well as college and university buildings and residence halls. Finally, this paper outlines how VRF zoning systems can help education buildings garner a substantial number of LEED points.



**Burlingham Hall, , Pacific University,  
Forest Grove, Ore., LEED Gold**

## VRF ZONING SYSTEM FEATURES

VRF zoning is a method of providing precise comfort control to buildings with multiple floors and areas by moving refrigerant through piping to the zone to be cooled or heated. Regardless of time of day, sun or shade, season of the year or special requirements, the systems provide personalized comfort to each room or space. The systems, which can simultaneously cool some zones while heating others, have many features, including the following:

**Energy efficiency.** Because its Inverter compressor varies its motor rotation speed and capacity (the indoor units vary their capacity, too), the system precisely meets each zone's load. Power consumption is reduced because the system operates only at the levels needed to maintain a constant, comfortable indoor environment. In addition, certain indoor units have sensors that compare air and floor temperatures and adjust the output as needed to optimize comfort.

**Design and installation flexibility.** The compact air-source outdoor units and water-source units, indoor units and other components can be installed in tighter outdoor and indoor spaces because they require less piping and duct space. They generally include two refrigerant pipes with a non-polar, two-wire control connections equating to faster installations with fewer installers.

**Lighter weight.** VRF zoning systems are 31 percent lighter than chilled-water systems, so they are easier to handle and cost less to transport. Moreover, the load can be distributed across an existing structure or avoided by mounting the units on the ground.

**Lower life-cycle costs.** The total installed cost of a VRF zoning system is less than or equal to the total installed cost of most conventional systems. Also, maintenance is greatly reduced and requires no special trades to perform the simple functions of changing/cleaning filters and cleaning outdoor condensing units.

**Quiet operation.** The system's Inverter technology is inherently quiet because it ramps up and down to meet the needs of the space served, and its outdoor compressor is encased in sound-dampening insulation to further reduce noise. Likewise, the indoor unit is designed for quiet performance.

**Discreet indoor units.** A wide variety of indoor unit styles offer greater design flexibility. Styles include wall-mounted, floor-standing (concealed and exposed) and vertical concealed. Ceiling options include suspended, recessed and ceiling ducted.



## EXCLUSIVE BENEFITS FOR SCHOOLS AND UNIVERSITIES

Architects, engineers and education professionals say that VRF zoning systems are ideal HVAC solutions for schools and universities. Here's why:

### Fast Installation

"Given a tight budget, aggressive schedule and our primary focus on sustainability, the VRF zoning system was the perfect choice. It installed quickly, met renovation and new construction time crunches, such as [installation] during summer break." — Kurt Haapala, associate, Mahlum Architects, talking about the installation in Burlingham Hall, Pacific University, Forest Grove, Ore.



Harvey Mudd College, Claremont, Calif.

### Indoor Air Quality

"With virtually zero pollutants and reduced humidity, our indoor air quality is greatly improved — so improved that one student with serious asthma issues was finally able to attend classes in the building again." — Lawrence Kicak, manager, HVAC operations and refrigerant compliance, Emory University, Atlanta, Ga.

### Chiller Expansion Capability

"We were also impressed with the ability to use the system as a backup for our gas-fired boilers. Vermont has high electricity rates, and this backup helps us conserve energy costs." — Holly Mussatti, director of physical plant, Champlain College, Burlington, Vt.

### Sound Reduction

"Our teachers love the improved teaching environment. With the old [window] units, teachers could either shout and stay cool, or turn off the units to be heard in an oppressive classroom." — Hal Holmes, assistant superintendent, Jackson County Schools, Vancleave, Miss.

### Individual Controls

"In the course of the last four years, we have received rave reviews from students in each of the three dormitories. They all like the individual room controls." — Randy Scholnick, director of sales, Sirius Mechanical, talking about the installation at Harvey Mudd College, Claremont, Calif.



## LEED CERTIFICATION

U.S. colleges and universities are recognized as thought leaders on the forefront of important societal and scientific trends, so it is no surprise that they often are models for environmental stewardship. A report by the U.S. Green Building Council (USGBC) reveals that of all LEED-certified buildings, nearly 14 percent are on college campuses and that 3,430 higher education projects are registered or certified under the LEED family of rating systems.

For LEED certification, VRF zoning systems can contribute a great number of points in the Energy & Atmosphere (EA) and Indoor Environmental Quality (IEQ) categories for the following LEED ratings: New Construction and Major Renovations; Core and Shell Development; Existing Buildings; Schools (new and renovation); Retail (new and renovation); and Healthcare (new and renovation). For all LEED certifications, buildings can gain points for the following categories:



**Burlingham Hall, Pacific University, Forest Grove, Ore.,  
LEED Gold**

### ENERGY & ATMOSPHERE (EA)

#### **Prerequisite: Fundamental Commissioning of the Building Energy Systems**

A VRF zoning system meets this prerequisite because it has an integrated control system providing for testing, control and reporting.

#### **Prerequisite: Minimum Energy Performance**

VRF zoning technology provides the means to exceed ASHRAE Standard 90.1-1999, thus achieving the prerequisite for minimum energy performance.

#### **Credit: Optimize Energy Performance**

The VRF zoning system's inherent energy efficiency provides the ability to achieve high levels of energy savings above ASHRAE Standard 90.1. Inverter technology, heat recovery and zone controls provide the best opportunities for energy savings.

#### **Credit: Measurement and Verification**

VRF integrated controls and maintenance software provide the ability to monitor and report building-energy usage on an ongoing basis in order to meet this credit.

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## INDOOR ENVIRONMENTAL QUALITY (IEQ)

### Prerequisite: Minimum IAQ Performance

VRF zoning systems can meet this prerequisite (Sections 4 through 7 of ASHRAE Standard 62.1-2004) through indoor units with ventilation connections or integrated dedicated outside air systems.

### Credit: Outdoor Air Delivery Monitoring

Integrated controls for CO<sup>2</sup> monitoring can be incorporated into a VRF system. Likewise, certain indoor units utilize MERV 8 filtration to meet the credit's intent.

### Credit: Controllability of Systems — Thermal Comfort

VRF's zoning capability allows occupant control with wall-mounted remote controllers.

### Credit: Thermal Comfort — Design

VRF zoning systems and the building envelope must be designed to meet requirements of ASHRAE Standard 55-2004, Thermal Comfort Conditions for Human Occupancy.

### Credit: Thermal Comfort — Verification

When properly designed into a building, VRF zoning systems provide temperature and humidity control in accordance with ASHRAE 55-2004 guidelines.



**PQRV Units, Minnie Howard Middle School, Alexandria, Va.**

VRF technology offers the ability to capture a significant number of points toward LEED certification.

For more information about how VRF zoning systems can contribute to LEED certifications, visit the U.S. Green Building Council's website at [www.usgbc.org](http://www.usgbc.org).

## SCHOOLS IEQ

VRF zoning systems also can contribute to one specific Schools certification requirement and one specific credit.

### Prerequisite: Minimum Acoustic Environment

Many VRF zoning system indoor units have tested noise levels that fall at or below 45 dB(A) as specified.

VRF zoning systems are sustainable, cost-effective HVAC solutions that offer many benefits, including energy savings, increased comfort, design and installation flexibility, lower maintenance costs and quiet operation. As important,



**Gilbert Hall, Pacific University, Forest Grove, Ore., LEED Gold**

## **CASE STUDY: GILBERT HALL, PACIFIC UNIVERSITY, FOREST GROVE, ORE.**

Founded in 1849, Pacific University is listed annually by U.S. News & World Report as one of America's Best Colleges. Although the university has a small student body (just under 3,000), it is big on sustainable practices. In addition to sustainability research and curricula, Pacific University boasts a permaculture project, bike rental program and organic and local food options. But perhaps the university's most important sustainable project is its green campus master plan that includes five LEED-certified buildings.

Following the success of another VRF zoning system installation, Pacific University chose the same technology for Gilbert Hall, a new 60,000-plus square-foot student residence featuring 26 apartments and suites for 157 students. VRF zoning systems are ideal for student housing because they offer design flexibility while supporting varying cooling and heating demands, according to Brian Shea, project manager, American Heating, Inc., the HVAC contractor for the Gilbert Hall project.

"[VRF zoning] is a great option for today's buildings where there are more and more tight spaces," Shea said.

Energy Use Index (EUI) is a standard measure of a building's energy usage, comparing energy consumed by similar buildings in identical climates. Monitoring actual performance, Pacific University has calculated that Gilbert Hall achieved an EUI of 46 kbtu per square foot per year. The average EUI number for student housing projects in the Northwest United States is 80 kbtu per square foot per year — and unlike Gilbert Hall, most of these buildings do not have air conditioning. Interestingly, the other building on Pacific University's campus that features VRF zoning technology — Burlingham Hall — also has an EUI of 46 kbtu per square foot per year.

Pacific University officials are thrilled by the results. "Gilbert Hall is performing wonderfully," said Chuck Carpenter, the university's facilities engineer.

In addition to garnering a LEED Gold certification, the building also met the aggressive Architecture 2030 Challenge benchmark for energy efficiency. Gilbert Hall's outstanding energy performance has been replicated each year, despite record-breaking low temperatures the last few winters. Because of its Gilbert Hall experience, Pacific University hopes to make VRF zoning the benchmark HVAC technology for all new student housing projects.





## CASE STUDY: MINNIE HOWARD MIDDLE SCHOOL, ALEXANDRIA, VA.

Designed for ninth grade students, Minnie Howard Middle School is located in Alexandria, Va. In 2008, Alexandria City Public Schools (ACPS) hired Hayes Large Architects LLP and B2E Consulting Engineers, both of Leesburg, Va., to help turn the 50-plus-year-old Minnie Howard campus into a laboratory for testing green building technologies that could be implemented system-wide.

Hayes Large and B2E devised an innovative package of technologies to create one of the most energy-efficient schools in the country. The technologies included a creative combination of solar and ground-source geothermal energy to significantly lower cooling and heating costs, a water-source VRF zoning system to simultaneously cool and heat the building, water-source heat pumps, solar-heat exchangers, ultra-low-flow plumbing fixtures and tubular skylights to bring natural light to classrooms, corridors and bathrooms.



**Minnie Howard Middle School, Alexandria, Va.**

Forty-two solar collector panels were placed on the school's front to provide water heating and to serve as a sun shade, reducing glare and cooling costs. For the new geothermal system, 60 wells were drilled 300 feet beneath the school's parking lot.

Shapiro & Duncan, Inc., Rockville, Md., installed the six VRF zoning units located next to the backup boilers, the solar heat exchanger and the makeup outside air unit. Shapiro & Duncan also set up the complex plumbing network that connected the 8,000 feet of piping that joined the geothermal closed-loop water system to the six VRF zoning units.

"The installation was hassle free and the system started up the very first time with no glitches," said Chris Ott, project manager, Shapiro & Duncan. "When you consider there are 8,000 feet of piping, that's amazing."

In the end, the VRF zoning system outperformed expectations. "The Minnie Howard system stands in a league of its own," said Ott. "The school went from an antiquated chiller that was keeping water at 40 degrees and two huge inefficient boilers maintaining 180-degree water all the time — even if it wasn't needed — to a variable-speed condensing unit coupled to a geothermal well system that only runs if an indoor air handler needs cooling or heating. Add to this the ability to cool and heat simultaneously and to zone with multiple condensing units — another energy-saving milestone."

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