



## CASE STUDY

### Government

#### Facility at a glance

##### Name

Sunset Drive Office Building

##### Location

Olathe, KS USA

##### Facility size

450,000 ft<sup>2</sup> expansion to 950,000 ft<sup>2</sup> facility

##### Issue

Design to have the smallest possible negative impact on the environment—and the largest possible positive impact on users

##### Solution

(2) Daikin Magnitude<sup>®</sup> magnetic bearing chillers

*Sunset Drive Office Building—home to Johnson County administration offices—was awarded a Gold Certification in the LEED-New Construction (NC) Version 2.1 program.*

## Johnson County Office Building Saves 57% on Energy Costs with Daikin Magnitude Chillers, Earns LEED Gold

The Sunset Drive Office Building in Olathe, Kansas, was designed from the beginning to have the smallest possible negative impact on the environment—and the largest possible positive impact on everyone who uses the building. In 2006, the building received Gold certification using the LEED<sup>®</sup>-New Construction (NC) Version 2.1 program from the U.S. Green Building Council (USGBC)—a recognition that both goals have been achieved. The LEED (Leadership in Energy and Environmental Design) Green Building Rating system is a third-party verification system and guideline for measuring what constitutes a green building.

Two Daikin Magnitude centrifugal compressor chillers played a major role in achieving these goals. Because of their innovative design, the chillers help to save energy and the environment and earn significant LEED points. “The chillers gave us the efficiency we needed to achieve the project goals,” said Katrina Gerber, engineer with BGR Consulting Engineers, Kansas City.

### Design-build for quality

The county’s Deputy Facilities Manager, Neal Angrisano, AIA, was one of the individuals that led the Sunset Drive Building project from its beginning and continues to monitor the building’s performance. He says the team’s decision to employ a design-build strategy rather than the more common design-bid-build approach was essential to achieving the goals of environmental responsibility and high building value. “We conducted a best-value competition—not a lowest-price competition,” said Angrisano. “That meant a lot of upfront work on the part of our team to define what we wanted. But that was appropriate because [Johnson County] wants the best quality. Design-build and other non-traditional delivery approaches are the only way we have to make the builder’s qualifications part of the process—otherwise it’s only about price. To have environmental responsibility you have to have the right builder.”

## Public outreach and public education

The building was designed from its inception to achieve LEED-NC Gold certification (it received a total of 43 points; see sidebar on the LEED program). According to Angrisano, the design team decided not to aim for the highest LEED-NC certification level—Platinum—in part because the community might not be ready to accept the additional front-end cost. “In discussions with our senior staff and elected officials, we collectively agreed to go for Gold. That was based on an initial cost-benefit analysis. LEED-NC Gold was seen as a saleable return on investment. We decided to do the first step very, very well. Now, the general acclaim we’ve achieved with this building makes it look like a prudent first step. That provides momentum to strive for even higher levels as we move forward with other building projects in the county.”

Public education is another part of Johnson County’s plan. The Sunset Drive Building has been designed as an object lesson in environmental stewardship—beginning with first impressions. Landscaping features indigenous plant materials. Inside the building, the visitor first encounters a prominent LEED-NC Gold medallion—and a large, stainless steel rainwater collection tank. “A lot of effort has gone into the public relations side—brochures, signage, and many, many tours. Someone showing up to pay taxes or a wastewater bill will probably also get 15 seconds of education on the design of the building,” said Angrisano.



*The Sunset Drive Building has been designed as an object lesson in environmental stewardship.*

## Saving energy with “mag-lev” chiller technology

From the point of view of residents and county officials, the most obvious way to measure the payback in a “green” building is in good old dollars and cents. Angrisano says the Sunset Drive Building was designed to save about 40 percent in energy costs compared to the baseline defined in ASHRAE 90.1, the nationally accepted baseline standard on energy performance. “We’re tracking energy use very closely,” he said. “Over the six months from May to October, 2006, the Sunset Drive Building has saved 57 percent on energy costs compared with the 15-year-old building across the street, which is also owned by the county. That building is typical of those constructed to the 90.1-standard. We’re also comparing the Sunset Drive Building with another county building a few miles away, which is newer and more energy efficient than the one across the street. Compared to the newer building, the Sunset Drive Building has saved about 43 percent in energy costs over the same six months.”

A major factor in achieving those impressive energy savings is the design of the air conditioning system. The Sunset Drive Building was awarded eight LEED points in the Energy and Atmosphere category, which is directly impacted by the energy efficiency of the HVAC system. The heart of the building’s air conditioning system is a pair of Daikin Magnitude centrifugal compressor chillers. Compared with other chillers, Magnitude chillers consume minimal electricity. When running at partial load, Magnitude chillers may consume as little as 0.20 kW/ton of cooling capacity—the most efficient performance of all available chillers in their tonnage range. And at full-load, Magnitude chillers are about ten percent more efficient than typical screw compressor chillers.

It is this ability to run at extremely high efficiencies at part-load that led the design team to specify the Magnitude centrifugal chillers in the first place. That resulting efficiency translates directly into savings on energy consumption.

The Daikin Magnitude compressor chiller uses HFC-134a refrigerant, which has no ozone depletion potential and no phase-out schedule.

The key to the chiller’s efficiency is the compressor’s digitally-controlled magnetic bearing system, which replaces conventional lubricated bearings. When in use, the only moving part in the chiller—its drive shaft—is suspended in mid-air by a system of permanent magnets and electromagnets. Positioning signals received by the electromagnets hold the shaft precisely in position within a tolerance of 0.00005 inches. Shaft position is sampled and adjusted 10,000 times each second.



## Magnitude Technology Benefits

The Magnitude technology, which has previously been proven in aerospace applications, provides many additional benefits:

- Vibration and noise associated with other types of chillers are virtually eliminated. “You can have a normal-voice conversation right next to the chillers when they start up,” said Angrisano. That’s because the compressor rotor and impeller shaft “float” on the magnetic cushion, virtually eliminating vibration and the metal-to-metal contact noise of conventional bearings.
- Most hermetically sealed compressors use induction motors with copper windings that form electromagnets. The windings are bulky, adding size and weight to the compressor. Furthermore, considerable current is needed to magnetize the electromagnets each time the motor is started. Because Magnitude chillers require less power, they can be built with permanent-magnet motors that require zero extra current at startup. As a result, the compressor in a Magnitude chiller uses about five amps to start, compared with 500 – 600 amps for a typical screw compressor with an electromagnet-driven motor

The impeller is only a few inches in diameter and operates at speeds up to 30,000 rpm, compared with low-speed impellers (typically around 3,600 rpm) with 2- to 3-foot diameter impellers. This means Magnitude chiller units are much more compact, take up less floor space, and can be delivered through a standard 3-foot door.

No oil is needed to lubricate the bearings so there are no oil pumps, filters, coolers, or heaters—and there is no need to dispose of used oil. Only a small amount of oil is used to lubricate other system components, such as seals and valves. All of this saves on maintenance and reduces the chiller’s weight and the space needed to house it.

## Under-floor Air Distribution System

The cold water produced by the chillers is fed to four air handlers. In turn, the air handlers supply a building-wide under-floor air distribution system, which delivers conditioned air through diffusers in a plenum formed by the raised floor and the concrete slab. This produces a floor-to-ceiling air flow that takes advantage of the natural buoyancy produced by heat sources in the office; even cooled air is eventually pushed up. As a result, air temperature in the space where people actually work—from the floor to a height of about six feet—is relatively uniform and pollutants are carried up and away from occupants. This not only helps improve indoor air quality, it also reduces energy demand.

## Energy-Saving Building Features

In addition to the HVAC system, many other building design features work together to reduce overall energy costs. They include:

- Narrow building footprint, oriented east-west to maximize sunlight intake
- Highly energy-efficient insulated exterior glass
- R-40 roof and R-30 walls
- Maximum use of glass—both exterior and interior—so lighting penetrates deep into building
- Automatic regulation of electric lighting to supplement daylight
- Reflective roof to minimize heat absorbency
- Light-colored concrete wherever possible in non-roofing exterior materials
- Highly efficient and innovative use of water, such as waterless urinals and re-use of grey water and rain water

## Green Design and LEED: Creating Synergies

The LEED® (Leadership in Energy and Environmental Design) Green Building Rating System is a voluntary standard, established by the U.S. Green Building Council in 1999, and widely recognized as a third-party verification system and guideline for measuring what constitutes a green building. LEED describes its goal as helping professionals across the country to improve the quality of buildings and their impact on the environment. Many federal and state government offices are strong supporters of the LEED program and require LEED certification where possible.

A LEED-certified building means it has achieved at least a minimum standard as judged in six categories: sustainable sites; water efficiency; energy and atmosphere; materials and resources; indoor environmental quality; and innovation and design process. Points are awarded in each category, depending on how the facility meets each category’s requirements. A building must receive a minimum of 26 points for LEED certification; up to 69 points are possible. There are four levels of LEED certification: Certified (26-32 points); Silver (33-38 points); Gold (39-51 points); and Platinum (52-69 points). The Johnson County building received 43 points.

Synergy is the key to accumulating the most points: understanding how each system affects the others and where to get the most trade-off between credits. For example, decreasing the indoor lighting required in a space (by adding more natural daylight) helps reduce the size and operating cost of the air-conditioning system required. Less lighting means less heat gain, which means less energy is required to cool the space. The Energy and Atmosphere category—one third of potential LEED points—is directly impacted by the HVAC system. This includes the amount of energy the HVAC system consumes, the environmental impact of generating that energy, and the refrigerant used in the equipment. Once a building has met three prerequisites (for fundamental building systems commissioning, minimum energy performance and fundamental refrigerant management), LEED-New Construction provides up to 10 points for the percentage of energy cost savings beyond the minimum required in the prerequisite. A computer simulation model or energy analyzing software can help assess the energy performance of a building’s design and identify the most cost-effective energy efficiency measures.



## Occupants Benefit by Improved IEQ

In addition to saving energy, Angrisano is confident that the many innovations in the Sunset Drive Building have a beneficial impact on workers—a factor recognized in the LEED-NC program. Fifteen of the possible 69 points that can be awarded to a building are in a category called Indoor Environmental Quality. The Sunset Drive Building received 10 points in that category—some due to the overall efficiency of the HVAC system and others for the resulting comfort afforded to each worker. “All you need is a one or two percent improvement on staff productivity, retention and reduction of sick time over four to five years to pay back the extra cost of the building,” said Angrisano. “This is one of the yet unsung realities within the discussion of sustainability. We can talk about saving money on gas and electricity, but these staffing issues are also very important.” That’s why Johnson County is doing research with the University of Kansas Architecture Department to quantify the reduction in sick-time and increases in worker retention and satisfaction.

## Quality for the Long Haul

When asked what he wishes more people understood about “green” building, Angrisano said, “I hope people will understand that we’re designing for the long term. One of the most harmful things is designing and constructing buildings for the short term. The last thing you want to do is end up with the building itself in a landfill in 40 years because it has outlived its usefulness or become too expensive to operate. Looking only at initial cost is a mistake. Designing for the long term is the way to be good stewards of taxpayer’s money and has put the Sunset Drive Office Building on the rise in terms of environmental stewardship and energy efficiency.”

For more information about the LEED certification program see [www.usgbc.org](http://www.usgbc.org). For specific information on LEED and its impact on HVAC systems, visit the GreenWay™ Resource Center at [www.DaikinApplied.com](http://www.DaikinApplied.com).