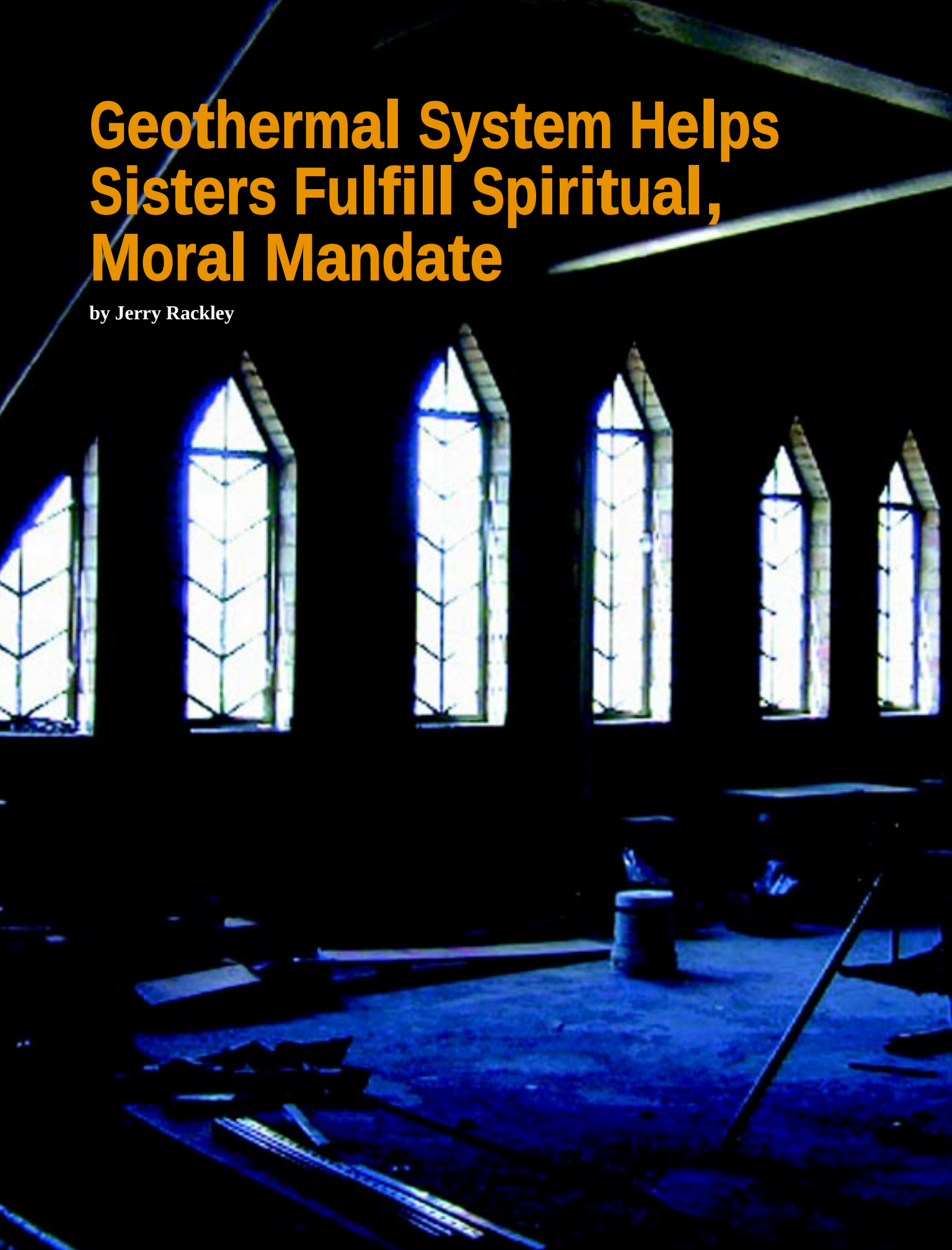
Geothermal System Helps Sisters Fulfill Spiritual, Moral Mandate

by Jerry Rackley



Cover Story

Since 1845, the Sisters, Servants of the Immaculate Heart of Mary (IHM Sisters) have been educating people. When the order was founded 158 years ago, its goal was to educate girls. Today the IHM sisters are educating the world about sustainability and the philosophy of green design by installing a geothermal heating and cooling system in their renovated Motherhouse. Although the system came online this year, its installation was set in motion about a decade ago when the Sisters decided to become advocates of the environment and educate others about environmental issues.

Photo courtesy of Denyse Burkhart

IMC Motherhouse is home to retired nuns. The sisters decided on a geothermal unit as a part of their home's renovation.

The IHM Motherhouse, located on a 280-acre campus in Monroe, Michigan, is a home for retired sisters. Originally built in 1932, the classic art deco structure contained 376,000 square feet of space. A few years ago, with the building showing signs of its age and having antiquated systems that weren't functioning, the sisters had to make a decision about their 70-year old home - should it be replaced or renovated? In keeping with their calling to educate, the sisters decided that a renovation would showcase the wise and appropriate use of resources, not the depletion of them.

A Vision for Geothermal

"We wanted to teach through this project that you could renovate in a sustainable way," said Danielle Conroyd, IHM Project Director for the Monroe Campus, Long Range Master Plan. "The World Commission on the Environment defines sustainability this way: 'meeting the needs of the present generation without compromising the ability of future generations to meet their own needs.' This concept guided our renovation effort. For us, it's not just about green design. It's a spiritually based vision expressing the right of all creation to thrive and flourish. We're learning how to say that we're not the center of the planet, that our demand should not outstrip the ability of the earth to sustain life. We see this as a spiritual and moral mandate." Geothermal heating and cooling is a technology that reduces dependence on non-renewable resources and thus is a major component of the green design philosophy. It was the desire to use renewable energy sources that led the sisters to choose this type of system for the renovation project.

With this vision for renovating the Motherhouse, the sisters hired Susan Maxman & Partners architects as the design team to begin the transformation of the building. Heating and cooling the Motherhouse to meet the needs of the residents, whose median age is 84, was a high priority. H.F. Lenz Company, a member of the architect's design team, was responsible for the engi-

Photo courtesy of Denyse Burkhart

Ariel photo shows magnitude of this geothermal undertaking.

neering and design work. Very soon afterwards, the sisters hired the Christman Company to manage construction. "We expected a lot of revisiting of decisions, and recommitting to the decisions made in support of our vision," stated Conroyd. "Inevitably, unanticipated conditions are encountered, causing 'rethinking' of some decisions, so we hired the construction manager during the design phase of the project so this firm could be part of the decision-making process as well."

Project Challenges

H.F. Lenz Company project engineer Bill Devlin designed the geothermal system for the Motherhouse. "Since this was a very old building, it was very difficult to get a balanced heating load throughout," stated Bill Devlin, Project Engineer with H.F. Lenz Company. The reason for this was primarily the age of the residents. "It is a heating-dominated building, harder to heat than cool." The challenge of integrating a state-of-the-art geothermal system with a 70-year old building created resolve for the team to do the job well. "When technologies get misused, the solutions get a bad rap," said Lynn Rogien, Project Manager for the Christman Company. "But when used smartly and correctly, they work well and people realize they can save a lot of money."

Devlin designed the heating and air-conditioning system within the Motherhouse, the geothermal system on the campus grounds, and the central plant that tied the two together. Construction began in Spring 2002. The central plant utilizes a 450-ton high-efficiency centrifugal chiller by Trane. Inside the Motherhouse, 466 fan coil units, over 10 miles of pipe and almost 6 miles of ductwork help heat and cool the interior. Outside the Motherhouse is the geothermal field - a system that includes 47 miles of piping and 232 bore holes each 450 feet deep.

Devlin and the entire project team overcame a number of problems presented by the age of the building. "This building is old and considered historical, which presented many challenges. Locating air-handling systems, getting outside air into the building, figuring out duct and pipe distribution were huge challenges. The building was never set up for this. It is a completely concrete structure, with concrete beams that didn't line

up floor-to-floor, so getting a vertical shaft through the building was very challenging." The solution was to do most of the work in the attic of the building.

The team overcame other challenges within the building as well. The design called for keeping the central plant within the confines of the building. "We went into a very limited space and worked around existing conditions to put in a chiller and boiler plant. This called for hiding the piping and masking the noise," continued Devlin.

Installing the Geothermal Field

On the outside, the Middleton Corporation and Jackson & Sons Drilling Company had the subcontract to install the turnkey geothermal field specified in the design. A "turnkey" field means the entire field up to and into the building: drilling of vertical bore holes, piping and grouting these holes, "headering" up (putting a manifold on the specified number of holes to make a circuit) the vertical bore holes and the installation of a pre-cast concrete vault where all field piping went into a secondary manifold. Each circuit was put on an isolation valve in the vault, allowing them to shut off a circuit without having to shut off the entire field. By having this vault outside, it saved space in the mechanical room. From this vault, two 12-inch lines ran about 700 feet to the building mechanical room.

During the installation of the geothermal field the greatest challenge of the project was encountered, specifically in drilling the holes. Drilling began in early April 2002. A test drill revealed a layer of loose rock strata existed between approximately 100 and 220 feet below the surface. "The formation into which we drilled was hard, fractured limestone, fairly near the surface," said Greg Wells, Geothermal Sales Engineer with Jackson & Sons Drilling and Certified Geoexchange Designer. "The rock was very fractured and in these fractures there was groundwater."

The Sisters went beyond their heating and cooling needs in their successful attempt to have a green renovation. They reused and recycled numerous materials either in their renovated facility or by donating them to local charities and recycling facilities. They also installed water conserving and energy efficient systems throughout the building. The land surrounding the facility was also considered as part of the renovation. They are working to reestablish the native trees into the landscape by planting native trees as non-native trees die.

The materials they reused from their existing building and landscape were:

- Approximately 800 wood windows, 500 cherry wood doors and millwork
- 100+ period light fixtures retrofitted
- Marble pieces reused for countertops on cabinetry and windowsills
- Topsoil removed during construction was reused in the landscaping

The materials they donated to local charities or recycling facilities were:

- 45, 260 sq. ft. carpet
- Sinks, toilets, wiring, and duct work
- Radiators and cabinets
- 50% of plaster used by local paving company
- Over 30% of construction debris

Green products used during construction were:

- Drywall material-made from recycled paper content and gypsum
- Trex,™-made from recycled wood and plastic was used for the outside veranda
- Floor coverings-made from linoleum and cork, which are rapidly renewing materials
- Benjamin Moore's Eco-Spec™ paint-low volatile organic compounds, such as this paint do not release many pollutants

Water conservation:

- 30% reduction in fresh water consumption
- 55% overall reduction in water consumption
- A greywater system was installed for use in toilets
- 7,270 gal/day of water is diverted to the constructed wetlands to be filtered for use in the greywater system instead of the city water treatment plant

The drilling was done using air-rotary technology - an air hammer with a 6-inch bit. As the hammer was run, air was injected into the hole to bring debris to the surface. The result was thousands of gallons of groundwater per minute coming out of the holes being drilled, which totaled nearly a million gallons per day. To deal with the displaced water, Jackson & Sons Drilling dug containment ponds to store the water, allowing the sediment to settle out before pumping it into the local storm sewer system.

The volume of water was not the only drilling challenge encountered. The fractures in the rock were so large, that in some instances the air pressure from the drilling process pushed groundwater into previously drilled adjacent holes and pushed the pipe in these holes right out of the ground. For Greg Wells and his crew, it was an exasperating process. "Prior to the start of the project, estimates were that it would take nine to 10 hours to drill holes to a depth of 450 feet. In reality, it took as long as 18 hours to complete a hole. At one point, we had four or five drilling rigs being run at one time. So much air was being injected into the formation as a result of all this drilling, that the formation became unstable and cave-ins were common. It was costly and time consuming."

Photo courtesy of Denyse Burkhart

Men from Jackson & Sons Drilling Company work hard to complete the drilling.

Many holes were drilled multiple times, and drilling conditions were almost impossible. During the insertion of the pipe, even after successfully drilling a hole, cave-ins would occur, making it necessary to re-drill the hole. The Jackson & Sons Drilling team ultimately decided to pull half the drilling equipment off of the site, because it was doing more harm than good. Working overtime and on weekends, the job was completed on time in late September 2002. "The drilling conditions were very tough," said John Turley, President of the Middleton Corporation. "Completing the drilling on this project was a heroic effort."

The drilling of the holes for the geothermal field taught the team that words have meaning when dealing with local regulatory bodies. Whether you call it a hole or a well does make a difference to government regulatory bodies, so the team was careful to always refer to what was being drilled as a "hole." "A well is for extracting water," explained Rogien. "To drill a well, you have to have a permit. This may seem like it is just semantics, but it is important. Code officials may not understand this distinction, so engineers need to take the time to educate them."

Once the holes had successfully been drilled, pipes were inserted - one to carry water down, and another to carry water back up, connected at the bottom with a "U." These pipes were then linked together via a 1.25-inch diameter flexible plastic piping system. A series of 10 holes and associated pipes were connected to a branch main, 2-inches in diameter to form one circuit, creating a total of 23 circuits in the geothermal field. If there is a leak or problem with any circuit, it can be shut down for repair without shutting the system down entirely.

With the geothermal field in place, Middleton Corporation made sure it was working properly. "We were responsible for the hydrostatic testing of the field," stated Turley. "This included flow testing of the field to ensure design flow rate through the field. We also flushed the system of air and filled it with water. In our seven

and a half years of doing geothermal projects, this is one of the largest we've done and certainly the largest system of its kind in the state of Michigan."

System Becomes Operational

The geothermal system at the Motherhouse was completed in December 2002 and became operational in January 2003. So far, this sustainable renovation project has won a Clean Air Excellence Award from the EPA and an award for leadership in sustainability from the Michigan American Institute of Architects. The system performed well during its first Michigan winter. Every sister has a thermostat in her room, letting her control temperature individually. The reliability of the system was recently tested during the power blackout that affected the Northeastern U.S. When the power went out, the geothermal system continued to function normally, running its pumps using a generator. It worked just like it was supposed to.

The approximate cost of the system was $1.7 million. "In most cases, the construction cost of a geothermal system is higher than a non-geothermal system," Rogien concluded. "But, if you can spend more money up front, your operating costs go down. Over the life of a building, you'll spend about 15 to 20 percent building a system and about 80 percent operating it. So the savings and payback are significant over the life of a building. The geothermal industry needs to get better at communicating these economics because they are to the industry's advantage. The reality is this: the person ultimately delivering this message to the owner is the designer or architect or engineer, and it doesn't matter if they are motivated by either sustainability or operating costs. It's not about making money verses improving the industry. You can do both."

Photo courtesy of Denyse Burkhart

The chiller is installed.

Today the Motherhouse is serving the educational purpose the sisters envisioned for its renovation. "The building is a metaphor for the whole way in which we need to live in relation to each other and to the planet," observed Conroyd. "We want to be as benign a presence as possible and value the gift. The sisters view the Motherhouse and where it sits as a gift. We want to make sure it is still viable for future generations."

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Jerry Rackley is a freelance technical writer based in Stillwater, Oklahoma.

System Vital Statistics

- 484 vertical fan coil units
- 232 bore holes, each 450 feet deep
- 47 miles of piping in geothermal field
- 24,539 fittings
- 2,159 valves
- 5.87 miles of duct
- 830 fire dampers
- 1,200 grills, registers and diffusers

Contributing Parties

- H.F. Lenz Company - Engineering
  www.hflenz.com.
- The Christman Company - Construction Manager
  www.christmanco.com
- GEM Industrial Inc. - Prime mechanical contractor
  www.rlcos.com/gem/index.html
- The Middleton Corporation - Geothermal subcontractor
- Jackson & Sons Drilling - Drilling subcontractor
  www.jacksongeothermal.com