Healthcare

Sherman Hospital Selects Advanced Geothermal System Design ***Case Study***

Integrated Plan, Individual Room Control

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An Illinois hospital took the big step of relocating and building an all-new facility with an efficient patient flow design and an advanced geothermal heating and cooling plant. The facility is pointing the way for future hospital designs, and already is being studied as an example of advanced designs for other healthcare facilities. The facilities director says, "In designing this building, we went to every department and asked for their ideas to make the new facility as efficient as possible. We were able to include most of those ideas in the design."

Replacement a Major Step

Replacing an existing hospital with a new facility at a new location is a daunting task. Often the route taken is to build one more addition to an existing facility. But that was not the path taken at Sherman Hospital in Elgin, Illinois. The existing community hospital building was in downtown Elgin, northwest of Chicago. That facility was originally built in 1918 and had been added onto a dozen times since then.

But the old facility still had insufficient space for the hospital's growing and changing needs. Its long history of additions led to facility inefficiencies. Compliance with building and hospital codes was lacking, and it did not meet all of the requirements of the Americans with Disabilities Act. Something needed to be done.

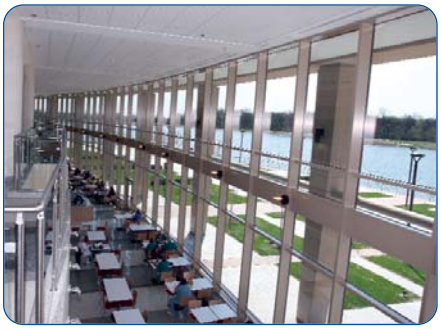
According to Ray Diehl, Director of Facilities for the hospital, the decision point was reached in 2004. "We were at the point where action was needed to move into the future." Diehl states that

At a Glance

- New Illinois hospital sets targets for energy and workflow efficiency.
- Massive geothermal system served by 15 acre site pond—largest in the nation.
- 18 Governair rooftop custom air handlers conserve interior space, improve efficiency.
- 540 individual room Mammoth® water-to-air heat pumps designed for corridor service access.
- 66 Mammoth water-to-water heat pumps condition fresh air.
- Heat wheels recover energy from building exhaust air.
- Integrated humidification provides building moisture level control.

Largest U.S. hospital geothermal installation lowers energy bill, improves comfort

The new Sherman hospital replaces an outdated facility. A 15 acre man-made pond serves as the heat sink/source for the geothermal heat pumps.



Sherman Hospital takes full advantage of natural lighting and features numerous advanced design elements for energy efficiency as well as optimized work flow.

Patient rooms maximize natural lighting and allow individual room comfort control.

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hospital's board and management, led by President and CEO Richard Floyd, had first considered a major facility overhaul to bring the existing building into compliance with all applicable codes and improve its operating efficiency. However at a cost of $450 million, and given that this would still not solve all of the needs for space, this option was rejected.

New Site in a Growth Area

The decision made in 2005 was to replace the existing 510,000 square foot facility with a new 645,000 square foot facility at a new location. The new site is northwest of central Elgin, near route I-90 and in an area of continuing residential and medical infrastructure growth. Ground was broken in June, 2006 and the building went into full operation in December, 2009. The building features a floor plan based on functional patient flow, and is designed to allow efficient expansion as needed. It has numerous design elements that promote both efficiency of patient case and reduced energy usage.

The project was completed under the stringent design and budget licensing constraints of Illinois' Department of Public Health. This is a major challenge for Illinois hospitals, because the facility plan must be reviewed and approved by the Department before construction begins, and from that point on, major design or budget changes are very difficult. Diehl says, "It required good planning and discipline to stay within the approved design and budget parameters."

Many Players Involved in Design

The hospital architect was Shepley Bulfinch Richardson & Abbott, Inc. of Boston, a recognized healthcare architectural firm. The local collaborating architect was Loebl Schlossman & Hackl of Chicago. Project engineering was done by KJWW Engineering Consultants, P.C. of Rock Island, Illinois. Also extensively involved in the system selection and design process was David Kahl, sales engineer with Midwest Applied Solutions, a CES Group® representative, of Hillside, Illinois. His firm provided many of the unit selections for the advanced HVAC system.

The new facility encompasses 255 patient rooms, all single beds, in a six-story tower. The balance of the hospital space is on three levels. As an example of the "functional flow" aspect of the design, the emergency room, critical care, day surgery and cardiac care patient rooms are all adjacent and on the same level, allowing easy and logical flow of patients, personnel and services.

Diehl notes that with constantly changing equipment and material costs, meeting the approved budget was a challenge, and required some adjustments to stay within the permitted figure. The final cost of the project was just under $325 million, of which $100 million was earmarked for hospital equipment and the balance for the site and structure itself. The project received a $1 million State of Illinois grant and a grant of $400,000 under the Clean Energy Act for its energy-efficient design.

Choosing the Geothermal Concept

An important feature of the project is its geothermal heat pump design. This concept was introduced by engineer KJWW, who recommended that hospital management visit Great River Medical Center in West Burlington, Iowa, to view such a system in use in a hospital environment. This facility has one of the lowest operating costs of any healthcare system in the U.S. It is believed that the HVAC system at that site saves over $1 million annually compared to a conventional plant. According to Diehl, the hospital board and management were impressed with the geothermal system and its potential to reliably provide building comfort at a operating cost far less than conventional systems.

Pond Supplies Heat Sink/Source

This solution was developed for the Sherman Hospital project, using an excavated 15 acre pond adjacent to the

hospital as a heat source/sink for the circulating fluid that serves the hospital heat pumps. The system is the largest hospital geothermal system in the U.S., and the pond is the largest heat exchange pond in the world. The system includes 171 submerged loops of one-inch high density polyethylene (HDPE) pipe. In total, the loops contain 152 miles of heat exchange pipe. The loops are supported on cribs on the bottom of the 18-foot deep flat-bottomed pond.

The working fluid for the system is an 80/20 solution of water and methyl alcohol, which is intended to prevent freezing if a loop is taken out of circulating service. Each of the 171 loops is independently valved in the impressive "manifold room." Here the loops empty into circulating fluid manifolds, which serve the building's heat pumps.

Individual Room Heat Pumps

Of the 255 patient rooms, 224 are served with individual water-to-air heat pumps that supply both heating and cooling. The heat pumps are vertical units and are located in an enclosure with access from the hallway outside the patient room. There units are Mammoth® Model N-Vintage and are typically ¾ ton (9,000 Btuh) capacity.

These units are designed for high efficiency operation and feature quick disconnects for circulating water, electrical and inlet and outlet air. In the event an individual unit requires service, it can be quickly changed out from the hallway without disturbing the patient. Each room has a ceiling supply diffuser and a return air inlet. The conditioned air supplied to each room is blended with ventilation air. In a clever design twist, the elevated unit enclosure creates space for a floor level half-closet in the patient room, suitable for linen storage and other purposes.

In addition to the heat pumps serving patient rooms, another 540 Mammoth model N-Vintage horizontal water-to-air units are located throughout the hospital and are located in ceiling spaces in corridors, nursing centers and other areas. The combined geothermal system provides more than 75% of the heating and cooling for the building. Although it is not the primary system for the emergency room and critical care areas, the heat pump system does provide reheat for the units that serve these areas. The hospital also has two large Johnston fire-tube boilers to provide steam for food service, domestic hot water, sterilizer supply and other purposes. These boilers can also provide supplementary steam for space heating.

Water-to-Water Units in Rooftop Air Handlers

Another major element of the hospital comfort system is 18 Governair® custom rooftop air handlers. According to David Harris from Governair, his firm is a true custom manufacturer. "We can design equipment to meet the customer's specific requirements both in capacity and unit configuration. Every component is carefully picked to meet or exceed the design criteria; this is not a modified standard package unit, it is truly a custom design."

These all-weather enclosures contain a total of 66 dual-compressor water-to-water Mammoth heat pumps rated at between 3 to 30 tons each. These units operate on the same circulating fluid as the water-to air units. Individual enclosures have two, four or six heat pumps. According to Harris, everything but the piping in the units was done at the factory. This includes air handlers, piping access and DDC controls. Additionally, 11 of the rooftop air handlers also house Innergy tech energy recovery wheels, which salvage heat from building exhaust streams and return it to incoming fresh air. The energy wheels are important contributors to overall building efficiency.

The Governair air handlers provide filtered, conditioned air to various administrative areas in the hospital, as well as providing conditioned ventilation air for the local heat pumps serving the rest of the building. The enclosure design emphasizes rugged construction and each unit is built to match the equipment it will house.

Individual room heat pumps are accessible for inspection or service through corridor enclosures, eliminating any disturbance of patient care.

66 Mammoth water-to-water heat pumps installed inside Governair rooftop air handlers that provide fresh air to the hospital.

Most of the mechanical plant equipment is housed within custom rooftop air handlers by Governair, thereby conserving interior space for hospital functions.

Governair air handlers encompass numerous mechanical plant functions such as energy recovery ventilation and Vapac® humidification as shown here.

Governair specializes in custom enclosures of this type, and the units were fabricated and assembled at the factory. The enclosures were then dissembled and shipped to the site, where they were reassembled on the rooftop. The architect and engineer recommended rooftop enclosures to isolate these operations from hospital functions, to improve maintenance access, and to conserve valuable hospital floor space for healthcare purposes.

According to Harris, engineers often prefer to use rooftops in place of in-building mechanical rooms for a couple of reasons. "Firstly, space. New hospitals often must house more medical equipment and interior space used for mechanical plant takes away from this. Secondly, having equipment on the roof allows units to be closer to the area they are serving, which holds down installation costs. Also, the equipment can be ordered and delivered later in the contract which spreads out the financial outlay."

Harris notes that the biggest challenge in designing these units was to get all the components and piping into a unit size that matched the supply and return air openings, which were pre-determined by the structural supports in the building. "We also had a very tight height restriction, which required us and the curb manufacturer to carefully design to make sure the ducting could be run from the units and curbs, missing all the structural cross members in the curb. We also had to write a sophisticated controls program for the heat pumps inside the unit to tie in with the building controls and pumps to make sure the whole unit was running at peak efficiency at all times."

Growing Trend Toward Geothermal

David Kahl from Midwest Applied Solutions indicates that there is a growing understanding of the benefits of using geothermal technology for buildings of all sizes. These benefits include significantly lower building energy costs. Although full-year operating data is not yet available, the similar system at Great River Medical Center is believed to operate at cost of over $1 million less annually than a conventional boiler-chiller system.

Illustration of common ground source applications where the heat sink/source is either the ground or pond.

Kahl notes, "This project is notable for its scale, and the completeness of the integration of the geothermal system from the earliest design stages. The engineer [KJWW] really understands the potential of geothermal systems." He notes that the Mammoth family of heat pumps is well adapted to this application because of its record of unit reliability, efficiency, and a wide range of models to meet many building needs.

Pond Offers Capacity for Growth

According to Diehl, the on-site pond provides an ample heat source/sink to allow for considerable future growth. "The pond has an HVAC capacity of 3,400 tons, and we currently are using 2,250 tons, so we have lots of room for expansion." In the event that one of the submerged loops requires service, air can be pumped into the fluid line, which causes the loop to rise to the surface for service access.

Comfort and Efficiency

The overall control of the building HVAC system control is accomplished with a building automation system. Because of the flexibility of the dedicated room heat pumps, each patient room is equipped with a thermostat that allows a control range of 65° to 75°F. Other hospital spaces are independently controlled to allow temperature levels appropriate to their usage.

According to Ray Diehl, data is still being accumulated on building operating costs, but he is already seeing savings in many areas. "For example, the monthly natural gas bills were significantly lower than in the old building, despite the fact that the new building is much larger. If the plant follows the example set by the Great River Medical Center in Iowa, the energy bills will be dramatically lower across the board." The new Sherman Hospital was achieved with four years of hard work, creative planning and attention to the needs of the patients and staff. It can serve as an efficiency model for many other facilities in the future.

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