



Advanced Energy Design Guide for Large Hospitals

**Achieving 50% Energy Savings
Toward a Net Zero Energy Building**



Developed by:
ASHRAE
The American Institute of Architects
Illuminating Engineering Society of North America
U.S. Green Building Council
U.S. Department of Energy

Kosair Children's Medical Center

Kosair Children's Medical Center is located in Louisville, KY, and was built as a satellite pediatric medical center for the existing downtown hospital. The facility was occupied in 2009 and was constructed to meet current hospital design standards. It is a 70,000 ft² building that includes a surgery department, emergency room, radiology area, laboratory, and central sterile and support spaces. The emergency and radiology departments are in constant operation.

Geothermal System

A project priority was to construct a sustainable facility with emphasis on minimizing energy consumption. A geothermal heat pump system was chosen to achieve this energy goal. It is the first healthcare facility in Kentucky to be 100% geothermal, utilizing all individual heat pump units for room temperature and humidity control. The heat pump units are generally located in mechanical rooms or penthouses to allow good service access. All heat pump units three tons and greater are provided with dual compressors piped to a single refrigerant circuit to improve part-load efficiency.

A dedicated outdoor air system (DOAS) is provided to supply conditioned outdoor air to all rooms. The unit has an integral heat recovery wheel and supplemental cooling/heating water coil to provide final tempering of the discharge air. Water-to-water geothermal heat pump chillers supply either chilled or hot water to the coil as dictated by outdoor air conditions. The air-distribution system includes constant-air-volume (CAV) boxes to deliver code-required outdoor airflow to all rooms. Time schedules are programmed so the outdoor airflow is reduced when areas are unoccupied.

The geothermal bore field supports 220 tons of installed HVAC equipment tonnage. The geothermal field is comprised of 84 vertical bores, each 400 ft deep. The bore field supply water temperature varies from the mid 80s in August to the mid 50s in February. A distributed water-pumping system recirculates the water between the geothermal bores and building heat pump units. Each heat pump unit has an individual water recirculating pump that runs only when its respective heat pump compressor is operating.

Heat pump units that serve patient treatment areas have prefilters and final filters to meet hospital air-filtration guidelines. Low pressure drop air filters were specified, and special attention was paid to duct layout to allow the heat pump fan to deliver proper room airflow.

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Kosair Children's Medical Center
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Energy Performance

The medical center is currently operating at 116 kBtu/ft² annually. To control energy consumption, heat pump systems offer several advantages over traditional healthcare HVAC systems. First, reheat energy waste, which occurs in all variable- and constant-volume air-handling systems is eliminated. The compressors only operate when room cooling or heating is necessary. Second, fan energy is reduced because system total static pressure is significantly lower than the standard healthcare VAV system. In addition, geothermal heat pump systems allow for distributed energy generation. Central steam boilers are eliminated along with the inefficiency of central steam production. Domestic hot water is generated via geothermal domestic water heaters. Central sterile equipment and HVAC humidifiers have point-of-use steam production. The exterior wall system is an insulated concrete form assembly.

Life-Cycle Costs

Energy performance of this facility, while great, must be balanced with the system first cost and maintenance costs. The healthcare organization that built this facility also built a full-service hospital a year earlier on the same campus. That facility used a traditional VAV system with central boilers and chillers. The geothermal heat pump system proved to be approximately the same cost to construct on a per-square-foot basis.

A walk-through of the building was performed with the maintenance staff. Since the staff services both facilities, they have experienced the time it takes to maintain each facility during the first two years of operation. The heat pump units have required only minimal service since installation, and the original concern over filter maintenance has proven unwarranted. The geothermal system has required extra time to retrain the staff, which would not have been required if a traditional system was installed. Integrating the heat pump factory controls into the healthcare systems direct digital controls has been more difficult than expected. A detailed analysis of maintenance requirements is warranted to provide factual data and a true comparison.



Example Patient Room Layouts
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