John W. North High School
Riverside, California

The John W. North High School 20-ton geoexchange, or ground source heat pump project, is located in the Riverside Unified School District, Riverside, California. The school is an existing high school where a major modernization project was undertaken in 2002. Some changes included updating the building to current fire, life and safety codes, replacing carpets, repainting walls, and upgrading the gym with new flooring and air conditioning.

During that time, the area where the metal and wood shops were located was renovated into a weight room and store for students. A four-pipe central plant served many of the existing core facilities while packaged equipment serves most of the outlying buildings.

The school district was very interested in implementing a GHP system as a test case in order to determine if the system was a viable alternative for any of the new construction projects in the preliminary planning phase. "Next to payroll, energy is our next highest operating expense," said Kevin Hauser, Assistant Director of Facilities. “We'd done all the easy stuff [related to energy efficiency] and wondered, ‘What else can we do?'"

For this endeavor, TMAD Engineers, the district’s engineering firm, focused on the existing building which housed the weight room and student store. The brick building is of masonry wall construction with a four-inch, un-insulated concrete roof. The original modernization plans called for a 25-ton package unit for the weight room and a 20-ton package unit for the student store. The high loads were attributed to the masonry construction, lack of insulation and fresh air demands.

Load calculations were performed with various insulation levels and it was determined that by adding R-19 insulation to the underside of the roof, the load could be reduced from 20 tons to approximately 10 tons for each room. This produced significant savings, both in equipment requirements and in base energy usage.

The next step was to have a soil conductivity test performed in order to determine the GSHP loop field requirements. A contractor was brought in to drill a 250-foot test bore and record the conductivity and diffusivity of the soils in the proposed loop field. With this data, specialized software (GCHPCALC) developed at the

SYSTEM SPECS

- Four 5-ton units, two for each room – 20 tons total
- Vertical closed loop field, located under the faculty parking lot, consists of 16 boreholes, each 360 feet deep
- Soil *k*-value of 0.77
- Heat pump units are controlled by the campus Siemens DDC system, staged for 5-ton capacity first stage operation and 10-ton second stage operation

University of Alabama was used to size the loop field. The final loop field arrangement consists of eighteen (18) 360-foot bores with the original 250-foot bore used as the safety factor.

The piping system consisted of high-density polyethylene (HDPE) piping below grade and type M copper piping above grade. A reverse return system was utilized to ease the balancing of the system and the loop field was separated into two zones with balancing valves.

The pumping arrangement consists of a base mount pump with a variable speed drive controlled by a differential pressure sensor. This arrangement allows the delivery of varying GPM to the heat pump units based on system operation. An enclosure was built around the pump to reduce the whining noise from the DC drive. Looking back, Hauser says the installation would have worked better had this been installed in the accessible, adjoining janitorial space.

There are four 5-ton water source heat pump units on the system, two for each room. The heat pump units are Trane high efficiency extended range water source heat pumps and the operating EER is estimated at 15.0, at the expected loop temperatures.

The campus Siemens DDC system controls the heat pump units, which are staged for the 5-ton capacity first stage operation and 10-ton second stage operation. This is typical for each room.

The variable speed pump provides the exact GPM requirement for each operating stage. The same operating sequence is used in both the heating and cooling modes.

This project was completed and was on-line in April 2003. The district has reached an agreement with University of California's Riverside Mechanical Engineering Department to monitor the system and measure energy usage and indoor comfort.

Riverside Unified School District will soon install monitoring equipment to determine exactly how much money and energy the system is saving. School staff has been extremely pleased with the installation's operation, and chances are good that it will use its bold vision to apply geoexchange for future school HVAC design as an example for other school districts, as well as public and private sectors to follow.

Project Participants

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