Geothermal THINK TANK Takes on the Extraordinary JOB

For the massive 235,000-sq-ft Merrimack County Nursing Home in New Hampshire, the geothermal source available nearby may not have been the fountain of youth, but it did prove key to the center's "uber-green" mechanical system retrofit. See how the companies involved brought together 16 wells, over 300 water-to-air heat pumps, and the rest of the 615-ton system to serve this 290-bed facility.

BY DAN VASTYAN

As a hedge against the certainty of increasing energy rates, managers of Merrimack County Nursing Home (MCNH), in Boscawen, NH, invested deeply in geothermal technology. Today, they and hundreds of residents there celebrate substantial savings and new levels of comfort and air quality.

It was back in 2005 when Hampstead, HN-based Water Energy Distributors, Inc. was hired as a subcontractor by the engineering firm, McFarland-Johnson, to design an all-geothermal mechanical system for MCNH. Work on the system — installed in several stages as the facility went through various construction phases — was just completed.

The 235,000-sq-ft facility has a staff of 425 and 290 beds with luxury accommodations for elderly residents. Merrimack's über-green mechanical system incorporates 16 standing column wells and 326 ClimateMaster water-to-air heat pumps for a total of 615 tons of capacity.

LOOKING BACK

Success of the project ties to early development of an energy-tapping technique developed by the founder of Water Energy Distributors. Carl Orio spearheaded development of the standing-column geo-exchange well almost 35 years ago. Today, the company he founded in 1981 is recognized as offering one of the highest efficiencies of any geo-exchange system.

Three years after Carl Orio incorporated Water Energy Systems, he brought his daughter Christina into the business as general manager. In 2000, she became president of the firm. All along, the focus has been the sale and design of sustainable, renewable energy systems.

So, as one generation encourages involvement of the next, mechanical challenges like this one benefit from decades-old vision and expertise and the latest technology.

NO JOB TOO BIG

"At MCNH, the first order of business was to closely study the area's hydrogeology to determine the best location for the well field. Water Energy was instrumental in determining optimal well spacing and number of wells within the identified area as being most suitable for geo-exchange," said Fred Mock, vice president of Binghamton, NY-based McFarland-Johnson.

"Based on the heat load, we recommended 16, 10-8-6 wells, each 1,500 ft deep," said Orio. The term "10-8-6" stands for a 10 in. casing sealed into the bedrock, an 8 in. rock bore, and a 6 in. sleeve and pump. Each submersible pump has a 10-hp motor to push water to the building's mechanical room and from there to all the heat pumps within the system.

FIGURE 1. The covered entry and courtyard at MCNH.

All 16 wells are located beneath the nursing home's parking lot. Split up into two well fields, eight wells are located under the upper parking lot, and eight below the lower, with the farthest well being 850 ft from point of entry into the building. Each eight-well field is piped to its own supply and return manifold. The caps are protected by manhole covers, and can be found in the green spaces between parking areas. Amherst, NH-based Skillings and Sons was the driller contracted for the MCNH job. The company had two of their four drilling rigs on the job, operated by five employees.

"Each well took us about six days to drill," said Roger Skillings, president. Drilling an 8 in. hole through 1,500 feet of solid granite is no small task; it was a blessing in disguise, though. According to Skillings, the number-one enemy of a healthy standing column well is soft rock that cracks, collapses, and caves in.

"The first thing we do at any job that is to include a standing column well, is to drill a test well," explained Skillings. "If the rock hardness, density, and the quality of the water are all desirable, that test well becomes the first well on the field." At this site, we found some of the best, mineral-free water we've ever seen, and the rock was also very stable." The average water temperature across all the wells was 52°F.

FIGURE 2. Standing column well manifolds for the geothermal system.

Four tips from Carl Orio for designing and installing a commercial standing column geothermal system

- All the deep well drillers in the Northeast have a second compressor on a trailer to back up the compressor on the drill rig. The truck-mounted compressor is sufficient to a depth of about 800 ft. Any deeper and one compressor just can't keep pace with high-yield wells.
- Handling of VFD systems can be tricky. Run lines for VFDs separately. Even though you may have numerous VFD lines side-by-side, they all have to be in separate conduit piping. All VFD manufacturers require shielded wire, and some even require running the lines through steel conduit.

  (Electronically speaking, VFDs create a very 'dirty' electronic signal. VFDs are actually capable of emitting signals in the AM radio range. You can drive through town with your car's radio set on a weak AM frequency and hear which house has an exercise bike or Stairmaster with a VFD. If the lines are run together, they can interfere with each other's signal.)
- Over the years, we've learned that when designing a geothermal system over 10 stories high, it's economically viable to use a primary and secondary well loop with an intermediate heat exchanger, instead of pumping well water all the way to the top. Some efficiency is lost with the intermediate heat exchanger, but somewhere between eight and 12 floors, that efficiency loss is justified by the money saved in system water pumping.
- The 10-8-6 standing column well is, for the most part, a special purpose well. Because of the higher installation cost, industrial systems that incorporate standing column wells generally utilize 8-6-4 wells, and residential systems always do.

  The 10-8-6 shines when ground space is limited. Various systems in New York City and several systems in Connecticut have used this Btu monster. Using the larger well cuts down on the number of wells needed. At MCNH, it would have taken five additional wells if 8-6-4s had been used. Not only would this have been too many wells to fit in the available green spaces of the parking lot, but it would have also required a third manifold.

FIGURE 3. The well manifold control room.

FIGURE 4. Open-air common room at MCNH.

SYSTEM DETAILS

"Each of the eight-well supply and return manifolds feed well water to a series of risers to the upper floors," explained Orio. "There are two of the big manifolds; each field feeds half of the building. We generally prefer to have no more than 10 wells, or 300 to 400 tons, on a given field. At MCNH, there's a nominal 310 tons on each field."

According to Orio, limiting the fields to 10 wells is for ease of balancing. The wellheads should be kept at the same elevation across the field. Since MCNH rests on a hill, the two fields are roughly five feet apart in elevation from each other.

As customary for all standing column well systems, no circulators are used; there aren't even any flow centers on the ClimateMaster units.

Pressure at the mechanical room supply manifolds are maintained by the VFD-controlled submersible pumps, which operate in parallel. Pressure in the manifold that serves the upper field is kept at 52 psi, and at 55 psi for the lower manifold, insuring 25 psi at the furthest, fourth floor heat pump. "You take the furthest well and the most distant heat pump, and that gives you the requirement for sizing the submersible pumps," said Orio.

PATHOGENIC PURITY

"Two key things come together when determining system head pressure," said Orio. "The design engineer determines the total dynamic head (TDH) in the building, and the geothermal engineer determines the TDH from the well to the manifold." Together, these provide the pressure drop to the highest heat pump in the building at peak flow.

Either three or four-ton ClimateMaster TS units with copper-nickel heat exchangers are suspended above drop-ceiling tiles. The majority of the units serve two bedroom areas. A big advantage in having many small units — as opposed to a large, central unit for each floor — is sanitation. With the smaller systems, air movement is limited to two rooms, greatly reducing the threat posed by airborne pathogens.

"I was skeptical at first," said Sid McDonald, director of facilities at MCNH. "The bugs got worked out the first year the system was in, and ever since then, it's has been phenomenal. I was really impressed with everyone involved and the technical solutions that were offered."

BTU GUSHER: A 'GEO DREAM'

According to Carl Orio, most standing column wells are designed to bleed off 10% of the water used. In the case of MCNH, the wells were designed to bleed off only 5% of the geo-exchange water. This was done to prevent water from overfilling the property's detention pond, which would then put it on a downhill course and into Merrimack River, requiring another, higher level of environmental permitting.

Yet aquifer flow under MCNH was much better than expected. The flow of water in the wells is so steady, easily maintaining design temp despite the influence of system geo-exchange, that there's no need even for a five percent bleed-off of water.

But it gets better. So rich and steady is the supply of waterborne Btu that, for eight or nine months of the year, only 10 of the 16 wells are used. So, just to keep things equal in the wells, BTUs are tapped from different wells on a rotating basis year-round.

"It's really amazing how well the system has worked out, almost like a dream," said Skillings. "By rotating wells, MCNH not only saves even more electric but conserves pump life and the aquifers as well." **ES**

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