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Real world hydronic system technology for Green Building design.

Penn Foundation

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Taco® Comfort Solutions™

A Taco Family Company

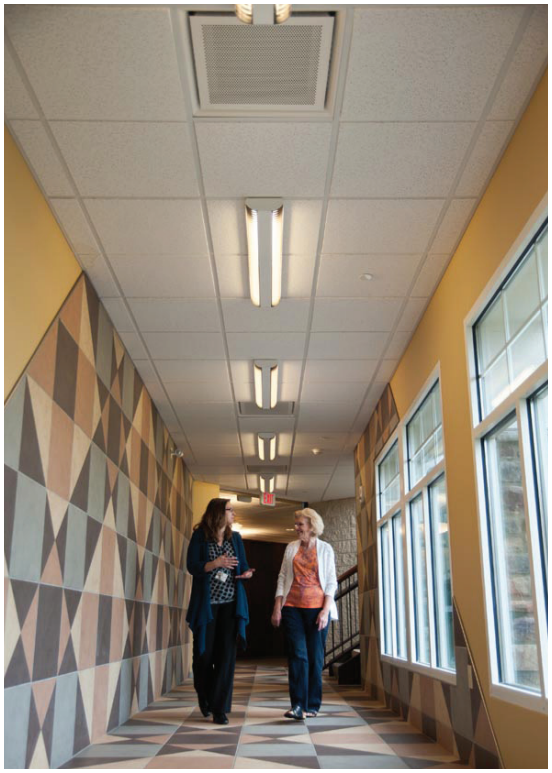
Penn Foundation —
Mental Health & Substance Abuse Recovery Facility

GEOTHERMAL PLUS TACO COMFORT SOLUTIONS TECHNOLOGY

When mechanical engineers and installers, architects and building owners have the rare luxury of designing a new facility specifically to meet or exceed energy efficiency and indoor comfort needs, big dreams become a reality. The key: smaller, smarter mechanical systems that wrench every last BTU from super-efficient ground-source heating and cooling systems.

"I don't know that you'll find a smarter, more efficient mechanical system than the one installed at the new Penn Foundation facility," said Glenn Snyder, PE of Lederach Associates Architects + Engineers. Snyder was one of several professionals who, in October of 2012, were literally living the dream as hundreds of mechanical components were brought together and connected by a modular control network to serve as the building's central nervous system.

The planning for the new 36,000 square foot, two story addition to the mental health and substance abuse recovery facility, located not far from Allentown, PA, began in 2004. Much of it existed only in the minds of several forward-thinking experts, but as the planning moved forward, the dream of an innovative mechanical system started to take shape. It wasn't until 2009 that the technology actually began to emerge to help bring such an innovative system into being.



"Geothermal systems were installed that harvest energy from the earth. But the real uniqueness of this job is the way BTUs are removed from or delivered to enclosed spaces," explained Greg Cunniff, application engineering manager for Cranston, RI-based Taco Comfort Solutions.

"Different water temperatures are readily available for a variety of terminal units throughout the facility from a single-pipe system because we're using new, off-the-shelf injection mixing blocks that blend supply and return water temperatures from the main," continued Cunniff.

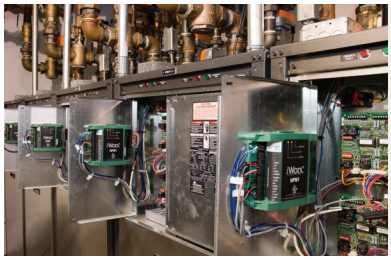
"Injection mixing provides the perfect balance of everything designers, installers and building owners most want," he added. "Their master list of essential needs included performance, efficiency, compact size, quiet operation, comfort and IAQ – an especially important facet for a health facility."

From underground to overhead Penn Foundation's freshly paved parking lot conceals 48 six-inch diameter bore holes containing one-inch diameter pipe. The holes are on 20 ft. centers and each circulate fluid to a depth of 300 feet. The wellfield uses Taco's KS series vertical in-line pumps to save space in the mechanical room.

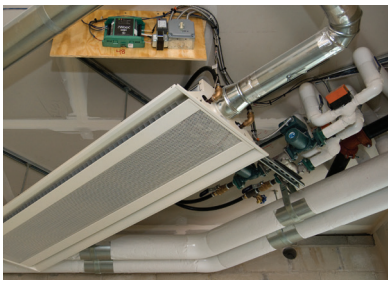
The bore holes provide ground-temperature water to five, 28-ton water-to-water geothermal heat pumps housed side by side in the main mechanical room. The units stage on and off, depending on current load requirements.

The big water-to-water units feed a total of 176 Semco chilled beams (88 zones), eight Carrier fan coil units to condition high-load interior spaces, and 10 water-to-air heat pumps to handle entry doors with high infiltration. A single-pipe distribution system tied to Taco's LOFlo® injection mixing blocks saves space, installation time, initial cost and long-term operating expense.

Taco's iWorX® control system carefully monitors room temperature, supply water temperature and ever-changing dew point, and circulators connected to the stainless steel mixing blocks. The new building automation system also controls circulation in the geothermal exchange field, water-to-water units, dedicated outdoor air system (DOAS) and all remote heat pumps.



The facility's fresh air is supplied through the chilled beams, via the DOAS, which in turn increases the capacity of the beams.



Active chilled beams use a combination of air supplied from the DOAS, and the air flow from natural convection, to either heat or cool a space.

Active chilled beam systems, like those installed by mechanical contractor IT Landes at the Penn Foundation, can approach 400 btuh/square-foot. In "passive" configurations, where only natural convection provides movement of air through the coil, capacity is closer to 150 btuh/square-foot.

" Coupling the LOFlo® distribution system with iWorX® controls and geothermal equipment provides the most energy efficient HVAC system available today"

— Greg Cunniff

"Coupling the LOFlo® distribution system with iWorX controls and geothermal equipment provides the most energy efficient HVAC system available today," said Cunniff.

Challenges solved

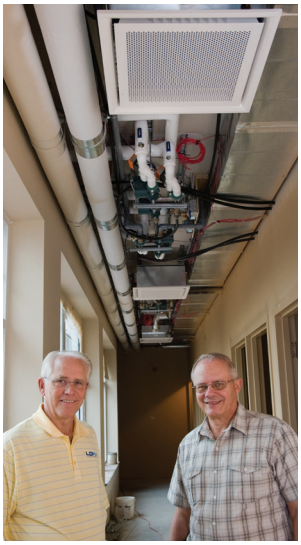
Since the project is an addition to the existing Penn Foundation facility, the design team wanted to match ceiling heights between the new and old portions of the building. But this limited space for mechanical components between the first and second floors.

According to Snyder, an all-air, ducted system was out of the question because of the space required for larger ducts. They also evaluated a conventional, four-pipe hydronic system centered on fan-coil units, but even that was too much for the restricted space.

"We offered the Taco single-pipe, LOFlo® system as an alternative," said Cunniff. "This reduced the number of pipes from four to two – one for heating, and one for cooling – and because of its low flow we can use a very large Delta-T which shrinks the size of the pipes needed."

The Penn Foundation facility addition uses a total of 98 LOFlo mixing blocks, 88 of which are coupled to chilled beams in the 1,000 to 6,000 BTU size range.

"When compared to a conventional chilled beam system, we're able to decrease the flow rate by almost 75%. Over a conventional four-pipe system, we're able to cut the flow rate by about 50%," Cunniff continued. "So not only were we able to cut the number of pipes in half, but we were also able to significantly reduce the size of the pipes." The result was adequate space for the engineer to fit the piping and the DOAS ductwork into the available ceiling space. Also, lower horsepower pumps were put to work in the main mechanical room.



Greg Cunniff, PE and Glenn Snyder, PE

Jeff Pitcairn, Taco's commercial regional manager, saw the project through, from design to commissioning and start-up, and Sean Connor, commercial sales manager at BJ Terroni helped with equipment selections and estimating.

For the engineers at Lederach, learning about the chilled beam concept and how it would work within the design concepts and requirement of the facility was an interesting challenge. Before Taco got involved with the project, initial design for the facility overshot the budget.

It took some time, effort, and collaboration with manufacturers to redesign the project in line with the available funding. The redesign, including some modifications to the building itself, came in at nearly 10 percent under the initial cost mark.

According to Lederach engineers, Penn Foundation will see a return on additional investment of the geothermal and chilled beam system – when compared to operation of conventional heat pumps – within 16 months. "Not only are energy costs substantially lower, but so are the maintenance costs," added Lutchendorf. The iWorX, chilled beam and geothermal combination is estimated to provide a $12,000 yearly energy savings over a standard water source heat pump system. An annual maintenance savings of $3,000 is also estimated.

"Using Taco's HSS [Hydronic Solution Software], we designed the majority of the system piping and cascading temperatures throughout the entire system. We were pleased with how easy the program was to use," continued Lutchendorf. The software produces clear, detailed schematics and blueprints for the mechanical contractor to follow.

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