WaterFurnace® Case Study

WaterFurnace boasts state-of-the-art facility.

The WaterFurnace International 115,000 square foot headquarters serves as a model for commercial geothermal installations worldwide. A pond loop and 41 of its own geothermal units meet all heating and cooling requirements.

Explosive sales

In 1990, explosive sales and a quest for a state-of-the-art facility which would spotlight the advantages of using geothermal energy, led WaterFurnace International, Inc. to build a 115,000 square-foot corporate headquarters and manufacturing facility in Fort Wayne, Indiana. In conjunction with the new building, WaterFurnace installed what was at the time the largest geothermal pond loop system in North America to provide heating and cooling for the building.

To provide total comfort for the new headquarters and plant, WaterFurnace uses a combination of its own geothermal units, including the Premier®2, Spectra® and water-to-water units. The system consists of horizontal units conditioning various zones within the two-story office space and seven large capacity horizontal units that total 70 tons conditioning the manufacturing area. The total capacity of the system is 153 tons, with 134 tons installed in 1991 and 19 more in 1995. The environmental control for the testing laboratory consists of 42 Premier units. The 168 tons of lab support equipment uses the pond loop as a tempering medium when lab requirements fluctuate outside of specified limits.

Pond loop installation

As is common in many parts of the Midwest United States, local zoning rules required WaterFurnace to construct a retention pond for storm water runoff as part of the new facility construction. WaterFurnace saw this as a great opportunity to combine a beautiful focal point with a cost-effective water loop installation.

A three-acre pond dominates the front of the facility, which overlooks a major thoroughfare. In instances like this where water retention is an issue, pond loops are by far the most cost-effective method of heat exchange. The pond is also used as a source of water for the lawn sprinkler system.

The water loop system consists of 12 heat exchanger zones spread over the bottom of the eight-foot-deep pond. Each zone is constructed from fifteen 300-foot long coils of 3/4-inch thermoplastic pipe connected to the building by two-inch supply and return lines. A heat fusion process that forms an unbreakable connection stronger than the pipe itself joins the high-density polyethylene piping used for the loop.

During the first five summers of operation, the maximum temperature of the water inside the loop was 85° F during periods of 100° F and higher outdoor air temperatures. In these conditions, the WaterFurnace Premier units cool with an energy efficiency ratio (EER) of 16, which is about double that of conventional cooling. During the winter when the pond is frozen at the surface, water loop temperatures are a minimum of 35° F. Under these conditions, Premier units heat with a coefficient of performance (COP) of 4. This is four times more efficient than electric resistance heating and provides considerable savings when compared to the highest efficiency gas systems.

Setting the standard
WaterFurnace's office and manufacturing facility is a model application from which architects and engineers can learn. The facility is a working model of a pond loop installation for large-scale commercial and industrial buildings, many of which currently require retention ponds.

At the WaterFurnace facility, visitors can see firsthand the operation of the geothermal water loop system. WaterFurnace offers tours of the facility, and the lobby features an interactive, touch-screen computer, which provides technical information on the system. In several areas throughout the building, the ceiling panels are made of clear plastic to display the conditioning equipment. For HVAC contractors and installers, WaterFurnace also offers in-depth training classes at the facility.

Energy management system
All space conditioning and lighting is controlled by a highly advanced Energy Management System (EMS), converting the structure into an "intelligent building." Intelligent building control substantially reduces operating costs while providing higher levels of safety, comfort and convenience for the occupants. The EMS gives complete computer control over connected devices as well as providing communication between them.

Direct digital controllers
The EMS consists of an interconnected network of Direct Digital Controllers (DDC). Each controller regulates a local system or device according to its own program or programs from central commands. Each geothermal unit has one controller, allowing sophisticated control over heating and cooling algorithms and schemes. A simple example is the scheduling program that automatically sets back heating and cooling set points during unoccupied times such as nighttime, weekends, or holidays. At each geothermal unit, the EMS monitors conditions such as space, air intake and air discharge temperatures, fault conditions, and occupant thermostat commands. Each controller analyzes these inputs, then controls the unit through the proper heating and cooling sequences to ensure a comfortable environment at maximum efficiency.

Each DDC controller is fully programmable over a LAN (local area network); thus individual controls throughout the entire building can be programmed from one central laptop computer which can be located anywhere in the building. Each controller can be programmed to communicate and share data dynamically with other controllers. Users may check the status and conditions anywhere on the EMS and, with proper password authorization, can alter system schedules, set points, and even individual control programming.

The EMS also monitors and controls the variable-speed water loop pumping system. Each unit was fitted with an actuator water valve that allows water flow only when required. Since the loop water flow fluctuates based on the number of units operating, the EMS determines the speed at which the variable-speed pumps must operate, thus minimizing pumping costs. Because electricity costs are based to a large extent upon maximum electric demand, the EMS monitors information at the main electric meter. When high demand periods arise, the EMS is programmed to turn off low priority loads. This feature minimizes utility loads during peak periods and saves substantially on utility costs.

System design
WaterFurnace located the units and designed the air duct systems by dividing the building into zones, grouping similar usage areas together. For example, one unit handles several offices facing the same direction and having similar heating and cooling needs. Breaking the building into zones with similar requirements provides better comfort than large central systems where all areas are governed by one thermostat.

Horizontal units were used throughout the facility to maximize usable floor space. The units are located above the suspended ceiling in an otherwise unused space, which also serves as the return air plenum. This also eliminates the need for expensive return air ductwork. A percentage of fresh outside air is ducted directly to each unit to provide a healthy indoor environment. A heat recovery system was installed to recover the energy from exhaust air such as in restrooms. This energy is used to condition the incoming fresh air providing for high-energy efficiency.

One of the many benefits of a geothermal system is the significantly reduced space requirement for the mechanical room. The WaterFurnace mechanical room is less than one-sixth the size that would have been required with a conventional system. This feature allows more floor space to be devoted to income-generating operations.

To maximize the pond view, a ribbon of glass surrounds the perimeter of the building throughout the office and manufacturing areas. When faced with large amounts of glazed areas, many engineers install perimeter radiation for heating, which is expensive to install and operate. With geothermal units, the supply air temperatures are high enough that ceiling-mounted linear slot air diffusers can be used to blanket the perimeter wall with warm air for high comfort at low installation and operation costs. The main lobby, designed with two-story glass walls, presented a challenge for lower level comfort. For this unique situation, a Premier AT downflow unit was installed to condition this space. The ductwork was located within the floor slab so the supply air could be introduced at floor level where the occupants are located.

The 24-foot high manufacturing area utilizes a stratified air concept to minimize cooling loads. In summer, the units are ducted to condition only the lower ten feet of the space. This allows the massive amounts of heat gain from the roof and overhead lighting to remain near the ceiling where it does not require conditioning. During the winter, this upper level air is used to assist in heating. By utilizing a stratified air system, only 70 tons of cooling is required in the 85,000 square-foot area. With a conventional rooftop system, a space this size would typically require 200 tons of cooling.

Clean sidewalks
In the fall of 1997, the sidewalks of the WaterFurnace facility were equipped with radiant heating coils, which melt ice and snow, resulting in a safe entryway into the main lobby while eliminating the need for shoveling or lying salt. The snow and ice melt system works in conjunction with the WaterFurnace Spectra 3-ton water-to-water unit, running heated water through a network of piping embedded in the concrete sidewalk.

A sensor detects when temperatures drop below 32° F and moisture is present on the slab, initiating the process of snow or ice melting. When the outdoor temperatures become warmer, the system automatically shuts down. The system protects the slab from cracking by limiting the rate of heat transfer into the slab, slowly ramping up the temperature difference across the slab and limiting the maximum temperature difference.

Great savings
The WaterFurnace facility demonstrates to architects and engineers how state-of-the-art geothermal technology can be successfully applied to their projects. Installation costs for a geothermal water loop

system can be surprisingly lower than many conventional systems. Best of all, tremendous comfort and operating cost benefits can be achieved by tapping into the free energy available just a few feet underground.