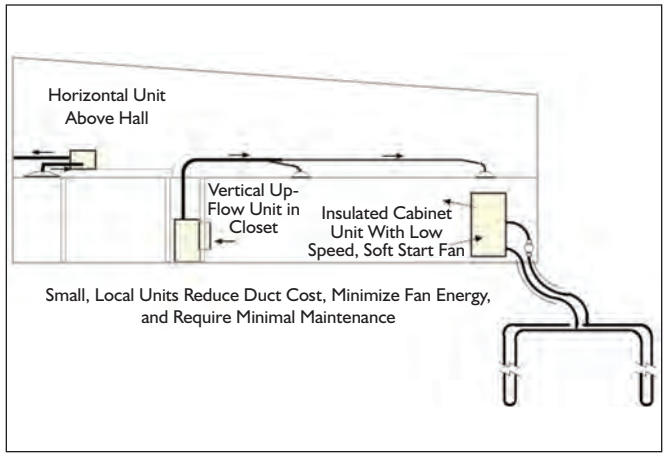

Figure 1: Options for heat pump location for simple GSHP.

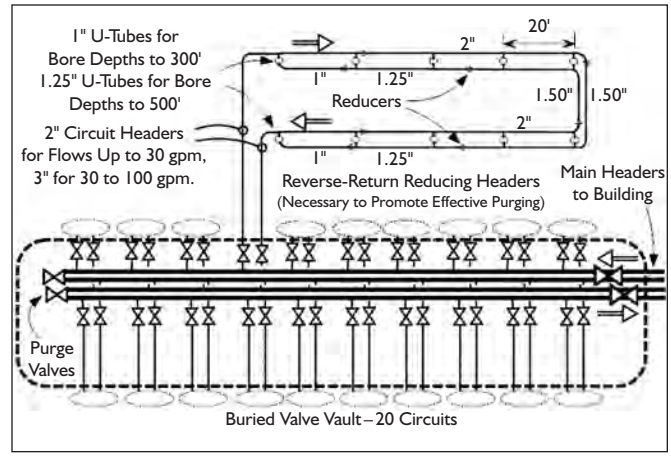

Figure 2: Exterior piping configuration for not-so-simple GSHP.

GSHPs: Simple Is Better

By Steve Kavanaugh, Ph.D., Fellow ASHRAE

As with many maintenance supervisors, Bob Lawson of the Austin (Texas) Independent School District (AISD) needed relief for an overextended workforce. Lawson turned to ground source heat pumps (GSHPs) in the mid-1980s when they were primarily a residential application. His priority was a simple, low-maintenance system that could easily replace failing conventional classroom units. He convinced a nearby manufacturer to produce water-to-air heat pump console units large enough for classroom loads with a sloped top so that books could not be stacked on the supply air vents.

Two or three vertical ground loops located just outside the building walls were linked to the unit with a small wet-rotor pump. Today, AISD and several nearby school districts have more than 125 schools that continue to use Lawson's simple one heat pump–one ground loop–one pump GSHP system.

Mike Green, a mechanical engineer in Texas, had several interesting experiences during the early days of GSHPs in Austin; including the time U-tubes were inserted at the end of the day into what was thought to be dry holes. The following morning the job site resembled a bowl of black spaghetti since the holes, which had been dried during the air drilling process, were filled with water. In spite of this and other challenges, he was sold on the technology since no one called to complain after the project had been completed.

Green continues to design GSHPs for new schools in districts surrounding Austin using the same simple loop designs. An important lesson learned was to increase the separation distance between vertical bores to at least 20 ft (6 m). The heat pumps are ducted and located in mezzanines above hallways (*Figure 1*). Although there are challenges to his allegiance to simplicity, the success of his approach is supported by school officials including those at Leander ISD. The district recently began applying for ENERGY STAR ratings and owns 19% of the rated schools in Texas.[1]

Simplicity in Illinois

Kirk Mescher, P.E., Member ASHRAE, Columbia, Mo., has his own twist on simplicity for retrofitting older schools in central Illinois. Mescher links several heat pumps to a one-pipe building loop and a central ground loop without costly exterior valve vaults.[2] The heat pumps are typically a variation of Lawson's approach of classroom units with on-off circulator pumps. However, these larger units are quiet and much more efficient and serviceable than those available in 1985.

Mescher's success is also verified by ENERGY STAR rating, with almost all of his projects rating above 90 and many of them without the benefit of building lighting or envelope upgrades. He is able to keep total HVAC system costs between $13 and $18/ft^2 ($140 and $190/m^2) to ensure that success is achieved without the elevated price tags of more elaborate GSHP designs. One of Mescher's clients is the McLean County Unit District No. 5, which owns 28% of the ENERGY STAR rated schools in Illinois,[1] and it is equally pleased with the lower maintenance of simple GSHPs.[3]

Simplicity Not Standard Practice

A more common approach to school GSHP design is to link a large central ground loop to an interior piping network connecting heat pumps throughout the building in a manner similar to conventional chilled water piping. The ground loop is a matrix of vertical U-tube ground heat exchangers that are arranged in subcircuits of six to 20 loops each. Typically, a network of valves is used

to balance and distribute flow. To save interior space, this is often done in a buried vault made of either poured-in-place concrete or prefabricated high-density polyethylene (HDPE) weighted with concrete as shown in *Figure 2*. In schools where the logic of central loop design is often driven by reducing ground loop cost through building load diversity, the high cost of the elaborate interior and exterior piping networks necessary to accommodate the central loop can compromise savings in ground loop costs. These networks usually require much larger pumps. Although variable speed drives can reduce energy use at part-load, nothing uses less energy than a pump that is off as with those in simple systems.

Low installation cost and energy consumption of central GSHP systems using conventional distribution and control methods have not been widely demonstrated in practice. Results can be compromised if systems do not adhere to best practices, especially when attempting to minimize fan and pump energy. There may be central system approaches that are improved and applications that are appropriate, but proof of performance must be demonstrated to verify the success of these designs. This includes ENERGY STAR rating, mechanical and ground loop cost, and building owner satisfaction.

Until documentation is provided to indicate otherwise, prospective GSHP building owners and designers should follow the suggestion of Albert Einstein, "Everything should be as simple as possible, but not simpler."

References

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