Use Oil Bills to Size Geothermal Systems

by Peter Tavino, P.E., CGD

A recent design project involved converting from an old oil-fired boiler to borehole-sourced geothermal. What we did applies to any size house, but this 25,000-square-foot structure featured existing water-to-air heat pumps dispersed throughout the building. The interior PVC piping circulates water, heated from the boiler or cooled by the cooling tower, to the heat pumps that blow conditioned air into the rooms.

To convert to geothermal inexpensively, using the existing plumbing system and water-to-air heat pumps, we bypass the boiler, and preheat water in storage tanks to 70°F (21°C). A new borehole field drilled nearby will provide the heating Btus (British thermal units) or receive the cooling Btus. This new design follows lessons learned on a similar geothermal conversion system last year. (Its 13,000 square feet is operating great, using water storage tanks and a new 30-ton water-to-water heat pump chiller.)

To size the new chiller tonnage that preheats, and to determine the length of vertically-drilled bore, we had two methods available.

The traditional way is to use heat loss and gain calculations for buildings that summarize block loads by multiplying surface area by insulation factors by Delta T (which is not just an airline beverage). ACCA J for residential and ACCA N for commercial are the base spreadsheet programs from the Air Conditioning Contractors of America (ACCA). One problem with ACCA J and N is the enormous influence and range in load from infiltration when selecting *Tight*, *Semi-Tight*, or *Average* (even with door test). Infiltration was a third of the total for the subject building. Ventilation and windows, which are covered or not, impact Btu total peak hourly load significantly too. For a new building there is no other choice.

The second and more reliable method is to study the past building history to see how much heating and cooling it really uses. Real data always trumps modeled data. If it can be weatherproofed too, all the better.

Btus are Btus whether from the deep earth or a fossil fuel combustion. For the 25,000-square-foot building, we easily determined from fuel oil bills it uses 4200 gallons per year. There are140,000 Btus in each gallon. The old boiler efficiency was 80%, so each gallon burned provided 128,000 BTUs to the building and 28,000 Btus went "up in smoke."

About 10% of the 4200 gallons was for hot water, to remain oil fired. So 3780 x 112,000 = 423 million Btus per year heat the building. This annual load is compared to peak hour load based on climate data and is provided in many software programs. The resulting 25-ton water-to-water heat pump could be specified. Based on this selection, the heat-dominated borehole lengths and spacings are determined next.

If air conditioning is dominant, the excess electrical use during the summer months can also convert from air source

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or cooling tower efficiencies to the greater ground source efficiency. The difference is summed up for the average year to determine annual cooling load Btus injected to the ground. From the annual loads, find the peak hour to size the heat pump and bore field.

> *Example:* A house in New York used 3800 gallons of fuel oil in the last 8 years. A quarter (950) was for hot water, so 2850/8 = 356 gallons per year to heat. Times a confirmed 80% boiler those years x 140,000 Btu/gallon = annual heat = 39.9 million Btu/year.
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> Input 27,500 Btu/hr in a software program to show an annual heat load of 40 million Btu (MMBtu). (55,000 yields 80 MMBtu.) Select a three-ton heat pump with full-load AHRI (Air-Conditioning, Heating, and Refrigeration Institute) heating capacity of 28,000 Btu/hr. Done!

In our experience, ACCA loads were greater than the actual oil bill records confirmed. Presenting both datasets to the owner allows them to choose how conservative (or oversized) they wish to be. Perhaps a geothermal retrofit project deemed too expensive by using new building design methods for an existing building can be analyzed again, using the established track record of energy actually used. Perhaps the more accurate design will allow resizing to a smaller more affordable system. Borderline financial projects might get the go ahead, when analyzed this way. If 4000 feet of borehole will yield the design entering water temperature instead of 6000 feet, go with it, and tap that ground source!

The statements and comments in this article are my own and are based on information and references believed to be true and factual. If you have any questions or comments, please forward them to me care of **WWGR**.

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