
CONSTRUCTION PROJECTS COMMITTEE
THURSDAY, FEBRUARY 21, 2008
NASHUA HIGH NORTH LECTURE HALL
6:00 PM

A meeting of the Construction Projects Committee was held at Nashua High North on **Thursday, February 21, 2008**. Alderman McCarthy called the meeting to order at **6:07 p.m.**

Present: Alderman McCarthy, Alderman Tabacsko, Mr. Kelley, Mr. Hallowell

Also Present: Mr. Mealey, Mr. Vaughan, Mrs. Ziehm, Alderman Teeboom
Dr. Gary E. Phetteplace (Geothermal expert)

Recording begins in mid- presentation

Some speakers were not in front of microphones and therefore were not audible for transcription

Presentation by Dr. Gary E. Phetteplace

Dr. Gary E. Phetteplace

Went through PowerPoint presentation.

It takes a lot less energy to move the heat up with a heat pump than other means as burning fuel. Heat pump easily works as an air-conditioner too at very small extra cost. It runs on electricity, which can be costly. However escalating fuel costs has decreased this disadvantage. Thermally connecting the heat pump to the ground can be costly. You need to make sure to have people who know what they're doing. Once you get down in the ground deep enough, you have fairly constant temperature. You can break down geothermal systems into three systems: Open Loop System; Closed Loop System; Lake Loop System. *Slides illustrated pros and cons of each system.*

I have a lot of data of school retrofit project from a colleague who has done a number of school jobs and has performance data. He didn't measure the results, the schools did. The first is a normal school in Illinois. He had a \$16-18/per sq. foot budget for one 43,000 sq. ft. school and another at 23,000 sq. ft. His original energy budget in the school was 59,000 BTU's per sq. ft. per year and after the renovation is was about 28,000. And the energy use is 47%. The energy cost went up 40% because he's using electricity instead of gas. But even with that, the cost is down 30% from what it was. He's figuring a 13-year payback... and they now have cooling.

Reviewed design issues. Sizing of the ground coupling for a heat pump is different than sizing conventional equipment. Bottom line is that you need to know the load duration information as well as peak load to design a tool that considers all factors and accurately models the heat transfer in the ground. So you really have to make sure you design it right.

Alderman McCarthy

To answer Mr. Vaughan's question earlier (Mr. Vaughan's microphone was not on), that means if you change the use of the building substantially over time, you either have overbuild upfront or you've got to add additional capacity later on when you change the use of the building.

Mr. Phetteplace

Yes, it's a substantial change, you could end up doing that. But changing the length of the school day an hour is not a substantial change, or adding a week to the school year. But it is something to take into consideration. There are ways to deal with it other than drilling more holes.

Alderman McCarthy

If I have a system for heating only... it seems to me that a system that's used for both heating and cooling would actually perform better over time and maybe require less capacity because you don't have the same net change in the sub surface temperature in the course of the year as if you're doing heating only.

Mr. Phetteplace

Absolutely. It can depend on how tight the building is too. Now with all the heat from computers, lights, people, etc. you can have more cooling requirements than heating over the year. In the end if you've got a good building envelope and efficient equipment, it doesn't cost you that much to keep that building condition.

Alderman McCarthy

So if we've got buildings that were built some time ago and don't meet the current fresh air standards, even if we tighten up the envelope to meet code, we need to bring in more air than we've been through the leaks. How does that change the equation?

Mr. Phetteplace

It doesn't. That's a design factor that you would design for in the system. That was one of the things the school I showed you had to deal with. Uncontrolled ventilation really doesn't work well.

Alderman McCarthy

So if we tighten up our envelopes and change the amount of fresh air replenishment by a factor of 3, we would still save energy?

Mr. Phetteplace

Certainly. You can do heat recovery on your ventilation. These are design considerations.

Mr. Hallowell

Since we do have the cooling, we may end up using these building more in the summer than we have. But I think I hear you saying that that would be less of an issue. Primarily heating is going to be the cost for sizing. And if we were doing cooling in the summer, it sounds like it would actually be beneficial.

Mr. Phetteplace

It would. And the cooling especially in the beginning of the summer would be extremely efficient. The design program is typically designed for a required length for heating and cooling. If there was a huge difference, you might provide supplemental heat. In the south, they use a cooling tower.

With heat pumps, bigger is not better. Most of the development effort has gone into the small units. The larger units that we received early on this business are becoming less common.

One thing you would never use with a heat pump is baseboard radiation, like what you've got. The heat pump would be terribly inefficient. We don't do that. If you wanted to do radiant floor heating, however they are very well suited to that. You probably wouldn't use it though if you were going to use air conditioning, too.

Slide showed entering water temperature over the year cycle at a school building in Maryland. As we dump heat into the ground during the cooling season, it peaks out someplace around mid-September. Then when you get into the end of September and October, it switches into the heating mode.

Alderman McCarthy

For this example, what was the average water temperature before the system started?

Mr. Phetteplace

That's a good question. In coastal Maryland, maybe 56-60 degrees. It would be very close to the middle of this, probably.

Alderman McCarthy

It looks like the upswing in temperature during cooling season is substantially higher than the downswing during heating season.

Mr. Phetteplace

It seems like it's more pronounced. Maybe it's because air conditioning season is slightly shorter. Plus, we're only looking at one-year data and their winter could have been slightly abnormal.

Mr. Hallowell

I might point out that that increase occurs at either end of the curve. There is actually a pretty sizable jump.

Mr. Phetteplace

When you switch from seasons, the drop is very fast when you switch to heating and the rise is very fast when you switch to cooling. And there could have been data missing.

Alderman McCarthy

My point was that if the average water temperature was about 57, the downswing was in the high 30's or around 40 and the upswing was above 80. So the actual change in groundwater temperature in the summer is higher.

Mr. Phetteplace

Yeah, so maybe I erred on the low side when I predicted that temperature. Again, I'm taking a guess at that. But it would depend on well balanced the loads are on this zone. So if there was a lot more cooling than heating, then that could still be the case.

Alderman McCarthy

If you actually disturb it so that it the graph doesn't start and end at the same place on an annual basis, ultimately you have enough impact on the ground temperature that the system doesn't work anymore, right?

Mr. Phetteplace

When we design them, these models that we use actually predict clear out for 10 years what the temperature change will be in the ground. So if you see in year 10, that you've driven it up or depressed more than a few depress, then you go back and size your loop bigger.

Unidentified Speaker

Brian, if I could just point out, this is Maryland, where they have a much higher air conditioning load than they have a heating load.

Alderman McCarthy

I'm more interested in just the overall stability of the systems in any fixed place.

Unidentified Speaker

That's why you see a much more pronounced exaggeration of the heating of the ground water in the summer, because of the additional cooling that's going on in the building vs. less of a dip in the winter.

Alderman McCarthy

I agree, but we put a lot of heat into the ground and then we took it out very quickly at the end of the cooling season. My question is, how does that happen? If our heating requirements are not as steep as our cooling requirements, we shouldn't be drawing it off as fast and that should have a different curve.

Mr. Phetteplace

When you see that temperature drop down at the beginning of the heating season, it doesn't mean that all of the ground temperature has gone down. It means that right next to the pipe I'm starting to see that impact. Does that help?

Alderman McCarthy

Yes.

Mr. Phetteplace

If you look at slide 50, it shows you what that does to the heat pump performance. You can see that at the beginning of the cooling season the cooling COP starts out with a higher COP and then drops off as the season goes on. When you switch over to heating, the same thing happens.

Unidentified Speaker

I'm seeing in the chart that if we can keep the entering water temperature warmer in the winter, we'd get a better performance from the heat pump, is that what you're saying?

Mr. Phetteplace

Right. If you have an open loop system, you will have more or less a constant temperature year round. However, the trade off is that the open systems tend to use more energy. In the end though, the overall system performance tends to be on an annual basis in the same place.

Mr. Hallowell

So, if you had a bunch of solar panels to heat water, they would go into the system?

Mr. Phetteplace

I've not seen that done. When would you do that? Would you try to regenerate the ground in the summertime when you could collect solar? That might make a little bit of sense. Would it be cost effective as opposed to putting in a few more boreholes? I don't know. Solar is a fairly expensive technology. Solar thermal for heating is probably less cost effective than this. I don't see it being deployed nearly as much as this. If you really had to have solar in a school system, I might think about solar electric. Then you can sell all that unused solar back to the electric company when you're not using it.

Unidentified Speaker

But Gary, we're talking about a 10-degree difference here. We're talking about solar to get 10 degrees on this water. That's where the efficiency comes in.

Mr. Phetteplace

But do you think it would pay for the solar? I don't know. Also, this was really data here from over 10 years ago. The performance of these pumps has gone up. That would do 2 things to this graph. One, all these points would come up, both cooling and heating. The other thing is that the heat pumps are now flatter so the heating performance does not drop off as fast. So to gain a few degrees on the water temperature on the entering water is not going to do a lot for your heat performance. In fact, circulating a lot more water to the heat pumps raises your temperature too. You can also do backup with electric, which is the lowest cost. However we are not finding that backup is very common with these systems.

Alderman McCarthy

Is that true for systems in Northern New England as well?

Mr. Phetteplace

There are not currently a lot of systems in Northern New England that we draw data on. But there are a lot of them in the Plains states and the Canadian Plains. Generally no, they're not using backup. When you add back up, you add complexity to the system. Without proper set points, more fuel than is necessary is used.

Alderman McCarthy

The motivation for the questions on back up boilers, is that it's an expensive problem if you make the mistake of under sizing the system for the 4 worst days of a New Hampshire winter.

Mr. Phetteplace

You're probably not going to make that mistake because of the elasticity that's built into these systems. As long as you have proper design, it should not be an issue and will get you through those few days.

Unidentified Speaker

When you say it will get you through those couple of days in the coldest period, what is the actual impact we're talking about in an elementary school.

Mr. Phetteplace

It means that you're not going to be getting the energy efficiency that you would have gotten, but you're probably going to be okay. You need to make sure you have a little bit of surplus capacity. Most designers are not going to cut it that close.

Mr. Phetteplace

All of these things, including this graph depend on the balance of load, and I can't tell you exactly what the balance on that graph was. In the same school the heating and cooling load balance for 4 different zones and how vastly different they are, depending what's going on in those zones... you would not believe. Some are substantially more cooling than heating and some are more balanced.

Moving on to economic data. I've got comparative installation costs on these slides. Slides showed comparative Commercial installation and comparative commercial maintenance costs. Slide 43 shows the electric generation mix in the US. The largest chunk is coal, and there is good amount of nuclear and natural gas. Slide 55 shows the average electric cost around the US. Slide 56 shows how the energy trends favor GSHP. On slide 57, I've calculated what my heating costs would be. The curve on the bottom is heat pump and the curve on the top is the furnace.

These systems are really quite simple, but are entirely foreign to people that design HVAC Systems in this part of the country. The inexperienced installer is going to try and do it like other HVAC systems and usually results in problems. Consider bringing both design and installation expertise in from other areas if the infrastructure is lacking in your area. I've included some references in the presentation that can be helpful to you. I would suggest you rely on unbiased sources.

Mr. Hallowell

I know Mr. Maedl is here. I would like it if we could give him a few minutes. Or explain to me what the process is going to be to get him on an agenda.

Alderman McCarthy

The process is I need to have a conversation at least with Corporation Counsel regarding what the interaction is of us having presentations from potential vendors outside of the normal vendor processes. Once I've had that, I will make sure we get in touch with him and schedule it if Corporation Counsel says there is no problem with that.

Alderman Tabacsko moved to adjourn. **So voted at 8:00 p.m.**

Submitted by Jacki Waters