Bill's Sales Presentation to Jim and Nora Smith -- Radiant Heating 101

"The goal of my company, which by the way is called Partridge Radiant Heating, is to install radiant systems that offer superior quality at a price which is competitive with forced air. We're going to do this is by adopting an industry standard design, and then buying, assembling, and installing the components in a much more efficient manner. I'll explain a bit later how we do this."

The next thing he wanted to do was make sure they fully understood how a radiant system would work in their home. They already knew quite a bit, but he didn't want there to be any surprises down the road.

"I know you've already done a lot of homework and understand quite a bit about radiant systems. However, I'd be happy to answer any questions you might have or even spend a few minutes on what I call, 'Radiant Heating 101,' just to refresh your memory."

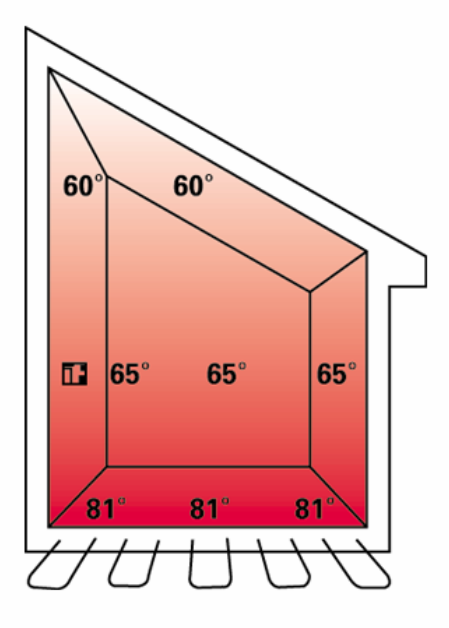
This time Nora spoke up, "I think we have a general understanding of how these systems work, but there are a few areas that are still a bit of a mystery, at least to me. Maybe you could take us through the basics and then I can ask my questions as we go along."

Bill said, "No problem. I'd be happy to do so. Just let me get some drawings out of my case."

Over the weekend, Bill had prepared some illustrations showing how a radiant heating system worked. The sketches were drawn freehand and were pretty crude. He wished he could have found a graphic artist to redraw them before this meeting, but he couldn't. He apologized in advance for the drawings, but the Smiths didn't seem to mind.

"Let's start with the difference between radiant and forced air heating. In simple terms, radiant heating systems warm the structure and the objects in it – the floor, walls and furnishings -- while forced-air systems heat the air. Let me elaborate.

"Radiant heat is a form of energy that travels through space from warm objects to cooler ones. The energy waves don't heat the air as they travel through it, only the solid objects they hit. This is how the sun heats the earth. Think back to when you've been outdoors on a cold day and the sun comes out. You can feel the sun's warmth on your skin, but the air isn't any warmer. A campfire is as another example, heat radiates from the fire and warms your body, but the surrounding air temperature remains largely unchanged."

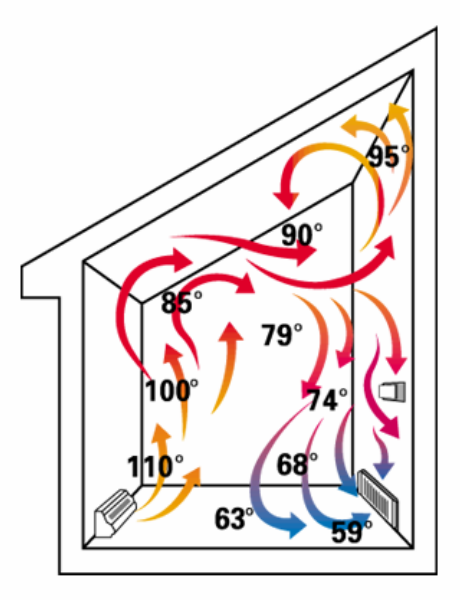


Radiant In-Floor Heating

Bill handed Nora the "Radiant Floor" illustration and said, "With a radiant heating system in the home, the heat source is warm water moving through tubing under the floor. As the water circulates, its heat is transferred through the wall of the tubing to the floor and then to the walls and the objects in the room. Eventually, the air warms up too, but the greatest warmth is maintained in the objects that you are in contact with. That's why you were so comfortable in that cabin in the mountains.

"The physical mass of the building retains heat very well, and so the room temperature can be maintained at a constant level with only small amounts of additional heat. That's one of the reasons why radiant systems are so energy efficient."

Then he handed Jim the "Forced Air" illustration. "Now let's discuss the alternative. Forced air systems work by superheating air in a furnace and blowing it through a series of ducts to each room in the house. But as we all know, warm air rises, so as it flows into the room, it rises to the highest points. The top of the room may be toasty warm, but the lower portions aren't. The thermostat may read 72 degrees, but if you're sitting on the sofa, you may still feel chilled, especially your feet!



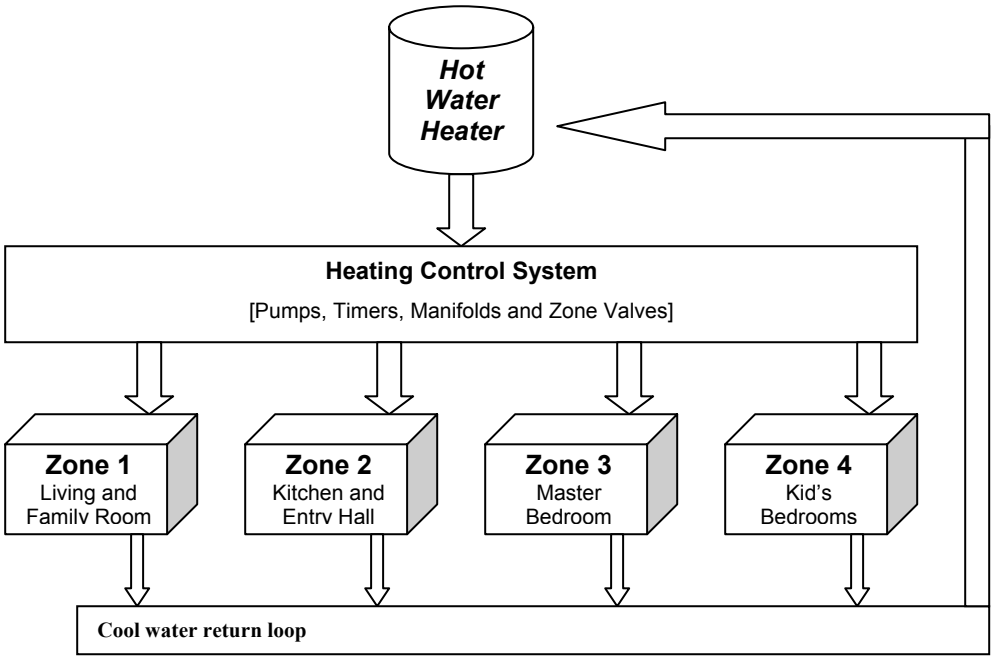
Forced Air Heating

"Another thing about forced air systems is they're not very energy efficient. Air doesn't retain heat was well as a solid mass does. It tries to give it to everything it comes in contact with including the heating ductwork, windows, doors, and other cold objects. It doesn't take long for the heat to dissipate causing the furnace to turn on and the cycle to repeat. Does that make sense?"

Nora and Jim nodded yes. He then laid an illustration on the table titled, "Hydronic Radiant Heating System."

"OK, now let me describe the mechanics of radiant heating. The system is made up of three basic elements: hot water source, heating control system, and zone distribution system.

Hydronic Radiant Heating System



"Starting with the hot water source, we use a high-efficiency water heater in our systems. If you talk to other companies, you'll find most of them use a boiler. We believe the water heater is a more energy-efficient and cost-effective solution for residential heating. Let me explain why.

"Boilers are designed to heat large volumes of water to very high temperatures (e.g., 180+ degrees). To achieve peak operating efficiency, they must be run constantly under heavy load. That's why they work so well in commercial and industrial applications, where the demand for steam or very hot water is high and constant.

"But for residential heating, a radiant system doesn't operate constantly or need very hot water. Instead, the demand is sporadic and the water only needs to be warm (i.e., 80°-85° F degrees). A boiler is overkill; when a zone requires more heat, it only takes a minute or two for the boiler to reheat and deliver water. This may sound like a good thing, but in practice, it means the boiler fires-up and shuts-down many times each hour and never reaches peak operating efficiency. This repeated on-off process is called "short cycling," and it wastes energy and can lead to premature failure of boiler components. You can think about it in another way -- consider a car that only gets used to drive around the block. The engine never

gets a chance to warm-up, and so it gets poor fuel economy, fouled spark plugs, sludge in the oil, and dramatically shortened engine life."

"On the other hand, a high efficiency water heater is designed specifically to meet the needs of residential heating systems. It too can heat water very rapidly, but it does so in a more efficient way and without any abnormal wear on the components. It consumes less energy than a boiler, and best of all, it costs less money."

Jim nodded his head approvingly. He seemed to like what he was hearing. Then he asked, "Can we get by with a single water heater for both radiant heating and household hot water?"

Bill was ready for this one. "That's a good question. I know it sounds pretty logical that a single heater could be used for both purposes, but for a couple of reasons, we don't recommend it. First, you want your household water to be heated to at least 130 degrees; if you drop much lower than this, you'll be unpleasantly surprised when you want to take a 'hot' shower. The heating system only needs water at 80-90 degrees. There are ways to work around this, but there's an even better reason not to do it -- you really don't want to drink water that may have been sitting around in the heating system for months at a time. During the summer the radiant system will be idle most of the time so there won't be any circulation of the water. When it finally does work its way through the system, it wouldn't hurt you to drink, but I doubt it would taste very good."

Jim smiled and said, "I get your point. I probably wouldn't be too happy if I mixed with a glass of good bourbon!"

It was Bill's turn to smile, and then he continued. "So we recommend using a hot water heater because it costs less than a boiler, and it is 20-30% more energy efficient. With our radiant system you can expect your monthly heating bill to drop by at least 50 percent. If you want to know what that means to you, I suggest you look at your utility bills for the last year or two and calculate how much of the total was spent on heating. Next year, you'll spend less than half of that!

Bill looked at the Smiths to see if they were both still with him. "If I'm going to fast or into too much detail, please let me know."

They both shook their heads and then Nora added, "This is really very helpful. We picked up bits and pieces of this information in the past, but this helps us put it all together."

Bill thanked her, and then pointed to the center box on his drawing. "Ok, let's move on to the heating controls. This is really the brain of the system. The controls are made up of an array of pumps, manifolds, timers, zone valves and other parts, which regulate the flow of

water and hence the amount of heat delivered to each zone. Now let me digress for a moment and explain what I mean by a 'zone.'

"When we install your heating system, we'll divide your house up into individual heating areas or zones, each controlled by a thermostat. This allows you to maintain a different temperature in each area. Of course we also use setback thermostats so you can vary the temperature based on the time of day. I'll come back to how the zones work when I get to the distribution system. But before I do that, I'd like to point out another major benefit of radiant over forced air heating.

"Most forced air systems work off a single thermostat. The only way to regulate the amount of heat in each room is by adjusting dampers built into the heating ducts. This works okay, but you still end up with rooms that are hard to heat. Do you have any examples of that?"

Nora giggled and nodded her head vigorously. "That sounds familiar. Until we bought one of those little space heaters, my sewing room was always cold. We had constant battles over the setting on the thermostat. I'd turn it up to 72, and he'd come along a few minutes later, complaining he was hot and set it back to 68."

Jim added, "I never thought too much about it, but what you say makes sense. Her sewing room is about as far away from the furnace as you can get, and those heating ducts aren't too well insulated. I bet we lose a ton of heat between the furnace and that room."

Bill was glad his examples were hitting home with the Smiths. "You won't have that problem with radiant heating, and you won't need that space heater.

"So let's go back to the system controls. When the temperature in a zone drops, the thermostat sends a 'turn on the heat' signal to the central controller, which then opens the water valve for that zone. A pump turns on, and warm water circulates through the tubing for that zone. As it flows through, the water's heat is transferred through the tubing wall to the floor and to all the walls and furnishings in the room. When the temperature reaches the desired level, a "turn off the heat" signal causes the valve to close. .

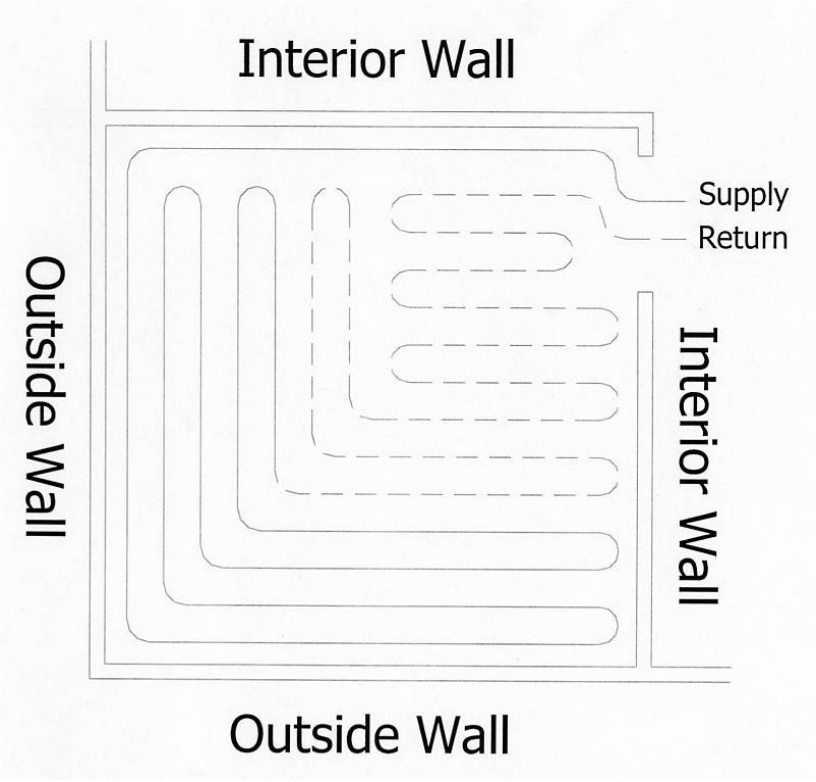
"The final element of the system is water distribution. As we've discussed, the house is divided into zones and each one has its own loop of PEX tubing that carries water to and from it. Now let's talk about how that tubing is installed and how it actually heats the house.

"First we make a layout drawing of your house showing all the rooms, windows, and interior and exterior doors. Then we work with you to decide how many zones you'd like to have. There's no limit; it's strictly a cost issue since each zone requires a separate thermostat, valve and tubing loop.

"Next, we plan the tubing layout for each zone. We look at a number of factors and perform engineering calculations to determine the best way to place the tubing to get the most uniform heating. The most important thing we consider is the location of doors and windows; these are areas where the heat loss is highest. We decrease the spacing of the tubing or add extra loops in these areas to provide more heat to offset the loss. Here's an example of a tubing layout drawing."

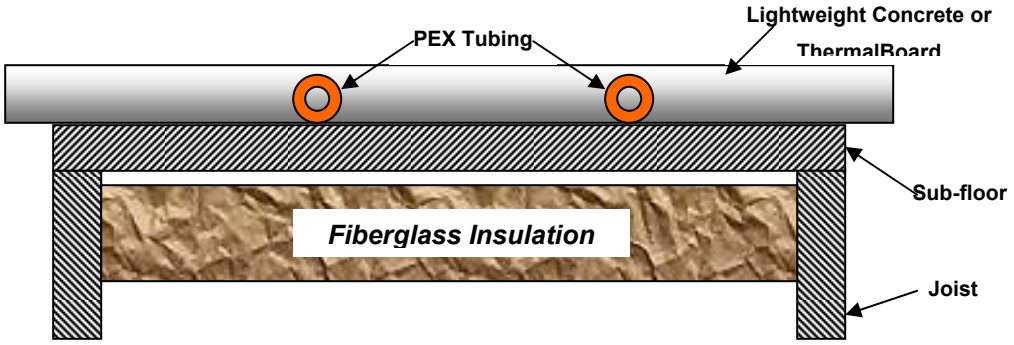
Bill unfolded a drawing that Joe had prepared when they were doing their engineering studies. He left it open on the table for them to review. Neither had any questions.

Tubing Layout Drawing



"There are a couple of ways for us to install the tubing. For new construction, we generally install the tubing over the sub-floor; we lay it out per the drawing, nail it down, and then cover it with either rigid foam insulation, called ThermalBoard, or a layer of lightweight concrete. This is the method you've seen used by the crew on "This Old House" when they install radiant heating.

Over the Floor Installation

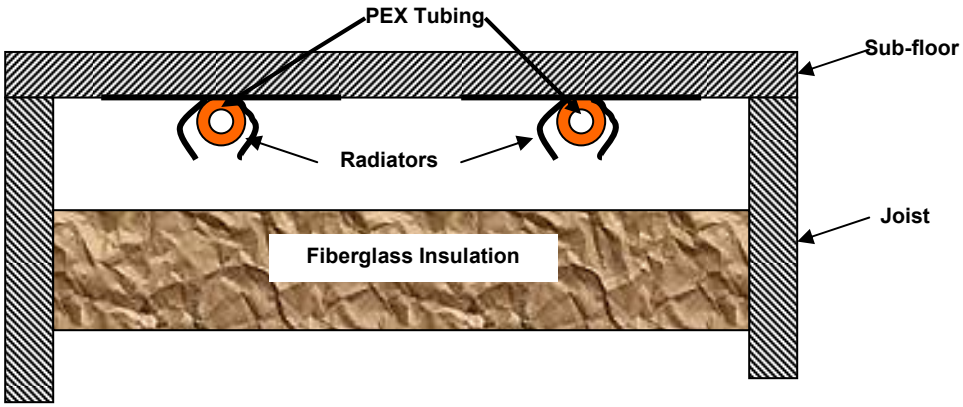


"We can use this method on remodeling projects too, but there's one drawback that needs to be considered -- it raises the height of the floor by an inch or so. This may not sound like much, but it's enough to have to shorten all the doors and rework all the baseboard moldings throughout the house."

Bill unfolded another drawing and laid it on the table. Then he reached into his briefcase and pulled out a 6-inch piece of aluminum that was formed to fit around the tubing. He picked up the PEX tubing sample that Jim had set on the table and snapped it into the groove.

"So in remodeling, we usually use a different method – we install the tubing under the floor. Our crew works from the basement or crawlspace. Again, following the layout drawing, they cut this specially designed aluminum conduit to length and attach it to the underside of the sub-floor. It's lightweight and holds the tubing in place; it also acts as a radiator and insures a uniform transfer of heat from the tubing to the floor.

Under the Floor Installation



"The final step is to install a thick batten of fiberglass insulation between the joists. This keeps the heat from radiating downward into the basement or crawlspace.

"The heating efficiency of both methods is equally good. The advantage of the under-floor method is that it avoids any disruption or rework of the area above."

Bill paused and looked over at the Smiths. "I've covered quite a bit of ground here. Do you have any questions?"

Jim said, "Yes, I've got a couple. First, you talk about heat being transferred to the floor and the furniture; what if you have carpeting or hardwood floors? Won't the heat damage them?"

Bill replied, "Not at all. One of the interesting things about radiant heating is that you don't need hot water to keep the room warm. As I mentioned earlier, the water is only 80 or 85 degrees, and by the time it's gone through the loop, it's cooled down to around 70 degrees. So we're not talking about steam or superheated water. With a radiant system the floor and furniture don't get any warmer than they would on a warm summer day."

Jim nodded his head and then paused for a second trying to think of his other question. "Oh yeah, what happens when the tubing breaks or someone runs a nail through it? I bet it's a mess!"

This was another common question and Bill was prepared. "Well it can be, particularly if you've used the over-floor method and covered the tubing in an inch of concrete. We always work with the floor guys and electricians and tell them there's radiant heating in the floor and they need to be careful. We even mark the locations of the tubing to remind them. But every so often, someone gets careless and drives a nail into a tube. It's no secret when it happens because we keep the system under pressure and the spurting water is a hard to ignore.

"But the fix isn't really that difficult. We just chip out the concrete around the leak, cut out the section of punctured tubing, and insert a special patch provided by the manufacturer specifically for this purpose. We splice the tube, check to make sure its holding, and then patch up the concrete. It usually takes less than an hour. The contractor's usually so embarrassed, it rarely happens a second time.

"Punctures are much less of a problem for under floor installations because there's a full inch of sub floor to protect the tubing. But if it happens, we use similar repair methods. And once contractors are out of the house, it's rare for a tube to get punctured; but if it ever does, you just give us a call and we'll take care of it.

Bill asked, "Any other questions?"

Both Jim and Nora nodded no.

