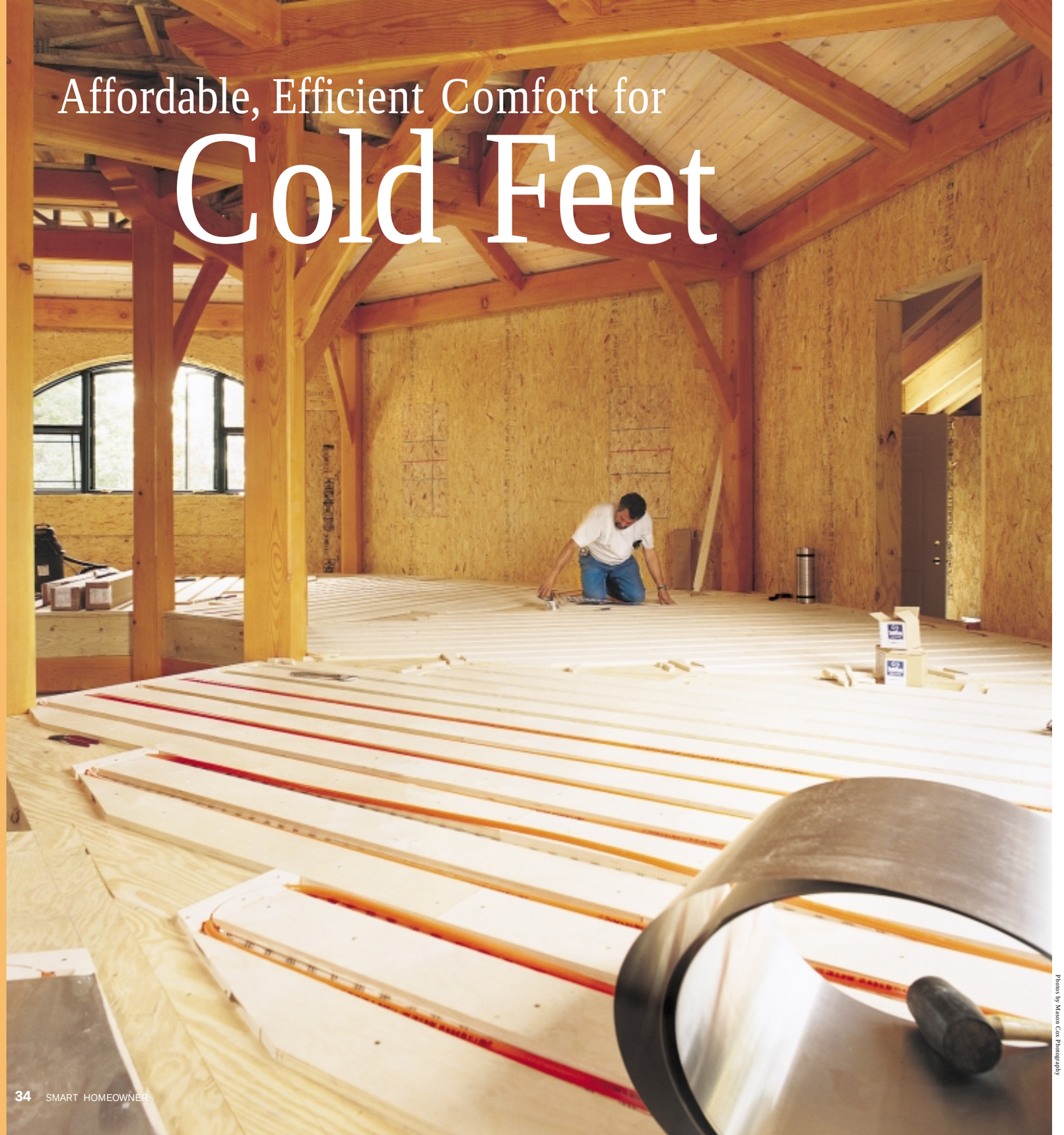
Affordable, Efficient Comfort for Cold Feet



Photos by Mason Cox Photography

The heavens opened wide, and there it was — our first real home! Granted, the fixer-upper needed work, but the loan was sufficient to get us well on our way. The small 1850s farmhouse would soon have a new addition for a master bedroom, new bath, kitchen and laundry room. A relatively new boiler heated the home, so we extended the hot-water heat into the new rooms with baseboards here and there.

We encountered the f-f-freezing problem that first winter. What should have been our most comfortable room of the house, a spacious new eat-in kitchen where we hoped to gather and entertain, was instead the least comfortable. The addition had been built 18 inches above a new concrete slab, offering a ventilated crawl space for access to piping and wires. Though insulated, the kitchen floor — with baseboards cranking out all the BTUs they could muster — was cold and uncomfortable. Guests politely retreated to carpeted rooms.

A plumbing contractor suggested that we consider radiant heat, so I started poking around. Among the websites I prowled, there was one for a firm that carried technology that I could specify through a professional and install chiefly on my own. What appealed to me most about the hot-water product was that the rubber tubing was entirely flexible, even when cold. They also offered an electric mat that we could use in the upper bathroom — no need to fuss with hot-water pipes.

After more research, I went back to the contractor for advice. At his shop, I could see and feel the more rigid plastic pex (cross-linked polyethylene) tubing (offered by most manufacturers) but decided that it was way too stiff to install on my own, in the cold and with only 18 inches to play in as I lay on my back while stapling tubing into joist bays. With a sigh of relief, the contractor gladly "sacrificed" that part of the job!

But he *was* more than happy to do the much more challenging electrical, manifold and near-boiler connections, and to pressurize what we determined would be four 200-foot loops of tubing to be sure there were no leaks. For me, it was a perfect match for my interest in doing a key part of the job, saving some money, and then turning the job over for completion by a pro. If you consider a completely direct-to-consumer resource, research their product offerings and make sure they provide adequate technical support for you to complete the job.

Following the contractor's instructions, and with the eager assistance of an engineer at the manufacturer, the system was designed to warm the floor, not necessarily to provide heat, since we planned to leave the baseboard where it was. I would do the stapling-up of the pipe, and the contractor would make all of the connections to the boiler.

Over a period of several weeks, I pulled tubing lengths behind me as I slithered through the crawl space, stapling it to the subfloor as I went. I'd stay down in that awful crawl space for as long as my wits — and my family — would allow.

An above-floor radiant-heat product (Sub Ray by Watts Radiant) is installed in a new home.

BY JOHN VASTYAN

driven and the last tube cut to length. I attached some new insulation — foil-faced batting 3 inches below the pipe — and then, below that, reused the old stuff. My task was complete.

My contractor friend arrived to inspect the job, make all the connections, and to pressure-test the tubing. It was a perfect test. The final step was to set up the digital thermostats, connected to sensors I'd attached to the subfloor. Nine months later, it was better than we expected. Winter came in with a cold, icy blast. On one side of the window was a frozen wonderland. And there we were in our skivvies and bare feet experiencing a giddy comfort.

The most common method of installing radiant heat in basement slabs or slab-on-grade foundations is to attach the tubing to a wire grid.

The tubing was marvelous. It worked like hemp rope — limp, easily pulled from one place to the next, and simply doubled-up and pushed through holes in the floor joists as I connected one joist bay to another. But make no mistake: It's no garden hose! I learned that the code-listed tubing is made specifically for radiant heat and includes an oxygen barrier to protect ferrous metal boiler components and fittings.

Another product helped me keep peace of mind while down in the abyss. It was the lowly, hand-powered staple gun recommended by the contractor. It's designed for just such a job, a simple device that required two or three squeezes of the trigger to anchor the pipe against the subfloor. Each staple had a plastic rocker shaped exactly to the underside of the pipe, eliminating the risk of squashing or puncturing the tubing.

Before I knew it, the last staple was

In this article, we'll look at different types of radiant heat, insulation and the influence of floor coverings — but before we get there, let's take a look at what this radiant heat stuff is all about and why it's becoming so popular.

Radiant Heat Basics

At the most basic level, the purpose of any heating system is to keep us warm. It does this not by heating us — we don't need the heat! — but by controlling the heat loss from our bodies. Objects around us don't have their own energy source, and since their surface temperature is less than our skin's 85° F, our bodies actually try to heat them. Comfort depends on the amount of heat we lose from our bodies. If we lose too much heat, we feel uncomfortably cold. If we lose too little heat, we feel uncomfortably warm. A heating system heats the objects around us to control the heat loss from our bodies.

Different types of heating systems do this with varying degrees of effectiveness. A baseboard system is a form of convective heat. The air around the baseboard unit is heated. Hot air rises to the ceiling, transfers its energy, cools and falls back to the floor.

A forced-air system heats the air by conduction in the furnace's heat exchanger, which is then convected around the room by the blower fan. It's too bad that air is a great insulator and a poor conductor of energy.

Radiant floor heating works by using water-filled tubes or electric heating elements to warm the mass of your floor. The surface of the floor then radiates energy that moves to all the objects in the room, making them — and your feet — cozy and warm.

Whether you're building a home or improving the one you live in, radiant heat can be a great investment. It can increase your comfort, raise your home's energy efficiency (typically a 25 percent improvement over forced air), and — with no air grates, radiators or baseboard to factor in — there's no interference with room function or furniture layout. Radiant-heat systems can also operate on any number of energy sources, and sometimes even a combination of two or more, including fuel oil, gas, electric, solar, ground-source heat and solid fuels. Today there are also many ways to deliver radiant heat to new or existing floors. These systems also offer snow-melting options for safe access to your home.

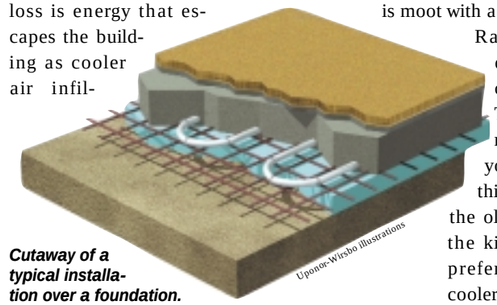
Radiant Benefits

The radiant heat from your floor will warm all the mass in your rooms, giving every surface an inviting sensation that you can feel. The floor becomes the warmest surface in the room, not the coldest. Surprisingly, those surfaces most uncomfortable without radiant heat — stone, tile and hardwood — become the most comfortable with radiant because they transfer the heat so well.

I've also heard the comment, "I breathe easier with radiant heat." There's a reason for it. A furnace dehumidifies the air you breathe. It can also blow dust, dander and allergens throughout your home, constantly stirring and recirculating it if the system is not properly filtered. Moving air can also be uncomfortable, making you feel cool as it dries your eyes, hair and skin. In many instances, allergies are reduced or even eliminated in homes with radiant heat. Also, anyone with arthritis or poor circulation may find some relief with a radiant system.

Whether hydronic or electric, radiant floor heat often costs less to operate than any other form of heat. Because radiant floors offer more comfort at lower thermostat settings, most people find that they're comfortable at lower room temperatures.

A key source of residential heat loss is energy that escapes the building as cooler air infiltrates the home. Because of the lower air temperatures in a radiantly heated home, there is less heat loss through the insulation, doors and windows. This is particularly true in rooms with high ceilings and lots of glass. Air in a radiant-heated room doesn't stratify at the ceiling like it does with improperly sized or installed forced-air systems. You pay for the warmth right at your feet where you want it.



Cutaway of a typical installation over a foundation.

Upton-Wissbo illustrations

Air in rooms of average height usually does not stratify due to the forced-air system. A proper forced-air system introduces warm air at floor level and returns the cooled air from ceiling level, thus preventing stratification (see *Warm-Air Heating* on page 40). The only time you get stratification is with very high ceilings and very large windows. With big windows, cold air generated next to the glazing falls down to the floor like a waterfall, and the room fills with cool air from the bottom up. Both forced-air vents and hydronic baseboards are strategically placed under large window areas to counteract this cold-air ponding effect. But the problem is moot with a radiant-heat system.

Radiant floors are often designed with thermostatically controlled zones. These zones give you room-by-room control over your energy use. We found this to be especially useful at the old farmhouse. We wanted the kitchen to be warmer, yet preferred the bedroom much cooler, especially at night while snuggled under feather blankets.

Using Water Wisely

Hydronic (water-based) radiant floor systems are used in larger areas or for an entire home. Generally, hot-water radiant is best for spaces of 500 square feet or more, or — in the case of our home's addition — in a home where hot water is already used as a heat source. Hydronic tubing can be embedded in concrete slabs, in thin-slabs over frame floors, stapled up between floor joists, or installed on top of the subfloor.

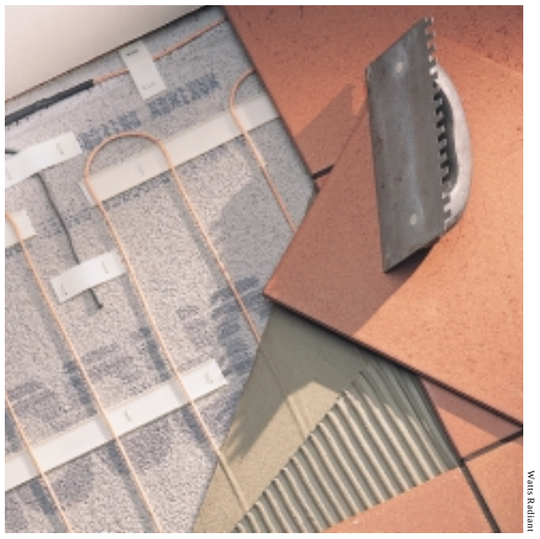
Modern hydronic radiant heating systems use a closed-loop design.

The many ways in which radiant heat can be applied. The same technology that creates comfortable tile or stone floors can be used to melt snow and ice.

Water is heated by a heat source (typically a boiler or water heater) and then circulated through the tubing to all areas of the home. Energy is then delivered to each zone as your thermostat calls for it. In a closed-loop system, the water is permanently contained in the tubing so that the same water returns to the heat source to be heated again. Don't fall for the argument that an open-loop system is safe. You don't want your drinking water to stand stagnant for months in the tubing under your floor. Hydronic radiant floor heating operates on low

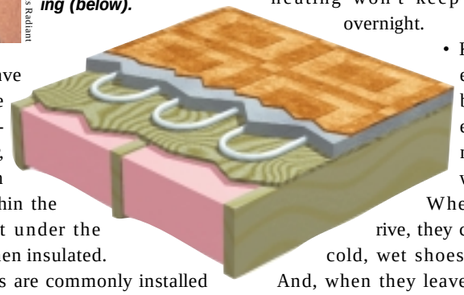
pressure (usually below 20 pounds per square inch, or psi) with low temperatures often in the 90° to 150° range.

Special distribution units, called manifolds, channel the heated liquid into multiple radiant floor pipe circuits. Manifolds are usually located close to the heated area, although they can be installed in a mechanical room. Each manifold set includes a supply (hot) and a return (cooler) manifold. Manifolds usually include balancing valves to control the flow of heated water to each circuit, or loop. Circuits are the loops of pex



Watts Radiant

Thinset is applied over the wire mesh of an electric radiant heat system, then the tiles are placed (left). The same basic techniques are used with concrete, hydronic tubing, and laminate, wood or sheet flooring (below).



or rubber tubing that begin at the supply manifold and end at the return manifold. The combination of manifolds and circuits heat a defined area that's called a zone. A zone can be comprised of one room or several.

Electrifying Possibilities

An electric system may be the best choice for small areas like a single master bathroom. Of course, if electric energy is cheap in your area, it could be used to heat, or provide floor warming to, an entire home. Typically, low-profile electric radiant floor systems are installed right in the thinset used to set a finished tile or stone floor. Warm solid-surface floors are popular for master bathrooms, entries, kitchens and sunrooms.

Watts Radiant offers mats that come in 12-, 24-, 30- and 36-inch-wide rolls with lengths up to 80 feet. These are shaped on the jobsite to fit any floor plan. The mats contain a woven-in heating element. Other types involve attaching spacers to the subfloor and stretching a wire back and forth that's attached to the spacers (EasyHeat). Yet another uses low-voltage screens that can be stapled directly to the subfloor (Step Warmfloor).

In most instances, installers of electric radiant products first attach a cementitous backerboard over the subfloor. The mats are then stapled or taped to the backerboard and thinset mortar is applied with a notched trowel just prior to setting tile or stone.

An option especially well-suited for remodeling projects where an existing solid-surface floor has no heat, is a new type of electric radiant mat that's UL-approved for joist-bay applications. If you have access to the framed underside of the floor, these mats can be secured within the joist bays, just under the subfloor, and then insulated.

Electric mats are commonly installed with programmable controllers that use a remote sensor embedded in the floor to keep your feet at the temperature you select. Your controller will turn your radiant floor on when you are in the room and off when you leave.

There's one thing to check on with electric products. Ask about electromagnetic field (EMF) radiation. EMF is generated by the flow of electrical current, and although the health impact is hotly debated, most experts advise you to minimize your exposure. Some manufacturers offer very low or zero-EMF electrical systems.

Comfort vs. Cash flow

Radiant heating can warm an entire house, so supplemental heat is rarely required. In extremely cold climates, however, a secondary source of heat may be desirable. Hot-water baseboard systems are often the natural choice. If your budget rules out heating the entire home with radiant, then you should definitely plan to install warm floors in the areas where comfort is most important to you. These can be done easily with electric or hydronic technology. For instance:

• Master bathrooms: You'll spend plenty of time in a master bathroom. Your investment there (on a per-square-foot basis) is sizable, your feet will be bare and your floors will be wet. By all means, make sure your next home has a warm floor in the master bath.

• Great rooms or family rooms: Frequently, these rooms have open or vaulted designs where forced-air heat would stratify. A radiant floor will warm every object in the room without drafts or noise and without sending the heat up to the ceiling.

• Sunrooms: They may be beautiful to look at, but sunrooms can be terribly uncomfortable because conventional heating won't keep them warm overnight.

• Kitchens and entries: Your bare feet will enjoy a warm massage all winter long. When visitors arrive, they can leave their cold, wet shoes on the floor. And, when they leave, they'll have warm, dry feet on the way home.

What to Install

When building a home or addition, radiant heat can be applied anywhere — floors, walls and ceilings. If you are remodeling and you have access to the floor from below, you can staple radiant tubing directly to the underside of the subfloor. To enhance efficiency and heat transfer, aluminum heat-emission plates can be used; these sheet-metal pieces attach to the pipe and are stapled to the subfloor. Then insulate below the tubing with fiberglass batt insulation. It's best to use a foil-faced batt, attached 2 or 3 inches below the pipe. This method works for any type of floor covering and does not affect the finished floor height.

The radiant purist's favorite (yet most expensive) technique is to staple tubing on top of the plywood subfloor. It's then covered with a thin slab of lightweight concrete or gypsum-based masonry. This method adds thermal mass to the floor and higher BTU output. It will increase the structural requirements of the floor and raise the floor height by at least 1 1/2 inches. To accommodate this type of floor, the builder "double-plates" the wall, using two 2x4 bottom plates rather than just one, and a sturdier joist system is also needed. Joist-bay staple-up is the most popular technique for new construction and remodeling.

There are also a variety of products suitable for new construction or remodeling. One method offered by a few manufacturers (see opening photos) provides excellent BTU output per square foot. Plywood sleepers are screwed to the subfloor and tubing is laid between. A floor installer then bridges over the system with any finished floor using hardwood, laminate wood products — such as those offered by Pergo — tile or stone (over backerboard). This method adds about 1/2 to 3/4 of an inch to the finished floor height.

Yet another, by EasyFloor, uses plastic interlocking blocks as an alternative to poured concrete. A thin, formulated stone covers the blocks to distribute heat and provide thermal mass for heat retention. The removable stone tiles — just below the chosen floor covering — allow access to tubing below.

Drawbacks to Radiant Systems

• Radiant systems usually require about twice the expense of a forced-air system. And depending on the bells and whistles you choose, it can be more.

• Since radiant heat isn't delivered through ductwork, a separate, dedicated mechanical system is needed for air conditioning.

• There's also a need to plan the use of interior spaces more carefully. Because the heat source is at your feet, you can't drill bolts into the concrete slab or drive nails into a floor without careful consideration. Better to plan it out initially.

• These systems also require more time to initially heat a space. Because radiant energy heats mass and must penetrate all flooring layers, its heat builds gradually.

On the other hand, once a floor is heated, it retains its heat very well. I know of one family that lost electricity for three days (the gas-fired boiler needed electricity to function). Yet the home's well-insulated, high-mass, radiant slab-on-grade system lost only 4° or 5° in that time. That's thermal storage!

The key, in my opinion, is to involve the talents of a professional installer who knows and has experience with radiant heat, preferably a member of the Radiant Panel Association. You can then choose with confidence to what extent you'd be involved in the process.

All This and Snow-Melting, Too?

While planning your radiant system, look at the floor plan carefully to see if there might be a door, a sidewalk, or a garage entrance that faces north or is exposed to ice and snow build-up. You may want to ask your radiant designer to add one or more snow-melting zones to your heating system.

This entails moving a heated water-antifreeze solution from a heat exchanger attached to your space-heating boiler or dedicated heat source underground to cold surfaces outside. You can activate snow-melting zones when the weather report calls for freezing precipitation or simply wait for the microprocessor control to do the job (that's one of the aforementioned bells and whistles).

For a snowmelt system, the designer specifies tubing embedded in outdoor or garage cement slabs. The designer must consider the influence of local weather, insulation, pipe spacing, pipe diameter and circuit length. As an option to hydronic snow-melting, one company — Delta-Therm — sells a heavy electric cable product well suited to the task.

Getting Started

Visit the Radiant Panel Association's website. Check the sites of the manufacturers listed in the sidebar at left. Interview a few professional installers; be sure to ask if they belong to the RPA. Also visit one of the best sites in the industry: www.heatinghelp.com. Try the contractor locator to help find a top firm.

It's important to know that many manufacturers sell their product only to professional installers. But there are plenty of ways to participate in the installation. Generally, the electric technology is easier to install than the hydronic. Ask the contractor what they'd be comfortable with. Of course, they can't guarantee work you do. And you can go to Home Depot and Lowes to find some of these products, ready for you to install. ■

FOR MORE INFORMATION

Radiant Panel Association
www.radiantpanelassociation.org
800-660-7187

Delta-Therm (electric products)
www.4deltawarm.com
800-526-7887

EasyHeat (electric products)
www.warmtiles.com
800-523-7636

Heatizon Systems
www.heatizon.com
888-239-1232

Infloor Radiant Heating
www.infloor.com
800-588-4470

Radiant Floor Company
(direct to consumer)
www.radiantcompany.com
866-WARM-TOES (927-6863)

Stadler-Viega
www.stadlerviega.com
800-370-3122

Uponor/Wirsbo
www.wirsbo.com
952-891-2000

Warmboard
www.warmboard.com
877-338-5493

Watts Radiant (hydronic & electric)
www.wattsradiant.com
800-276-2419

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