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RADIANT FLOORING GUIDE

2013 EDITION

YOUR GUIDE TO SUITABLE FLOOR COVERING AND SUBMATERIALS FOR USE WITH RADIANT HEATING

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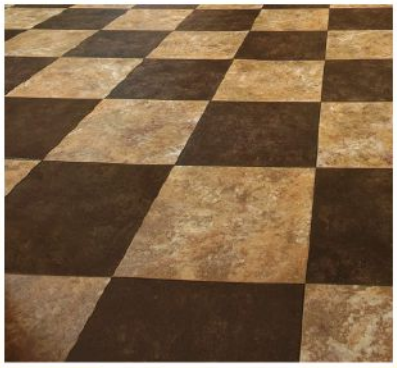

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RPA RADIANT PROFESSIONALS ALLIANCE®

A Supplement to:

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COMFORT'S PAST HAS MET ITS FUTURE

The Radiant Professionals Alliance is energized and equipped to chart a course of action that will direct and create the future of the hydronic and radiant industry.

The new RPA member leaders, pictured on the right, have a smart and distinct focus for industry expansion, which includes initiatives specifically designed to meet the needs of all RPA members. They are dedicated to the professional growth and advancement of everyone in the industry — no matter what role or capacity. RPA Chairman Mark Chaffee said it best in a speech he delivered to the RPA membership: "The RPA is an alliance strong in its core values and true to its meaning."

Among many new initiatives, the RPA is advocating codes and standards that govern the design, installation, methods and materials in the plumbing, mechanical and solar systems in homes and businesses, which will give consumers confidence in the technologies and installers and inspectors confidence that installed systems meet expectations. The RPA is working with the International Association of Plumbing and Mechanical Officials to develop an American National Standards Institute-accredited radiant, solar and geothermal code.

With this code, the RPA will have the basis on which to do many great things, including developing an education curriculum and a certification program for the next generation of contractors and installers. This program will help homeowners select certified contractors to properly install renewable energy solutions with their radiant heating systems.

The RPA is the only organization worldwide where radiant professionals have the opportunity to be in immediate and constant contact with each other. This is why the RPA is best positioned to "Grow Radiant." The future is promising with members' renewed enthusiasm. This edition of the Radiant Flooring Guide is a superb example of the commitment members have made via their skillful expertise in making this the best guide published to date.

The 2013 Radiant Flooring Guide is the go-to resource and a highly regarded reference for dealers, contractors, design professionals and consumers. What, where, why and how? Wood, tile, stone, carpet, laminate or resilient floor coverings? Every question about all types of radiant flooring systems is addressed. It is the leading resource for ideas and inspiration.

The RPA is dedicated to continue to play a significant role in the acceptance of radiant into the mainstream of the HVAC comfort market and as an organization of stakeholder members who are dedicated to the professional growth and advancement of everyone in the organization, including each other. The RPA is the future of radiant.

KATHLEEN MIHELICH

EXECUTIVE DIRECTOR
RADIANT PROFESSIONALS ALLIANCE

The RPA Radiant Flooring Guide unites the various floor covering industries and the mechanical heating trades with one goal in mind: To ensure maximum performance and satisfaction with all elements in a radiant floor heating system.

Since 1994, the RPA has been dedicated to providing information and education about radiant heat.

Photo credit: Radiant Professionals Alliance

The Radiant Professionals Alliance board of directors (left to right): Secretary **Carol Fey** (Carol Fey & Associates); Treasurer **Mike Dietrich** (REHAU); Government Relations Committee Chairman **Tom Meyer** (National Environmental Balancing Bureau); Codes and Standards Committee Chairman **Randy Knapp** (Plastic Pipe Institute); Education Committee Chairman **Mark Eatherton;** RPA Board Chairman **Mark Chaffee** (Taco); Membership Committee Chairman **Joe Kennard** (Intermountain Sales & Marketing); and RPA Board Vice Chairman **Ingrid Mattsson** (Uponor). Not pictured is past chairman **Dorothy Biggs** (Viega).

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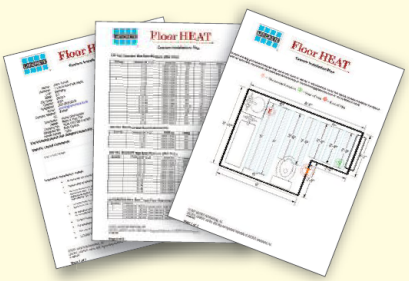

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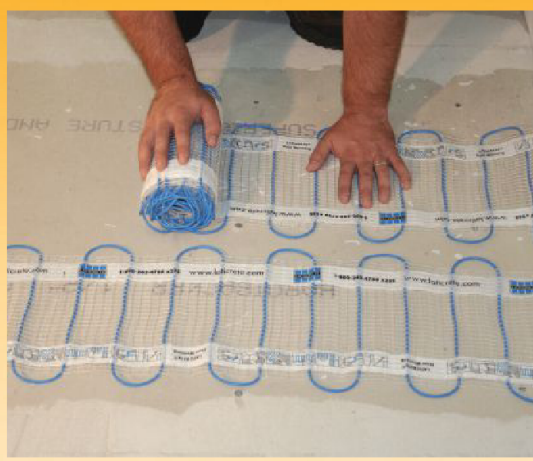

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A BRIGHTER FUTURE AHEAD

The Radiant Flooring Guide has been a staple in the industry, providing valuable information about the application of radiant heat in combination with suitable floor coverings and submaterials. Another staple in the industry has been the Radiant Professionals Alliance. The RPA works daily to broaden the recognition, acceptance andproper installation of radiant and hydronic technologies. It also serves the stakeholder members with technical expertise, education and support programs. One example of this is our partnership with BNP Media to publish the Radiant Flooring Guide.

There have been many changes in the industry over the past few years: a steady increase in technology; introduction of numerous advanced controls and heat generation options; increasing government mandates and oversight; and the growing green movement.

This is all mixed in with a poor housing market, economic uncertainty and a shrinking share of new home heating systems which use any style of hydronics or electric radiant. Sure it has made it more difficult for radiant professionals to prosper and grow their businesses, but it is certainly not all gloom and doom — especially when the industry has RPA on its side.

At the RPA, we see a much brighter future for our industry. It starts with the organization's foundation, which is rooted in technical expertise, education and professionalism to the art and science of radiant and hydronics. We then focus on a unilateral move forward in support of an industry of professionals, aligned in a mission of growth and advancement.

Our commitment to the industry means:

- That the RPA will be an advocate of codes and standards that govern the design, installation, methods and materials in the plumbing, mechanical and solar systems in homes and businesses. This will give consumers the confidence in the technologies and will give installers and inspectors confidence that installed systems meet expectations.
- That we will have a basis on which to set the curriculum for the next generation of installers — passing on a legacy of professionalism.
- Exploring a major campaign to expand the recognition and acceptance of radiant and hydronic technologies among consumers and decision makers.
- Being the clearinghouse for industry analysis and data.
- Industry advocacy; making sure our industry's interests are represented in front of policy makers in Washington, D.C.
- Upgrading our technical education, especially with the convergence of multisystem technologies — solar, geothermal, radiant and electric.

And finally, it means continuing to make available professional publications such as the Radiant Flooring Guide, one of the premier resources in the industry.

All of us at the RPA are dedicated to providing superior leadership, a professional alliance driven by engaged active members, and fostering the awareness of radiant and hydronic technologies in order to "grow radiant."

MARK CHAFFEE
CHAIRMAN
RADIANT PROFESSIONALS ALLIANCE

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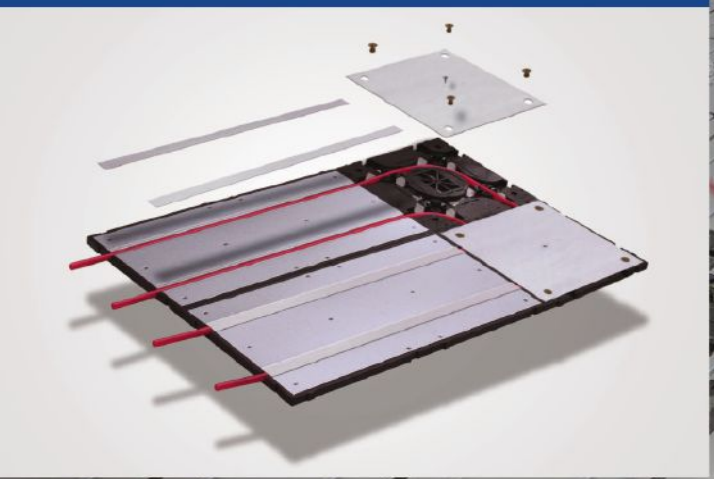

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THE VIRTUES OF LOW-MASS RADIANT MATERIALS

Back in the good old days, radiant flooring was simple. The concrete floor was covered with linoleum, 12" x12" tiles or carpet. Water temperatures circulating through the copper circuits might be a little high due to other parts of the home that were heated with baseboard or radiators. Today, the most common radiant "add on" is a still a basement-and-garage package. The tubing installed during new construction is the perfect method for heating these two places in the home.

As with all technology, new products and thus new opportunities made it possible to provide radiant comfort and efficiency throughout the entire home. At the same time, floor coverings have evolved due to personal tastes and construction practices.

Hardwood flooring use to be exclusive to full-cut, solid wood in a variety of species. Today the look of hardwoods can be purchased in solid, engineered and even simulated in vinyl and composite products. Tile and natural stones again are available in a variety of solid and engineered offerings.

With these new flooring products, today's radiant home systems and homeowners' use of their homes also have changed. With the capability to reset temperatures in individual rooms or the whole house for comfort and fuel savings, it is critical that designers and contractors employ today's latest under-floor technologies to accomplish a correctly operating system.

We now have handheld devices that can control everything in our homes. You can set your cable box to record, view a security camera, turn on a soaking tub and, of course, monitor and adjust the temperature of your home. High-mass concrete radiant systems don't react quick enough to respond to these changes as the mass holds temperature longer. These systems are perfect in spaces where the temperature never changes. However, if you want to change temperatures on a regular basis, such as when you go to work, low-mass panel systems fit the bill.

Radiant manufacturers offer a variety of low-mass engineered panel systems, in a wide range of materials, in order to design the correct solution for the demands of today's modern homes. These complete radiant panel systems are assembled on-site, require no other external products for installation and are preferred by installers and general contractors for the ease of installation and a lower impact on the jobsite.

After the final appropriate underlayment has been placed, these systems can accept any finished floor. A room can be installed with radiant, covered and the flooring installed all on the same day. In most cases, very little change is needed in the construction process as most of these systems are no thicker than 1" and add very little weight to the structure. This installation option is perfect for new homes and remodeling applications.

For the homeowner, a low-mass system means the ability to change temperatures quickly between rooms, raise the basement temperature right before movie night, or turn on the weekend house remotely at 4:00 p.m. on Friday, at the same time saving precious energy.

The Radiant Flooring Guide has detailed drawings of these systems and should be considered when your home project is being designed.

MICHAEL GEAGAN
TECHNICAL DIRECTOR
RADIANT PROFESSIONALS ALLIANCE

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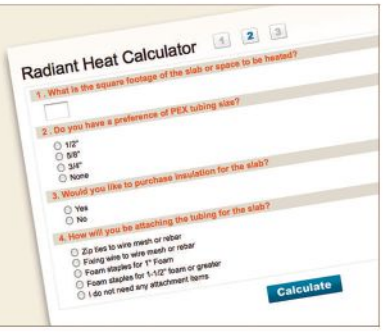

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RADIANT WINDOWS HELP CREATE THERMAL COMFORT

PEX tubing under the floor is not the only way to make a room more comfortable.

We have all felt the warmth of the sun shining through a window. Conversely, we also have noticed the cold that a window gives off on a chilly day. Windows are our visual connection to the outside; they bring in views, natural light, ventilation and, unfortunately, the temperature discomforts of the exterior as well. Very often for clients and architects, bigger windows and more windows are better; but thermal shortcomings exist with a lot of glass.

Along with some doors, windows are the only building material that is the same material on the inside through to the outside, a material which is not a good thermal insulator. Also like doors, windows are the only exterior elements that are touched, operated and seen from both the inside and outside of a structure. They can be considered the most important element visually and functionally in any building. Even though windows continue to become better insulators through innovation, their inherent thermal resistance does not compare to the insulating properties of other exterior building systems.

Windows are responsible for more than 50% of a building's heat loss, states the American Society of Heating, Refrigerating and Air-Conditioning Engineers. This causes human discomfort, especially for folks sitting near windows, even with a properly sized heating system. There is, however, an application for any window that prevents interior heat loss. It does this by also heating the interior of a structure and offering the most comfortable source of heat perceived by the human body.

A window, framed with steel, fiberglass, wood or vinyl material, can be re-glazed to have the proper components to produce heat and reduce heat loss. A radiant-heated window can be the primary heat source, such as in new construction, or a supplemental heat source, commonly used in additions. Similar to heating under the floor or a burning fire, a "dynamic" window gives off radiant heat, which is the most efficient and most comfortable heat felt by our skin. It radiates heat into the room, warming interior surfaces and creating evenly distributed warmth, which is transferred to and absorbed by the human body to regulate comfort.

It enables lower room air temperatures without losing comfort because it is the radiant heat that makes us feel warm, and it is this sensory perception that is important for a good heating system. Thermal comfort is a subjective perception and the mean radiant temperature (MRT) of an enclosed space is the best measure of what our bodies feel and respond to.

Most of our homes and buildings are acclimatized by measuring air temperature, also known as dry bulb temperature, to control our furnaces and boilers. However, this measure of temperature is less effective at creating a comfortable environment.

Radiantly heated windows are regulated by a black globe thermostat, which has an interior sensor to measure radiant heat in an interior space. When the radiant temperature drops, the MRT thermostat triggers a low duty cycle energy draw to keep the interior warm and comfortable to inhabitants.

These windows work by running a current through the metal oxide coating on a standard low-emittance window. The coating is between the two panes of glass on a double-pane window mechanically fastened to the interior pane. Most of the heat generated radiates into the interior space. The air space between the panes and exterior pane of glass allows a portion of the energy to be lost to the outside. However, this "lost" heat prevents condensation and reduces rot on the exterior of the window.

Unlike typical windows, radiant-heated windows create a thermal barrier at the point of a typical building's thermal break. They offer a higher-performance building exterior, allowing larger windows, more natural daylight and a superior living environment.

Rebecca (Becky) Alexis
Denver architect and residential contractor, www.hivearchitecture.com.

Photo credits: Rebecca Alexis

Radiant-heated windows work by running a current through the metal oxide coating on a standard low-emittance window. Most of the heat generated radiates into the interior space.

The value, in addition to the sensory comfort, is that there are no moving parts, no filters to change, no ducts or vents to install or clean, and no blowing air that moves dust and dirt particles around a space. There are no wires through the glass and no tinting. The window functions visually just like a normal low-e window.

It has been independently proven that this type of window uses up to 40% less power than conventional heating systems. When compared to the installation of a forced-air system, the initial cost is comparable and the life-cycle cost saves hundreds of dollars on winter heating costs.

Thermal conditions in any home or business are a major factor in comfort and efficiency. In addition to the HVAC systems, the exterior skin of a building should be the first defense against uncomfortable exterior conditions. Radiant-heated windows offer protection from the elements at the point of contact and radiate controlled, efficient and comfortable heat into the interior space.

9 TIPS FOR DESIGN SUCCESS

Some things to consider when designing your radiant comfort system.

Photo credit: ©iStockphoto.com/ArtisticCaptures

Involve your entire team early in the process to arrive at the best solutions for flooring and comfort for your family.

Q&A

What's the difference between 'wet' and 'dry' radiant heating systems?

A wet system is embedded in poured concrete or gypsum. Moisture is then cured out of the slab. A dry system is one that is either hung below the flooring or tubed through a prechanneled modular board — neither of which involves moisture or curing.

If you have reasonable, educated expectations about your radiant comfort system — and the finished flooring installed over it — you'll enjoy a wonderful heating system and beautiful floors.

1. Learn how a radiant floor heating system works. Understand how flooring affects heat transfer, and learn about the few limitations in choosing flooring for radiant heat. You can find much of that information in this guide.

2. Involve your entire team early in the process to arrive at the best solutions for flooring and heat. Realize that radiant heating systems can affect both the height of flooring assemblies and project sequencing, so this needs to be coordinated as early as possible.

3. Research the qualifications of the radiant and flooring contractors and encourage good communication among the whole team. Whenever possible, select team members who have expertise in design and installation. The Radiant Professionals Alliance is a good resource.

4. Get an accurate heat loss and radiant project design done by one or more radiant professionals. Request that it include the R-value limitations of your design's specific floor coverings. Look for flooring products that fit within these parameters and are suited to radiant floor heating.

5. Have the flooring installer check with flooring manufacturers and trade associations for their recommendations over radiant heat. Avoid using flooring that the manufacturer doesn't recommend over radiant heat.

6. As the project progresses, pay attention to sequencing and any construction details unique to a radiant heating system.

7. If your radiant system is being installed in concrete or gypsum cement, make sure the system has run long enough to drive out all the moisture before you install your finished flooring goods. This eliminates the single biggest possible source of trouble for your flooring: moisture.

8. Realize that a state-of-the-art temperature control system will accurately control room and floor temperature, as well as guide your floor through gradual temperature changes.

9. Make certain that the designer, building contractors and installers understand the critical need to place proper insulation below the heated surface to guarantee directional flow of heat into your home. Don't fall into the "heat rises" trap. Radiant energy flows in all directions, including down. See additional insulation information on page 24 of this guide.

Todd Fratzel, P.E.
United Construction Corp., Newport, N.H.

Photo credits: Todd Fratzel/United Construction Corp.

Consumers currently in the market to build new homes are focused not only on energy efficiency, but also on making sure any 'extras' offer a good ROI when it's time to move or retire. Today, radiant heat has replaced fireplaces as a must-have feature, especially in colder climates.

RADIANT FLOOR HEATING IS HERE TO STAY

Long-term benefits include healthier indoor air, cleaner floor plans and quiet operation.

Not too long ago, I remember that less than 25% of our new house-builds included radiant floor heating. Today, the discussion of radiant seems to be more about which rooms will get it versus whether the homeowner wants to invest in the technology at all. It surely seems as though this type of highly comfortable, energy-efficient heating has finally embedded itself into our society and is here to stay.

Another important change: In years past, the discussion about radiant heating always focused first and foremost on cost and budget. For those on a limited budget, radiant was thrown out quickly during negotiations. For customers with a sufficient budget, the discussion quickly turned to comfort, efficiency and, ultimately, return on investment.

Today, the discussion typically starts off with homeowners wanting to make a good investment in the building's components, energy efficiency and comfort. The higher cost of radiant is being offset with smaller house designs and the elimination of things such as porches, fireplaces and extravagant decks.

Consumers currently in the market to build new homes are very focused not only on energy efficiency, but also on making sure any "extras" offer a good ROI when it's time to move or retire. That's why it's not surprising that radiant is in high demand in colder regions such as where I live and work in New Hampshire. While house hunters might have once sought a fireplace, now they often list radiant heat as a must-have feature.

LONG-TERM BENEFITS

Of course, some homeowners remain on the fence as to whether to install radiant in their homes. We work to educate them on the benefits versus a more traditional baseboard or forced-air system. To persuade a reluctant buyer, I like to share some of the long-term benefits radiant heat can do for them both personally and financially. These include:

- **Healthier indoor air quality.** Elimination of forced-air heating is one of the biggest health benefits radiant heat can provide. No more dust and dirty duct work.
- **Cleaner floor plan.** Eliminating duct work and/or wall-mounted radiators offers homeowners many options on where to place their furniture. Radiant eliminates the need for baseboard and radiators, which can interfere with positioning dressers, beds and cabinetry.
- **Quiet operation.** One of the more overlooked benefits of a radiant heating system is how quiet it is compared with forced-air and even radiator systems. Properly designed, installed and controlled radiant systems make almost no noise except for an occasional sound of the boiler ramping up to temperature.
- **Efficiency.** Studies have shown that the long-term efficiency of radiant heating is better than both forced-air and baseboard heating systems. With fuel costs likely to continue rising year after year, any advantage in efficiency is a huge benefit.

COMFORT

Radiant heat is, by far, the most comfortable heating available. Nothing feels better on a bitterly cold winter morning than stepping onto a warm bathroom floor. After personally living with and enjoying radiant heating for the past six years, I can say I'll never go back to the old drafty days of forced air or the moaning and gurgling of hot-water radiators.

Radiant is here to stay, and we're all the better for it.

KEEPING AN OPEN MIND

The best radiant contractors will install efficient radiant heating systems at the best value for their homeowner clients.

The hardest part about using radiant floor heating in your home may be finding a qualified installer. You may be fortunate enough to live in an area where radiant heating is popular. For others, you may encounter objections to using radiant floor heat from those in the building industry.

Objections to the unknown are normal. However, working with professionals or trades people who are unfamiliar with radiant heating systems can result in inflated costs and potentially poor installation.

When choosing a radiant contractor to install your floor heating system, make sure he has the experience and proper training or your floors will not provide the comfort you are seeking. Check with the Radiant Professionals Alliance for a list of experienced members in your area.

A good radiant contractor knows how to make radiant heating systems work properly and efficiently while exceeding the comfort expectations of their homeowner clients.

"We keep pace with the latest, most-efficient technology, especially renewable energy systems," says **Mike Bernasconi,** vice president of piping operations at Woburn, Mass.-based Central Cooling & Heating. "It's all about educating customers and providing them with the best value."

Central ensures things are done the correct way by providing education to service technicians — and customers. On the second floor of Central's headquarters is a large training center with the capacity to seat 40 technicians. Bernasconi designed the center, which features an extensive hands-on area with low-temperature radiant loops, a higher-temperature radiant panel, an indirect water heater, a mod-con gas boiler, a mini-split HVAC system and a variety of hydronic components.

Photo credit: John Herr Photography

Central Cooling and Heating Vice President of Piping Operations Mike Bernasconi (left) and Service Manager Phil King make preparations in Central's training room prior to a class.

"The service guys are able to see the same type of equipment on a consistent basis," Bernasconi states. "We discuss issues we're seeing out in the field. If we hire a new person, we can give private lessons and show him what he's going to see. Customers will come in and see what finished systems look like."

In addition to providing sustainable solutions that make the most sense, Central works to keep its systems as unencumbered as possible.

"We still do some complicated high-end things, but because the way houses are being built, it's allowing systems to be simplified," says **Darren Hamilton,** a co-owner of Central. "Think about the technician who walks into your house Christmas Eve and tries to figure out what is wrong with your heating system. You have to keep it simple and less complicated — and more efficient."

Hamilton also places a major emphasis on educating customers on the various rebates available for installing energy-efficient technology. Central employs an individual full-time to handle nothing but rebates.

While netting a customer savings is key, making sure a system is producing the most bang for its buck is an even bigger must. "We approach every job with an open mind and give the customer the best-valued comfort solution that fits their needs," Bernasconi says.

ASK FOR REFERENCES

You're spending a lot of money on your radiant system as well as the finished flooring; do your research.

Photo credit: Launstein Hardwood Floors

Hardwood manufacturer Launstein has its own testing facility to educate consumers as well as radiant contractors on the correct way to install wood flooring over radiant floor-heating systems.

Your radiant floor-heating system is a major investment in your home; you want to make sure it is installed correctly to provide the comfort you seek, as well as protect the flooring you choose to go over it. First, learn about the differences in material costs for various flooring products if you are having new floors installed, and decide which type of flooring you want to use. Flooring types that can be used over radiant heating systems are described in the back of this guide (pages 27-41).

Ask friends and relatives for recommendations to help find a flooring contractor or check with the Radiant Professionals Alliance. When calling the contractor, ask if he has experience with installing flooring over radiant heating systems.

Request a list of homeowners who have used the contractor for installing finished flooring over radiant floor heating. Call and ask if you can visit the home and talk to the homeowner (this also is a good practice when looking for a radiant contractor).

Once you decide on a flooring material, you also can ask the manufacturer for a list of flooring installers in your area. Testimonials, such as the following from Launstein Hardwood Floors, are helpful, too.

"We recently had your floor installed in our log home, located in Northern Wisconsin. We are so happy with the floor. It absolutely looks like the home was built with the floor already in it. I love that no two pieces are alike. It has the rustic look we were going for.

"When we knew we were going to need wood floors for our home, I began to look online for something unique. Rob [Rob's Tile and Hardwoods, Rhinelander, Wis.] brought over samples but everything I saw looked so manufactured. It all looked like it was created to have the natural look that your floors already have. Since we have radiant heat, I knew we had some limitations. When I saw your site, I knew I had found something different and unique and, most importantly, made for radiant heat.

"I just thought I'd drop you a line to let you know that as I look at the floor right now, I'm simply in love with it. It's an amazing product. Rob did a fantastic job putting it in and we are looking forward to enjoying it for many, many years to come."

Launstein has its own testing facility, which was built a few years ago to gather data on the affects that different radiant systems — hydronic and electric — have on different species of wood. Its goal is to educate consumers and radiant contractors on the correct way to install wood flooring over radiant floor-heating systems. View the recent results at www.launstein.com/test-results.html.

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A PERFECT MARRIAGE

Comfort and economy of operation are linked with well-designed and properly installed hydronic radiant floor systems.

Providing thermal comfort by transferring energy from point-of-source to point-of-use in hydronic (water-based) systems is achieved by a wide variety of radiant-floor installation methods and each requires varying degrees of water temperature to deliver the same results. The radiant floor temperature boundary for human comfort revolves around maintaining a floor surface temperature below 85° F.

The human body loses heat in four basic ways: radiantly (your body radiates heat); convectively (air currents); conductively (direct contact — barefoot on an unheated tile floor); and perspiration (latent heat of evaporation). Skin surface temperature averages 85°. A floor surface temperature above 85° upsets the balance between the four and will cause people to be uncomfortably warm.

A general misconception about radiant floor warming is that the 85° design limitation was required to protect hardwood flooring. If that was true, hardwood floors heated to well above 100° while baking in direct solar gain would be easily and permanently damaged!

Radiant floors are often a perfect marriage with all types of hardwood floor coverings and all available floor surface materials are compatible with hydronic radiant heating. Modern hydronic radiant design programs provide the system designer with the ability to "install" virtually any type of floor covering over the radiant floor panel, which provides an ability to determine compatibility and the required water delivery temperatures to offset the heat loss.

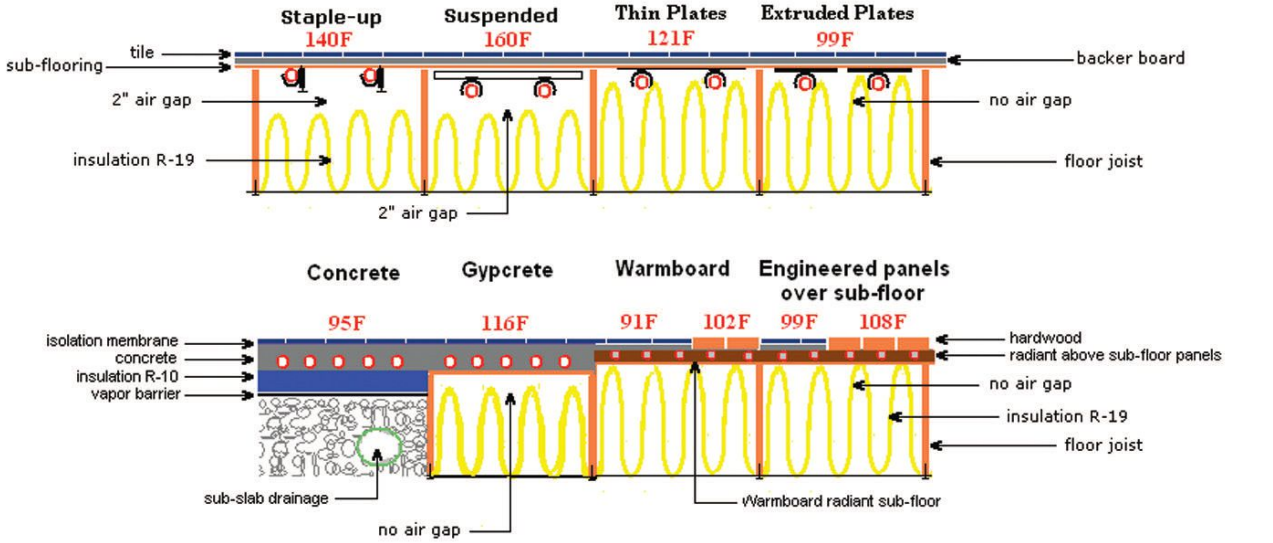
It is not unusual for room-by-room designs to require a wide variety of water delivery temperatures. Numerous reliable methods are available to precisely control multiple-temperature delivery from a single-temperature source or from blended systems where multiple- and varying-temperature energy sources are incorporated.

Comfort and economy of operation are inexorably linked with well-designed and installed hydronic radiant floor systems. Low-temperature designs offer the greatest opportunity to blend a wide variety of energy sources, maintain peak operating efficiencies (especially true for geothermal or air-to-water heat pumps), and to incorporate alternative energy sources such as wind, solar photovoltaic and solar thermal. The lower the system's temperature requirements, the better the overall system-wide efficiency, which will ensure the lowest possible operating costs for fuel and power.

The majority of hydronic radiant systems, certainly the better-designed ones, will employ a control strategy that will alter water temperature based upon whatever Mother Nature is giving us outside. The building's heat loss will be greater as outdoor air temperatures fall. Conversely, system water delivery temperature will be increased to transport more comfort-energy to the radiant floors — the colder it gets outdoors, the hotter the water.

How hot depends on the installation method used for the floors, the materials between the radiant tubing and/or panels and the room served, the desired

Water temperatures required to meet the required 80F floor surface temperature.



Drawing by Dave Yates

temperature of the room, and the insulation below the radiant tubing/panels that directs radiant energy toward the conditioned space.

CONSTRUCTION/DESIGN METHODS

When designing or considering installation methods, system delivery temperatures will vary widely. In order to provide thermal comfort, offset the heat loss of the space being served, conserve energy, stay within consumers' budgets and use heat sources effectively. Limiting floor surface temperatures to a maximum of 85° ensures comfort.

The illustration on page 20 depicts a variety of installation methods and their corresponding required water delivery temperature where the floor surface temperature must equal 80° on a design day in order to provide sufficient thermal comfort.

RETROFIT AND ADDITIONS

A large market exists for adding hydronic radiant floors to existing homes where steam, hot water baseboard or even hot air systems exist. A number of manufacturers provide add-a-zone prebuilt hydronic radiant control panels that incorporate everything required except for the installation of the radiant floor components.

FLOOR WARMING

High-density tile and stone products feel cold (conduction) to bare feet and the human body can sense heat loss (radiant) to the high-mass flooring products

Imagine the joy of stepping onto a warmed bathroom floor in summer and/or winter and then discover it can be a reality instead of just a dream. Floor-warming systems are typically controlled via programmed cycles so the floor is heated only as desired.

CONTROL STRATEGIES, ENERGY CONSERVATION

If the existing heating system in the home is water-based, then heated water is available but most likely not at the correct temperature. Once the radiant system's design and installation method is chosen, any primary hot water source can be tapped into and adjusted in the radiant zone's mixing strategy — from simplistic mixing valves to more advanced injection mixing.

Electrically commutated motor circulators can dramatically reduce electrical power consumption by 80% or more. Low-wattage zone valves can be incorporated to complete the energy conservation picture.

If the existing system is air-based, older low-efficiency furnaces can be upgraded by the addition of a hydro-coil or replaced with a hydro-air furnace. Existing water heaters can be replaced with ultra-efficient indirect water heaters or by boilers with a built-in domestic hot water generation system.

BEYOND COMFORT

Homeowners today want to know what Energy Conservation Value the installed hydronic system will provide and how it relates to the return on investment. ECV is the amount of energy conserved at today's utility rates when compared to an existing appliance and/or new appliances. The entire system from energy source to energy transportation to radiant panel construction determines the real-world performance and efficiency.

Hydronic radiant heating equals healthy heating, too. Indoor air quality is enhanced, homes are easier to keep clean, drafts are not created, germs have fewer places to hide and people get sick less often.

THE COMFORT OF WARM FLOORS

With electric radiant, just enough heat is supplied to the floor to combat the chill.

Photo credit: Watts Radiant

Some electric radiant systems are designed solely for use under tile, but there are many that can support a range of floor coverings.

Electric radiant floor heating systems have seen tremendous growth in residential applications, due in part to the varied, innovative products introduced that cater to many needs. It can be used as a primary source of heating or simply to take the chill off some of the cooler flooring products people like, such as tile.

In floor-warming applications, just enough heat is supplied to the floor to combat the chill and make the material feel warm. This is attractive in all climate areas because wherever you live, it feels good to wake up to a warm floor.

Electric systems also can be cost-effectively installed in small projects on a room-by-room basis. This is particularly useful in remodeling projects, where a few rooms are being added to a home.

Another plus for using electric radiant in remodels and retrofits is its method of installation. Many electric systems can be installed in a very thin thermal mass or mortar layer on top of a subfloor, with a minimal increase in finished floor height, a major advantage.

Flooring dealers are beginning to sell electric radiant products as a companion to flooring, particularly to their tile customers, since many systems can be sold in quantities customized to a particular room or project.

DIVERSITY OF SYSTEMS

You'll find great variety in electric radiant systems. Some are intended only for floor warming and only under specific flooring materials. Others are designed to be used as primary heating systems. Some of these systems are designed solely for use under tile, but there are many that can support a range of floor coverings.

Discuss the diversity of electric products with your radiant professional,

and check with individual manufacturers for specific installation requirements and floor-covering limitations.

Electric systems are available in many configurations, both in low and high voltage. They're available as cable, as thin cable in preformed mats or in mesh, elements embedded in plastic film, or as self-regulating mats and cables (see page 44).

Self-regulating products are formulated so that as the temperature of the mat or cable increases, the resistance goes up, which limits the heating output to a fixed temperature. Fixed output cable systems in a thin mortar layer put out a uniform heat extending the length of the cable.

However, topping your cable system with boxes, bean bag chairs, large pillows or high R-value floor coverings is not advised, since those covered areas won't allow the heat of the cables to dissipate and the cables may become too warm. This type of system is mostly used under tile.

Low voltage and self-regulating systems are available in thin mats and films that can be installed under almost any floor covering. Several systems can be installed from below the subfloor. Cable products often are installed in a thermal mass of concrete — much like hydronic tubing — and covered with a thicker layer of concrete or mortar. This allows for installation of a wider range of flooring products.

Make certain that installers place the proper insulation below the heated surface so heat is directed *into* the room, not down into the basement or crawlspace. See additional insulation information on page 24 of this guide.

CONTROL STRATEGIES

The controls that run your radiant floor systems maintain your comfort and protect your flooring investment. Most electric radiant systems are controlled with dual-sensing thermostats that include a room temperature sensor and a floor temperature sensor. As with hydronic systems, the floor sensor sets a high temperature limit. When the floors dip below this temperature, heat flow is cycled on and off by the room temperature thermostat.

In floor-warming systems, the floor sensor maintains the floor at a modest temperature that takes the chill off. Some electric radiant systems have a self-regulating feature, limiting heat output to a certain level.

Having zones in different areas with different floor coverings is possible and practical with electric systems because of the precise temperature control. This is a big selling point for exotic wood flooring suppliers — proper moisture in the flooring prevents warping or buckling of wood floors.

IMPROVED PERFORMANCE

Invest in quality insulation for your radiant floor-heating system.

Insulation figures into radiant system design in three distinct areas: in the structure itself, between floors in multilevel homes and in the foundation.

A well-insulated home allows for more system and floor-covering options. Insulation under concrete slabs reduces operating costs and speeds up the response of a floor-heating system. Insulation between floors improves your radiant system's performance and control. Investment in quality insulation makes great sense.

The Radiant Professionals Alliance has developed minimum guidelines for insulation required under radiant floor-heating systems (see the chart below). Local codes and system suppliers may have other requirements.

Insulation below the heat-emitting floor is required by code in areas enforcing the International Energy Conservation Code. If the code does not apply in your area, at a minimum the insulation below the floor should be two times greater than the R-value of the finished goods.

UNDER SLABS

Insulation of concrete slabs lessens the back loss of heat to the ground. In residential applications, most radiant system suppliers recommend full insulation under a slab, particularly if there is moist, conductive soil beneath. Less-stringent options include insulating either in or down the sides in perimeter areas.

The traditional method has been to use closed-cell foam insulation specifically manufactured for use in damp locations and under slabs. It comes in a variety of compressive strengths. For the correct type and strength, consult with both the insulation supplier and your concrete applicator.

BETWEEN FLOORS

Between-floor insulation in a radiant floor heating system makes the system much easier to control and assures the heat travels where you want it to — upward through the floor, not down through the ceiling to the space below. Under more insulating floors, higher levels of insulation are recommended to prevent this downward heat loss.

Many types of insulation may be used, depending on the application and local codes. Between floors, traditional fiberglass batt insulation or foil products may be used. Foil products, often referred to as reflective insulation, slow heat transfer in two ways: by reflecting the radiant energy back to the heated surface, and by emitting lower amounts of heat to the space below.

RADIANT PROFESSIONALS ALLIANCE INSULATION TABLE

INSULATION TABLE

Floor Type	Application	Min. R-value	Coverage
Slab			
Slab On Grade	Alternate # 1	* (Ti-To) x 0.125	perimeter to below frost line
Slab On Grade	Alternate # 2	R-5	4' horizontal or vertical at perimeter
Slab On Grade	Alternate # 3	R-5	under entire slab
Slab Below Grade		** R-5	
Conventionally Framed Floor			
Over Heated Space	Hard Surface	R-5	under entire floor with 2" air gap
Over Heated Space	Carpeted Surface	R-11	under entire floor with 2" air gap
Over Unheated Space	Hard Surface	R-13	under entire floor with 2" air gap
Over Unheated Space	Carpeted Surface	R-19	under entire floor with 2" air gap

* R-value = inside temperature (°F) - outside temperature (°F) x 0.125

** For slabs above frost line

RENEWABLE ENERGY RESOURCES

Solar thermal and geothermal systems are perfect complements to radiant heating.

Photo credit: Ron Hoffman

A solar thermal system can supply the hot water for a hydronic radiant system to heat floors, ceilings and walls — providing comfort and conserving energy at a reasonable price.

Properly designed and installed radiant heating systems can improve the energy efficiency of a home, especially when combined with renewable energy technologies such as solar and geothermal systems to produce warm water.

THE POWER OF THE SUN

In a typical American home, nearly 20% of energy use goes toward heating water, second only to space heating in energy consumption, says the Eneref Institute, a nonprofit research firm (www.eneref.org). That's a larger load than a home's lights, computers, refrigerators and electronics combined. In dollars, that's about $40 billion annually for U.S. homes.

The Solar Energy Industries Association (www.seia.org) states that the return on investment for solar water heating is about 3 to 6 years. And because water is such a great heat conductor, the efficiency of today's solar heating collectors is typically at least four times that of PV systems.

Solar water heating systems can be installed on most homes in the United States and are comprised of three main elements: the solar collector, insulated piping and a hot water storage tank. Electronic controls can be included, as well as freeze protection or drainback systems for colder climates.

The solar collector — either flat plate or evacuated tube — gathers the heat from solar radiation and transfers the heat to potable water. This heated water is stored in a water tank and used as necessary. Auxiliary heating can remain connected to the hot water tank for backup.

In a 2011 Gotham Research Group poll, when asked about solar thermal applications, only 63% of respondents were aware that solar energy could be used to heat water, heat and cool buildings, heat swimming pools and produce electricity. Nearly half say they were likely to consider installing a solar water heating system in their homes.

The two obstacles to having these systems installed? The cost of purchasing the system (72%) and the maintenance costs (56%).

Industry manufacturers are now designing equipment and systems with better technology to increase efficiency and lower installed costs.

"Slowly the technologies are improving," explains **Ron Hoffman,** a distributor of solar products for Indiana-based Solar Usage Now. "The new solar

Photo credit: REHAU Construction

Because of the lower temperatures found in a geothermal system, it is another renewable heating option that can be used with a radiant comfort system.

products are more efficient, which allows most installations to be done on a surface-mount base rather than the traditional tilt-up units. Homeowners associations in metropolitan areas have banned solar panels tilted skyward. With these new installs, you can show people they actually look like skylight installations."

Not only can a properly designed and installed solar thermal system provide domestic hot water for a home, it also can supply the hot water for a hydronic radiant system to heat floors, ceilings and walls — providing comfort and conserving energy at a reasonable price.

"Radiant uses less energy no matter what the energy source is," says **Patrick Spearing** of Thermomax Industries in Victoria, B.C. "But with solar you get a given amount of energy from the sky to put into the heating system, so it's important it is dispensed efficiently."

THE POWER OF THE EARTH

Geothermal technology taps another form of renewable energy that harvests the consistent earth temperature found 50+ ft. deep in most areas of North America and as little as 10 ft. deep in half of the United States. Geothermal heating systems extract this energy by pumping water or other fluid through a piping loop (vertical or horizontal) buried underground, says the Geothermal Exchange Organization (www.geoexchange.org), which absorbs the earth's heat energy. That energy is distributed through the home via a heat pump.

In the summer, the process is reversed as heat is extracted from the air in the home and transferred through the heat pump to the ground loop piping. The fluid in the ground loop transfers the heat back to the earth.

Note that piping loop also can be placed in a pond or lake on the property if it meets minimum volume, depth and quality criteria. Your system installer should evaluate the geological, hydrological and spacial characteristics of your property to determine the best type of ground loop for the site.

A geothermal system will use one unit of electricity and provide up to four units of heat. According to the Environmental Protection Agency, geothermal heat pumps (also called ground-source heat pumps) can reduce energy consumption up to 72% compared to electric resistance heating with standard air-conditioning equipment. They also improve humidity control by maintaining about 50% relative indoor humidity.

Geothermal heat pump systems allow for design flexibility and can be installed in both new and retrofit situations. When designed and installed properly, it is another renewable heating option that complements a radiant comfort system.

"A perfect fit with geothermal is radiant heat," says **John Ringel** of New Jersey-based Jersey Devil, a design-build group. "The slightly lower temperatures work well in a radiant floor (which require max temps of 85° F)."

Looking for more information on flooring trends, renewable energy, radiant heating methods and eco-friendly flooring?

Then visit these BNP Media websites:

www.edcmag.com
www.floortrendsmag.com
www.pmengineer.com
www.pmmag.com
www.supplyht.com
and www.tile-magazine.com

A REWARDING COMBINATION

With a little extra care, wood flooring over radiant heating can provide a comfortable living space.

The inherent natural beauty of traditional wood flooring lies in its variability — in each plank's unique expression as a product that was once a living tree. While this variability is what we tend to admire aesthetically, it also underlies the challenges wood flooring installers must overcome. These include:

- Expansion and contraction of the wood due to temperature changes;
- The humidity of the wood at the time it's installed;
- The effects of the way in which the wood was sawed, dried and stored;
- The humidity of the jobsite where it will be installed;
- Seasonal and regional climate conditions; and
- The materials in the subfloor.

The key to installing wood floors over radiant heating systems is to give extra care to wood species, wood width and thickness, moisture levels, installation practices, the heat output requirements of your system and radiant heating control. The result is a rewarding combination of a floor that's beautiful and warm — and provides a comfortable living space.

Talk carefully to the flooring installer about how you can work together to make good choices. Our five perspectives (pages 14 to 18) provide good insight into the process.

MOISTURE, HUMIDITY CONTROL

The maximum surface temperature of a wood floor should be limited to 85° F. Use a control strategy that assures this will not be exceeded and brings the floors through temperature changes gradually.

Wood naturally expands and contracts in response to changes in moisture. With this in mind, avoid installing wood flooring during stages such as sheet rocking or painting, when significant moisture may be introduced into a structure.

When radiant floor heat is installed in concrete, mortar beds or gypsum cement, it is very important to operate the heating system until these materials are completely dry before the wood flooring is installed on top. This can take several weeks. Be patient.

It is possible to check for residual moisture in the cementitious materials by tightly taping a 1' square piece of clear, heavy mil plastic to the floor and allowing it to set for 24 hours. If at the end of that period moisture is still trapped beneath the plastic, you need to keep heating the floor and ventilating the space. Move the plastic to another location and continue this process until no more moisture is visible beneath the plastic.

Operate the heating system until the humidity in the structure stabilizes to the average level expected for the area in which the wood floor will be installed. Then allow the wood to acclimatize to this humidity level by "sticking" (usually several weeks) before installation. This will minimize dimensional changes due to moisture.

Make sure the wood flooring is dry, since radiant heat itself can be drying. Experienced flooring installers recommend buying wood for radiant at around 6% to 8% moisture content. This figure may change regionally. Use a moisture meter during the construction process and then use the average of many readings.

Remember, the average expected humidity level of a structure is an average of seasonal conditions. So if the structure is expected to average 30% humidity in the winter and 50% in the summer, the average would be 40%. This equates to about a 7.5% moisture content in the wood. Most installers consider this average the ideal moisture level at which to install wood flooring. These numbers can vary by region.

In climates with large humidity variations, install humidity controls. In vacation cottages with intermittent use, consider back-sealing boards before installation to make them more stable to changes in moisture in the structure.

If the flooring is being installed on other subflooring, consider the subfloor's moisture level and material. Most industry experts recommend the moisture content of the flooring and subflooring materials are within 4% of the expected average. Most installers prefer plywood for subflooring since it has a long, successful history of working well beneath wood floors. Oriented strand board also is beginning to gain acceptance as a subflooring material.

TROPICAL WOODS

If you're importing tropical or exotic woods, pay close attention to the source,

Q&A

Can you break the rules on board width?

Yes, but only under very specific conditions. Quartersawn wood, carefully selected from known sources and thoroughly proven with radiant, may be used for wide plank flooring – up to 7"– installed over radiant heat. Launstein Hardwood Flooring of Michigan, with an in-house testing lab, models a responsible approach to wide plank wood flooring.

Photo credit: Mullican Flooring/Hardwoodinfo.com

Pairing an oak floor over a radiant heating system provides a comfortable living space for the little ones in the home.

age and how the wood has been dried. Tropical wood needs to dry slowly; quick-drying creates stresses that can affect the wood later as it expands and contracts. If your supplier has stored the wood in your region with no problems for one to two years, surprise stress-related problems are much less likely.

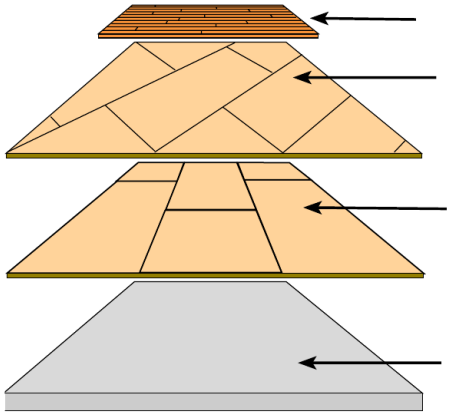
Though it can be fun to be unique, avoid pioneering the use of a wood where little information is available on its dimensional stability.

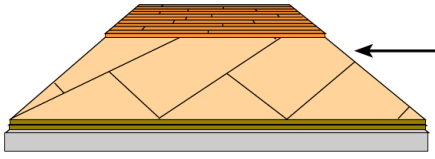
DIMENSIONAL STABILITY AND BOARD WIDTH

Quarter-sawn wood is significantly more stable than wood that is plain-sawn. Select a wood variety known for its dimensional stability. American cherry, ash, most softwoods and teak fill this bill, and oak is reasonably stable. By contrast, hickory, maple, madronne and American beech are known to be less stable.

When using plain-sawn flooring, narrow board widths are preferable, usually 3" or less. Since plain-sawn wood tends to move from side to side, narrow boards provide more gaps for expansion and contraction across a floor; therefore, gaps resulting from natural movement are much less noticeable. The maximum recommended board depth is 3/4". Thicker boards add too much resistance to heat transfer.

NWFA DOUBLE LAYER METHOD
(2 layers 1/2" plywood)





WOOD FLOOR INSTALLATION METHODS

When possible, use a "floating" method of installing wood floors over slabs. The National Wood Flooring Association (www.nwfa.org) developed general guidelines for installing traditional wood floors over radiant floor heating systems. It is strongly recommended that these guidelines be studied prior to installation. You can see graphic examples of these methods on the following pages.

• **Floating.** Basically, floating a wood floor over radiant slabs involves attaching the flooring to one or more layers of plywood that "float" independently, unattached to the slab. This way, the wood flooring can expand and contract separately from the thermal mass of the slab.

The NWFA guidelines for installing strip wood flooring over radiant call for two layers of 1/2" plywood installed at 45° angles to each other and screwed together. The wood flooring is then nailed on top. Since the 1" thickness of the two layers of plywood adds R-1.1 to the

(Continued on page 31)

RENEWABLE 'WOOD' FLOORING: BAMBOO

Although bamboo is classified as a grass and not a wood, it's become a popular alternative to traditional hardwood floors — and has demonstrated a successful track record over radiant floor heating. A wide variety of bamboo flooring is available, but the quality between brands varies significantly. It's important to do your research before purchasing.

Moso bamboo, the species most used for flooring, grows up to 2' to 4' daily and reaches full maturity in 3 to 5 years, compared with the 60 years or more hardwood trees can take to mature. Bamboo harvested and manufactured correctly can be 25% harder than oak and twice as stable as maple. Strand bamboo is even more durable; manufactured through a process that fuses together bamboo strands with an environmentally safe adhesive, it can be 100% harder than oak.

Harvested bamboo is cut into strips, flattened and laminated together. A process called caramelizing can give bamboo a range of colors. Bamboo can serve as the finishing veneer layer on an engineered wood floor, or the strips can be laminated on edge in either direction to make a solid bamboo board.

Photo credit: DuroDesign Flooring

Bamboo can serve as the finishing veneer layer on an engineered wood floor, or the strips can be laminated on edge in either direction to make a solid bamboo board.

SINGLE LAYER METHOD
(1 layer of 3/4" plywood)

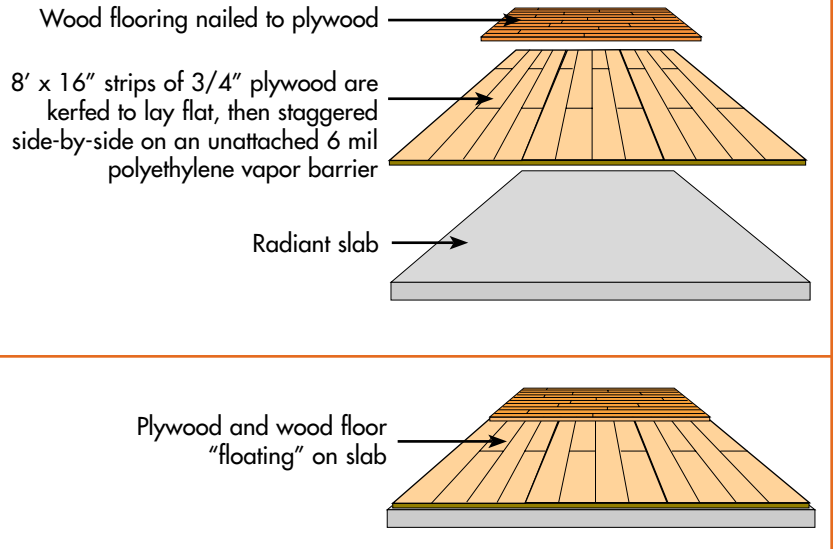


Photo credit: Mullican Flooring/HardwoodInfo.com

A fireplace may not be necessary with a radiant comfort system installed under wood flooring such as this cherry floor.

(Continued from page 29)

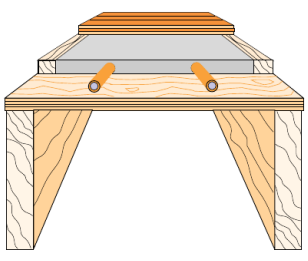
resistance to heat transfer, a less-resistant alternative may be required.

In this method, 3/4" (R-.78) plywood is cut into 8' x 16" strips laid side-by-side. The plywood strips are kerfed on the bottom to get them to lie flat. Then the strip wood flooring is nailed to the plywood. Since this system adds less resistance to heat transfer, it's more attractive in projects with a high heat load.

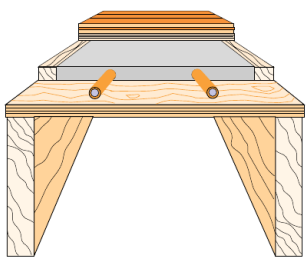
• **Installing over a thin slab.** Floating also can be used over a thin slab. When a thin slab with sleepers is used, the NWFA suggests either the "direct nail to sleeper" method or methods that include layers of plywood nailed to the sleepers. The direct-nail method, with fewer layers of wood, obviously offers better heat transfer. This method is particularly useful when using materials with temperature limitations, such as gypsum cement.

However, since the wood doesn't "float" in this method and is closer to the thermal mass, a good control system is crucial. It allows the floors to change temperature gradually, putting less stress on your wood flooring system.

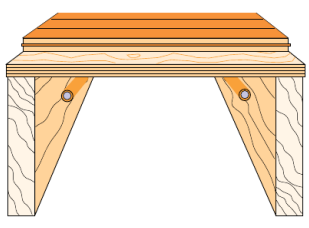
• **Installing from below.** When the radiant system is installed from below the subfloor, traditional wood flooring is attached to the top of the subfloor in the normal way. In this case, proper nail selection is essential. Otherwise, the nails may penetrate through the subfloor and damage the radiant system.



Floating over a thin slab directly nailed to sleeper



One layer of plywood nailed to sleeper with wood flooring nailed directly to plywood



Conventional installation method over system installed from below

Drawings are conceptual and illustrative in nature and are not intended for any specific installation.

BEAUTY AND STABILITY

Engineered wood flooring has a true wood top layer and transfers heat well.

Don't rule out engineered wood floors if you're thinking of wood. With its authentic top layer, you get all the beauty of real wood, yet less of the sensitive temperament. Engineered wood floors are more resistant to higher moisture levels than solid wood flooring. This makes them appealing for use in damp basements or in areas that have higher relative humidity levels.

Edge-glued, "floating" engineered wood floors have a host of advantages for use with radiant floor heating. Because of this unique installation design, they are free to expand and contract separately from the radiant floor heating system. Made of multiple wood veneers and dimensional wood products that are glued or adhered together, these floors are inherently dimensionally more stable than traditional wood flooring systems. Plus, being thin, they transfer heat well.

Over a slab, the modest R-value of a 5/8" thick engineered floating floor system has considerable heat transfer advantages over floating traditional wood flooring systems, which require additional layers of plywood to float. The R-value of a 5/8" engineered wood floor (R-0.625), plus a thin pad (R-0.3), is less than R-1.

Compare this to a traditional wood floating system of 3/4" hardwood (R-0.8), plus two layers of 1/2" plywood (R-1.1), for a total of R-1.9, or nearly double. You'll often find cost-savings in installing an engineered wood floor in a floating application.

However, not all engineered wood floors are recommended for use over radiant floor heating. Maximum recommended surface temperatures differ by product. They need to be followed.

Photo credit: Armstrong Hardwood Flooring/HardwoodInfo.com

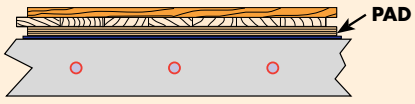
Because of the unique installation design of engineered wood floors, they are free to expand and contract separately from the radiant floor heating system.

For added comfort, a thin pad may be used between the engineered flooring and thermal mass, which puts some give back in the floor. This is particularly welcome when the wood flooring is installed over concrete.

It's important, though, that the pad you choose be recommended for use with radiant heating — and don't forget low R-value for optimum heat transfer. Not only will a pad soften the feel, but the proper thin pad can also attenuate sound on the floor.

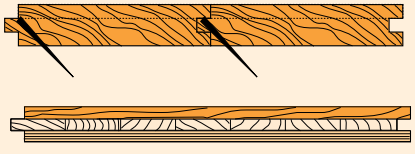
Engineered flooring such as parquet can be glued down in radiant applications with recommended adhesives, if so advised by the manufacturer. However, this is a less-preferred method over radiant, since the floor doesn't float independently from the heating system.

FLOATING ENGINEERED WOOD FLOORS



Engineered wood can be edge-glued and "floated" over the radiant heating system. A thin foam pad is usually placed under the wood flooring. This allows the flooring and the radiant system to expand and contract separately.

COMPARISON OF WEAR LAYERS



Notice how in traditional wood flooring (top) the resurfaceable thickness is limited by the nails. The top wear layer in engineered flooring (bottom) may be similar in thickness, or is often hardened by acrylic.

UNIVERSAL LAMINATE

Laminate flooring offers a full spectrum of contemporary looks.

Photo credit: TORLYS/North American Laminate Flooring Association

Because the top layer is made of durable, clear plastic, properly installed laminate floors are strong, scratch-resistant and long-lasting.

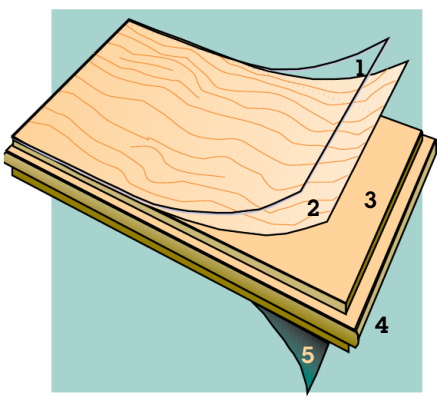
Because laminate flooring is thin, dense and conducts heat well, it is ideally suited for use over radiant floors. Better yet, in recent years, the laminate flooring industry has developed an astounding array of designs.

Originally, laminate floors were limited to mimicking hardwood, but now they offer a full spectrum of contemporary looks. Not only do they incredibly mimic hardwood floors, but you can buy laminates that look like real tile, stone and even vinyl. The authenticity lies in the view layer that is printed with almost photographic quality. This view layer is covered with a top layer of intensely durable, clear plastic.

Because of this protection, properly installed laminate floors are strong, scratch-resistant and long-lasting. Most laminate floor manufacturers offer extensive warranty protection against stains, fading and moisture damage. The result is flooring that is attractive yet can withstand the wear and tear from everyday life — kids, pets, spills, high heels and skateboards.

Most laminate floorings are recommended for radiant floors, but not all, so it is very important to check with the manufacturer before installing. Quality of the lamination is an issue. Because laminate flooring is a complex lamination of many layers, it is important that the layers are well-bonded and suitable for radiant floor heating.

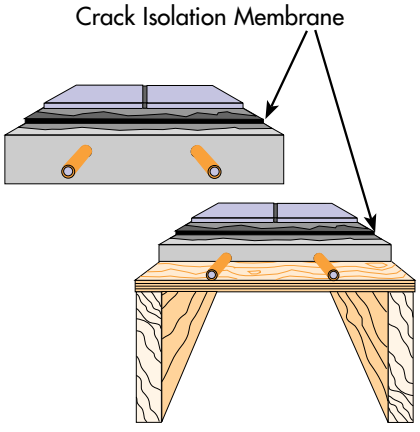
The instructions for installing laminate flooring over slabs are very specific in terms of moisture content. In addition, laminate floors often have temperature limitations over radiant. The North American Laminate Flooring Association (www.nalfa.com) recommends that the radiant heating system be in operation for at least two weeks before the installation of the laminate flooring.



Laminate floors are typically multiple layers of materials that are thermofused together using thin films of glue that bond under the heat and great pressure of a press. In this example, layer 1 is a clear plastic wear layer, layer 2 is the "view" layer, layer 3 is an HDF or MDF board, as is layer 4, which has the locking tongue and groove. Layer 5 is a plastic bonding layer.

Photo credit: United States Ceramic Tile

Homeowners and flooring contractors are now installing more tile and stone in radiant-heated homes. And radiant heating can be installed in walls and ceilings for additional comfort.



Tile installed over slab (above) and thin slab (right) with crack isolation membrane.

COMFORT TRANSFORMATION

With radiant heating, traditionally cool surfaces take on a whole new level of comfort.

Radiant floor heating has transformed cool surfaces such as tile, stone and marble into an inviting source of warmth and comfort. It has solved the problem of how to make these surfaces behave as beautifully as they look — they may be warmed in cold weather, then offer a cool feel in warmer months as the heating system is turned off.

Tile and radiant floor heating are a great match because tile is thin, dense and conductive, which means it transfers heat exceptionally well. The floor temperatures of a well-controlled radiant comfort system are well-suited to properly installed tile.

Imagine a dark tile floor in a sun-filled room — that's the level of warmth possible with a radiant heating system. Homeowners and flooring contractors are now installing more tile and stone in radiant-heated homes.

HYDRONIC OR ELECTRIC?

In houses with hydronic radiant systems, many successful methods are available to install tile, stone and marble. Electric radiant systems, too, have seen tremendous market growth in warming tile — even in Southern climates — since it can be installed on a room-by-room basis. Many radiant electric floor warming and heating systems are designed to go directly in a mortar layer under the tile.

Additionally, some proprietary systems on the market come ready with an integrated floor assembly recommended for use with tile.

INSTALLATION TIPS

Methods for installing tile, stone and marble over radiant heat are evolving. Many methods recommend the use of a crack isolation membrane as added crack prevention. A crack isolation membrane is a flexible layer of material placed below the tile that allows the tile layer to expand and contract separately from the flooring layers that contain the radiant heating. This independent flexibility reduces the likelihood that tile installed over radiant heat will crack.

As with all radiant flooring, a control system that changes floor temperatures gradually is the best preventative measure.

If used, crack isolation membranes should be recommended for use in radiant heating applications and have a low R-value for effective heat transfer.

"The Standard Guidelines for the Design and Installation of Residential Radiant Panel Heating Systems," published by the RPA, makes the following recommendations for hydronic radiant systems: "Ceramic, Quarry Tile And Marble … installed over suspended radiant floor panels shall have a crack isolation membrane placed between the tile and the thermal mass." This applies to tile installed over thin slabs on subfloors.

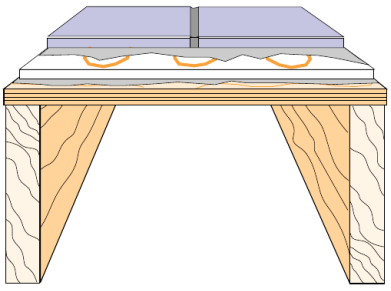
INDUSTRY GUIDELINES

Individual manufacturers of electric radiant systems should be contacted for their installation instructions, as industry standards for installing tile over radiant floor heating are continuing to develop.

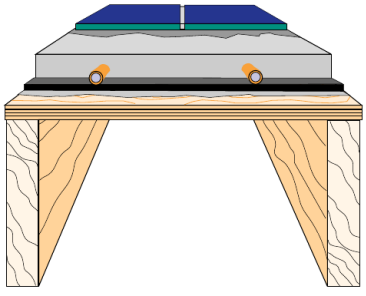
The Tile Council of North America (www.tileusa.com) has additional publications detailing specific installation methods over hydronic and electric radiant heating systems: "Ceramic Tile: Interior Floors with Radiant Heat Over Concrete," "Ceramic Tile: Interior Floors with Radiant Heat Over Wood," and "Natural Stone: Interior Floors with Radiant Heat Over Concrete and Wood."

The TCA hydronic details apply to tubing installed in/on: a concrete slab; a concrete slab in a gypsum underlayment; and a wood subfloor in a gypsum underlayment.

The TCA electric details apply when electric elements are installed in/on: a concrete or cured mortar bed on a concrete slab; a concrete slab in a



Electric cable installed in mortar layer under tile over cementitious backboard (no membrane).



The Marble Institute of America recommends a thicker thermal mass with a crack isolation membrane below for stone and marble.

Drawings are conceptual and illustrative in nature and are not intended for any specific installation.

self-leveling underlayment; a wood subfloor encapsulated in mortar; a backer unit encapsulated in mortar; and a wood subfloor in a self-leveling underlayment.

The Marble Institute of America (www.marble-institute.com) has somewhat different, and more restrictive, recommendations for stone and marble over radiant. Many stone and marble tiles installed at a 3/4" thickness are more prone to cracking than ceramic tile, so a stiffer floor is specified. Plus, a 2 1/2" thermal mass is recommended to insure the heat is dispersed more evenly. It also specifies that a crack isolation membrane be installed under the layer with the tubing or cable.

RESISTANCE IS THE KEY

Thin carpet over radiant floor heat is more comfortable than thick carpet on a cold floor.

Consumers care about the aesthetics of carpet: what it looks like, how it's designed and how it feels. But if they also care about radiant heat, they need to understand a key concept: *resistance.*

Resistance is the "R" in the R-value assigned to various insulating products, including, in this case, subflooring + carpet + pad. The resistance of floor covering matters when using radiant floors, so if you're applying carpet over radiant, don't leave the R-value to chance. Choose a carpet and pad that will maximize the heat transfer of the system, not work against it. Remember, the resistance of the pad and carpet are additive.

Photo credit: © iStockphoto.com/ ideabug

When selecting carpet to go over your radiant-heated floors, look at thin carpets. They will have lower R-values.

UNDERLAYMENT

Thick carpet and pads were in fashion to counteract cold, poorly insulated floors. But that plushness doesn't make sense with radiant floor heating. In fact, thinner carpet that is radiantly warmed, on top of a thin, high-quality pad, will feel much more comfortable than thick carpet on an cold floor.

In a radiant floor heating system, the cushion has two functions. It must act as a shock absorber to reduce wear on the carpet and it must effectively conduct radiant heat. It's possible for a thin, high-quality pad to do both, but with a thick pad it's impossible to get the desired heat transfer.

A thin, conductive pad under carpet will assure good heat transfer in a radiant floor system. Thin slab rubber and synthetic fiber pads are the best choice because they are the least resistant to heat transfer. Waffled rubber, frothed polyurethane, hair and jute are good choices as well, although they have more than twice the thermal resistance of slab rubber.

Prime and bonded urethane pads, the most common carpet pads, have almost four times the resistance of slab rubber and, therefore, are not recommended for use with radiant floor heating systems. For example, 3/8" prime urethane has an R-value of 1.62, while a 1/4" slab rubber pad has an R-value of 0.31.

This means the surface beneath the urethane must be 40° F hotter to transfer the same amount of heat as the rubber pad. (See the R-value chart on page 45.)

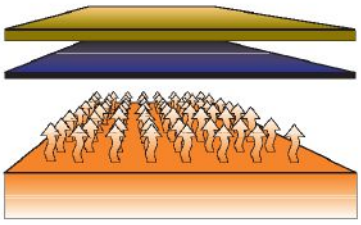
Rubber pads are typically sold at a premium, so homeowners must be sold on its added benefits.

With radiant floor heat, if budget is a concern, it is wise to spend a little more on the right pad and a little less on carpet.

CARPETING

When selecting carpet to go over a radiant system, remember to keep it thin. Next, specify a thin, synthetic carpet rather than wool. Wool has hollow, highly insulating fibers, so while it's a natural flooring choice, it works against radiant's natural warmth. Thinner, denser commercial-style carpets work well in transferring heat, as do Berber and other popular low-profile synthetics.

And since the R-values of the pad and carpet are added together, the resistance of the pair needs to be considered in combination. The math is easy: A thin, conductive pad lets you



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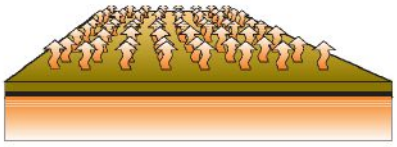

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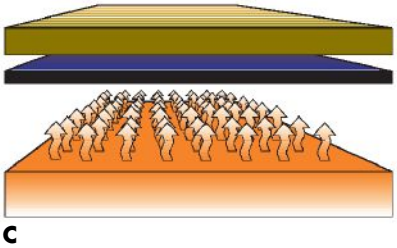

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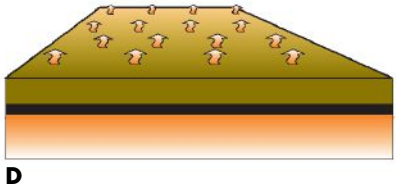


D

With thin carpeting and pad (A) on top of a radiant floor, the majority of heat is able to transfer upward into the room (B).
But if a thick carpet and pad are placed atop the system (C), only small amounts of heat can enter through the floor (D).

use slightly thicker carpet and vice versa — thicker pad, thinner carpet.

Ask your heating contractor or designer for a maximum combined carpet and pad R-value that will work with your particular system.

Using rugs on your heated floor instead of carpet? Make sure to tell your heating contractor so the R-values can be factored in.

Photo credit: Decorative Concrete Institute/ConcreteNetwork.com

The number of different products for coloring concrete has increased in recent years, and many manufacturers offer an extensive palette of shades.

CREATIVE EXPRESSION

Turn concrete floors from cold and boring to comfortable and colorful.

Concrete is no longer plain, gray and boring. It has been reborn as a decorative flooring material, yet many people aren't aware of its transformed possibilities. Stain it, color it, stamp it, stencil it, etch it, engrave it, paint it, polish it — when done right, it's hard to believe it's concrete.

One look at these floors, however, and it's evident concrete has earned its designer status.

Homeowners, builders and designers now recognize the value in using concrete in their designs and plans. In recent years, concrete flooring has developed into a highly innovative industry. ConcreteNetwork.com notes that advancements in tools, stains and dyes, textures and patterns have made concrete a versatile, durable and cost-effective material.

New techniques allow concrete floors to become artistic expressions in themselves and to mimic other materials — such as stone and tile — to be polished to a luster, to be colorful and patterned.

As you make your choice of flooring over radiant, give these techniques an open-minded look. Designers and artisans who recognize and admire the inherent virtues of concrete as a decorative medium are poised to help you. Think of your floor as a blank canvas, and add color and texture as creative components. Techniques can be combined or juxtaposed for exciting effects.

All this is great news for the radiant market, since so many radiant flooring systems are installed in concrete. In fact, a concrete finished floor ensures that your radiant heating system will have the highest possible output since there are no additional layers the heat must pass through.

With an open mind, skilled contractors and the right creative partners, you won't be calling concrete floors boring anymore.

ACID STAINING

Staining concrete is one of the most popular applications for transforming concrete slabs. Acid staining uses metallic salts to color the concrete, usually in variations of black-brown and blue-green. But newer products on the market such as water-based penetrating stains and water- and solvent-based concrete dyes are greatly expanding the color range from soft pastels to vivid reds, oranges, yellows and purples.

Other products, such as new, thin, polymer-based coatings, can be created in any color from the Pantone color chart and applied to concrete for decorative effect.

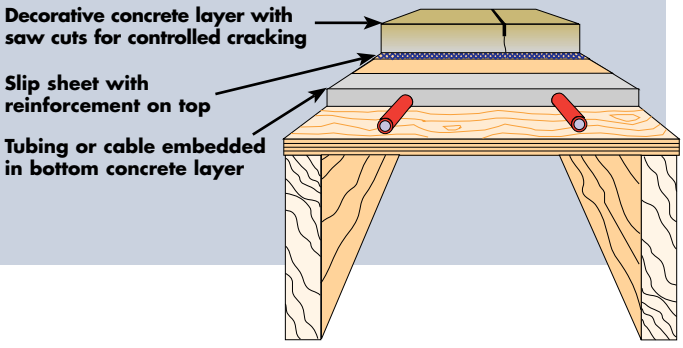
STAMPING

Stamped concrete — also known as patterned stamped concrete or imprinted concrete — can be patterned and colored to take on the look of brick, flagstone, tile and wood, usually at a much lower cost

Photo credit: Kemiko Concrete Products/ConcreteNetwork.com. Installation: Jagger SSC, Dallas

A concrete finished floor ensures that your radiant floor heating system will have the highest possible output since there are no additional layers the heat must pass through.

David Pettigrew of Diamond D Co. of Capitola, Calif., proves that decorative concrete can be done on thin slabs also. He uses a double-pour method, with the tubing or cable in the bottom layer of concrete, a slip sheet in between, reinforcement on top of the slip sheet, and a carefully controlled mix. He quickly saw-cuts the patterns on the top layer right after pouring, so the thin slab cracks where he intends it to. The cuts are later filled with a flexible material. Pettigrew is just one of many innovative craftsmen in this expanding trade. Fifty percent of his work is now over radiant. This drawing illustrates how Pettigrew installs decorative concrete over thin-slab radiant.



than the original model. An increased demand of customization from homeowners and designers has led to innovative tools and unique color effects.

COLORING

Colored concrete is made by either adding colorants that are integral to the mix for lasting color or with colorants that are dusted on — the "dry shake" method — which give the top surface layer and intense color. The number of different products for coloring concrete has increased in recent years, and many manufacturers offer an extensive palette of shades.

SCORING AND SAW-CUTTING

Scoring is done with a groover tool when the concrete is fresh. Score lines can be straight, but are often diagonal to the edges of the flatwork or bands. Saw-cut lines are done after the concrete is hardened and can be straight or diagonal to the edges of the concrete or bands.

POLISH AND GLOSS

Due to innovative techniques, concrete can now be polished to a high-gloss finish that doesn't need waxing or coating. These easy-to-maintain surfaces have traditionally been used in commercial projects, but are now at home in residential flooring.

Q&A

With my radiant heat system, do I need to worry about cracking or expansion of concrete?

Concrete contains variable materials from the natural environment and is affected by the weather, humidity and mixing itself. No one can ever guarantee that concrete won't crack, but by the proper use of expansion joints, good material mix and installation practices, a great deal can be done to prevent it from cracking where you don't want it to.

For more information, visit www.concretenetwork.com.

VERSATILE, DURABLE AND ECO-FRIENDLY

Resilient floors can be a great choice with radiant when chosen and installed properly.

Resilient flooring is all about versatility — and durability. As a flooring category, it covers a wide range of materials: sheet vinyl and vinyl composition tiles, true natural linoleum, rubber and cork. These materials come in all kinds of colors, patterns, textures and designs to suit a wide variety of styles and preferences for residential applications, notes the Resilient Floor Covering Institute. And they hold up well under the most trying conditions.

Not only are resilient floors easy to clean and maintain, they are tested for slip-resistance and designed for better indoor air quality. And many, but not all of them, are great for radiant heat.

Photo credit: Armstrong Flooring/Resilient Floor Covering Institute

Vinyl composition tile accounts for more square footage than any other category of resilient flooring.

TEMPERATURE LIMIT IS CRITICAL

Most resilient flooring products are manufactured to an American Society of Testing & Materials resilient flooring standard with an upper-floor temperature limit of 85° F. This makes them widely applicable for radiant heat. Individual manufacturers should be contacted for their specific installation instructions, particularly involving suitable substrates and adhesives.

The few cases of radiant heat discoloring or banding resilient flooring have been attributed to the use of the wrong adhesive, which then affected the resilient flooring from below. In a few cases, the floor was simply overheated.

Tropical Luan plywood as an underlayment has sometimes caused problems, too. It can contain an anaerobic bacteria that dies as the plywood dries, out-gasses, and thereby discolors the flooring above. Many manufacturers do not recommend Luan as an underlayment.

VINYL MATERIALS

Sheet vinyl, luxury vinyl tile and vinyl composition tiles can imitate ceramic, stone and even wood grain. The RFCI notes that sheet vinyl flooring offered today is the product of years of advancements in manufacturing technology and design capabilities. It is typically offered in 6' and 12' widths. Vinyl sheet provides the perfect flooring solution for many areas because of its low cost, durability and easy maintenance.

Luxury vinyl tile typically has a much higher vinyl content for embossed-like surfaces that replicate natural stone, wood, concrete, metal and other materials, says the RFCI. Many of these products such as the wood designs are made in plank form to enhance the look of the finished installation.

The primary raw material in vinyl composition tiles is limestone, which is a natural, highly abundant ingredient. Vinyl and color pigments are added to provide product flexibility and design. The tiles are typically manufactured in 12" x 12" squares and can be used in a wide range of color and design combinations to create unique, custom effects. The RFCI notes that vinyl composition tile accounts for more square footage than any other category of resilient flooring.

Be sure to check with individual manufacturers for installation instructions over radiant heat. Most recommend that the product be installed at room temperatures warmer than 65° F, and that floor temperatures not exceed 85° F.

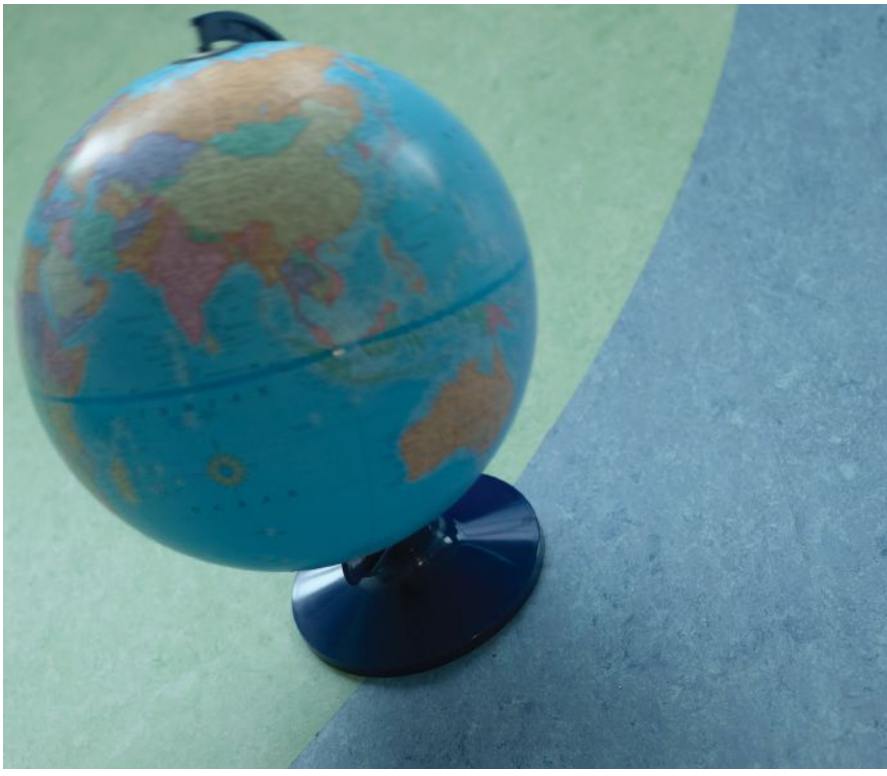
NATURAL LINOLEUM

This 100-year-old product is enjoying a resurgence in popularity since it is made from natural materials. It comes in sheets made from linseed oil, cork, limestone, wood flour and tree resins. It's extremely durable. The color you see in linoleum goes all the way through; the pattern won't wear off with heavy use.

Natural linoleum has been used successfully over radiant heat, but you'll need to consider certain issues. It expands and contracts with temperature changes more than most vinyl, which may pose problems for large-room radiant applications in high heat-loss areas. It's also sensitive to concrete moisture and alkali conditions, so slabs must be well-cured. And it must be installed within a very specific ambient temperature.

Make sure to discuss these issues with your heating and flooring contractors. It takes a commitment to install such a particular product, but when you do it right, it's amazingly durable. Natural linoleum owners swear by it.

Photo credit: Johnsonite/Resilient Floor Covering Institute



Today's rubber flooring can be as dazzling as any other type of resilient flooring choice.

RUBBER FLOORING

While most of today's rubber flooring contains synthetic materials, some natural rubber is still used by manufacturers to create their products, notes the RFCI. In the past, rubber floors were appreciated for function over beauty, but today's rubber flooring can be as dazzling as any other type of resilient flooring choice. Rubber flooring is easy to clean and great for exercise, laundry and mud rooms.

But pay close attention to the thickness of the product when using it with radiant. Some rubber flooring is thick enough that it's hard to get the heat through it. Use 3/8" (R-1.8) or thinner products, preferably 1/4" or 1/8" rubber.

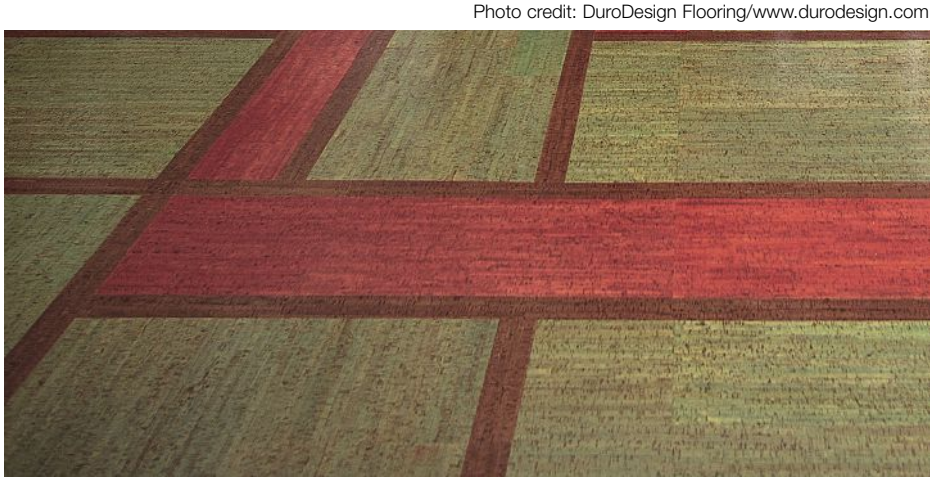
CORK FLOORS

Cork flooring is a natural product made from the bark of the cork oak, a renewable resource. Installed much like hardwood flooring, it has nice give to it and a terrific, natural look.

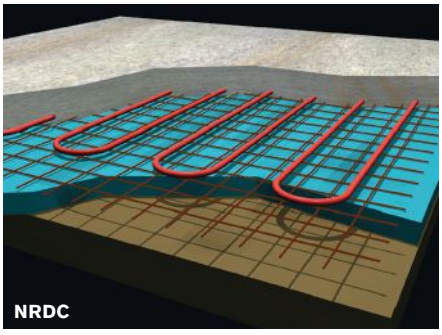
However, cork is a fairly insulating product, and thick cork flooring is not a good choice for radiant. But there are some options. Try to use 3/8" or thinner cork. Or consider the newer cork flooring products, built more like laminate flooring: They have a thin top and bottom layer of cork, with a middle layer of MDF (a dense, more conductive board). These composite products work well and are often 1/2" thick or less. Several can be installed as "floating" flooring.

Also, avoid installing cork flooring in a bathroom as it will absorb moisture, notes the RFCI.

Photo credit: DuroDesign Flooring/www.durodesign.com



Installed much like hardwood flooring, cork flooring has nice give to it and a natural look.

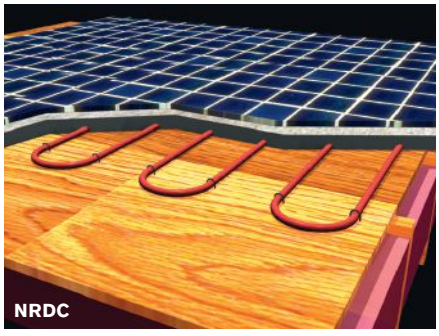


HYDRONIC

Slab on Grade

Radiant tubing is embedded in cement. The tubing is typically attached to metal mesh with plastic ties. A 4" slab is most typical. The tubing is best placed in the middle of the slab. Full under-slab insulation is recommended for most residential applications. Slabs have a large thermal mass, which stabilizes temperature swings but slows response. This method is recommended whenever a slab is poured.

Estimated Assembly R-value*: R-0.69 - R-1.0

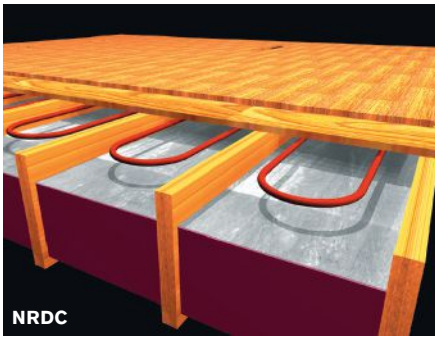


HYDRONIC

Thin Slab on Subfloor

Radiant tubing is attached on top of subfloor with approved staples or plastic clips. A thin slab of gypsum-based cement or cement is poured over the tubing. Typical slabs are 1 1/2" thick when using 1/2" tubing, but may be as thin as 1 1/4" thick when using 3/8" tubing. Gypsum cement is lighter than cement, but a little less conductive.

Estimated Assembly R-value*: R-0.69 - R-1.0

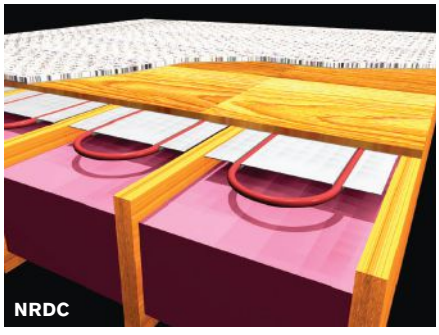


HYDRONIC

Hanging or Attached Below Subfloor

Radiant tubing is hung or attached to the underside of the subfloor in an air space with insulation below. This requires higher water temperatures and has more limited heat output than other systems. It is often used for retrofitting when access from below is possible. Hanging systems have more even joist cavity temperatures than when pipe is attached in contact with subfloor joists.

Estimated Assembly R-value*: R-1.7 - R-2.2 (pipe + 3/4" plywood only)

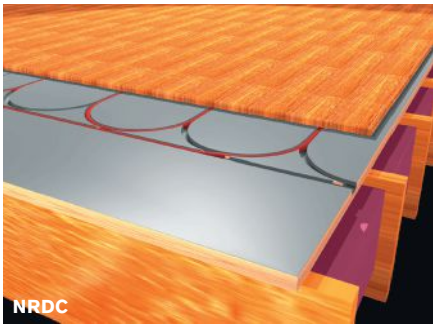


HYDRONIC

With Plates Below Subfloor

Radiant tubing is attached to the underside of the subfloor with metal plates to diffuse the heat. Insulation is recommended below the plates. This has higher water temperatures and more limited heat output than above subfloor systems, but plates make it more effective than hanging pipe from under joists. It is often used for retrofitting when access to joist space is available.

Estimated Assembly R-value*: R-1.3 - R-1.8 (pipe + 3/4" plywood only)

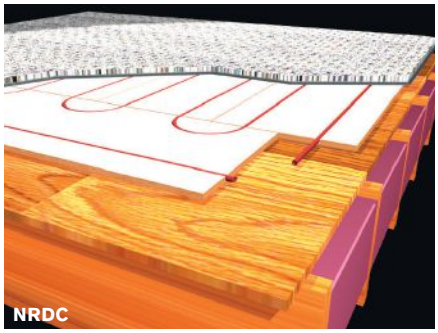


HYDRONIC

Structural Radiant Subfloor with Aluminum and Grooves

Premanufactured 1 1/8" thick panels have grooves for tubing and an aluminum sheet bonded to the board. In this case, the premanufactured panels serve both as the structural subfloor and as the channel into which the tubing is installed. The aluminum sheet makes the system accelerate rapidly and spreads out the heat. Tubing is installed 12" on center in the grooves.

Estimated Assembly R-value*: R-0.6

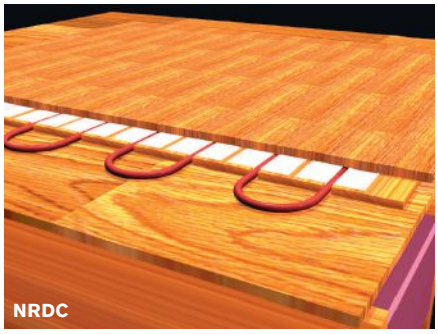


HYDRONIC

Boards with Grooves and Metal, Attached to Top of Subfloor

Several varieties currently exist. One board has metal on the bottom and another on the top. Both serve to spread the heat laterally. Normally they are glued and screwed or stapled to the top of a wooden subfloor. Under some conditions they may be attached on top of existing slabs. These are modular systems with straights and end pieces that are assembled to make a channel for pipe. Different products use different pipe sizes.

Estimated Assembly R-value*: R-0.75 - R-1.1 depending on product

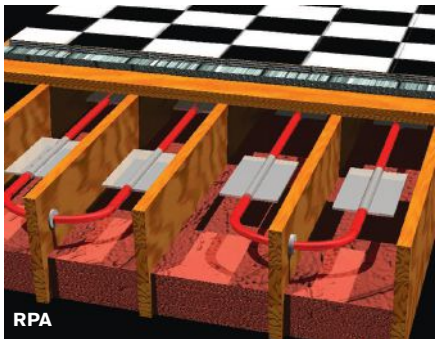


HYDRONIC

Sandwich Method with or without Plates on Top of Subfloor

Typically, 1" x 4" x 3/4" sleepers are attached to the top of the subfloor, and pipe is placed in between the sleepers with or without the addition of the metal plates. The metal plates typically cover about 80% of the pipe, adding significantly to the even dispersion of the heat.

Estimated Assembly R-value*: R-1.1 - R-1.5 depending on product and plates

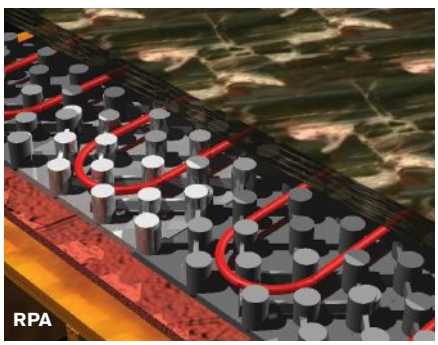


HYDRONIC

Joist Bay Convection Plates

The radiant tubing is suspended in a clear air space beneath the subfloor between the joists with metal plates or fins attached to the tubing. The tubing and metal fins heat the air within the joist space, which, in turn, heats the subfloor. Insulation is mandatory below the plates. Higher water temperatures are required than in systems with the plates in direct contact with the floor. Tubing may be run parallel to the joists or perpendicular if holes are drilled to accommodate the tubing.

Estimated Assembly R-value*: R-1.7 - R-2.2 (pipe + 3/4" plywood only)



HYDRONIC

Preformed Support Panels

Molded panels designed to hold the radiant tubing cover the entire floor surface. This system may incorporate insulation molded as part of the panel. Some systems are designed to be embedded in cement, while others have dense, stone-like tiles that are supported by the molded pedestals. They may also include metal heat transfer plates to help disperse the heat evenly.**Estimated Assembly R-value*: R-0.69 - R-1.0**

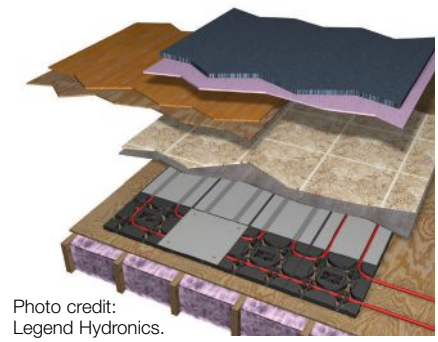


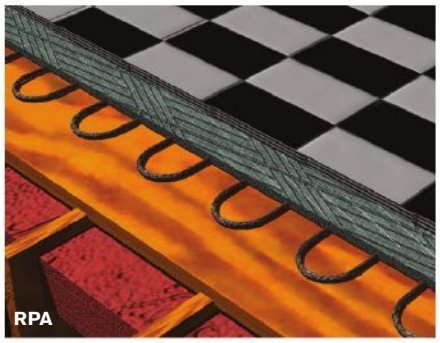
Photo credit:
Legend Hydronics.

HYDRONIC

Integrated Plate Panels

The integrated plate panel system is designed to install over an existing subfloor. The 3/4" panels are pre-insulated and water resistant. The use of 1/2" pipe allows for greater circuit lengths and is 100% covered by metal. The integrated plate panels float unattached over the top of the wood subfloor or existing concrete slab and vapor barrier for carpet; are sandwiched between the wood subfloor and wood nailing surface for hardwood flooring; and sandwiched between the wood subfloor and cement board for ceramic tile installation.

*Assembly R-values are illustrative estimates only, and do not include the R-value of the floor coverings, which must be added to determine total system R-value. System design and installation should only be done by qualified professionals.
NOTE: Insulation is usually required under radiant heating systems.

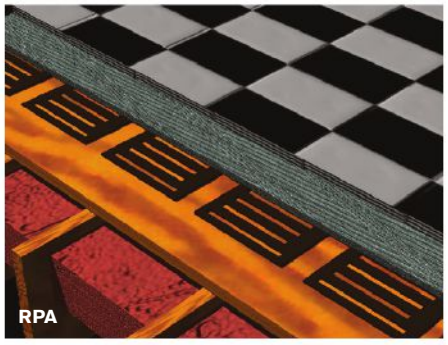


ELECTRIC

Embedded Cable or Mat

The electric cable or mat is encapsulated by embedding it in a 1/8" to 2" mud bed or in thinset mortar on top of the subfloor as required by the National Electric Code. It is available as a low or line voltage for warming or heating. Higher output systems utilize wider spacing and require a thicker embedding layer. When only floor warming is desired, the system is controlled by a floor temperature sensor. Heating systems are usually controlled with a thermostat, often in combination with a floor sensor. Different systems and embedding thicknesses allow for a variety of floor coverings. Check with manufacturer for limitations and recommendations regarding flooring goods.

Estimated Assembly R-value*: R-0.3 - R-1 depending on embedding layer

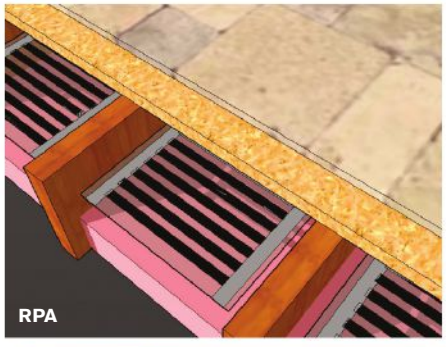


ELECTRIC

Self-Regulating PTC Cable or Flat Heater

These heaters are made of semi-conductive polymer and are self-regulating, which means that when the ambient temperature goes up, the electrical resistance increases and the consumption of electricity decreases. The cables are line-voltage and the flat heaters are low-voltage. They can be embedded in a mortar layer or used directly (as recommended by the manufacturer) under a wide variety of floor coverings.

Estimated Assembly R-value*: R-0.3 - R-1 depending on embedding layer

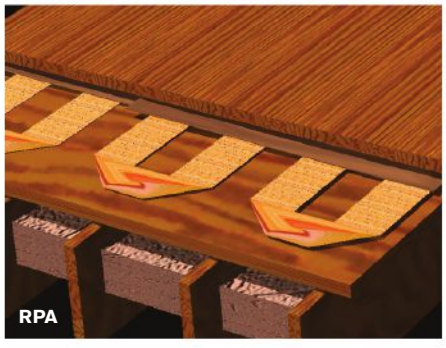


ELECTRIC

Film Type Installed from Below

With the film-type product, elements are printed with a conductive ink and embedded in a film of plastic. Current products are line voltage. These systems have higher resistance to heat transfer than embedded systems since the heat must travel through an air space and the subfloor. They must be installed with an air space.

Estimated Assembly R-value*: R-1.7 - R-2.2 (element + 3/4" plywood only)



ELECTRIC

Mesh Installed Directly Under Floor Covering

Some low-voltage products such as wire mesh can be installed directly under floor covering such as wood or carpet and pad. They can also be applied to the underside of a wood subfloor. Nails or staples to hold the floor covering may be driven directly through mesh as long as the nail or staple does not come in contact with any other metal object.

Estimated Assembly R-value*: R-0.5 – R-3.0 depending on floor covering

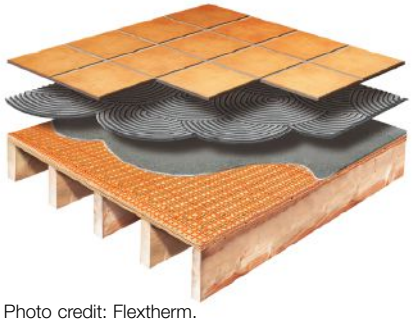


Photo credit: Flextherm.

ELECTRIC

Cable Snapped Into Plastic Mesh

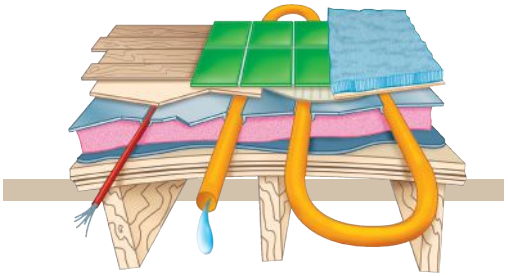
Plastic mesh replaces the second layer of plywood (only under ceramic tile) usually needed to increase the floor's rigidity and stability. Once the plastic mesh has been laid down and covers the entire floor, heating cable can be installed. A polymer-modified dry-set mortar can be glazed directly over the installation. The mesh protects the heating cable against impact damages that can occur during the installation.

*Assembly R-values are illustrative estimates only, and do not include the R-value of the floor coverings, which must be added to determine total system R-value. System design and installation should only be done by qualified professionals. NOTE: Insulation is usually required under radiant heating systems.

COMPARATIVE R-VALUES OF FLOORING AND SUBFLOORS

Material	R-value Per Inch	Typical Thickness	Typical R-value
Plywood	1.10	3/4"	0.825
OSB	1.40	3/4"	1.050
Softwood	1.10	3/4"	0.825
Sheet Vinyl	1.60	1/8"	0.200
Vinyl Composition Tile (VCT)	1.60	1/8"	0.200
Linoleum	1.60	1/4"	0.400
Linoleum	1.60	1/8"	0.200
Dense Rubber Flooring	1.30	21/64"	0.250
Recycled Rubber Flooring	2.20	1/2"	1.100
Cork	3.00	3/8"	1.125
Cork/MDF/Laminate	2.35	1/2"	1.175
Brick	2.25	1 1/2"	3.375
Marble	0.80	1/2"	0.400
Ceramic Tile	1.00	1/4"	0.250
Thinset Mortar	0.40	1/8"	0.050
MDF/Plastic Laminate	1.00	1/2"	0.500
Laminate Floor Pad	1.92	5/32"	0.300
Engineered Wood	1.00	1/4"	0.250
Engineered Wood	1.00	3/8"	0.375
Engineered Wood	1.00	5/8"	0.625
Engineered Wood	1.00	3/4"	0.750
Engineered Wood Flooring Pad	1.60	1/8"	0.200
Engineered Bamboo	0.96	3/4"	0.720
Oak	0.85	3/4"	0.638
Ash	1.00	3/4"	0.750
Maple	1.00	3/4"	0.750
Pine	1.30	3/4"	0.975
Fir	1.20	3/4"	0.900
Carpet Pad/Slab Rubber 33 lb.	1.28	1/4"	0.320
Carpet Pad/Slab Rubber 33 lb.	1.28	3/8"	0.480
Carpet Pad/Slab Rubber 33 lb.	1.28	1/2"	0.640
Carpet Pad/Waffle Rubber 25 lb.	2.48	1/4"	0.620
Carpet Pad/Waffle Rubber 25 lb.	2.48	1/2"	1.240
Carpet Pad/Frothed Polyurethane 16 lb.	3.53	1/8"	0.53
Carpet Pad/Frothed Polyurethane 12.lb.	3.48	1/4"	0.87
Carpet Pad/Frothed Polyurethane 10 lb.	3.22	3/8"	1.20
Carpet Pad/Frothed Polyurethane 10 lb.	3.22	1/2"	1.61
Hair Jute	3.88	1/2"	1.940
Hair Jute	3.88	21/64"	1.250
Synthetic Fiber Pad 20 oz.	1.8	15/64"	0.421
Synthetic Fiber Pad 27 oz.	1.98	18/64"	0.545
Synthetic Fiber Pad 32 oz.	2.1	19/64"	0.630
Synthetic Fiber Pad 40 oz.	2.2	11/32"	0.770
Prime Urethane	4.30	21/64"	1.400
Prime Urethane	4.30	1/2"	2.150
Bonded Urethane	4.20	21/64"	1.350
Bonded Urethane	4.20	1/2"	2.100
Carpet	2.80	1/4"	0.700
Carpet	2.80	3/8"	1.050
Carpet	2.80	1/2"	1.400
Carpet	2.80	5/8"	1.750
Carpet	2.80	3/4"	2.100
Wool Carpet	4.20	3/8"	1.575
Wool Carpet	4.20	1/2"	2.100

RADIANT FLOORING GUIDE



RADIANT FLOORING/SUBFLOORING/EQUIPMENT GUIDE

Many flooring products that are not listed may be suitable for use with radiant heating. Readers should contact the manufacturers.

ADVANCED ADHESIVE TECH
419 S. Glenwood Ave., P.O. Box 1887,
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1550 Double Dr., Norman, OK 73069
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www.accucrete.com
- Has specific info available on radiant applications

AccuRadiant high-strength gypsum underlayment can be poured over hot water or electric radiant floor heating to provide a smooth finish for floor coverings.

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359 Clay Rd., Sunnyvale, TX 75182
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www.marazzitile.com
- Company website lists distributors

U.S. manufacturer and distributor of Italian-inspired porcelain and glazed ceramic floor and wall tile.

AMORIM CORK COMPOSITES
26112 110th St., Trevor, WI 53179
(262) 862-2311; (800) 558-3206 Fax: (262) 862-2500
www.acousticorkusa.com
RECOMMENDED PRODUCTS
- AcoustiCork R60 6mm thick
- AcoustiCork S130 13mm thick
- Recommended Temperature Range for Use with Radiant Systems: Up to 140° F
- Product R-values are published
- Has specific info available on radiant applications

AcoustiCork provides a thermal break in slab-on-grade applications so auxiliary heating systems work more efficiently and warm up about 50% faster.

ANDERSON HARDWOOD FLOORS
384 Torrington Rd., P.O. Box 1155, Clinton, SC 29325
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- Recommended Temperature Range for Use with Radiant Systems: Floor temperature not to exceed 80° F
- Has specific info available on radiant applications

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- Company website lists distributors
- Has specific info available on radiant applications

Radiant controls including radiant manifolds, zone valves, mixing valves, hydro separators, air vents, air separators, dirt separators, balancing valves, boiler fill valves, solar water heating systems, solar components and more.

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RECOMMENDED PRODUCTS
- FLORTRAK
- DRYABOVE
- Company website lists distributors
- Has specific info available on radiant applications

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www.compotite.com
- Recommended Temperature Range for Use with Radiant Systems: -15° F to 158° F
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RECOMMENDED PRODUCTS
- Cork underlayment
- Recommended Temperature Range for Use with Radiant Systems: 85° F
- Product R-values are published
- Company website lists distributors
- Has specific info available on radiant applications

Cork underlayment in sheets and rolls for use between radiant heating systems and subfloors; cork plank floating floors for use with radiant heating.

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- Product R-values are published
- Company website lists distributors
- Has specific info available on radiant applications

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- Company website lists distributors
- Has specific info available on radiant applications

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- Recommended Temperature Range for Use with Radiant Systems: 70° F to 100° F
- Product R-values are published
- Company website lists distributors

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- Company website lists distributors
- Has specific info available on radiant applications

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- STEP Warmfloor™
- Recommended Temperature Range for Use with Radiant Systems: Depends on application and flooring
- Company website lists distributors
- Has specific info available on radiant applications

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(715) 453-1111 Fax: (715) 453-4900
www.theezroute.com
- Company website lists distributors

Multipassage guide system for routing PEX tubing up out of the concrete in both radiant heat and domestic water line applications.

FLEXTHERM
2400 de la Province St., Longueuil, QC J4G 1G1 CANADA
(450) 442-9990; (800) 353-9843 Fax: (450) 442-1099
www.flextherm.com
- Company website lists distributors
- Has specific info available on radiant applications

FLEXTHERM is recognized as an industry leader and introduced floor heating systems as we know it today.

GLOBAL MARKET PARTNERS, LYPTUS BY WEYERHAEUSER
6125 Discover Dr., Memphis, TN 38141
(901) 755-6758 Fax: (901) 753-7966
www.globalmarketpartners.com
RECOMMENDED PRODUCTS
- Upo Floor
- Cork Floors USA
- Golvabia
- Recommended Temperature Range for Use with Radiant Systems: Subfloor must not exceed 85° F

Global Market Partners markets high-quality, real wood flooring products.

GOODFELLOW
9184 Twiss Rd., Campbellville, ON L0P 1B0 CANADA
(905) 854-5800; (800) 263-6269 Fax: (905) 854-6104
www.goodfellowinc.com
- Company website lists distributors

GREEN BOILER TECHNOLOGIES, WESTERN ENGINEERING
918 W. Walnut St., Danville, KY 40422
(859) 236-3181 Fax: (859) 236-3184
www.greenboilertechnologies.com or www.gbt-inc.com
- Company website lists distributors
- Has specific info available on radiant applications

Manufacturers of gas-fired high-efficiency boilers at 99.8% effciency and mid-efficiency boilers gas-fired at 86.5% effciency. Uses both natural and propane gas, models modulate 7.5:1. Available in sizes of: 2000m; 1500m; 1000m; 500m.

GREENWOOD CLEAN ENERGY
13429 S.E. 30th St., Ste. A, Bellevue, WA 98005
(888) 788-3090; (425) 522-3326 Fax: (425) 871-0802
www.greenwoodusa.com
Greenwood manufactures high-efficiency wood and biomass boilers and heaters.

HACKER INDUSTRIES
1600 Newport Center Dr., Ste 275,
Newport Beach, CA 92660-8037
(800) 642-3455 Fax: (800) 906-8548
www.hackerindustries.com
- Product R-values are published
- Company website lists distributors
- Has specific info available on radiant applications

For comfortable, evenly heated floors, specify Hacker Industries' GYP-SPAN Radiant. Installed by licensed applicators, GYP-SPAN Radiant provides a smooth, durable and warm surface for finished floor coverings.

HALEX CORP.
750 S. Reservoir St., Pomona, CA 91766
(909) 622-3537 Fax: (909) 622-3047
www.halexcorp.com
- Recommended Temperature Range for Use with Radiant Systems: >120° F
- Has specific info available on radiant applications

Carpet tack strip, carpet seam tape, underlayment, flooring moisture suppressant, nails.

HEATIZON SYSTEMS
4137 S. 500 West, Murray, UT 84123
(801) 293-1232 Fax: (801) 293-3077
www.heatizon.com
- Company website lists distributors
- Has specific info available on radiant applications

Low-voltage roof-deicing, floor-warming, radiant-heating, snow-melting and water-warming products. Listed to UL standards. 25-year warranty.

HEATLINK
4603E 13 St. N.E., Calgary, AB T2E 6M3 CANADA
(800) 661-5332; (403) 250-3432
Fax: (800) 869-6098; (403) 250-1155
www.heatlink.com
- Has specific info available on radiant applications

Radiant heating and radiant cooling systems, including panels, electronic controls, insulated PEX, design software and modular manifolds. Potable water distribution components, including stainless-steel press sleeve, sleeved PEX tubing, greywater tubing and potable manifolds.

HEATTECH ELECTRIC FLOOR HEATING PRODUCTS
P.O. Box 350068, Brooklyn, NY 11235
(800) 470-5685; (800) 476-5102
www.heattechproducts.com
- Has specific info available on radiant applications

HeatTech offers a large selection of 120V and 240V electric floor heating cable and mats for installation under tile, stone, granite and many other flooring types. Get free quotes and layout design plus fast shipping and knowledgeable technical support.

HYDROLEVEL CO.
83 Water St., New Haven, CT 06511
(203) 776-0473 Fax: (203) 773-1019
www.hydrolevel.com
Low-water cut-offs, boiler water feeders, liquid level controls and flow switches.

INFLOOR SALES & SERVICE
P.O. Box 4945
Buena Vista, CO 81211
(800) 588-4470; (719) 395-3400
Fax: (719) 395-3555
www.infloor.com
RECOMMENDED PRODUCTS
- InfloorBoard™, a modular hydronic radiant heating system
- Electric radiant floor warming/heating system
- Hydronic radiant floor heating system
- Company website lists distributors
- Has specific info available on radiant applications

Full line of hydronic floor heating systems consisting of quality-assured, proven components: PEX and BPEX tubing, manifolds in copper and brass. For floor warming, Infloor electric cable is flexible, moisture-resistant and tough. Complete line of plumbing materials, as well as solar.

INSULATION SOLUTIONS
401 Truck Haven Rd., East Peoria, IL 61611-1749
(309) 698-0062 Fax: (309) 698-0065
www.insulationsolutions.com
RECOMMENDED PRODUCTS
- Space Age
- The Quip
- Insul-Tarp
- Recommended Temperature Range for Use with Radiant Systems: -60° F to 180° F
- Product R-values are published
- Has specific info available on radiant applications

Insul-Tarp, Space Age, Radiant Panel Pro Plus and the Quip are excellent ways to increase the profitability of your radiant project. Whether you are looking for increased efficiency, lower cost or quicker installation, the technology offered by Insulation Solutions can make it happen.

JOHNSON BROS. METAL FORMING CO.
5520 McDermott Dr., Berkeley, IL 60163-1203
(708) 449-7050 Fax: (708) 449-0042
www.johnsonrollforming.com
Manufactures roll-formed metal, radiant floor tubing, panels, clamp rings, troughs, cableways, framing and more. All metals used: nonferrous and ferrous, pre finished and plain. Inline fabrications.

JOHNSONITE
16910 Munn Rd., Chagrin Falls, OH 44023
(800) 899-8916 Fax: (440) 543-5774
www.johnsonite.com
RECOMMENDED PRODUCTS
- Roundel Rubber Flooring
- Recommended Temperature Range for Use with Radiant Systems: Not to exceed 85° F

The leader in providing innovative, high-quality specialty flooring products of design excellence which aesthetically enhance the design of interior environments.

JUNCKERS HARDWOOD
270 Lafayette St., Ste. 1200, New York, NY 10012
(212) 334-8060 Fax: (212) 334-8062
www.junckershardwood.com
RECOMMENDED PRODUCTS
- Distressed wood flooring
- Recommended Temperature Range for Use with Radiant Systems: 65° F to 80° F
- Product R-values are published
- Company website lists distributors
- Has specific info available on radiant applications

Solid and engineered wood flooring for use with radiant-heated subfloors.

LAARS HEATING SYSTEMS CO., A SUB. OF BRADFORD WHITE CORP.
20 Industrial Way, Rochester, NH 03867
(603) 335-6300; (800) 900-9276 Fax: (603) 335-3355
www.laars.com
- Company website lists distributors

Laars Heating Systems is a U.S. designer and manufacturer of residential and commercial boilers and water heaters in sizes from 50 MBH to 5,000 MBH.

LATICRETE INTERNATIONAL
1 Laticrete Park N.,
Bethany, CT 06524-3423
(800) 243-4788; (203) 393-0010
Fax: (203) 393-1684
www.laticrete.com
RECOMMENDED PRODUCTS
- Laticrete® 254 Platinum multipurpose thin-set mortar
- Recommended Temperature Range for Use with Radiant Systems: 40° F to 104° F (5° C to 40° C)
- Company website lists distributors
- Has specific info available on radiant applications

Maintenance-free and backed by a lifetime warranty, Laticrete floor heat is the most complete self-adhesive electrical floor warming system available. Easy-to-use design layout software allows projects to be quickly created, with an in-house design group available for assistance. **See our ad on page 9.**

LAUNSTEIN HARDWOOD FLOORS
384 S. Every Rd., Mason, MI 48854
(517) 676-1133 Fax: (517) 676-6379
www.launstein.com
RECOMMENDED PRODUCTS
- Hardwood floors
- Quarter-sawn hardwood floors
- Wide-plank hardwood floors
- Recommended Temperature Range for Use with Radiant Systems: 70° F to 80° F
- Product R-values are published
- Company website lists distributors
- Has specific info available on radiant applications

We manufacture wood floors designed to work with radiant systems, both solid and engineered. Shipped nationwide, wide-plank quarter-sawn flooring is our specialty.

= Premium listing. For expanded online listings, go to www.radiantandhydronics.com/radiantflooringguide

LEGEND HYDRONICS

300 N. Opdyke Rd.,
Auburn Hills, MI 48326
(866) 752-2055
Fax: (866) 752-2054
www.legendhydronics.com or www.legendvalve.com

- Has specific info available on radiant applications

Legend's hydronics division offers a full line of innovative products: from radiant panel systems to solar, from innovative accessories to the largest most-flexible selection of manifolds in the industry. Guaranteed shipped in 24 hours and backed by the always outstanding customer service the hydronics and mechanical industries have become accustomed to from Legend. **See our ad on page 11.**

MACDUFFCO MFG.

P.O. Box 46011, 2642 Quadra St.,
Victoria, BC V8T 4E4 CANADA
(888) 565-2267
www.ultra-fin.com
RECOMMENDED PRODUCTS

- Hydronic radiant floor heating system

The proven and patented design of the ULTRA-FIN radiant floor heating system allows for more heat to be delivered faster and more efficiently without overheating the floor. The only radiant system compatible with all floor coverings, even hardwood.

MAXXON CORP.

920 Hamel Rd., P.O. Box 253,
Hamel, MN 55340
(800) 356-7887; (763) 478-9600
Fax: (763) 478-2431
www.maxxoncorporation.com
RECOMMENDED PRODUCTS

- Therma-Floor® underlayment
- Recommended Temperature Range for Use with Radiant Systems: Maximum 150° F
- Product R-values are published
- Company website lists distributors
- Has specific info available on radiant applications

Maxxon, recognized worldwide as the pioneer and leader in floor technologies, provides Therma-Floor, the ideal thermal mass for radiant heat. Always a green building material, it's the specially formulated, high-strength underlayment that pours 1 1/4® thick over hydronic tubes or electric heating cables.
See our ad on page 35.

METROFLOR CORP.

15 Oakwood Ave., 2nd Fl.,
Norwalk, CT 06850
(888) 235-6672;
(866) 882-4407 ext. 1
Fax: (706) 243-4761; (203) 750-8754
www.metroflorusa.com

- Recommended Temperature Range for Use with Radiant Systems: 48 hours before/after installation, 65° F to 85° F; all other times: 65° F to 85° F

Metroflor offers superior vinyl construction in a wide selection of wood, ceramic, stone, metal and concrete patterns that are suitable for residential and commercial applications.

METROPOLITAN CERAMICS, DIV. OF IRONROCK CAPITAL

1201 Millerton St. S.E., P.O. Box 9240,
Canton, OH 44711-9240
(330) 484-4887; (800) 325-3945
Fax: (330) 484-3584; (330) 484-4880
www.metroceramics.com or www.ironrock.com

- Company website lists distributors

Low-absorption, natural through-the-body colors and tight die skin surface of extruded Metropolitan Ceramics' quarry tile makes it the right choice for demanding commercial and residential applications, indoors and outdoors.

MIRAGE/BOA-FRANC

1255 98th St., St. Georges, QC G5Y 8J5 CANADA
(800) 463-1303 Fax: (418) 227-1188
www.miragefloors.com

- Recommended Temperature Range for Use with Radiant Systems: The wood surface temperature must never exceed 80° F

Absolute consistency in species, finish, coloring, width and thickness guarantees that Mirage prefinished hardwood floors are smooth, uniform, easy to install and beautiful beyond compare.

MP GLOBAL PRODUCTS

P.O. Box 2283,
2500 Old Hadar Rd.,
Norfolk, NE 68702-2283
(888) 379-9695 Fax: (402) 379-9737
www.quietwarmth.com or www.quietwalk.com
RECOMMENDED PRODUCTS

- QuietWarmth™
- Recommended Temperature Range for Use with Radiant Systems: Not to exceed 90° F
- Product R-values are published
- Company website lists distributors
- Has specific info available on radiant applications

QuietWarmth is designed to be the easiest, safest and most effective radiant heat system to use under laminate, wood and tile floor coverings. Made with ThermoSoft FiberThermics heating elements, QuietWarmth is convenient, can assist in sound absorption, warms the floor and helps to heat a room.
See our ad on page 7.

M.P. METAL PRODUCTS

P.O. Box 170, Ixonia, WI 53036-9797
(920) 261-9650 Fax: (920) 261-9652
www.mpmetals.com

Heat transfer plates manufactured to customer specifications in a variety of sizes and shapes, in aluminum and other metals, typically for OEM accounts.

MR. PEX SYSTEMS

2613 87th Ct. W., Northfield, MN 55057
(952) 652-2472 Fax: (952) 652-2378
www.mrpexsystems.com

- Recommended Temperature Range for Use with Radiant Systems: Up to 200° F

Mr. PEX offers flexible PEX tubing for radiant floor heating, snow-melt systems and PEX-AL-PEX plumbing systems.
See our ad on page 37.

NATIONAL APPLIED CONSTRUCTION PRODUCTS

3200 S. Main St., Akron, OH 44319
(800) 633-4622 Fax: (330) 644-3557
www.nacproducts.com
RECOMMENDED PRODUCTS

- SAM3/Super Sam sound abatement membranes
- Strataflex waterproofing membrane
- ECB anti-fracture membrane
- Has specific info available on radiant applications

Temperature fluctuations between wood or concrete substrates and hard floor surfaces like porcelain, ceramic and marble often lead to tile failure. Specify anti-fracture membranes, waterproof membranes and sound control membranes from NAC Products to solve the problem for radiant heat and tile warming systems.

NATIONAL GYPSUM CO.

2001 Rexford Rd., Charlotte, NC 28211
(704) 365-7302 Fax: (704) 365-7276
www.nationalgypsum.com

- Product R-values are published

PermaBase cement board is a rigid substrate made of Portland cement, aggregate and glass mesh that provides an exceptionally hard, durable surface that is able to withstand prolonged exposure to moisture.

NAVIEN AMERICA

20 Goodyear, Irvine, CA 92618
(800) 519-8794; (949) 420-0420 Fax: (949) 420-0430
www.navienamerica.com

NIBCO

1516 Middlebury St., Elkhart, IN 46516
(574) 295-3000; (800) 234-0227 Fax: (574) 295-3307
www.nibco.com

- Recommended Temperature Range for Use with Radiant Systems: 140° F or lower
- Company website lists distributors
- Has specific info available on radiant applications

NIBCO's basic radiant-heating system provides a comfortable, efficient and affordable method of heating. Our pre-engineered panels and installation kits get the job done quickly.

NOBLE CO.

P.O. Box 350, Grand Haven, MI 49417-0350
(800) 878-5788 Fax: (231) 799-8850
www.noblecompany.com
RECOMMENDED PRODUCTS

- NobleSeal SIS
- NobleSeal TS
- NobleSeal CIS
- Recommended Temperature Range for Use with Radiant Systems: Up to 180° F
- Has specific info available on radiant applications

Noble Co. produces composite sheet membranes ideally suited for use under thin-set tile installations with radiant heat. NobleSeal sheet membranes can provide crack isolation, waterproofing and sound control.

RADIANT FLOORING/SUBFLOORING/EQUIPMENT GUIDE

NORTHWESTERN OHIO FOAM PRODUCTS

725 Enterprise Dr.,
Wauseon, OH 43567
(800) 339-4850; (419) 335-4850 Fax: (419) 335-2380
www.thebarrier.com or www.nofp.com
RECOMMENDED PRODUCTS

- Premiere — duct wrap insulation
- Microfoil — radiant barrier for staple-up
- The Barrier — under concrete insulation
- Recommended Temperature Range for Use with Radiant Systems: -30º F to +300º F
- Product R-values are published
- Has specific info available on radiant applications

Barrier, BarrierXT and BarrierX5 were specifically designed to use under concrete slabs with radiant in 4' x 64' rolls. Solex reflective insulation for staple-up.
See our ad on page 29.

NOVA DISTINCTIVE FLOORS

1710 E. Sepulveda Blvd., Carson, CA 90745
(866) 576-2458 Fax: (310) 830-9589
www.novafloorings.com

- Recommended Temperature Range for Use with Radiant Systems: Max 85º F
- Product R-values are published
- Company website lists distributors
- Has specific info available on radiant applications

Cork, corkstone, slate and leather flooring. Cork underlayment rolls and sheets.

OJ ELECTRONICS

P.O. Box 366, Arlington Heights, IL 60006
(847) 870-1906 Fax: (847) 870-1907
www.ojelectronics.com
Leading manufacturer of thermostats for electric floor heating and controls for ice- and snow-melting applications since 1964.

OSCODA PLASTICS

5585 N. Huron Ave., P.O. Box 189, Oscoda, MI 48750
(989) 739-6900 Fax: (989) 739-1494
www.oscodaplastics.com
RECOMMENDED PRODUCTS

- All Protect-All products
- Recommended Temperature Range for Use with Radiant Systems: Not to exceed 85º F

PROTECT-ALL flooring is manufactured from 100% recycled vinyl. It's 1/4" thickness provides comfort under foot with extreme slip-resistance and durability.

PETER MANGONE

12687 W. Cedar Dr., Ste. 100,
Lakewood, CO 80228-2013
(800) 338-2448; (303) 986-5447 Fax: (303) 989-1207
www.petermangone.com

- Company website lists distributors

Offers PEX tubing installation tools for radiant floor heating systems: the Reddi-Strip System for foamboard, and manual and pneumatic tools for wooden surfaces.

PEXSUPPLY.COM

P.O. Box 416,
Farmingdale, NY 11735
(888) 757-4774
www.pexsupply.com

- Has specific info available on radiant applications

PexSupply.com is your source for plumbing, heating and HVAC supplies. **See our ad on page 13.**

PEXUNIVERSE

196 Henry St., Hempstead, NY 11550
(800) 818-3201
www.pexuniverse.com

- Product R-values are published
- Company website lists distributors
- Has specific info available on radiant applications

PexUniverse.com is here to offer you the highest quality radiant heating and plumbing supplies at the most competitive pricing online. Our extensive line of PEX supplies includes PEX tubing, PEX-AL-PEX tubing, PEX fittings, PEX manifolds and PEX tools. We also offer a large selection of brand-name heating and plumbing supplies such as Taco circulator pumps, Grundfos pumps, Little Giant pumps, Honeywell thermostats, Stiebel Eltron and Takagi tankless water heaters, Amtrol expansion tanks, ball valves and many others.

PRECISION HYDRONIC PRODUCTS

6807 N.E. 79th Ct., Ste. E, Portland, OR 97218
(503) 445-4188 Fax: (503) 445-4187
www.phpinc.us

- Product R-values are published
- Company website lists distributors
- Has specific info available on radiant applications

Precision Hydronic Products manufactures primary radiant modular panels, hydraulic separators and canisters, copper manifoolds and insulated heat flooring underlayment for 3/8" PEX tubing.

PREVERCO

285 de Rotterdam,
St. Augustin, QC G3A 2E5 CANADA
(800) 667-2725 Fax: (418) 878-8931
www.preverco.com
RECOMMENDED PRODUCTS

- Engenius engineered floors
- Company website lists distributors

Preverco offers a wide variety of hardwood flooring using the most beautiful wood species offered in various grades, widths and trendy colors.

QUALITY WOODS

95 Flanders Bartley Rd., P.O. Box 86,
Flanders, NJ 07836
(973) 584-7554 Fax: (973) 584-3875
www.qualitywoodsltd.com
RECOMMENDED PRODUCTS

- Merbau flooring

Solid wood flooring: Burma teak, Merbau and straight-grain Brazilian cherry, all suitable for radiant heat.

QU-CORK

6125 Discover Dr., Memphis, TN 38141
(901) 755-6758 Fax: (901) 753-7966
www.qu-cork.com

RADIANT ENGINEERING

501 East Peach St., Ste. A, Bozeman, MT 59715
(406) 587-3442 Fax: (406) 587-1617
www.radiantengineering.com
RECOMMENDED PRODUCTS

- ThermoFin extruded aluminum heat transfer plates

Radiant Engineering specializes in the design and supply of hydronic heating systems for residential and commercial buildings. We also manufacture and sell heat transfer plates.

R.C.A. RUBBER CO.

1833 E. Market St., P.O. Box 9240,
Akron, OH 44305-0240
(330) 784-1291; (800) 321-2340 Fax: (330) 794-6446
www.rcarubber.com or www.flexi-flor.com

- Recommended Temperature Range for Use with Radiant Systems: After adhesive sets, up to 120º F.
- Has specific info available on radiant applications

Rubber flooring is dimensionally stable and does not require seam welding. Rubber flooring needs no sealers or finishes for maintenance. Made in the USA.

REED MANUFACTURING CO.

1425 W. 8th St., P.O. Box 1321, Erie, PA 16512-1321
(814) 452-3691; (800) 666-3691 Fax: (814) 455-1697
www.reedmfgco.com
Reed Manufacturing Co. makes pipe tools for professionals. For the radiant flooring industry Reed offers tubing cutters, PEX tools, stud punches and a whole line of water services tools.

REFLECTIX

1 School St., Markleville, IN 46056
(765) 533-4332 Fax: (765) 533-2327
www.reflectixinc.com
RECOMMENDED PRODUCTS

- Double Bubble White
- Staple Tab
- Standard Double Bubble
- Product R-values are published
- Has specific info available on radiant applications

Reflectix is a great enhancement to any radiant floor-heating application. It reflects 97% of radiant energy striking its surface. Reflectix is tough, easy to install, radiates heat in desired direction, is an excellent vapor barrier and increases efficiency in heating.

REHAU

1501 Edwards Ferry Rd., N.E., Leesburg, VA 20176
(800) 247-9445 Fax: (800) 627-3428
www.na.rehau.com
RECOMMENDED PRODUCTS

- EVERLOC® fittings
- RAUPEX®
- RAUPANEL™
- Company website lists distributors
- Has specific info available on radiant applications

REHAU offers geothermal, radiant heating/cooling and computer-based controls systems along with training and design support to help you achieve high-performance residential and commercial installations.
See our ad on page 56.

RELIANCE CARPET CUSHION

P.O. Box 58584, Vernon, CA 90058-0584
(800) 522-5252; (323) 321-2300 Fax: (323) 973-1284
www.reliancecarpetcushion.com

- Product R-values are published

Manufactures carpet cushion for commercial and residential flooring applications and noise reduction products for residental, commercial, construction and automotive applications.

= Premium listing. For expanded online listings, go to www.radiantandhydronics.com/radiantflooringguide

ROBERTS CONSOLIDATED INDUSTRIES, A Q.E.P. CO.

1001 Broken Sound Pkwy., Ste. A,
Boca Raton, FL 33487
(866) 435-8665 Fax: (561) 241-2830
www.robertsconsolidated.com

Roberts Consolidated Industries manufacturers a full line of floor-covering adhesives, ceramic setting materials, floor-covering tools and waterproofing membranes for the construction industry.

ROBINA FLOORS

825 Great Southwest Pkwy. S.W., Atlanta, GA 30336
(678) 626-0510
www.robinafloors.com

- Recommended Temperature Range for Use with Radiant Systems: NWFA guidelines
- Company website lists distributors
- Has specific info available on radiant applications

We manufacture high-end engineered wood and laminate flooring. Both product lines feature our Vaelinge 5G locking system.

ROTH INDUSTRIES

P.O. Box 245, Syracuse, NY 13211
(315) 579-3326 Fax: (315) 475-0220
www.roth-america.com
RECOMMENDED PRODUCTS

- Hydronic radiant heating systems
- Product R-values are published
- Has specific info available on radiant applications

Roth specializes in environmentally-friendly products that produce (domestic hot water solar and geothermal heat pumps), distribute (radiant floor heating and PEX-c plumbing systems) and store (septic, cistern, rainwater collection and oil storage tanks) energy for the finest homes.

RPM RADIANT CORP.

P.O. Box 14478, Mill Creek, WA 98082
(425) 583-7886 Fax: (425) 585-0168
www.rpmmats.com

- Company website lists distributors
- Has specific info available on radiant applications

RPM Mats are a lightweight alternative to backerboard and anti-fracture membrane, specifically designed for the installation of electric floor heat wire.

SCHLUTER SYSTEMS

194 Pleasant Ridge Rd., Plattsburgh, NY 12901
(800) 472-4588 Fax: (800) 477-9783
www.schluter.com
RECOMMENDED PRODUCTS

- Schluter®-BEKOTEC
- Recommended Temperature Range for Use with Radiant Systems: Up to 175° F (79° C)
- Product R-values are published

Schluter-BEKOTEC is a lightweight, modular screed system used to create continuous screed surfaces without control joints or reinforcement and accommodate hydronic radiant heating tubes.

SOLIDA CORK, ERACO INTERNATIONAL

216 Britannia Rd. E., Mississauga, ON L4Z 1S6
CANADA
(905) 712-9976 Fax: (905) 712-3417
www.solidacork.com
RECOMMENDED PRODUCTS

- Solida cork flooring
- Recommended Temperature Range for Use with Radiant Systems: 64° F to 84° F
- Product R-values are published
- Has specific info available on radiant applications

Solida Cork is a leading-edge manufacturer of made-to-order traditional glue-down tiles and glueless floating cork floor with a comprehensive range of designs, colors, finishes and shapes available today. More than 10,000 distinct variations. Now available: custom-colored bamboo (65 standard colors and custom colors).

SOUND SEAL, IMPACTA FLOORING DIV.

P.O. Box 545, Agawam, MA 01001
(413) 789-1770 Fax: (413) 789-4444
www.acousticflooring.com

SPIROTHERM

25 N. Brandon Dr., Glendale Hts., IL 60139-2024
(630) 307-2662 Fax: (630) 307-3773
www.spirotherm.com

Air eliminators, dirt separators, automatic air vents, hydronic baseboard, convectors.

SPONGE CUSHION, A LEGGETT & PLATT CO.

P.O. Box 709, 902 Armstrong St., Morris, IL 60450
(800) 435-4062; (815) 942-2300
Fax: (800) 423-3557; (815) 942-9636
www.sponge-cushion.com
RECOMMENDED PRODUCTS

- TredMor commercial systems
- Berber Supreme
- Full House
- Product R-values are published

Manufacturer of high-density carpet cushions made from 100% synthetic rubber for residential and commercial installations. These products have low R-values, are not heat sensitive and are the type rated as "Best Choice" by the RPA.

SSHC

P.O. Box 769, Old Saybrook, CT 06475
(800) 544-5182 Fax: (860) 399-6460
www.sshcinc.com
RECOMMENDED PRODUCTS

- ENERJOY radiant ceiling panels
- Recommended Temperature Range for Use with Radiant Systems: No restriction
- Has specific info available on radiant applications

Warm floors radiantly without obstruction or temperature concern using Enerjoy modular ceiling panels. Radiant flooring, modular Enerjoy radiant ceiling panels, snow-melting systems, underdesk heaters, thermostats and controls. Complete line of UL-listed electric radiant products.

SUREPLY, PATRIOT TIMBER PRODUCTS

P.O. Box 19065, Greensboro, NC 27419
(336) 299-7755; Tech Support: (336) 299-7755
Fax: (336) 299-4050
www.patriottimber.com

TACO

1160 Cranston St.,
Cranston, RI 02920
(401) 942-8000 Fax: (401) 942-2360
www.taco-hvac.com

Residential circulators, zone valves and hydronic specialty products as well as pumps, valves and heat transfer equipment for both residential and commercial use. **See our ad on page 3.**

TEKMAR CONTROL SYSTEMS

5100 Silver Star Rd., Vernon, BC V1B 3K4 CANADA
(250) 545-7749 Fax: (250) 545-0650
www.tekmarcontrols.com
RECOMMENDED PRODUCTS

- tekmarNet®4
- Company website lists distributors
- Has specific info available on radiant applications

tekmar Control Systems add comfort, energy savings and convenience to a wide range of HVAC systems. Product line includes mixing, boiler and setpoint controls and thermostats.

TERAGREN

12715 Miller Rd., N.E., Ste. 301,
Bainbridge Island, WA 98110
(206) 842-9477; (800) 929-6333 Fax: (206) 842-9456
www.teragren.com
RECOMMENDED PRODUCTS

- TimberGrass® bamboo flooring
- Teragren™ bamboo floating floor
- Teragren™ bamboo 6' by 6" wide plank
- Recommended Temperature Range for Use with Radiant Systems: No higher than 80° F
- Company website lists distributors

Teragren is the nation's leading manufacturer of fine bamboo floors, countertops, panels and veneer. All Teragren bamboo flooring products are suitable over radiant heat.

THERMOSOFT INTERNATIONAL CORP.

701 Corporate Woods Pkwy., Vernon Hills, IL 60061
(877) 249-6422 Fax: (847) 279-8845
www.warmfloorsource.com
RECOMMENDED PRODUCTS

- THERMOFLOOR®
- THERMOTILE®
- Recommended Temperature Range for Use with Radiant Systems: Up to the maximum allowed by floor-covering manufacturers
- Product R-values are published
- Has specific info available on radiant applications

Thermosoft manufactures affordable electric radiant floor-heating solutions in the USA that are UL/CSA/NEC compliant, easy-to-install, energy-saving and designed for every type of floor.

TOOLS THAT ROCK

2295 Continental Dr., Ste. A,
West Bend, WI 53095-7833
(262) 306-7625 Fax: (262) 335-4180
www.toolsthatrock.com

TRIANGLE TUBE

1 Triangle Ln.,
Blackwood, NJ 08012
(856) 228-8881 Fax: (856) 228-3584
www.triangletube.com

Stainless-steel condensing boilers, stainless-steel indirect fired water heaters, stainless-steel heat exchangers. **See our ad on page 4.**

TYCO THERMAL CONTROLS

307 Constitution Dr.,
Menlo Park, CA 94025
(800) 545-6258 Fax: (800) 527-5703
www.raychemquicknet.com

- Has specific info available on radiant applications

The Raychem QuickNet floor heating system provides uniform heating for tiled areas. The system includes a heating mat for easy installation and a programmable thermostat. **See our ad on page 53.**

UPONOR

5925 148th St. W.,
Apple Valley, MN 55124
(800) 321-4739; (952) 891-2000
Fax: (952) 891-2008
www.uponorpro.com or www.uponor-usa.com
RECOMMENDED PRODUCTS

- Quik Trak®
- Product R-values are published
- Has specific info available on radiant applications

Uponor provides a comprehensive product offering as well as training and design support for radiant heating and cooling applications for the commercial and residential markets. **See our ad on page 2.**

U.S. BOILER CO., BURNHAM BOILERS

P.O. Box 3020, Lancaster, PA 17604-3020
(717) 397-4701 Fax: (717) 481-8478
www.usboiler.net
Manufacturer of residential cast-iron and steel gas/oil-fired space-heating boilers, gas-fired condensing aluminum and stainless-steel boilers and indirect-fired water heaters.

VIEGA

301 N. Main St., 9th Fl., Wichita, KS 67202
(800) 976-9819 Fax: (316) 425-7618
www.viega.com or www.viegapropress.us
RECOMMENDED PRODUCTS

- Radiant heating systems

Viega offers the most complete line of high-tech, high-quality radiant heating application methods and snow-melting systems in the world, alongside the most comprehensive customer support in the industry.

VIESSMANN MFG. CO.

45 Access Rd., Warwick, RI 02886
(800) 288-0667 Fax: (401) 732-0590
www.viessmann-us.com

- Company website lists distributors

Wall-mounted condensing boilers, floor-standing oil- or gas-fired hot water heating boilers, solar thermal systems, advanced biomass heating boilers, control technology and DHW storage tanks.

VINTAGE HARDWOOD FLOORING

409 Evans Ave., Toronto, ON M8Z 1K8 CANADA
(416) 252-0962; (416) 252-4182
Fax: (416) 252-3487; (416) 252-8213
www.vintageflooring.com

- Recommended Temperature Range for Use with Radiant Systems: 40° C to 54° C (104° F to 129° F)
- Company website lists distributors
- Has specific info available on radiant applications

Vintage Hardwood Flooring offers it's crafted 13mm engineered flooring and its 3/4" solid-sawn flooring and 10.5mm U-LOC locking hardwood flooring in 21 species, more than 70 colors and widths from 3 1/4" to 12".

WARM FLOORS

908-A Enterprise Way, Napa, CA 94558
(800) 542-9276; (707) 257-0880 Fax: (707) 257-0119
www.warmfloors.com

- Recommended Temperature Range for Use with Radiant Systems: Domestic temperature

Design, build and installation of hydronic radiant heating as well as thermal solar systems in California. Also offering packaged hydronic radiant heating systems and electric radiant mats throughout America.

WARMBOARD

8035 Soquel Dr., Ste. 41-A, Aptos, CA 95003
(877) 338-5493; (831) 685-9276 Fax: (831) 685-9278
www.warmboard.com

- Recommended Temperature Range for Use with Radiant Systems: 90° F to 120° F
- Product R-values are published
- Has specific info available on radiant applications

Warmboard manufacturers Warmboard and Warmboard-R, which offer the same superior heating performance, comfort and energy efficiency. Generally, new construction and new additions will use Warmboard, while remodeled homes will use Warmboard-R.

WARMLYYOURS

2 Corporate Dr., Ste. 100, Long Grove, IL 60047
(800) 875-5285 Fax: (800) 408-1100
www.warmlyyours.com

- Company website lists distributors
- Has specific info available on radiant applications

Buy electric floor heating direct from WarmlyYours and get 24/7 installation support, overnight custom design layouts and friendly, knowledgeable customer support.

WARMUP

52 Federal Rd., Unit 1F, Danbury, CT 06810
(888) 927-6333; (203) 791-0072
Fax: (888) 927-4721; (203) 791-4721
www.warmup.com
RECOMMENDED PRODUCTS

- Electric radiant heat
- Recommended Temperature Range for Use with Radiant Systems: Varies based on floor type
- Company website lists distributors
- Has specific info available on radiant applications

Warmup offers electric radiant heating systems for all floor types, including laminate and wood floors. All products are UL-listed and easy to install.

WARWICK HANGER

34 Canal St., Westerly, RI 02891
(401) 596-8062 Fax: (401) 596-8063
www.warwickhanger.com
Warwick Hanger is a manufacturer of pipe hangers, radiant heat installation products and other plumbing-related products.

WATTS RADIANT

4500 E. Progress Pl., Springfield, MO 65803
(417) 864-6108 Fax: (417) 864-8161
www.wattsradiant.com
RECOMMENDED PRODUCTS

- Heatweave electric floor warming
- RadiantPEX radiant tubing
- Onix radiant tubing
- Company website lists distributors
- Has specific info available on radiant applications

Watts Radiant provides several radiant solutions. Our systems can be installed using any type of floor covering.

WE CORK

16 Kingston Rd., Unit 6, Exeter, NH 03833
(800) 666-2675; (603) 778-8558 Fax: (603) 778-7052
www.wecork.com

- Recommended Temperature Range for Use with Radiant Systems: less than 85° F
- Product R-values are published
- Company website lists distributors
- Has specific info available on radiant applications

WECU is the economic and effective solution for sound control, stress crack protection and a thermal insulator under ceramic, tile and hardwood floors.

WEBSTONE CO.

One Appian Way,
Worcester, MA 01610
(800) 225-9529 Fax: (800) 336-5133
www.webstonevalves.com
Residential and commercial valves for plumbing, hydronic, radiant, solar and geothermal applications. Designs focus on time- and space-saving concepts that simplify maintenance and upkeep of all piping systems. **See our ad on page 6.**

WEIL-MCLAIN

500 Blaine St., Michigan City, IN 46360
(219) 879-6561
www.weil-mclain.com
Residential and commercial boilers, baseboard radiation, indirect-fired water heaters, heat exchangers, pool heaters, BCP panels, ancillary products.

YEMM & HART

1417 Madison, Ste. 308, Marquand, MO 63655-9153
(573) 783-5434 Fax: (573) 783-7544
www.yemmhart.com
Resilient rubber and cork floor tiles and rolls made with recycled materials.

ZURN INDUSTRIES, ZURN PEX

Hwy. 11 E., Commerce, TX 75428
(903) 886-2580 Fax: (903) 886-2583
www.zurnpex.com
RECOMMENDED PRODUCTS

- Simply Heat™ radiant floor warming
- Product R-values are published
- Has specific info available on radiant applications

Zurn, a leading manufacturer of radiant heating products, offers barrier and nonbarrier tubing, a variety of installation methods, and a range of controls and manifolds.

AD INDEX

PRODUCT SHOWCASE

THE FLOOR HEATING THAT SUITS YOU

Comfort is everything, especially in your home. With a Raychem QuickNet electric floor heating system, you can enjoy true warmth and comfort. QuickNet floor heating systems can be installed under tile and stone as well as laminate and engineered wood floors. QuickNet has been designed for ease of installation and can be customized on the jobsite for new construction or renovations.

Pentair Thermal Management (formerly Tyco Thermal Controls)

STEP warmfloor™

STEP WARMFLOOR: A VARIETY OF APPLICATIONS

STEP Warmfloor™ is a patented, thin (1.2 mm) and flexible homogeneous semi-conductive polymeric heating element. The system operates on low-voltage (24V AC or DC) and is extremely energy-efficient. Because the heating elements are self-regulating and cannot overheat, they can be used under almost any flooring. The elements are cut to length on the jobsite, making it ideal for new construction and remodeling. The applications include primary heat, floor warming, snow-melting and deicing.

Electro Plastics, dba STEP Warmfloor

RADIANT & HYDRONICS ENEWS, WEBSITE

The Radiant and Hydronics eNews is a twice-monthly enewsletter full of the latest happenings in the world of radiant and hydronic heating professionals. Each edition features industry news, the latest products, radiant tips, training and networking events. All editions are archived at the Radiant and Hydronics website (www.radiantandhydronics.com). The website has additional news, products and information for "wet side" heating pros.

EDUCATION AND RESEARCH STILL IMPORTANT

In a mid-2010 radiant heating study conducted by BNP Media's market research arm, Clear Seas Research, contractor respondents cited two reasons for an increase in the number of radiant projects they were involved in — customer comfort and customer awareness of the technology.

Educating the construction industry as well as consumers about radiant heating systems has been a significant goal of the Radiant Professionals Alliance since 1994. And the Radiant Flooring Guide has been part of that educational package for almost a decade. Many RPA contractor members leave this guide with their clients but also with builders, flooring contractors, architects — anyone they believe would benefit from learning about radiant floor-heating systems.

The 2013 Radiant Flooring Guide helps homeowners choose the best finished flooring options to be installed over their radiant floor-heating systems. With research and the help of experienced contractors, homeowners can provide their families with comfortable living spaces while protecting the investment in their flooring.

Not only does the Radiant Flooring Guide give advice on different flooring types that can be used over radiant systems — wood, tile, laminates, cork, vinyl and even carpet — it explains in simple terms how hydronic radiant and electric radiant systems work, what R-values are and their importance in heating, the best way to insulate and how to achieve energy efficiency by incorporating renewable energy technologies such as solar heating and geothermal systems.

The basic concept of radiant heat is easy to understand. Radiant floor-heating systems heat the space above the floor in a wide area, keeping the lower area of a room warmer. The finished flooring becomes part of the heating system. Forced-air systems pump in warm air, which then rises, leaving occupants much cooler.

I've written many feature articles on radiant heating — residential and commercial projects, big and small projects. And I've felt envious of those who built a home with a radiant system or incorporated radiant into remodeled or additional rooms.

You see, I am a renter. I live in a vintage apartment building in the northeast part of Chicago. Most of the time I enjoy renting; if something in my apartment needs attention such as the plumbing or heating, I just call the maintenance man and it's repaired in a reasonable amount of time.

But for the last 14 winters I have wished for radiant heat under my hardwood floors. That's when I first learned about radiant heat — when I entered the world of plumbing and heating trade journalism. Since then I have attended various heating industry trade shows and touched sections of radiantly heated wood or tile — even mirrors and under-desk mats.

Homeowners reading this guide don't need to be envious. They can add radiant heat in their homes by starting small — bathrooms, powder rooms, dining areas and small bedrooms. While electric radiant is probably easier to install during a remodel, hydronic radiant also is possible.

And radiant heating is not only for floors. The technology has advanced so that radiant can be installed in ceilings and walls, in tub surrounds and in shower floors.

So use the 2013 Radiant Flooring Guide as a research tool. Then discuss your findings with your heating and flooring contractors to make sure your radiant heating system delivers what you expect.

KELLY FALOON
EDITOR
RADIANT FLOORING GUIDE

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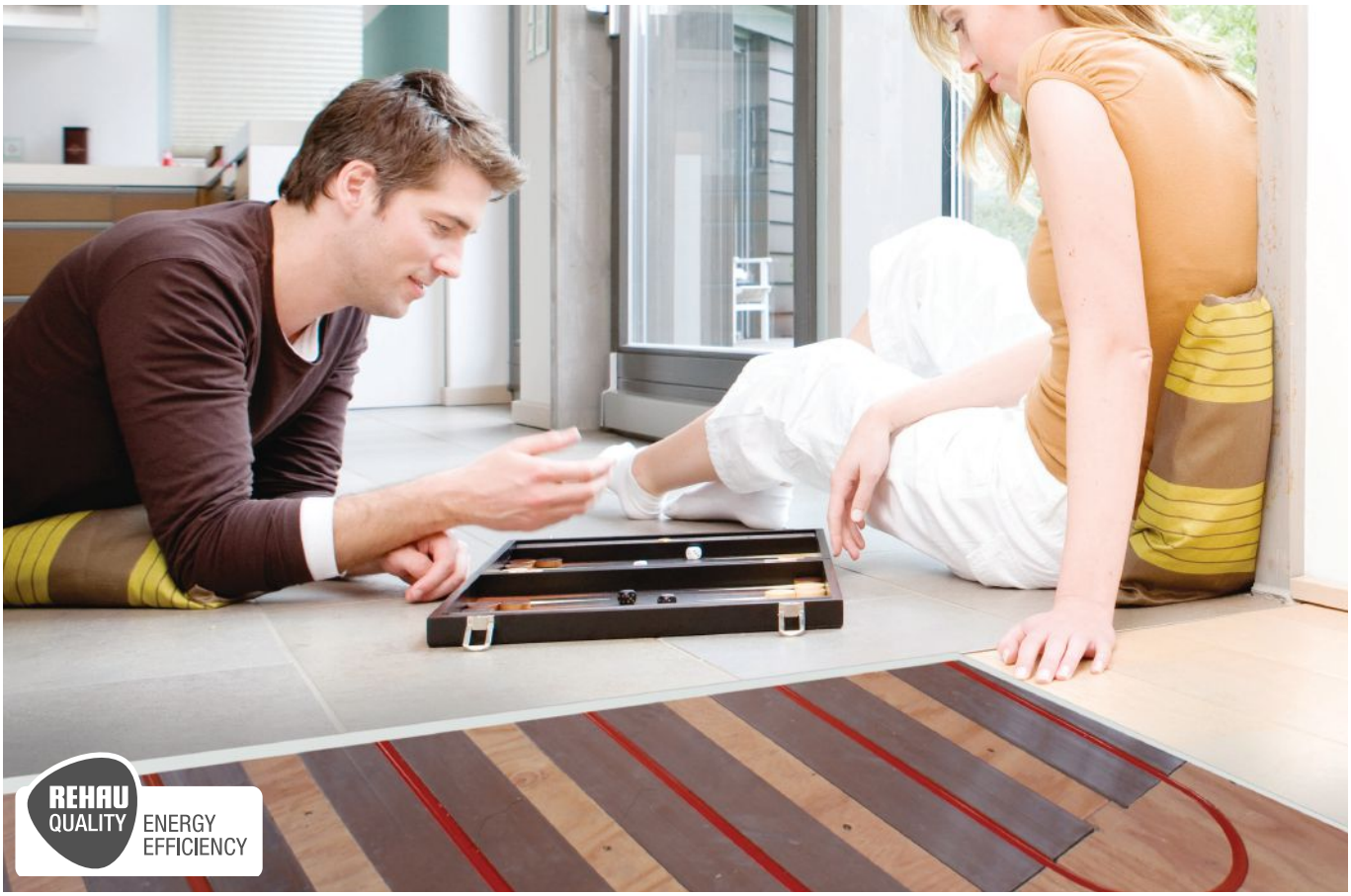

GEOTHERMAL, RADIANT AND MORE

OPTIMIZE COMPLEX HVAC WITH REHAU SMART CONTROLS

Install a geothermal heat pump with a radiant heating/cooling system and you'll increase comfort while saving up to 70% of the energy consumed by traditional HVAC systems.

Now imagine having an HVAC control center that responds to weather forecasts and allows you to change settings from your smart phone. These are just some of the conveniences you'll enjoy as your REHAU Smart Controls system works to manage the "greenest" available energy.

Only REHAU offers you this industry-leading combination of durable PEXa piping systems and intelligent controls that make the most of your residential or light-commercial HVAC investment.

Satisfied customers share their stories at na.rehau.com/smart