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Available on the RPA website, (**www.radiantpanelassociation.com**), this book is a must have if you are in the hydronic heating/cooling business.

The Low Mass Above Floor Systems

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The ultimate radiant floor system would be one that could uniformly heat the entire floor surface to the exact temperature required to warm the space at each moment in time. That would mean that the surface temperature would have to adjust constantly as the heating load changed throughout the day.

High mass systems that embed tubes or elements in concrete or gypsum products allow the heat to transfer laterally from the heating element as it rises to the surface. The result is that high mass systems with properly placed tubes or electric elements usually produce the most even

surface temperatures. The fact that they are "high mass" also means that the slab temperature is slow moving, so the surface temperature does not adjust quickly to a change in the heating load of the space. Controls are needed to anticipate the changes in the environment and adjust the slow moving mass temperature accordingly.

The closer the heating elements are to the surface of the floor, the more difficult it is to get a uniform temperature across the surface. If the elements are spaced a distance apart, highly heat conductive material such as aluminum is needed to rapidly spread the heat laterally before it dissipates into the room. What often happens is what the trade refers to as heat striping. These are stripes of elevated temperatures running along the floor over the tops of the heating elements. In extreme cases, this striping can discolor floor goods. At minimum, it can feel uncomfortable to a person in bare feet as they walk across the floor from warm to cool and back again.

Ideally, having a heating element beneath the entire surface of the floor would provide the most uniform surface temperature. In the case of a hydronic system this would amount to a sheet of heated water circulating evenly under the floor: not a very practical system.

Some electric systems that use mesh, films or mats of closely spaced elements come the closest to perfecting the concept of uniform surface temperature. Many of these products can be embedded in a thinset material under tile or stone. Unfortunately, they still have not fully mastered the challenge of finitely regulating surface temperatures. Electric systems are either on or off. They basically pulse heat to the floor. This can be done effectively with the proper controls, but do not modulate the temperature of the electric element. If it were not for the cost of electricity, electric systems might very well be the radiant floor heating system of choice. It is worth researching comparative energy costs in many locations. Low initial installation costs and simplicity often make them a good choice over hydronics in small spaces.

Hydronic systems, on the other hand, can regulate the water temperature delivered to the floor. Unfortunately, tubes spaced from six to twelve inches apart usually deliver this water. To overcome the wide spaces between the tubes, some sort of aluminum "fin" is used to transfer the heat delivered by the water to these voids. This does not eliminate striping, but the more effective the fin, the less noticeable the striping.

These low mass systems overcome the challenge of lag time experienced with high mass (concrete and gypsum) systems, but their low mass creates a new challenge.

Because they react quickly to a change in temperature of the heating element, they heat up fast and cool down fast. Once the heat source stops producing heat, the floor cools, unlike high mass systems that retain the heat. Hydronic systems can compensate by modulating the water temperature and keep it circulating. This is often done using an outdoor sensing control that varies the water temperature based on outdoor temperature. The colder the outdoor temperature gets, the warmer the water gets. In effect, these systems substitute the mass contained in the concrete of a high mass system, with water that is more easily controlled. Electric systems have very little mass, unless they are embedded in concrete, so they simulate mass by cycling on and off to hold a constant temperature.

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An important element in temperature uniformity in radiant floor heating systems is the choice of floor coverings. The higher the insulation properties of the floor covering, the more even the surface temperatures. This is because a highly insulative floor covering slows the heat transfer from the heating element to the surface of the floor covering. This gives the heat more time to spread out laterally under the floor covering. Striping is more likely felt on a tile floor than a carpeted floor. Like most things in life, there are compromises. As the insulation value of the floor covering increases, the heat flow decreases. In order to maintain the necessary heat flow,

the temperature of the heating element must be increased. There comes a point where it is no longer possible or desirable to raise this temperature.

Like all radiant floor systems, above-floor, low mass systems perform based on the sum of their parts. The nature of the heating element, fins, spacing and controls all affect the eventual performance outcome.

The system that does the best job of spreading the heat laterally, controlling the temperature constantly, and providing the most even surface temperature matched to the needs of the environment will do the best job of heating the space and, at the same time, provide the most comfort to the occupants.