

# Chapter 11

## Design Considerations

When planning and designing a hydronic radiant heating system, it is important to consider design options that support the intended need of the customer and the type of heat source available to the system. Radiant systems are significantly different from other hydronic or forced-air heating systems.

Differences include:

- A relatively large size of the heat transfer surface
- The panel's ability to absorb and disperse surges or fluctuations in supply water temperature (capacitor effect)
- A relative composition of the heat transfer (i.e., conduction, radiation and convection) as it relates to how the human body perceives thermal comfort

It is important to realize that the strategies used in forced-air systems are not necessarily applicable for radiant systems. The way in which energy is evaluated and managed is on a more finite level with radiant systems. The temperature in one room will not impact the temperature in the next room. This is why it is easier and less expensive to zone a radiant system than a forced-air system. Since most people like to sleep in a cooler room, bedrooms can be set to a lower setpoint temperature than common-use areas (e.g., kitchen, family room).

The air exchange in a structure does not affect radiant systems in the same way it affects forced-air systems. Forced-air systems use heated air circulating within the structure to heat objects. If a door is opened in a forced-air system,

the heated air (the medium for heating) is lost to the outside. In contrast, radiant systems heat objects, not air. As a result it is not necessary to overdesign systems.

### Surface Area

The surface area of a radiant panel system is relatively large compared to other methods of radiant heating, such as baseboards and radiators. Therefore, the heat required per square foot of heated surface and the corresponding surface temperature is much lower.

### Capacitor Effect

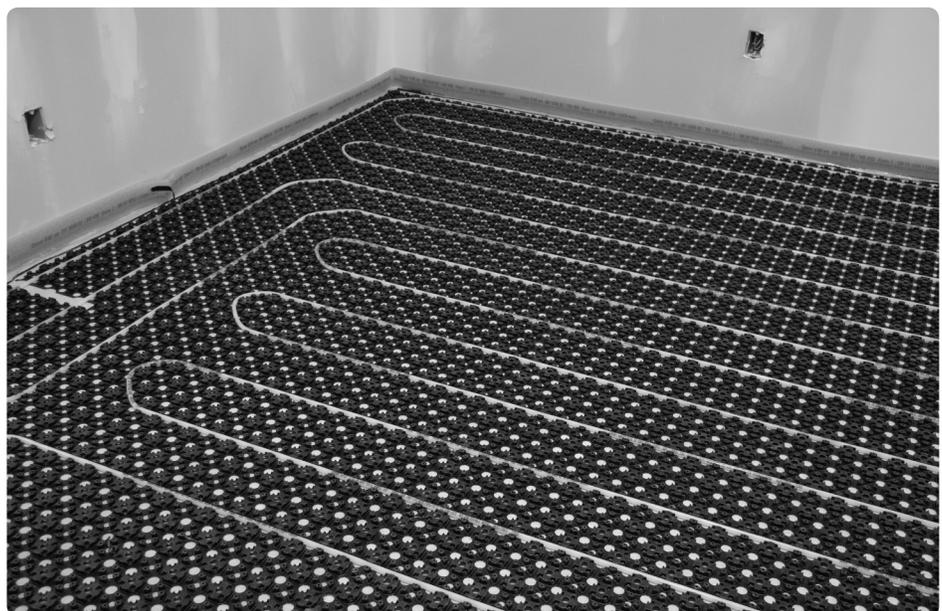
Because the radiant panel is massive, its surface temperature does not change instantly when heat is introduced. Instead, the mass of the system (as well as normal resistance) spreads the heat. Internally, heat disperses until the mass reaches capacity while gradually transferring heat to the space. Because of this

natural capacitor effect, a radiant panel is not as sensitive to supply water temperature fluctuations as baseboard convectors or radiators.

### Composition

Radiant panels effectively use all three forms of heat transfer: radiation, conduction and convection. The unique composition of radiant panel heat transfer results in a comfortable environment at lower room air temperatures because a radiant panel produces more consistent mean radiant temperatures than other types of heating systems.

Remember also that hot air — not heat — rises. Radiant systems are successful because the heat transfers primarily through conduction and radiation. The amount of convective transfer is minimal from radiant systems. Consider the fact that the majority of radiant systems operate with surface temperatures



between 75°F to 80°F. Very little convective action is moving from a panel at that temperature.

### Zone Selection

A zone is an area of a radiant floor or ceiling served by one or more tubing loops and controlled by a dedicated thermostat. Consider the following issues when determining zones.

#### Heat Loss

Place areas with different heat losses in separate zones. For example, a room with a 10 BTU/h/ft<sup>2</sup> heat loss and one with a 25 BTU/h/ft<sup>2</sup> heat loss should be in different zones.

#### Floor Construction

Place areas with different floor constructions in separate zones. For example, do not zone rooms constructed over a concrete slab (heavy-floor construction) with rooms constructed over suspended wood floors (light-floor construction) with aluminum plates.

Heavy construction contains a great mass and uses large or thick concrete slabs. More energy is required to accelerate the mass and increase the temperature; similarly, more time is required to decelerate the slab or reduce the temperature.

Light construction contains less mass and uses suspended wood floors with heat emission plates or a poured-floor underlayment and radiant ceiling. Less energy is required to increase temperature and less time is required to decrease temperature. Low-mass construction provides a quick response, but may be subject to hot spots when supplied with sudden increases in water temperature. Radiant ceiling is especially sensitive to excessive supply water temperature as are

radiant floors with low R-value floor coverings.

### Use Patterns

The use of a building can affect the desired setpoint temperature and the heat load. Analyze the intended use of each area before selecting zones. In many situations, use patterns will change over the life of the building. Design the zones with some flexibility to accommodate potential changes.

**Residential** – The use patterns of homes cover a wide range of possibilities. The age of residents as well as the types of activities in the home can vary greatly. For example, high-energy use patterns, such as cleaning, exercise, children’s play, etc., may require cooler temperatures. Low-energy activities, such as reading and watching television may require higher temperatures. Additionally, clothing is also something to consider. Some rooms may need to be warmer or cooler (e.g., bathrooms versus living rooms). Rooms unused for extended periods of time are often zoned separately, so the temperatures can be set lower to conserve energy and reduce operating costs.

**Commercial** – A commercial building usually centers on one or two activities, such as shopping, eating or entertainment. Consider the activities when determining zones. Also consider that the commercial buildings house a variety of businesses or enterprises over time, and use patterns may significantly change with each new occupant. Zones should be versatile enough to accommodate changes in the use patterns.

**Industrial** – Industrial buildings usually house a process that dictates zone requirements. The process may necessitate temperature and air changes

that make proper zoning critical. An industrial plant may house equipment that significantly contributes to the heat in the building or the heat load of the building. Industrial processes often produce heat that can be recovered in heat exchangers and used to supply warm water to the radiant panel.

### Internal Gains and Losses

Take into account additional heat gains and losses when determining zones.

In residential structures, additional gains may result from cooking, bathing or mechanical equipment. Additional losses may result from frequently used doors.

In commercial and industrial structures, additional gains may result from industrial processes, mechanical equipment or lighting. Additional losses may result from introducing cold vehicles or materials.

Consider zoning areas exposed to different solar conditions separately. Solar gain is influenced by the orientation of the building, length of the eaves and the amount of window area. Windows that provide a heat gain when it is sunny become a significant heat loss when there is no solar gain. The presence of large windows or significant window area increases the need for precise local zone control. Window coverings are useful for controlling solar exposure and window heat loss.