Description

- The design of a radiant floor heating system goes beyond just heat calculations. The structure itself must be examined and correct materials must be used with this type of heat. This webinar will look into material compatibilities when installing radiant floor heat along with simple design methods.

Learning Objectives

- Review the compatibility of materials for the installation of radiant floor heat.
- Review the construction limitation for installing radiant floor heat.
- Understand how radiant floor heating can impact the finish materials and potentially cause occupant discomfort.
- Review standard installation procedures which can formulate an outcome that will be comfortable to the occupant.
What is Radiant Floor Heating?

How does heat flow?

First let’s discuss the different paths heat can flow:
- Conduction
- Convection
- Radiation

Outline

- What is radiant floor heat?
- General code requirements for radiant floor heating
- Types of radiant heating
- Common compatibility issues
How does heat flow?

- Next let's take a look at how heat travels:
- Heat flows from warmer to cooler until there is no longer a temperature difference.

Conductive Heat Loss

- $Q = U \times A \times \Delta T$
  - $Q =$ heat flow (Btu/hr)
  - $U =$ thermal conductivity ($U = 1 / R$)
  - $A =$ surface area (square feet)
  - $\Delta T =$ temperature difference across component (°F)

Conductive Heat Loss

- Can you stop heat flow?

  $Q = U \times A \times \Delta T$

  Answer: No
  - Conductive heat flow can be managed, but not eliminated
• First the boiler system must use conduction to quickly and efficiently heat the water.

Movement of Heat in Radiant Floors

• Next the hot liquid being pumped throughout the house heats the concrete, tile, or other type of flooring through conduction as well as radiates heat into the room.

Movement of Heat in Radiant Floors

• Lastly, the flooring surfaces then radiate the heat they gained from the hydronic system into the room.
Movement of Heat in Radiant Floors

- Comparison of air movement in a room with forced air and radiant heating

![Diagram showing temperature differences between forced air and radiant heating systems.]

- Finished floor materials should take thermal mass and thermal resistance into account as well as aesthetics.
  - Thermal Mass – The ability of the material to absorb and retain heat.
  - Thermal Resistance – The rate at which a material transfers heat through conduction.

- The goal for an efficient radiant system is to choose materials that have:
  - High thermal mass
  - Low thermal resistance

This is Why Materials Matter

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Vinyl Flooring

- Vinyl Flooring

![Image of person installing vinyl flooring.]

Source: houseunderconstruction.com
This is Why Materials Matter

• Laminate Flooring
  Source: thespruce.com

This is Why Materials Matter

• Carpet
  Source: timbercreekflooring.com

This is Why Materials Matter

• Tile flooring
  Source: hgtv.com
But it Doesn’t Stop There

• Construction materials
  — Insulation
  — Subfloor
  — Concrete

• Location
  — Above the subfloor
  — Below the subfloor
  — Slab on grade
  — Ceiling

General Code Requirements for Radiant Floor Heating

• Table N1102.1 out of the 2009 IRC
  — Slab R-value and depth
    • Zone 4 & 5 – R-10 for 2ft
    • Zone 6 – R-10 for 4ft
  — Footnote d
    • R-5 shall be added to the required slab edge R-values for heated slabs.

Slab Insulation
Hydronic Piping

- **M2103.1.1 – Slab on grade installation.** Radiant piping used in slab-on-grade applications shall have insulating materials having a minimum R-value of R-5 installed beneath the piping.

- **M2103.2.2 – Suspended floor installation.** In suspended floor applications, insulation shall be installed in the joist bay cavity serving the heated space above and shall consist of materials having a minimum R-value of R-11.

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**How to Achieve Insulation Values?**

- Rigid foam is one of the easier ways to accomplish the sub slab insulation requirements.
Reflective Insulation?

- Be careful of installation details.
- Review ICC-ES report to ensure printed details are also part of the documented ICC-ES report.
- Some manufacturers recognize the importance of an airspace.

Note: Reflective insulation can provide R-values as high as R-15, however, the R-value is completed through testing and not by the product itself. An added benefit is that it is highly reflective, therefore, more effective when used in conjunction with other mass insulation products like fiberglass, foam, etc., or with radiant barrier systems.

Types of Radiant Floor Heating

Electric Radiant Floors

- Electric radiant floors are usually installed within the thermal mass of the flooring. In most cases, this means it will be installed between the subfloor / concrete floor and the finished flooring material.
Electric Radiant Floors

- Electric radiant floors typically are not used to “heat” the space, but used as a secondary system to focus on specific areas of the home. (Floor Warming)
- This is why electric radiant floors are more commonly found in bathrooms but this does not mean it can’t be designed as a whole house heating system.
- Another electric system would include an electric ceiling radiant heating system

Hydronic Radiant Floors

- Potentially one of the more popular forms of radiant floor heating systems and arguably one of the most efficient.
- There are several types of systems to choose from:
  - Underfloor Radiant Loops

Source: blog.buildllc.com
Hydronic Radiant Floors

- Potentially one of the more popular forms of radiant floor heating systems and arguably one of the most efficient.
- There are several types of systems to choose from:
  - Baseboard Heaters / Radiators
Hydronic Radiant Systems

- Potentially one of the more popular forms of radiant floor heating systems and arguably one of the most efficient.
- There are several types of systems to choose from:
  - Radiant Wall Systems

Common Material Compatibility Issues
Material Compatibility issues

- Material compatibility must be at the top of the list when designing a radiant heating system.
- Items to consider when choosing a finished flooring material to be installed over a radiant system:
  - Thermal conductivity of the flooring material
  - Moisture content of the flooring material
  - Temperature limitation of the flooring material
  - Furniture type and placement

Carpet as a Finished Floor

- Carpet can be considered an insulator over a radiant heating system.
- Example conducted by the Georgia Institute of Technology School of Textile Engineering:
  - 24 oz. Plush carpet had an R-value of R-1.12
  - Bonded Polyurethane 4lb padding had an R-value of R-2.09
  - Total R-value of R-3.21
  - Equivalent to over ½” of XPS

Vinyl as a Finished Floor

- Some types of vinyl floors can be installed over a radiant floor:
  - Luxury Vinyl Flooring (LVF)
    - Luxury vinyl planks (LVP)
    - Luxury vinyl tile (LVT)
- Vinyl products that may need special attention
  - Vinyl sheet material that must be glued in place. Off-gassing of the adhesives may occur.
3/4” Solid Hardwood as a Finished Floor

- Because ¾” hardwood is a natural material, it is subject to movement based on the environment in which it is installed.
- Solid hardwood, if installed over a radiant heated floor, should be quartersawn, narrow planks should be selected. This has the greatest chance to resist horizontal expansion and distortion.
- The surface temperature of the subfloor should not exceed 80°.
- Most if not all hardwood floor manufacturers will not warranty hardwood installed over a radiant floor heating system.

Floating Engineered Hardwood as a Finished Floor

- Due to the product’s engineered design, it can be more forgiving to the introduction of heat and moisture.
- Because a floating floor is not nailed to the subfloor, but instead locked together, it allows the whole floor to move as a single unit if a dimensional change within the wood floor takes place.
- Most manufacturers of engineered floating floors provide a warranty for installations over radiant systems (with the possible exceptions of their Maple and Brazilian Cherry species)

Tile or Stone as a Finished Floor

- Due to the thermal mass and thin profile, tile and stone can be one of the best flooring materials for the transfer of heat.
- These materials are highly conductive which can lead to a more effective system.
What is trapped heat?
Heated mat placed over a laminate floor for 30 minutes

After the removal of the mat

After the removal of the flower pot
Furniture and Trapped Heat

- Never install radiant heating under permanent fixtures
- Ensure there is a minimum 2-3 inches between the floor covering and the underside of the furniture
- Avoid placing furniture such as bookcases, closed-bottom furniture and stands that have shape points as feet over a radiant floor system
- The goal is to allow free movement of air as to reduce hot spots or trapped heat

Summary

- Radiant floor heating can be an efficient way to heat a home
- Proper insulation must be installed to promote heat flow in the desired direction
- Flooring materials must be chosen to reduce an insulating type reaction
- The compatibility of flooring materials must also be taken into consideration when installing a radiant floor heating system
- The type and placement of furniture must be taken into consideration when using a radiant floor heating system