The path to Net Zero travels right through

Hydronicsville

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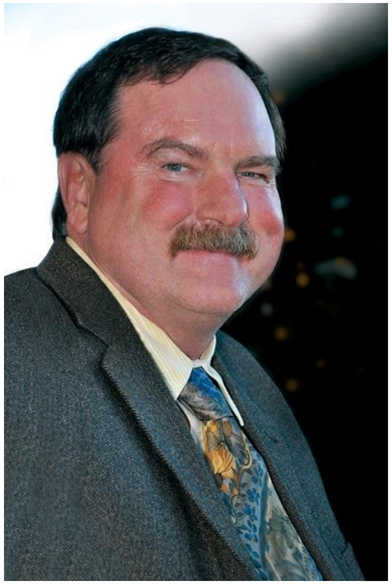
Who is this guy and what does he do?



Mark Eatherton
Executive Director
Radiant Professionals Alliance
www.radiantpros.org
Author (Contractor Magazine, P&M Magazine, numerous other trade magazines)
Instructor (RPA)
Has been doing hydronics and radiant for nearly 40 years.
Former expert witness.
Former adjunct college professor.

Learning Objectives

Upon completion of this program, attendees will be better able to:

- Describe how hydronic based radiant systems work and operate.
- List the benefits of utilizing non floor radiant systems for heating and cooling.
- Identify the major components of a hydronic based radiant heating or cooling system.
- Identify the appropriate materials and components to be used in the system.
- Ensure hydronic radiant systems are designed correctly and efficiently to achieve a net zero capability.

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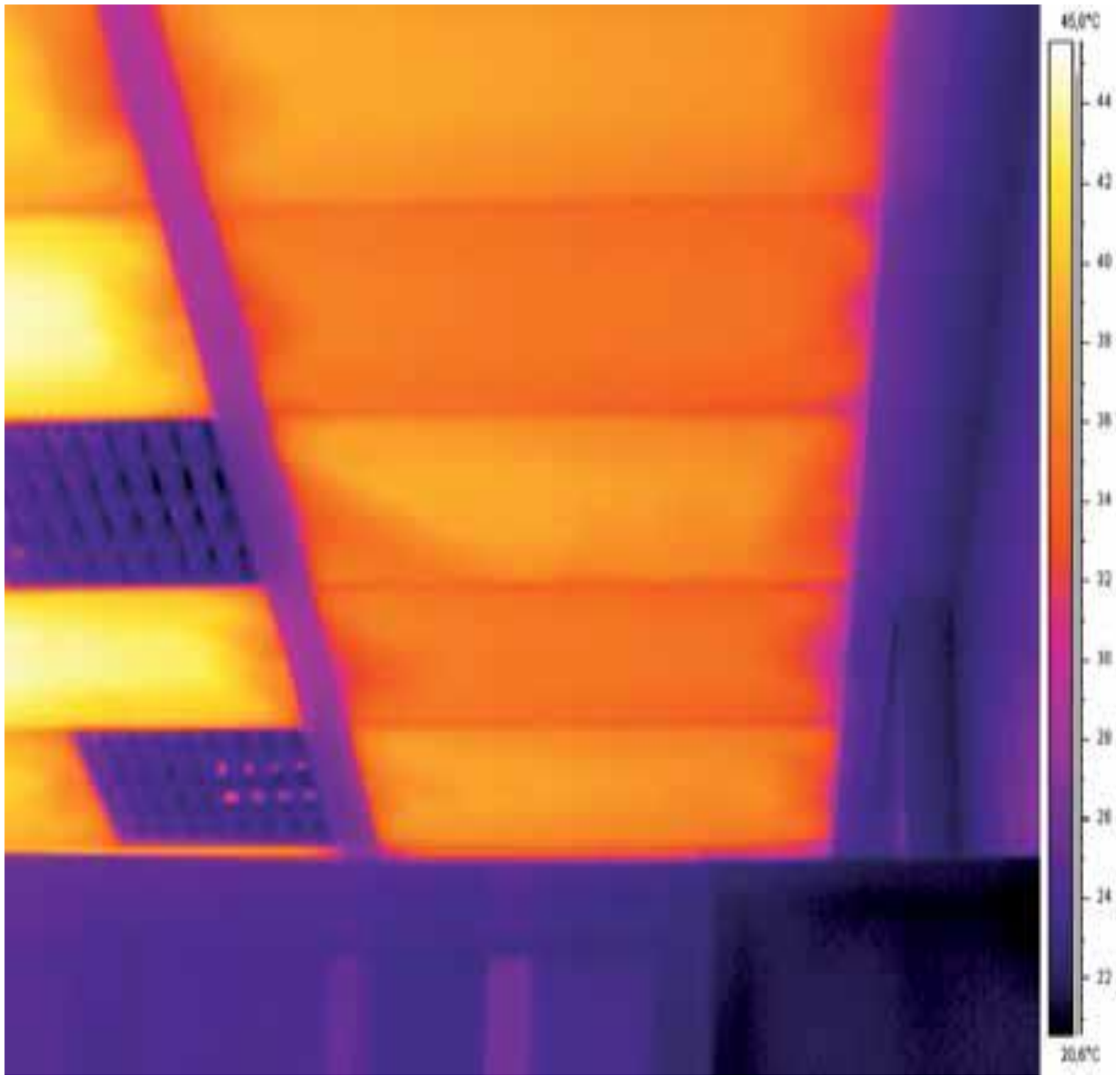
What is Radiant Heating?

- A process by which energy leaves the surface of an object or body and travels omni-directionally to the surface of another cooler object or body in Mother Natures efforts to balance out all things thermal.

We’ve all experienced radiant heating…



We’ve all experienced radiant heating…

- Standing next to a dark brick wall in the evening that had been exposed to sunshine.

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- Standing next to a dark brick wall in the evening that had been exposed to sunshine.
- Sitting in front of a camp fire on a clear starlit night.

We've all experienced radiant heating…

- Standing next to a dark brick wall in the evening that had been exposed to sunshine.
- Sitting in front of a camp fire on a clear starlit night.
- Walking into a radiantly heated home out of the cold.

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What dictates human comfort?

- Mean (average) radiant temperature
- Ambient air temperature
- Relative humidity
- Noise

Mean Radiant Temperature

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- Ambient air temperature
- Relative humidity
- Noise

A definition of comfort…

- You are not too hot.
- You are not too cold.
- You are not over humidified.
- You are not under humidified.
- You are not hearing the delivery system in the back ground.
- Simply stated, if all of the above conditions are TRUE, then you are comfortable.

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What is radiant cooling ?

- A process by which energy leaves the surface of a warm body and travels to the surface of another cooler object, again in Mother Natures effort to balance out all things thermal.

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We've all experienced radiant cooling…

Image courtesy Messanna Cooling Solutions

We've all experienced radiant cooling…

- Sitting outside on summer night with high ambient air temperatures, but clear cloudless sky.
- Walking down the frozen produce isle at the local grocery store and feeling the coolness coming from the glass reach in freezers
- Walking into a hockey arena when air temperature is 70 degrees F.

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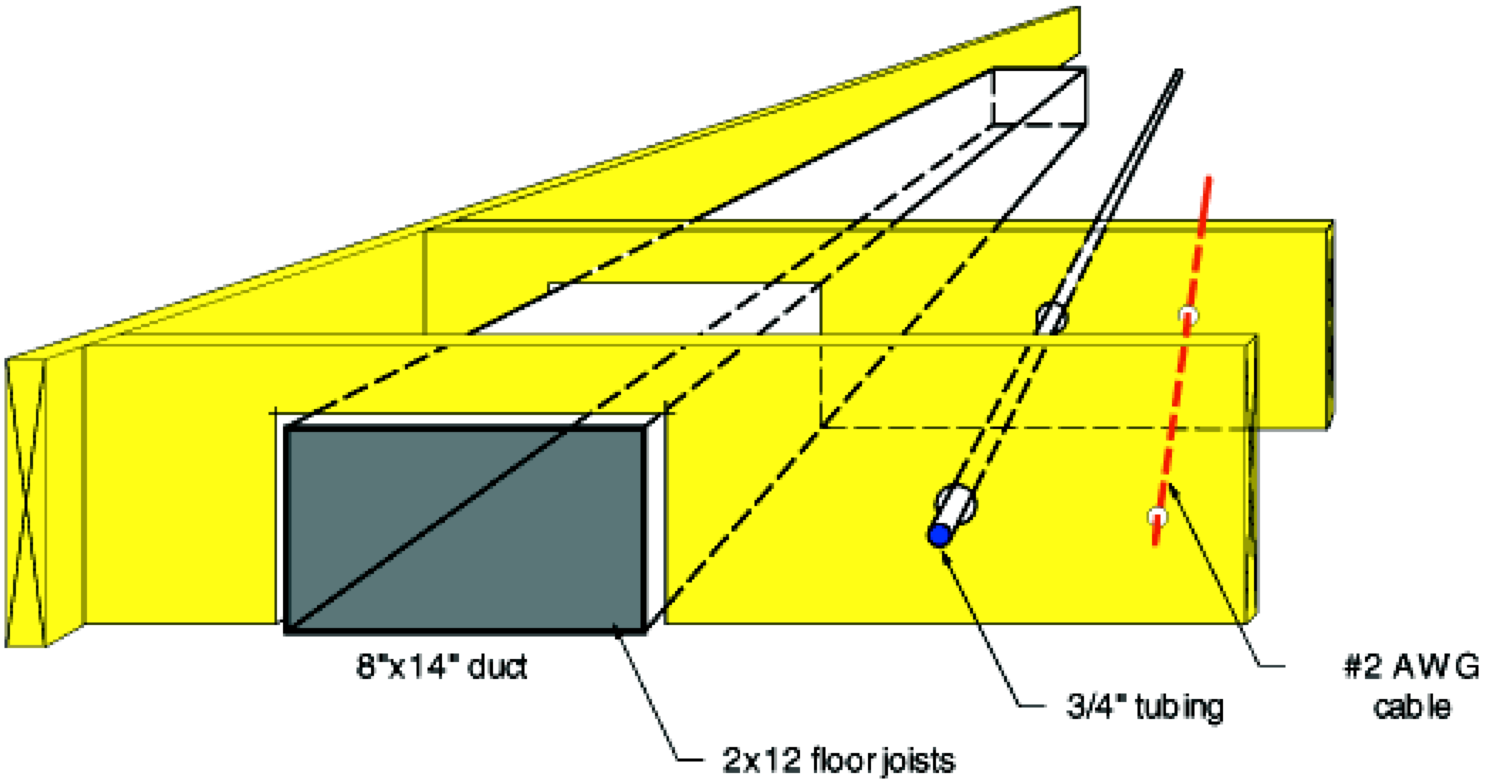
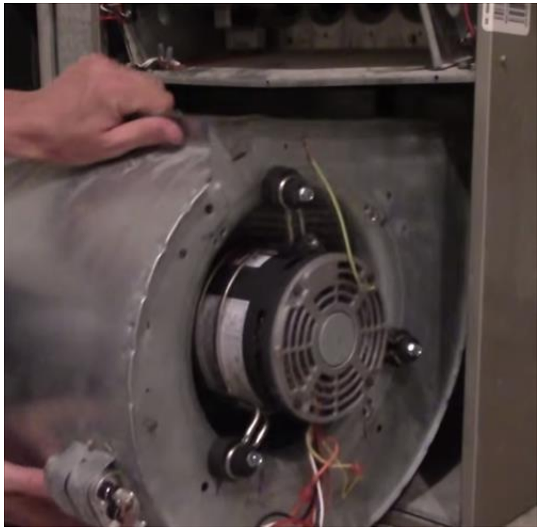
Energy Transport Capacity



Parasitic Energy Consumption

3,000
watts/hour



500 to 650
watts/hour

25 watts
(average)

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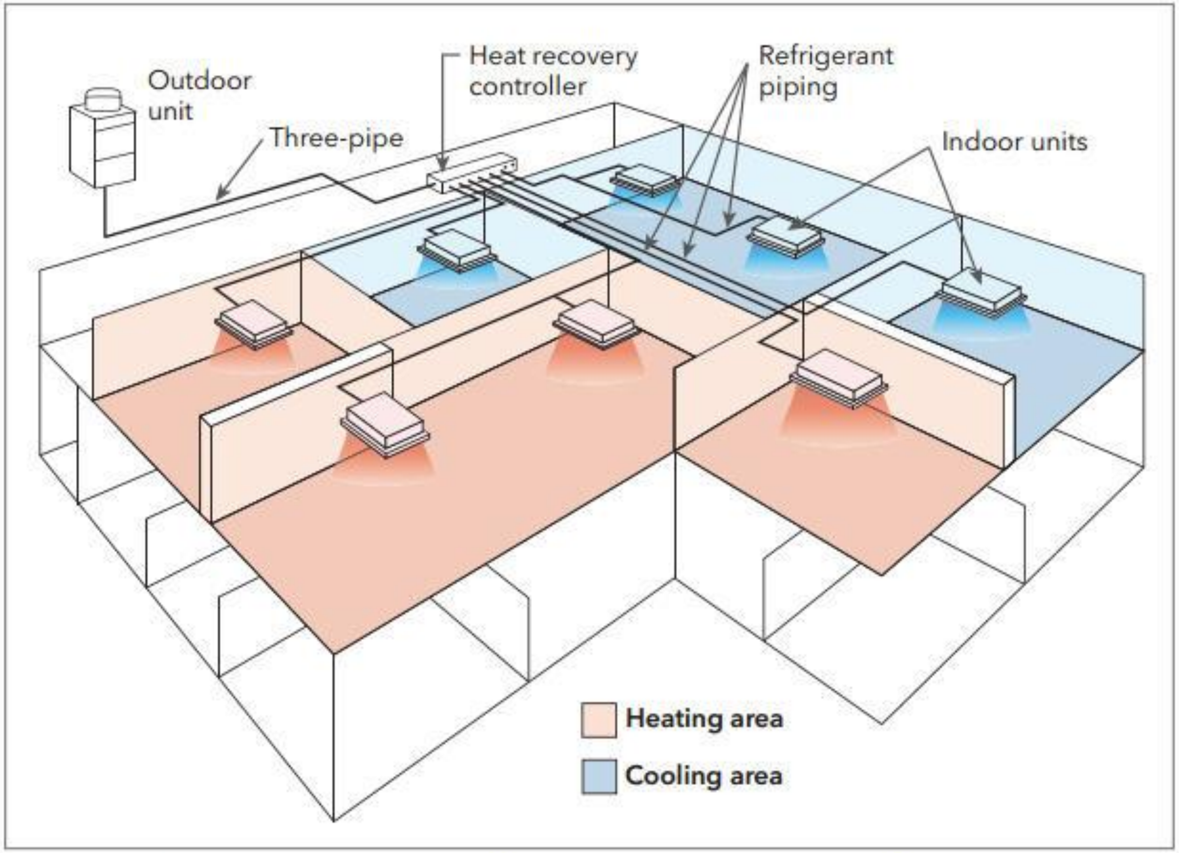
Thermal Energy Capacity for Common Fluids

Air	Water
.018 BTU's/cubic foot per degree F difference	62.4 BTU's/cubic foot per degree F difference

Result: Water carries ***3,400 times*** as much energy as air does for the same volume and temperature differential…

Typical VRF distribution



Variable refrigerant flow systems can deliver cooling to some zones and heating to others, with no reheat needed (an air-source system is shown here).

Radiant Ceiling Panel Distribution

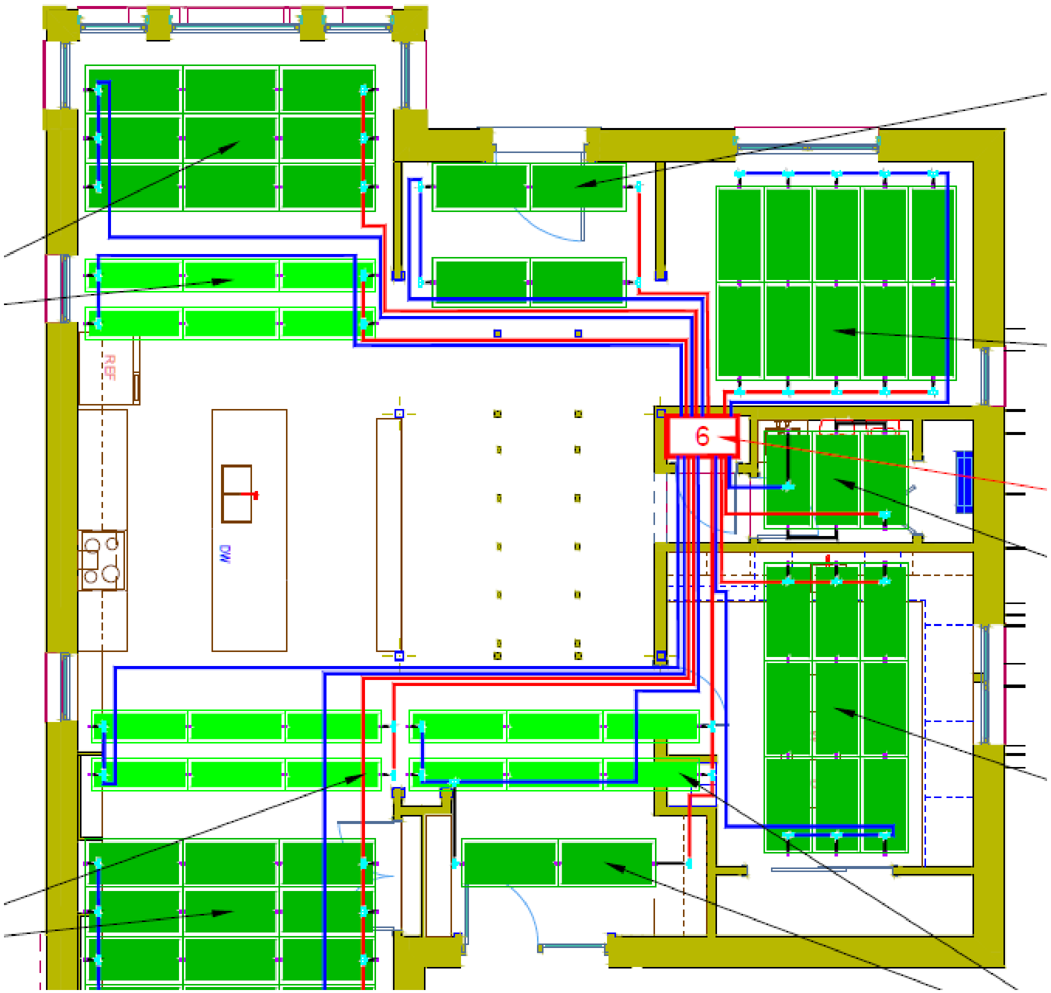


Image courtesy H3.com

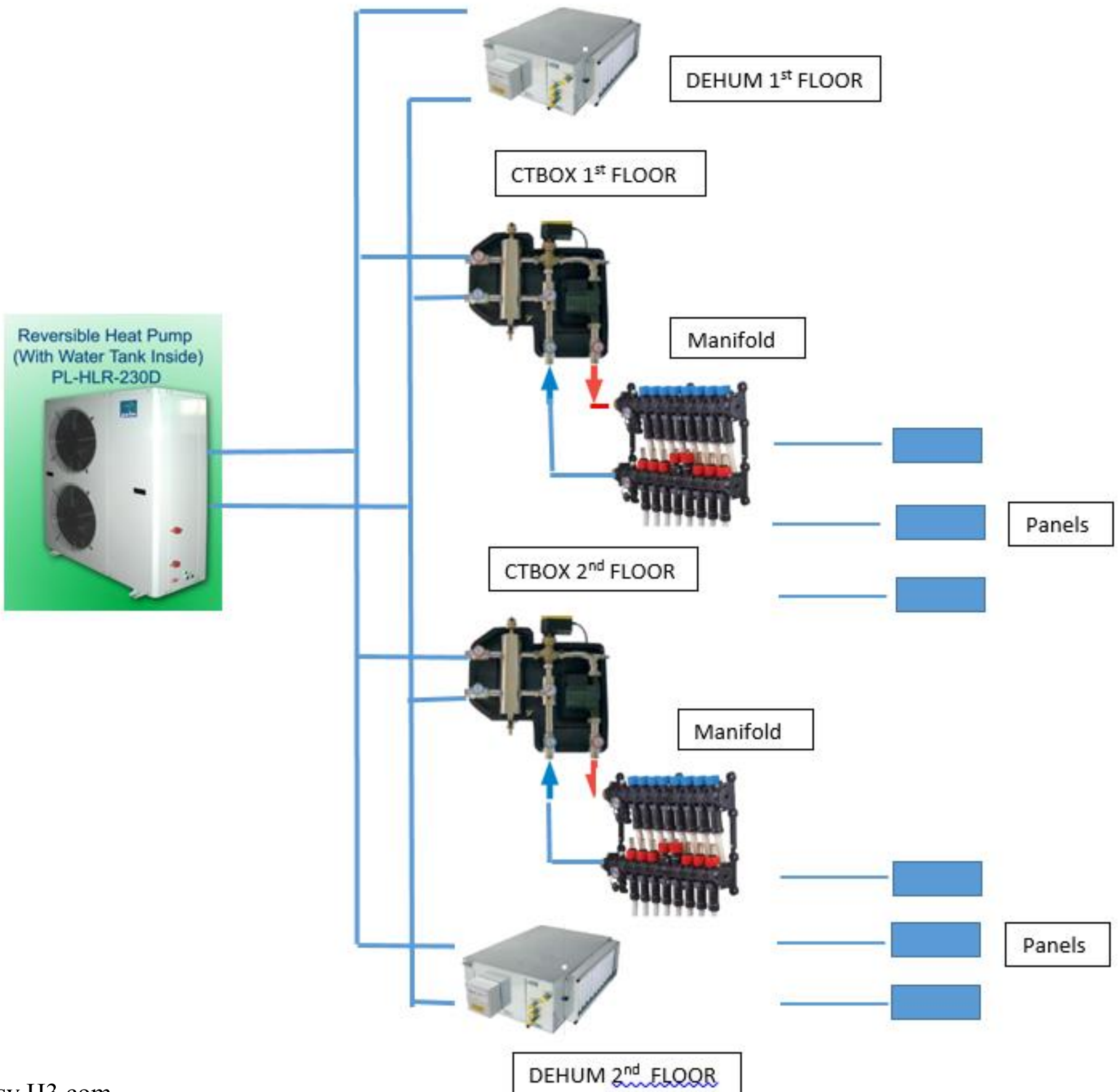


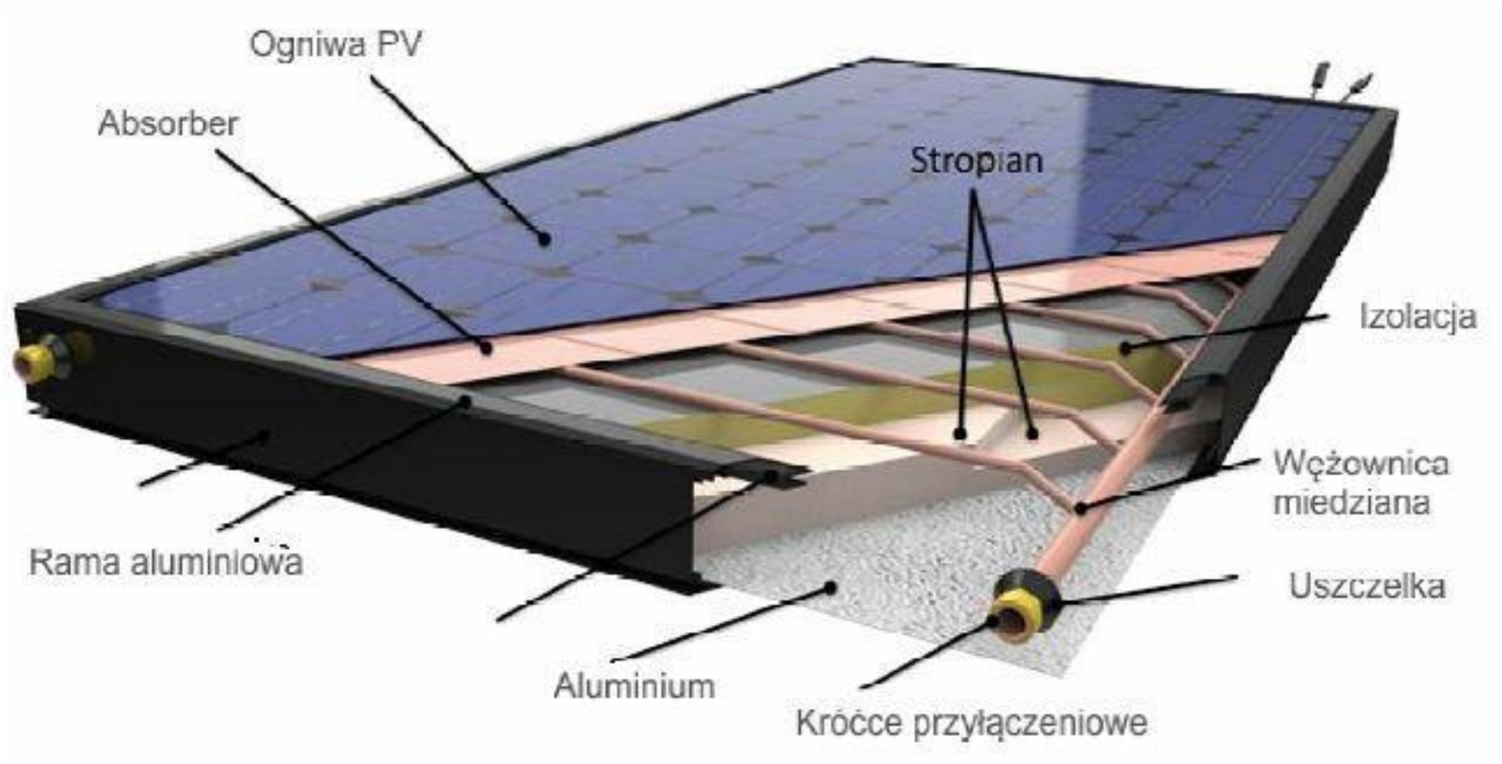
Image courtesy H3.com

How compatible is hydronics with alternative energy?

- Solar Thermal

How compatible is hydronics with alternative energy?

- Solar PV/Thermal



How compatible is hydronics with alternative energy?

- Ground Source Heat Pump

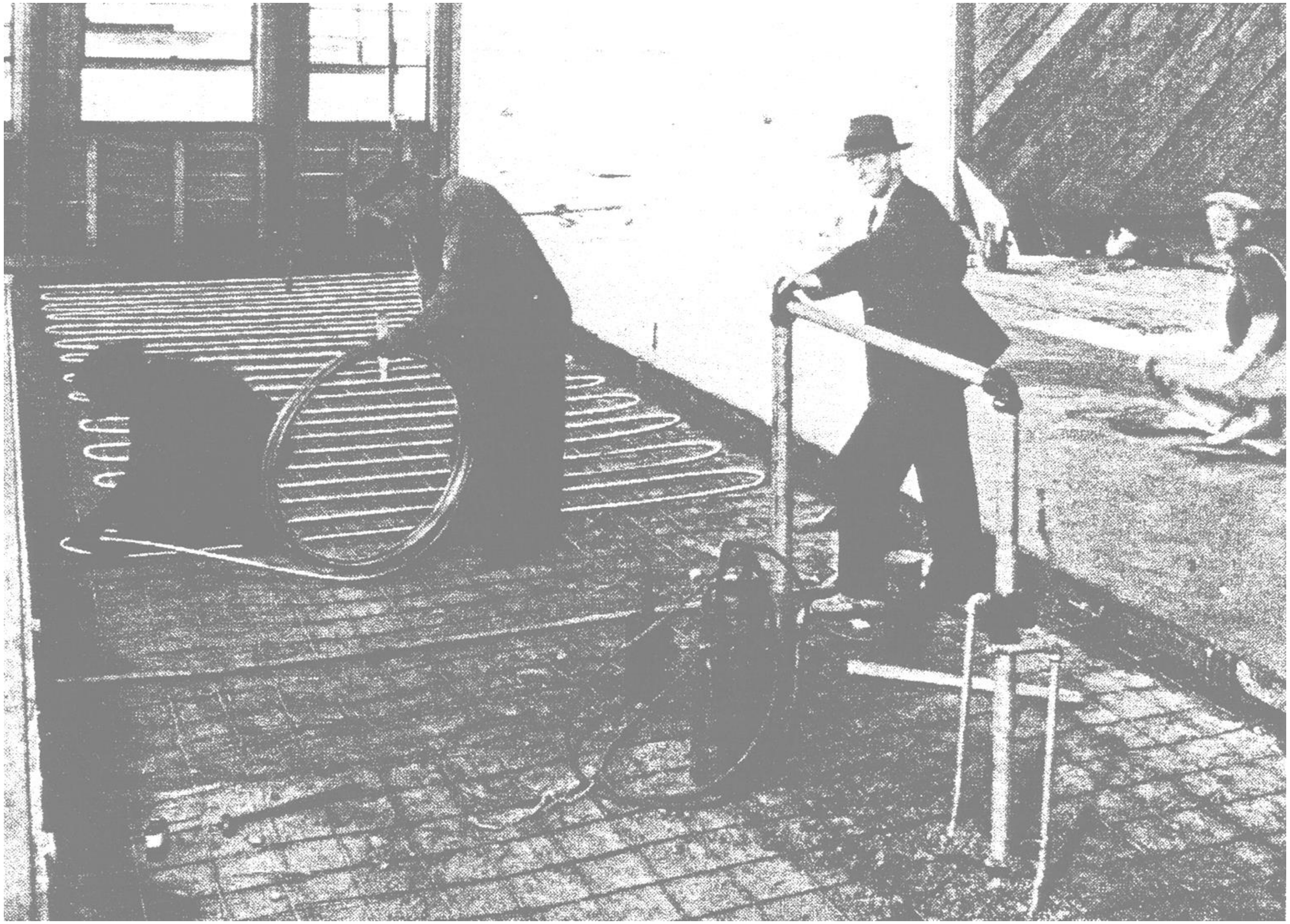
How compatible is hydronics with alternative energy?

- Thermal Battery Storage systems.

How compatible is hydronics with alternative energy?

- Simply stated, hydronics is completely compatible with every alternative energy known to mankind, including those that haven't been invented yet…

How long has hydronics and radiant been around?



History of Radiant Panel Heating

- Roman bath houses
- 1907 - first use of iron pipe in England
- Frank Lloyd Wright - radiant pioneer
- 1940’s - copper and steel pipe systems
- 1960”s - PEX developed in Europe
- 2015 – Saw a 10% increase in the sales of PEX tubing over 2014, and still climbing…

Advantages of Radiant Panel Heating

- Improves comfort by increasing average surface temperature
- Allows comfort at lower (or higher) air temperatures
- Provides an almost ideal match to human thermal comfort requirements
- Reduces room temperature stratification and mechanically induced exfiltration

Advantages of Radiant Panel Heating

- Many systems are out of sight
- Easily zoned
- Creates gentle room air circulation
- Easily routed through buildings
- Systems with high thermal mass can respond quickly to increased loads when necessary

Advantages of Radiant Panel Heating

- Systems with low thermal mass release heat almost instantly
- Heated floors dry quickly
- Resistant to physical damage
- Can operate with virtually no noise
- Adaptable to almost any heat source and fuel
- Reduces energy consumption

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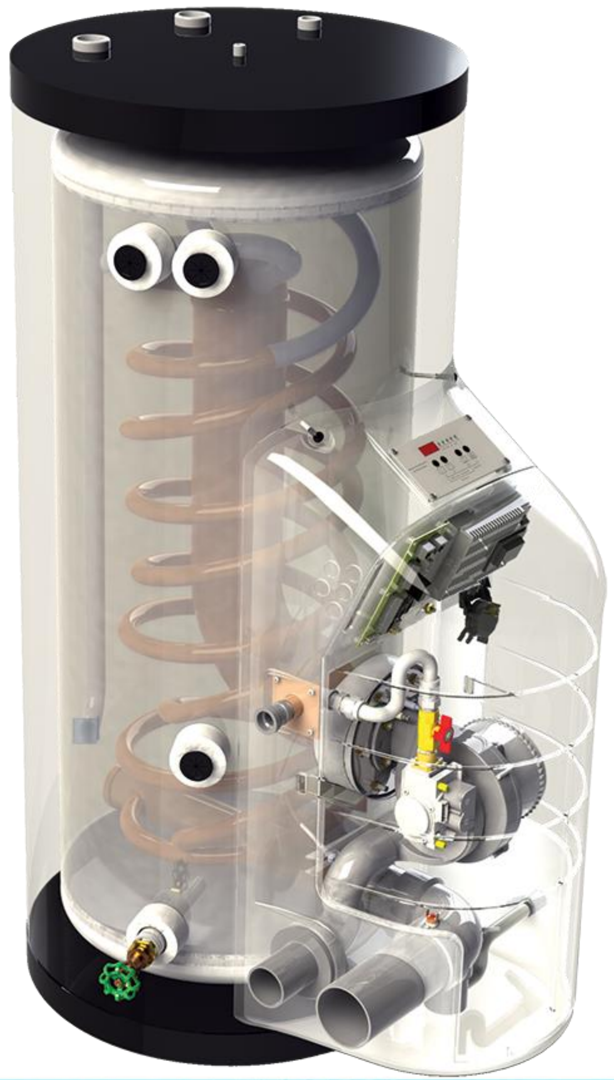
Case Study Slab-On-Grade House

Fig. 2-1

Embedding Tubing in Concrete Slab

Fig. 2-2

Water Heater as Heat Source



Piping Schematic for Case Study # 1

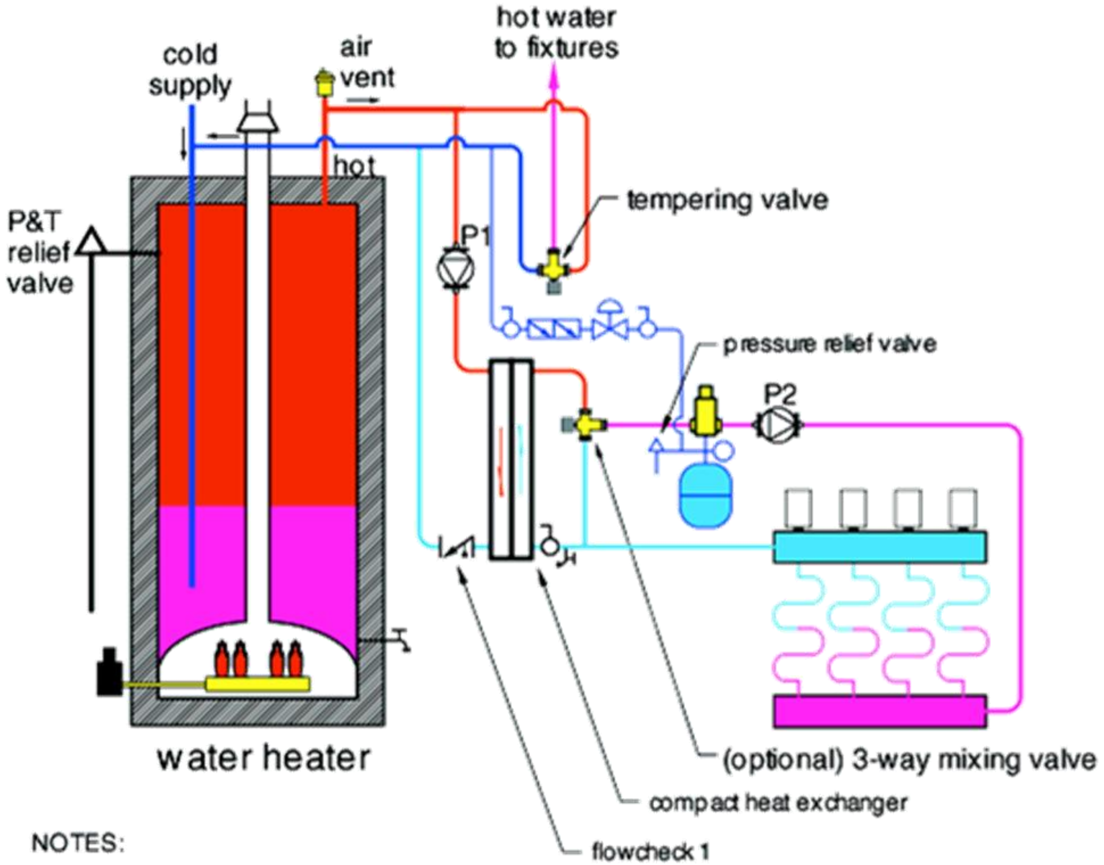


Fig. 4-51

Case Study # 2 Radiant Wall application

Radiant walls prior to insulation

Radiant walls after insulation

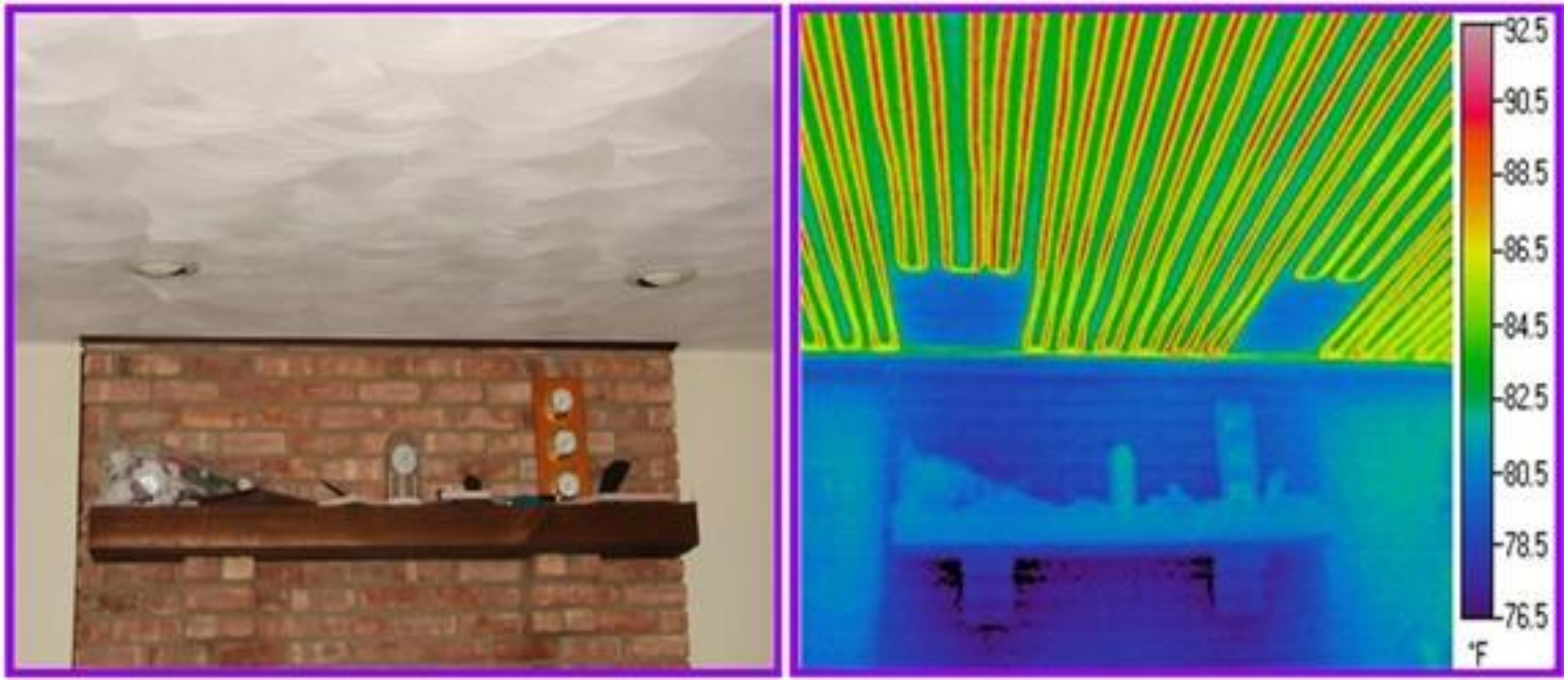
Radiant walls (high mass)

Radiant walls (low mass)

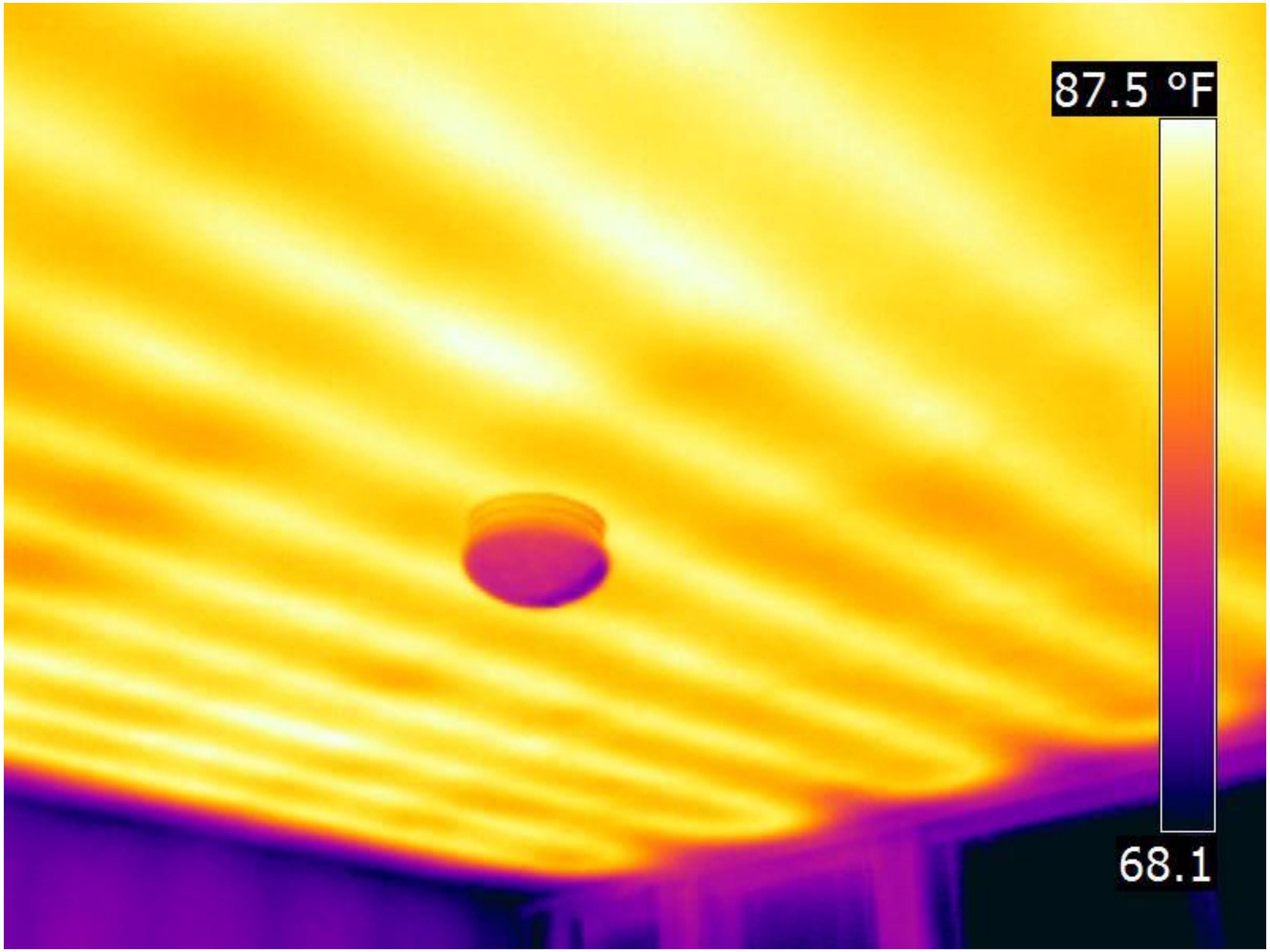
Image courtesy Robert Bean

Radiant Ceiling applications

Radiant Ceiling applications



Radiant Ceiling applications



Radiant Ceiling applications

Radiant Ceiling applications

Image courtesy Ahhm Radiant

Piping Schematic

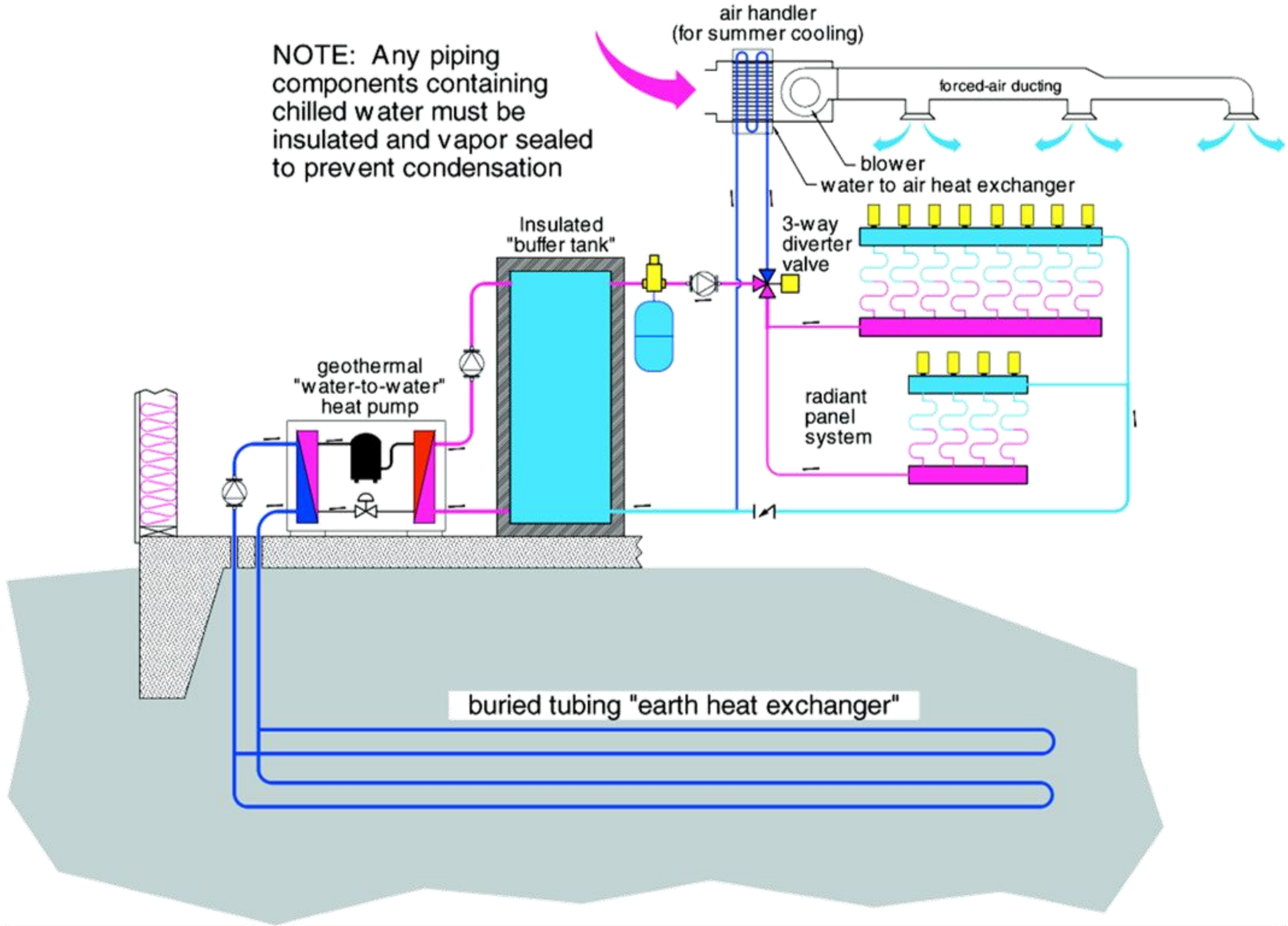


Fig. 4-50

Case Study
Electric Cable Heated Foyer

Fig. 2-14

Foyer Tile Warmed by Electric Cable

Fig. 2-15

Electric Cable on Wood Subfloor

Fig. 2-16

Wiring Schematic

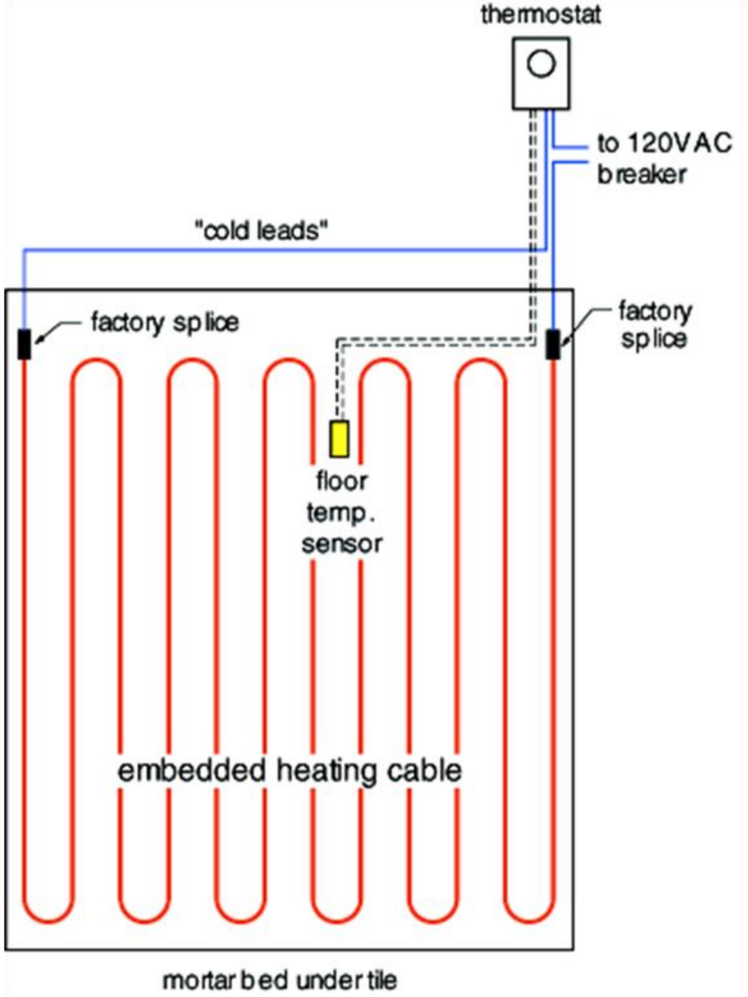


Fig. 2-17

Enclosure for Temperature Controllers and Contactors

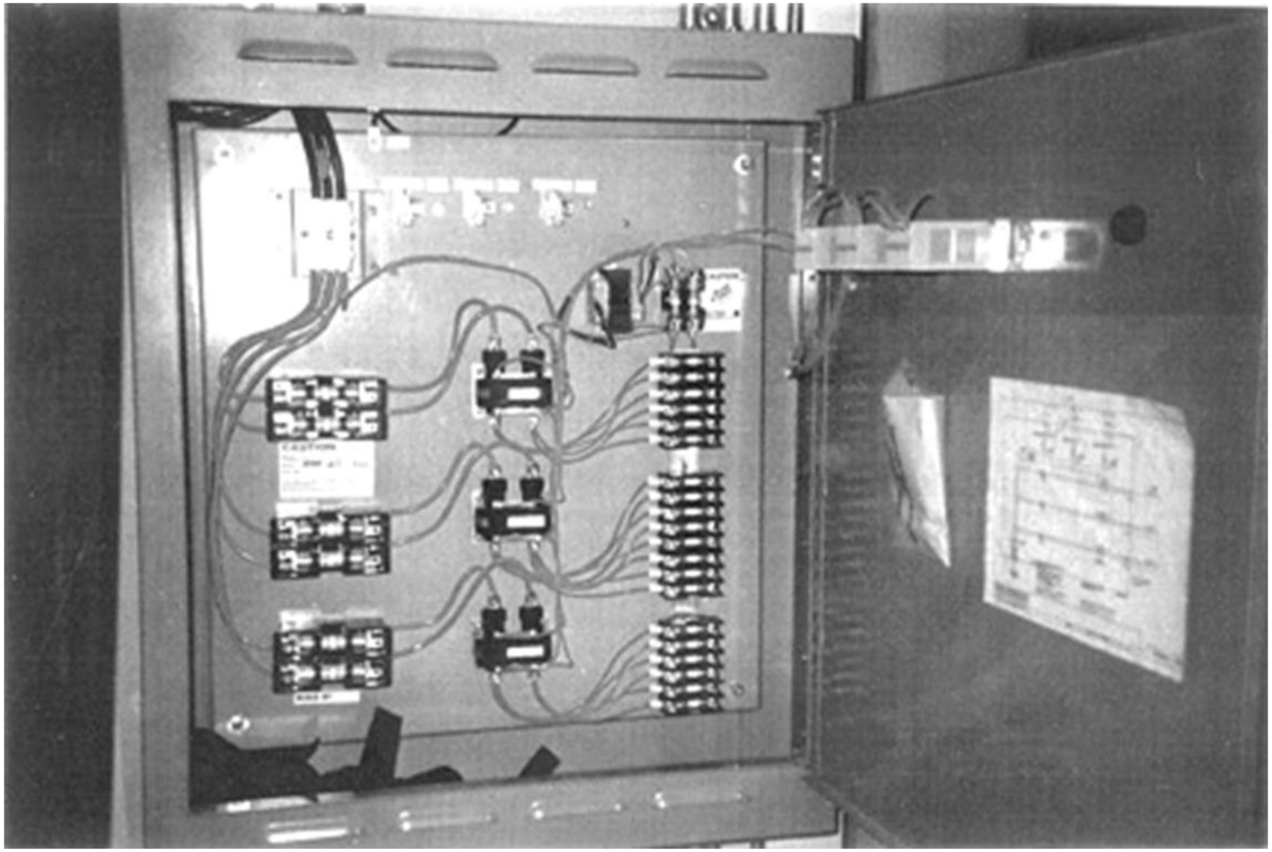


Fig. 2-34

Wiring Schematic

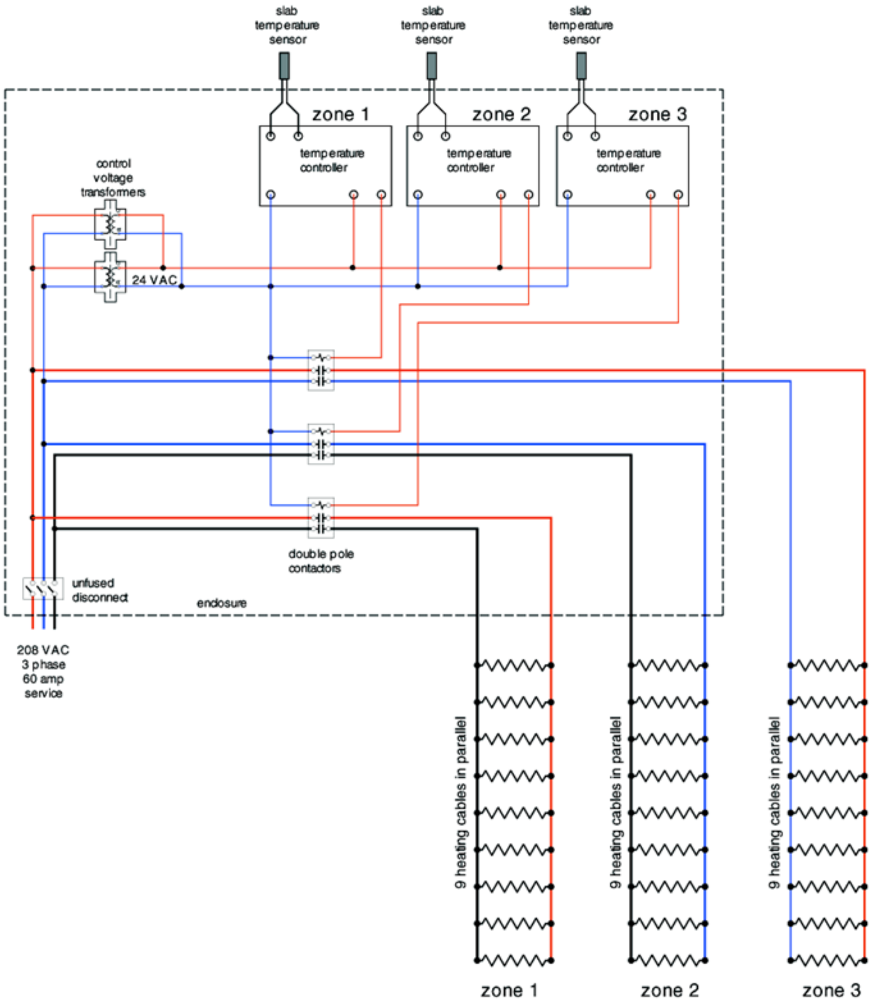


Fig. 2-35

SAMPLE HYDRONIC RADIANT PANELS

Hydronic Radiant Panel Systems

Hydronic Radiant Floor Panels

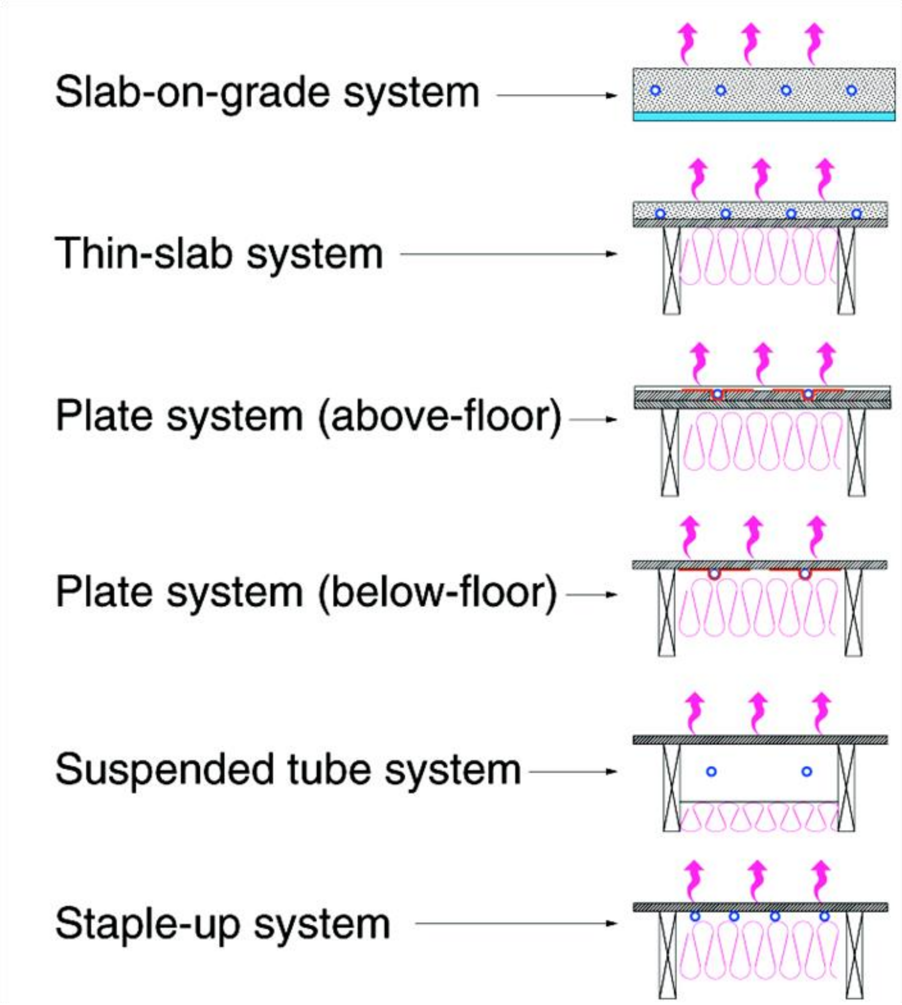


Fig. 3-1

Hydronic Radiant Wall and Ceiling Panels

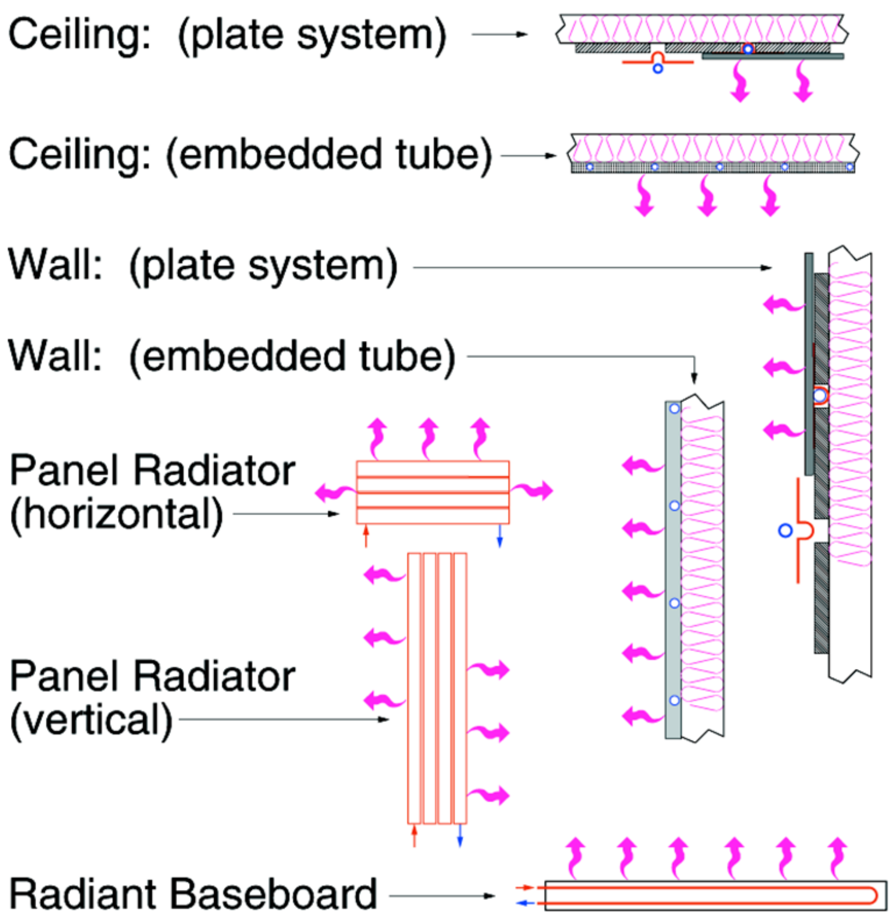


Fig. 3-2

Slab-on-Grade System

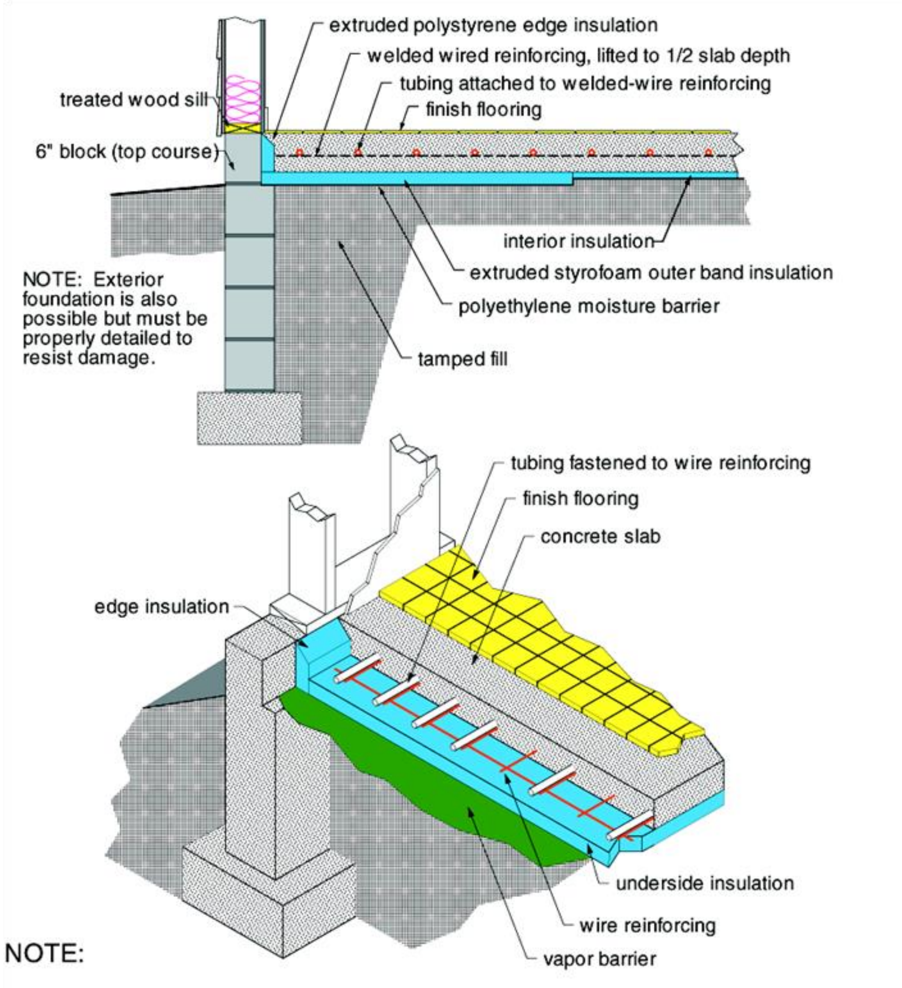


Fig. 3-3

Gypsum Thin-Slab

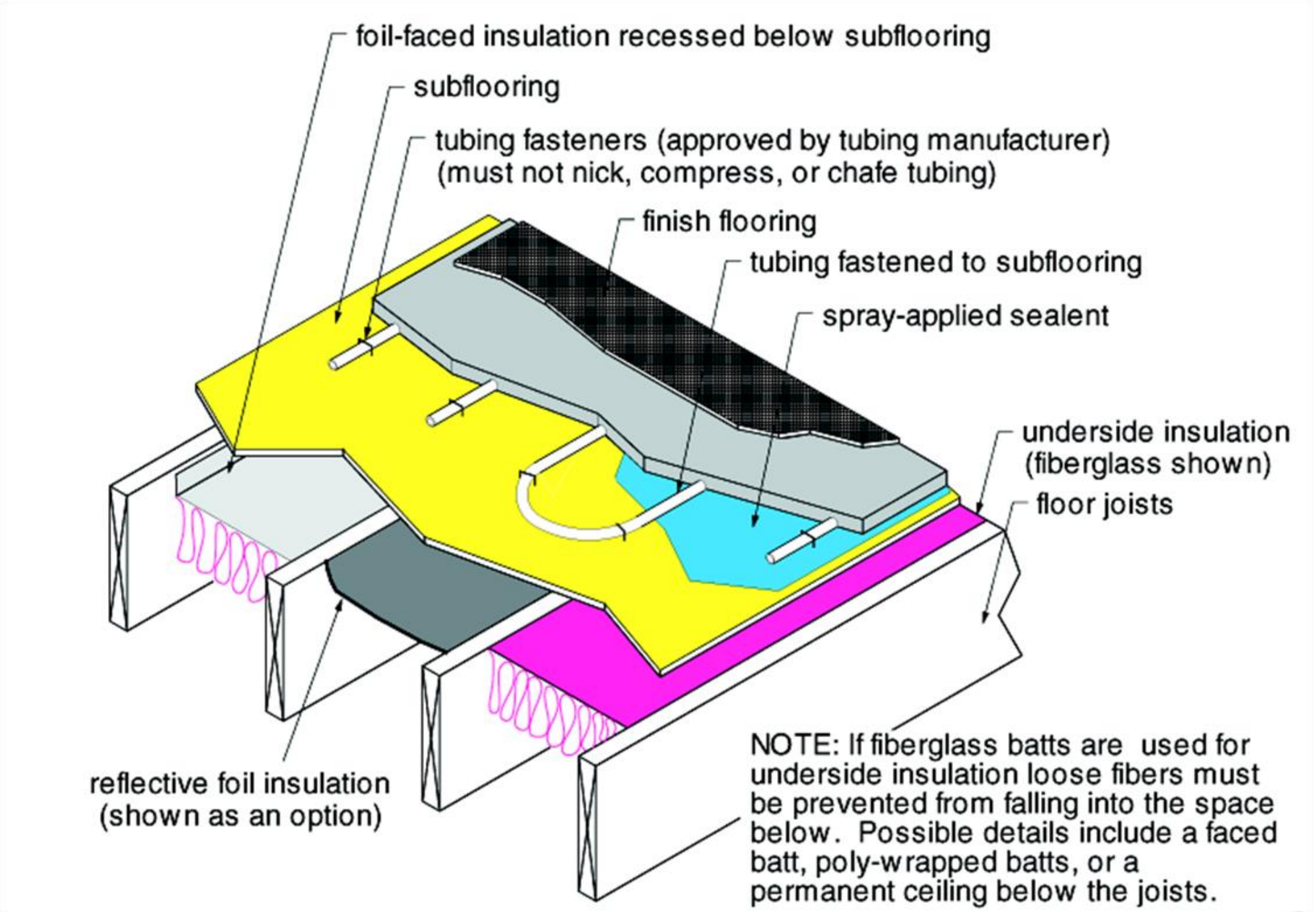


Fig. 3-4

Concrete Thin-Slab

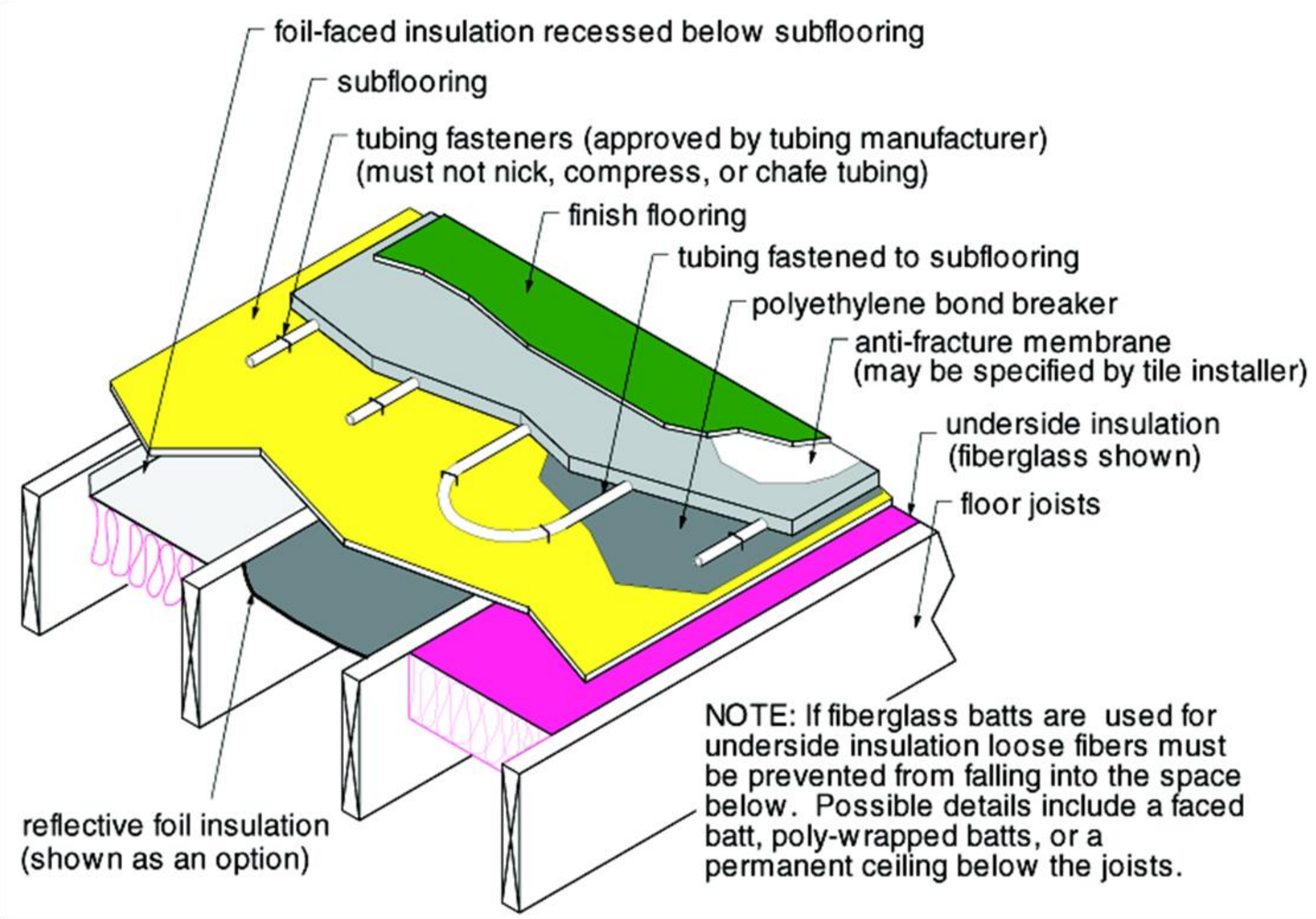


Fig. 3-5

Above Floor Plate System

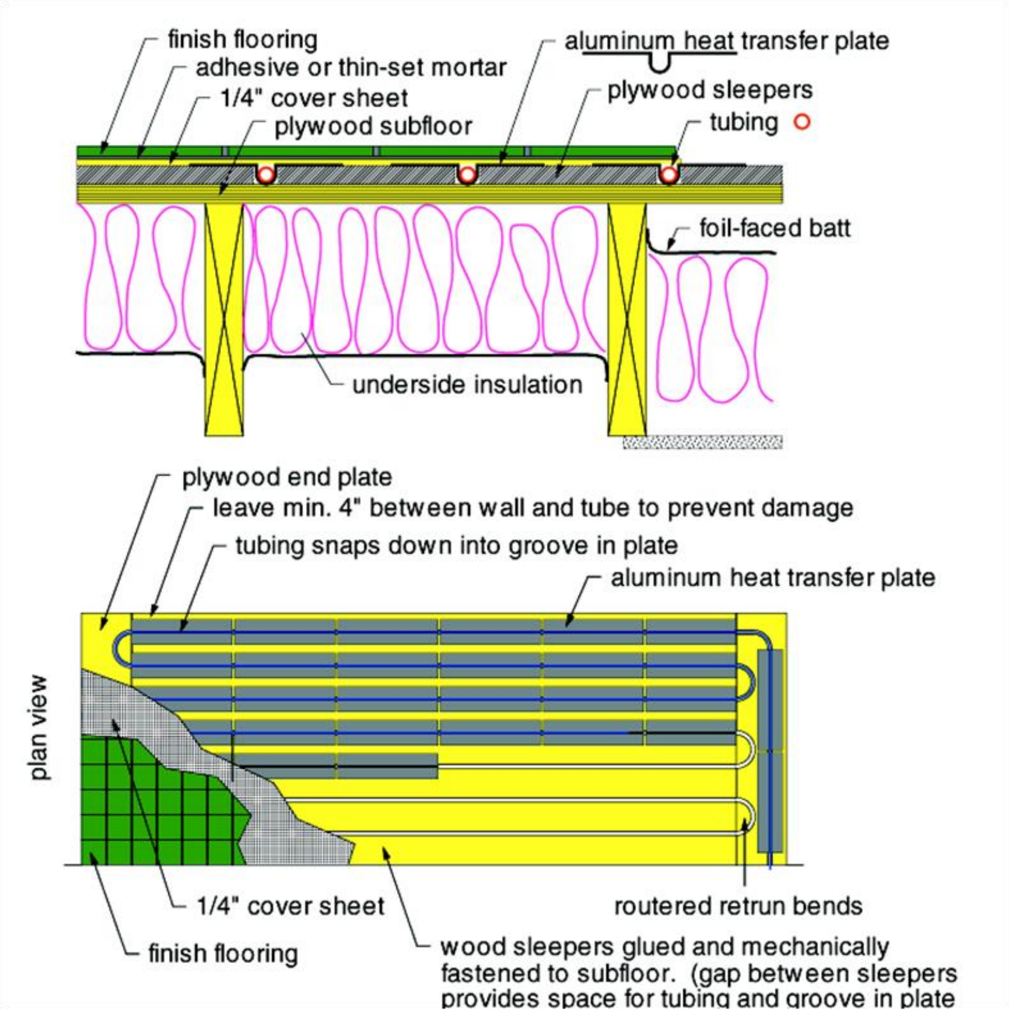


Fig. 3-7

Below Floor Plate System

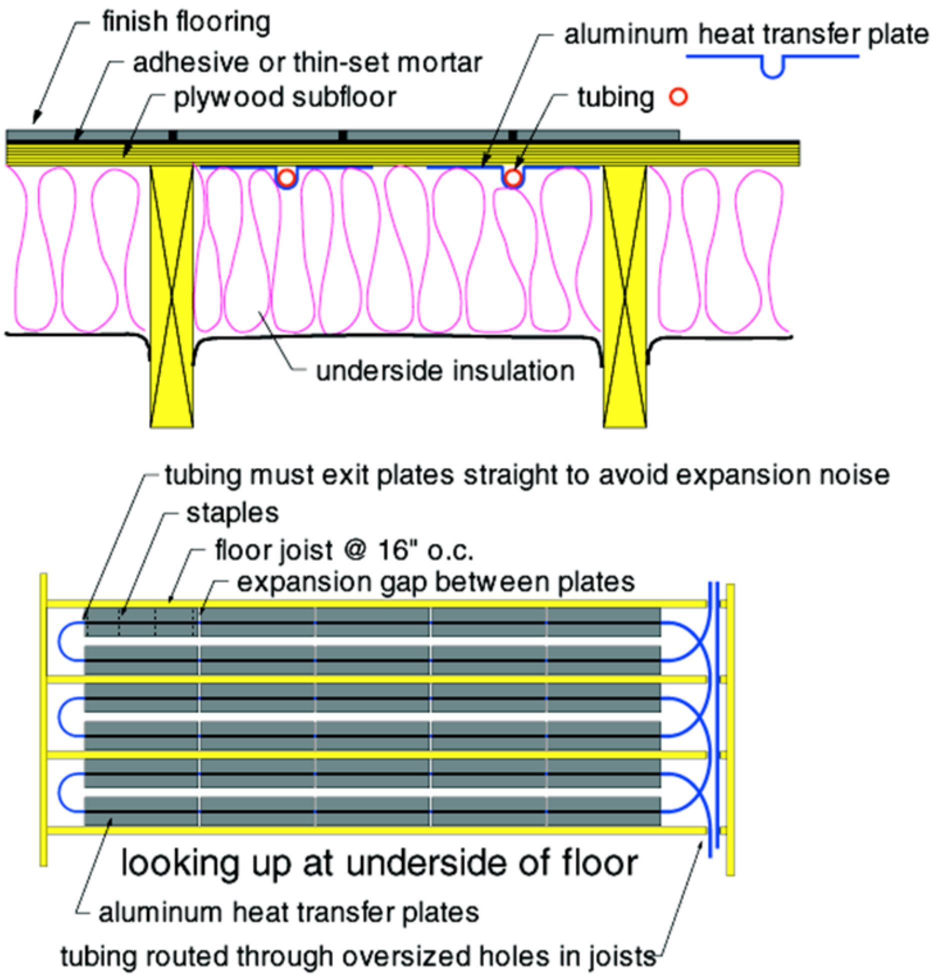


Fig. 3-8

Engineered Subfloor

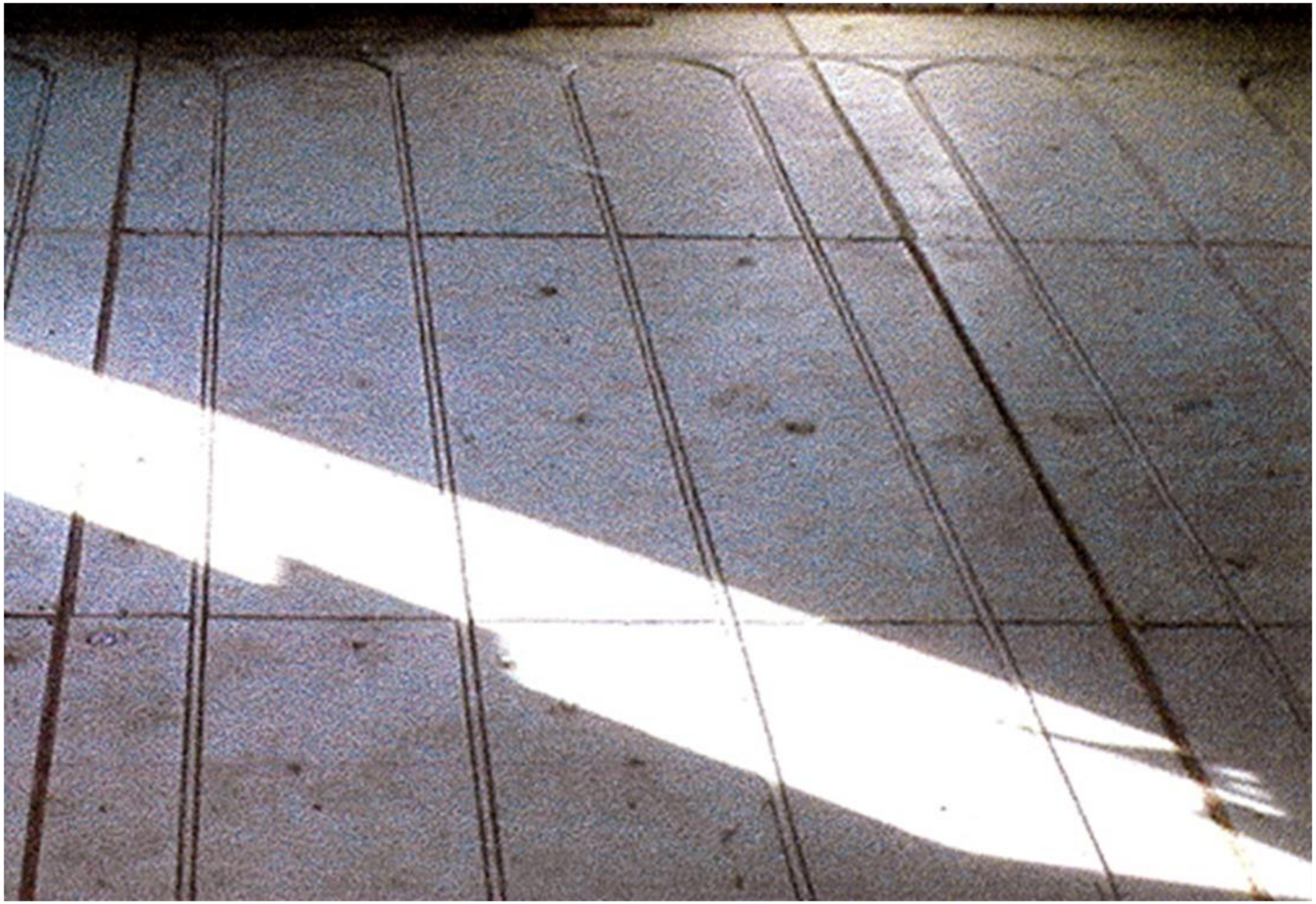


Fig. 3-11

Installation of an Engineered Subfloor System

Fig. 3-12

CAD Layout of an Engineered Subfloor System

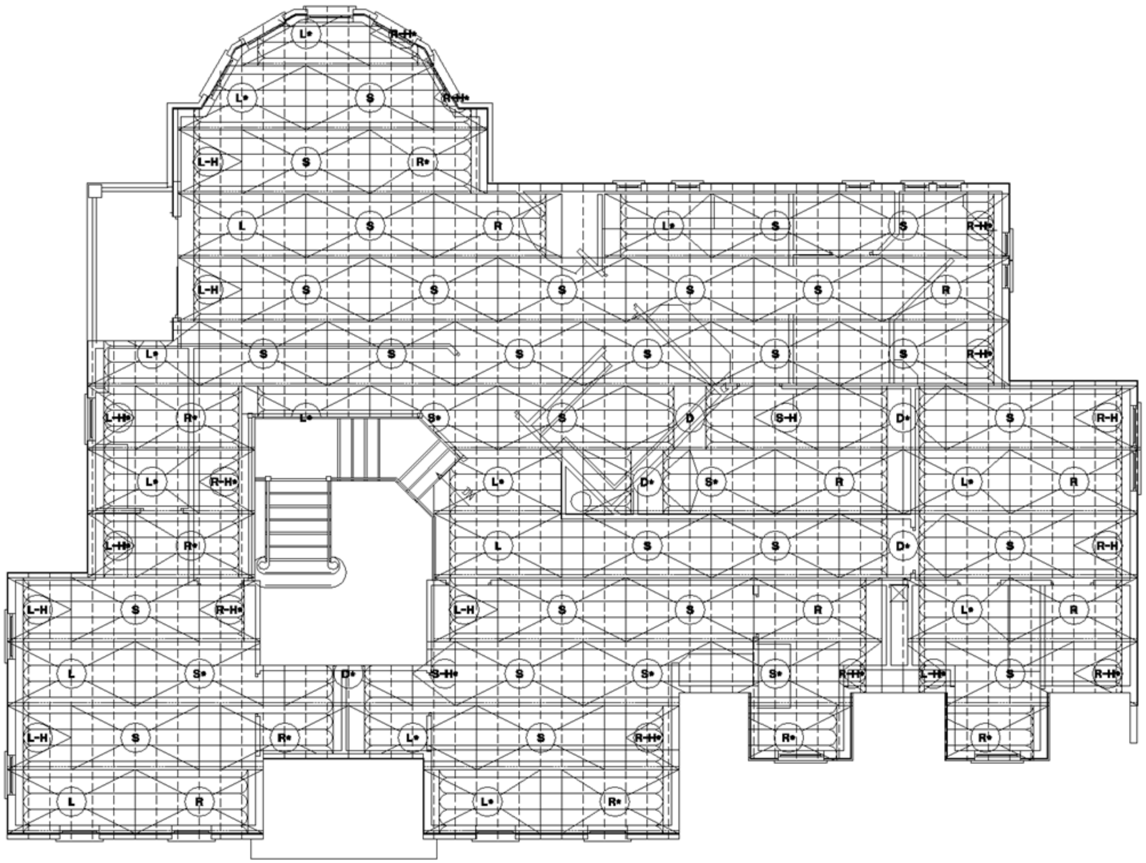


Fig. 3-13

Modular Board System

Fig. 3-14

CAD Layout of Modular Board System

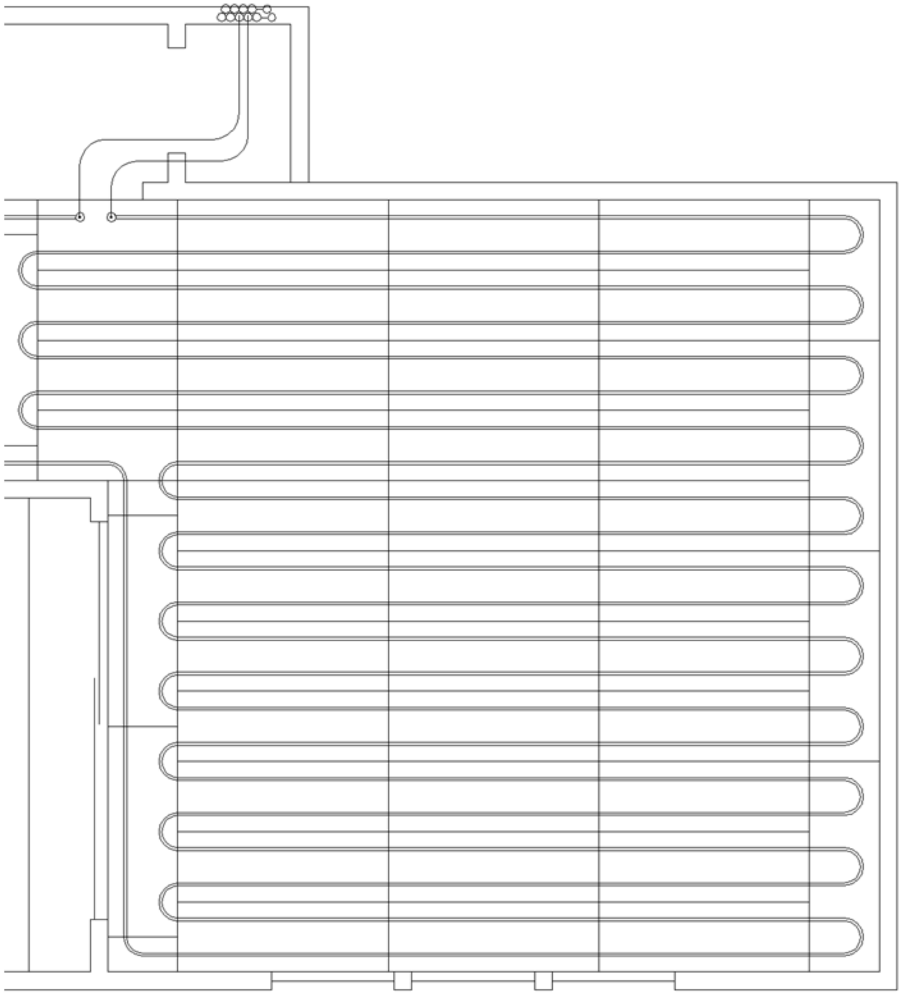


Fig. 3-15

Characteristics of Radiant Ceilings

- Can operate at higher temperatures than floors
- Not affected by floor coverings and furniture
- Most respond faster than floors
- Will warm the floor as well as objects in the room below
- Take up less vertical space
- Add very little weight
- Induce very little air circulation

Radiant Ceiling Plate System

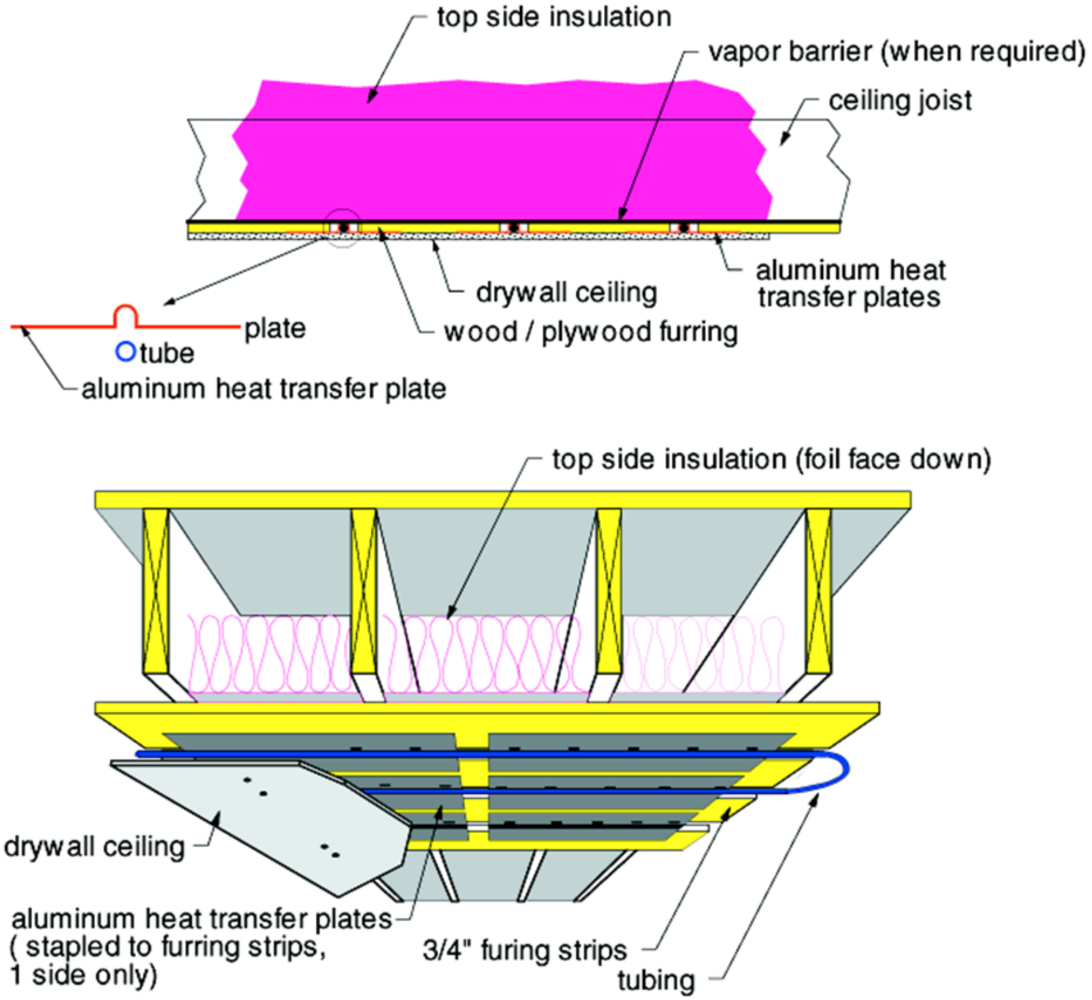


Fig. 3-16

Ceiling Panels for T-Bar Ceilings

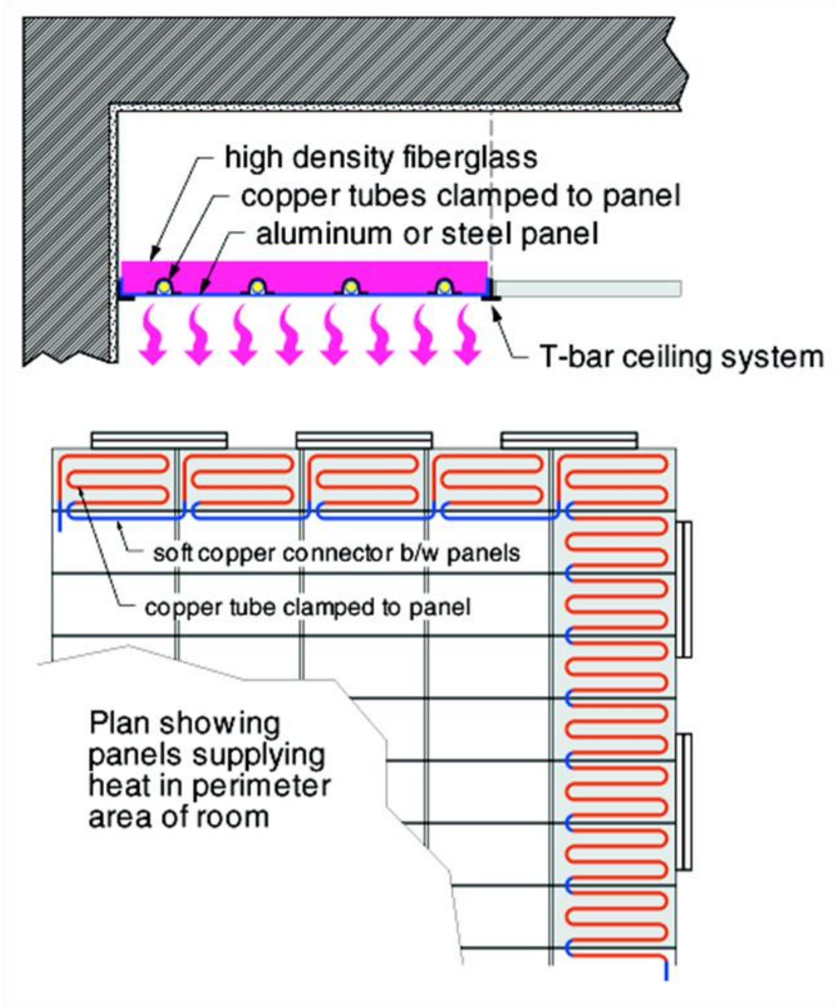


Fig. 3-17

Radiant Plate Wall System

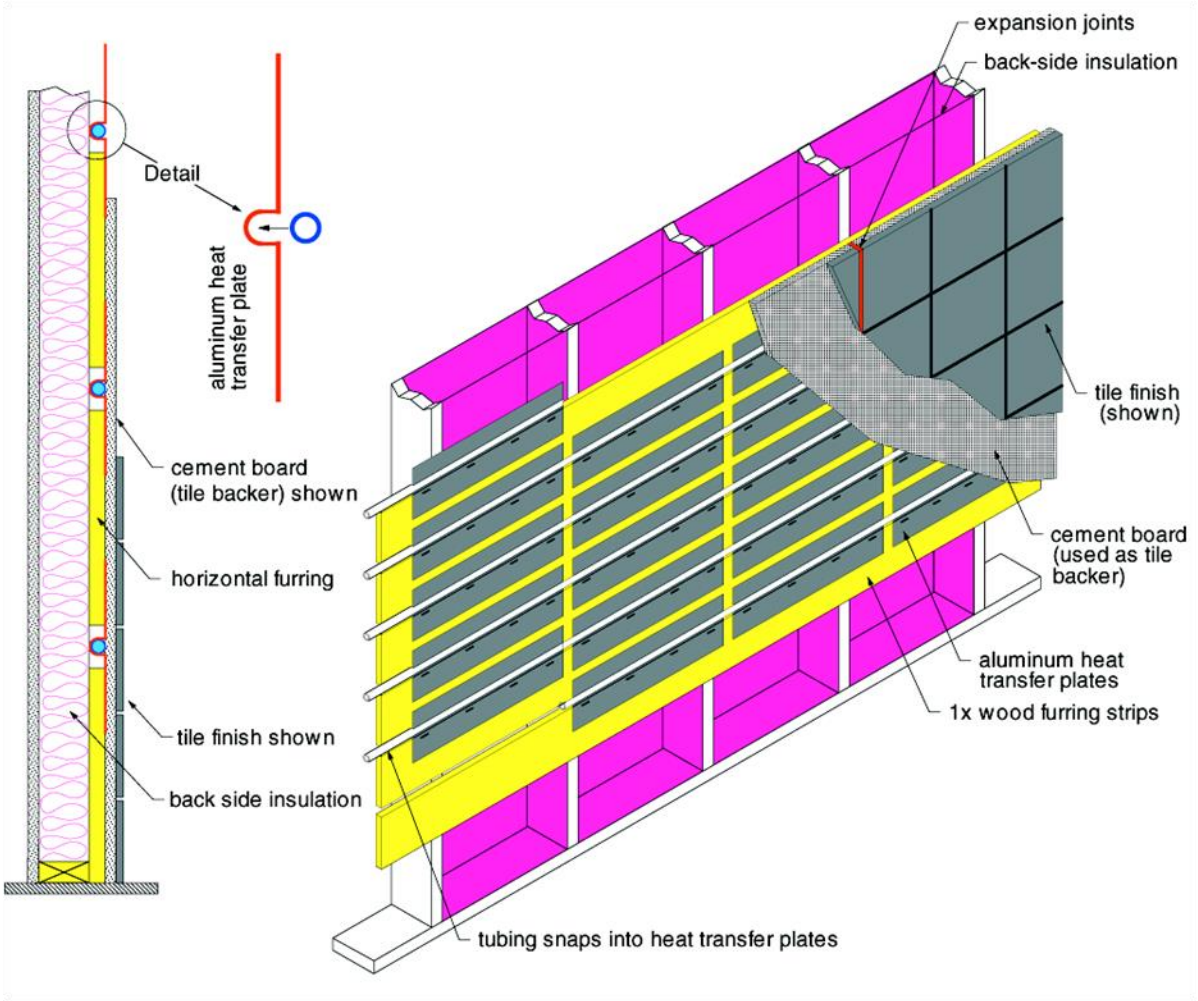


Fig. 3-18

Heat Source Options

- Gas- and Oil-Fired Boilers
  - Condensing and non-condensing
- Hydronic heat pumps (air and ground source)
- Water heaters
- Combination water heaters
- Other sources
  - Solar, solid fuel, thermal storage, etc.

Gas- and Oil-Fired Boiler Options

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Heat Pumps

Water to Water

Air to Water

Buffer Tank in Heat Pump System

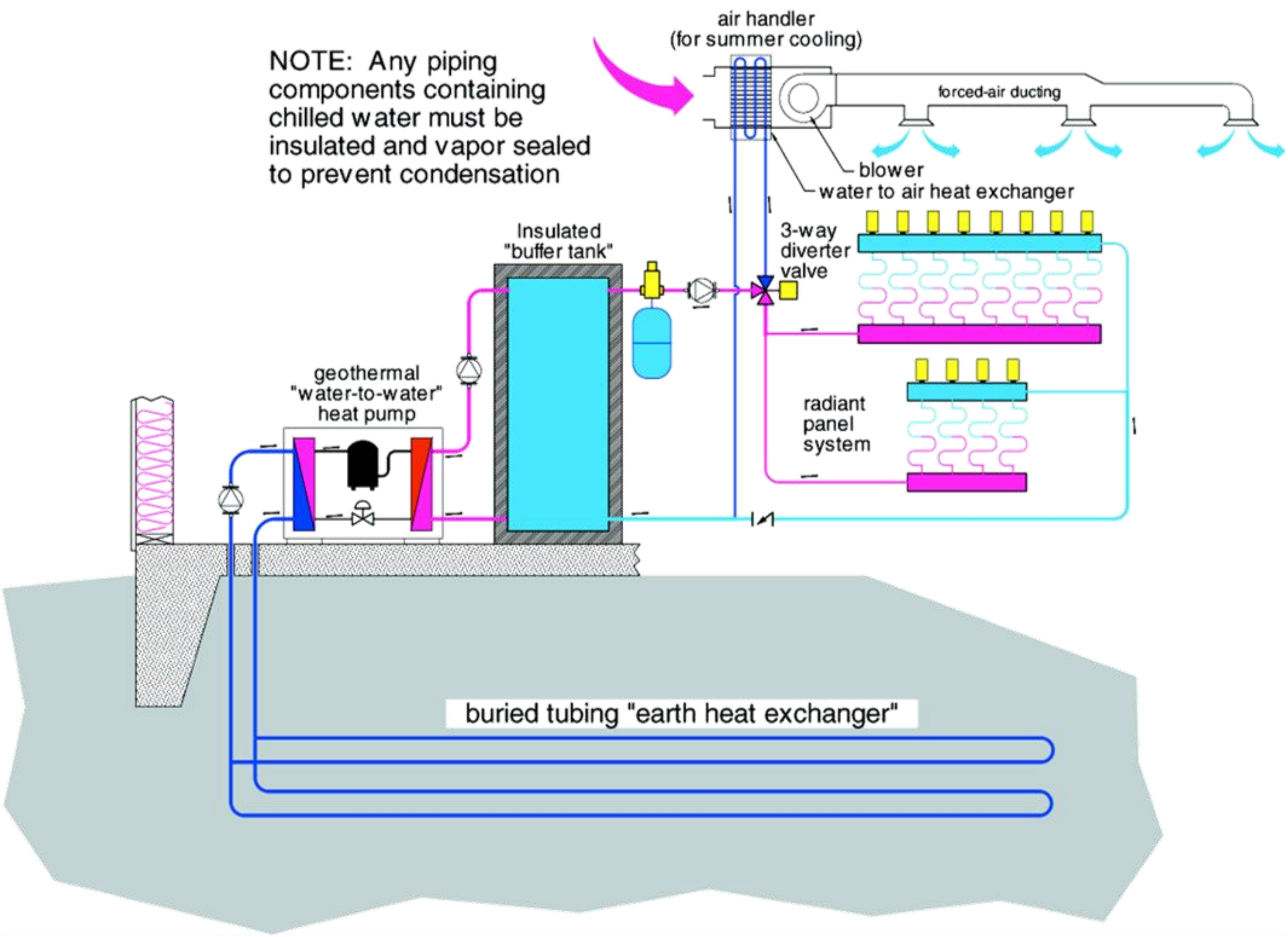

Fig. 4-50

Combination System with Heat Exchanger

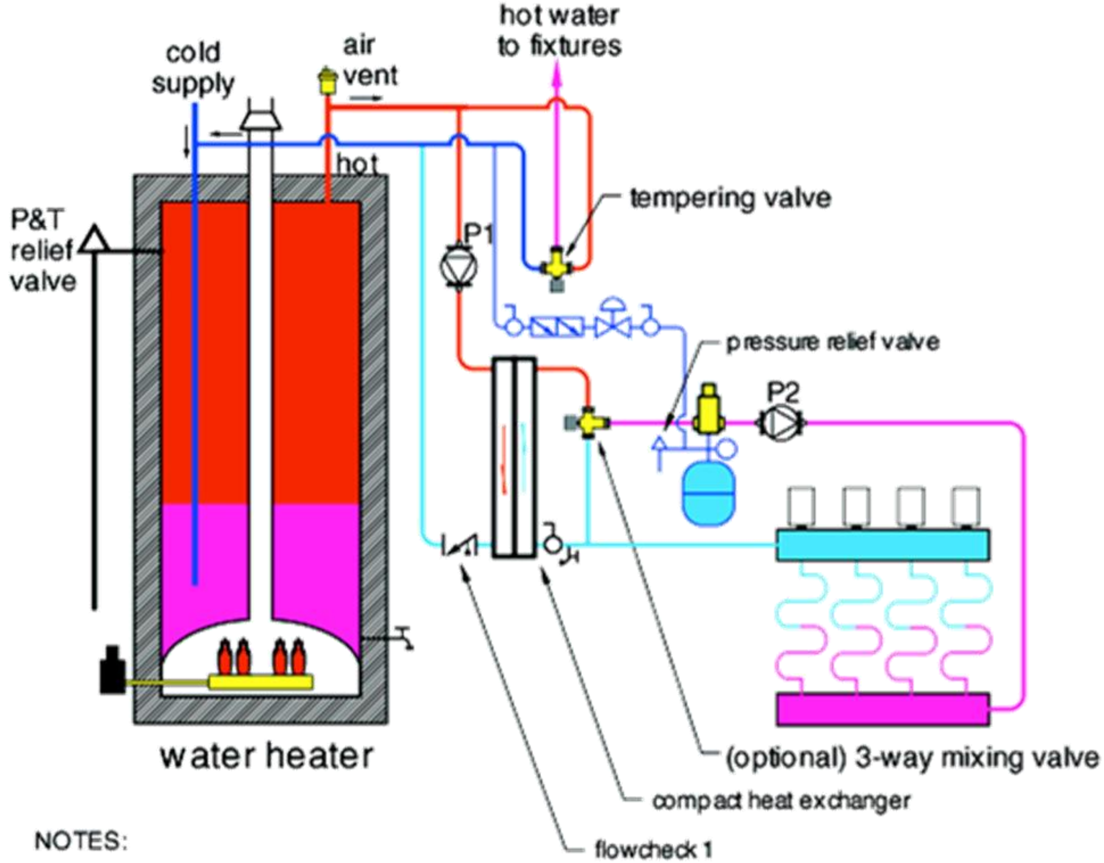

Fig. 4-51

Ventilation and Cooling Options

- Exhaust fan
- Heat recovery ventilator
- Energy Recovery Ventilator
- DOAS units
- Evaporative coolers
- High-velocity systems
- Conventional air-conditioning
- Radiant cooling
- Hybrid solutions

Variable-Speed Fan

Heat or Energy Recovery Ventilator

Image courtesy Bryant Heating and Cooling Systems

High-Velocity Air-Conditioning System

Fig. 6-4

Managing the consumers expectations

- Warm floor concept versus radiant comfort…

Toasty warm feet concept

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Managing the consumers expectations

- Beware of high efficiency homes and floor temperatures

Managing the consumers expectations

- Where are “warm floors” best utilized?

Bathroom floor warming. A MUST have

Managing the consumers expectations

- Can a radiant floor work better than a radiant wall/ceiling?

Floor … Ceiling …. Or Wall ?

SURFACE	CEILING	FLOOR	WALL
Contact with people	**NO**	YES	YES
Response in **less than 30 min**.*	**YES**	NO	YES
Response in **more than 3 hours**	**NO**	YES	NO
Furniture limit	**NO**	YES	YES
Heating	**GOOD**	EXCELLENT	GOOD
Cooling	**EXCELLENT**	POOR	GOOD
Certified performance	**YES**	NO	YES

*Coupled with 5/8” drywall or metal panel

Image courtesy Ahhm Radiant

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Managing the consumers expectations

- What about the production of condensation?

Condensation requires ***complete*** environmental control

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Managing the consumers expectations

- What about fresh air ventilation (open window policy)

OK, maybe not THAT drastic….

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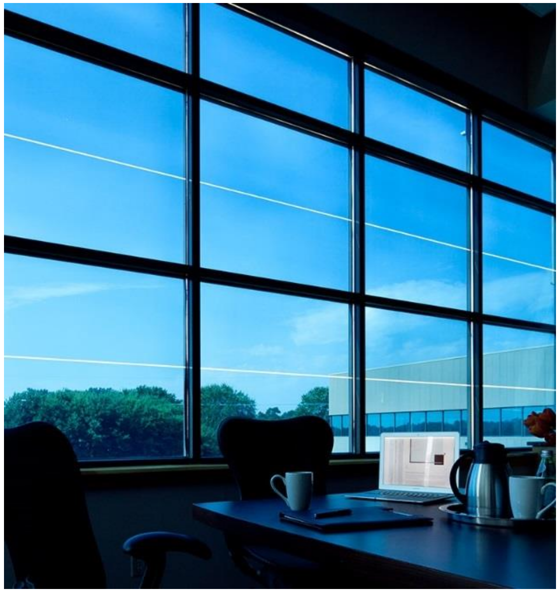
Speaking of windows…



Managing the consumers expectations

- Is radiant cooling a proven technology?

Suvarnabhumi International Airport (Bangkok, Thailand),

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Hydronic Slab-on-Grade

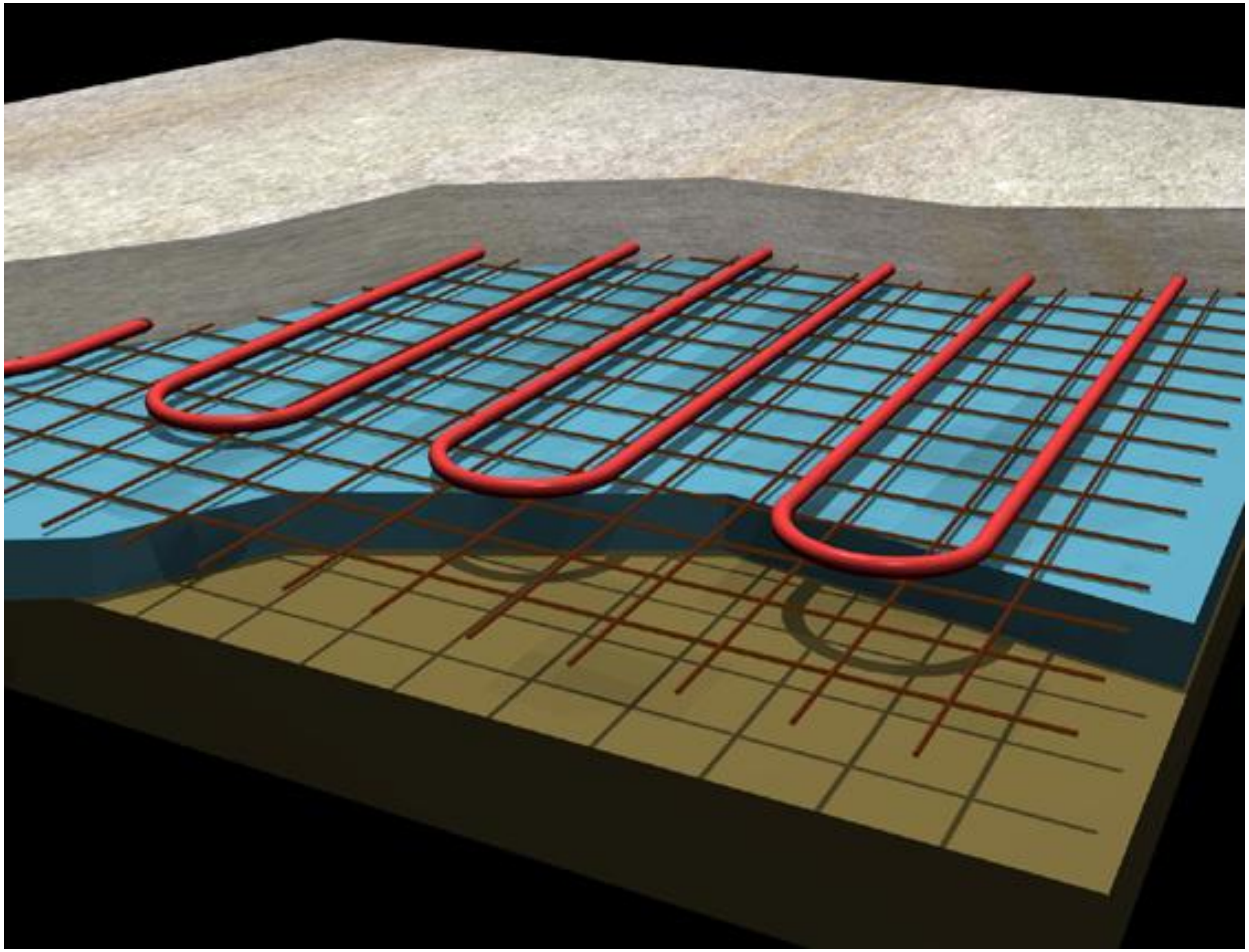


Fig. 9-8

Hydronic Topping Slab

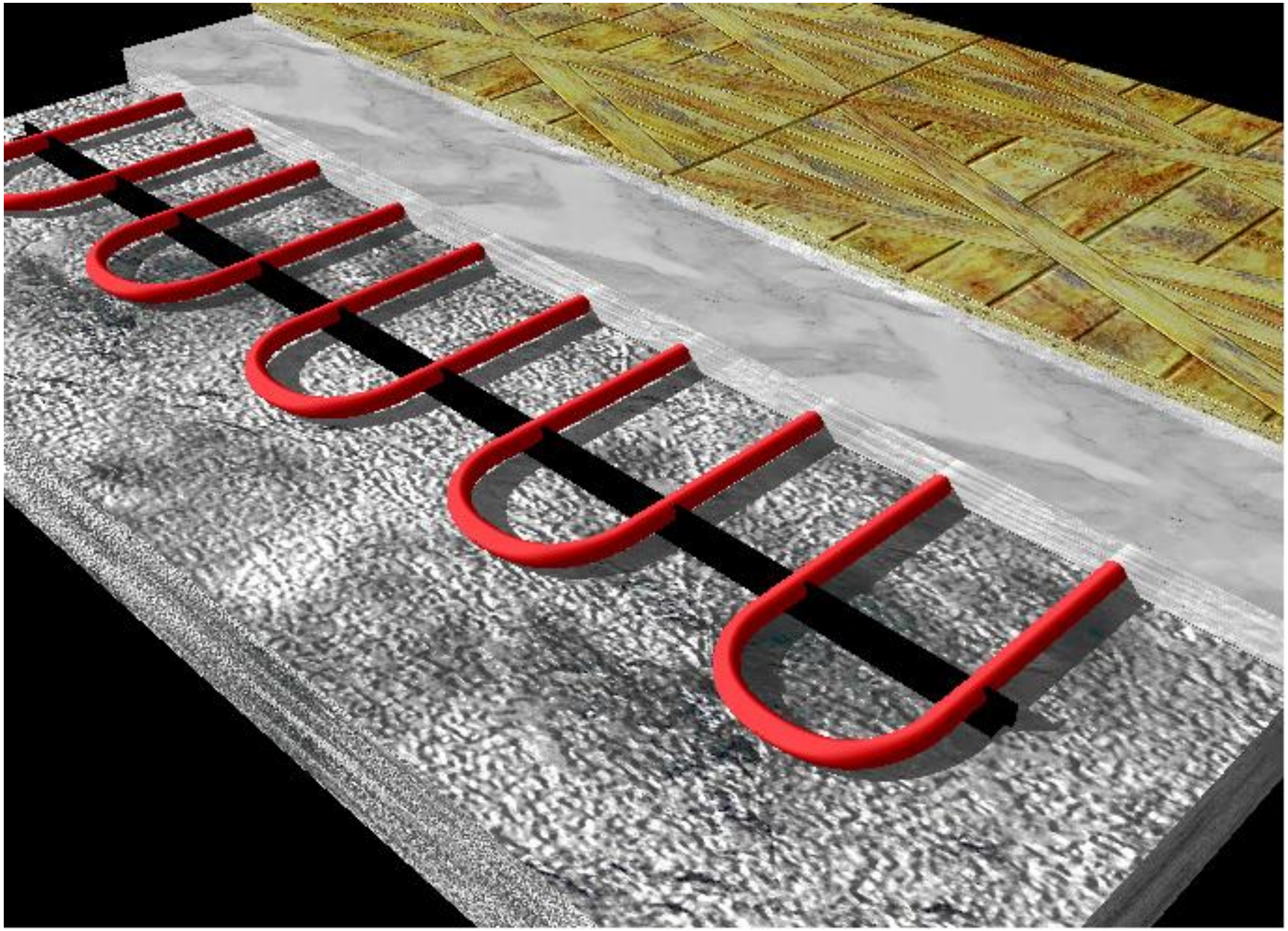


Fig. 9-9

Thin-Slab on Subfloor

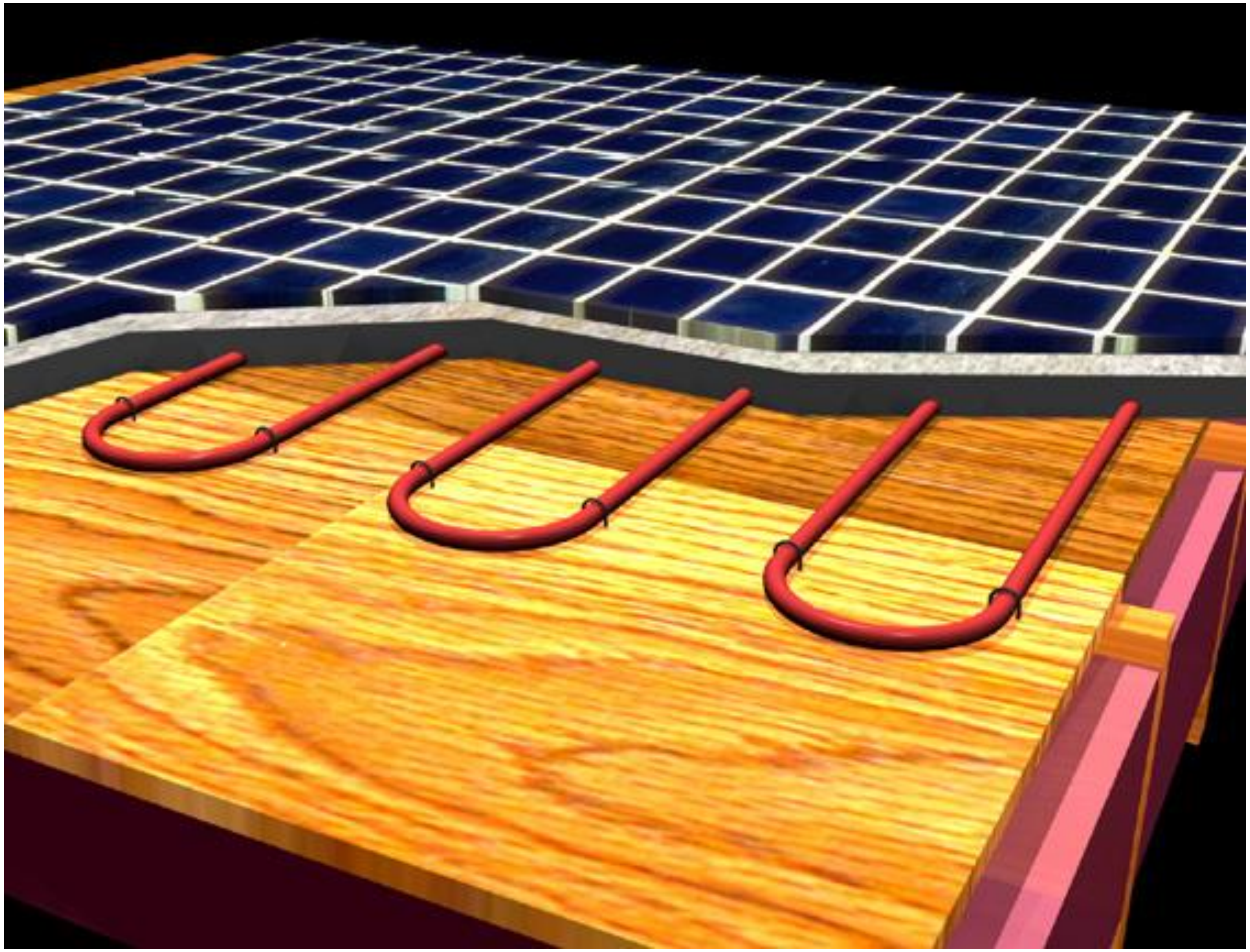


Fig. 9-10

With Plates Below Subfloor

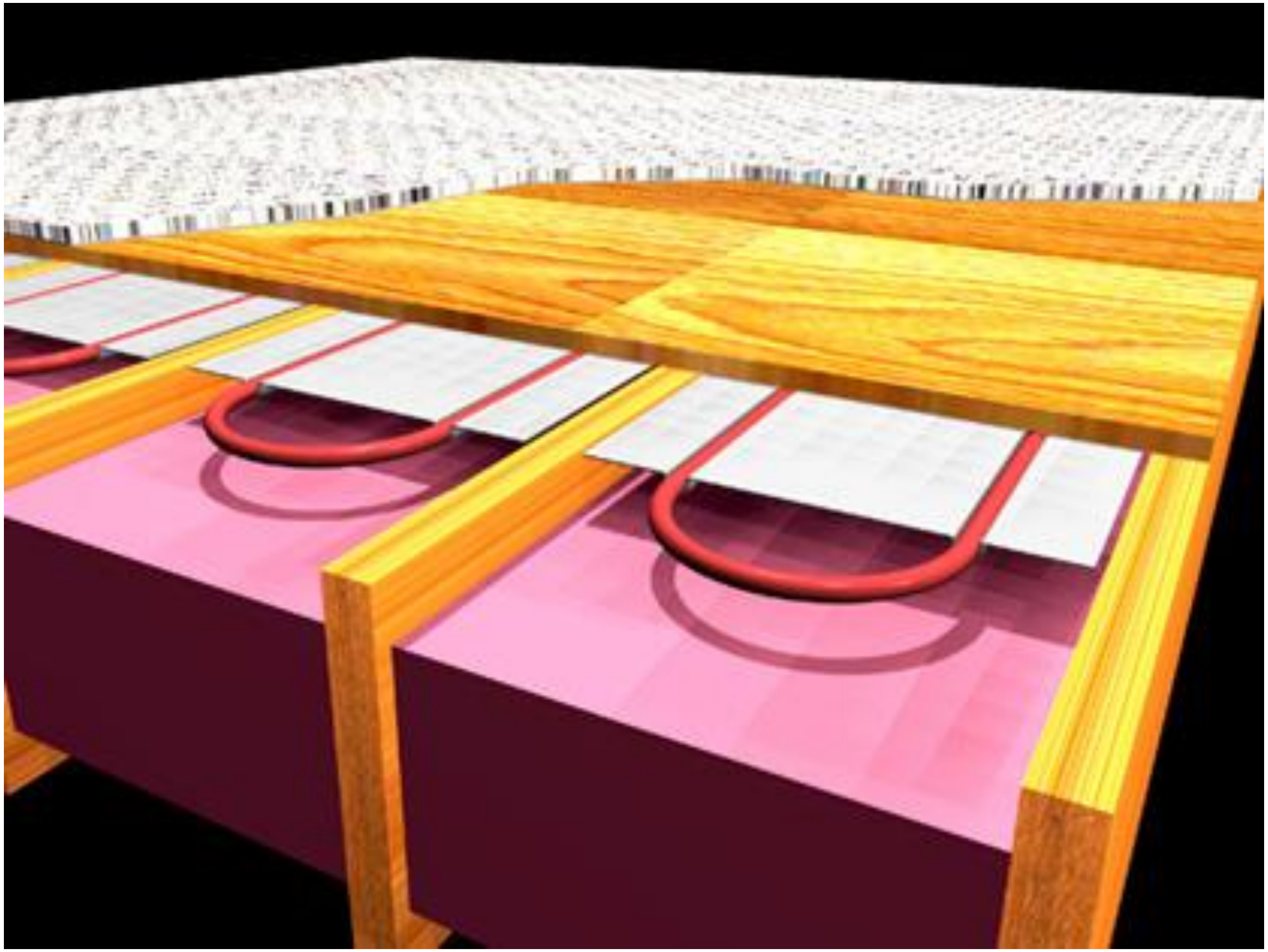


Fig. 9-12

Engineered Subfloor with Metal and Tubing Grooves

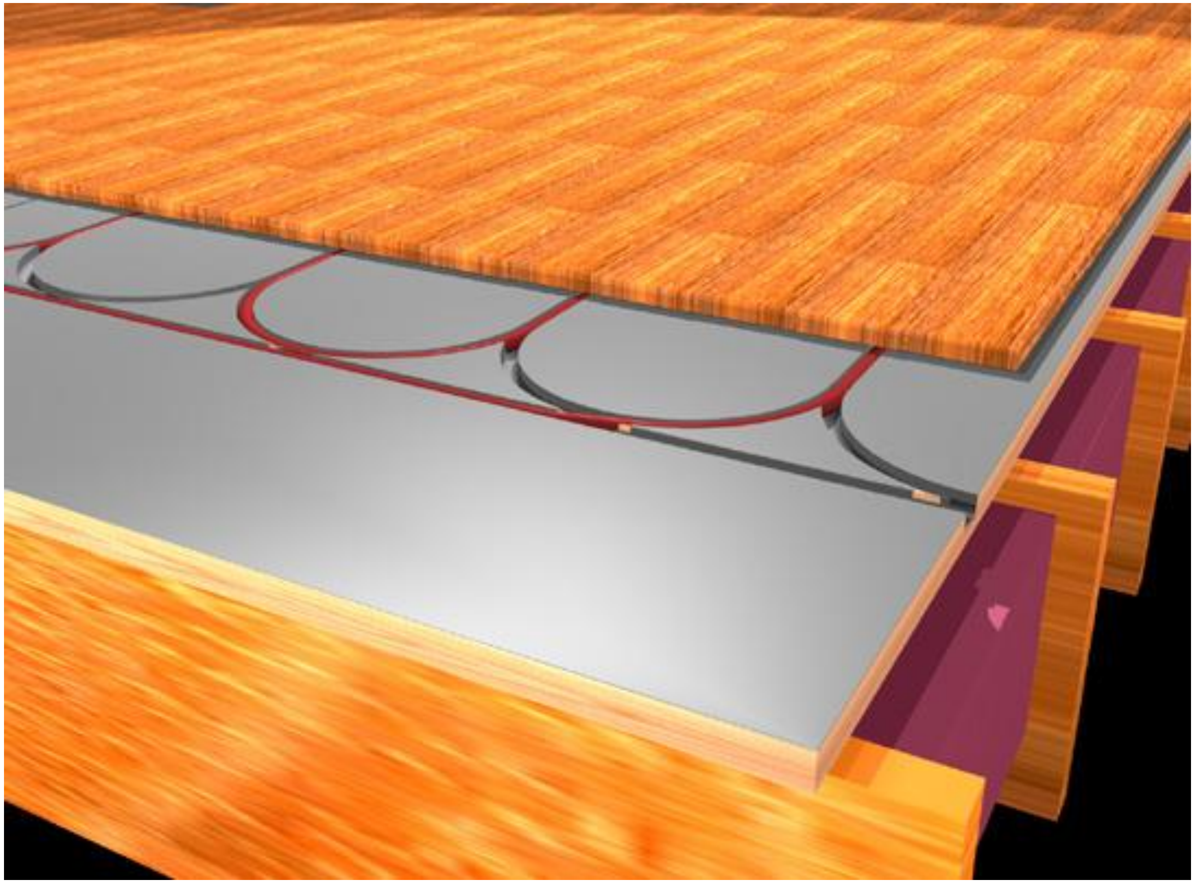


Fig. 9-13

Radiant Wall with Plates

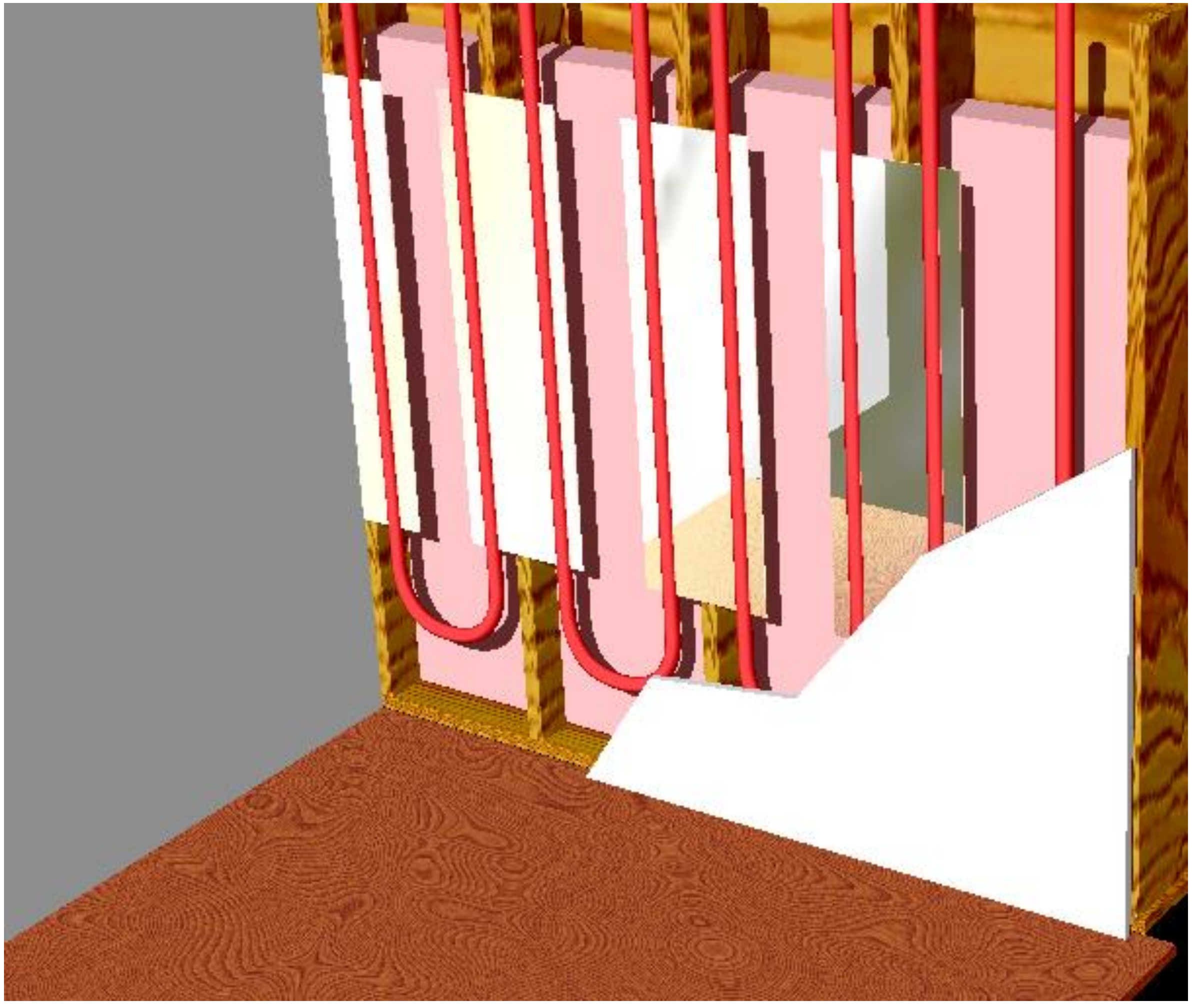
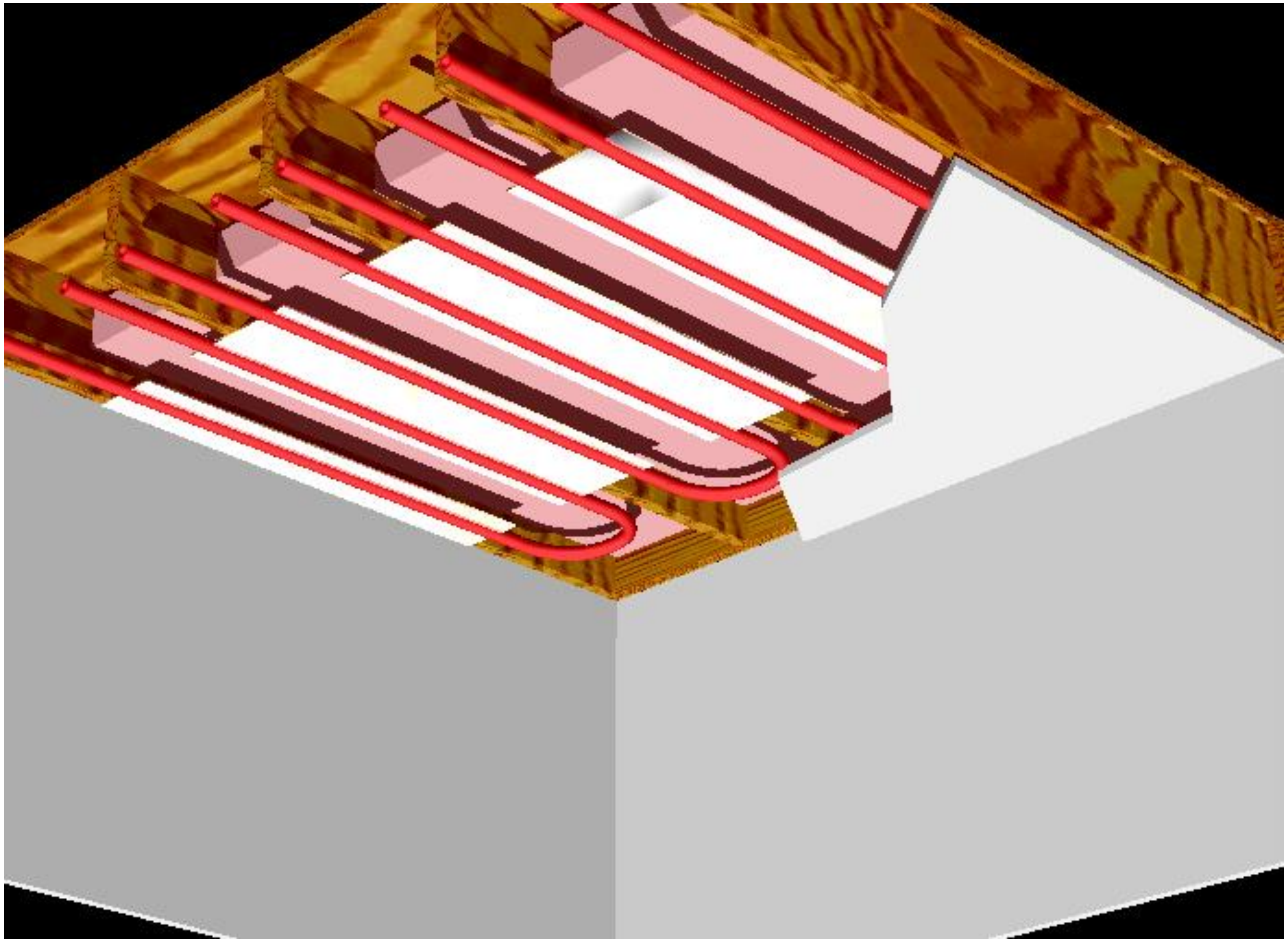


Fig. 9-16

Radiant Ceiling with Plates



Modular Ceiling Radiant Heating and Cooling

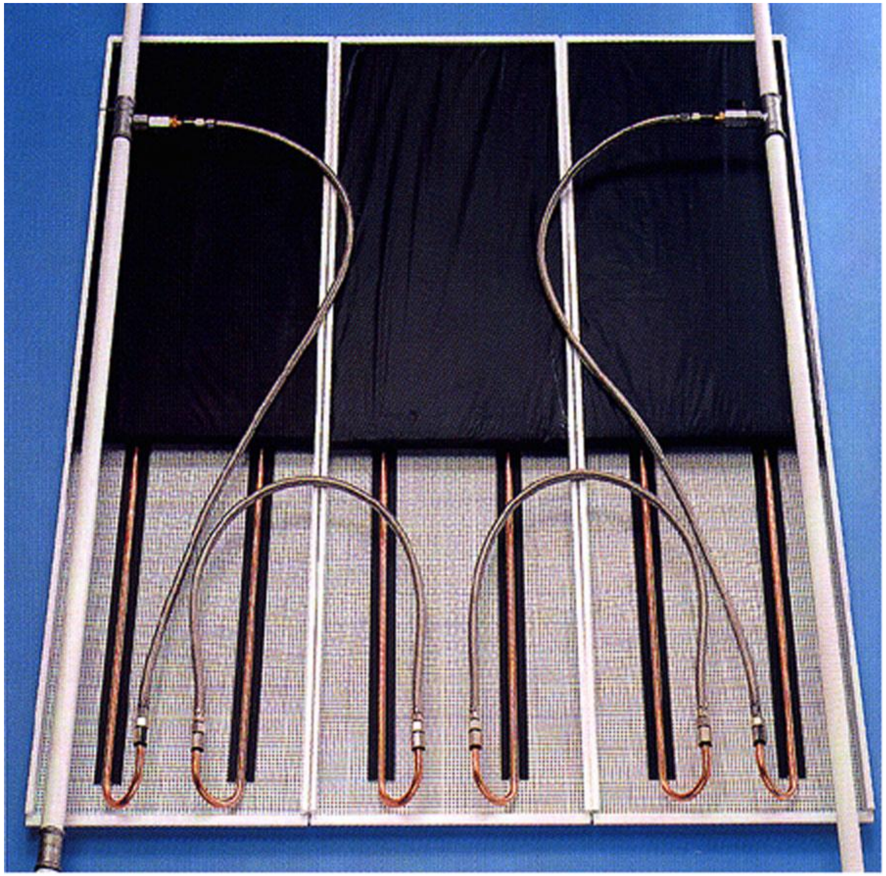


Fig. 9-18

Embedded Electric Cable and Mat

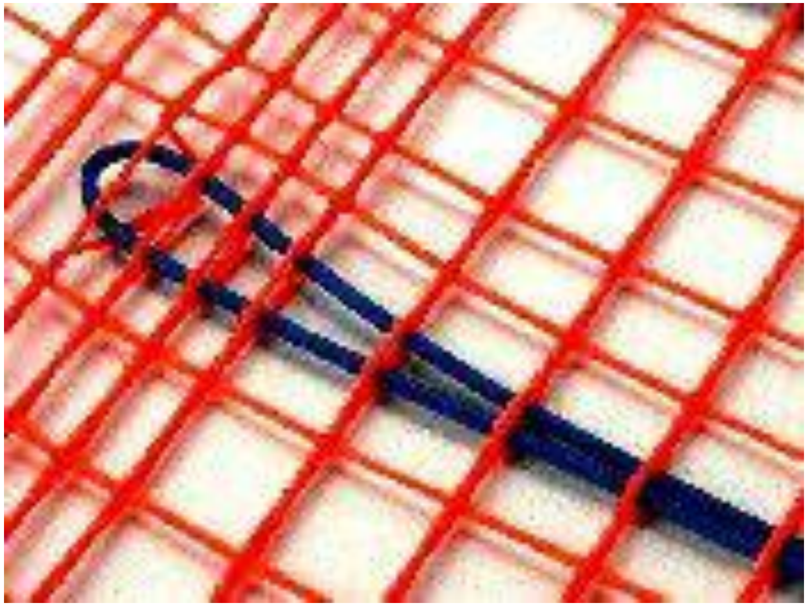
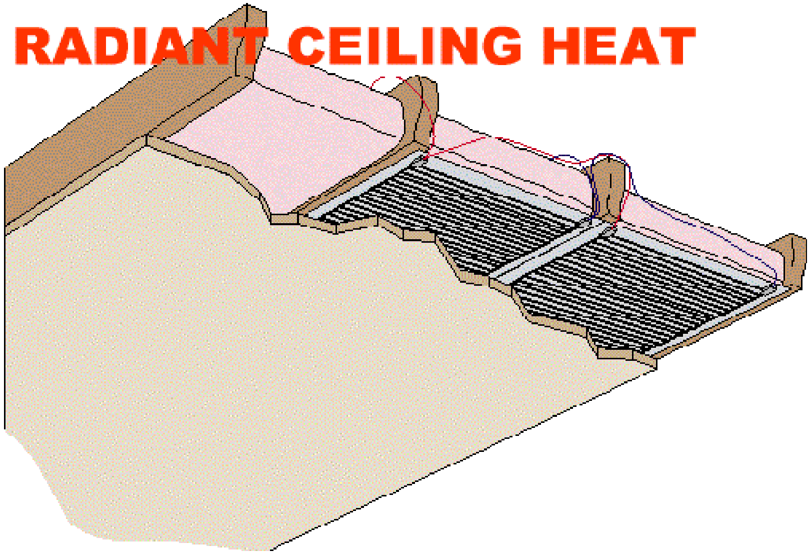


Fig. 9-20

Thin Electric with Plastic Film



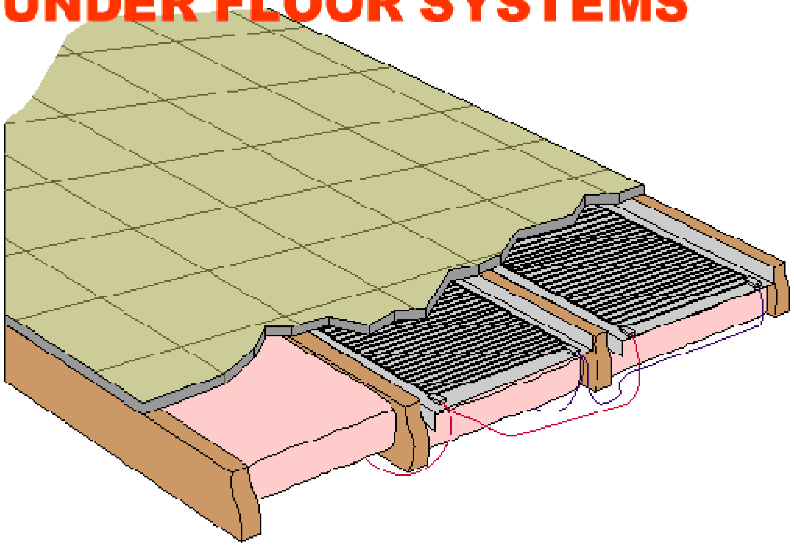
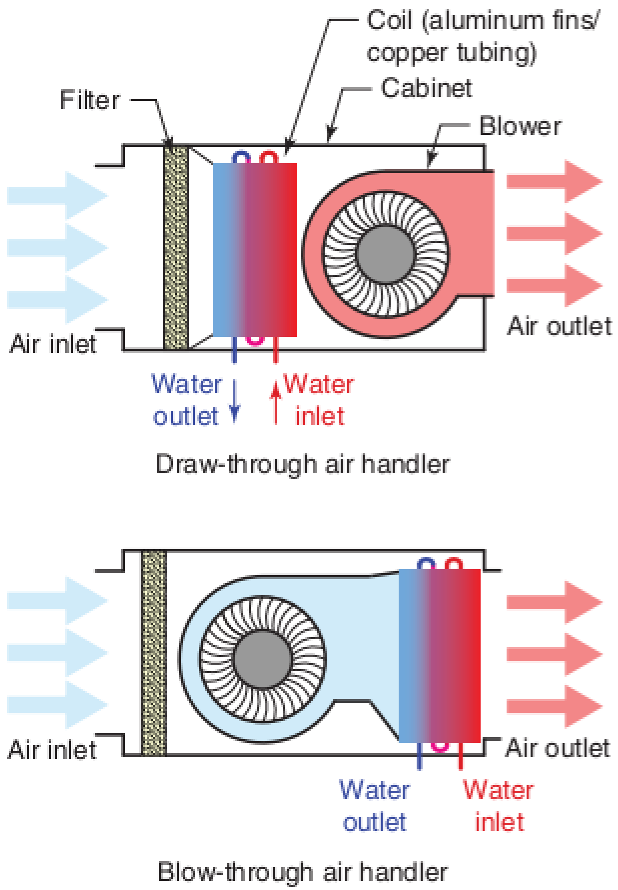


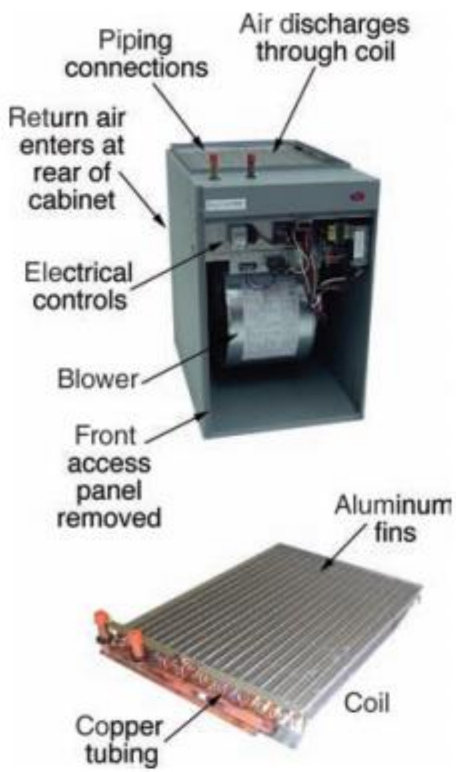
Fig. 9-21

Non radiant (convective) hydronic systems

Non radiant (convective) hydronic systems



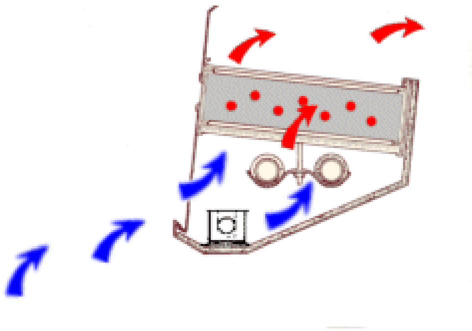
(a)



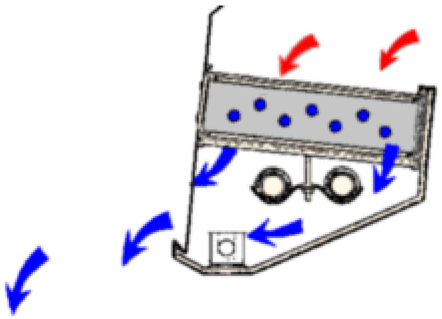
(b)

Image courtesy Modern Hydronic Heating v3.0

Non radiant (natural convective) hydronic systems



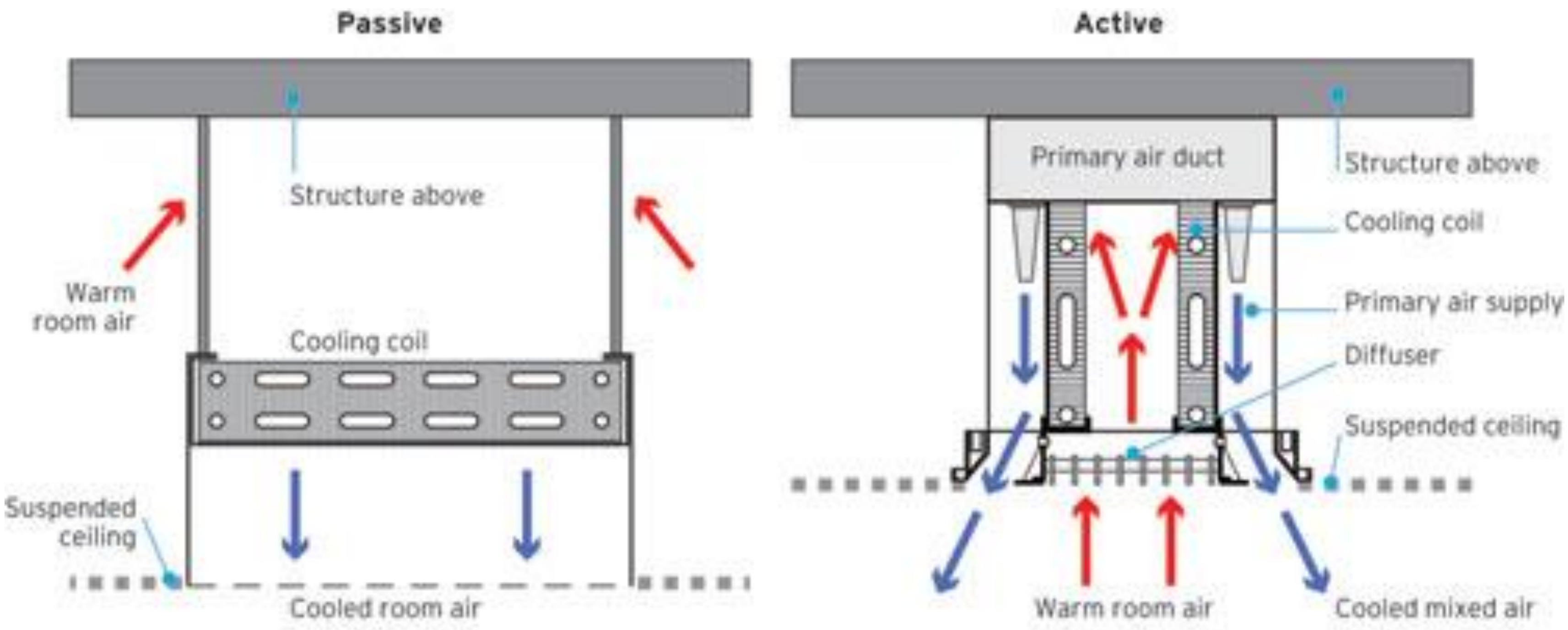
Valance Ceiling in heating mode



Valance Ceiling in cooling mode

Non radiant (natural convective) hydronic systems

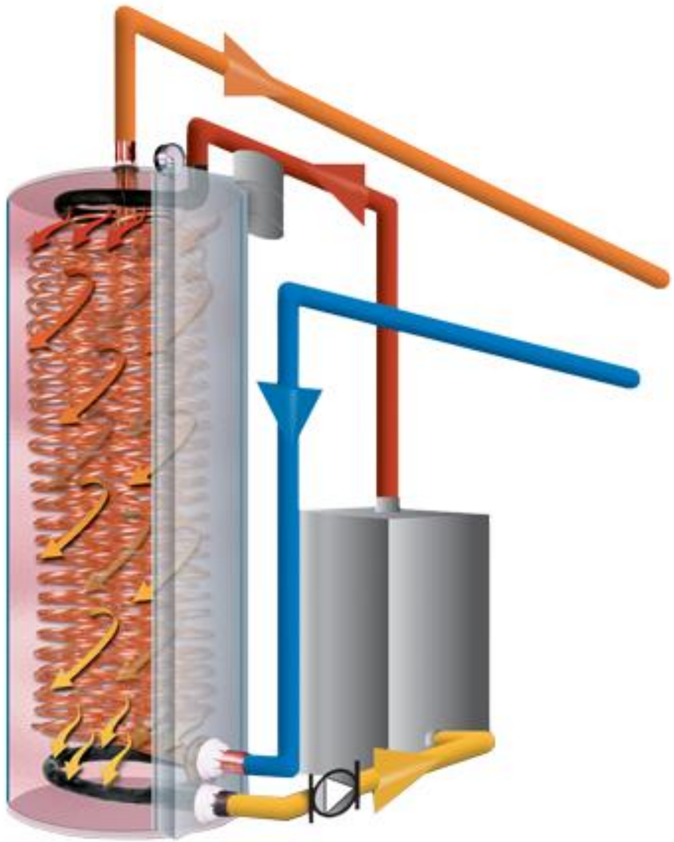
Non radiant (natural and forced convective) hydronic systems



ACTIVE AND PASSIVE CHILLED BEAMS IN COOLING MODE

Non radiant (forced convective) hydronic systems

Handling the DHW needs.



Calculating DHW hourly needs for showering

- Total showers per hour (assume 4 people, 2 adults, 2 children)

Calculating DHW hourly needs for showering

- At 2 GPM flow rate, with 110 degree F draw, and an 8 minute shower duration per person, = 64 GPH at a 100 degree F rise = 53,312 btuH demand.

Calculating DHW hourly needs for showering

- Fire power needed = 53,312 divided by appliance efficiency (assume 92%) = 57,947 btuH input.

Calculating DHW hourly needs for showering

- Storage needed is based on estimated hourly demand, divided by .8 (assume 80% draw before dilution and mixing).

Calculating DHW hourly needs for showering

- 32 gallon base load divided by .8 = 40 gallons of storage required.

Calculating DHW hourly needs for showering

- If large soaking tub is present, take filled volume and divide by .8 to calculated required storage tank volume. i.e. 80 gallon soaking tub divided by .8 = 100 gallon tank. DO NOT compound unless there is zero diversity in loads.

Calculating DHW hourly needs for showering

- Bottom line, at 5 btuH per square foot, DHW heater is capable of carrying a substantial (53,000 divided by 5 = 10,600 square feet) space heating load.

Best way to provide remote hot water. (circ return)

- On demand.

Best way to provide remote hot water. (circ return)

- Push button, wired or wireless

Best way to provide remote hot water. (circ return)

- Motion detector, wired and wireless

Best way to provide remote hot water. (circ return)

- Remote circulator or located in mechanical room

Best way to provide remote hot water. (circ return)

- Dedicated circ return line versus using cold water line to return to source.

DHW circ return diagram

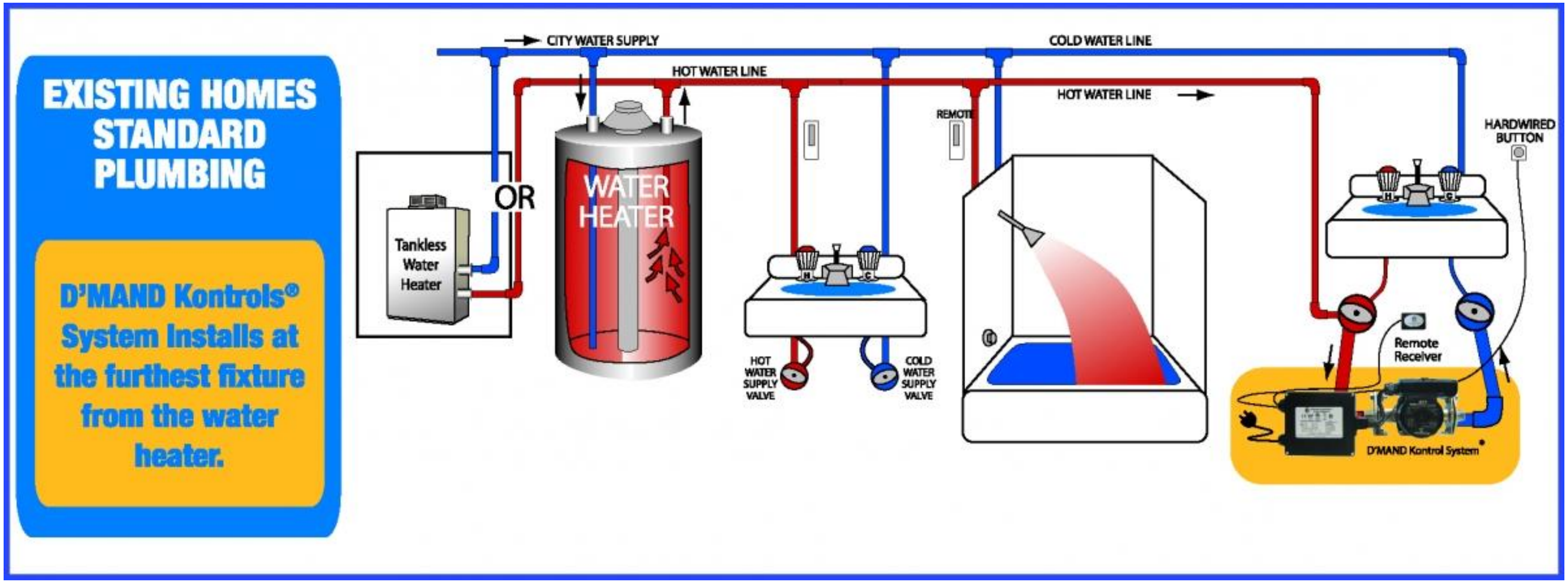


Image courtesy gothotwater,com

DHW Circulation Return Needs

- Code requirements
- Mechanical Methodologies
- Control logics
  - Circulators
  - Control valves
  - Control logics

Image Courtesy of Taco Comfort Solutions

DHW Circulation Return Needs

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Image Courtesy of Taco Comfort Solutions

Waste Heat Recovery

- Drain/Waste Heat Recovery System
  - Types
    - Static

Image Courtesy of Swing Green, Inc

Thank You to EEBA for the opportunity to share information!

Got questions ???

Thank you EEBA and EEBA attendees

CONTACT INFORMATION

Mark Eatherton, Executive Director for RPA
720-375-3107
Radiant Professionals Alliance
18927 Hickory Creek Drive Suite 220
Mokena, Il 60448