

Figure 4-27 – Combined Hydronic System with Boiler and Indirect Fired Water Heater

The other type of hydronic heating uses a water heater as a heat source. The water heater provides domestic hot water as usual. Space heating is accomplished by circulating water from the water heater through the space heating delivery system. Sometimes a heat exchanger is used to isolate potable water from the water circulated through the delivery system. Some water heaters have built-in heat exchangers for this purpose.

For compliance calculations, the water heating function of a combined hydronic system is analyzed for its water heating performance as if the space heating function were separate. For the space heating function, an “effective” AFUE or HSPF rating is calculated. These calculations are performed automatically by the compliance software (see the compliance program vendor’s supplement).

4.7.2 Radiant Floor System

One type of distribution system is the radiant floor system, either hydronic or electric, which must meet mandatory insulation measures (see below). Radiant floors may take one of several forms. Tubing or electric elements for radiant floor systems may be:

- Embedded in a concrete floor slab,
- Installed over the top of a wood sub-floor and covered with a concrete topping,
- Installed over the top of wood sub-floor in between wood furring strips, or
- Installed on the underside surface of wood sub-floor

In the latter two types of installations, aluminum fins are typically installed to spread the heat evenly over the floor surface, and to reduce the temperature of the water as required. All hydronic systems use one or more pumps to circulate hot water. Pumps are controlled directly or indirectly by thermostats, or by special outdoor reset controls.

Mandatory Insulation Measures

§118(g) *Insulation Requirements for Heated Slab Floors*
 Standards Table 118-A *Slab Insulation Requirements for Heated Slab-On-Grade Floors*

Table 4-10 – Slab Insulation Requirements for Heated Slabs

Location of Insulation	Orientation of Insulation	Installation Criteria	Climate Zone	Insulation R-value
Outside edge of heated slab, either inside or outside the foundation wall	Vertical	From the level of the top of the slab, down 16 inches or to the frost line, whichever is greater? Insulation may stop at the top of the footing where this is less than the required depth. For below-grade slabs, vertical insulation shall be extended from the top of the foundation wall to the bottom of the foundation (or the top of the footing) or frost line, whichever is greater.	1-15	5
			16	10
Between heated slab and outside foundation wall	Vertical and Horizontal	Vertical insulation from the top of the slab at the inside edge of the outside wall down to the top of the horizontal insulation. Horizontal insulation from the outside edge of the vertical insulation extending 4 feet toward the center of the slab in a direction normal to the outside of the building in the plan view.	1-15	5
			16	10 vertical and 7 horizontal

Radiant floor systems in concrete slabs must have insulation between the heated portion of the slab and the outdoors.

When space heating hot water pipes or heating elements are set into a concrete slab-on-grade floor, slab-edge insulation from the level of the top of the slab, down 16 inches (200 mm) or to the frost line, whichever is greater (insulation may stop at the top of the footing, where this is less than the required depth), or insulation installed down from the top of the slab and wrapping under the slab for a minimum of 4 ft toward the middle of the slab, is required. The required insulation value for each of these insulating methods is either R-5 or R-10 depending on climate zone as shown in Table 4-10. Any part of the slab extending outward horizontally must be insulated to the level specified in Table 4-10.

When using the performance compliance method with slab-on-grade construction, the standard design includes slab edge insulation as described above using the F-factors in Reference Joint Appendix JA4, Table 4.4.8.

When space heating hot water pipes or heating elements are set into a lightweight concrete topping slab laid over a raised floor, insulation must be applied to the exterior of any slab surface from the top of the slab where it meets the exterior wall, to the distance below ground level described in Table 4-10. If the slab does not meet the ground on its bottom surface, the specified insulation level must be installed on the entire bottom surface of the raised slab. Any part of the slab extending outward horizontally must be insulated to the level specified in Table 4-10. For lightweight slabs installed on raised floors and inside exterior walls, the overall wall R-value and overall floor R-value (determined as $1/(U\text{-factor})$) may be counted toward meeting the minimum R-value requirements specified in Table 4-10.

Raised floor insulation that meets the mandatory minimum R-value for wood floor assemblies also meets the requirement for insulation wrapping under the lightweight topping slab.

Slab edge insulation applied to basement or retaining walls (with heated slab below grade) must be installed so that insulation starts at or above ground level and extends down to the bottom of the foundation or to the frost line, whichever is greater.

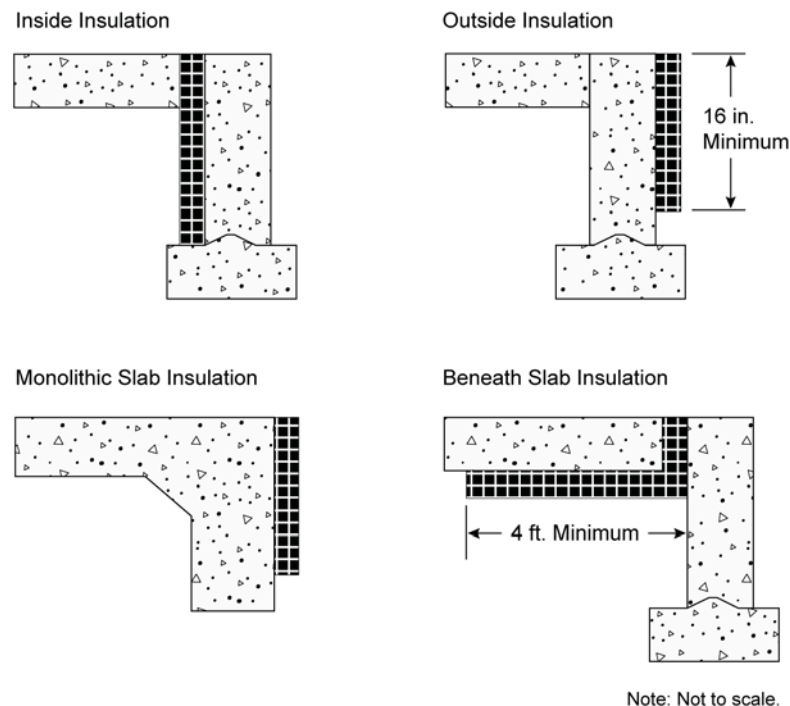


Figure 4-28– Heated Slab-On-Grade Floor Insulation Options

Local conditions (such as a high water table) may require special insulation treatment in order to achieve satisfactory system performance and efficiency. To determine the need for additional insulation, follow the recommendations of the manufacturer of the hydronic tubing or heating element being installed. Where there is a danger of termite infestation, install termite barriers, as required, to prevent hidden access for insects from the ground to the building framing.

In addition to the insulation R-value requirements, the Standards also set mandatory measures related to moisture absorption properties of the insulation and protection of the insulation from physical damage or pest intrusion.

Example 4-39**Question**

My client wants a dedicated hydronic-heating system (space heating only), but a few things are unclear: (1) What piping insulation is required? (2) Can I use any compliance approach? (3) Do I have to insulate the slab with slab edge insulation? and (4) What special documentation must be submitted for this system type?

Answer

(1) The supply lines not installed within a concrete radiant floor must be insulated in accordance with §150(j)—1.0 inch (25mm) of nominal R-4 on pipes that are 2 inch (50 mm) or less in diameter, and 1.5 inch (38 mm) for pipes greater than 2 inch (50 mm) in diameter.

(2) You can use any compliance approach, but the boiler must meet the mandatory efficiency 80 percent AFUE.

(3) The slab edge insulation shown in Table 4-10 is required only when the distribution system is a radiant floor system (pipes in the slab). When this is the case the insulation values shown are mandatory measures (no modeling or credit).

(4) No special documentation is required.

Example 4-40**Question**

What are the slab edge insulation requirements for a hydronic-heating system with the hot water pipes in the slab?

Answer

The requirements for slab edge insulation can be found in §118 and §150(l).

Material and installation specifications are as follows:

- insulation values as shown in Table 4-10
- protected from physical damage and ultra-violet light deterioration,
- water absorption rate no greater than 0.3 percent (ASTM-C272), and
- water vapor permeance no greater than 2.0 per inch (ASTM-E96-90).

4.7.3 Evaporative Cooling

Evaporative coolers provide cooling to a building by either passing outdoor air through a wetted evaporative media (direct evaporative cooler), by indirect cooling through a non-porous heat exchanger separating evaporatively cooled secondary air from outdoor air, or by a combination indirect-direct system that combines an indirect heat exchanger with a downstream direct evaporative process. Although direct coolers are the most common systems available, the more advanced