Chapter 9:
Radiant ceiling system design

Designing a radiant ceiling heating system is fairly simple. Unlike radiant floor heating, floor coverings are not a concern and the surface temperature limitations are higher. The exception is when radiant ceiling is installed over an un-insulated concrete slab. In this case, using a high R-value floor covering may be beneficial.

Uponor radiant ceiling systems are designed for residential applications over suspended wood floors. The system can be used as a sole source of heat or as a supplemental heat. Radiant ceiling is not recommended over un-insulated, bare concrete floors.

It is important to perform an accurate room-by-room heat-loss analysis using an appropriate indoor design temperature. Uponor recommends a 70°F room setpoint temperature for radiant ceiling systems.

With radiant ceiling, it is not always necessary to install piping over the entire ceiling area. If the BTU/h/ft² requirement is low, increasing the load per square foot and concentrating the piping and plates in the high heat-loss areas of the room reduce the amount of material required and lower the installed price.

Note: This tutorial is designed with Joist Trak™ aluminum plates. Joist Trak aluminum plates produce approximately 26 BTU/h/ft² with 120°F supply water. Joist Trak plates provide a higher output than Quik Trak® panels in the ceiling. On average, Quik Trak panels provide 20 BTU/h/ft² output using 120°F supply water. Quik Trak panels are recommended for supplemental use in radiant ceiling applications.

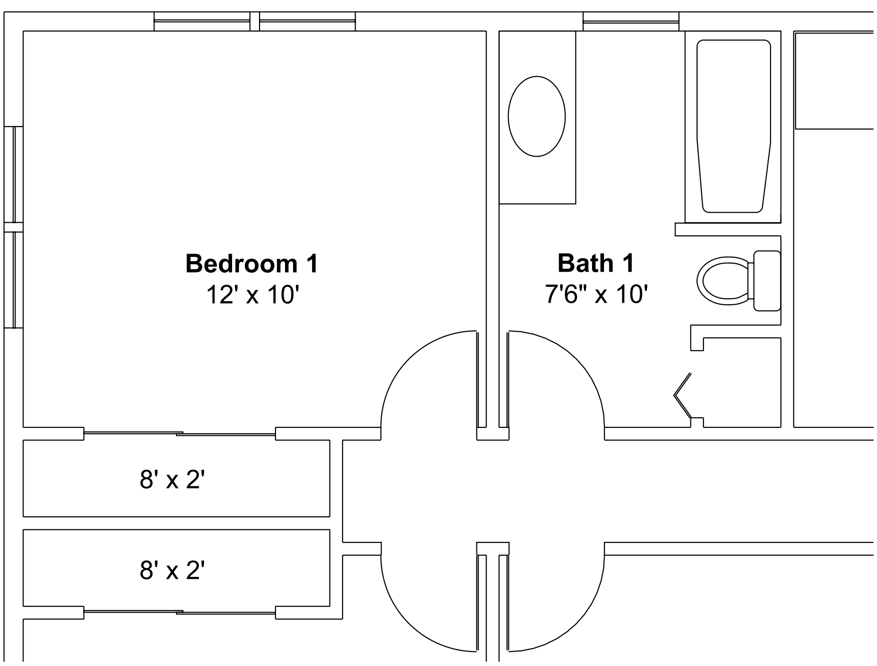

Figure 9-1: Uponor training house (partial)

At the most basic level, five performance factors must be calculated when designing a hydronic radiant ceiling heating system.

1. Accurate room-by-room heat-loss analysis
2. Surface temperature requirements
3. Supply water temperature requirements
4. Fluid flow requirements
5. Pressure loss

Bedroom 1 (floor plan 1)	
Total area	136 ft²
Average height	8 ft
Volume	1,088 ft²
Air changes	0.35/hr
Room temperature	70°F
Components	1,990 BTU/hr
Infiltration	454 BTU/hr
Ceiling upward	1,089 BTU/hr
Floor downward	0 BTU/hr
Total heat loss	3,533 BTU/hr
Supplemental	0 BTU/hr
Total room loss	3,533
Radiant to room load	2,444 BTU/hr
Unit load	18 BTU/ft²/hr
Total radiant load	3,533 BTU/hr
Unit load	26 BTU/ft²/hr

Figure 9-2: Heat-loss data for bedroom 1

Radiant ceiling design tutorial

To demonstrate the radiant ceiling design process, this exercise walks step by step through the design of a single room (Bedroom 1) of the Uponor Training House.

Step 1: Heat-loss analysis

The radiant heating design worksheet provides a format to organize the building's raw heat-loss information. A copy of this worksheet is available in **Appendix A**. Copy as necessary. Fill out the worksheet for the project, and then enter the information into the computer heat-loss program. Entering the data into the computer will go much faster if you complete the worksheet first.

The heat loss for this tutorial has already been completed. **Figure 9-1** shows a partial floor plan for the Uponor Training House. **Figure 9-2** shows heat-loss data from the radiant design program for Bedroom 1.

The radiant ceiling design worksheet template in **Appendix B** is provided for recording the radiant ceiling design information. Note that this appendix also contains worksheets for radiant floor and Quik Trak designs. Copy the template and fill in the information during the tutorial. Enter the following information from the Bedroom 1 heat loss into the design worksheet: room name, setpoint temperature, zone number (thermostat) and BTU/h load.

Step 2: Calculating the BTU/h/ft² requirements

1. Determine the heat loss. For Bedroom 1, the total load is 3,533 BTU/h. It is slightly different from the radiant floor heat loss from **Chapter 8** because the setpoint temperature increases from 65°F to 70°F.
2. Calculate the total ceiling area available for radiant ceiling panel. Remember to subtract areas that must be avoided. For example, allow a 6-inch clearance for any flues and 12 inches for light fixtures. This example uses 130 ft², which will become the active square footage.
3. Divide the heat load by active ceiling area available to find the BTU/h/ft² (3,533 BTU/h ÷ 130 = 27.2 BTU/h/ft²).

Step 3: Ceiling surface temperature

The ceiling surface temperature is the temperature at the bottom of the sheetrock needed to transfer the calculated BTU/h into a single area at design heat load. If the conditions are milder than design, the ceiling surface temperature will be lower. Surface temperature is based on a simple relationship between the room setpoint temperature and the required BTU/h/ft² load. Areas with differing BTU/h/ft² requirements or setpoints require different surface temperatures.

The coefficient of radiant ceiling thermal transfer is 1.1 BTU/h/ft²/°F. This transfer coefficient changes as the position of the radiant panel changes in the room.

For Bedroom 1:

Example
(27.2 BTU/h/ft² ÷ 1.1 BTU/h/ft²) + 70°F
= 95°F ceiling surface temperature

The formula used to calculate the ceiling surface temperature is precise and is supplied by the radiant design software. If manually designing the system, use the formula or the ceiling surface temperature chart found in **Appendix C**. An excerpt of this chart is shown in **Figure 9-3**. This chart quickly brackets the ceiling surface temperature to determine if the temperature is within limitations.

Ceiling surface temperature limitations

Ceilings up to 8 feet = maximum of 100°F surface temperature

If the surface temperature exceeds a limitation, reduce the heat loss or the load per square feet (if it was artificially increased), or add supplemental heat.

Note: The Uponor radiant ceiling system is designed for residential applications with ceilings up to 12 feet.

Using the ceiling surface temperature chart:

Find: The ceiling surface temperature.

Procedure:

1. Find the desired room setpoint temperature in the room setpoint column (70°F).
2. On the BTU/h/ft² column, move right until you reach the correct BTU/h/ft² requirement (27.5).
3. The temperature at the intersection of the two is the required ceiling surface temperature (95.0°F).

Enter the calculated surface temperature (95ºF) into the design worksheet.

Radiant ceiling surface temperatures

Ceiling surface temperature = (BTU/h/ft² ÷ 1.1) + room setpoint

Room setpoint	10.0	15.0	20.0	25.0	27.5	30.0	35.0	40.0
75°F	84.1	88.6	93.2	97.7	100.0	102.3	106.8	111.4
72°F	81.1	85.6	90.2	94.7	97.0	99.3	103.8	108.4
70°F	79.1	83.6	88.2	92.7	95.0	97.3	101.8	106.4
68°F	77.1	81.6	86.2	90.7	93.0	95.3	99.8	104.4
65°F	74.1	78.6	83.2	87.7	90.0	92.3	96.8	101.4
60°F	69.1	73.6	78.2	82.7	85.0	87.3	91.8	96.4

BTU/h/ft²

Exceeds maximum recommended surface temperature for 8-foot ceilings.

Figure 9-3: Radiant ceiling surface temperatures

Step 4: Piping size

Because Uponor radiant ceilings use Joist Trak aluminum heat emission plates, piping size is limited to ⅜" or ½". It is important to note that increasing the piping size does NOT increase the heat delivered.

The following example uses ½" Wirsbo hePEX to minimize head loss per loop. If using ⅜" Wirsbo hePEX, the resulting head loss on this loop would be 16 feet. For residential systems, maximum recommended head loss per loop is 12 feet to keep pumping costs down.

In this example, using ½" Wirsbo hePEX will ensure the pump can be purchased off-the-shelf and is cost-effective.

Enter the piping size (½") into the design worksheet.

Step 5: Differential temperature

The supply and return differential temperature is the temperature drop from the supply manifold to the return manifold. A supply and return differential temperature of 10°F is ideal for residential radiant ceilings.
For the exercise, use a supply and return differential temperature of 10°F.

Enter the differential temperature (10ºF) into the design worksheet.

Step 6: On-center distance

Piping spacing is 8 inches on center.

Enter the piping on-center distance (8") into the design worksheet.

Step 7: Supply water temperature

The required supply water temperature is the temperature necessary to achieve the required ceiling surface temperature. The information required to calculate supply water temperature for a radiant ceiling is:

- Required BTU/h/ft^2 load
- Room setpoint temperature
- Piping on-center distance
- Supply and return differential temperature

All the information needed to calculate the supply water temperature is available. See **Appendix E** and **Figure 9-4**.

Find: Required supply water temperature.

Procedure:

1. Enter the chart at the required BTU/h/ft^2 (26) in the BTU/h/ft^2 column.
2. Move to the right until you intersect the diagonal line. Move straight down and read the required supply water temperature. This chart is based off a 10°F temperature differential.

   Example The required water temperature is 120°F.

   The chart calculates the correct supply water temperature at 70°F room setpoint temperature and a supply and return differential temperature of 10°F.

   Enter the supply water temperature (120°F) into the design worksheet.

Radiant ceiling with Joist Trak plates (8" on center)

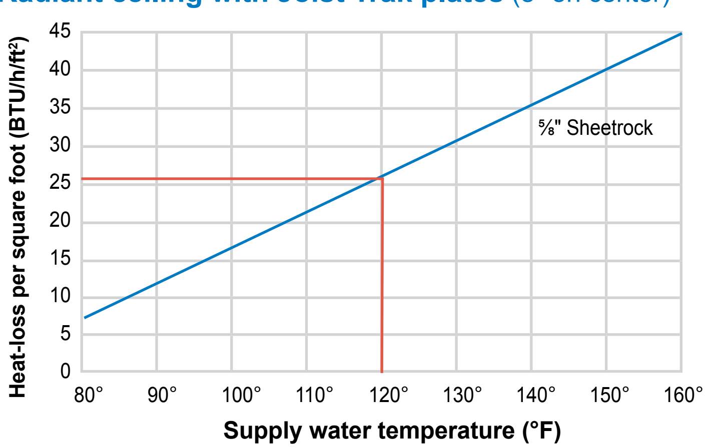

Figure 9-4: Radiant ceiling with Joist Trak plates (8" on center)

Radiant ceiling design worksheet

Project name: Training House main level

			Loop 1
	A	Room name	Bedroom 1
Step 2	B	Room setpoint temp. (°F)	70°F
	C	Zone number	1
	D	BTU/h	3,533
Step 3	E	Ceiling square footage	136
	F	BTU/h/ft^2	26
	G	Active square footage	130
	H	Ceiling surface temp. (°F)	95°F
Step 4	I	Piping size	½"
Step 5	J	Differential temp. (°F)	10°F
Step 6	K	Piping o.c. distance (in)	8"
Step 7	L	Supply water temp. (°F)	122°F
	M	Active loop length	
	N	Leader loop length	
	O	Total loop length	
	P	Loop flow in gpm	
	Q	Loop head pressure (ft)	
	R	Loop balancing turns	

Manifold totals

S	Supply water temp. (°F)	
T	Manifold flow in gpm	
U	Highest pressure head (ft)	

Figure 9-5: Radiant ceiling design worksheet

Radiant ceiling design worksheet

Project name: Training House main level

			Loop 1
	A	**Room name**	**Bedroom 1**
	B	Room setpoint temp. (°F)	70°F
	C	Zone number	1
	D	BTU/h	3,533
	E	Ceiling square footage	136
	F	BTU/h/ft²	26
	G	Active square footage	130
	H	Ceiling surface temp. (°F)	95°F
	I	Piping size	½"
	J	Differential temp. (°F)	10°F
	K	Piping o.c. distance (in)	8"
	L	Supply water temp. (°F)	120°F
Step 8	M	**Active loop length**	**195**
	N	**Leader loop length**	**66**
	O	**Total loop length**	**261**
Step 9	P	**Loop flow in gpm**	**0.69**
Step 10	Q	**Loop head pressure (ft)**	**5.6'**
	R	Loop balancing turns	

Manifold totals

S	Supply water temp. (°F)	
T	Manifold flow in gpm	
U	Highest pressure head (ft)	

Figure 9-6: Radiant ceiling design worksheet

100% Water | 10º Supply/return differential flow in GPM per foot of piping.

	Piping on-center distances					
BTU/h/ft²	6" o.c.	7" o.c.	8" o.c.	9" o.c.	10" o.c.	12
50	0.00507	0.00591	0.00676	0.00760	0.00845	0.
49	0.00497	0.00579	0.00662	0.00745	0.00828	0.
48	0.00487	0.00568	0.00649	0.00730	0.00811	0.
47	0.00476	0.00556	0.00635	0.00715	0.00476	0.
46	0.00466	0.00544	0.00622	0.00699	0.00777	0.
45	0.00456	0.00532	0.00608	0.00684	0.00760	0.
44	0.00446	0.00520	0.00595	0.00669	0.00743	0.
43	0.00436	0.00508	0.00581	0.00654	0.00726	0.
42	0.00426	0.00497	0.00568	0.00639	0.00709	0.
41	0.00416	0.00485	0.00554	0.00623	0.00693	0.
40	0.00405	0.00473	0.00541	0.00608	0.00676	0.
39	0.00395	0.00461	0.00527	0.00593	0.00659	0.
38	0.00385	0.00449	0.00513	0.00578	0.00642	0.
37	0.00375	0.00437	0.00500	0.00563	0.00625	0.
36	0.00365	0.00426	0.00486	0.00547	0.00608	0.
35	0.00355	0.00414	0.00473	0.00532	0.00591	0.
34	0.00345	0.00402	0.00459	0.00517	0.00574	0.
33	0.00334	0.00390	0.00446	0.00502	0.00557	0.
32	0.00324	0.00378	0.00432	0.00487	0.00541	0.
31	0.00314	0.00367	0.00419	0.00471	0.00524	0.
30	0.00304	0.00355	0.00405	0.00456	0.00507	0.
29	0.00294	0.00343	0.00392	0.00441	0.00490	0.
28	0.00284	0.00331	0.00378	0.00426	0.00473	0.
27	0.00274	0.00319	0.00365	0.00410	0.00456	0.
26	0.00264	0.00307	0.00351	0.00395	0.00439	0.

Figure 9-7: Excerpt from 100% water flow chart on page 194

Step 8: Determining loop length

Loop length is a function of room size (or coverage area), piping on-center, distance to and from the manifold, and the ability to supply a pump to circulate the required flow through the loop(s).

The amount of piping per loop equals the square footage of ceiling coverage by the loop (installed 8 inches on center), the leader length and an additional length of about 10 feet to get up and down the wall to the manifold (as required).

The net ceiling area for Bedroom 1 is 136 square feet. The adjusted ceiling area when calculated to the ideal load of 26 BTU/h/ft² is 130 square feet. Distance from the room to the manifold location is 10 feet. Additional distance within the room is 7 feet. Add 6 feet for the distance from the ceiling to the manifold.

Find: The active loop length for Bedroom 1.

Procedure: Convert the active square footage into length of piping: 130 x 1.5 = 195 feet

Example Active loop length for Bedroom 1 is 195 feet.

Enter the active loop length (195 feet) into the design worksheet.

Find: The leader length for Bedroom 1.

Procedure:

1. Determine the distance from the heated panel in the room to the exit location from the room. In this example, the distance is approximately 7 feet. Multiply this value by 2 to account for the supply and return piping (7 x 2 = 14 feet).
2. Determine the distance from the room exit location to the appropriate manifold location. In this example, the distance is approximately 20 feet. Multiply this value by 2 to account for the supply and return piping (20 x 2 = 40 feet).
3. Determine the distance above the manifold location to the manifold itself. In this example, the distance is approximately 6 feet. Multiply this value by 2 to account for the supply and return piping (6 x 2 = 12 feet).

4. Add all the piping lengths from the three steps above to obtain the amount of leader length for this loop (14 + 40 + 12 = 66 feet).

   Example The leader length for Bedroom 1 is 66 feet.

   Enter the leader length (66 feet) into the design worksheet.

Find: Total loop length for Bedroom 1.

Procedure: Add the active loop length with the leader length to obtain the total loop length (195 + 66 = 261 feet).

The total loop length for Bedroom 1 is 261 feet.

Enter the total loop length (261 feet) into the design worksheet.

Step 9: Fluid flow

To satisfy the calculated heat load, the system must provide adequate fluid flow through each loop of the hydronic radiant ceiling system. Fluid flow is based on a relationship between the heat load, active loop length and the supply and return differential temperature. The information required to calculate fluid flow is:

- BTU/h/ft^2 load
- Piping on-center distance
- Active loop length

All the information required to calculate the required flow for Bedroom 1 has been determined. Use the charts in **Appendix F** to calculate flow for each loop of the system. Select the appropriate chart for either water or water/glycol solution when calculating flow.

Find: The required flow for the loop in Bedroom 1.

Procedure:

1. Find the appropriate chart based on the type of fluid used. In this tutorial, use the 100% water chart.
2. Enter the chart at the total BTU/h/ft^2 load (26) in the BTU/h/ft^2 column.
3. To obtain the flow value per foot of active piping, move to the right until you intersect the column for 8 inches on center (0.00351).
4. Multiply the flow per foot by the amount of active loop length 0.00351 x 195 = 0.69 gpm).

   Example The flow for the loop servicing Bedroom 1 is 0.69 gpm.

   Enter 0.69 gpm in the flow per loop cell in the worksheet.

Step 10: Pressure loss

To correctly size a circulator for a radiant ceiling heating system, you must know two things.

1. Total gpm required
2. Feet of head pressure drop across the system the pump services

The flow requirement for the loop was determined in **Step 9** (0.69 gpm). Next, determine the feet of head pressure drop for the loop. For this exercise, use the charts in **Appendix G** to calculate feet of head drop per foot of piping.

Select the chart for the correct type and size piping, water temperature and water or water/glycol mixture.

Find: Feet of head drop.

Procedure:

1. Identify the appropriate pressure loss chart (½" Wirsbo hePEX piping using 100% water).
2. Enter the chart at the calculated flow value (0.69 gpm). For smaller applications such as this, round to the next value (0.72).
3. Move right until you intersect the appropriate supply water temperature column (for 122°F, use 120°F column).
4. Find the feet of head drop per foot of piping at the intersection of the flow row and water temperature column (0.02144).
5. Multiply the feet of head value per foot by the total loop length to determine total feet of head for the loop.

   Example 0.02144 feet of head per foot x 261 feet of total loop length = 5.6 feet of head.

> **Note:** If the system water temperature is between two columns, round up or down to the nearest temperature. If the temperature falls exactly between two columns (110°F for example), use the lower temperature column (100°F column).

If the feet of head is too great, you may need to decrease loop length(s), add additional loops or increase piping diameter. If the total loop length or piping diameter changes, recalculate pressure loss.

Enter the feet of head drop per loop (4.8) into the design worksheet.

This completes the design of Bedroom 1. Once all rooms are designed and calculated for the Training House tutorial, check your answers on **page 98**. Then, perform the initial flow balancing and determine the system totals.

½" Uponor PEX — 100% Water — feet of head per foot of piping

Velocity (ft./sec.)	GPM	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C
0.9	0.50	0.01334	0.01284	0.01241	0.01202	0.01168	0.01137	0.01109
1.0	0.55	0.01596	0.01537	0.01486	0.01440	0.01399	0.01363	0.01330
1.1	0.61	0.01878	0.01809	0.01749	0.01696	0.01649	0.01606	0.01568
1.2	0.66	0.02179	0.02100	0.02031	0.01970	0.01916	0.01867	0.01823
1.3	0.72	0.02498	0.02409	0.02331	0.02262	0.02200	0.02144	0.02094
1.4	0.77	0.02837	0.02736	0.02648	0.02570	0.02501	0.02438	0.02381
1.5	0.83	0.03193	0.03081	0.02983	0.02896	0.02818	0.02748	0.02684

Figure 9-8: ½" Uponor PEX pressure loss chart (100% water)

Performing initial flow balance calculations

In order to ensure adequate flow among the varying loop lengths of 1¼" brass manifolds, they must be balanced. The balance valve on an Uponor manifold is located on the return manifold under the protective plastic cap.

Note: This only applies to TruFLOW manifolds without flow indicators. Manifolds with flow indictors should be balanced to the specified gpm.

To calculate the setting, use the formula below.

$$\frac{\text{Length of loop to be balanced x 4}}{\text{Length of longest loop/manifold}} = \text{Number of half turns from closed position (balance setting)}$$

Example

Calculate the balance for a 200-foot loop with the longest loop in the manifold being 300 feet. (200' x 4) ÷ 300 = half turns from closed 800 ÷ 300 = half turns from closed 2.67 = half turns from closed

To adjust the valve setting for an individual loop, follow the steps listed below.

1. Remove the protective plastic cap and turn it upside down.
2. Place the cap over the operating pin and insert the notch in its slot.
3. Close the valve by turning it clockwise until it stops.
4. Turn the valve counterclockwise the calculated number of half turns from the closed position.
5. Perform this adjustment for each loop on the manifold.
6. Replace the balancing cap on the manifold and tighten a maximum of a half turn or the valve may begin to close.

Selecting the system water temperature

The supply water temperature used in a single-temperature system is the highest required water temperature of any individual room or area. In some instances, the highest water temperature required may be too high for other areas of the building. If the highest water temperature exceeds all other water temperatures by more than 20°F to 25°F, take steps to decrease the supply water temperature for that room. The other option is to provide two water temperatures. Careful manifold planning is required for systems requiring multiple water temperatures.

Compare the various required supply water temperatures and select the highest for the project. Because radiant ceilings are generally designed to an ideal load of 40 BTU/h/ft^2, supply water temperatures are generally very similar.

Enter the system supply water temperature (120°F) into the design worksheet.

System flow requirement

Calculate total flow (for the system or the portion of the system that an individual circulator will serve) for circulator sizing. Add all the individual loop requirements together to determine total flow.

Enter the system flow (3.64 gpm) into the design worksheet.

Determining feet of head for system

The feet of head for circulator sizing is the sum of the feet of head for the heat plant components, supply piping, manifolds and the loop in the system with the highest feet of head loss (generally the longest loop). For the Training House, the loop with the highest feet of head is the dining/kitchen loop with 4.1 feet of head.

Do not calculate pressure loss for each loop and add them together. Find the loop with the highest feet of head and add that to the feet of head of the system components. Make your calculations using the correct supply water temperature.

Enter the system feet of head drop (4.1 ft hd) into the design worksheet.

In order to size the circulator for this level of the training house, all the head pressure drops before and after the manifold location must be added together to determine the total head drop. To properly size the circulator, identify the total system flow and head.

The final step is to follow the manufacturer's circulator performance curves to determine which circulator provides the correct flow and feet of head capacity. When designing a system with multiple circulators, determine the flow and feet of head separately for each circulator.

The complete design

To complete the design, use the radiant ceiling worksheet found in **Appendix B**. See **page 98** for the completed tutorial design calculations.

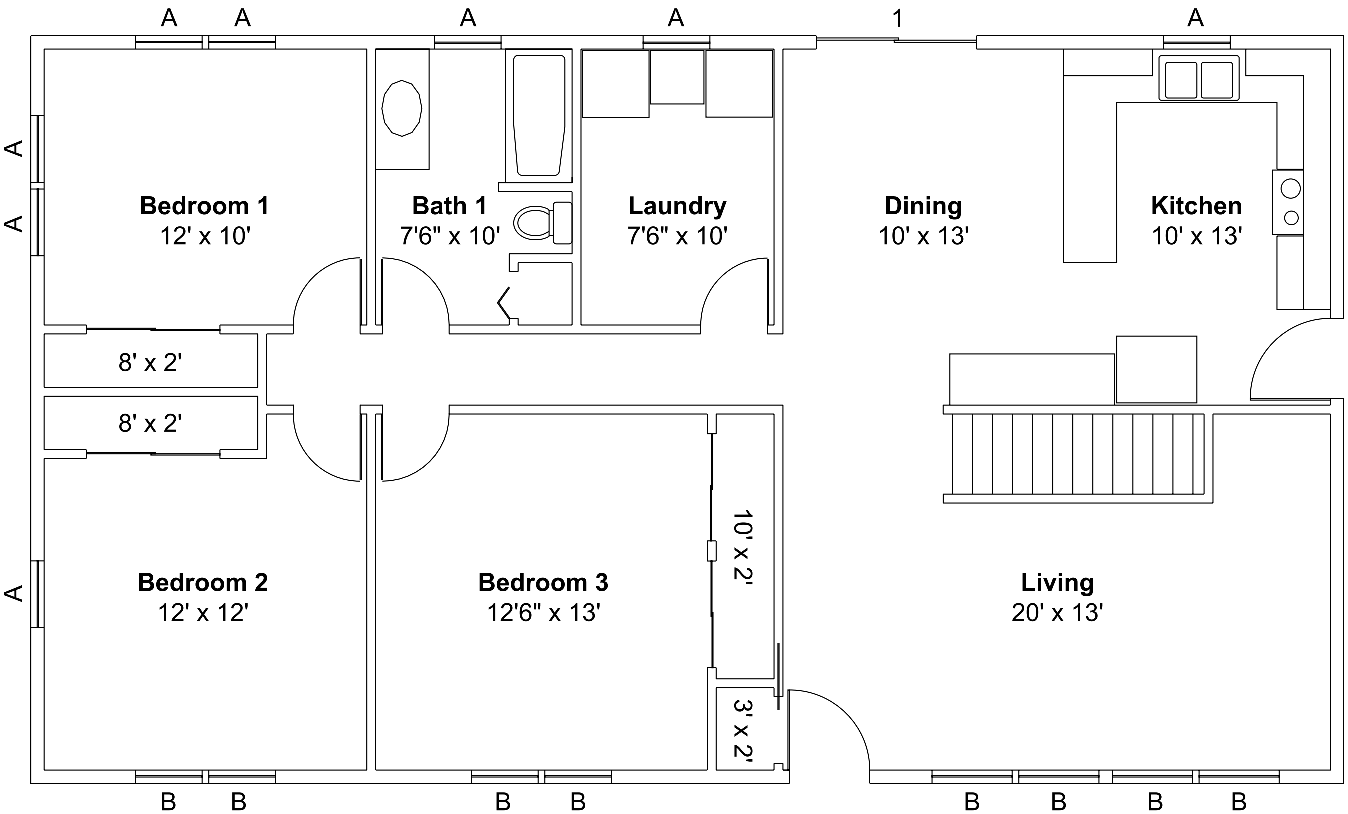

Figure 9-9: Main-level floor plan (no scale)

Room schedule		
Bedroom 1	136 ft²	¼" nylon saxony with ¼" bonded urethane
Bedroom 2	160 ft²	¼" nylon saxony with ¼" bonded urethane
Bedroom 3	183 ft²	¼" nylon saxony with ¼" bonded urethane
Living room	260 ft²	¾" oak
Kitchen/dining	260 ft²	¾" oak
Bath/laundry	150 ft²	¼" ceramic tile with ¼" underlayment
Bedroom 4	209 ft²	¼" nylon saxony with ¼" bonded urethane
Bath 2	75 ft²	¼" ceramic tile with ¼" underlayment
Family room	270 ft²	¼" nylon saxony with ¼" bonded urethane
Recreation room	270 ft²	¼" nylon saxony with ¼" bonded urethane
Storage	383 ft²	No floor covering

Window schedule		
Window 1 — 2'6" x 4'0"	Double pane, wood frame	R-1.81
Window 2 — 5'0" x 4'0"	Double pane, wood frame	R-1.81

Door schedule		
Door 1 — 6'0" x 7'0"	Sliding, double pane, wood frame	R-1.82
Door 2 — 3'0" x 7'0"	Metal with urethane core	R-5.29

Figure 9-10: Room, window and door schedules

Radiant ceiling design worksheet

Project name: Training House **Manifold number:** 1

Note: Ensure insulation between floors is at least R-19. Ensure ceiling exposed to the attic is at least R-38 (higher if required by code).

		Loop 1	Loop 2	Loop 3	Loop 4	Loop 5	Loop 6	Loop 7	Loop 8	Loop 9	Loop 10
A	Room name	Bedroom 1	Laun/Bath	Din/Kit	Living room	Bedroom 3	Bedroom 2				
B	Room setpoint temp. (°F)	70°F	70°F	70°F	70°F	70°F	70°F				
C	Zone number	1	2	3	4	6	6				
D	BTU/h	3,533	1,822	4,252	4,177	2,122	3,506				
E	Ceiling square footage	136	150	260	266	183	165				
F	BTU/h/ft²	26	40	40	40	40	22				
G	Active square footage	130	47	106	105	53	155				
H	Ceiling surface temp. (°F)	95°F	95°F	95°F	95°F	95°F	84°F				
I	Piping size	½"	½"	½"	½"	½"	½"				
J	Differential temp. (°F)	10°F	10°F	10°F	10°F	10°F	10°F				
K	Piping o.c. distance (in)	8"	8"	8"	8"	8"	8"				
L	Supply water temp. (°F)	120°F	117°F	117°F	117°F	117°F	113°F				
M	Active loop length	195	47	106	105	53	232				
N	Leader loop length	66	30	38	25	25	50				
O	Total loop length	261	77	144	130	78	282				
P	Loop flow in gpm	0.69	0.38	0.86	0.85	0.43	0.72				
Q	Feet of head drop per loop	5.6	0.5	4.1	3.7	0.7	5.2				
R	Loop balancing turns* (TruFLOW)	3.8	2.1	4.0	3.6	2.2	3.8				

Manifold totals

S	Supply water temp. (°F)	122°F									
T	Manifold flow in gpm	3.64									
U	Highest pressure head (ft)	5.6'									

A Enter the name of the room. The room may have more than one loop.

B Room setpoint temperature is normally 70°F for radiant ceiling.

C Zone is equal to thermostat. First zone is 1.

D Enter the "Total Unit Load" value from radiant design printout in BTU/h.

E Enter the ceiling square footage.

F Divide Row D by **Row E**. If value is less than 40 BTU/h/ft², divide **Row D** by 40.

*When using TruFLOW manifolds

G If **Row F** was obtained through dividing by 40, then divide **Row E** by 40. If Row F was greater than 40 BTU/h/ft², then enter the value from **Row E**.

H **Row F** divided by 1.6 plus the value in **Row B** equals the ceiling surface temperature. Do not exceed 100°F for ceilings at 8 feet or less. Do not exceed 110°F for ceilings greater than 8 feet.

I Enter the size of PEX piping for project (½" Wirsbo hePEX piping).

J Use 10°F differential temperature for all radiant ceiling applications.

K Maximum piping o.c. distance is 12" for all radiant ceiling applications.

L Use information from Rows F and J with **Appendix E** to obtain the supply water temperature.

M Multiply **Row G** by the on-center factor of 1.5.

N Enter the length of the piping from the room being heated to the respective manifold and multiply by 2 to account for supply and return.

O Use formula: (**Row M** + **Row N**) = total loop length.

P Use the values in **Rows F** and **L** with **Appendix F** to obtain the flow per loop.

Q Use the values in **Rows I, L** and **P** with **Appendix G** to obtain the feet of head pressure drop per foot. Next, multiply this value by **Row O** to obtain the feet of head drop per loop.

R These cells are calculated after the design is completed. Use the formula: (current loop value in Row O x 4) / longest loop length on the manifold.

S Enter highest temperature from **Row L**.

T Add all values in **Row P**.

U Enter highest value from **Row Q**.

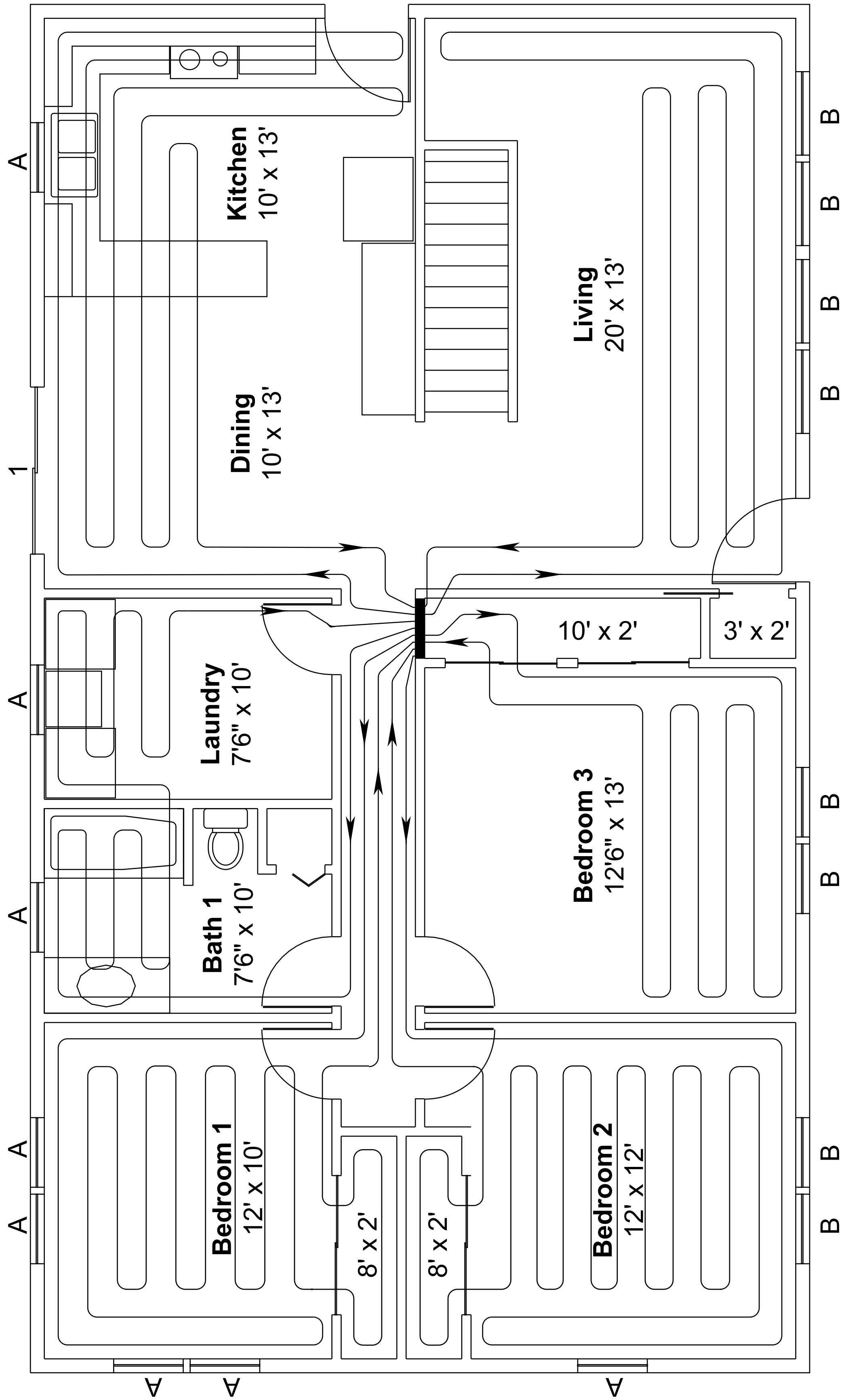

Figure 9-11: Main-level floor plan (no scale)

Radiant ceiling design worksheet

Project name: ______________________ **Manifold number:** _____

Note: Ensure insulation between floors is at least R-19. Ensure ceiling exposed to the attic is at least R-38 (higher if required by code).

		Loop 1	Loop 2	Loop 3	Loop 4	Loop 5	Loop 6	Loop 7	Loop 8	Loop 9	Loop 10
A	**Room name**										
B	Room setpoint temp. (°F)										
C	Zone number										
D	BTU/h										
E	Ceiling square footage										
F	BTU/h/ft²										
G	Active square footage										
H	Ceiling surface temp. (°F)										
I	Piping size										
J	Differential temp. (°F)										
K	Piping o.c. distance (in)										
L	Supply water temp. (°F)										
M	Active loop length										
N	Leader loop length										
O	Total loop length										
P	Loop flow in gpm										
Q	Feet of head drop per loop										
R	Loop balancing turns* (TruFLOW)										

Manifold totals

S	Supply water temp. (°F)										
T	Manifold flow in gpm										
U	Highest pressure head (ft)										

A Enter the name of the room. The room may have more than one loop.

B Room setpoint temperature is normally 70°F for radiant ceiling.

C Zone is equal to thermostat. First zone is 1.

D Enter the "Total Unit Load" value from radiant design printout in BTU/h.

E Enter the ceiling square footage.

F Divide Row D by **Row E**. If value is less than 40 BTU/h/ft², divide **Row D** by 40.

*When using TruFLOW manifolds

G If **Row F** was obtained through dividing by 40, then divide **Row E** by 40. If Row F was greater than 40 BTU/h/ft², then enter the value from **Row E**.

H **Row F** divided by 1.6 plus the value in **Row B** equals the ceiling surface temperature. Do not exceed 100°F for ceilings at 8 feet or less. Do not exceed 110°F for ceilings greater than 8 feet.

I Enter the size of PEX piping for project (½" Wirsbo hePEX piping).

J Use 10°F differential temperature for all radiant ceiling applications.

K Maximum piping o.c. distance is 12" for all radiant ceiling applications.

L Use information from Rows F and J with **Appendix E** to obtain the supply water temperature.

M Multiply **Row G** by the on-center factor of 1.5.

N Enter the length of the piping from the room being heated to the respective manifold and multiply by 2 to account for supply and return.

O Use formula: (**Row M** + **Row N**) = total loop length.

P Use the values in **Rows F** and **L** with **Appendix F** to obtain the flow per loop.

Q Use the values in **Rows I, L** and **P** with **Appendix G** to obtain the feet of head pressure drop per foot. Next, multiply this value by **Row O** to obtain the feet of head drop per loop.

R These cells are calculated after the design is completed. Use the formula: (current loop value in Row O x 4) / longest loop length on the manifold.

S Enter highest temperature from **Row L**.

T Add all values in **Row P**.

U Enter highest value from **Row Q**.