By Lance MacNevin

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One thing leads to another

It is extremely important for radiant designers to understand the impact of their specifications on pipe size, spacing and circuit length as they relate to required fluid temperature, operating efficiency and, ultimately, occupant comfort. Although less-than-ideal pipe size, spacing and circuit length combinations can be forced to "work" given a large enough circulator, proper design is the key to efficient system operation.

PRO tip

Since room sizes vary widely in residential applications, experienced radiant designers will often select different pipe sizes for different rooms to satisfy required heat loads, heated area requirements, installation techniques and tail lengths.

TABLE 1 Pipe Volumes (typical)

Nominal PEX Pipe Size	1/4 in	3/8 in	1/2 in	5/8 in	3/4 in	1 in
Approximate Volume (US Gallon / 100 ft)	0.23	0.5	0.98	1.34	1.89	3.2

The skinny (or not so much) on pipe sizing

Essentially, there are six radiant PEX (nominal) pipe size choices found in both CSA B137.5-09 and CSA B214-07: 1/4", 3/8", 1/2", 5/8", 3/4" and 1". Though at first glance there might not seem to be much difference between pipe sizes like 1/2" and 5/8", each pipe size actually has relative advantages and limitations.

The obvious difference between a small pipe and a larger one is that a larger pipe has more fluid volume.

A larger pipe also has more surface area contacting the thermal mass, and transfers a slightly greater heat output per foot length of pipe in a given situation. Since the circulating fluid is used to transfer energy and subsequently heat a space, a larger pipe technically carries more BTUs per foot length, and the fluid can travel farther before it gives off its energy and significantly cools. Most radiant designers try to keep the maximum temperature difference between supply and return fluid at 20°F (11°C).

To better illustrate the pros and cons of pipe sizes, let's compare 1/2" pipe and 5/8" pipe, both embedded in a poured thermal mass for radiant heating.

At the same fluid temperature, flow rate and thermal mass, the 5/8" pipe can transfer approximately eight per cent more heat than a 1/2" pipe, based on greater

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surface area. While this may not seem like much of a difference, remember that PEX pipes have a standard dimension ratio of nine (OD is nine times the wall thickness), so a 5/8" pipe also has a thicker wall than a 1/2" pipe.

All things being equal, a 5/8" pipe can use a 20 per cent longer circuit length before the fluid gets "cold." This may reduce the number of circuits by 20 per cent, which can translate into a significant difference on larger projects in terms of sizing manifolds.

A 5/8" pipe has approximately 66 per cent lower head loss than a 1/2" pipe for the same flow rate. This may allow the designer to specify a smaller circulating pump, saving both initial and operating costs.

Although 5/8" pipes will cost a bit more and be slightly stiffer to install than 1/2" pipes, in a light commercial application with long, straight runs the advantages probably outweigh the drawbacks.

Drawbacks with larger pipes

While larger-diameter pipes can provide benefits, they are not always the ideal choice for a job. It's important to consider the cost-benefit analysis of those issues against:

1. Flexibility – Larger pipes do not bend as easily or as tightly as smaller pipes, which can create significant challenges in tight pipe spacing situations and also slow down installation time.

2. Thin overpour requirements – Most thermal mass installers want to see at least 3/4-in coverage of thermal mass above the top of the pipes, which can be difficult to achieve with larger pipes.

3. Cost – Simply put, larger pipes cost more than smaller pipes.

Sometimes it's all in the spacing

Typically measured as on-centre (o-c) spacing, tighter pipe spacing means there is more pipe in the floor and, therefore, more fluid transferring the required energy into the heated space. Depending on the application and installation technique, viable pipe spacing can vary between four and 18 inches, although most radiant projects use spacing in the range of six to eight inches in perimeter areas and nine to 12 inches in occupied areas.

So tighter spacing means more pipes in the floor, more fluid in the floor and more contact between pipe and the thermal mass. Therefore, a space can be heated with lower water temperature, potentially increasing the efficiency of the heat source.

Other benefits of tighter pipe spacing include helping to avoid floor striping (i.e., avoiding hot and cold spots), providing faster response time when heating the floor, and protecting sensitive flooring against localized hot spots.

The main drawback to tighter pipe spacing is that more piping material is required, and installation may take slightly longer.

As with pipe diameter, it becomes very important for the radiant designer to weigh all aspects of spacing in relation to the specific project requirements prior to determining the optimal pipe spacing design for the space.

Circuit lengths

Circuit lengths are dependent on selected pipe diameter, because the farther the fluid travels in the pipe, the more heat it gives up. At some point, the fluid has lost so much temperature that it is no longer effective in heating the space.

A larger diameter pipe usually facilitates longer circuit lengths and greater coverage areas. Longer circuit lengths allow the designer to select distribution manifolds with fewer outlets/stations and may reduce the cost of manifold valve actuators if the designer is doing circuit zoning.

TABLE 2 Typical Maximum Circuit Lengths

Nominal PEX Pipe Size	Typical Maximum Circuit Length	Typical Applications
1/4"	Up to 125 ft (39 m)	Used in some dry panel systems and very small rooms like bathrooms
3/8"	Up to 250 ft (76 m)	Used in dry panel systems, joist-space systems, small rooms like bathrooms
1/2"	Up to 300 ft (91 m)	Most common for residential "wet" systems like poured slabs and overpours, and joist-space
5/8"	Up to 400 ft (122 m)	Larger residential and light commercial "wet" poured systems
3/4"	Up to 500 ft (152 m)	Large commercial and industrial "wet" poured systems
1"	Beyond 500 ft (152+ m)	Large commercial and industrial systems where manifold placement may dictate circuit length