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always the
best climate



**Everything you need
to know about Radiant
Heating but didn't dare ask**

Introduction

Radiant heating technology has been around for over one hundred years.

As a mature and proven technology it is in use across many commercial and public building applications worldwide. However, there currently is a misconception that this is a fairly new technology, meaning its merits are not fully understood.

This e-book discusses 10 key factors around radiant heating, debunking some of the myths and misunderstandings to detail why radiant heating can be used to create the perfect indoor climate.





① Energy Saving



Have we heard it all before? Each heating technology claims to be more energy efficient than the other. Independent proof can be produced to validate claims, but it is never easy to collate – with so many factors in play, to ensure a level playing field, and realistically comparable information is difficult.

However, let's think about this logically. Radiant heating ceiling panels operate by only heating rooms as and when they are in use, by heating the objects and occupants within a room by direct radiant heat transfer. This means that the occupant feels warmer than the air temperature, and therefore less energy is used to achieve the same mean temperature.

A 3°C lower air temperature is required, due to less fabric and infiltration losses – surely this sounds more efficient than other methods of heating?

Underfloor heating will provide a consistent temperature across a space environment, but does not take into consideration the use (throughout the day or night) and occupancy levels within a room.

Whilst hugely popular over the last decade (being hidden from view, like radiant ceiling panels), and providing a warm 'touch' temperature, the set temperature is somewhat limited so as to avoid hot and sweaty feet. Does this save energy? It can, but with highly resistant floor coverings, such as certain carpets and wood, the amount of energy that can penetrate is significantly reduced. In addition, underfloor heating isn't considered the most responsive of systems to reach set temperature, or to cool down in a timely nature.

Space heating, through split units or fan coils (air conditioning) naturally heat the air in a space. Effectiveness is influenced by the size of the room and number of units installed, but space heating can prove inefficient and costly – depending on which areas of the room are heated, the air that's being heated (determined by factors including the fabric of the building).

Not convinced? Read on further.

② Radiant Panels – aren't they just radiators in disguise?



Aren't radiant panels the same as radiators, just that one is typically found on a wall surface the other in the ceiling?

Well, no. Radiant panels should not be confused with radiators, which are primarily convectors. Radiators generally distribute 80% of their output via convection (heat that is carried from a warmer to a cooler body by an intermediate fluid such as air) and only 20% via radiant heating (heating objects or people as just mentioned).

If you took a radiator, removed the convectors from the back, insulated it and installed it in a ceiling, you would be converting it into a radiant panel, and the output ratios would change to 70% radiant heat and 30% convection.

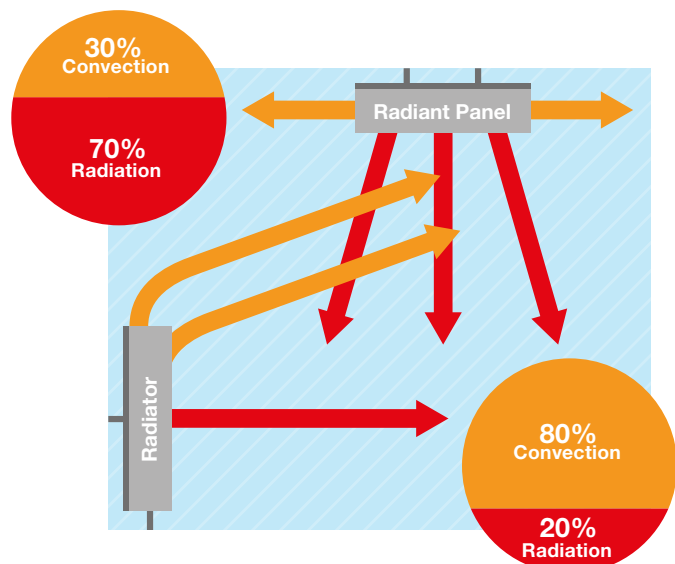
Putting these figures in context, for a radiator to heat a room on a cold winter's day, it must first warm itself and then the air around it. This air, which will be warmer than the surrounding air, will rise due to buoyancy, until the room is at a homogeneous temperature and the desired comfort level is achieved. By standing close to the radiator, we can take comfort from the 30% radiant heat available once the panel has reached its operational temperature.

So radiant panels transfer heat to all objects that are 'seen' by the panel(s) (and through re-reflection) that are at a lower temperature than the panel itself. This is similar in manner to how lighting operates!

RADIANT HEATING EXPLAINED +

Try to think of it like the sun on a clear day in winter. The air temperature may be cold but when the sun shines on you, you feel warmth even though the air temperature hasn't changed.

It's like the sun needs to be in the line of sight so that you feel its direct warmth, radiant panels also need to be in line of sight to the objects in a room for it to be fully effective.

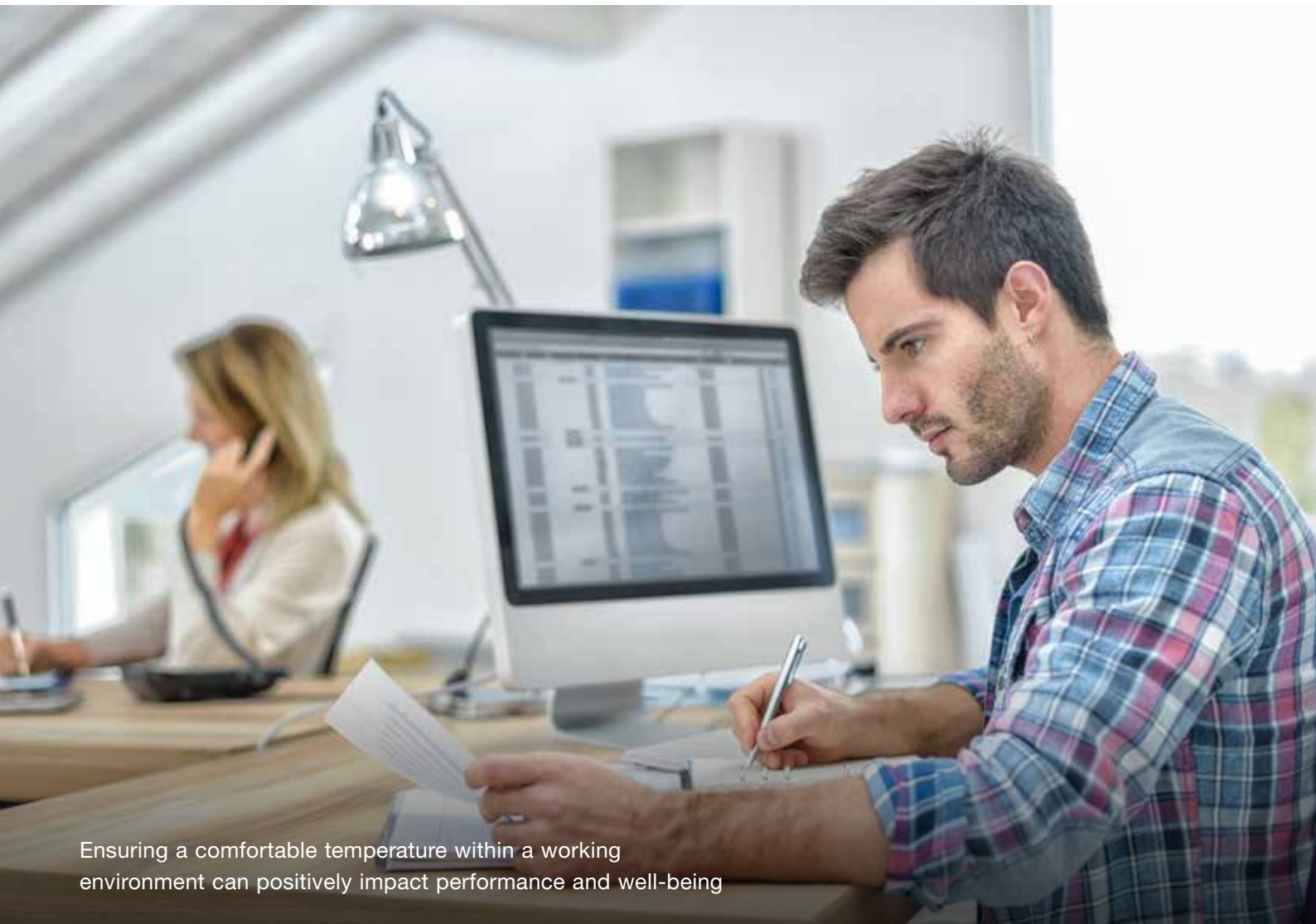


③ The importance of mean radiant temperature and how radiant heating helps...

Mean radiant temperature = Average of all temperatures of all surfaces and people in a room

It's all about comfort control and ensuring that people within a room feel comfortable. The effectiveness of radiant heating can be measured by the mean radiant temperature (MRT) of the space; simply the average of all temperatures of all surfaces and people in a room. Air temperatures matter less in this equation (see example, Page 7). So, heating systems involving radiant are expected to be more efficient than those that heat or cool air, with quicker response times and lower system inertia.

For example if a room temperature was 18°C, with radiant heating panels you typically feel as if it was 21°C. This makes radiant panels more efficient.



Ensuring a comfortable temperature within a working environment can positively impact performance and well-being

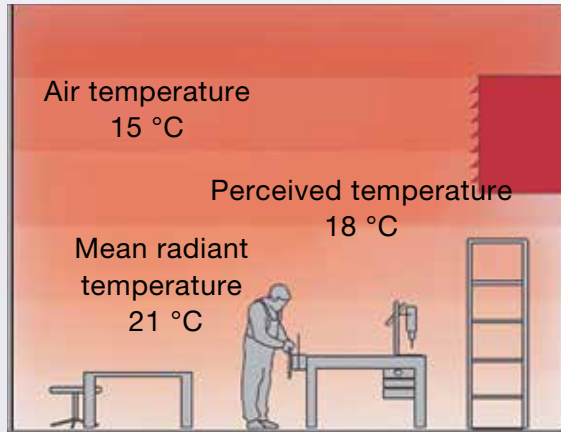
The same comfort conditions are achieved with a lower air temperature, by utilising radiant panels

When heating with radiant ceiling panels, the room air temperature is lower than with a conventional air heating system, but the perceived temperature is the same.

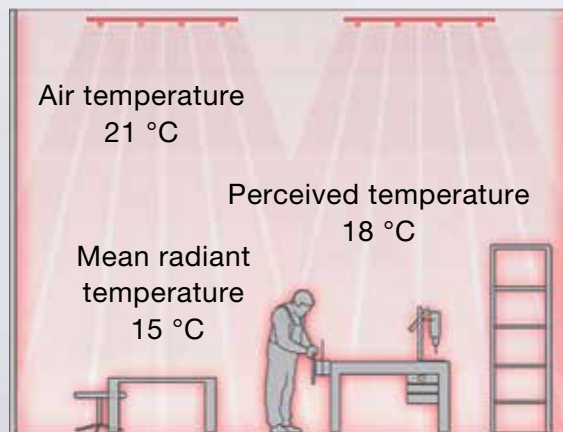
The result: The smaller difference between the temperature of the indoor and outdoor air means lower heat losses. (Fig. 1)

Fig. 1: Air temperature and perceived temperature

Fig. 2: Potential savings with radiant ceiling panel heating compared with conventional air heating system with the same perceived temperature.



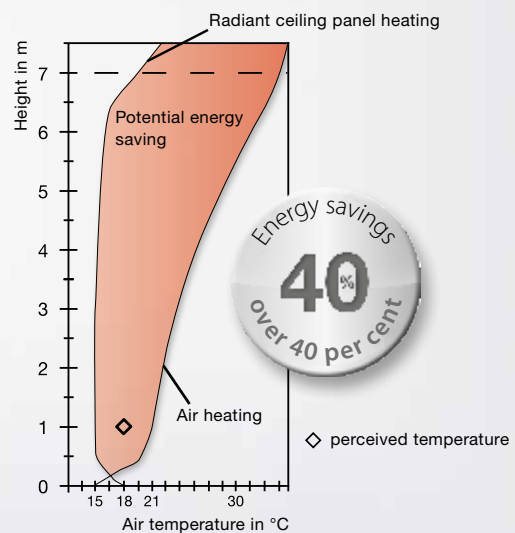
With air heating systems (fig. 1)



With radiant ceiling panels (fig. 2)

Heat distribution up to the height of a building

When using radiant ceiling panels, radiant heat acts upon the objects it meets (the floor), rather than the effect of hot air rising as in the case of air heating systems, for example. This results in an even temperature distribution over the entire height of the room, and thus a considerably lower energy consumption. (Fig. 2)



④ How radiant heating keeps people comfortable.

One of the key advantages of radiant ceiling panels is that when a system is designed, panels can be positioned to ensure that occupants will benefit from the heat produced, directing the heat to the interior of the space and to reduce or eliminate excessive temperatures on outer walls and ceilings.

Rooms heated by convection heaters lose heat as soon as they are switched off because they only heat the air, not the objects which in turn heat the air. Draughts and natural convection currents make it difficult to control warm air movement within a building.

The responsiveness of radiant panels, their ability to meet a change in heating load efficiently, through distributing heat where needed should be a pre-requisite for today's heating systems. Some radiant floor heating is slow to respond, taking a significant amount of time to meet heat requirement and with lack of consideration of occupancy of a room.

Moreover, conventional (air) heating systems allow distributed heat to collect in areas where it is more likely to escape – along ceilings and walls - so achieving a comfortable temperature can prove difficult.

The possibility of 'shadowing effects' is sometimes questioned with regards to radiant ceiling panels. For example, human legs hidden from view under a table might potentially experience cold. However, the impact of this is negligible. Heated surfaces radiate heat to unheated surfaces, to achieve uniform distribution of heat.

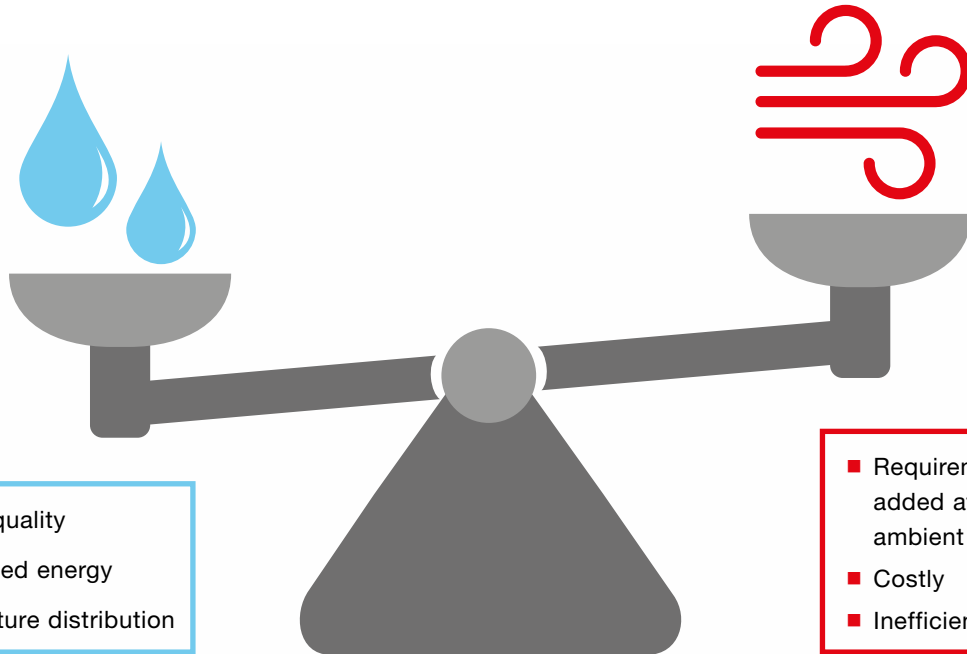
Radiant ceiling panels cannot really be compared with radiant floor heating, because the panels are so much more effective. With floor heating, objects that are placed on the floor such as cabinets and rugs are likely to affect temperature distribution.



Key Advantages:

- Effective design will ensure distribution of heat where required.
- Responsive to changing temperature requirements.
- Heat distributed when and where required – minimal waste.
- Panels can be positioned to ensure that occupants will benefit from the heat produced.

⑤ Water. We all need it. But is it better than air at transporting heat?



- Improved air quality
- Reduces wasted energy
- Even temperature distribution

- Requirement for air to be added at 10-15°C above ambient temperature
- Costly
- Inefficient

Many factors contribute to being able to effectively heat a building: its size, how well insulated it is, and the climate of the building's location can all significantly impact heat efficiency, in addition to the heating system adopted.

Let's look at energy consumption. As a general rule, you can save around 5% of your energy consumption for every 1°C decrease in indoor temperature. To heat and ventilate a large building can prove to be a challenge and air convective systems can cause various problems with uneven temperatures, draughts and wasted energy.

When using warm air to heat a space, you would normally add air at a temperature of 10-15°C above the ambient temperature, which is both inefficient and costly, as heating air can be as much as 25% greater than heating hydronically – because water is a better medium to transport heat.

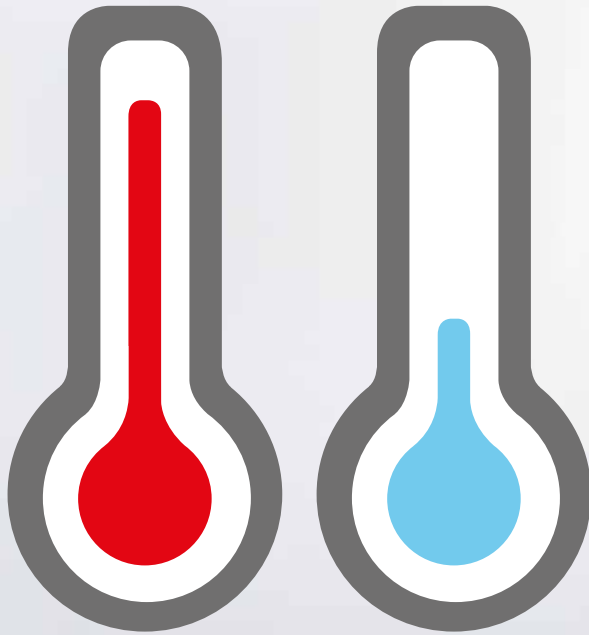
Radiant heating will also provide an even temperature, with minimal differences between air temperatures near the ceiling or temperatures in the occupied zone.

'Better' shouldn't just concern itself with energy and cost implications. Air quality is also considerably improved with radiant heating, as dust and other air pollutants such as mould, fungi, bacterium and viruses are not circulated by the constant air movement associated with conventional convection systems.

You can
save around
5%
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indoor temperature

⑥ Heating and Cooling. The ideal compromise.



Cooling is becoming more of an issue as buildings become better insulated and more airtight, in addition to experiencing heat gains from their geographical location, for example in densely populated environments.

The versatility of radiant panels enables them to provide both heating and cooling simultaneously. This continues to deliver the benefits that we have already seen for radiant heating: responsiveness to comfort requirements and effective distribution of temperature requirements to objects in a room. Simultaneous heating and cooling from radiant panels is also more cost effective, through the lower need for maintenance or servicing than that of air conditioning units that are utilised for both heating and cooling purposes.

If a cooling function is a requirement, separate controls and dew point sensors will be required and pipework design will need to be based on the cooling requirements at building design stage.

As well as being versatile, radiant heating and cooling panels are adaptable for use with alternative energy sources, such as solar panels and heat pumps.

Benefits:

- Provide heating and cooling simultaneously.
- Responsiveness to comfort requirements.
- Cost effective in operation.
- Low maintenance.
- Adaptable for use with alternative energy sources.



A building experiencing solar heat gains



Insulation can increase the temperature within a building

How does cooling work?

People and objects within a room, due to their higher temperature, give off heat by radiation which is absorbed directly by the chilled ceiling.

Simultaneously, warm air within the room also rises up to and along the ceiling, where it gives off its heat to the cooling ceiling. The cool air falls back into the room. Typically radiant ceilings in cooling absorb heat for 60% by radiation and the remaining 40% by natural convection. The combination of these two effects significantly increase the performance of a radiant ceiling compared to radiant floor.



⑦ How low or high can you go with radiant panels? And what is their impact on heat dispersion?

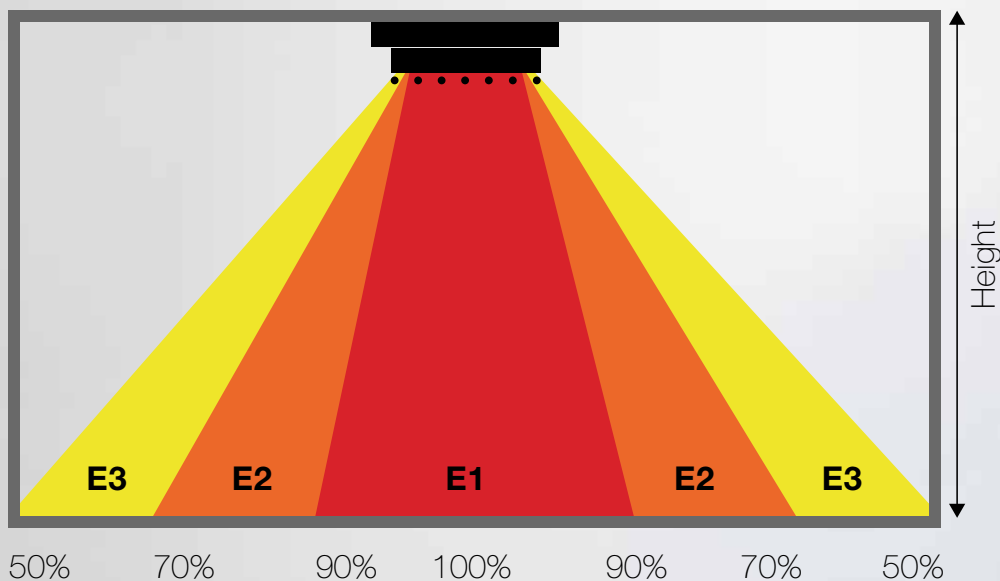
This is always a discussion point with industry professionals; how high? 10 metres, 20 metres? Or more? In fact, radiant panels can comfortably be installed at heights of 30 metres, whilst still providing a pleasant and comfortable heat on the ground. How is this achieved effectively?

Well, not needing to heat up the air helps! The panels provides a high proportion of radiant heat and low proportion of convective heat, which makes it possible to heat large spaces with high ceiling heights without unnecessary heat losses through only releasing energy when it comes into contact with a surface. A seldom recognised advantage with radiant panels is the warm floor it provides; often 2-3° C warmer than the surrounding air.

Radiant energy will heat the surfaces of all objects which are in direct line of sight from the panel; that means all walls, floors, ceilings, chairs, tables, or people in line of sight to the radiant panel. Therefore, a heated ceiling will raise the surface temperature of floors and walls, while heated floors will raise the temperature of ceilings and walls. Air coming in contact with these surfaces is also gently heated.

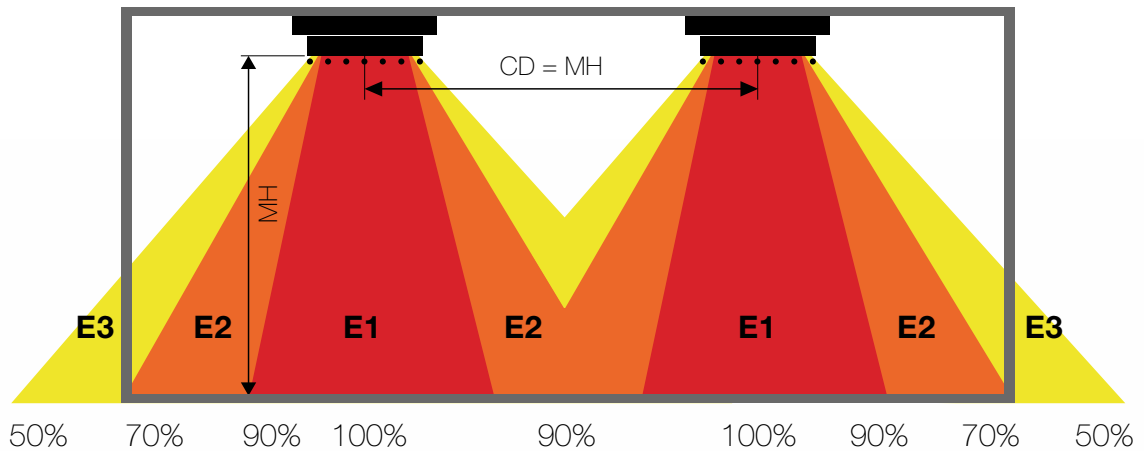
The larger the output area, the greater the heat-load requirement. For installations up to 10m, there is no need to increase the panel output as radiant heat passes through the air without any loss.

Radiant Action Field



Within the radiant field itself, there are also varying levels of intensity. The diagram above shows that the area directly under the centre of the panel (E1) receives an output level of 90-100%, while the outer edge (E3) is 50% of the intensity of E1. These calculations are important when positioning panels in specific buildings.

Design Optimisation



When using more than one panel within a room, it is good practice to provide an even spread and an overlap of intensity above head height.

When installing radiant panels within rooms with low ceilings, careful design is required to avoid uncomfortable extremes of temperature. One large output panel will create areas of high temperatures and an uneven distribution of heat. A lighting engineer would not light a small room with a low

ceiling with a few, high output lights. Rather, they would use many small intensity lights spread evenly around the room to achieve a constant lux value. We should consider radiant heating in the same way. The lower the intensity and the more even the distribution, the better the resulting environment will be.



Installing radiant panels: Basic rules.

- The center distance (CD) of the panels should be equal to their mounting height (MH), so width of space divided by $MH + 1 = \text{number of panels}$.
- As the mounting height is increased, the intensity of the heat is reduced and the output is spread over a greater area.
- Radiant panels can be installed at even lower heights than 3m, through utilising a lower water temperature.

⑧ Space – the final frontier. It's always at a premium.



Whether in a domestic or commercial environment, space is always an issue and it's important to make best use of it.

Radiant panels, by being installed within the fabric of the ceiling, are unobtrusive and allow for making best use of available floor space. In addition, as it can form part of the ceiling structure, unlike radiant floor heating, there is no need to raise the floor to lay modules meaning less excavation and routing. Installing air ducts often involves considerable planning. If appropriate, it is also more cost effective to lower a ceiling if free- hanging sails are preferred.

One product: 4 functions! As radiant panels require only a short space under the structural ceiling, they are even ideal for properties with low room heights.

With lower ceilings, low water temperatures can be used to provide a comfortable temperature.

⑨ A comfortable environment – without the stress!

Most radiant heating panels are hidden away into the ceiling. If you didn't know what they looked like, you wouldn't notice they were there. Being passive, radiant panels are silent in operation, providing a good working environment, with the only noise coming from the boiler which is usually located in a plant room.

Air quality is gaining greater importance within the domestic and commercial environments. Radiant heating does not 'suffer' the same issues as air conditioning units as air is not constantly circulated, preventing spread of air pollutants.

The combination of these benefits - where radiant panels are situated, and their reduction of air pollutants – additionally helps reduce maintenance costs to a bare minimum, as the panels will not suffer the wear and tear that could be expected from activities in high traffic areas. They can be cleaned easily if needed, merely by wiping the surfaces. Other heating systems involve more costly and time consuming processes.

A black bulb sensor is used for radiant heat to calculate comfort temperature in indoor spaces. A simple wall thermostat is generally all that is required to control temperature. Operating behind the scenes, a weather sensitive control may be used to adjust the panel temperature, based on outside temperatures.

A big advantage is the option of a thermostat in every room. This provides additional comfort as well as energy savings, because the temperature can be turned down in rooms that are not in use or where occupants prefer to be cooler – thus providing effective zone control. Energy savings will be achieved, based on a typical room temperature being set, as a lower air temperature is necessitated, through the radiant transfer temperature compensating for this.



Panels hidden
from view



Silent in operation



Better
air quality



Easy to maintain /
clean

⑩ Radiant heating applications

There are a host of radiant heating (and cooling) options available, from different styles and sizes to designs (acoustics) and the incorporation of additional services (such as lighting). There is usually an appropriate configuration, whatever the building's size or purpose.

Cooling requirements notwithstanding, the main consideration will be whether to have radiant panels incorporated within the fabric of the ceiling or be free-hanging. Each has its own advantages and choice may be influenced by the fabric of the building and whether a new build or refurbishment project.





ADDITIONAL SERVICES:



Lighting



Fire alarms



Acoustics



Sprinkler Heads



Speakers

For more information about radiant heating and cooling solutions from Zehnder please contact us: sales.international@zehndergroup.com

