

# Cooling Effects & Chilled Beams

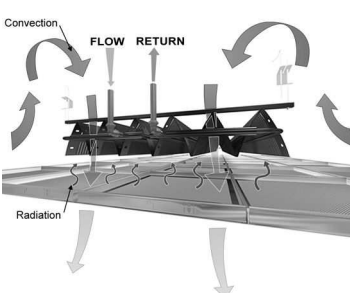
## Thermal Comfort Principles

How we experience the thermal indoor climate depends primarily on our overall heat exchange with the surroundings. A person's thermal comfort is affected by the following: Air temperature, radiant temperature, relative humidity, air velocity, activity and clothing.

Thermal comfort is realised when a person feels in thermal balance, ie. they are neither too hot nor too cold. In addition, there should be no unwanted heating or cooling of individual exposed body areas (draughts in the neck or on the ankles). We primarily exchange heat to our surroundings via convection and radiation.


These two methods of transferring heat are approximately equal with normal air movement in a room. Therefore, we are affected just as much by the room's surface temperatures as we are by the air temperature.

If the temperature of the room's surface is decreased, fully or in part, the air temperature can be increased by an amount corresponding to the decrease in the room surface's mean temperature. Therefore, when we cool an environment with a radiant cooling device, the desired operative temperature can be raised slightly as a result of a perceived lower room temperature. This effect is in the region of 1-2°C.



**Frenger Passive Beam Features**

- 35% Radiant Effect / 65% Convective
- Passive System
- Can be concealed behind micro perforated ceiling systems.
- Requires minimal control
- 75W/m<sup>2</sup> - 140W/m<sup>2</sup> cooling capacity



**Frenger Active Beam Features**

- Fresh air introduced via unit
- Room air induced through cooling batteries
- High Capacity - up to 1500W/linear metre cooling capacity
- Can integrate lighting heating, sprinkler outlet and data cables
- Architectural Casing Options

## Running Cost / Energy Use - Chilled Beams

There are several aspects of an active chilled beam system that promotes a more energy efficient operation than air based systems such as fan coil units and VAV. Typically the chilled water is distributed to the chilled beams at 14-17°C to minimise the risk of condensation, whereas fan coil units operate typically at 6-12°C.

Elevated chilled water temperatures offer two principal benefits in terms of energy efficiency:

- By operating the chiller plant at elevated temperatures its co-efficient of performance (COP) is increased & energy consumption reduced. The efficiency of the compressor can be increased by using a dry cooling system (inlet water 14°C instead of 7°C) with a percentage increase in COP of typically 22%.
- Elevated temperatures enable a significant increase in the opportunity to avail free cooling from sources such as outdoor air or ground water heat sinks. That is an annual increase from 800 hours to 2000 hours for a 12 hour day and 2100 to 5200 hours for 24 hour operation.

Fan coil unit and VAV systems rely on a fan assisted cooling distribution; that is each fan coil unit incorporates a fan. Chilled beam systems utilise a centralised fan that delivers just enough air to meet respiratory requirements (or a little more in the case of some active chilled beam systems); with a consequent reduction in capital cost, electricity consumption and maintenance cost.

To deliver 100 W/m<sup>2</sup> cooling:

|   | Fan Coil Unit       | Passive Chilled Beam | Active Chilled Beam  | VAV System (12°C) | Displacement System (18°C Supply Air) |
|---|---------------------|----------------------|----------------------|-------------------|---------------------------------------|
| <b>Approx Air Volume Required (l/s/m<sup>2</sup>)</b> | 1.2 (Min Fresh Air) | 1.2 (Min Fresh Air)  | 1.22 (Min Fresh Air) | 8                 | 14                                    |

## Maintenance Costs - Chilled Beams Vs. Fan Coil Units

There are no moving parts in chilled beams and therefore maintenance requirements are very low. An active chilled beam will require the cleaning of the batteries - using a vacuum cleaner and brush attachment - at intervals of 3-4 years by simply wiping the surfaces with a damp cloth. The chilled beam itself requires no further maintenance and can be expected to last the life of the building; however water quality must be appropriate and associated control valves and flexible hoses will require frequent inspection/replacement.

The maintenance and replacement cost illustrated below is taken from REHVA's Chilled Beam Application Guidebook issued 2005:

| Fan Coil in 300 Rooms, 20 Year Life Cycle:              |  | Cost (€ Euros)  |
|---|--|-----------------|
| Filter Change   | 25 Euros / Filter Twice a Year                 | 300,000         |
|   | 15 Min to Replace @ 20 Euros/Hour              | 60,000          |
| Cleaning of Condensation System                         | 3 Times / Year @ 15 Mins                       | 90,000          |
| Motor Replacement                                       | 200 Euros / Motor                              | 60,000          |
|   | 2 Hours Work @ 20 Euros / Hour                 | 12,000          |
| Fan Coil Replacement                                    | 1000 Euros / Unit                              | 150,000         |
| <b>TOTAL</b>  |  | <b>672,000</b>  |
| Chilled Beam in 300 Rooms, 20 Year Life Cycle:          |  | Cost (€ Euros)  |
| Cleaning of Chilled Beams                               | Once Every 5 Years / 15 Mins @ 20 Euros / Hour | 6,000           |
| <b>TOTAL</b>  |  | <b>6,000</b>    |
| <b>Difference in Maintenance &amp; Replacement Cost</b> |  | <b>€666,000</b> |