

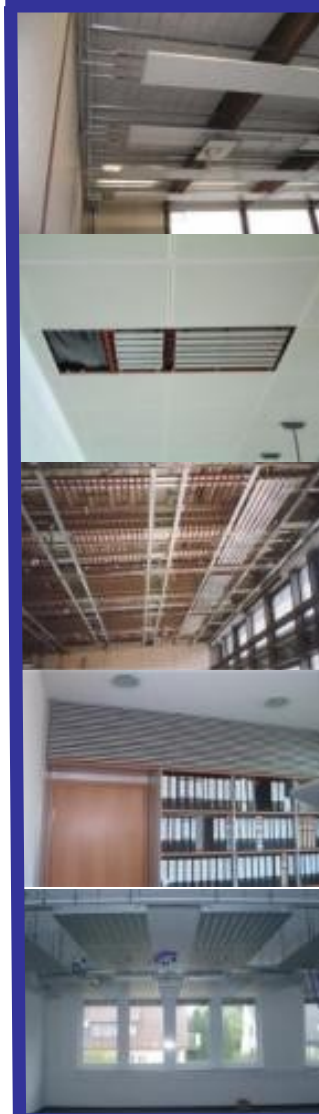


FRENGER  
SYSTEMEN BV



# RADIANT HEATING AND COOLING SYSTEMS

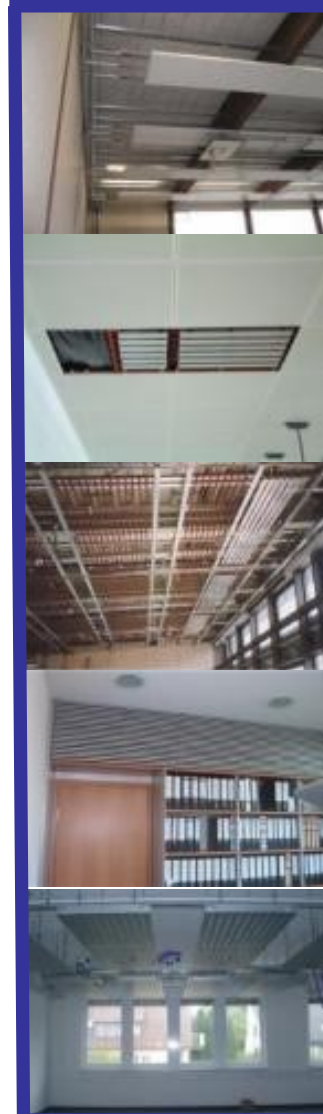
Produced by  
FRENGER SYSTEMEN BV



# Basics: Impact factors on Energy efficiency

- Choosing the right heat transfer system determines the comfort and energy saving in buildings
- Energy savings up to 50% are possible and have been confirmed
- Impact factors:
  1. Temperature sensation of human beings
  2. Heat transmission via height of the room
  3. Reaction time and ability of controlling
  4. system temperatures

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# Basics: How radiant heating works

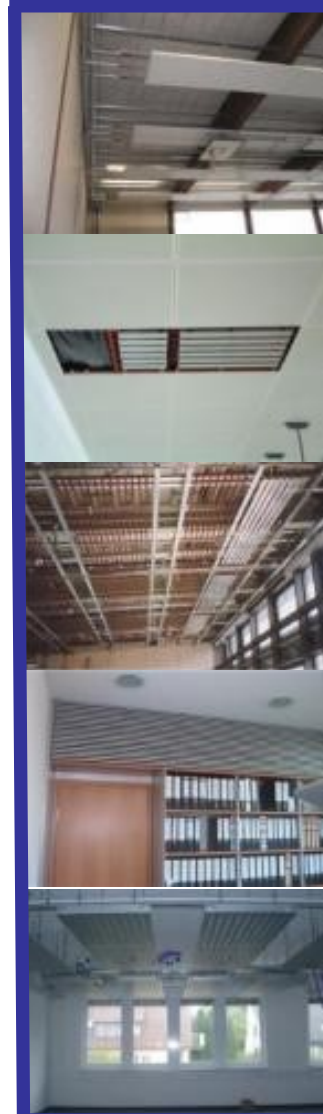
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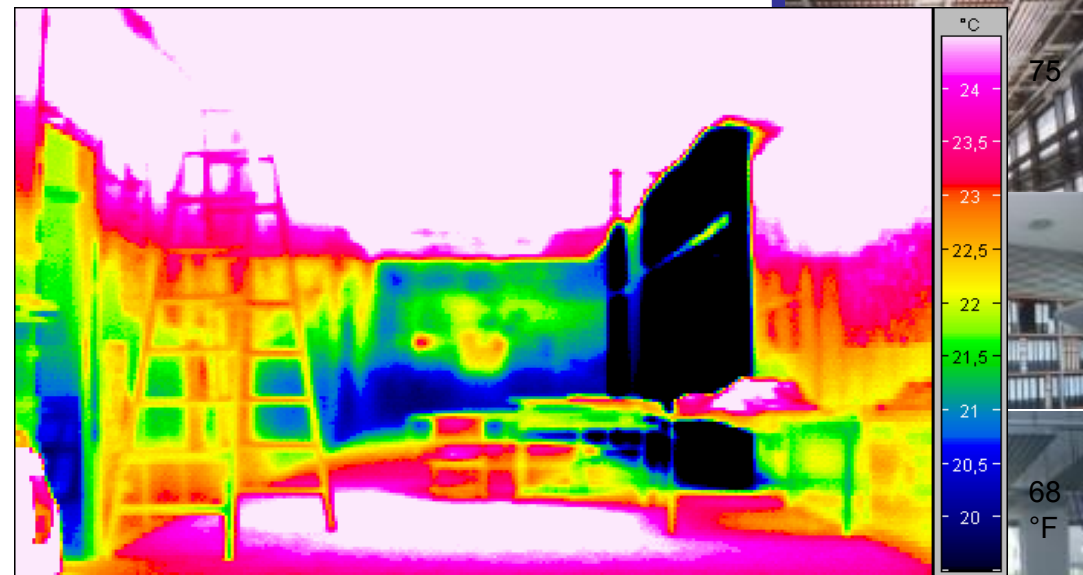
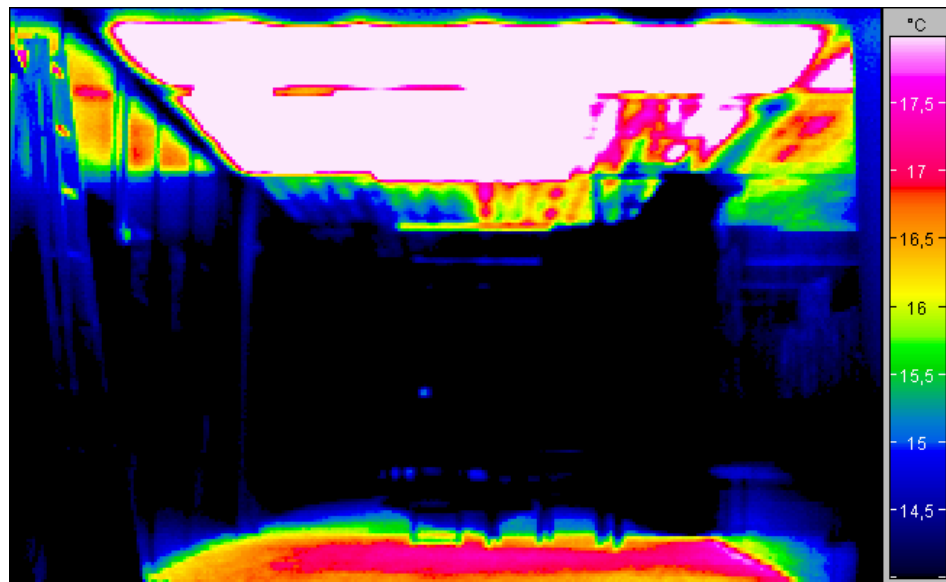
**The principle of the radiation heating system can be explained with sunbathing on a glacier.**

**The temperature there is mostly below zero but in the sun it's comfortably warm. This is because of the radiant heat (infrared radiation) of the sun**

**When the radiation touches the surface of any solid object, the warmth of the object re-radiates back the heat and warms the surrounding space.**



# Basics – working principle

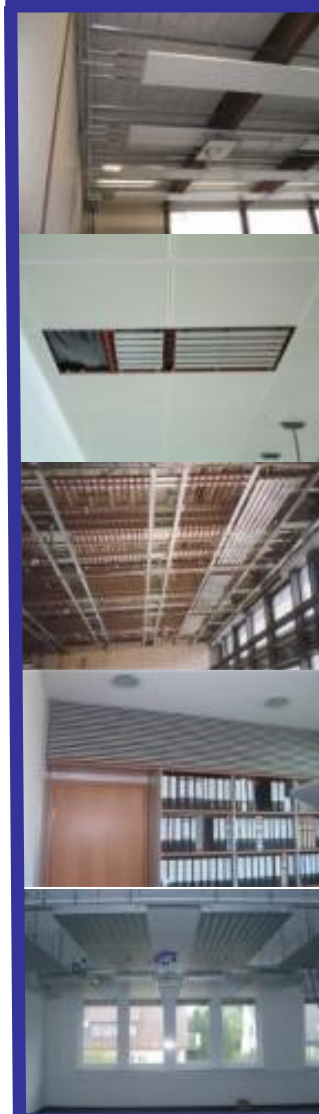


Thermographical images of warming-up-procedure of heated ceiling and room after 15 and 40 min

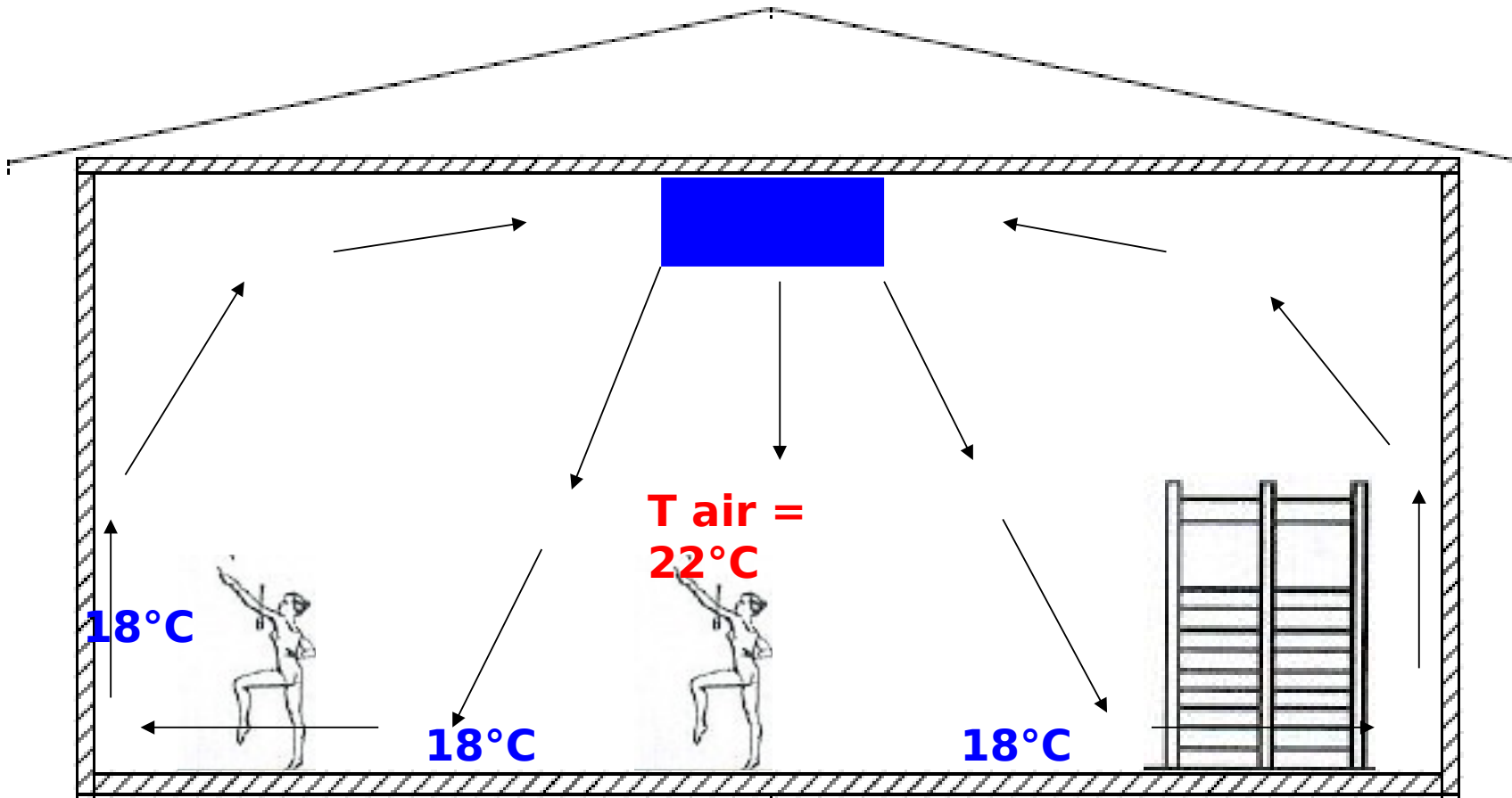
# Basics:

Why is radiation heat so comfortable?

- No air circulating
- The air itself will not be warmed (doesn't dry out the air)
- Walls, floors and ceilings will be warmed up and the user loses less energy

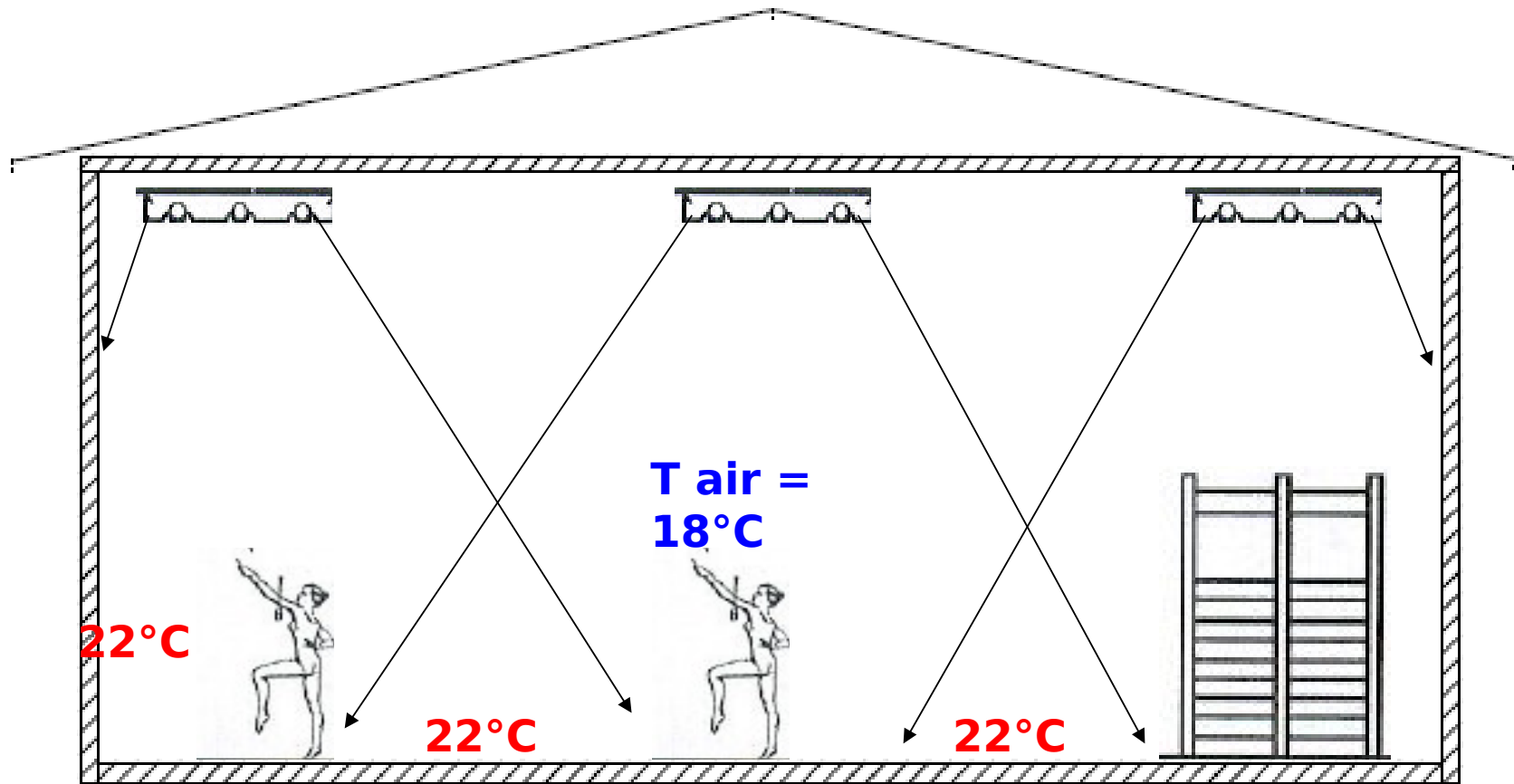


# Basics: Air heating



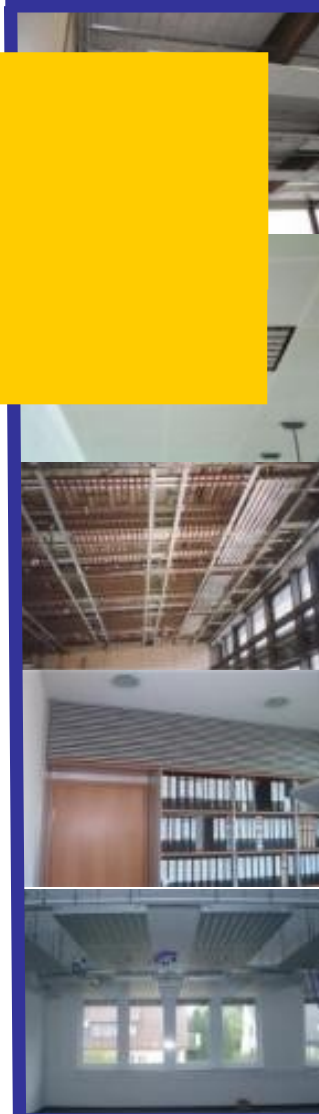
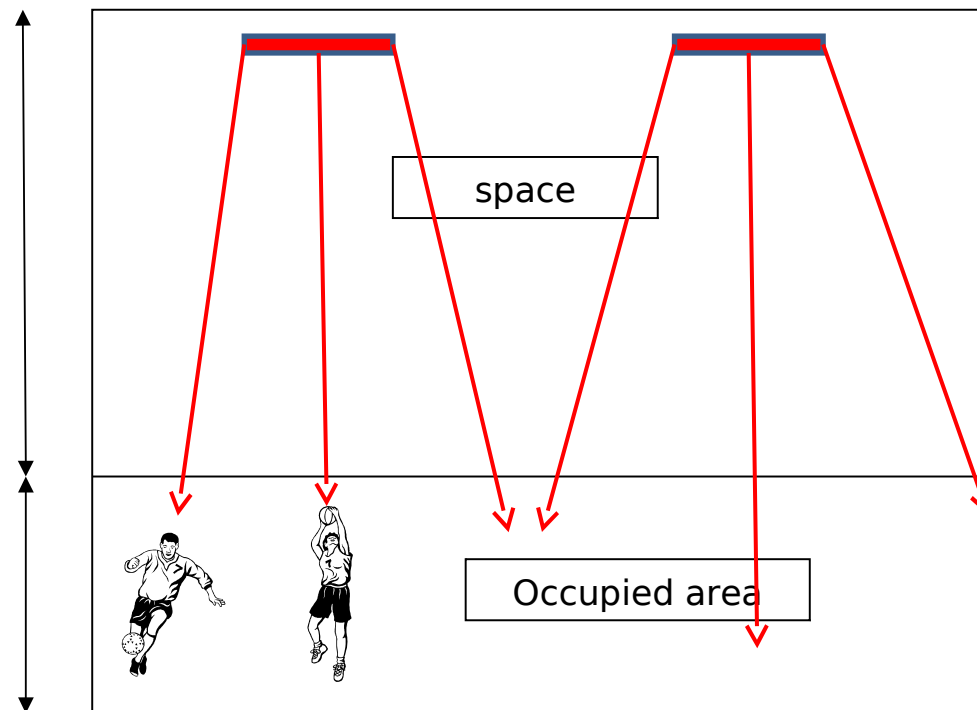
# Basics: Radiation heating system

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# Basics - working principle

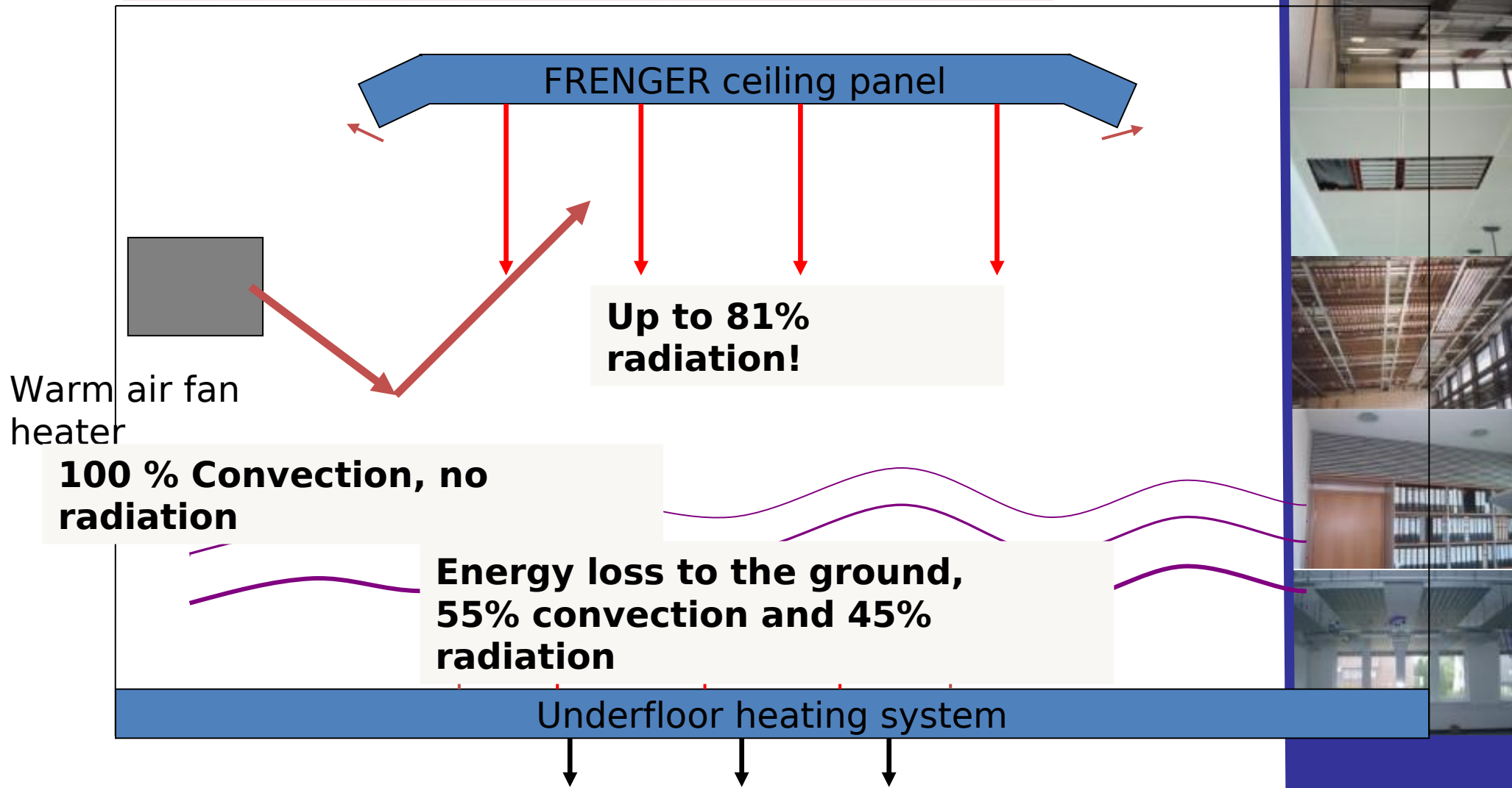
Where is heat required?  
In the occupied area of a room!  
Radiant heat is reaching down!





# Basics - working principle

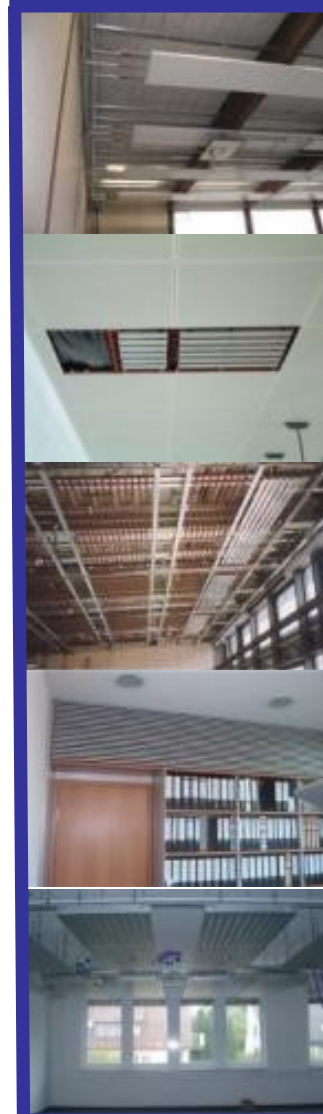
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# Energy principle of FRENGER SYSTEMEN BV



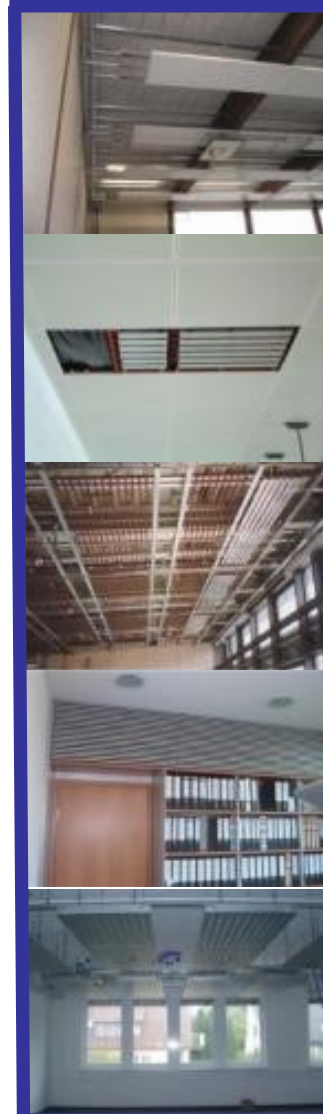
- › Our ceiling systems based on heat radiation principle
- › Tubes with water circulation for heating and cooling are behind many different ceiling types like metal ceilings, gypsum ceilings, aluminium stripes, expanded metal or integrated in acoustic ceilings
- › The heating systems will be driven by energy saving low temperature oil or gas heating systems or by solar energy



# Basics



- Radiant heat is reaching down!
- that means that it radiates from top to bottom and heats any solid object (people, furniture, floor)
- For the cooling the ceiling panels (water tubes behind) will take the surplus heat and transfer it to the water which is circulating in the tubes and cools them down
- **ADVANTAGE:** All systems can be used for heating and cooling!



# Products



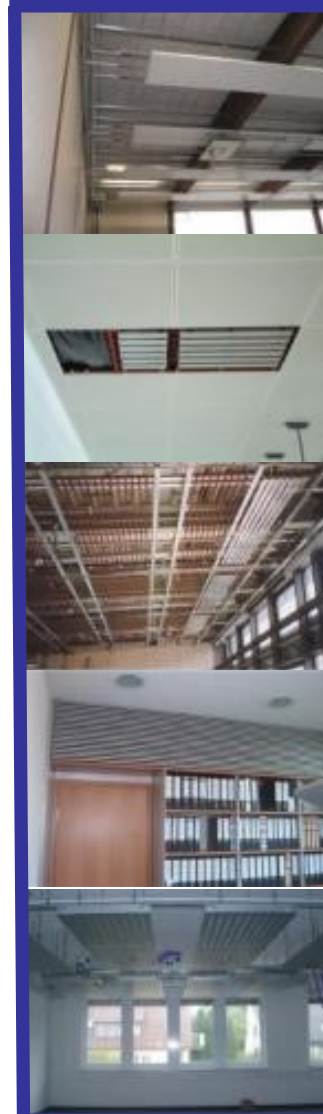
## 2 different types of ceiling systems:

### 1. Overall radiation systems

it means the whole area is covered with ceiling panels:

metal, aluminium, acoustic ceilings and gypsum board ceilings

Can be installed in schools, office buildings, swimming pools, supermarkets, show rooms, **HOSPITALS**

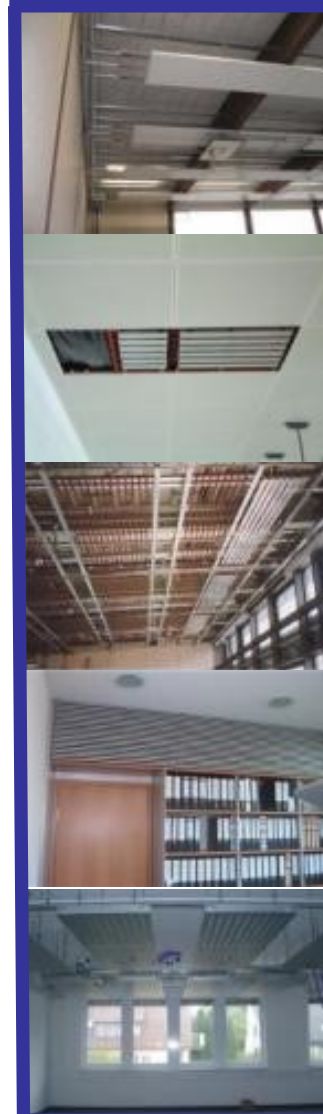


# Products



## Active metal ceilings:

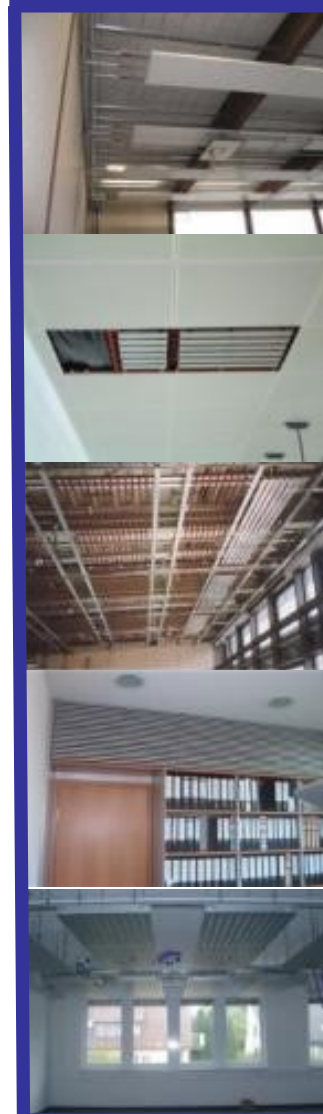
- Metal ceilings made from steel and/or aluminium in combination with a clever suspension system.
- Own light fittings are available in different variations which are fitting in the systems
- No acoustic fleece is needed because the mineral wool which lays on the top absorbs the sound.
- Also oversized metal ceilings are no problem because of the special patented magnet technic.



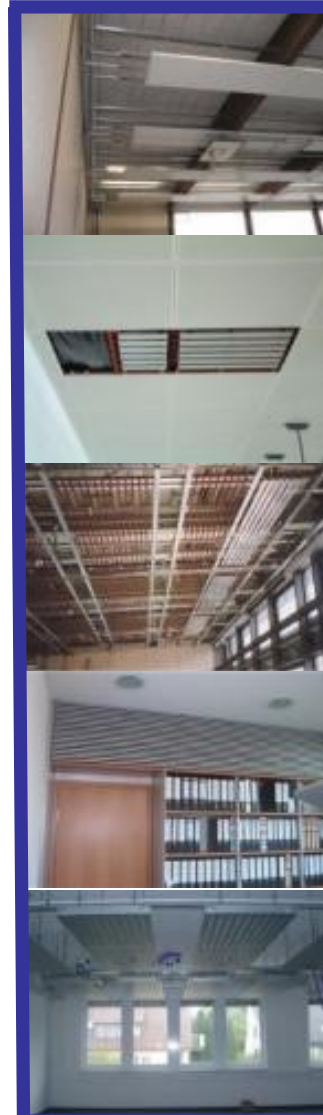
# Active metal ceilings

## Technical datas:

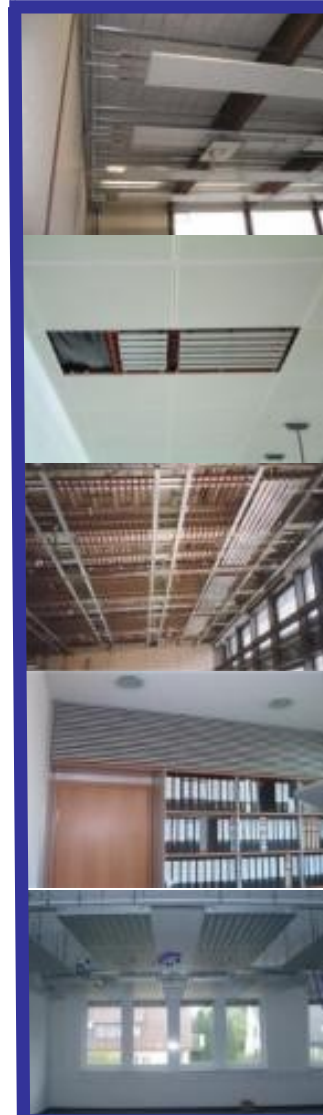
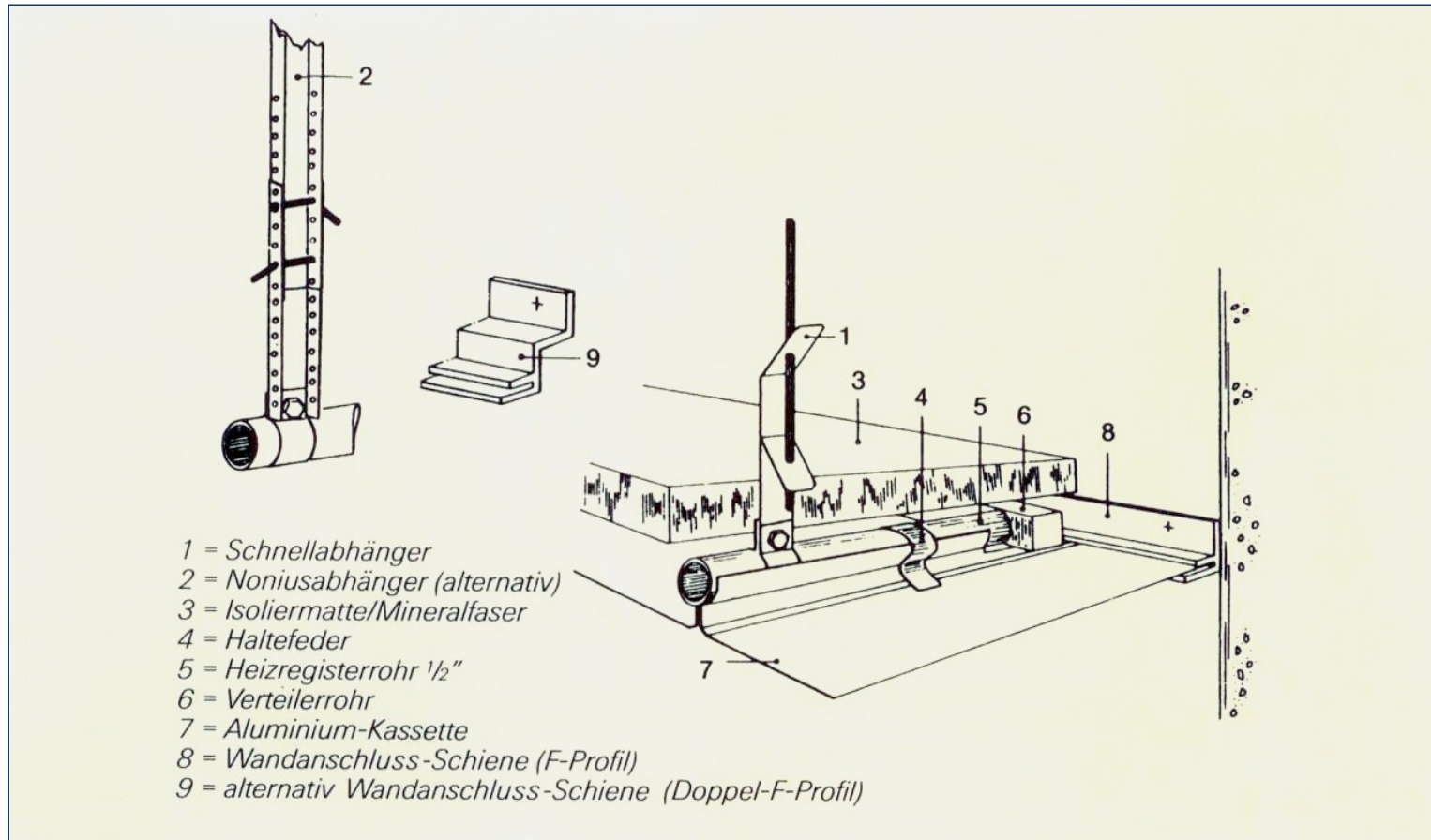
- Suspension with Nonius or suspension hanger
- Heating tubes: steel tubes mit special anti-rost protection
- Material: 0,7 mm thick aluminium
- Sizes: width: from 180 mm, length: from 200 till 3000 mm or standard sizes: 600x600 mm and 600x300 mm
- Perforated or unperforated
- Weight: 8 kg/m<sup>2</sup> including the water for metal panels, 5,5 kg/m<sup>2</sup> for 600x600 mm



# Active metal ceilings



# Active metal ceilings





# Products

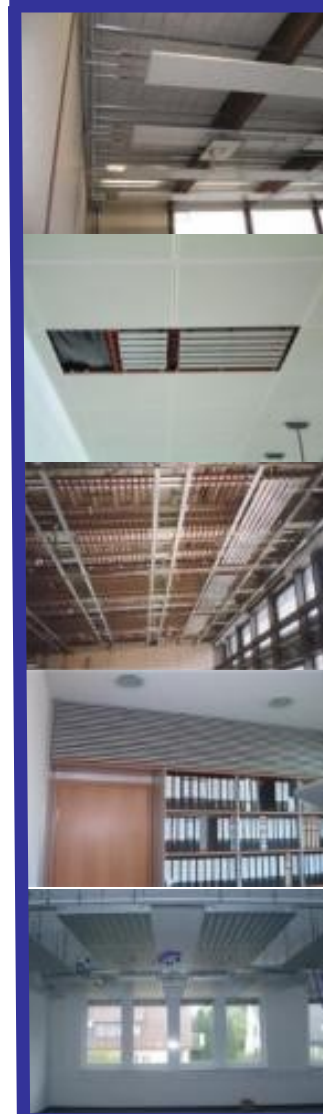
## Active canopies:

Heating and cooling canopies from FRENGER SYSTEMEN BV gives you a lot of advantages:

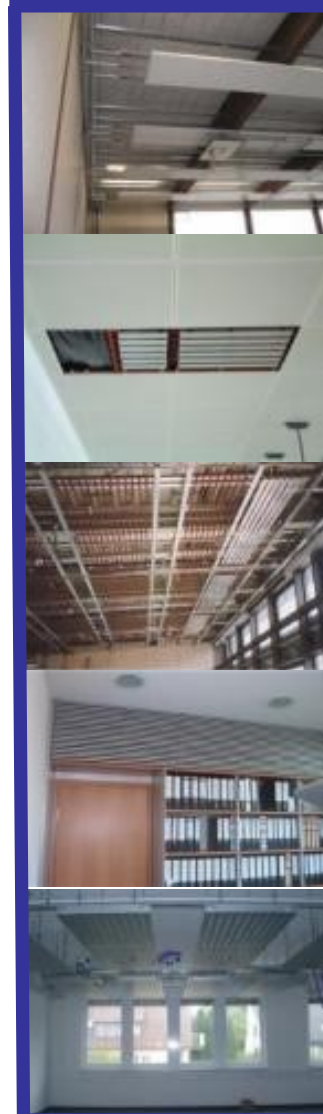
- High heating and cooling power
- Excellent sound absorption
- Free access to the ceiling soffit
- Swing down of the whole canopies including the water tubes
- Installation of light fittings and air outlets
- Oversize panels without joints are possible

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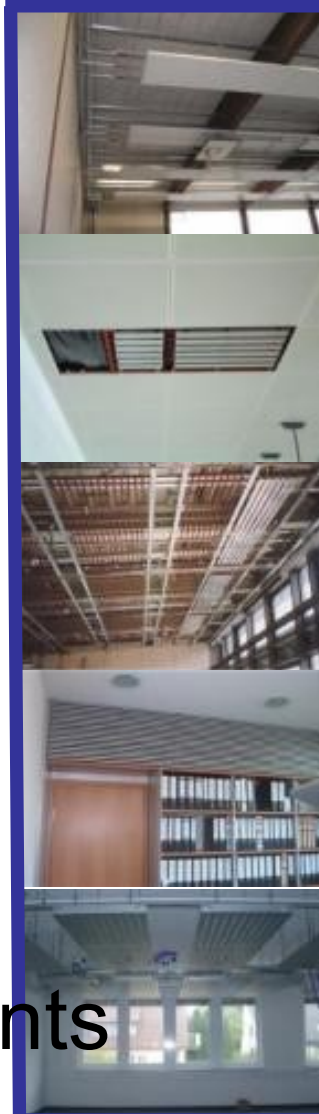


# Active canopies



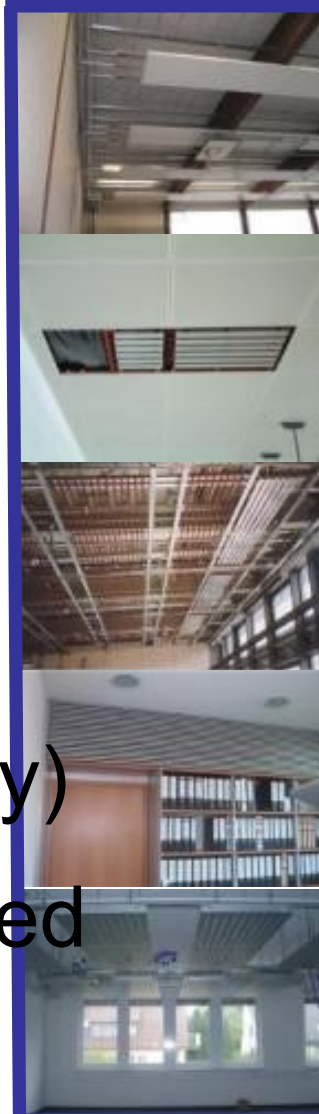
# • HKE-EL

- Technical data:
- Lightweight aluminium radiant ceiling panels, 1,0 mm thick
- Copper tuber 15x0,75 mm pressed in thermal conductive extruded profiles
- Manifolds 28x1,5 mm
- Clip-in stiffeners from steel which can be changed on site to have variable fixing points



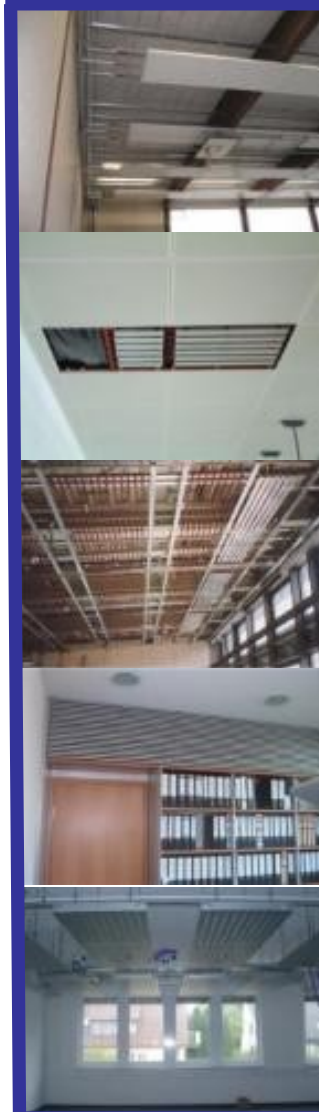
# •HKE-EL

- Also available with 70 degrees upstand for integration in suspended ceilings
- Variable lengths up to 300 cm
- Nearly jointless connections for stripes
- Connections made with patented sliding sleeve (no pressing and welding necessary)
- No additional cover plates or screws needed



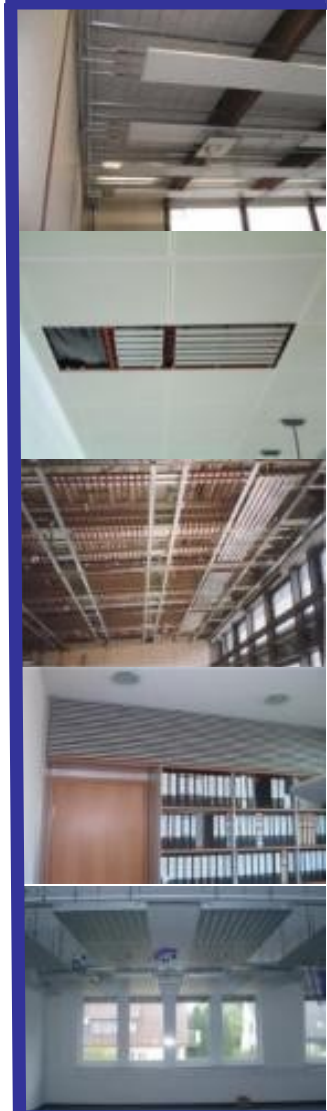
# • HKE-EL

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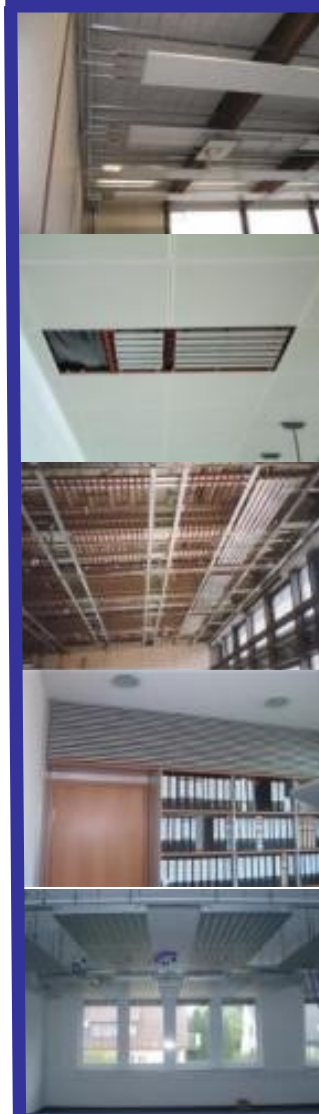
# • HKE-EL

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# • HKE-EL

FRENGER  
SYSTEMEN BV



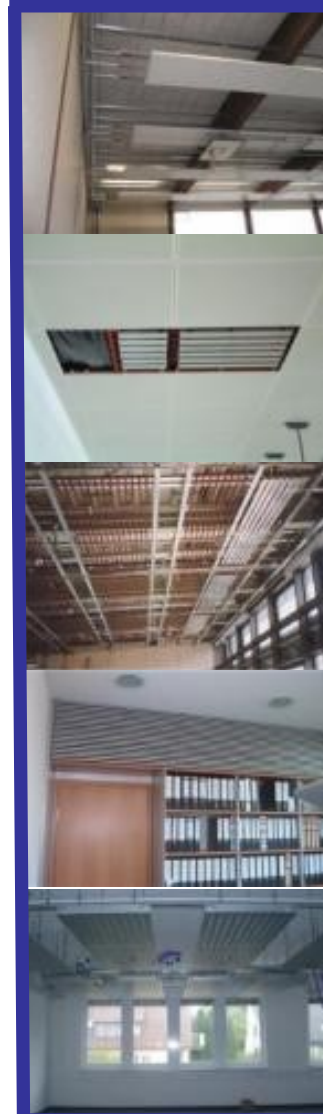
# Gypsum boards for cooling and heating

The jointless ceiling as invisible air condition

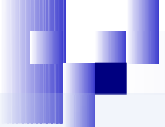
The function as an active cooling and heating system is hidden behind the gypsum ceiling.

## Technical datas:

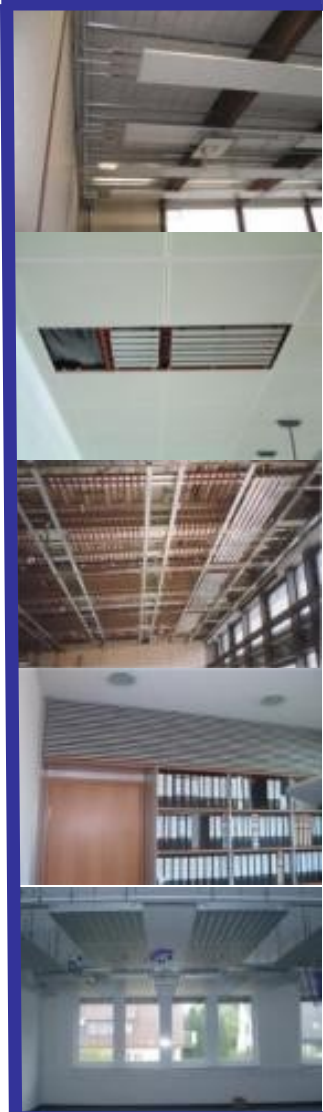
- cooling and heating with water
- 12,5 mm gypsum boards
- Energy transmission through special thermal conductivity profiles made from aluminium in combination with the normal steel tubes



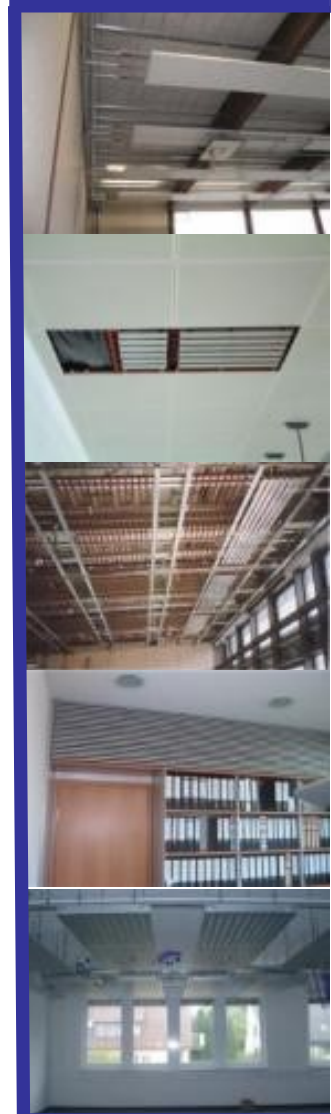




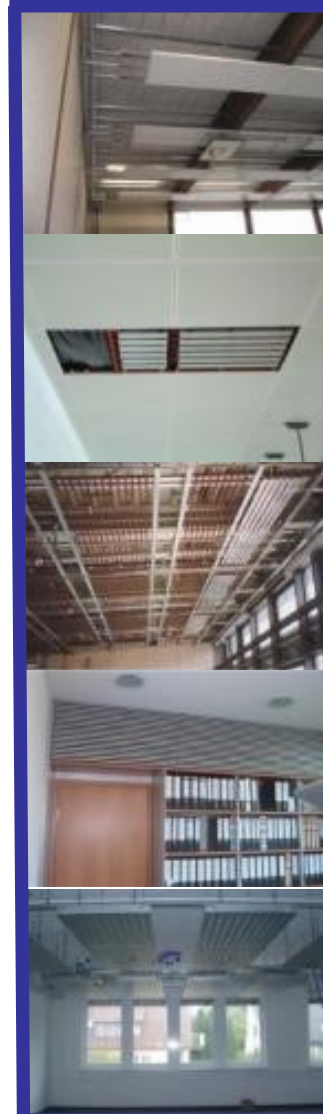
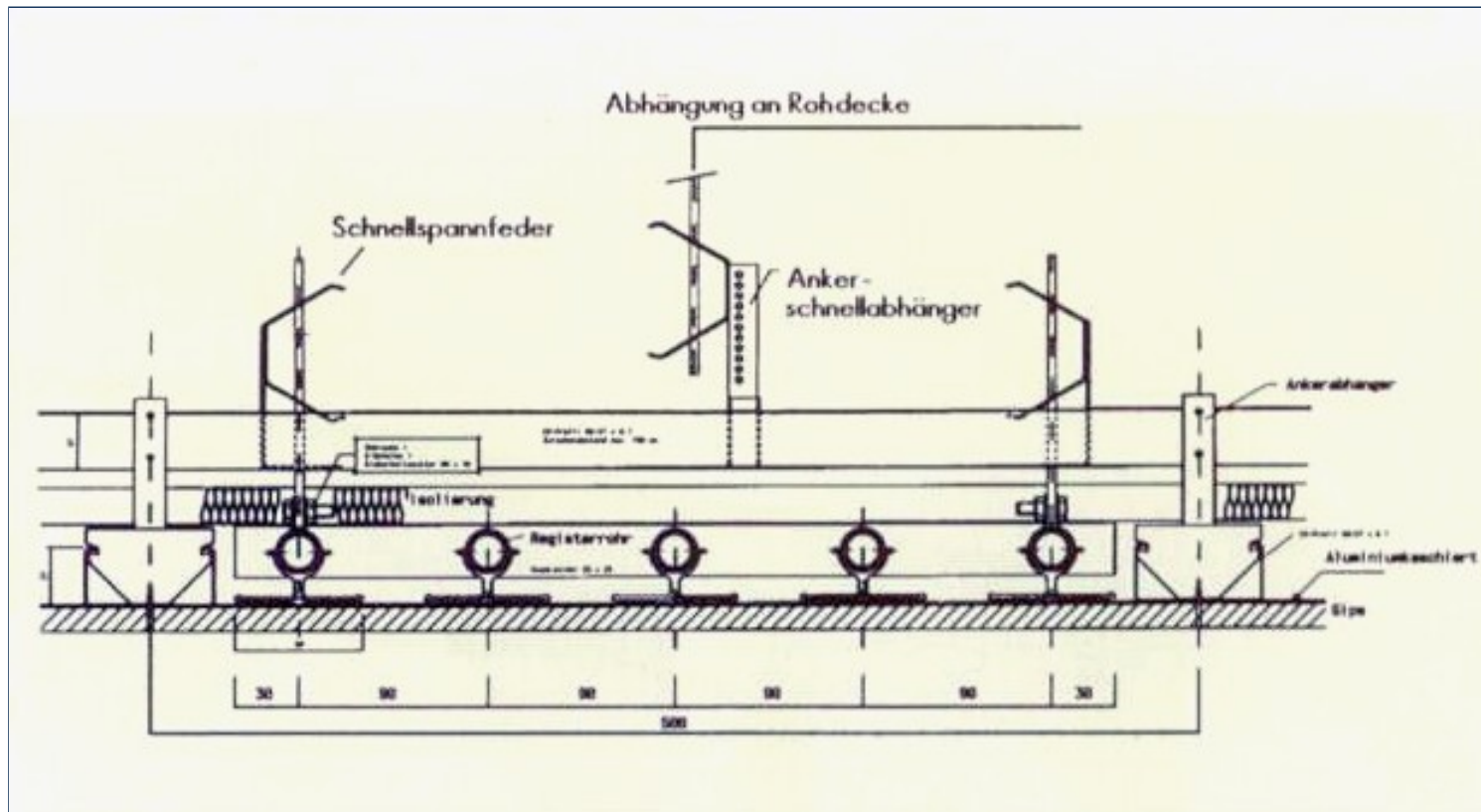
# Gypsum board ceilings: Monolith



# Gypsum board ceilings



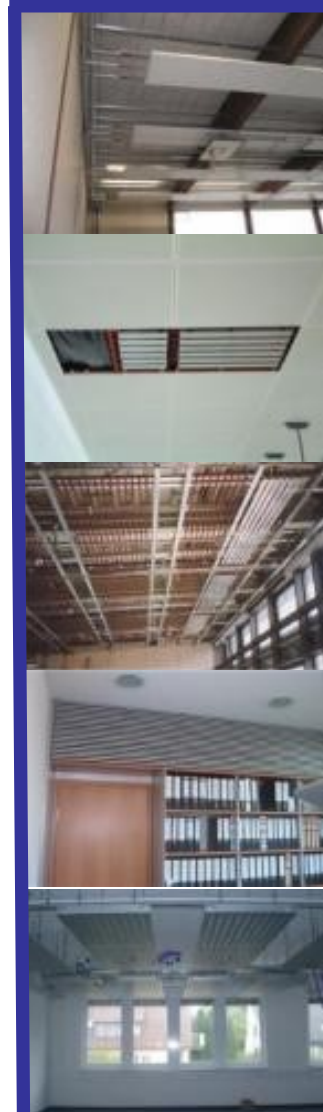
# Gypsum boards ceiling



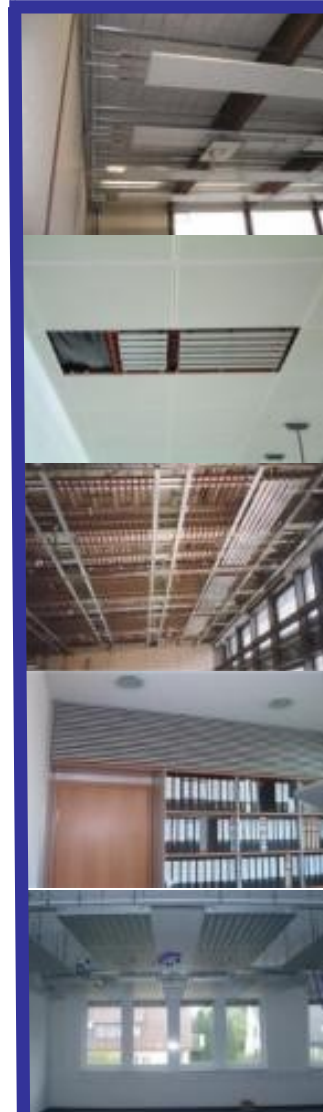
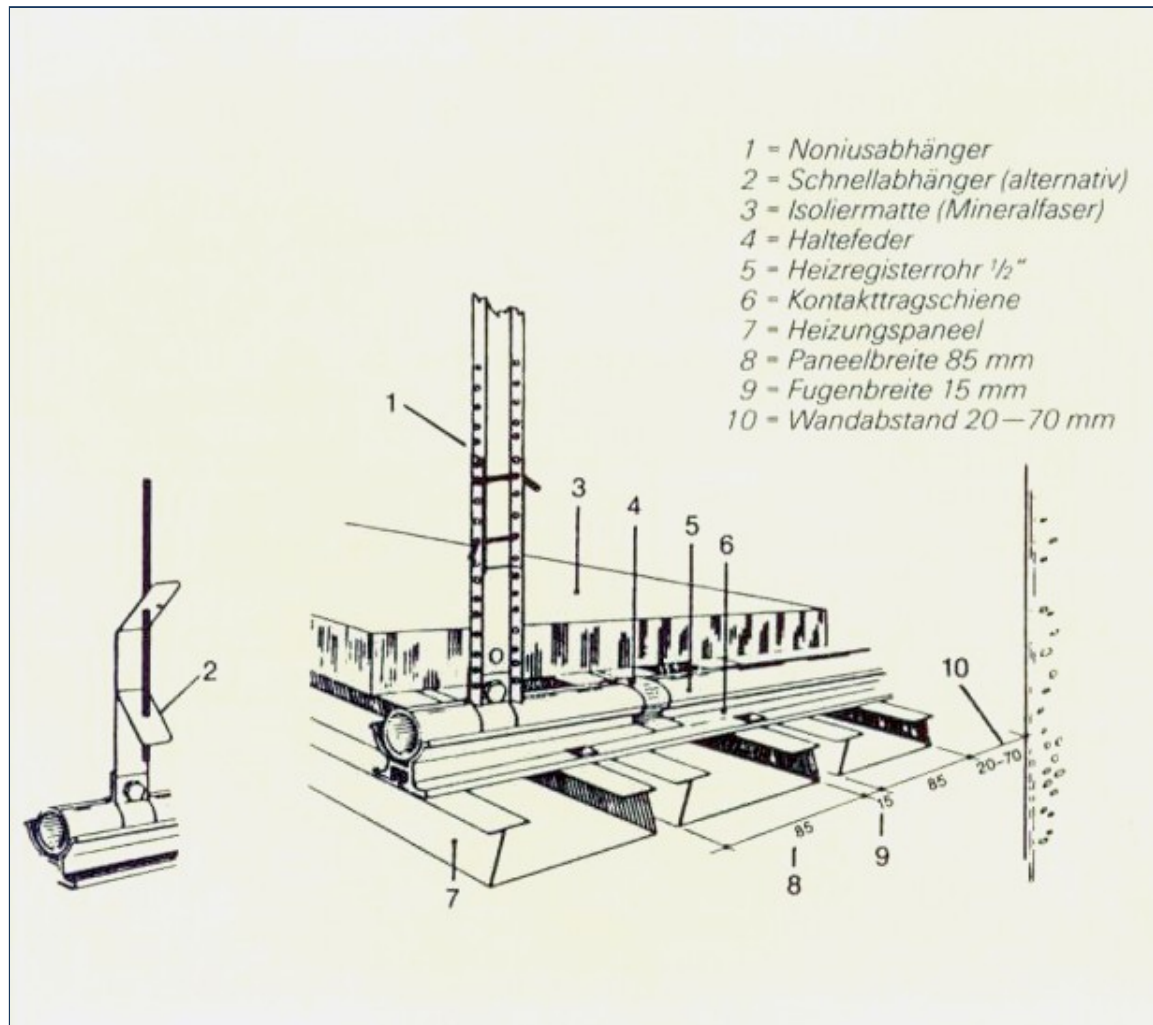
# Panel ceilings – S 85

## The system for strong usage

Sport halls, swimming pools, schools and supermarkets, office buildings and show rooms. Complete system is patented



# Panel ceilings – S 85

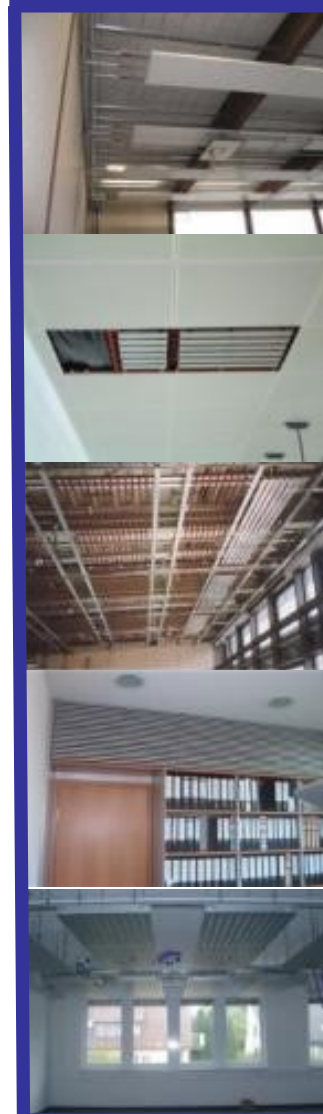


# Panel ceilings



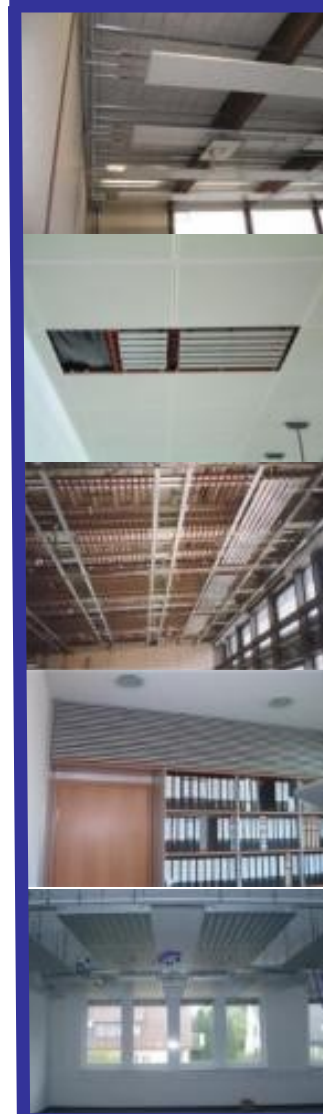
## Technical datas:

- Standard colour: steel: white similar to RAL 9002, backside with an additional protection paint, aluminium similar to RAL 9010, other colours possible
- Own on-top and/or integrated light fittings especially for sport halls and industrial buildings available
- Sound absorption, reduction of reverberation time



# Panel ceiling S 85

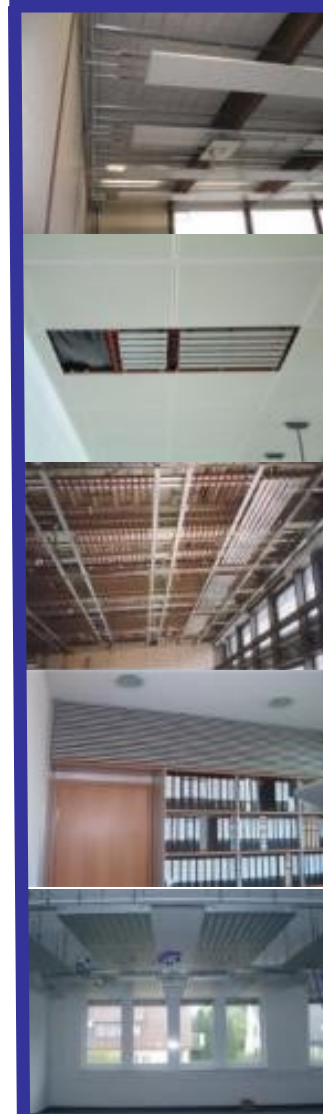
- Sound energy will be absorbed by the mineral wool on the backside
- Perforated panels are also available
- Ball proof according to EN Norms, certificates available
- Width: 100 mm modular size (85 mm plus 15 mm gap)
- Galvanized steel
- Thickness: 0,065 mm according to DIN/EN
- Contact main runner: extruded aluminium
- Surface painted in coilcoating way (antistatic)



# Panel ceilings – S 85

## Advantages:

- Installing of strip lights with emergency lights possible where it is needed
- Whole system including light fittings are ball proof
- Light weight because of aluminium radiant panels
- Usage in buildings where you can't hang heavy materials from the ceiling because of static reasons
- If you build new buildings you can calculate already with the light weight and you can reduce the costs for less requirements for static => less building costs

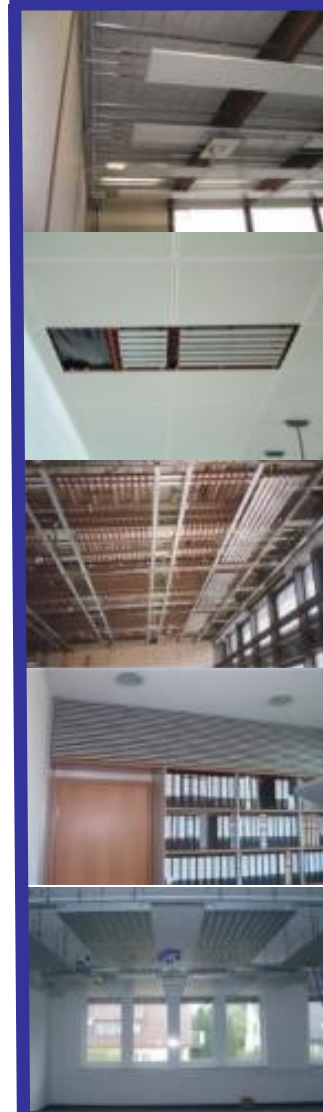




## 2. Radiant ceilings panels

Freely suspended radiation panels in open areas  
(also like canopies)

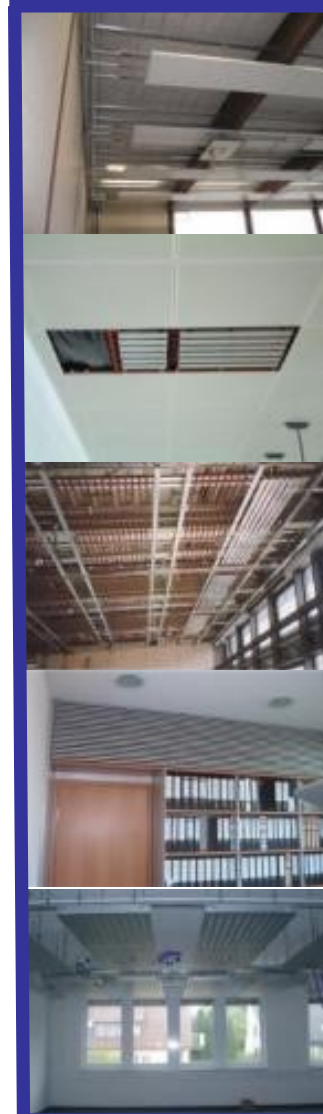
Can be installed in production-, maintenance halls  
and logistic centres, plane hangars, shipyards,  
sport, tennis and Squash halls



# Radiant ceiling panels

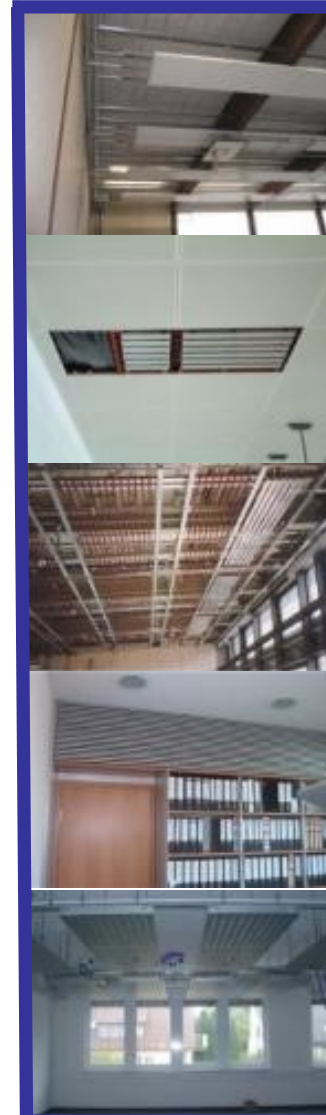
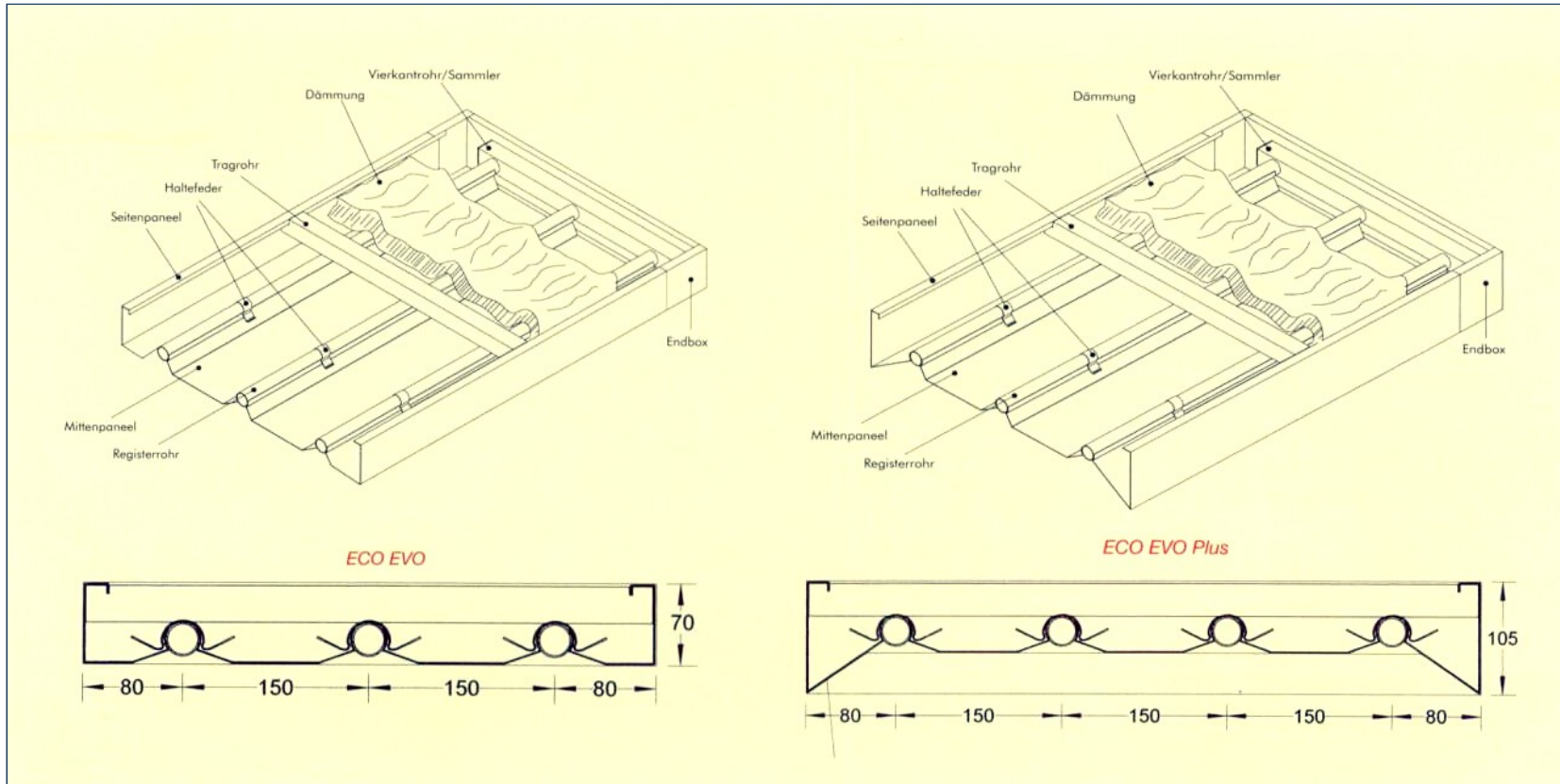
Radiant ceiling panels for heating and cooling – powerful and ball proof

- Will be installed selectively because of high efficiency.
- Ideal for areas where a lot of energy needs to be transferred: many kW for less money
- Ball proof
- Can be installed that only special areas will be heated, e.g. floors between storage racks
- Can be used as solid complete heating system because of high efficiency



# EVO ECO and EVO ECO PLUS

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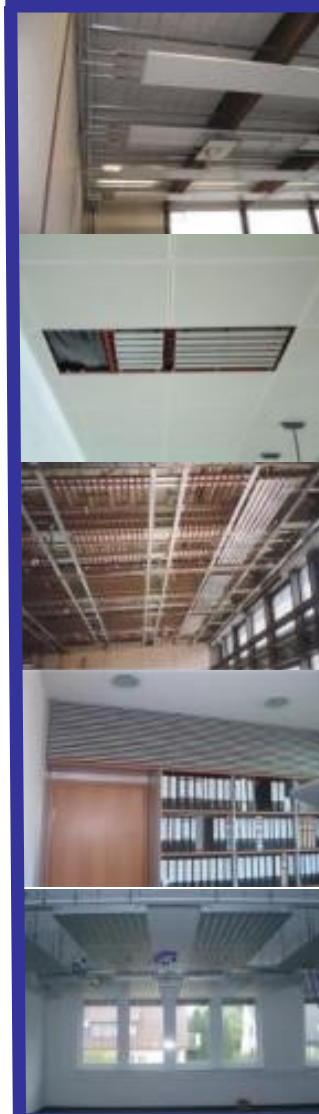
# NEW: ECO EVO PLUS

Normal radiation heat panels Eco Evo has a effectivity of 68% which is already much much better than normal air heaters and underfloor heating

The research and development department of FRENGER SYSTEMEN BV studied the interaction of heat radiation and convection

**Result: Development of ECO EVO PLUS with a radiation of 81%!!**

Additional 10-15% energy saving to the normal Eco Evo radiation panel



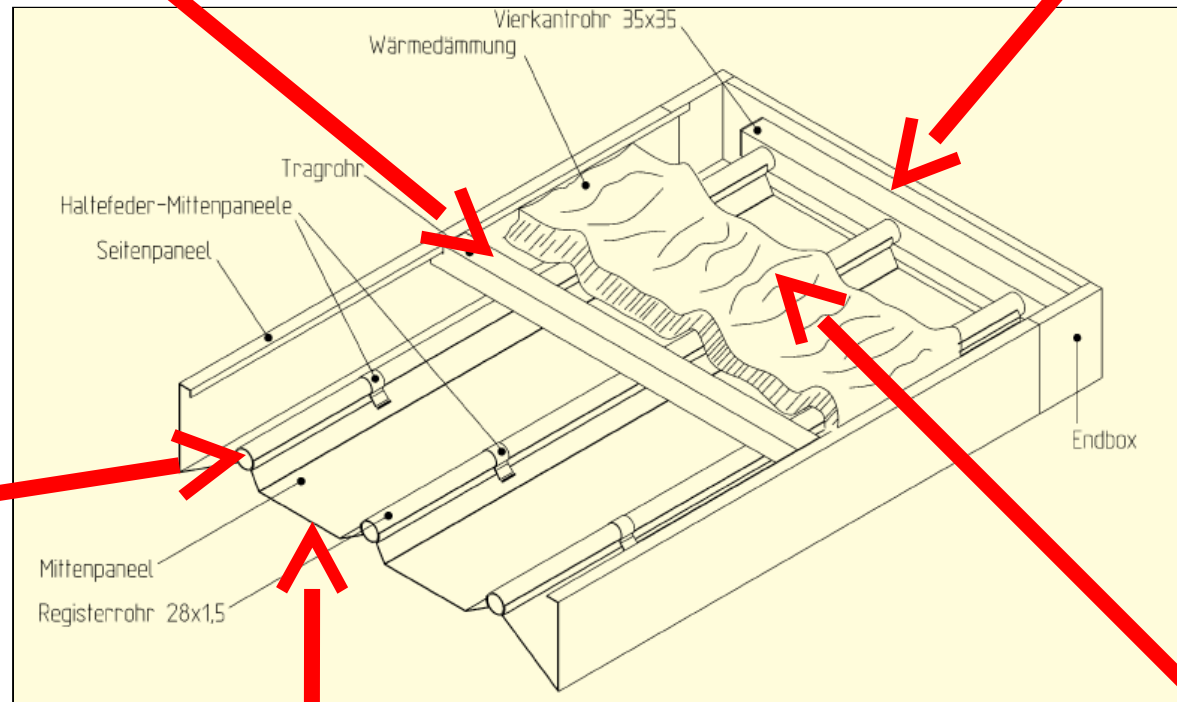
# Basics – working principle



Stiffeners and mounting  
elements

Manifolds for flow and  
return connections

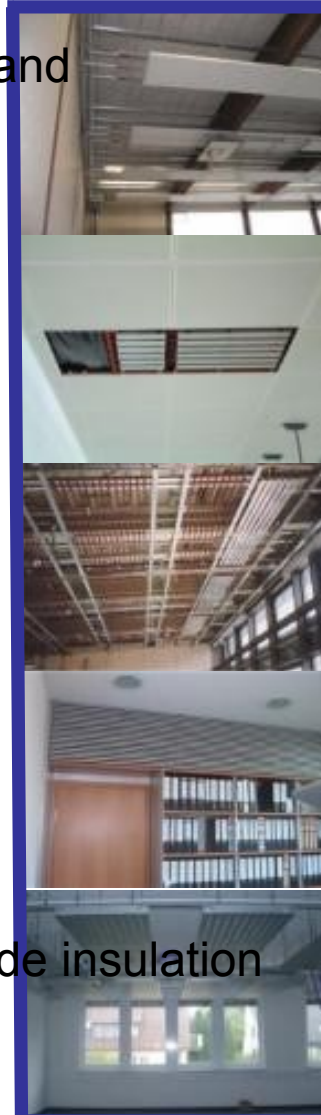
Tubes with  
heated water



Heated surface which emits  
infrared heat

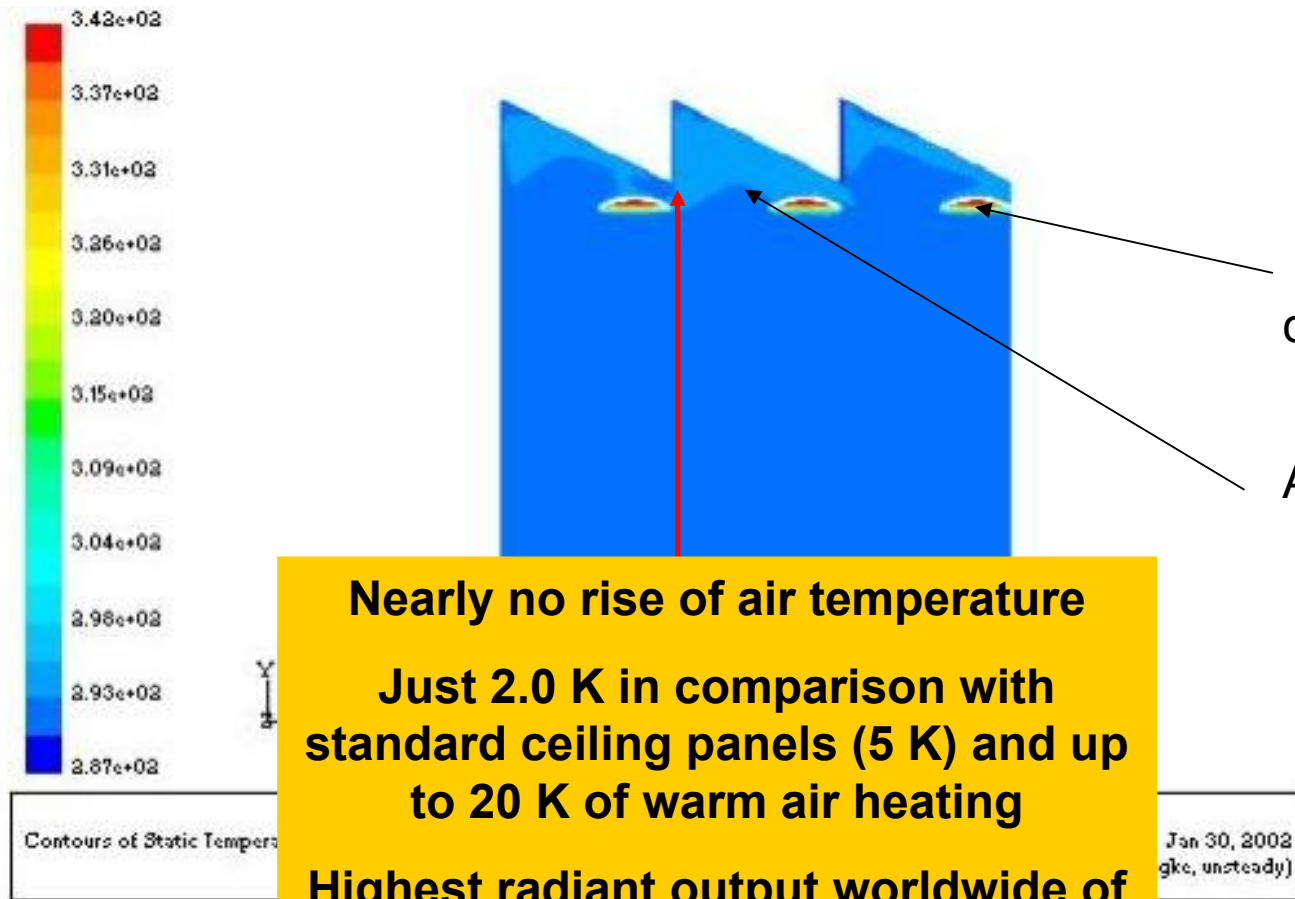
Encapsulated backside insulation  
to prevent heat loss

**You will find a sample of the radiant panel in the exhibition!**



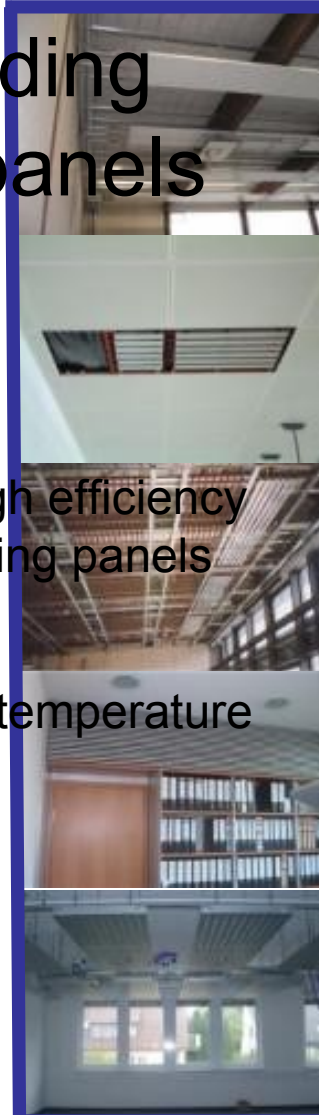
# Basics – Research

CFD - Simulation of 8 m high industrial building equipped with FRENGER high efficiency panels



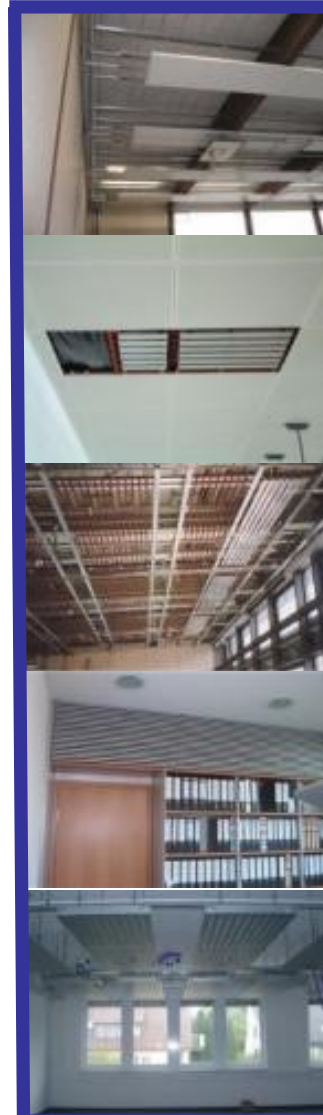
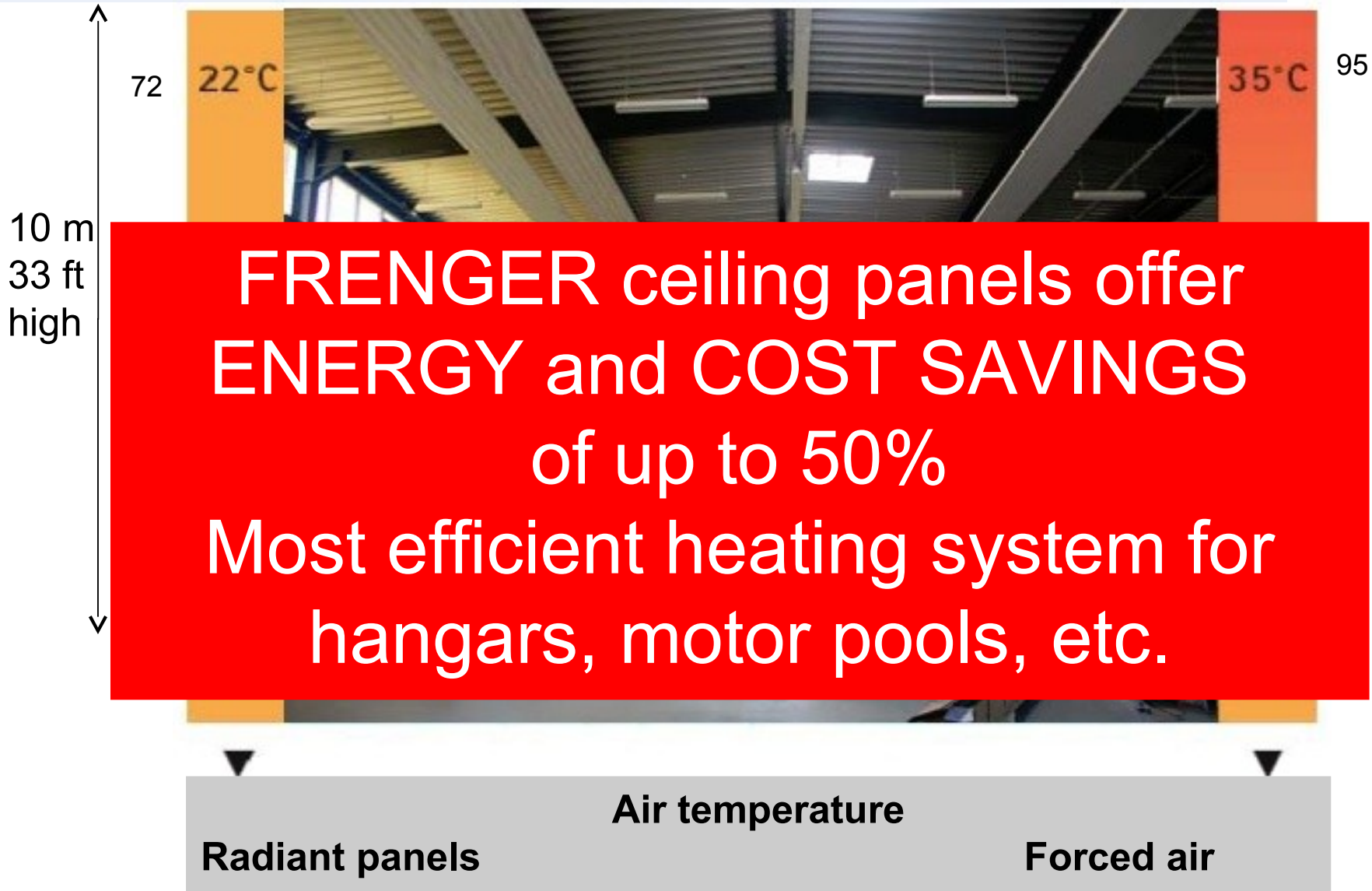
High efficiency ceiling panels

Air temperature



# FRENGER ceiling panels

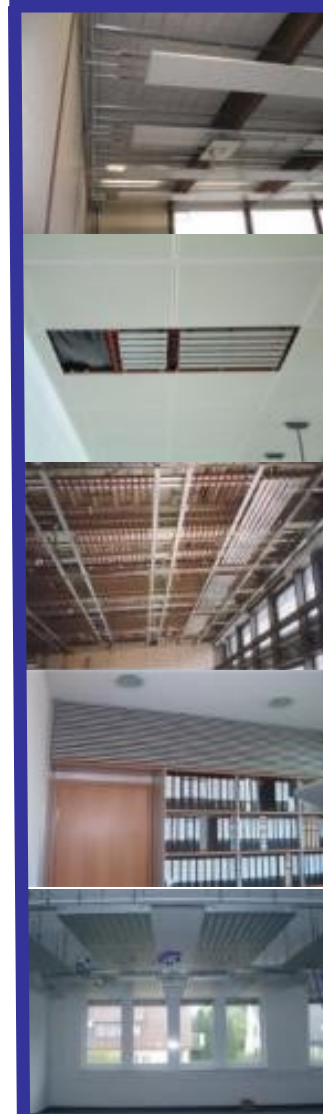
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# Product benefits

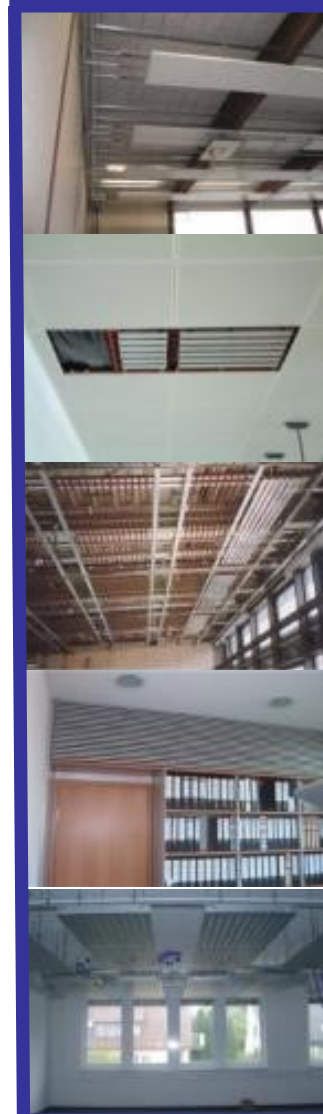
## Advantages of FRENGER ceiling panels:

- Energy savings of up to 50%
- Rapid warming up
- Maintenance free - no moving parts
- Noiseless - no fans
- Life expectancy > 30 years
- Hygienic - no air movement
- Easy to install - for new and existing buildings
- Very lightweight - just 14 kg/m<sup>2</sup> including water
- No replacement of concrete floor





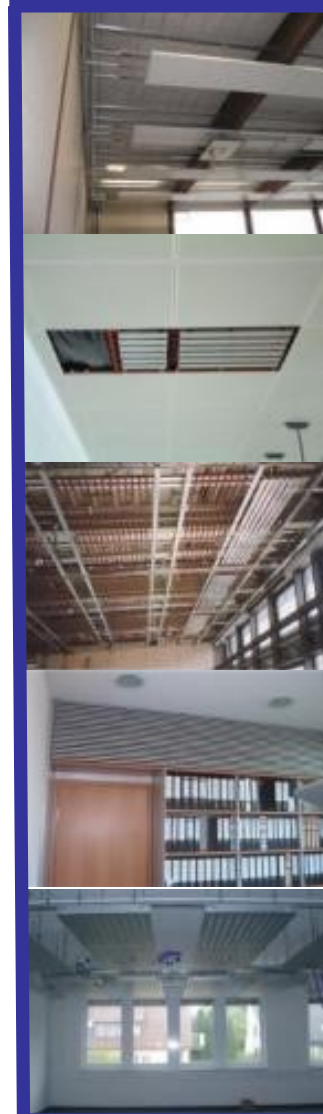
# Cooled beams



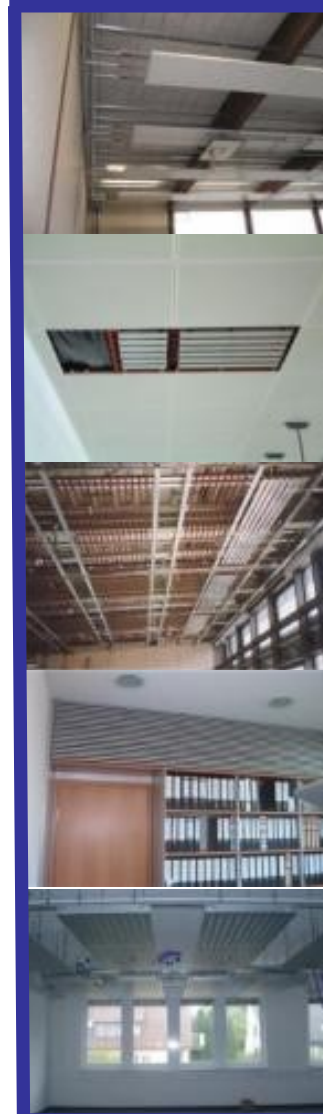
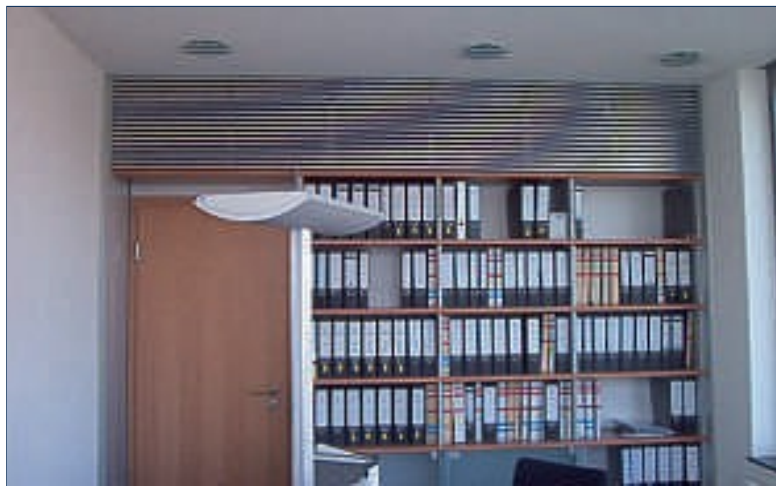
# Chilled beams

## Silent cooling from FRENGER SYSTEMEN BV

- Cooling convectors are used for room cooling.
- Alternative to normal ventilation systems
- Taking away high cooling loads with water without mechanical ventilation system

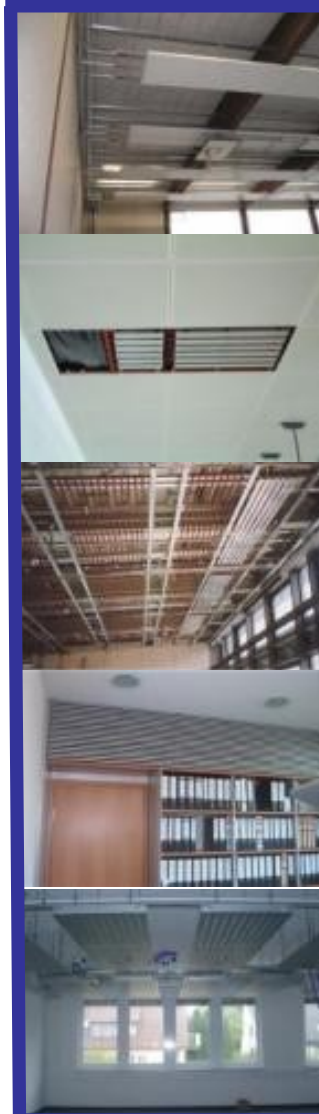


# Chilled beams



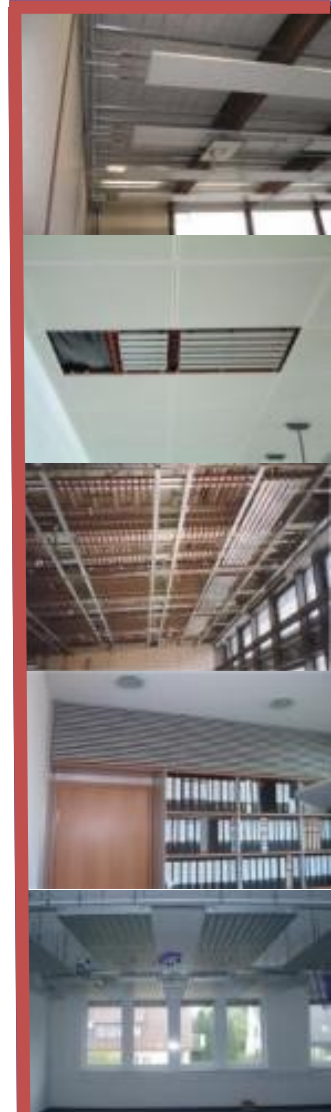
# •CASE STUDIES

1. Airplane hangar (Fan heaters)
2. Sport hall (Fan heaters)



# Case study

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**WAAF - Hangar 1035 - 1053 m<sup>2</sup> Floor Area**

09/08/12

# Case study

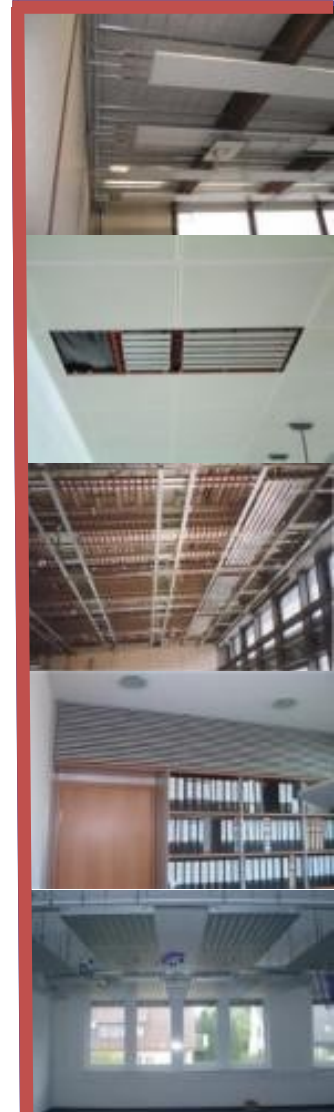


6 warm air fan heaters

38 kW heat capacity each → 228 kW in total

Fan power: 0,9 kW each → 4,5 kW in total

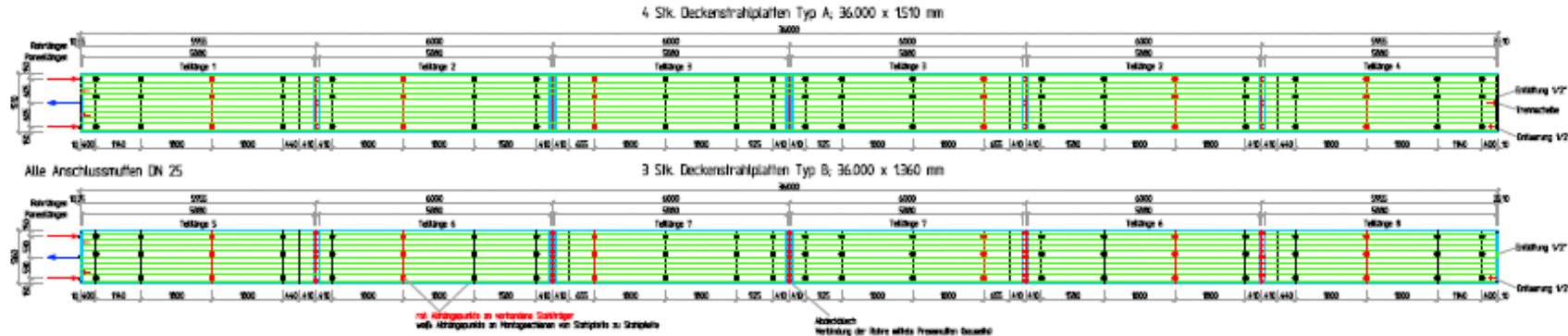
**Waste of Energy!**



**WAAF - Hangar 1035**  
**FRENGER high efficiency radiant panel**

# Case study

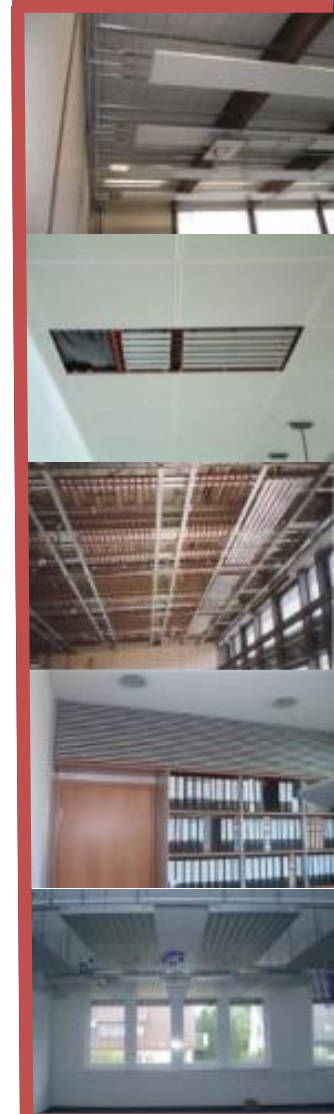
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7 panel runs in total - 36 m long  
4 panels 1.51 m / 5 feet wide 22 kW each → 88 kW  
3 panels 1.36 m / 4.5 feet wide 20 kW each → 60 kW

**Installed heat capacity: 148 kW**      warm air was 228 kW

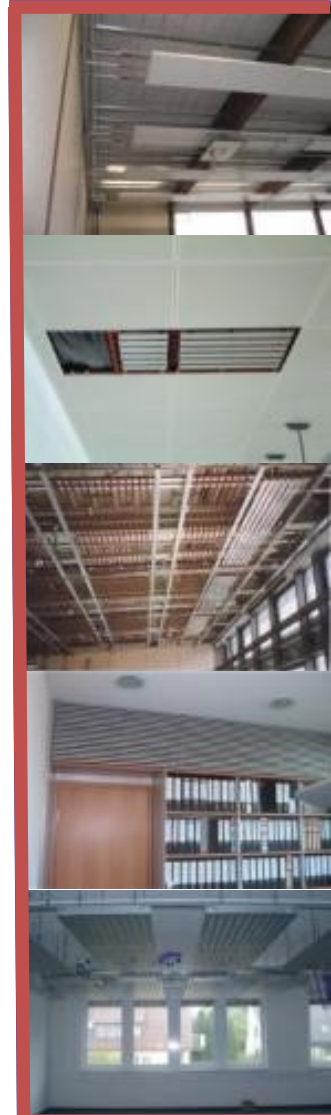
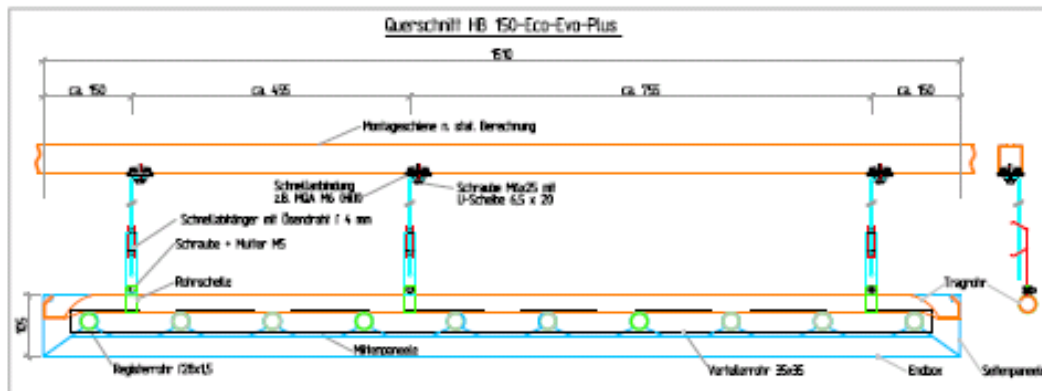
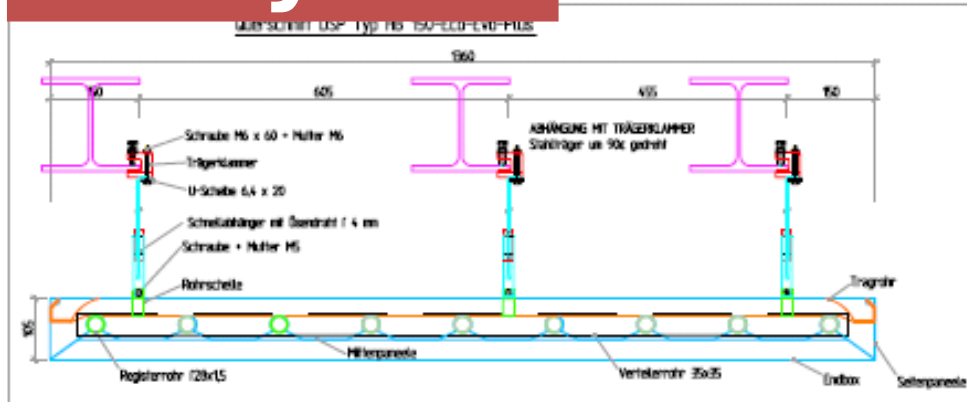
**Due to the high efficiency of FRENGER panels and 81% of radiation this size is large enough to heat this hangar to 20°C/68°F at -15°C/5°F outside!**



**WAAF - Hangar 1035**

**FRENGER high efficiency radiant panel**

# Case study

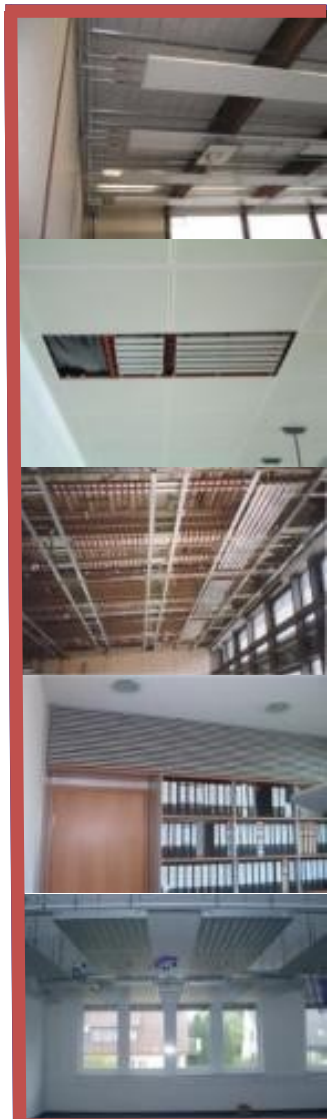


**WAAF - Hangar 1035**  
**FRENGER high efficiency radiant panel**



# Case

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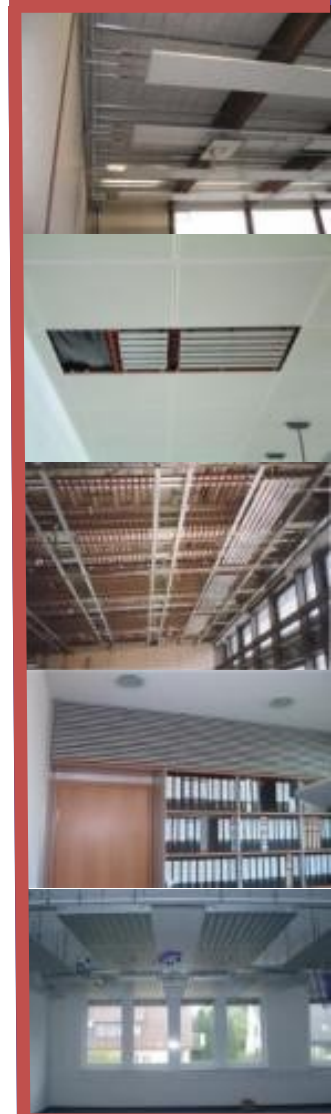


**WAAF - Hangar 1035**  
**FRENGER high efficiency radiant panel**

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# Case

FRENGER  
SYSTEMEN BV



**WAAF - Hangar 1035**  
**FRENGER high efficiency radiant panel**

09/08/12

# Case study

## Results - costs

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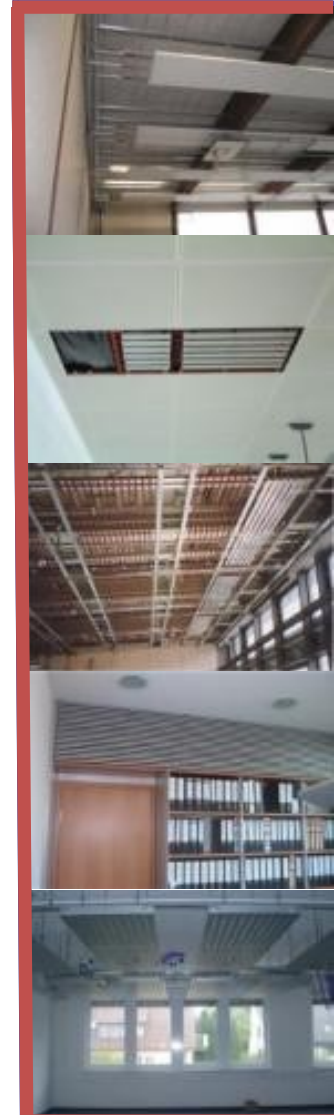


- FRENGER high efficiency radiant panels including supporting steel beams, modification of pipework, new controls

90,000.00 €

- Replacement of forced air:

25,000.00 €



**WAAF - Hangar 1035**  
**FRENGER high efficiency radiant panel**

# Case study

## Results - savings

### Savings of FRENGER radiant panels

- Heating: 15,087.49 €/year
- Electricity: 4,392.00 €/year
- Maintenance: 350.00 €/year

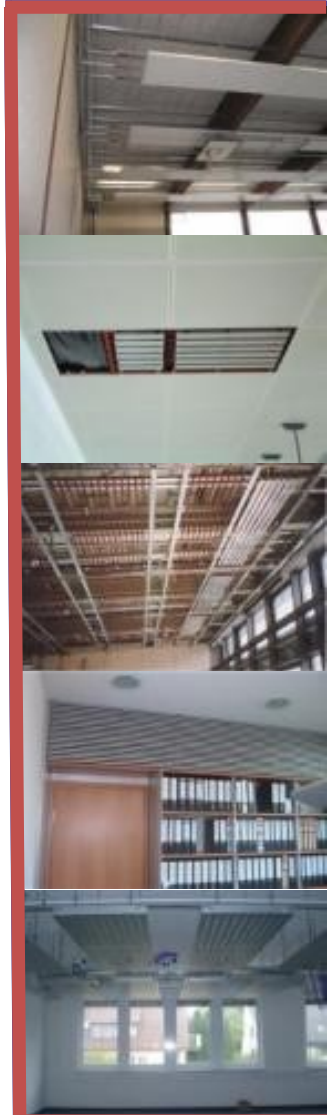
**Total savings of FRENGER radiant panels:**

**19,829.49 €/year**

**Total reduction CO<sub>2</sub>: 49,435.00 kg/year**

**Payback period: 4.1 years**

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**WAAF - Hangar 1035**

**FRENGER high efficiency radiant panel**

# Case Study

1968:

Retrofit in 2006:

Lengths 42,75 m

Width 21,68 m

Height 7,21 m

Ground area 927 m<sup>2</sup>

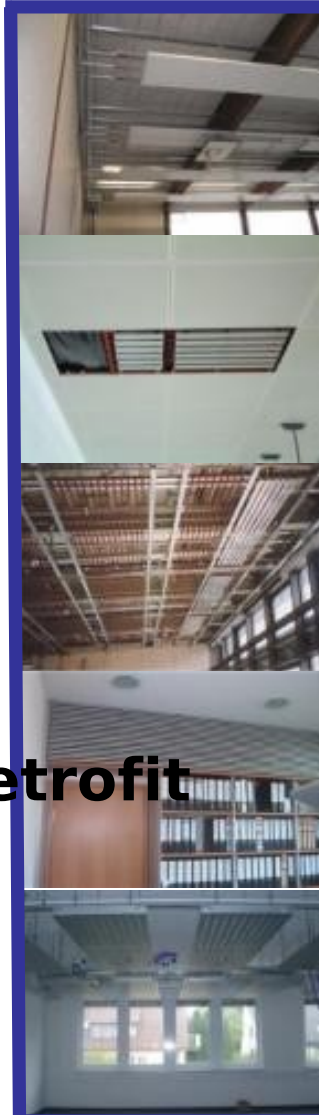
Ground area with adjoining room 1.393 m<sup>2</sup>

Intended room temperature 20°C

## **Energie consumption of the sport hall before retrofit in average with air heaters:**

Heating energy in average: 200.222 kwh / a

Electrical energy in average: 25.648 kwh / a

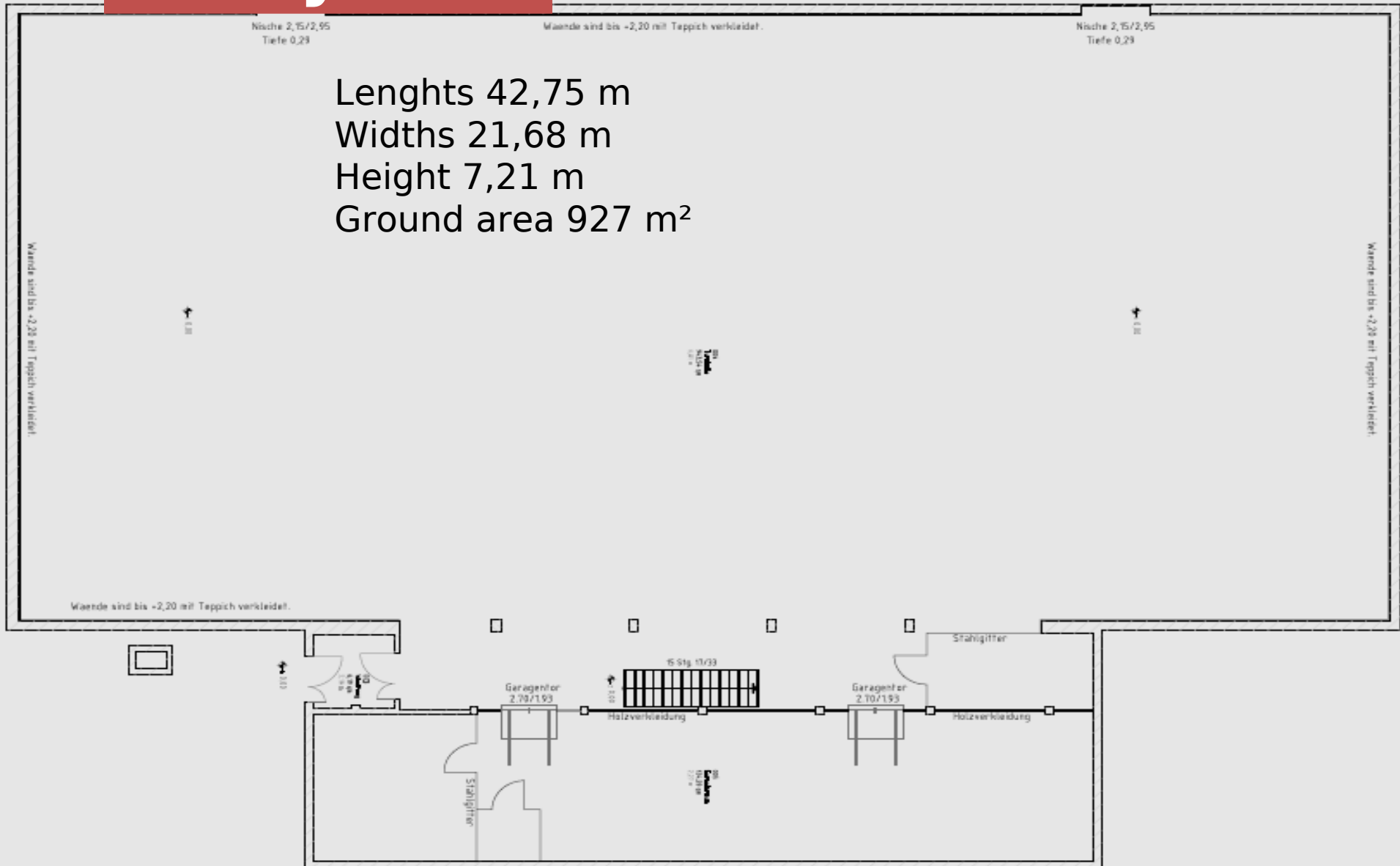


# Case Study

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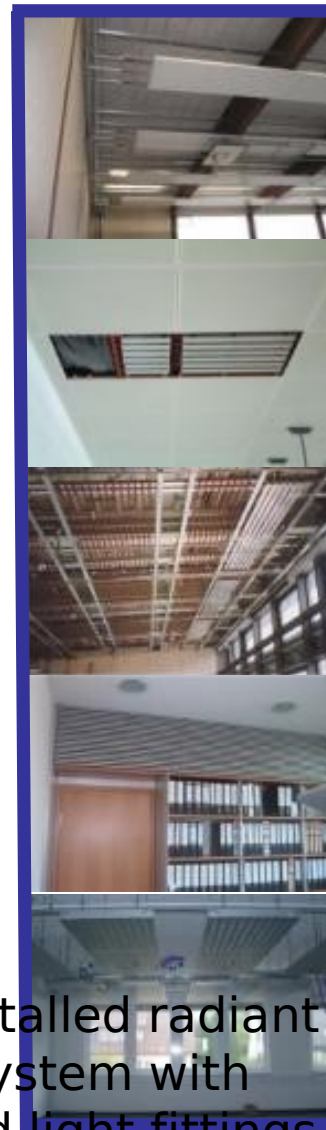


Lengths 42,75 m  
Widths 21,68 m  
Height 7,21 m  
Ground area 927 m<sup>2</sup>



# Case Study

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Ready installed radiant heating system with integrated light fittings

Complete system is proved according DIN 18 032 to be ball proof

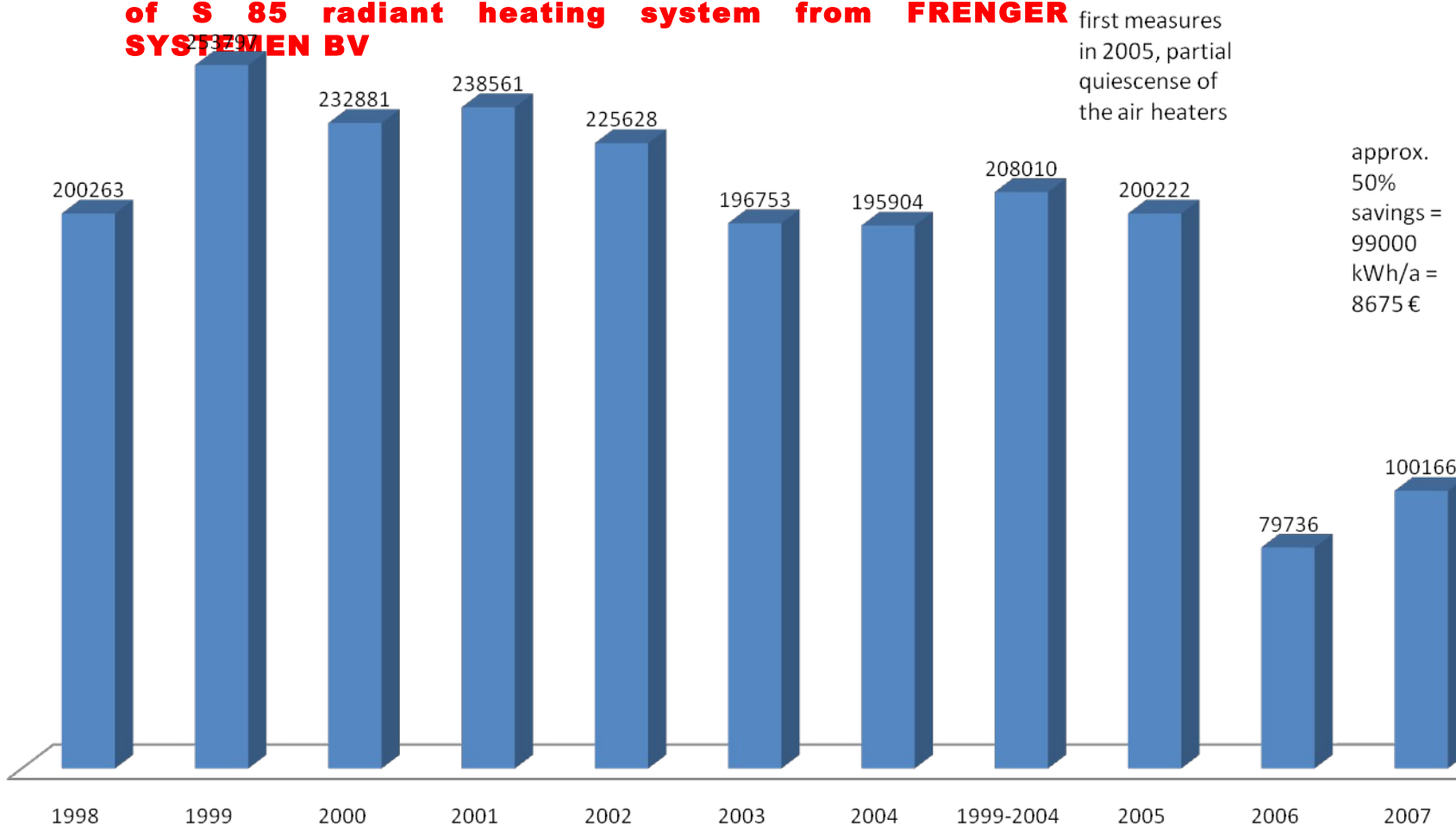
# Case Study

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## Weather revised heat demand after retrofit

**Consumption of heat energy before and after installing of S 85 radiant heating system from FRENGER SYSTEMEN BV**



first measures in 2005, partial quiescence of the air heaters

approx. 50% savings = 99000 kWh/a = 8675 €

approx. 53% savings = 105000 kWh/a = 10928 €





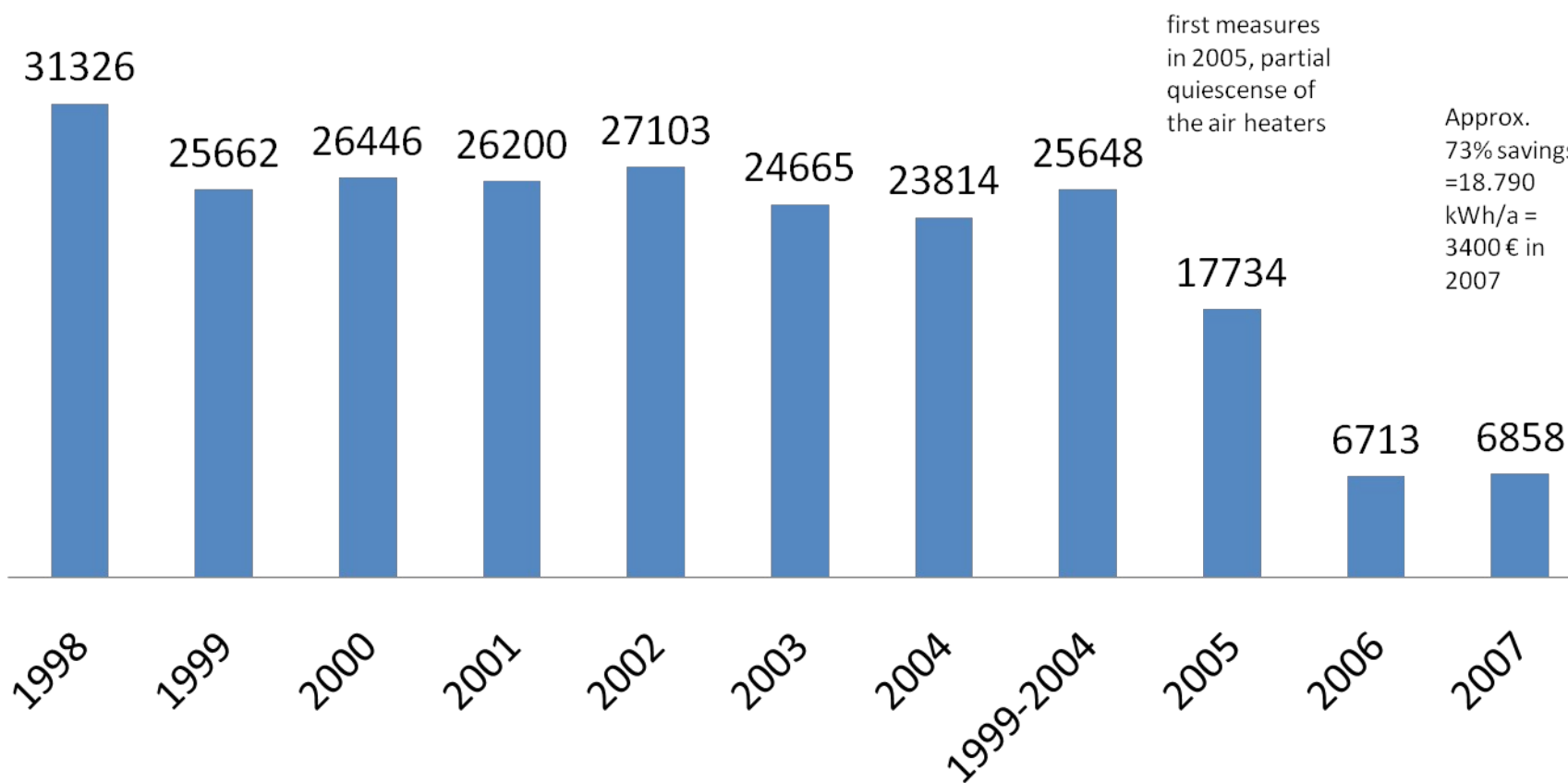
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## Electrial demands after retrofit

**Consumption electrical energy before and after installing of the S 85-radiant heating system from FRENGER SYSTEMEN BV**



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## Result:

After changing the the heating system from air heating to a closed radiant heating system, type S-85, from FRENGER SYSTEMEN BV, Heiz- und Kühltechnik GmbH, the following results could be achieved

Average savings of heat energy 99.000 kwh / a

Average savings of electrical energy 18.790 kwh / a

Reduction of CO<sup>2</sup> for heating

19.800 kg / a ( gas )

Reduction of CO<sup>2</sup> for electrical energy

7.516 kg / a ( coal power station )



# Case Study

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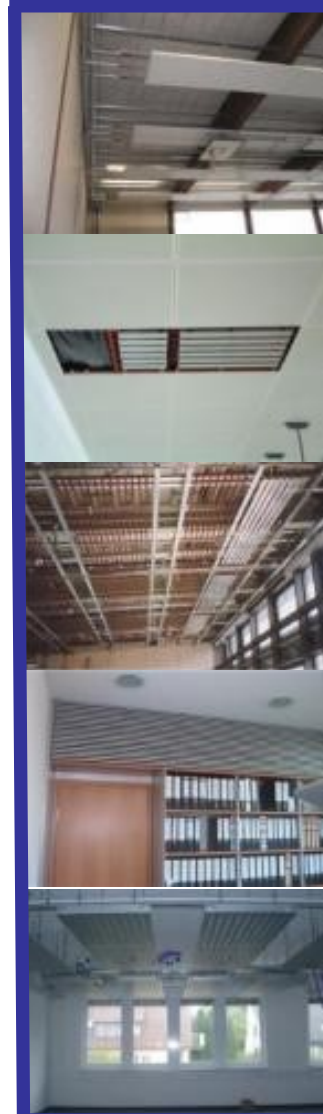
**Average savings per year with radiant heating system, type S-85, from FRENGER SYSTEMEN BV, Heiz - und Kühltechnik GmbH.**

**Savings heating energy 8.675 € / a**

**Savings electrical energy 3.400 € / a**

~~**Savings maintenance costs 900 € / a**~~

**Total sum 12.975 € / a**



# Case Study



Year	2007	2008	2016
Heating energy	8.675 €	9.412 €	18.077 €
Electrical energy	3.400 €	3.638 €	6.251 €
Maintenance	900 €	932 €	1.227 €
<b>Total sum</b> <b>25.555 €</b>	<b>12.975 €</b>	<b>13.982 €</b>	

## Basis of energy costs:

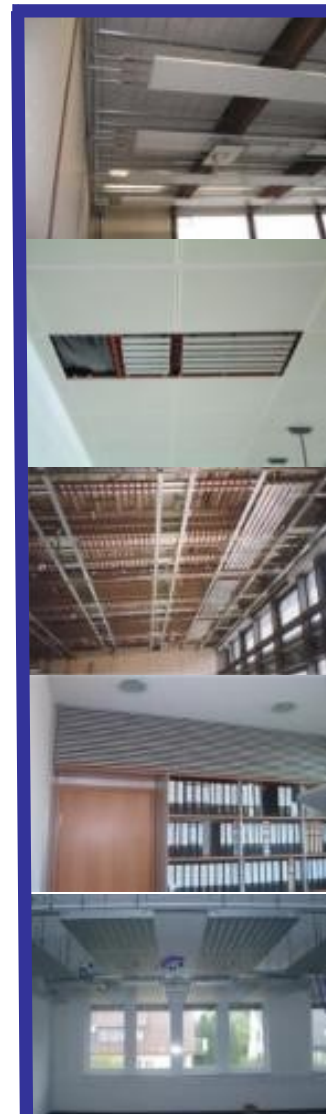
Heating energy rate of price increases approx. 8,5 % / a

Electrical energy rate of price increases approx. 7 % / a

Maintenance rate of price increases approx. 3,5 % / a



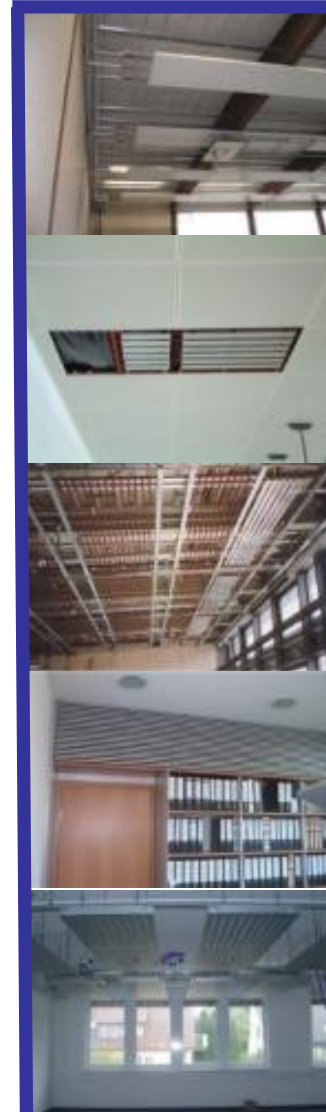
# References



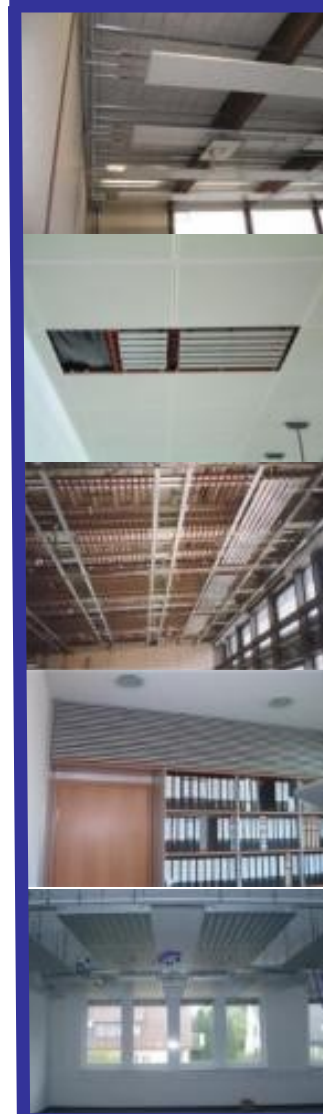
# References



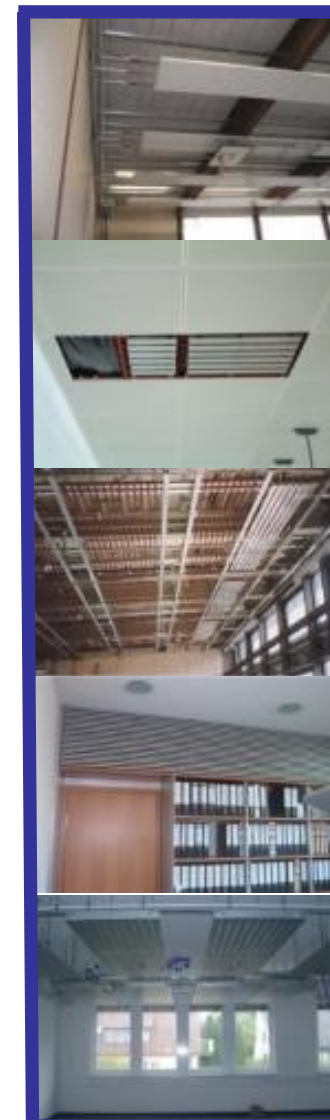
Energiesparende Hochleistungsdeckenstrahlplatten mit integrierter Beleuchtung



# References



# References



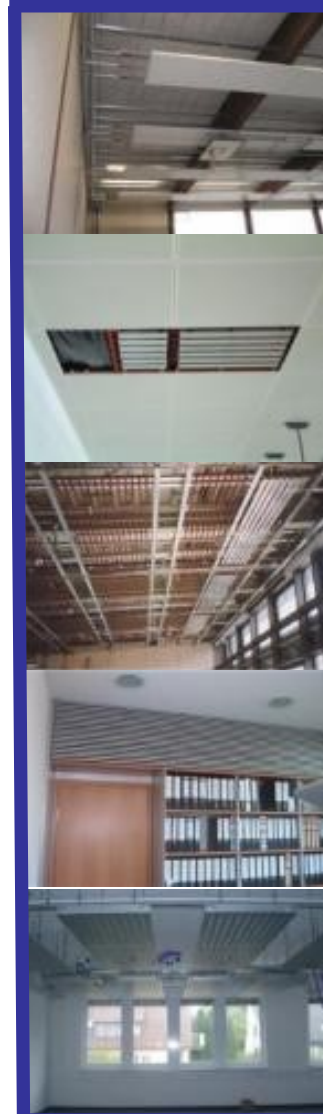


# •References

FRENGER  
SYSTEMEN BV



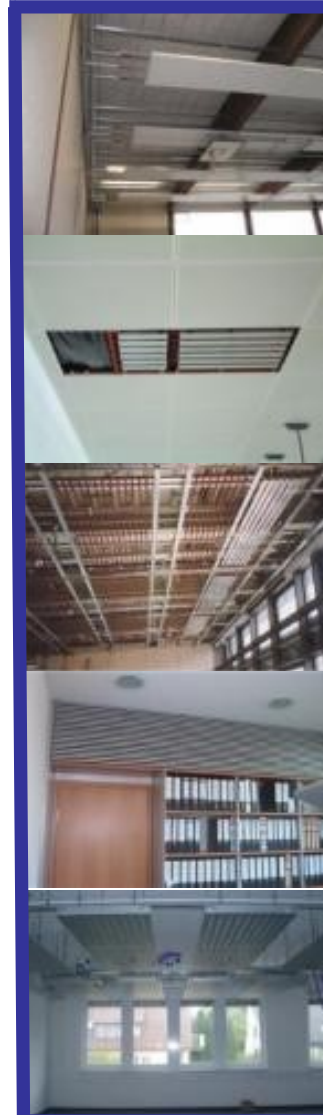
Aiken Gym, Dundalk



# •References



Retail outlet and warehouse in  
Kilkenny



# •References

FRENGER  
SYSTEMEN BV



Retail outlet and warehouse in  
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