BEEP
BUILDING ENERGY
EFFICIENCY PROJECT

Basics of Radiant Panel Cooling

CONTENTS

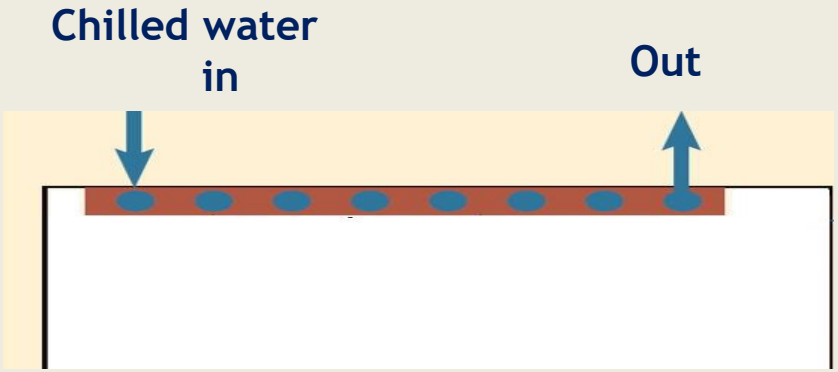
- Slab cooling systems vs Panel cooling systems
- Types of panel cooling
  - System sizing
  - Panel layouts
- Installation procedure
- Recap of panel systems

Slab cooling vs Panel systems - Construction

Structure integrated	Panel system
	
• Integral part of slab construction • Suitable for new buildings only	• External fittings to ceilings and walls • Suitable for existing buildings and new buildings also

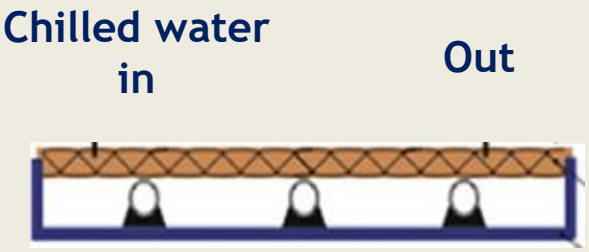
Slab cooling vs Panel systems - Cooling process

Slab cooling:



- Cools the entire structure / slab
- High thermal mass
- Response time to load is high

Panel cooling:



- Cools only panel surface
- Less thermal mass
- Response time to load is less

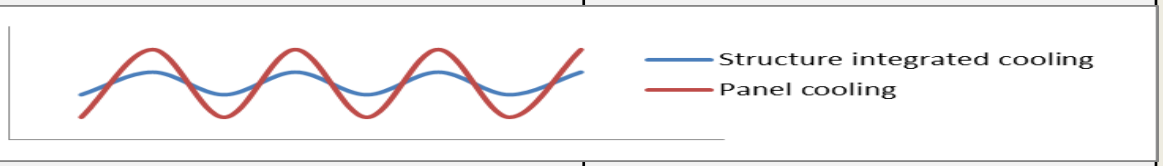
Slab cooling vs Panel systems – Cooling capacity

- Combined heat transfer coefficient $h_{rad+conv}$ = 8 – 11(W/m^2 K)

Source: European standards EN 1264 and 15377

System (Ceiling)	Dew point temperature	Surface temperature	Operative Temperature	Delta T	Cooling capacity
	^{0} C				W / m^2 (active area)
Slab cooling	16 @ 25 ^{0}C; RH – 55 %	18	25	7	56 - 77
Panel systems	14 @ 25 ^{0}C; RH – 50 %	16		9	72 - 99

Slab coolingcooling systems vs Panel cooling systems

No	Parameter	Structure integrated	Panel cooling
1	New Buildings / Existing Buildings	New buildings	New buildings & Existing buildings
2	Application	Less variation in loads	Variations in loads in allowed
			
3	Thermal mass utilization	High	Less
4	Cooling Surface Temperature	18 – 20 ^{0} C	16 – 18 ^{0} C
5	Cooling Capacity	56 - 77 W / m^2	> 70 W / m^2
6	Cost / unit surface area	Relatively low	Relatively high

Radiant panel systems – Classification

1. Radiant panel – Plaster boards

2. Radiant panel – Boned (metal finish) With insulation on rear end

3. Radiant panel – Suspended Without insulation on rear end

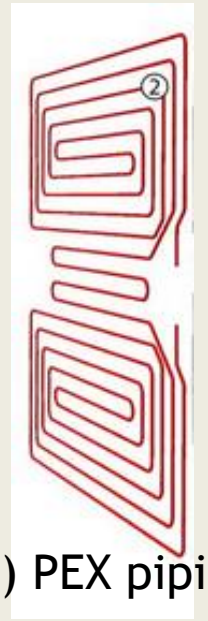
4. Radiant panel with higher heat transfer area

Source: CBCA Publication

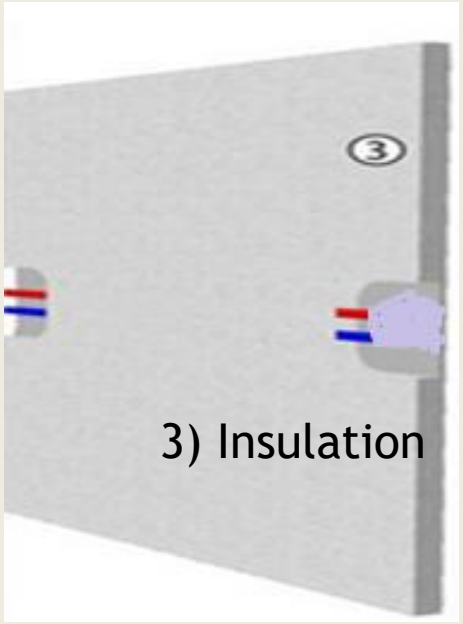
1. Radiant panel – plaster boards

Plaster board

1) Plaster board



2) PEX piping



3) Insulation

- These boards can directly be fitted to slabs

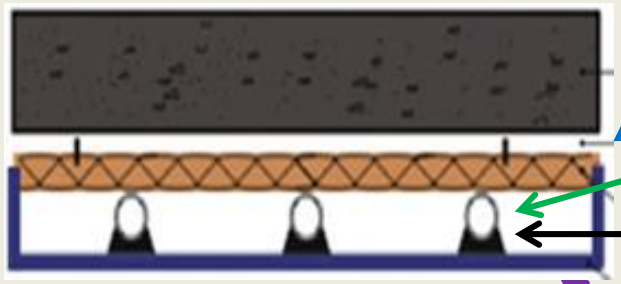
1. Radiant panel – embedded coils in plaster

Fitting coils to slab

Connecting loops

Plastering over loops

2. Radiant panel – Bonded (metal finish)

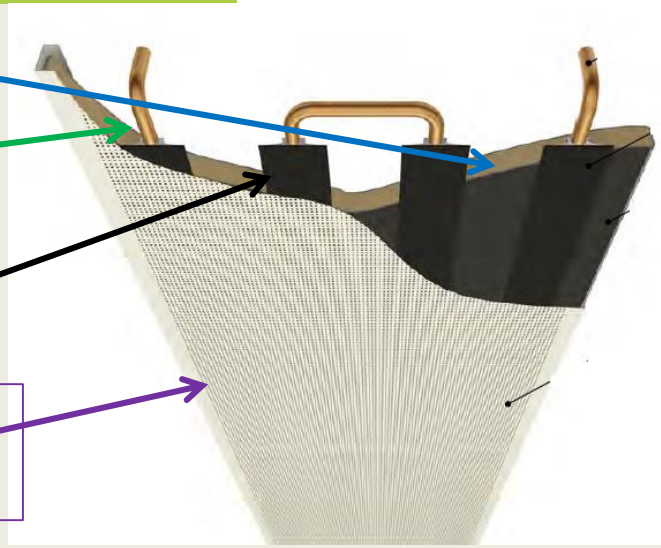


Insulation

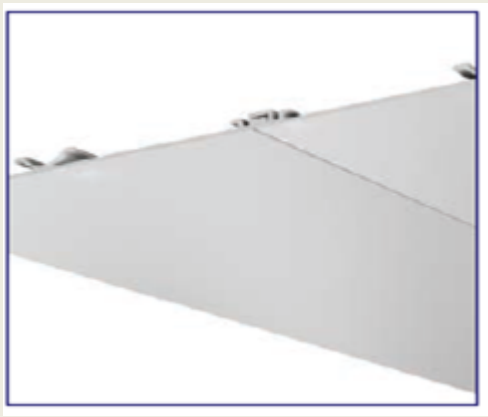
Copper pipe coil

Pipe seat – Heat transfer extrusion

Micro perforated tile (Acoustic attenuation)



Different surface finishes



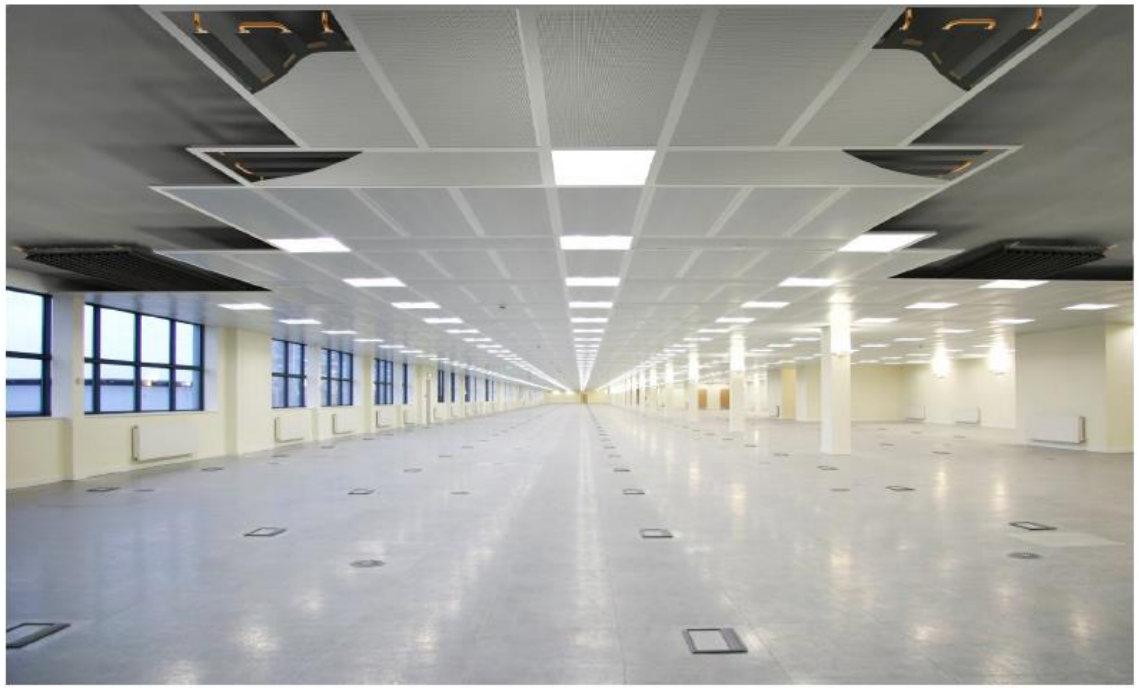
3. Radiant panels – Suspended

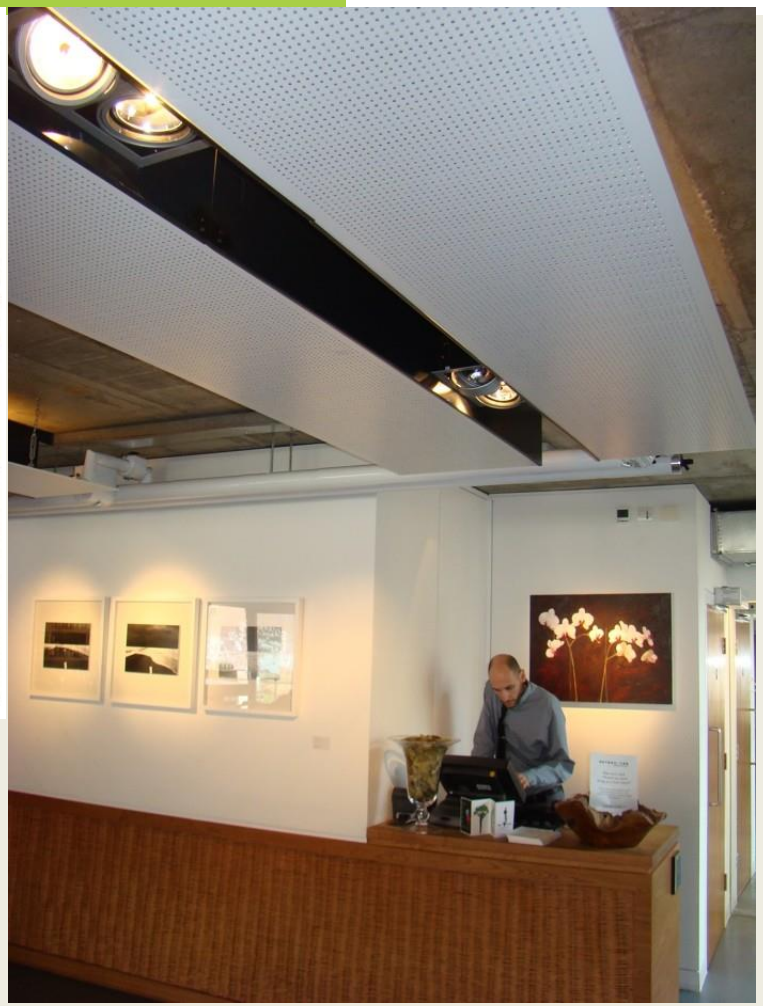
- No insulation on top of the radiant panels
- Air above the sails (partly perforated) also cooled and this provides additional convective heat transfer

- Radiation ~ 70 %
- Convection ~ 30 %

Source: CBCA report_Chilled ceilings

3. Radiant panels – Suspended (layouts)

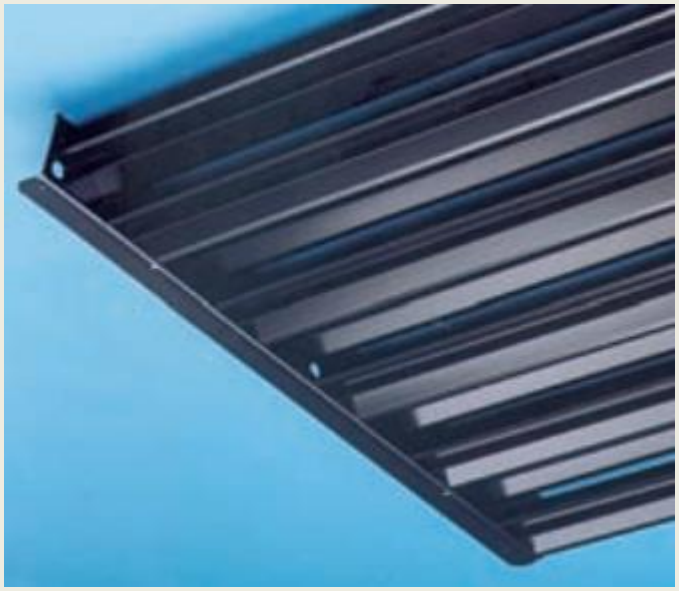


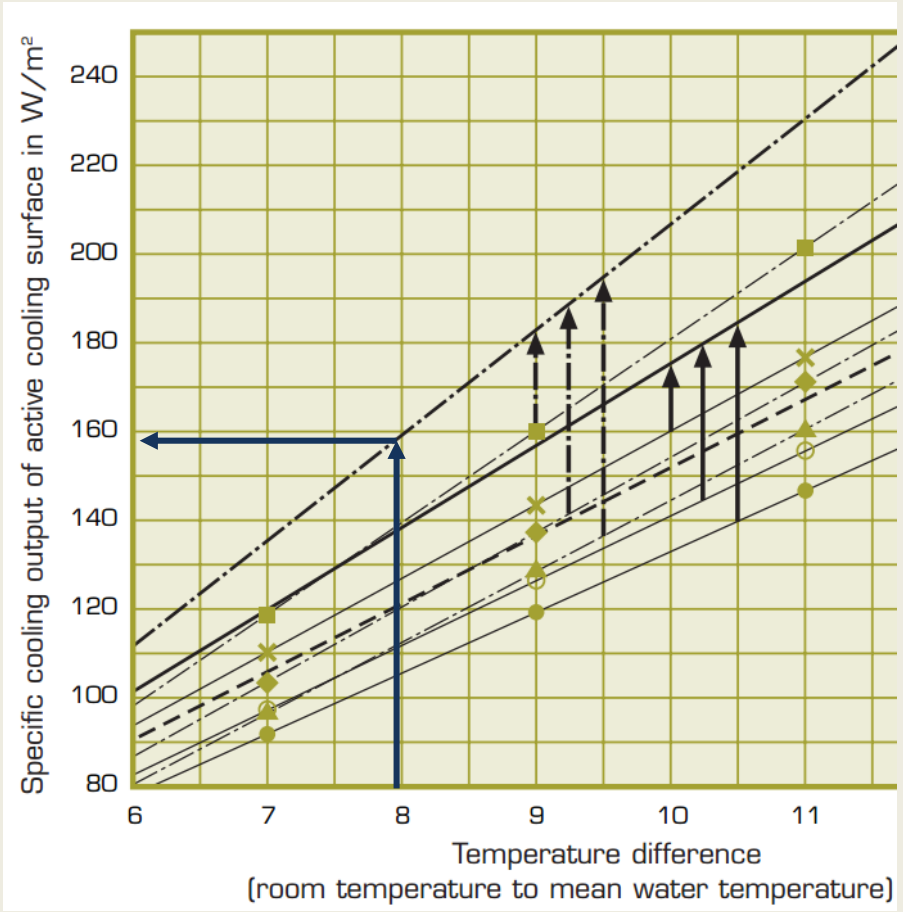


Source: Frenger Chilled ceilings Brochure

High performance with radiant panel using more convective heat transfer

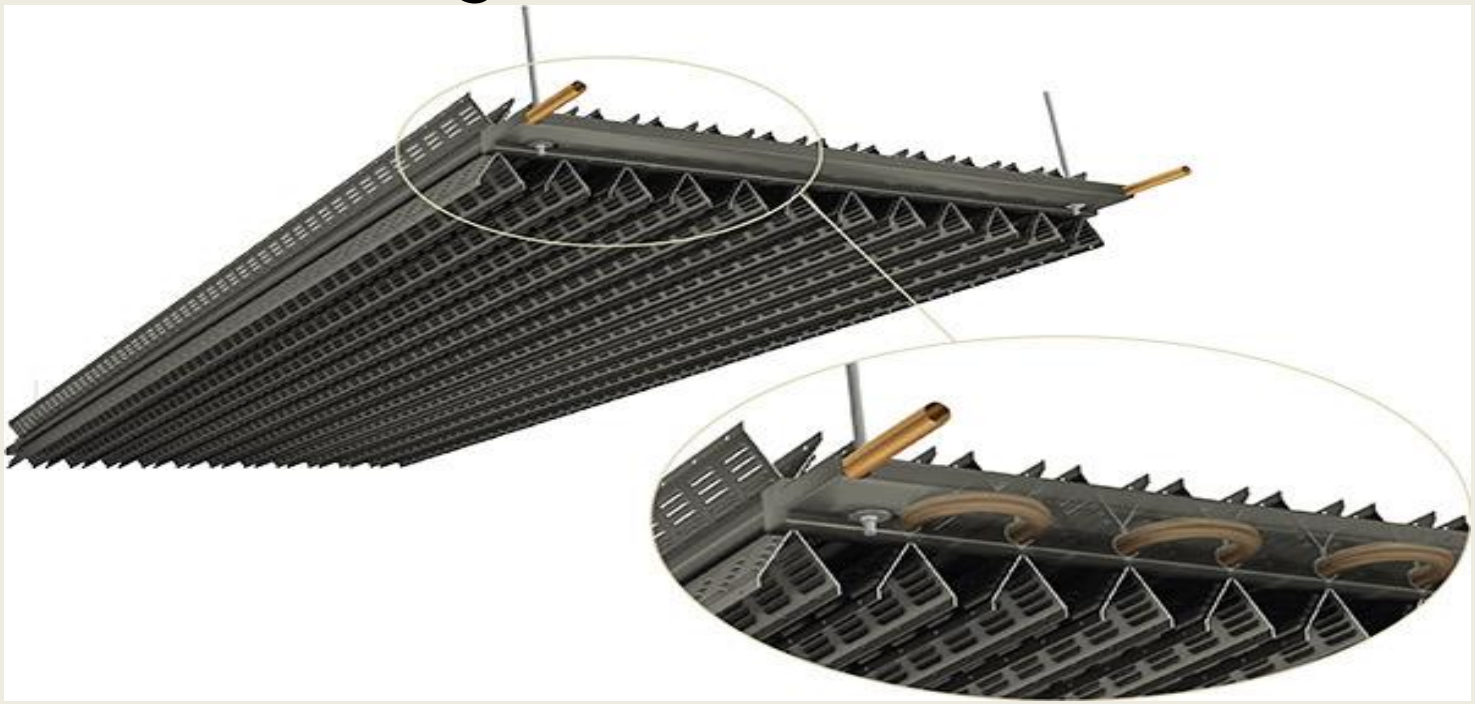
- ~160 W/m² of elements





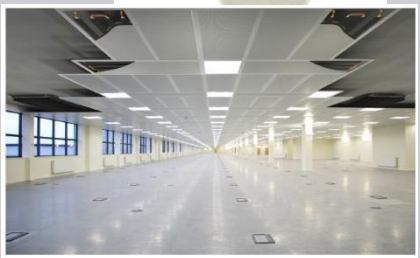
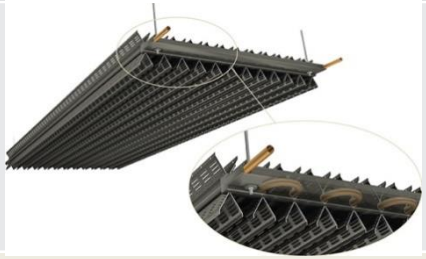
4. Radiant panel with higher heat transfer area

- These systems comprises a framework of angled fins with chilled water pipe integrated into the center of each angled fin



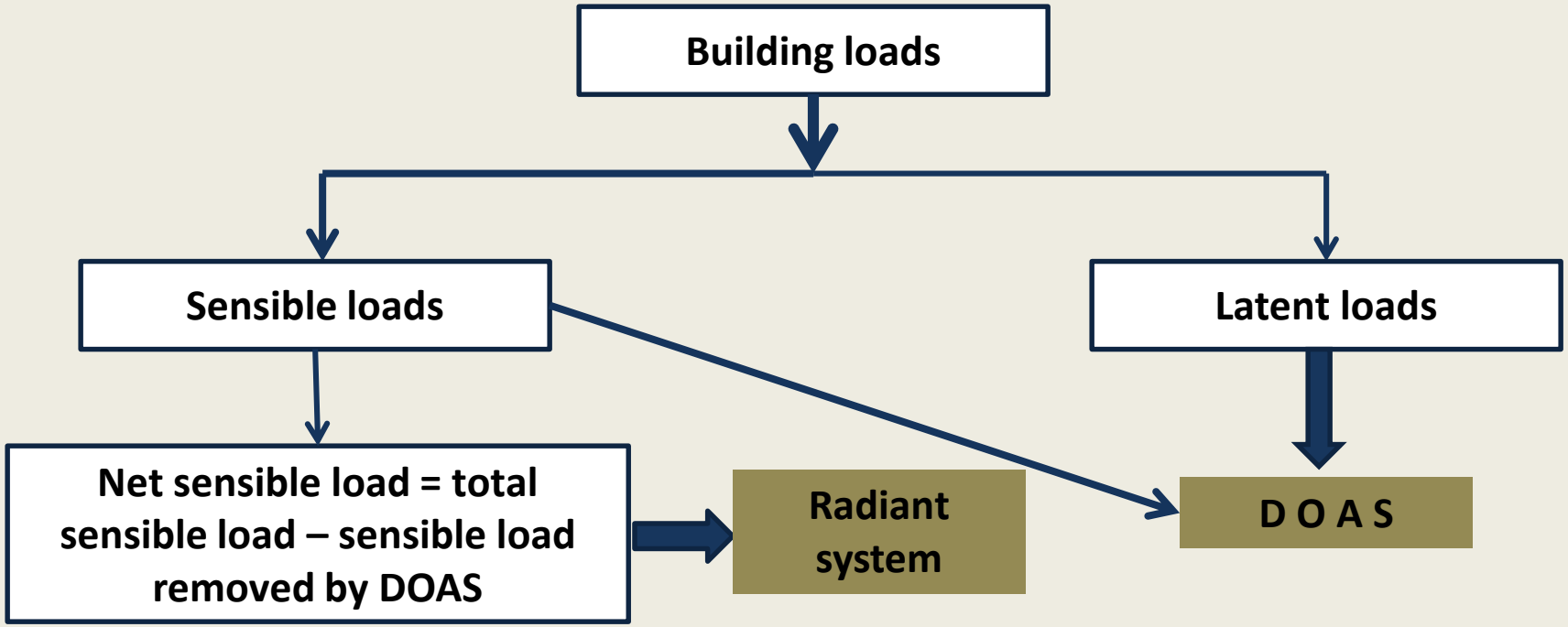
4. Radiant panel with higher heat transfer area

Characteristics of panel systems

No	System type	Capacity W / m² (active area)	Radiation & Convection	Surface finish
1	Radiant panel - Plaster boards 	55 – 65	**Radiation - 70% Convection - 30%**	Special Plaster
2	Radiant panel – Boned 	72 - 99	**Radiation - 70% Convection - 30%**	Metal (Al/steel)
3	Radiant panel – Suspended 	80 – 120	**Radiation - 60% Convection - 40%**	Metal (Al/steel) With no insulation on rear end
4	Radiant panel with higher heat transfer area 	90 - 200	**Radiation - 50% Convection - 50%**	Fins over copper tubes & Perforated ceiling

RADIANT PANEL SIZING

Panel system sizing



- D O A S cools the fresh air to lower temperatures to remove the moisture
- Cooled air supply removes some part of the sensible loads

Radiant panel cooling - determining capacity

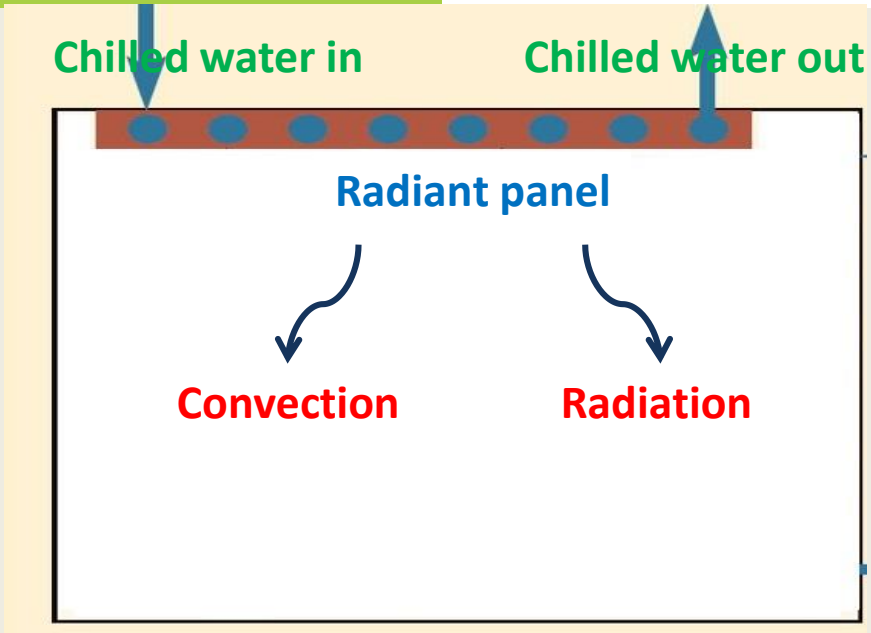
- Determine cooling load
- Cooling capacity of radiant panels

  = Area x (design cooling load)

E.g. Design conditions:

- Dew point temperature - 14 ^{0}C

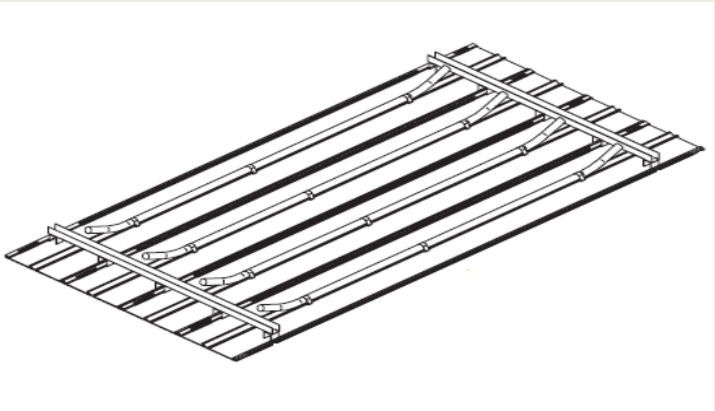
  @ 25 ^{0}C; RH – 50 %
- Operative temperature = 25 ^{0}C

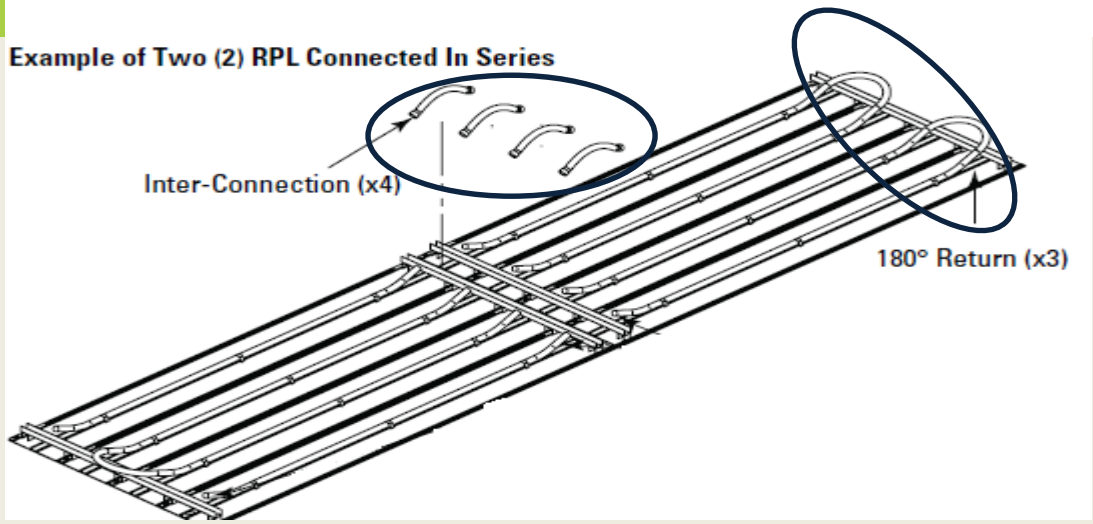


Cooling surface	Combined Heat transfer coefficient $H_{rad+conv}$ (W/m^2 K)	Allowable surface temperatures ^{0}C	Capacity per unit chilled surface area W / m2
Ceiling	8 - 11	16	99

Panel modules

- Linear

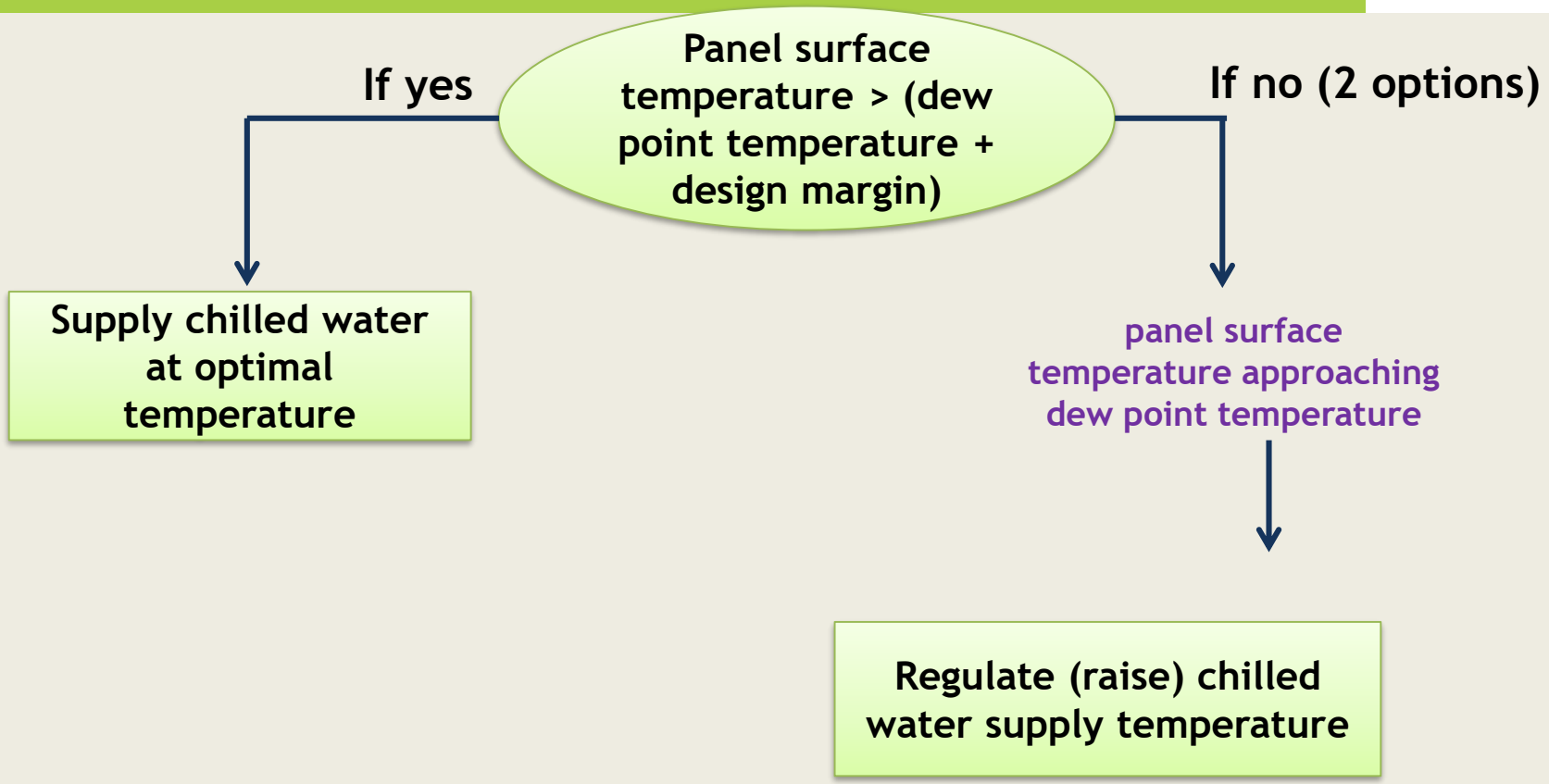




- Modular

Different arrangements

Controls to avoid condensation



Panel cooling - Summary

- Simple and quick installation
- Available in different capacities (55 – 160 W/m^2)
- Can be installed in existing and new buildings
- Responds quickly to load variation because of less thermal mass
- Can be quickly controlled to avoid condensation

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THANK YOU