

# Cool ceiling

## Ventilation principles

- ✓ Sustainability
- ✓ Innovative and simple
- ✓ Aesthetics and common sense





# About AJS ventilation

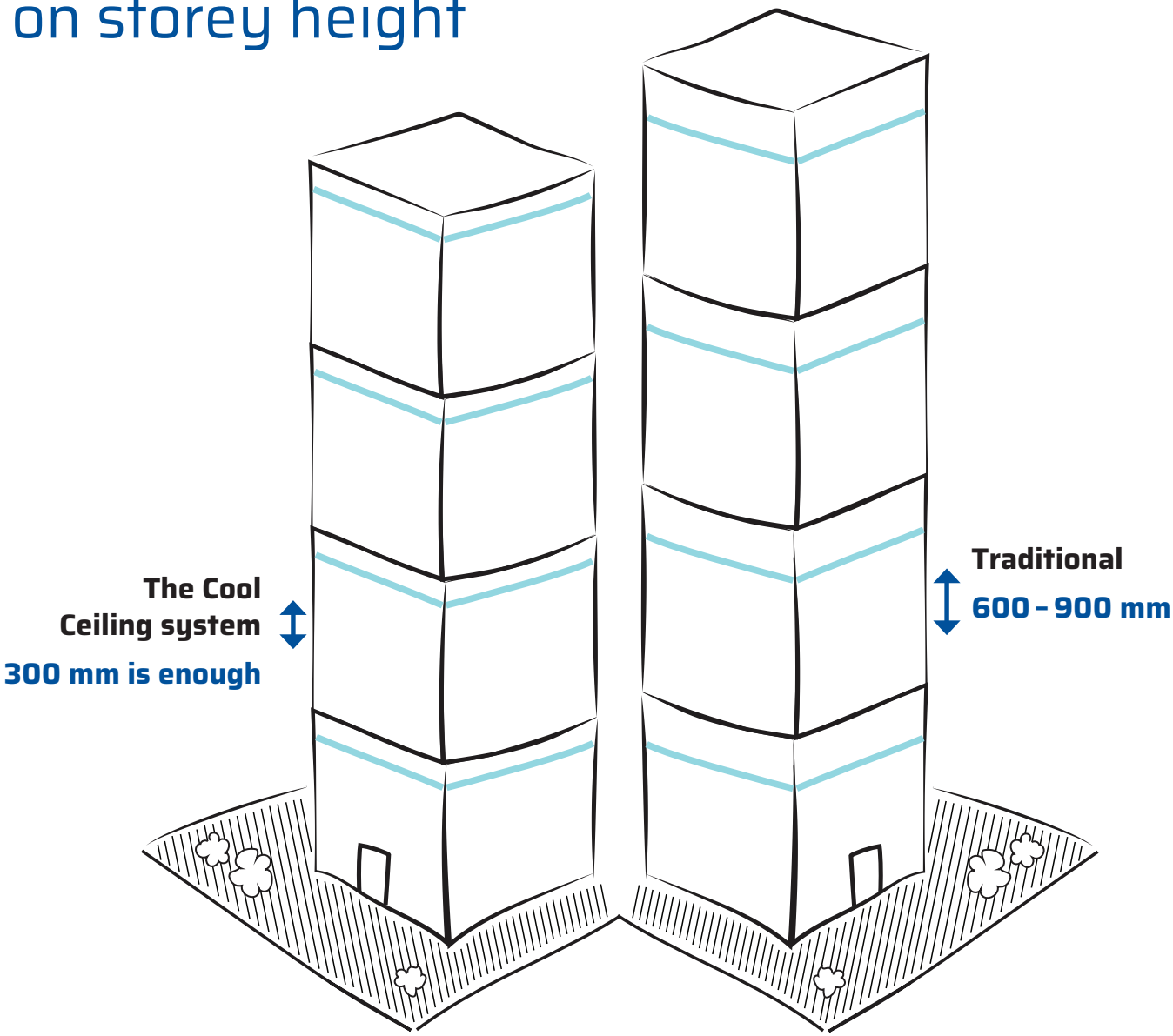
AJS ventilation is a joint venture between the Danish JS Ventilation and the Bangladeshi ABG Interlinks, established in April 2018. AJS ventilation brings Danish technology in Bangladesh with a fully trained workforce. ABG Interlinks Ltd. and JS ventilation's partnership, is offering a fresh and very focused approach to the market of ventilation equipment. It's a partnership accompanied by Danish know how and Bengali competencies.

## The Cool Ceiling system

"Cool Ceiling" is the fruit of skills and hard work. The solution is greeted by a hands-on approach combined with an innovative approach to solving often complicated challenges. With the use of natural laws and smart design, AJS ventilation has invented a combined cooled Ceiling and ventilation solution, which can reduce the building height or provide space for more floors when constructing multi-story buildings. This means: no ducts, design freedom, shorter construction time, no maintenance, and it contributes to lower energy consumption. "Cool Ceiling" is therefore a sustainable solution that can handle large refrigeration requirements without condensation and draft inconvenience and meets the requirements for indoor climate category A. "Cool Ceiling" is patented and developed in close cooperation with and tested by the Danish Technological Institute.



# Save 10% on storey height



## Minimise:

- ✓ Investment
- ✓ Energy consumption
- ✓ Maintenance
- ✓ Operating costs

## Segments:

- |                |                           |                       |
|----------------|---------------------------|-----------------------|
| • Offices      | • Pharmaceutical Industry | • Kindergartens       |
| • Industry     | • Concert Halls           | • Sports Halls        |
| • Housing      | • Auditoriums             | • Industrial Kitchens |
| • Hospitals    | • Schools                 |                       |
| • Laboratories |                           |                       |



# Cool Ceiling

Example for office 10 - 1000 m<sup>2</sup>

## Normal to high cooling load

### Conditions

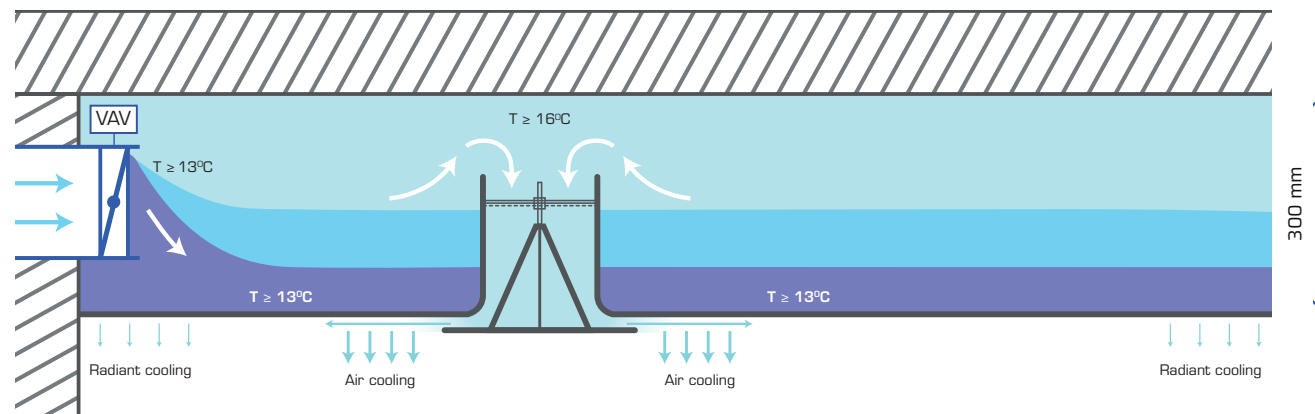
Room with heating load from persons, lighting, IT (machinery), heat transmission through the building and solar irradiance through the windows.

### Solution

Cool Ceiling controlled ventilation, cooling and heating. Control of the air volume (VAV-Damper) according to whether there are persons in the room, temperature and/or CO<sub>2</sub> load.

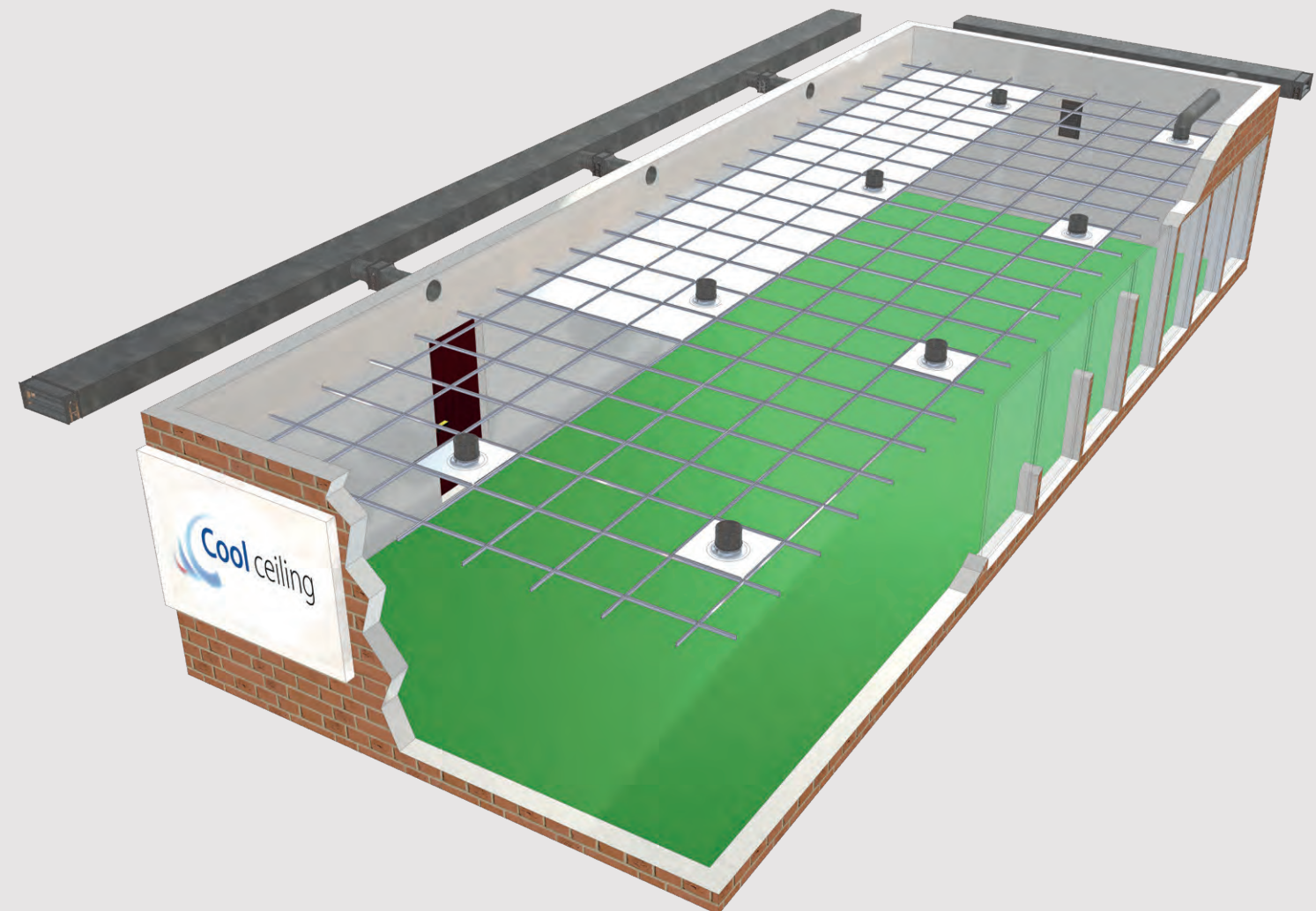
### Components

- Air inlet from the main ventilation system over the ceiling (no ducts)
- VAV-Damper
- Cool Ceiling (Metal Ceiling)
- Inlet diffusers integrated in the ceiling
- Exhaust diffusers can be placed in the ceiling, in the wall or where it is best for the design of the room



### Benefits

- Ventilation, cooling and heating in the same installation
- No Ducts
- Low differential pressure (Energy saving)
- Reduced floor height (gross)
  - 300 mm above ceiling
- Cover large cooling needs up to 67W/m<sup>2</sup> in indoor climate cat. A and up to 100W/m<sup>2</sup> in indoor climate cat. B
- No Draft
- Variable airflow 25-100%
- Flexible ceiling solutions
- Short construction period
- Design, calculation and documentation



# Cool Ceiling with Fan Coil(s)

Example for office 10 - 1000 m<sup>2</sup>

**Normal to very high cooling load**

## Conditions

Main ventilation system with low air volume (only for air change).

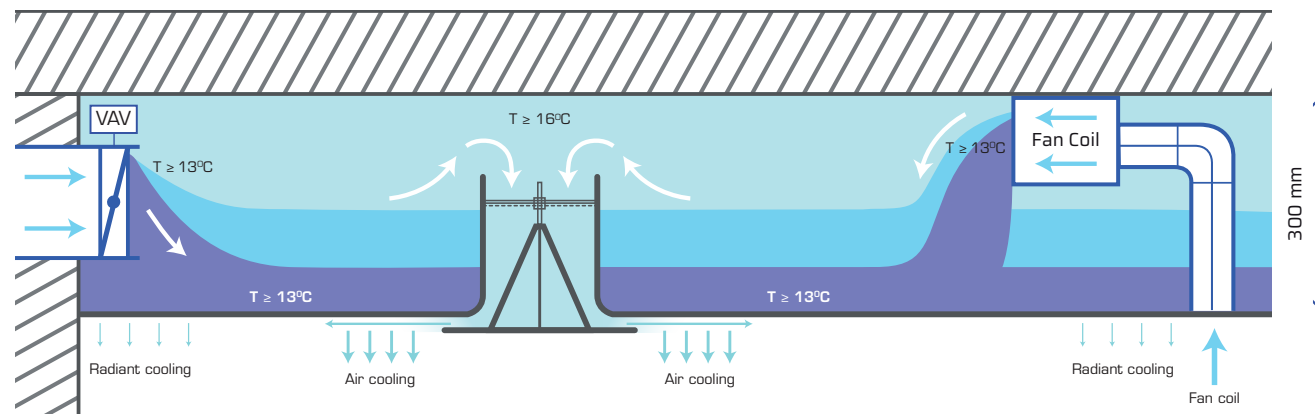
Room with heating load from persons, lighting, IT (machinery), heat transmission through the building and solar irradiance through the windows.

## Solution

Cool Ceiling controlled ventilation, cooling and heating. Supplied with Fan Coil(s) for high cooling capacity. Control of the air volume (VAV-Damper) and Fan Coil(s) speed according to whether there are persons in the room, temperature and/or CO<sup>2</sup> load.

## Components

- Air inlet from the main ventilation system over the ceiling (no ducts)
- VAV-Damper
- Cool Ceiling (Metal Ceiling)
- Inlet diffusers integrated in the ceiling
- Fan Coil(s)
- Exhaust diffusers can be placed in the ceiling, in the wall or where it is best for the design of the room

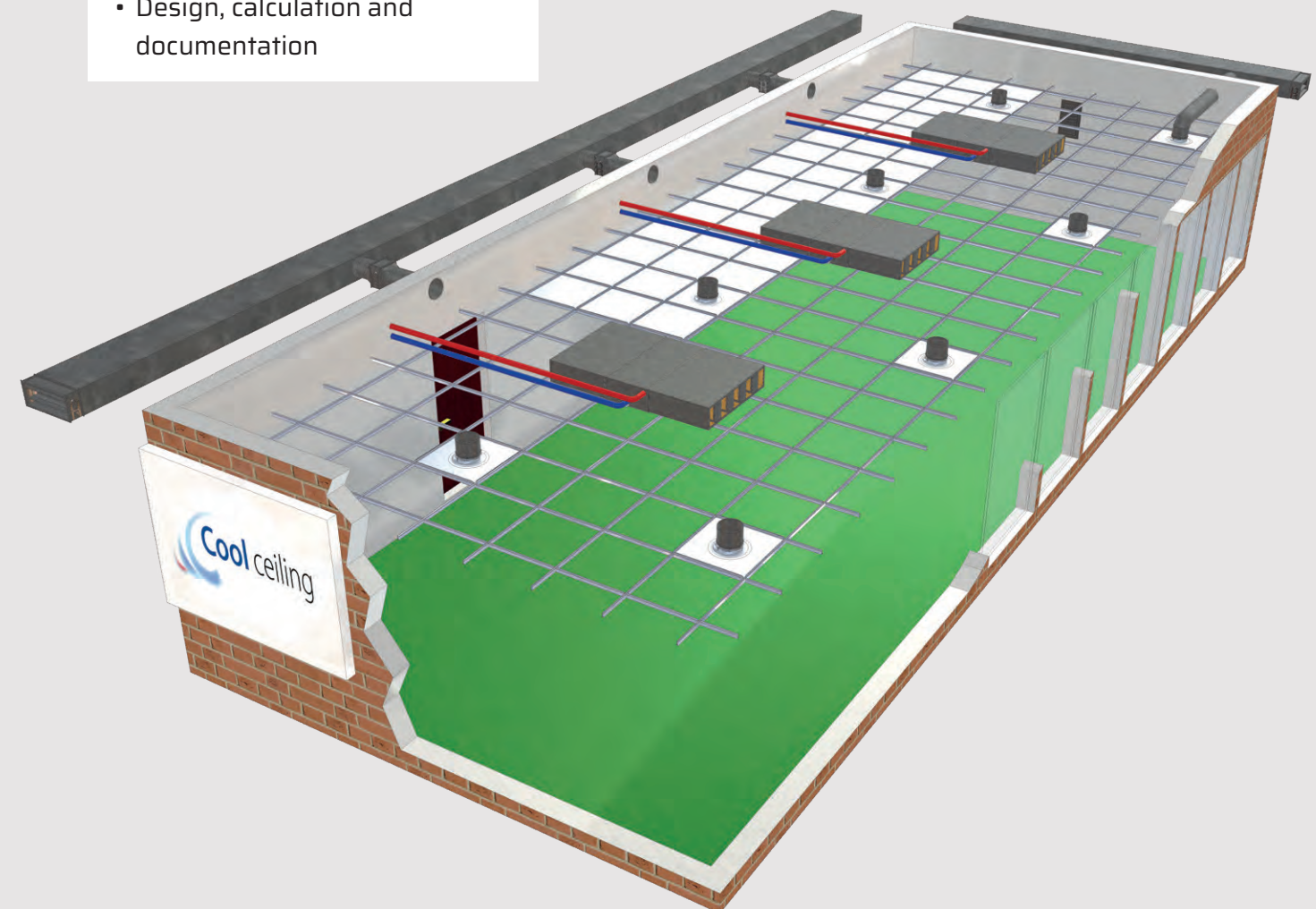
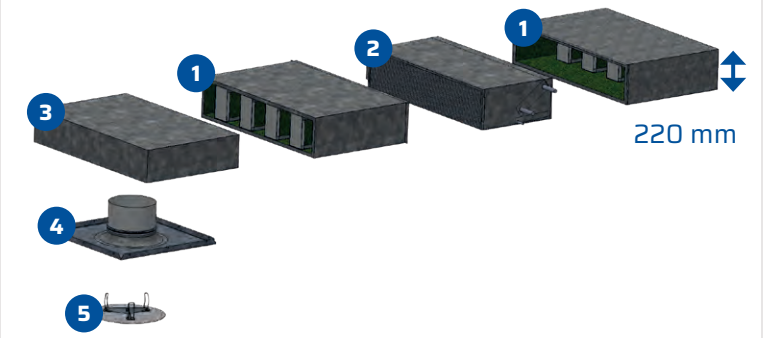


## Benefits

- Ventilation, cooling and heating in the same installation
- No Ducts
- Smaller main ventilation system (Lower building costs. Energy saving)
- Low differential pressure (Energy saving)
- Reduced floor height (gross) - 300 mm above ceiling
- Cover large cooling needs up to 67W/m<sup>2</sup> in indoor climate cat. A and up to 100W/m<sup>2</sup> in indoor climate cat. B
- No Draft
- Variable airflow 25-100%
- Flexible ceiling solutions
- Short construction period
- Design, calculation and documentation

## Fan Coil(s) description Pc.

- 1 Absorbent silencer
- 2 Fan Coil with air filter
- 3 Duct for exhaust air
- 4 Cool Ceiling ductconnection
- 5 Vacuum distribution plate





# Cool Ceiling with Hybrid Solution

Example for office 10 - 1000 m<sup>2</sup>

## Normal to very high cooling load

### Conditions

Low outdoor temperature part of the year or at night for night cooling.

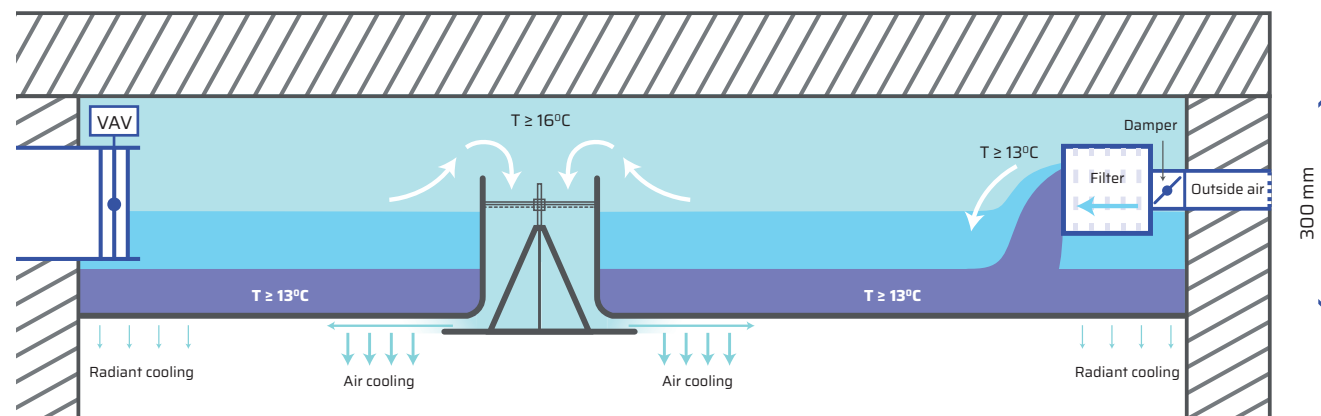
Room with heating load from persons, lighting, IT (machinery), heat transmission through the building and solar irradiance through the windows.

### Solution

Cool Ceiling controlled ventilation, cooling and heating supplied with Hybrid for direct cooling and using low outside temperature. The damper for the inlet air is closing (or the fan can be halted), when the Hybrid damper opens. Control of the air volume (VAV-Damper and Hybrid Damper) according to the temperature and/or the CO<sub>2</sub> load.

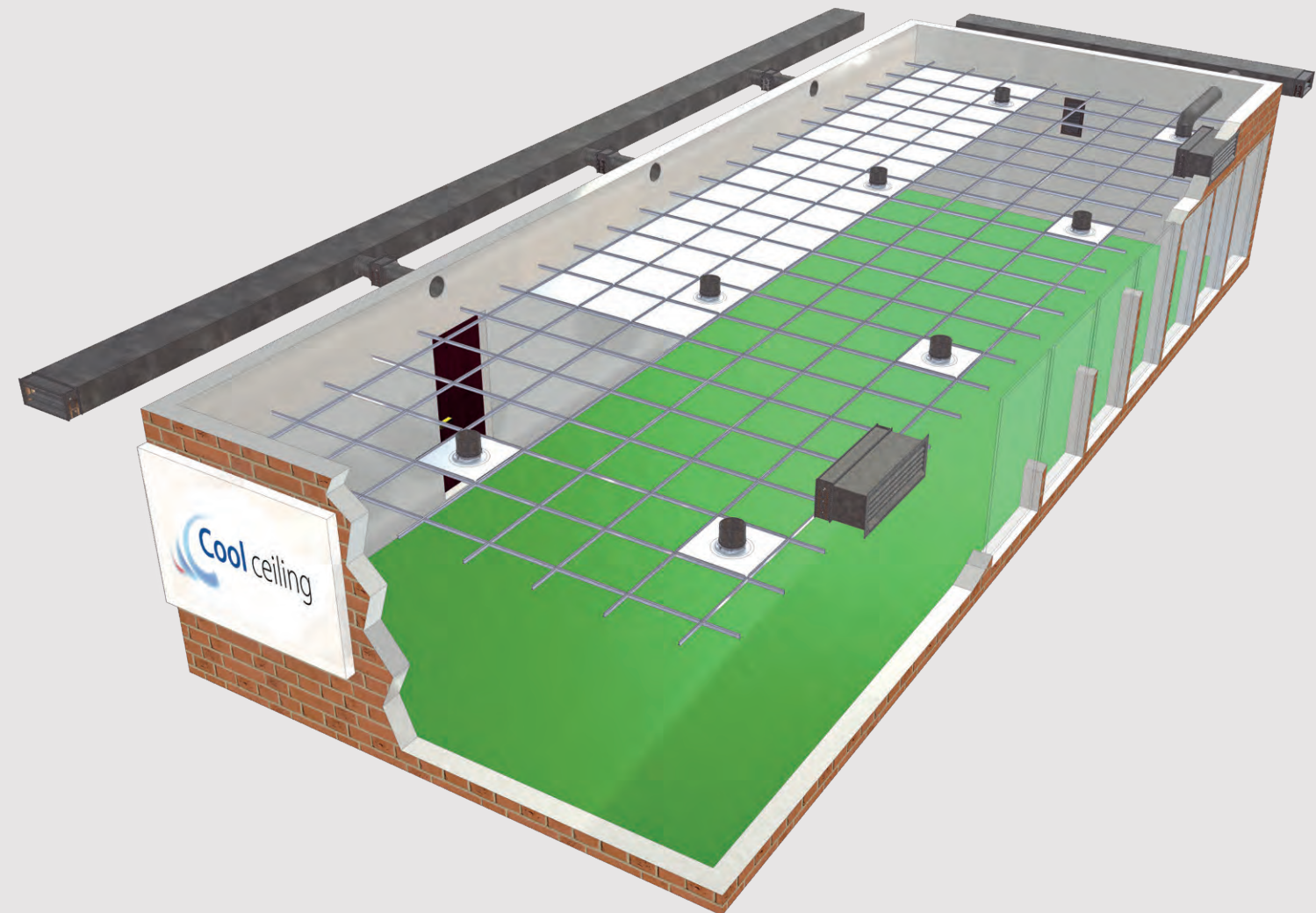
### Components

- Air inlet from the main ventilation system over the ceiling (no ducts)
- VAV-Damper
- Hybrid inlet with damper
- Smart Ceiling (Metal Ceiling)
- Inlet diffusers integrated in the ceiling
- Exhaust diffusers can be placed in the ceiling, in the wall or where it is best for the design of the room



### Benefits

- Ventilation, cooling and heating in the same installation
- No Ducts
- Closing the inlet damper and halting the fan (Energy saving)
- Low differential pressure (Energy saving)
- Reduced floor height (gross) - 300 mm above ceiling
- Cover large cooling needs up to 67W/m<sup>2</sup> in indoor climate cat. A and up to 100W/m<sup>2</sup> in indoor climate cat. B
- No Draught
- Variable airflow 25-100%
- Flexible ceiling solutions
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# New build with major savings and good indoor climate

Construction calls for new solutions and new solutions call for innovative thinking. That’s why Copenhagen International School chose to install Cool Ceiling; prior to launch in Nordhavn January 2017.

Cool Ceiling is a climate ceiling system reducing height between floors, shortening construction time, resulting in a better overall economy. We delivered approx. 19.000 m² ceiling plates resulting in a 4% saving of the entire construction sum. This corresponded to more than DKK 20 million (USD 3.3 million).

Copenhagen International School’s large construction consists of 4 towers; of which 1 tower has 7 floors. Choosing Cool Ceiling saved 2 meters of overall height – also resulting in a cut-off of stairs, glass fronts, steel and concrete.

Many students generate a lot of heat. It was of utmost importance that our solution was able to cool rooms, with many people and large glass sections. The Danish Technological Institute confirmed that Cool Ceiling complied with the strict requirements within indoor climate, as regards draft and temperature.

Thus, Cool Ceiling perfectly suited Copenhagen International School’s needs and wishes for creating a sustainable school with the latest technology and optimal indoor climate.

**FACTS:**

- 19.000 m²
- Approx. 4% saving of overall economy (USD 3,35)
- 2,1 meters lower overall height
- No pipes or ducts
- Indoor climate category A
- No draft

**Builder:** ECIS  
**Contract:** Ventilation  
**Contract sum:** DKK 13 million (USD 2.1 Million)  
**Period:** 2015 - 2017  
**Advisor:** NIRAS A/S  
**Architect:** CF Møller







## New ventilation solution for Rigshospitalet's OPS intensive care wards

**Rigshospitalet (the Copenhagen University Hospital) needed better cooling of its intensive care wards and to get rid of draft that were problematic for both patients and staff.**

To solve these air cooling and draft problems, the Cool Ceiling system with ventilation and cooling was installed in eight OPS intensive care wards. This system can handle cooling loads even larger than 100W/m<sup>2</sup>, while at the same time ensuring a comfortable indoor climate without draft.

An extra bonus for Rigshospitalet was that the new ceiling system also solved existing problems with a shortage of space above the ceiling. This was caused by the many technical installations above the ceiling, that this type of ward usually has. With the Cool Ceiling system, no ventilation ducts are necessary; because of the entire air handling space above the ceiling functions as an air pressure chamber.

### Finalised projects at Rigshospitalet:

- 8 OPS intensive care wards
- Medication room
- Pharmacy - massage room
- Pharmacy - office
- 8 intensive care wards and 2 observation wards for Children with paediatric cardiac
- Recovery ward
- Scanning room
- Operation theater

## New renovated operating room with "Cool Ceiling" LAF-solution

**Rigshospitalet wanted to transfer the good experiences from their Intensive care wards with "Cool Ceiling" as they were to renovate an operating theater because they wanted better cooling capacity with no draughts.**

Less expensive installation costs and simpler coordination of available space above the ceiling due to no ducts connections to supply air diffusers.

At first, the operating room was built with a TAF solution (turbulence air flow), but soon they wanted to change it to LAF (laminar air flow) solution.

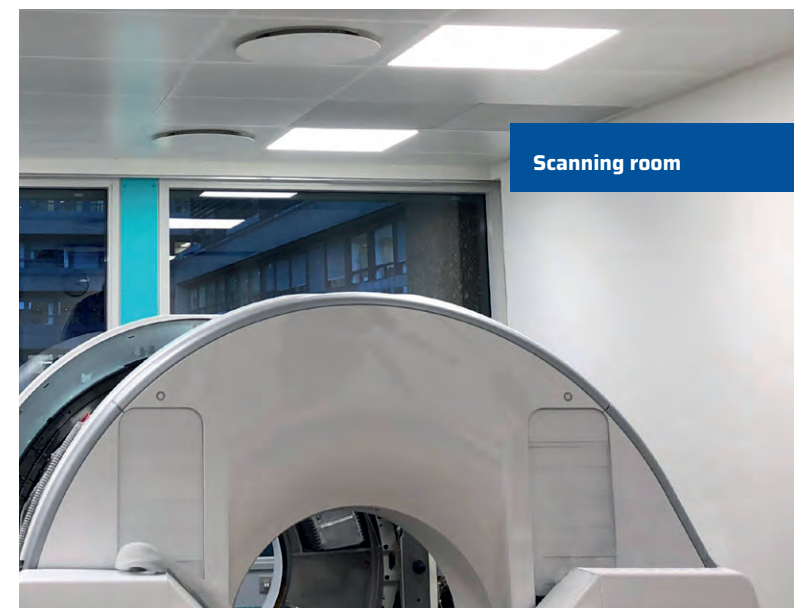
The operating theater can be changed from TAF to LAF (and vice versa) in a short time as the supply air system is built into the ceiling tiles and can be replaced in a short time.

### Test results

Both at the TAF and LAF solution, the "Cool Ceiling" system more than fulfilled all of the limit values for particulate matter and air distribution

### Service and Maintenance

The ventilation unit and the associated HEPA-filter are located outside the operating room, which provides easy access to service and maintenance and the room avoids contamination during the process.







## Office Building in Vordingborg, Denmark

### Renovating

#### Challenge:

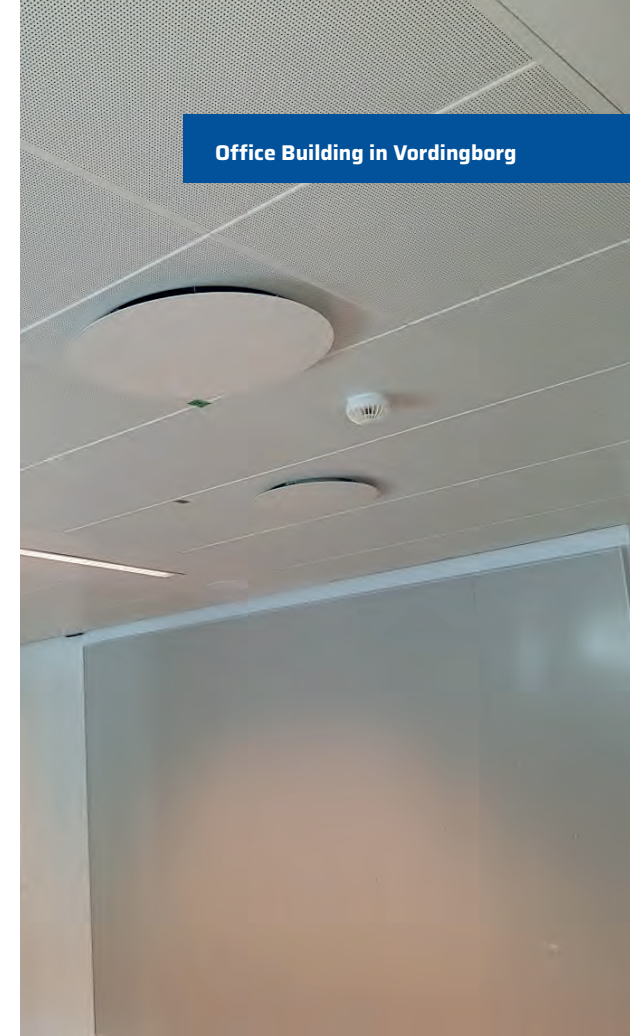
Higher heating load from more people and great solar irradiance. Draft problems.

#### Solution:

Cool Ceiling with fancoils and air change by small main ventilation system.

#### Result:

Perfect temperature without draft and very quiet rooms. All tested to satisfaction of the Danish Technological Institute.



## Renovating Dansk Metal, Sydporten, 7000 m<sup>2</sup>

#### Challenge:

High sun load. Existing ventilation system too small to provide enough cooling. New ceiling should be installed.

#### Solution:

Instead of changing the entire ventilation system to a larger one, "Cool Ceiling" was installed with Fan Coils to deliver the extra cooling needs.



Fan Coils mounted over the ceiling





## “Loose particles” Test in the new mockup at OUH-intensive care ward

### Hypothesis

Thesis: “Loose” particles in the air handling space above the ceiling are ejected from the ventilation system within short time, after which the air handling space above the ceiling will no longer contaminate the air being injected into the room.

### Discussion

When there is a varying volume of airflow and possible mechanical effects on parts of the air handling space above the ceiling, is it probable that this could cause a short-term effect of particles being released into the injected ventilation air?

When the air handling space above the ceiling is used as part of the ventilation system for clean-rooms, should the surfaces in the air handling space be cleaned for dust before closing off the system? Would this not reduce the risk of a short-term particle load to a negligible level?

### Conclusion

Testing showed that the air handling space does not contribute to any contamination of the ventilation air, when the air handling space is used as a pressure chamber. This is documented in the below figure.

### Testing in the new mockup at OUH-intensive care ward

Testing was performed 15 September 2015, with measurements taken in- and outside the intensive care ward, an area of about 25 m<sup>2</sup> with a ventilation rate of approx. 800 m<sup>3</sup>/h.

### Room and ceiling

The room had very recently been renovated and a new and airtight ceiling from AJS ventilation installed. H14 filters had also been installed after the air injection Smart System. The ceiling air handling space had not been cleaned, treated with a dust control system or anything of that nature after the renovation work had been completed, so there was a certain level of particles present on the surfaces in the air handling space above the ceiling.

### Filters

Nilan ventilation system type VPM 120 with built-in prefilter. After the system is a Camfil FCBS-A filter cabinet, with a built in Camfil Absolut-V H14 Hepa Filter VEXL 14 610X610X292-M.

A 250 mm duct is running from the filter cabinet to the air handling space above the dropped ceiling in the intensive care ward, and this duct ends with a silencer. The air extracted from the intensive care ward, exited through two 250 mm air outlets in the ceiling, with a duct running from each outlet ending in one 250 mm duct that runs directly back to the Nilan system.

The ceiling is a Cool Ceiling climate ceiling, and it is featured with four 160 mm integrated air diffusers, which not are connected by ducts.

Particle size	Measurement areas			
	In the duct after the H14 Hepa filter	In the inlet air diffuser	Intensive care ward	Hall near entrance
0.3 - 0.5 µm	0	0	2,210,161	8,723,172
0.5 - 1.0 µm	0	0	113,523	336,450
1.0 - 3.0 µm	0	0	60,309	147,196
3.0 - 5.0 µm	0	0	0	10,514
5.0 - 10.0 µm	0	0	0	3,504
>10.0 µm	0	0	0	0

The figures indicate the number of particles per m<sup>3</sup>.

Particle levels were measured in the hall at the entrance, to serve as a reference.

### Measuring instrument

The particle-level testing was performed using an Aerotrak 8220 particle counter, serial number 70 910 218.





# Sustainability

Where can “Cool Ceiling contribute” to sustainability:

✓ **Integrated Design Process:**

Relevant qualifications and subject areas are included in the planning process.

*If guidance of “Cool Ceiling” is included early in the design process, it may be possible to build lower or more floors. Ventilation systems can be minimised and reduce installation costs.*

✓ **Life Cycle Assessment (LCA)**  
- **Primary Energy**

3 Resource Indicators:

- consumption of non-renewable energy
- consumption of primary energy
- share of renewable primary energy

*With “Cool Ceiling”, ventilations systems should only be dimensioned according to volume of fresh air, as energy can be added via fan coils. Less volume of air results in a smaller duct system and lower energy consumption.*

*“Cool Ceiling” has lower pressure drop, which also provides less energy consumption.*

✓ **Thermic Comfort:**

Users' satisfaction with the indoor climate; no excess temperature, draft or cold radiation.

Indicators:

- operative temperature Summer and Winter
- humidity Summer and Winter
- draft Summer and Winter
- radiation- and floor temperature Summer and Winter

*“Cool Ceiling” causes no draft or condensation problems and produces cover large cooling needs up to 67W/m² in indoor climate A and up to 100W/m² in indoor climate B.*

*JS Ventilation’s calculation programme, developed by The Danish Technological Institute, makes a complete and accurate calculation of air and temperature. This calculation is made for all rooms and equals as documentation for the system. With this documentation it is only necessary with regulation for the room and not for every inlet diffuser.*

✓ **Indoor Air Quality (Knockout-criteria, where a minimum score is needed):**

The purpose is to secure the users’ comfort and health.

Especially schools and child care centers are important. Gradually, it is well-documented that children are particularly sensitive to the innumerable impact of the indoor climate and that it may affect students' well-being and, in particular, learning; if the indoor climate in the classroom is not good enough.

This can be avoided by not having too high concentrations of harmful substances and obnoxious smells.

Air Quality can be divided into 2: "The Experienced" and "The Healthy"	<b>"The Experienced"</b>	<b>"The Healthy"</b>
	<ul style="list-style-type: none"><li>• too low humidity</li><li>• smell</li><li>• too high/low temperature</li><li>• draft</li></ul>	<ul style="list-style-type: none"><li>• degassing from material</li><li>• degassing from people</li><li>• particles by burning</li><li>• moisture build-up</li><li>• radon</li></ul>

**Indicators**

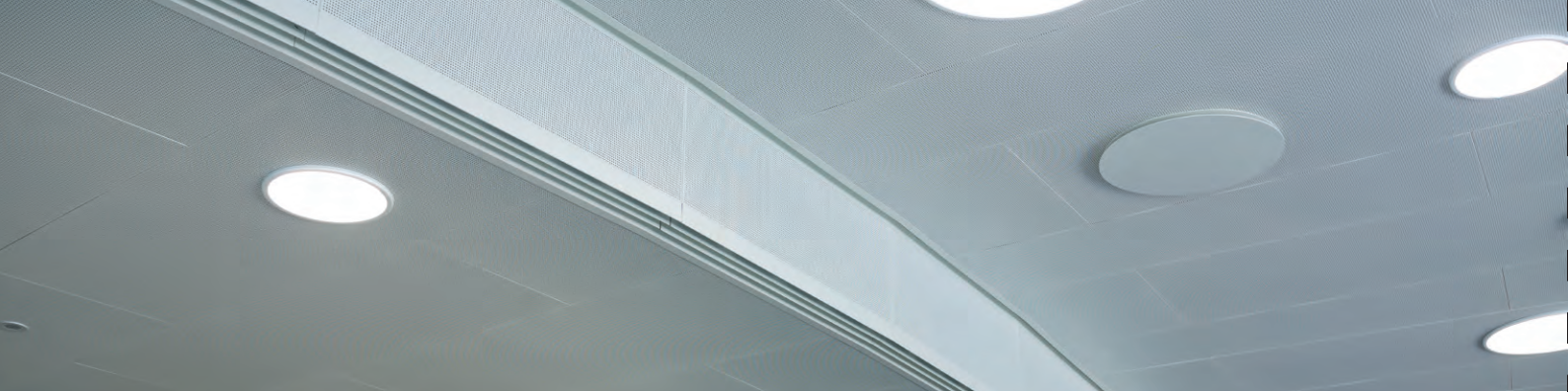
- CO² concentration below 1000 ppm
- measuring of volatile organic compound (VOC). TVOC-concentration below 3000 µg/m³
- formaldehyde concentration below 100 µg/m³

*All components of the metal ceiling are free from formaldehyde and are therefore assigned to Class E1.*

*The manufacturer declares that no substances were used for manufacturing metal ceilings, which cause hazardous emissions, thus no initial test is required. Furthermore, sub-structure components and covering layers were tested for compliance with the reference values for volatile organic compounds (VOC) according to the assessment system of the German Committee for Health-Related Evaluation of Building Products (AgBB).*

*“Cool Ceiling” is not a part of the problem, but part of the solution because the system supplies fresh air.*





### ✓ Users' possibility for controlling the indoor climate:

Focus on the fact that users, to a great extent, can control ventilation, solar radiation and glare shielding, temperature and lighting.

"Cool Ceiling" is controllable through CO<sub>2</sub> and temperature of plain operation.

### ✓ Fire Proofing and Safety:

Compliance of current fire regulations.

"Cool Ceiling" complies with the current fire regulations with a fire damper for each room like all other ventilation systems.

The fire classification was verified in accordance with EN 13501-1 and certified by classification reports from „MPA Stuttgart" (Notified Body No. 0672).

### ✓ Acoustics and Soundproofing:

To be evaluated from e.g. reverberation time in primary room.

"Cool Ceiling" is the markets' best metal ceiling

Class B (alpha)  $w = 0.80$

### ✓ Maintenance and cleaning-friendliness of buildings:

To be evaluated from e.g. maintenance grade and cleaning-friendliness.

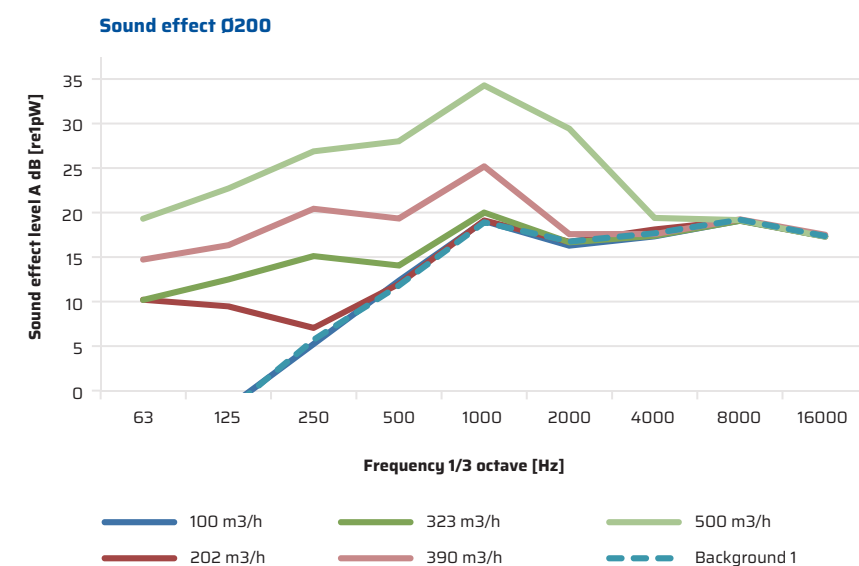
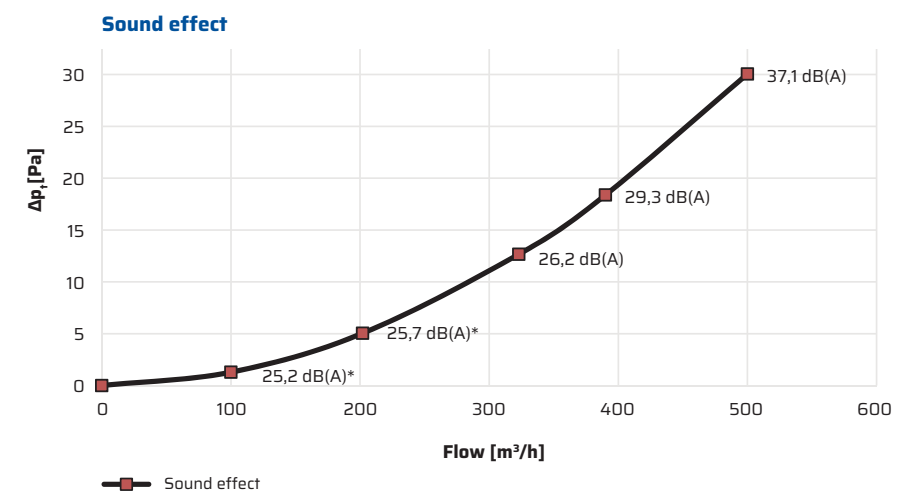
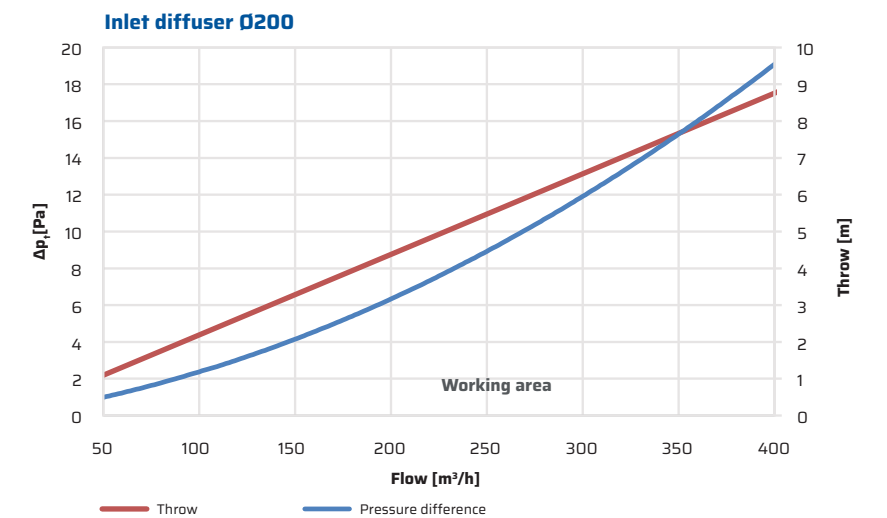
"Cool Ceiling" consists of no movable parts and needs no maintenance. The system has smooth surfaces and is very cleaning-friendly; with either a vacuum cleaner or a dry or damp cloth. In kitchens, laboratories etc. where standards may be higher, surfaces without perforation should be used.

### ✓ Suitability as regards dismounting and reusability:

To be evaluated from whether the material can be split up and sorted as regards reusability.

All "Cool Ceiling" parts can be split up and reused.

## Example Inlet Diffuser Ø200





# Design, calculation and documentation

In cooperation with the Danish Technological Institute we have developed a calculation programme, that can make an exact calculation of each room. We calculate the air volume, the cooling needs and the noise level. We will work closely together with you, your architects and engineers to meet your requirements and provide a good-looking design of the Ceiling and an optimal indoor climate.

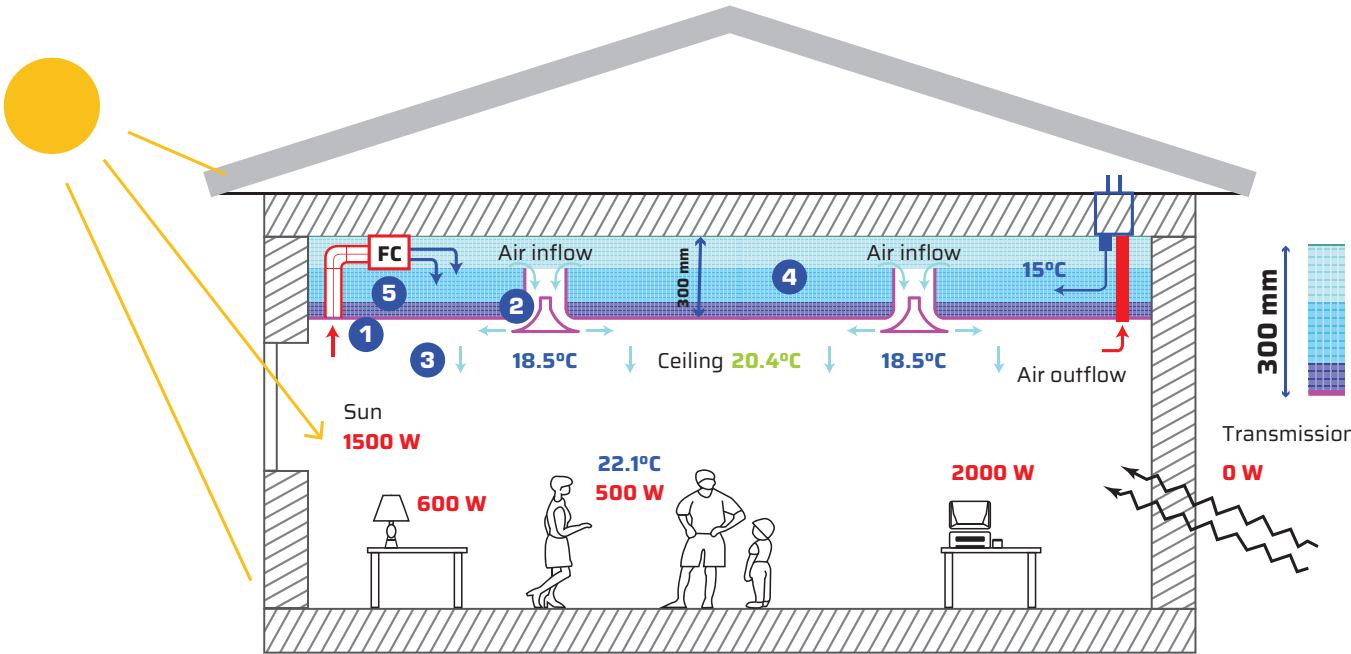
## Calculation Programme

Case reference: Test facility 01		
Test customer 01		
Test street 01		
Test city		
Phone	E-Mail	Reference number

### Cool Ceiling

Input			
Load			
Sun	1500 W	Ceiling height	2,7 m
Lighting	600 W	Floor area	114 m²
PC machines	2000 W	Outdoor temperature	25°C
Persons	500 W	Indoor temperature	23°C
		Inlet air diffuser	15°C
		Air volume	1846,8 m³/h

Area	U-value	Temp.	Calculation Result	
Outer walls			Air exchange (times per hour)	6
Inside walls			Inlet air temperature	18,5°C
Windows/doors			Operating temperature	22,1°C
Floor/deck			Ceiling Temperature	20,4°C
			Cooling Total	47,2 W/m³



- Ceiling Radiative cooling: 7.2 W/m²

Air cooling: 40 W/m²

Floor area: 114 m²

Ceiling height: 2.7 m
- 1 Metal ceiling

2 Air inflow unit

3 Cool air
- 4 Hollow space/ Pressure chamber

5 FanCoil = FC (Optional)

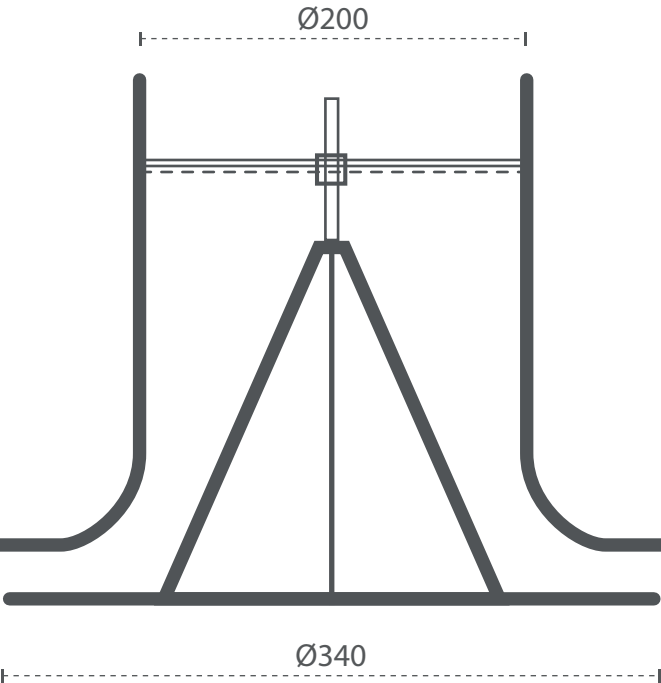




# Diffuser

Newly developed inlet air diffuser integrated in the ceiling. It is developed for variable airflow 25-100%

The diffuser is designed for VAV (variable air volume) without any moving parts, so that the Coanda effect is obtained from 25% - 100% of the designed airflow.

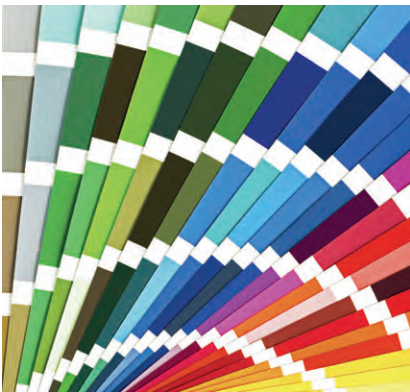


Patented

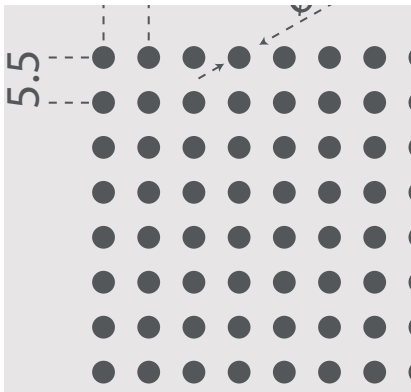
# Design Freedom



Format up to 625x3000 mm.



Colors



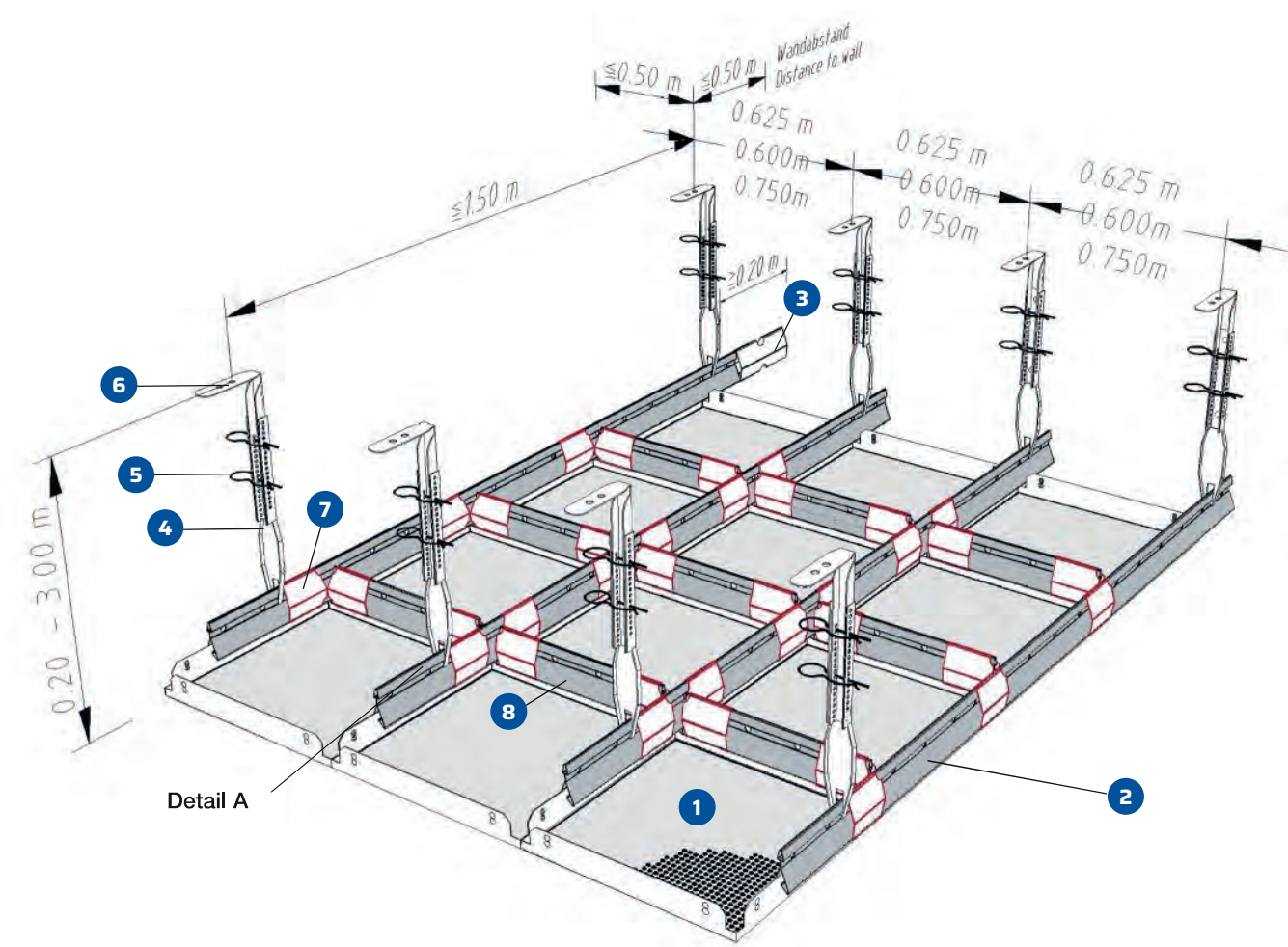
Perforation

# Data sheet

**KQK**  
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Square tiles - clip-in system

Standard design with cross rail at the same level (50 pascal)



Standard components required:

Designation	m²			Quantity / m²
	750	625	600	
1 Ceiling tile	1,78	2,56	2,78	units
2 Clipping rail 16/38	1,33	1,60	1,67	lin. ft.
3 Main runner connector	0,33	0,40	0,42	units
4 Lower nonius	0,89	1,07	1,11	units
5 Securing pin	1,78	2,14	2,22	units
6 Upper nonius	0,89	1,07	1,11	units
7 T-connector	3,56	5,12	5,56	units
8 Clipping rail	1,33	1,60	1,67	lin. ft.



# Notes

[illegible][illegible]





Contact us if you are considering an innovative and sustainable ventilation solution for new construction or renovation of existing buildings.

We design, calculate and solve the task in close cooperation with you, your architects and engineers.

Want to know more about the Cool Ceiling system?

Contact us:

Line ID : AS FRIIS LTD



**AS Friis Ltd.**

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Tel: +66 20 95 56 95 Fax: +66 20 95 56 90 email: [info@as-friis.com](mailto:info@as-friis.com) website: [www.as-friis.com](http://www.as-friis.com)