zehnder
always the best climate

# Zehnder Carboline

Technical document for heating and cooling ceiling modules

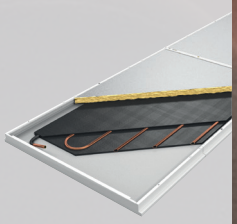
# Responsive and energy efficient.

As regulations for the thermal protection of buildings become stricter, the insulation used in buildings has to keep improving. As the building fabric is so well insulated, temperatures inside rooms rise significantly during the warmer seasons of the year. This is because the high external temperatures are boosted by the interior heat load; this heat is created by computers, copiers, printers and other technical equipment – as well as the people occupying the space. As a result, the future is set to see significantly more interest in not only keeping buildings at a comfortable level of warmth, but also in creating rooms that are pleasantly cool.

Zehnder Carboline represents an elegant, innovative response to the demands placed on today's indoor climate control systems, by offering heating and cooling at an exceptionally high level of energy efficiency.

## SPECIAL FEATURES OF ZEHNDER CARBOLINE

Due to expanded natural graphite, the Zehnder Carboline modules or heating and cooling ceiling elements provide optimal conditions for fast changes in temperature and energy-efficient usage once installed.



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## MOUNTING AND INSTALLATION

Zehnder Carboline offers you numerous installation systems for closed ceilings and ceiling sails. Your specific requirements will be professionally accommodated by Zehnder's expert staff.

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## TECHNICAL SPECIFICATIONS

- Calculation of pressure loss and minimum mass flow
- Heating and cooling performance
- Technical specification

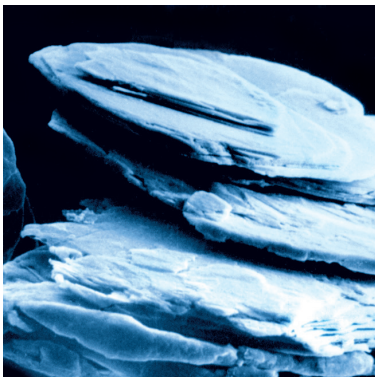
PAGE **16 – 23**

# Special features of Zehnder Carboline

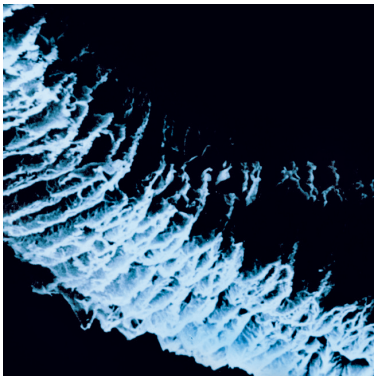
Due to the advanced design, excellent response characteristics are achieved in the event of a change of temperature. Combined with the excellent performance in the field of energy efficiency and architectural freedom, Zehnder Carboline modules for heating and cooling ceiling elements provide optimal solutions in all areas of application.

## Natural graphite

What distinguishes Zehnder Carboline from other modules or heating and cooling ceiling elements? One aspect is the ideal properties of the material used for the heating and cooling ceiling elements: expanded natural graphite.
Combined with Zehnder's expertise in the development and manufacture of surface heating and cooling systems, the result is a high-performance system that can be easily and practically integrated into new and existing grid ceilings.
This makes Zehnder Carboline perfectly suited to providing indoor climate control in offices, schools, hospitals, meeting rooms and surgeries – in short, everywhere that a comfortable and healthy indoor climate plays a decisive role.



Natural graphite

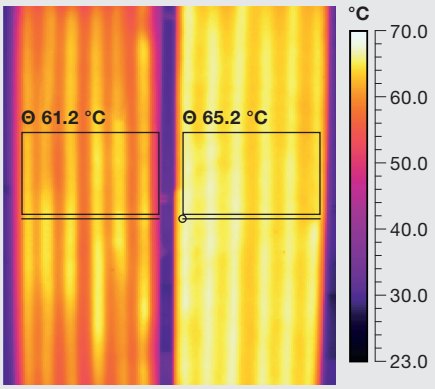


Expanded natural graphite

**Expanded natural graphite: an innovative material with ideal properties**

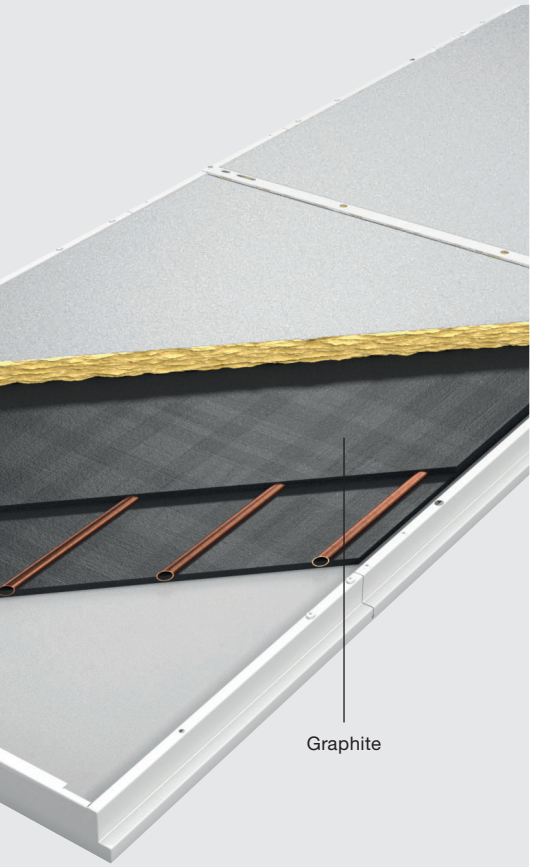
The material used for Zehnder Carboline is manufactured from scale-shaped natural graphite with a good crystalline structure.
It is a naturally occurring material and one of the inorganic modifications of carbon. The carbon atoms of the graphite are arranged in a hexagonal crystal lattice in flat, superimposed layers. The production process enlarges the volume of these parallel scales by 200 to 400 times. For Zehnder Carboline, the expanded natural graphite is then processed further into appropriately lightweight panels.

**Areas of application**
- Offices and meeting rooms
- Schools
- Nurseries
- Hospitals

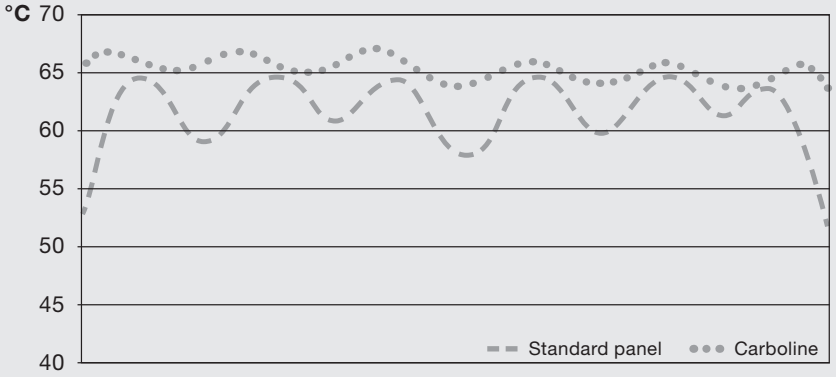


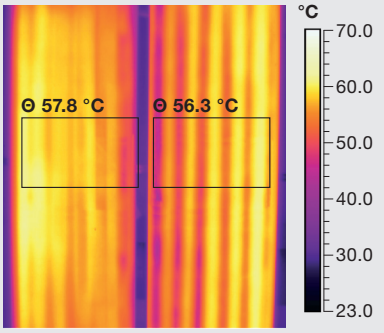

**left:** standard panel **right:** Carboline

The thermography shows the comparison between Zehnder Carboline (panel on right) and a competing product, both exposed to the same temperature and mass flow.
**Θ** = average surface temperature

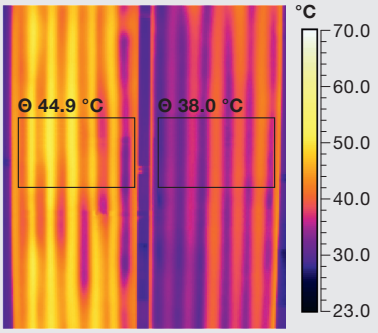



**Temperature variance across the panel width**

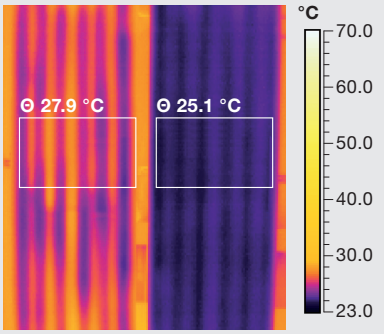


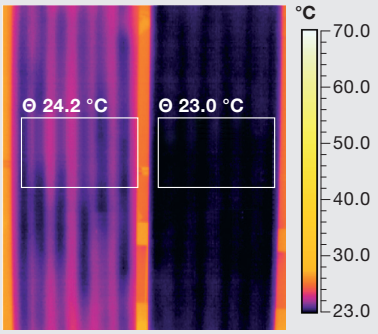

After 30 seconds
**left:** standard panel **right:** Carboline




After 1 minute




After 5 minutes




After 25 minutes

The reaction test also makes it clear that Zehnder Carboline reacts much more quickly than the competing product during a change of temperature from heating to cooling. Both systems were subjected to the same temperature and same mass flow for the test series. It can be seen that Zehnder Carboline cools much quicker and also shows better performance after 25 minutes.
**Θ** = average surface temperature

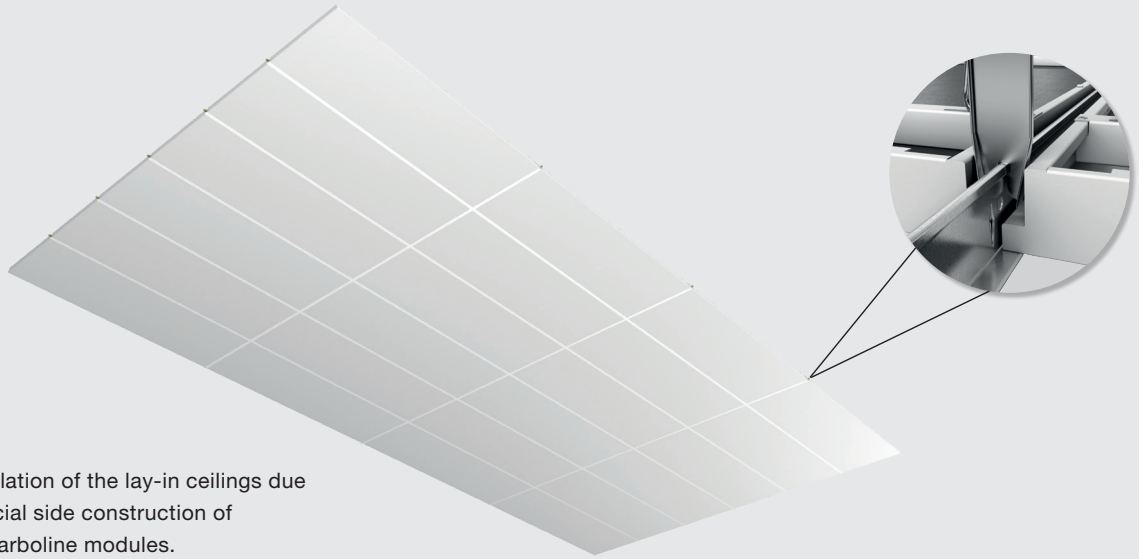
## + ADVANTAGE

- Good thermal conductivity
- Low density
- Non-flammable
- Long lifetime
- Physiologically inactive

# Lay-in modules for closed ceilings

Zehnder Carboline is tailored for use in new or existing lay-in ceilings. The available basic grid dimensions are 600. The lay-in modules come in five standard lengths. The length of the various lay-in modules is based on the basic grid dimension and can be up to five times the basic grid dimension.

The use of longer modules can reduce the cost of installation by up to 80% compared to conventional systems available on the market. The special side construction makes it possible to insert the modules easily into the lay-in ceilings.

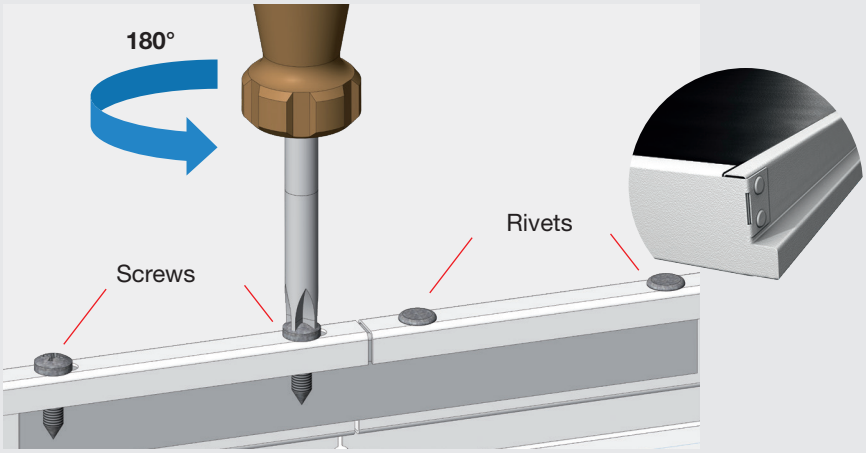


Easy installation of the lay-in ceilings due to the special side construction of Zehnder Carboline modules.

## Anti-flec technology for lay-in modules

**For use with lay-in modules in high temperatures and other applications.**

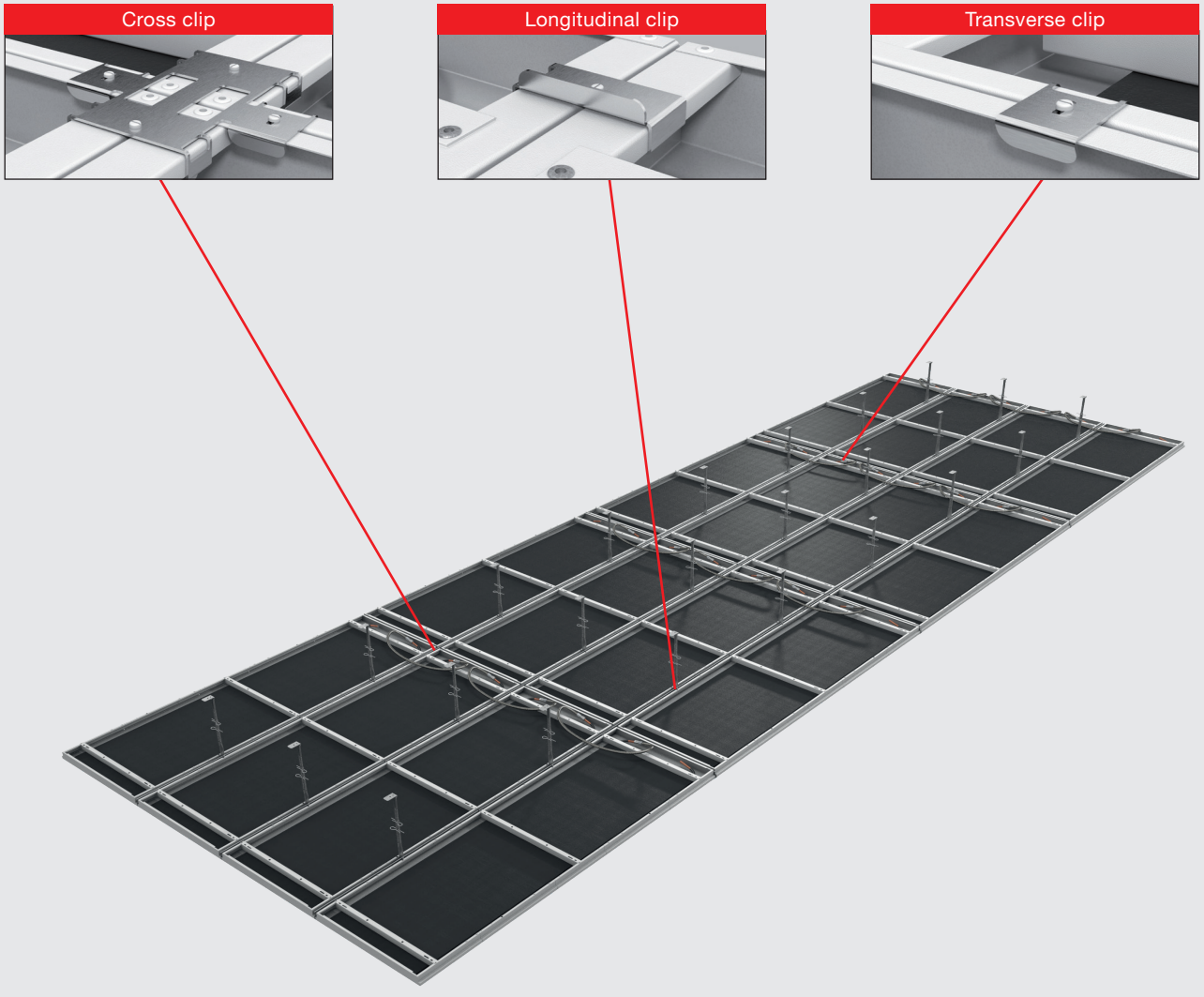
The Zehnder Carboline lay-in modules for grid ceilings are produced from a length of 1,500 mm with anti-flec technology. This ensures an even contact surface on the ceiling grid, even when heating. After laying the modules in the grid, the anti-flec profiles are loosened in the ceiling grid by opening the screw pairs.



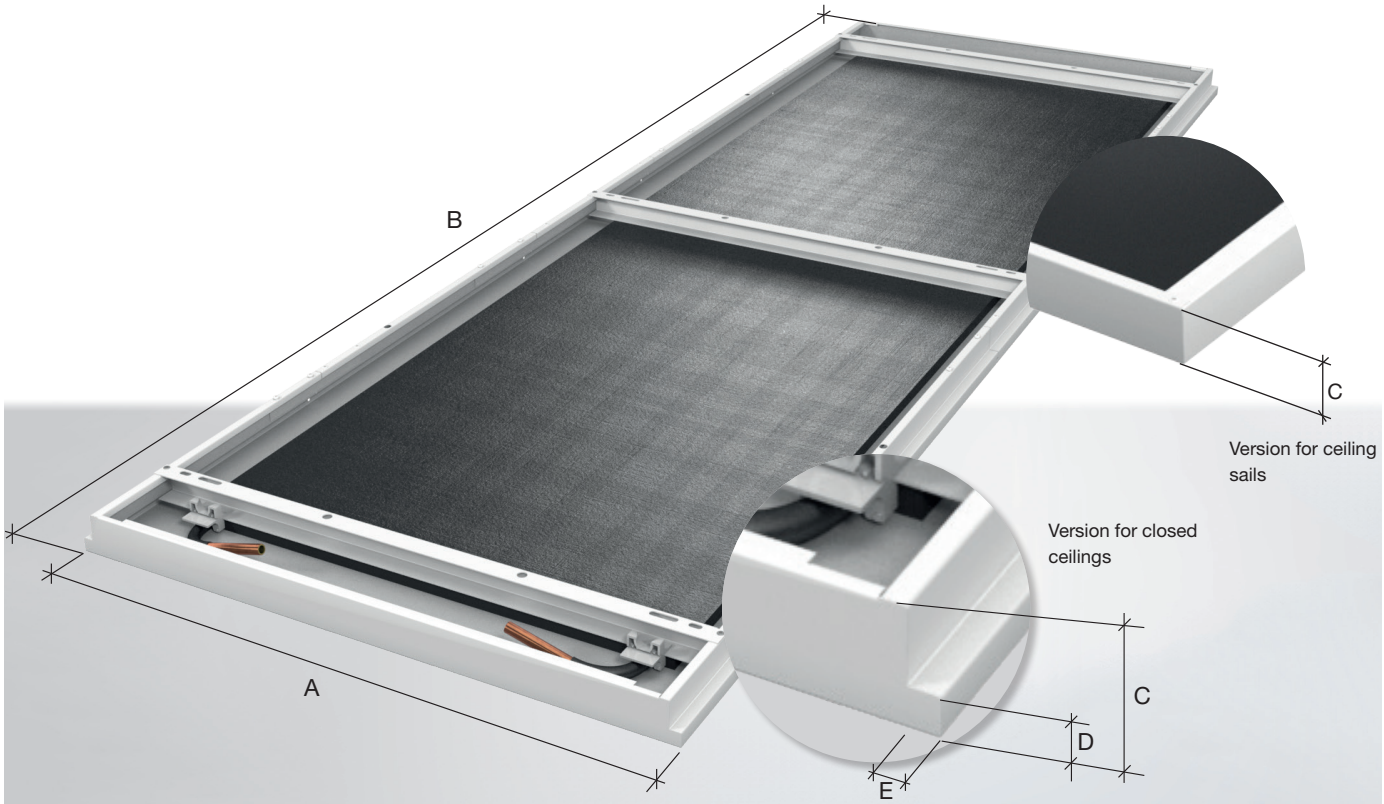
# Freely suspended modules for ceiling sails

Efficient, flexible and great looks: Zehnder Carboline ceiling sails are the energy-efficient and cost-effective alternative for cooling and heating rooms in various types of building. As they only require a short space under the structural ceiling, they are even ideal for properties with low room heights. The dimensions of Zehnder Carboline ceiling sails can be tailored to suit the individual requirements of any design. Free-hanging and without a substructure, they are quick and easy to install. Additionally, they offer improved sound absorption compared with closed ceilings. With their unobtrusive design and broad colour palette, Zehnder Carboline ceiling sails are also easy on the eye.

## Connecting clips for sail surfaces



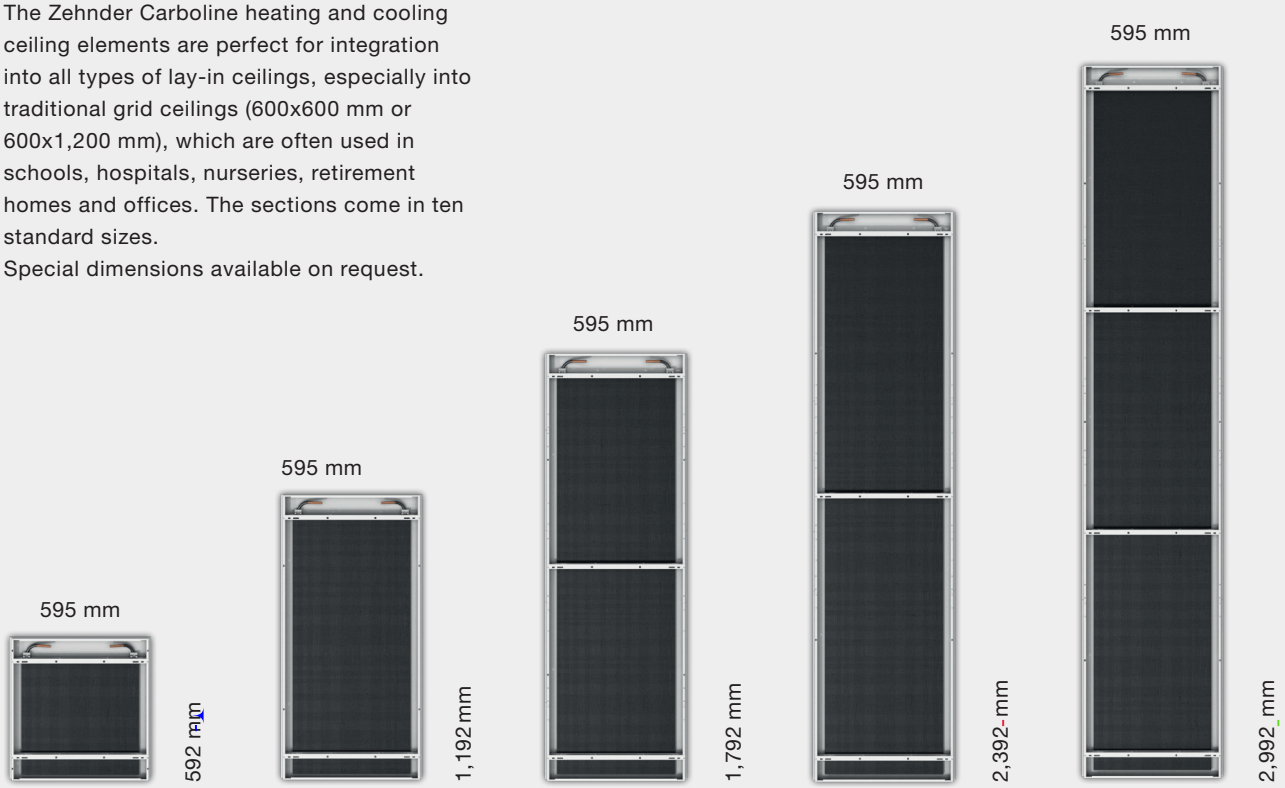
# Flexible installation options




| Module 600 | | | | |
|---|---|---|---|---|
| **Dimension** | **Description** | **Unit of measurement** | **Lay-in module** | **Ceiling sails** |
| A | Total width | mm | 595 | 600 |
| B | Total length | mm | 592 - 2,992 | 600 - 3,000 |
| C | Total height | mm | 40 | 40 |
| D | Height of the supporting edge | mm | 14 | - |
| E | Width of the supporting edge | mm | 10 | - |

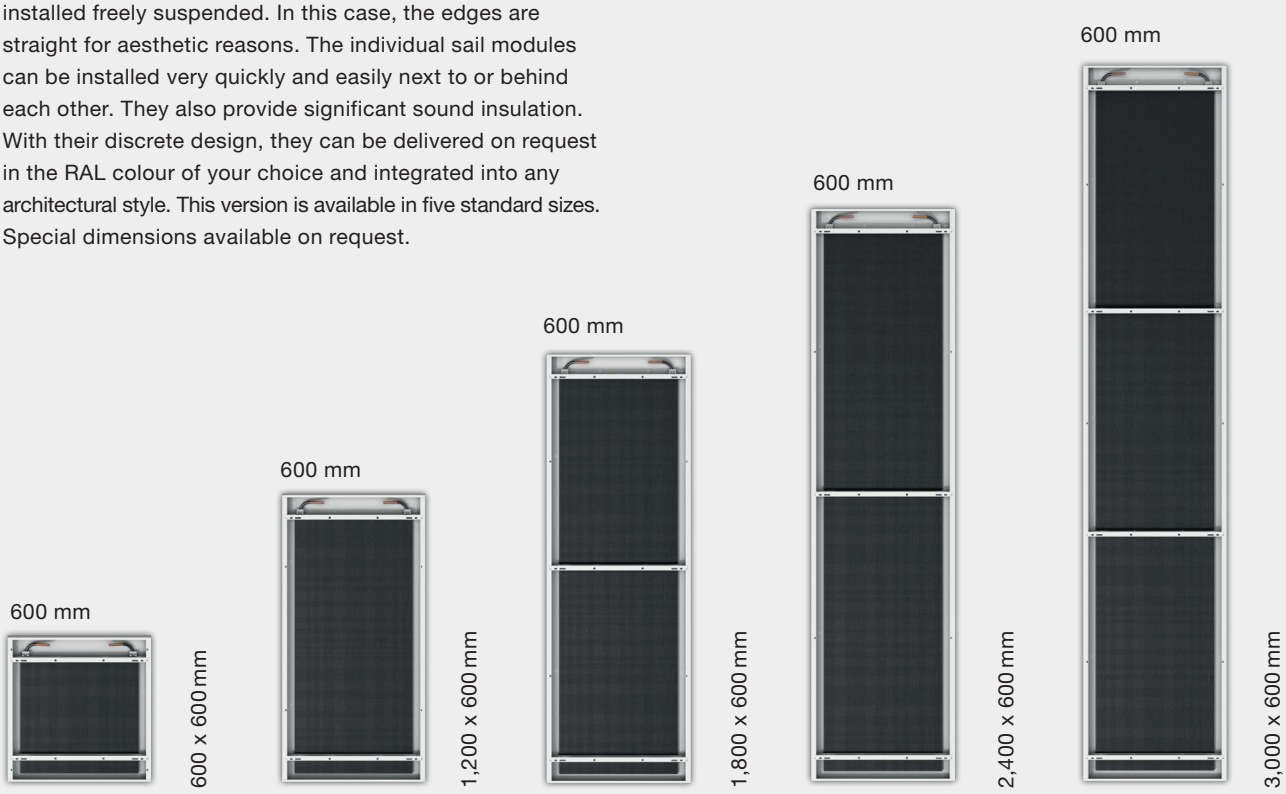
## Modules for closed ceilings

The Zehnder Carboline heating and cooling ceiling elements are perfect for integration into all types of lay-in ceilings, especially into traditional grid ceilings (600x600 mm or 600x1,200 mm), which are often used in schools, hospitals, nurseries, retirement homes and offices. The sections come in ten standard sizes.
Special dimensions available on request.




## Modules for ceiling sails

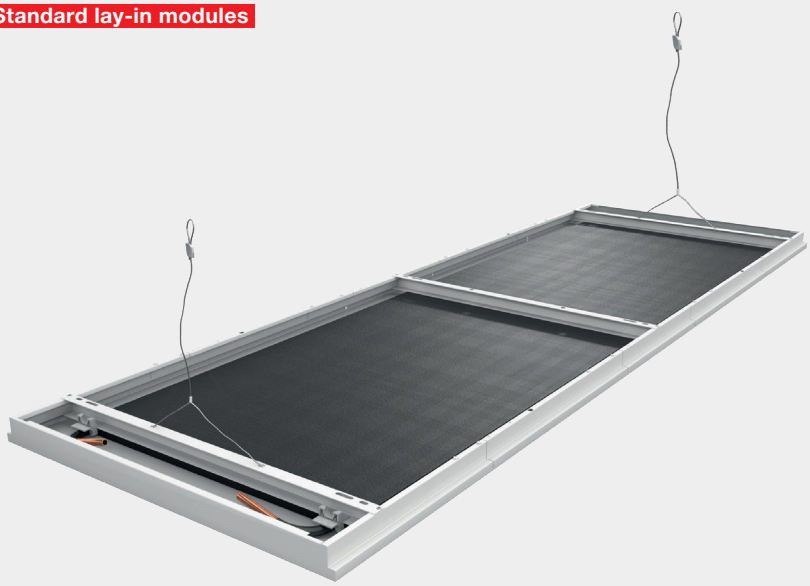
The Zehnder Carboline radiant ceiling panels can be installed freely suspended. In this case, the edges are straight for aesthetic reasons. The individual sail modules can be installed very quickly and easily next to or behind each other. They also provide significant sound insulation. With their discrete design, they can be delivered on request in the RAL colour of your choice and integrated into any architectural style. This version is available in five standard sizes.
Special dimensions available on request.



# Suspension and attachment

Our various installation kits for hanging and fastening the radiant ceiling panels have not only undergone rigorous safety engineering testing but will also integrate seamlessly into your overall ceiling layout.

**Standard lay-in modules**

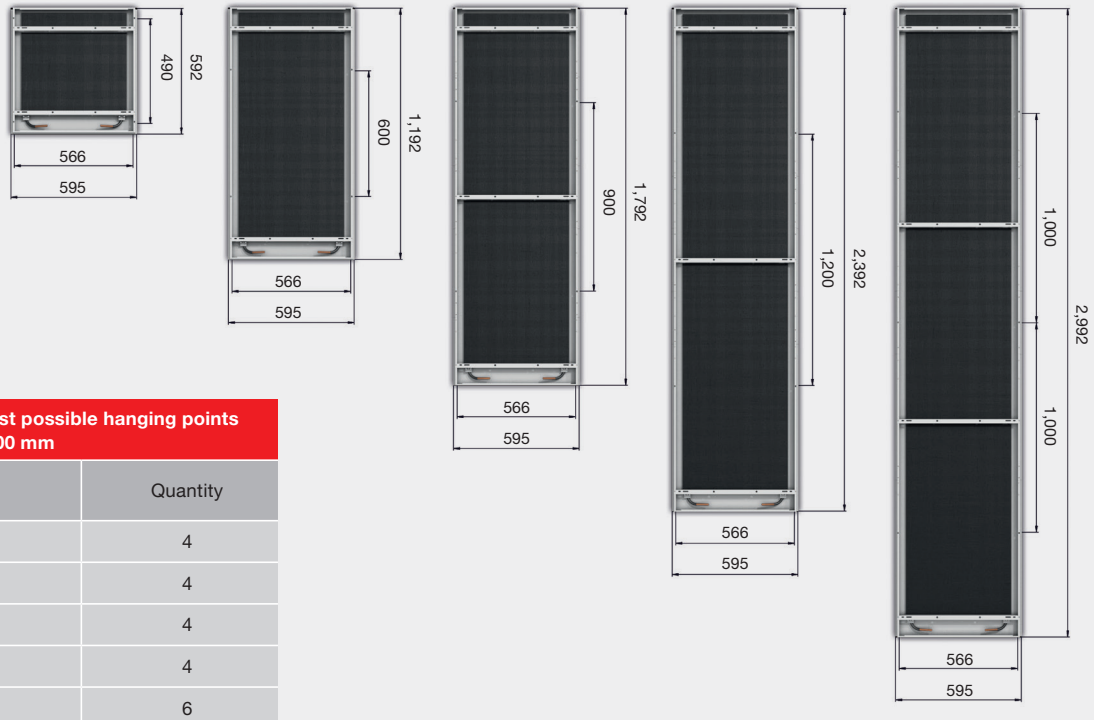


Zehnder Carboline's "grid version" is designed for installation in grid ceilings. We recommend the additional use of suspension wire to secure the panels to the ceiling.

Cross anchor

**Plasterboard frames**

Zehnder Carboline ceiling panels can be integrated into Plasterboard ceilings using the purpose made Zehnder Plasterboard Frame or utilising a suitably built aperture in the ceiling.

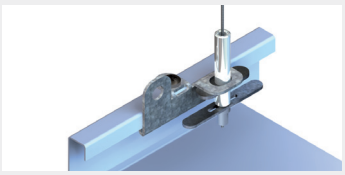



| Number of highest possible hanging points Nominal width 600 mm | |
|---|---|
| **Nominal length** | Quantity |
| 600 mm | 4 |
| 1,200 mm | 4 |
| 1,800 mm | 4 |
| 2,400 mm | 4 |
| 3,000 mm | 6 |

## Suspension system using multi-clips (sails)

The multi-clip is pushed into the lateral edge of the module. The suspension points can therefore be varied.
*See the areas specified at the bottom of the drawings.

Multi-clip with carabiner



Multi-clip with wire cable and fine adjustment

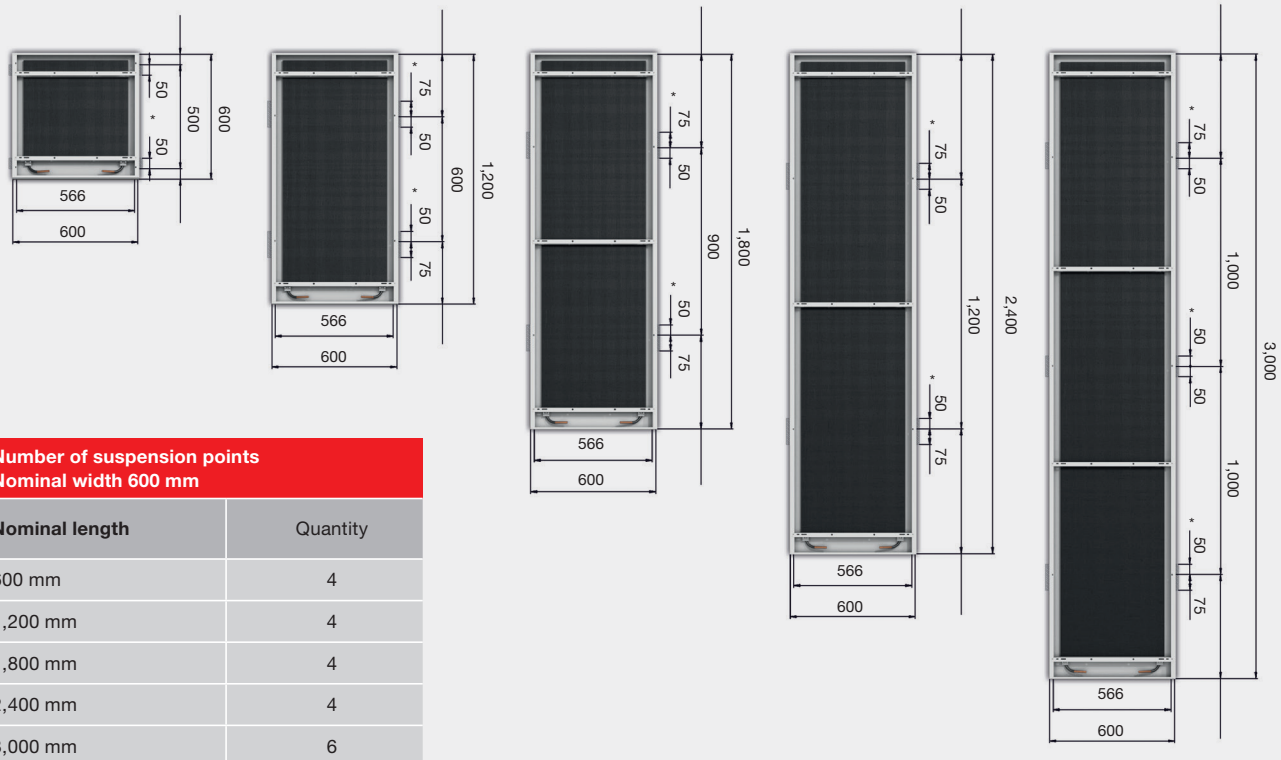
**Standard sail**

The sail version can be attached directly to a concrete ceiling, for example. Sails of different sizes can be created by arranging the Zehnder Carboline panels in various combinations next to and in line with one another.

**Long hole with fine adjustment**

**Cross anchor**

Fine adjustments enable the modules to be aligned exactly, which makes installation easier.

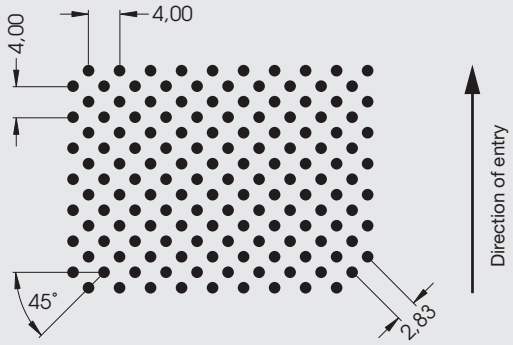



| Number of suspension points Nominal width 600 mm | |
|---|---|
| **Nominal length** | Quantity |
| 600 mm | 4 |
| 1,200 mm | 4 |
| 1,800 mm | 4 |
| 2,400 mm | 4 |
| 3,000 mm | 6 |

# Surface finishes

Zehnder Carboline offers the option of a smooth or perforated surface. The surface is coated with a high-quality powder coat finish. Zehnder radiant ceiling panels are available in the standard colour similar to RAL 9016. Additional colours and perforations available on request.

## SOUND-ABSORBING VERSION, PERFORATED PLATE




The Zehnder Carboline radiant ceiling panels can be perforated to provide optimised sound absorption. Sound waves pass through the perforations and are absorbed by the specially developed sound insulation. With sails, the sound waves are also absorbed by means of reverberation on the top of the product. This significantly reduces noise and the associated vibrations, especially in open-plan offices, call centres, schools, etc.
Acoustic calculation data on request.

| | |
|---|---|
| Hole diameter | 1.5 mm |
| Open cross section | 22% |

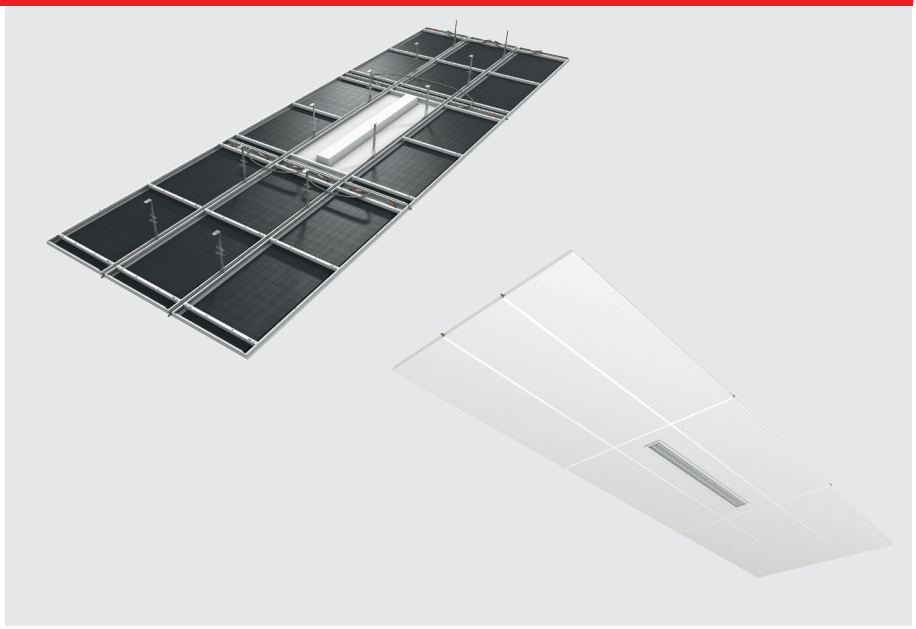
## SURFACE FINISHES

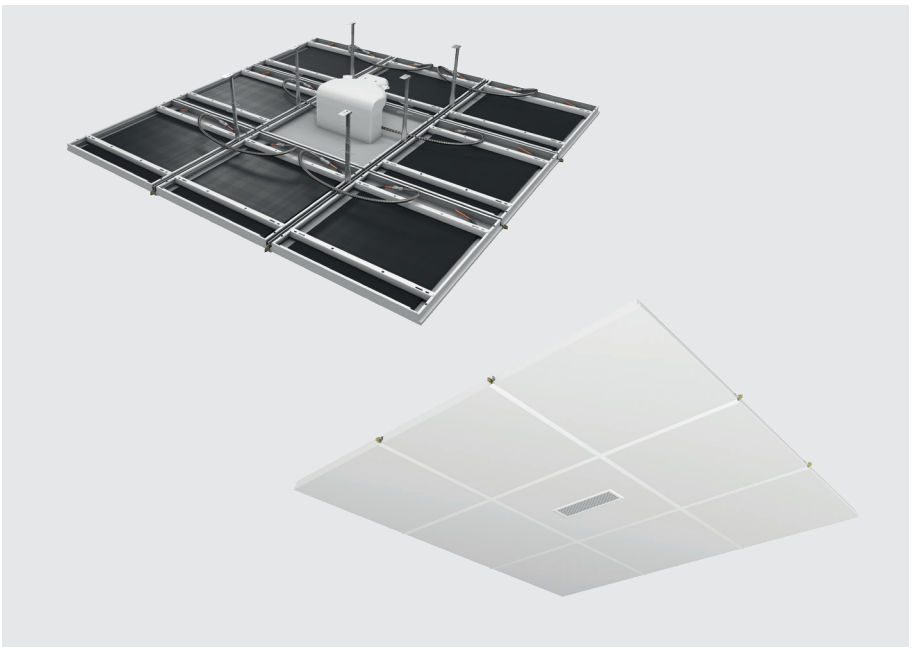
Standard colour
Smooth version, RAL 9016

More colours are available on request

## SPECIAL SOLUTIONS

Ceiling cut-outs can be integrated into the panel elements of Zehnder Carboline as required. Especially in offices or meeting rooms, it may be necessary to provide ceiling recesses, e.g. for air outlets, projector brackets, speakers, fire alarms, lighting or similar. Zehnder produces the required ceiling cut-outs precisely to the customer's specifications.



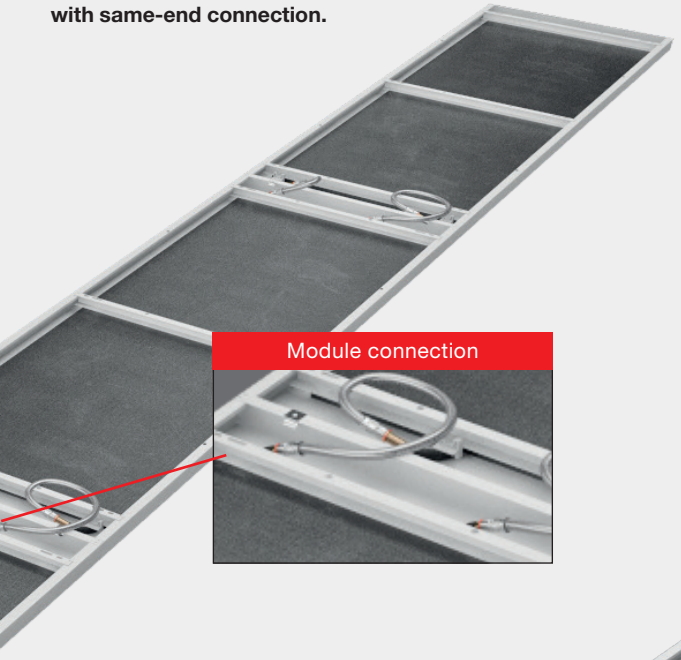


# Connection technology 6-pipe rows

The Zehnder Carboline radiant ceiling panels can be installed as strips up to a maximum of 9 metres in length. In this case, the front-facing radiant ceiling panels have 2 serpentine circuits with hydraulic couplings on both sides of the panels, which enable a series connection.

**Two modules next to each other with same-end connection.**

**Three modules behind each other with same-end connection.**



Module connection



**Two modules behind each other with centre connection.**



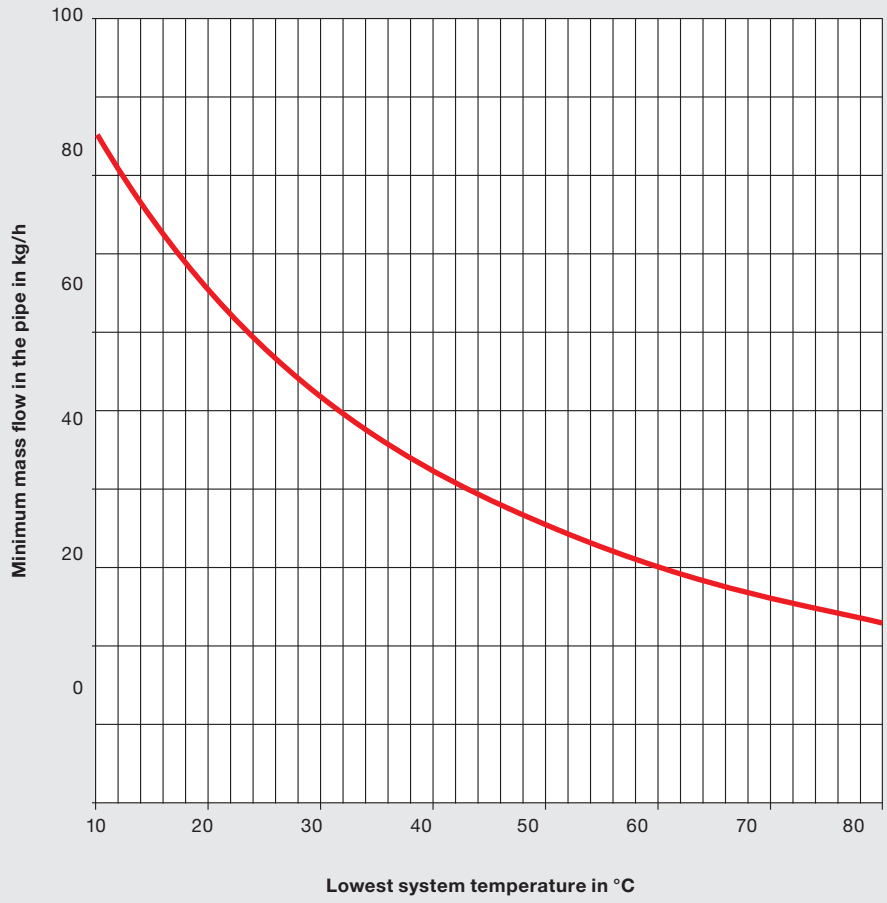
Module connection



Hydraulic connection

# Minimum mass flow

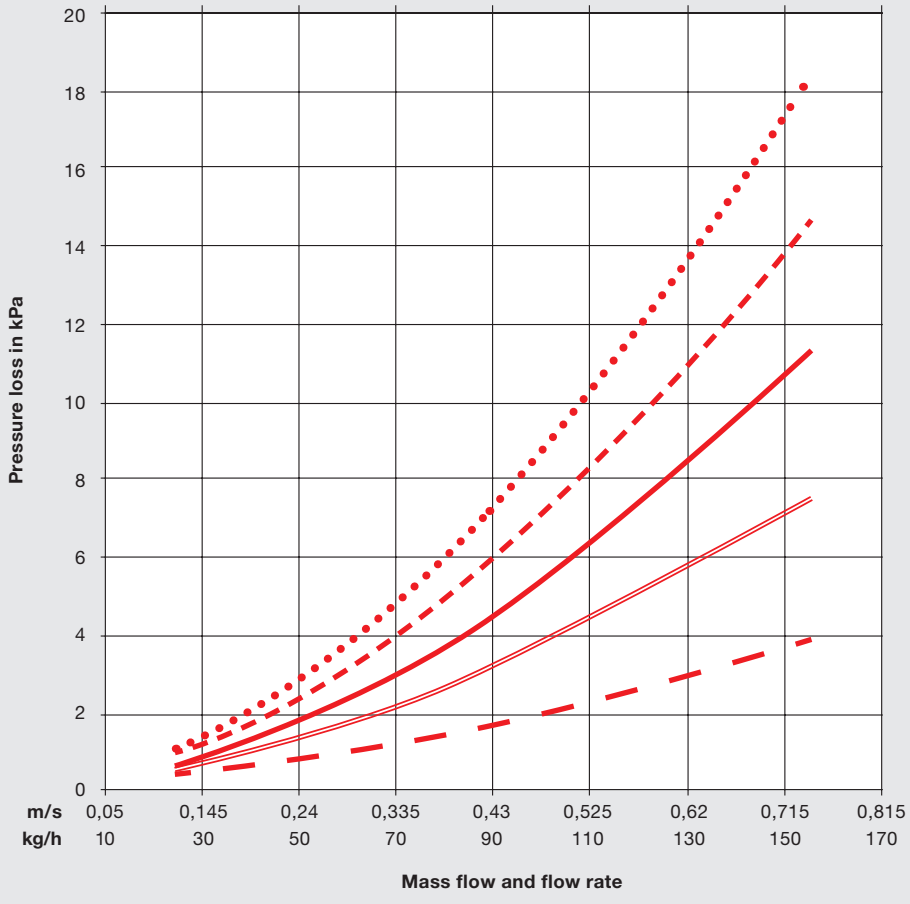
To maintain the output shown in the table, a turbulent flow must be ensured within the pipes in the radiant panel system. This minimum mass flow depends on the lowest system temperature. When heating, this corresponds to the return temperature. When cooling or in a combined cooling/heating mode, this corresponds to the cold water flow temperature. If the minimum mass flow per pipe is not achieved, this can result in a drop in performance of up to 15%.



# Pressure loss calculation

The pressure loss, depending on the module size and mass flow, is shown in the diagram. The maximum permitted flow speed is 0.5 m/s.

**Pressure loss per module**




600 x 3000
600 x 2400
600 x 1800
600 x 1200
600 x 600

# Heating and cooling performance

The following tables show the Zehnder Carboline heating and cooling performance dependent upon heating or cooling Delta T, measured based on EN 14037 (heating) and EN 14240 (cooling).

## Thermal outputs for 6-pipe activation

| | Sail module / ceiling sail with insulation | | | | | Sail module / ceiling sail without insulation | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Dimensions** | **600 x 600** | **600 x 1200** | **600 x 1800** | **600 x 2400** | **600 x 3000** | **600 x 600** | **600 x 1200** | **600 x 1800** | **600 x 2400** | **600 x 3000** |
| **K** | 2,254 | 5,027 | 7,790 | 10,552 | 13,314 | 2,382 | 5,316 | 8,241 | 11,156 | 14,081 |
| **n** | | | 1,093 | | | | | 1,134 | | |
| **Δ t (K)** | **W** | **W** | **W** | **W** | **W** | **W** | **W** | **W** | **W** | **W** |
| 70 | 234 | 523 | 810 | 1097 | 1384 | 295 | 658 | 1019 | 1381 | 1742 |
| 68 | 227 | 506 | 784 | 1063 | 1341 | 285 | 637 | 986 | 1336 | 1686 |
| 66 | 220 | 490 | 759 | 1028 | 1298 | 276 | 615 | 953 | 1291 | 1629 |
| 64 | 212 | 474 | 734 | 994 | 1255 | 266 | 594 | 921 | 1247 | 1574 |
| 62 | 205 | 458 | 709 | 960 | 1212 | 257 | 573 | 888 | 1203 | 1518 |
| 60 | 198 | 442 | 684 | 927 | 1169 | 248 | 552 | 856 | 1159 | 1463 |
| 58 | 191 | 426 | 659 | 893 | 1127 | 238 | 532 | 823 | 1115 | 1407 |
| 56 | 184 | 410 | 634 | 859 | 1084 | 229 | 511 | 791 | 1072 | 1352 |
| **55** | **181** | **402** | **624** | **845** | **1065** | **222** | **495** | **766** | **1037** | **1309** |
| 54 | 176 | 394 | 610 | 826 | 1042 | 220 | 490 | 759 | 1029 | 1298 |
| 52 | 169 | 378 | 585 | 793 | 1000 | 210 | 470 | 728 | 986 | 1243 |
| 50 | 162 | 362 | 561 | 759 | 958 | 201 | 449 | 696 | 943 | 1189 |
| 48 | 155 | 346 | 536 | 726 | 916 | 192 | 429 | 664 | 900 | 1136 |
| 46 | 148 | 330 | 512 | 693 | 875 | 183 | 409 | 633 | 858 | 1082 |
| 44 | 141 | 315 | 487 | 660 | 833 | 174 | 389 | 602 | 815 | 1029 |
| 42 | 134 | 299 | 463 | 628 | 792 | 165 | 369 | 571 | 774 | 976 |
| 40 | 127 | 284 | 439 | 595 | 751 | 156 | 349 | 540 | 732 | 923 |
| 38 | 120 | 268 | 415 | 563 | 710 | 147 | 329 | 510 | 691 | 871 |
| 36 | 113 | 253 | 391 | 530 | 669 | 139 | 310 | 480 | 649 | 819 |
| 34 | 106 | 237 | 368 | 498 | 628 | 130 | 290 | 449 | 609 | 768 |
| 32 | 100 | 222 | 344 | 466 | 588 | 121 | 271 | 420 | 568 | 717 |
| 30 | 93 | 207 | 321 | 434 | 548 | 113 | 252 | 390 | 528 | 666 |
| 28 | 86 | 192 | 297 | 403 | 508 | 104 | 233 | 361 | 488 | 616 |
| 26 | 79 | 177 | 274 | 372 | 469 | 96 | 214 | 332 | 449 | 567 |
| 24 | 73 | 162 | 251 | 340 | 430 | 88 | 195 | 303 | 410 | 517 |
| 22 | 66 | 148 | 229 | 310 | 391 | 79 | 177 | 274 | 372 | 469 |
| 20 | 60 | 133 | 206 | 279 | 352 | 71 | 159 | 246 | 334 | 421 |
| 18 | 53 | 118 | 184 | 249 | 314 | 63 | 141 | 219 | 296 | 373 |
| 16 | 47 | 104 | 161 | 219 | 276 | 55 | 123 | 191 | 259 | 327 |
| 14 | 40 | 90 | 139 | 189 | 238 | 48 | 106 | 164 | 223 | 281 |
| 12 | 34 | 76 | 118 | 160 | 201 | 40 | 89 | 138 | 187 | 236 |
| 10 | 28 | 62 | 97 | 131 | 165 | 32 | 72 | 112 | 152 | 192 |

Heat outputs may vary if ceiling panels are integrated within ceiling grid.

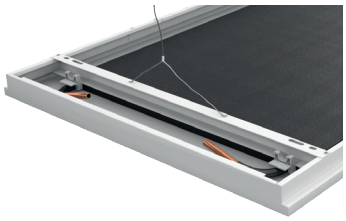
Note: the ollowing data was measured using smooth surfaces; a perforated surface will reduce the capacity slightly. The removal of the insulation has a positive effect on the cooling capacity (see table). However, this additional output can only be attributed to the room if it has an open ceiling.

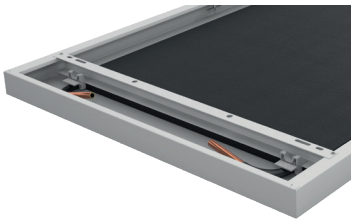
Removing the insulation increases the heat output, but can lead to heat accumulation under the ceiling for larger room heights.

## Cooling capacities for 6-pipe activation

| | Sail module / ceiling sail with insulation | | | | | Sail module / ceiling sail without insulation | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Dimensions** | **600 x 600** | **600 x 1200** | **600 x 1800** | **600 x 2400** | **600 x 3000** | **600 x 600** | **600 x 1200** | **600 x 1800** | **600 x 2400** | **600 x 3000** |
| **K** | 3,085 | 6,885 | 10,612 | 14,406 | 18,183 | 3,714 | 8,309 | 12,885 | 17,482 | 22,018 |
| **n** | | | 1,094 | | | | | 1,092 | | |
| **Δ t (K)** | **W** | **W** | **W** | **W** | **W** | **W** | **W** | **W** | **W** | **W** |
| 15 | 60 | 133 | 207 | 280 | 353 | 71 | 159 | 247 | 335 | 422 |
| 14 | 55 | 124 | 192 | 260 | 328 | 66 | 148 | 229 | 310 | 391 |
| 13 | 51 | 114 | 177 | 239 | 302 | 61 | 136 | 211 | 286 | 361 |
| 12 | 47 | 105 | 162 | 219 | 277 | 56 | 125 | 194 | 262 | 331 |
| 11 | 43 | 95 | 147 | 199 | 251 | 51 | 114 | 176 | 239 | 301 |
| 10 | 38 | 86 | 133 | 180 | 227 | 46 | 102 | 159 | 215 | 271 |
| 9 | 34 | 76 | 118 | 160 | 202 | 41 | 91 | 142 | 192 | 242 |
| **8** | **30** | **67** | **104** | **141** | **177** | **36** | **80** | **124** | **169** | **213** |
| 7 | 26 | 58 | 90 | 121 | 153 | 31 | 69 | 108 | 146 | 184 |
| 6 | 22 | 49 | 76 | 103 | 129 | 26 | 59 | 91 | 123 | 155 |
| 5 | 18 | 40 | 62 | 84 | 106 | 22 | 48 | 75 | 101 | 127 |
| 4 | 14 | 31 | 49 | 66 | 83 | 17 | 38 | 58 | 79 | 100 |
| 3 | 10 | 23 | 35 | 48 | 61 | 12 | 28 | 43 | 58 | 73 |
| 2 | 7 | 15 | 23 | 31 | 39 | 8 | 18 | 27 | 37 | 47 |
| 1 | 3 | 7 | 11 | 14 | 18 | 4 | 8 | 13 | 18 | 22 |

## Zehnder Carboline technical specifications





| | | Lay-in module | | | | | Sail module | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Dimensions** | **Unit of measurement** | | | | | | | | | | |
| Type width | - | 600 / 625 | | | | | 600 | | | | |
| Type length | - | 600 | 1,200 | 1,800 | 2,40 | 3,000 | 600 | 1,200 | 1,800 | 2,400 | 3,000 |
| Total width | mm | 595 / 620 | | | | | 600 | | | | |
| Total length | mm | 592 | 1,192 | 1,792 | 2,392 | 2,992 | 600 | 1,200 | 1,800 | 2,400 | 3,000 |
| Number of suspension points per module | piece(s) | 4 | 4 | 4 | 4 | 6 | 4 | 4 | 4 | 4 | 6 |
| No. of parallel pipes | piece(s) | 6 | | | | | 6 | | | | |
| Pipe spacing | mm | 90 | | | | | 90 | | | | |
| Pipe material / dimension (outside ø) | - / mm | copper pipe / 10 | | | | | copper pipe / 10 | | | | |
| Panel material | - | Galvanised steel | | | | | Galvanised steel | | | | |
| **Parameters** | | | | | | | | | | | |
| Max. operating temperature [1] | °C | 83 | | | | | 83 | | | | |
| Max. operating pressure[2] | bar | 6 | | | | | 6 | | | | |
| **Weight** | | | | | | | | | | | |
| Operating weight without water, with insulation | kg | 4.56 | 8.15 | 12.04 | 15.62 | 19.51 | 4.56 | 8.15 | 12.04 | 15.62 | 19.51 |
| Operating weight with water, with insulation[3] | kg | 4.77 | 8.59 | 12.71 | 16.52 | 20.64 | 4.77 | 8.59 | 12.71 | 16.52 | 20.64 |

### Plasterboard Frames

The Zehnder Plasterboard frames are available as standard to fit the standard Zehnder Carboline ceiling panel range (600 width x 600, 1,200, 1,800, 2,400 or 3,000mm lengths). The frame consists of a white powder-coated Carboline T-section sides and ends which are joined at the corners with an internal bracket. The frame is secured by fixing through the upstand of the T-section into the subframe of the aperture of the plasterboard ceiling.

Bespoke plasterboard frames are available to order.

[1] A max. operating temperature of 50 °C only is possible with the perforated version.
[2] Higher operating pressure on request.
[3] Insulation made of mineral wool in LDPE foil, mass per unit area = 0.84 kg/m$^2$, λ = 0.03 - 0.04 W/(m*K)

# Tender specification

**Ceiling sail – free-hanging modules**

Carboline sail version … x … mm, active
(standard modules: 600 x 600 mm; 600 x 1,200 mm;
600 x 1,800 mm; 600 x 2,400 mm; 600 x 3,000 mm)
Carboline sail version … x … mm, active
(bespoke version)

Metal ceiling panels according to the TAIM e.V. quality standard.
Version: November 1998, material: galvanised sheet steel, minimum thickness 0.7 mm, lip on longitul side in line with static requirements.
Surface similar to RAL … (9016), smooth surface similar to RAL … (9016), perforated, hole pattern … RD - L30 (1.5 mm - 22% - 45°), surrounding non-perforated edge, approx. 10 mm wide.
A special heat-conducting acoustic fleece has been force-fitted to the back of the perforated version, without pleats, to improve sound absorption. The supplier must present test results to prove that sound absorption is achieved in conjunction with the metal ceiling panels on offer.
Sound absorption measured according to EN ISO 345.

**Fixing:**
Fixing to the bare ceiling via metal anchors approved by the building authorities, with a maximum load of at least 0.5 kN per anchor. Suspension via galvanised nonius suspending brackets and transverse profiles, can be folded down.
Suspension height from bottom edge of reinforced concrete ceiling to bottom edge of metal cassette approx. 300 mm.
All parts made of galvanised sheet steel.

**Insulation:**
Heat and sound-absorbing insulating layer, based on mineral wool, coated with black fleece on one side and shrink-wrapped in LDPE foil.

**Cooling register:**
Cooling and heating element comprises a sheet steel cassette and a graphite element containing a copper pipe. The copper pipes (diam. 10 mm, pipe spacing 90 mm) are fitted in a compressed graphite panel in an interlocking manner. This allows very quick, even and very good thermal conductivity to be achieved across the entire area of the element.
This high-performance element is firmly bonded to a sendzimir-galvanised sheet steel cassette. The deburred pipe ends are screwed to the cassette using special axles in order to guarantee strain and pressure relief.
Chamfers and reinforcement profiles are used to provide static reinforcement of the sheet steel cassette. The visible side is coated with a high-grade polyester fine-structure paint.
The cooling ceilings must be hydraulically connected so there is a maximum pressure loss of 25 kPa per control circuit.

**Heating technical specification:**

| For example: | |
|---|---|
| Room temperature: | 20 °C |
| Hot water flow: | 40 °C |
| Hot water return: | 36 °C |
| Thermal output smooth / perf.: | approx. 158 W/m² |
| | based on EN 14037 |

**Cooling technical specification:**

| For example: | |
|---|---|
| Room temperature: | 26 °C |
| Cooling water flow: | 16 °C |
| Cooling water return: | 19 °C |
| Cooling power smooth / perf.: | approx. 98 W/m² |
| | based on EN 14240 |

Sails consisting of module sizes: … pieces … x … mm
Material: galvanised sheet steel, similar to RAL … (9016), perforated or smooth, including insulation

Smooth version:

| | |
|---|---|
| Maximum operating temperature: | 83 °C |
| Maximum operating pressure: | 6 bar |

Perforated version:

| | |
|---|---|
| Maximum operating temperature: | 50 °C |
| Maximum operating pressure: | 6 bar |

# Tender specification

**Lay-in modules for T24 grid ceiling**

All positions below cover the materials supplied for a T24 ceiling construction.

Heating and cooling ceiling modules for a T24 grid ceiling

As flush lay-in metal cassettes for a visible T24 track supporting structure for heating and cooling, in a perforated / smooth version, for removing sensitive heat loads in an approximate ratio of 60% via radiation and 40% via convection.

A minimum suspension height of 350 mm (bottom edge of bare ceiling to upper edge of heating and cooling ceiling) is required.
Components and additional loads must be suspended from the bare ceiling separately; alternatively, they can be attached by means of reinforcements on the back of the panels, additional profiles and additional suspending brackets on the substructure. The supplementary work must be carried out professionally.

Tolerances and quality requirements according to TAIM e.V.

Hydraulic pipework for the individual metal cassettes as per the room-specific calculations. The Tichelmann ring is installed on the room side by others on the building site. Hoses connected to the outlet connectors of the pipework on the room side by 10 mm outlets.

**Zehnder Carboline active:**
Metal ceiling panels according to the TAIM e.V. quality standard.
Version: November 1998, material: galvanised sheet steel, minimum thickness 0.6 mm, lip on longitudinal side in line with static requirements. Surface similar to RAL … (9016), perforated, hole pattern RD - L30 (diameter 1.5 mm – open cross section 22% - 45°); surrounding non-perforated edge, approx. 10 mm wide.

A special heat-conducting acoustic fleece has been force-fitted to the back, without pleats, to improve sound absorption. The supplier must present test results to prove that sound absorption is achieved in conjunction with the metal ceiling panels on offer.
Sound absorption measured according to EN ISO 345.

Inserted thermal insulation as a heat and sound-absorbing insulating layer, based on mineral wool, flame-resistant, classified as Euroclass B1 and tested to EN 13501-1.
Placed over the entire copper pipe register.

The copper pipes (diam. 10 mm, pipe spacing 90 mm) are fitted in a compressed graphite panel in an interlocking manner. This allows very quick, even and very good thermal conductivity to be achieved across the entire area of the element.
This high-performance element is firmly bonded to a sendzimir-galvanised sheet steel cassette. The deburred pipe ends are screwed to the cassette using special axles in order to guarantee strain and pressure relief. Chamfers and reinforcement profiles are used to provide static reinforcement of the sheet steel cassette. The visible side is coated with a high-grade polyester fine-structure paint.

The cooling ceilings must be hydraulically connected so there is a maximum pressure loss of 25 kPa per control circuit.

In line with the pressure loss stated above, a corresponding number of radiant panel systems must be connected in series, then connected to the distribution pipe in parallel.

**Heating technical specification:**

| For example: | |
|---|---|
| Room temperature: | 20 °C |
| Hot water flow: | 34 °C |
| Hot water return: | 30 °C |
| Thermal output smooth / perf.: | approx. 88 W/m² |
| | based on EN 14037 |

**Cooling technical specification:**

| For example: | |
|---|---|
| Room temperature: | 26 °C |
| Cooling water flow: | 16 °C |
| Cooling water return: | 19 °C |
| Cooling power smooth / perf.: | approx. 87 W/m² |
| | based on EN 14240 |

All given performance values must be verified by an official test report from an independent institute.

Module size of the linear panel active: ... mm x ... mm
Standard width 595 mm (600 mm)
Standard width 620 mm (625 mm)
Material: galvanised sheet steel, similar to RAL … (9016), perforated or smooth

| Smooth version: | |
|---|---|
| Maximum operating temperature: | 83 °C |
| Maximum operating pressure: | 6 bar |

| Perforated version: | |
|---|---|
| Maximum operating temperature: | 50 °C |
| Maximum operating pressure: | 6 bar |

**Accessories**

**Hose connection 10 x 10 mm**

Flexible connector, with oxygen barrier, stainless steel braid, brass plug-in connectors and pressed on both sides. Plastic plug-in connectors are not permitted. Plug-in connector on both sides for copper pipe (10 mm).
The copper pipes used on site to connect the flexible connection pipes must meet the requirements of EN 1057. Only copper pipes in the conditions R220 (soft) and R250 (half hard) are permitted.

- Tight against diffusion according to DIN 4726

| | |
|---|---|
| Maximum operating temperature: | 80 °C |
| Maximum operating pressure: | 6 bar |

Length: … mm (1,000 mm, 1,500 mm, …)

**Hose connection 10 x ½" female thread as coupler**

Flexible connector, with oxygen barrier, stainless steel braid with brass plug-in connector pressed on one side and ½" female thread as coupler, flat gasket.
Plastic plug-in connectors are not permitted.
Plug-in connector for copper pipe (10 mm).

- Tight against diffusion according to DIN 4726

| | |
|---|---|
| Maximum operating temperature: | 80 °C |
| Maximum operating pressure: | 6 bar |

Length: … mm (500 mm, 750 mm, …)

**Fixing:**

Suspension system with auto-blocking zinc housing for concrete ceiling, wire cable 1.5 mm with cross brace (distance below concrete ceiling 1 m)
Anchorage in concrete: hexagon nut, drive-in anchor, eyelet screw, galvanised steel.

Fine adjustment consisting of:
M6 threaded bolt with 2.5 mm drill hole along the entire length and cross brace with M6 female thread; thread length 25 mm

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Air cleaning systems from Zehnder effectively reduce the amount of dust and other particles in the air. The result: clean working environments, significantly improved employee health and enhanced business performance.

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Zehnder Group UK Limited · Concept House, Watchmoor Point · Camberley · Surrey · GU15 3AD
T +44 1276 408404 · enquiries@zehnder.co.uk · www.zehnder.co.uk