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ДОДАТНЕ ИНФОРМАЦИЈЕ И ПОЈАШЊЕЊА
У ВЕЗИ СА ПРИПРЕМАЊЕМ ПОНУДЕ

Број јавне набавке: III-04-404-1-23/2015

„Изградња фискултурне сале са пратећим садржајима – Банатско Карађорђево“

На основу члана 63. став 3. Закона о јавним набавкама („Службени гласник Републике Србије“ бр.124/2012, 14/2015 и 68/2015), а у вези са пристиглим питањима потенцијалних понуђача, дајемо следећа појашњења у вези са припремањем понуде:

1. **Питање:** У тендеру су дефинисани ЗЕНДХЕР плафонски плочасти грејачи (део II – ИНСТАЛАЦИЈА ПЛАФОНСКИ ПЛОЧАСТИХ ГРЕЈАЧА , поз 1) који нису у складу са техничким подацима произвођача. Потребно је да пројектант дефинише величине грејних плоча и начин њиховог повезивања са тачном спецификацијом да би смо на основу тога дали понуду. Потребна је консултација пројектанта и произвођача плафонских плочастих грејача?

Одговор: Понудити цене по предмеру радова, у прилогу Проспект фирме ЗЕХНДЕР, / у понуди може или одговарајући /.

2. **Питање:** Поштовани да ли у случају кад је инвеститор био и извођач радова (сами смо финансирали и изградили објекат високоградње) прихватате употребну дозволу и записник о техничком пријему објекта јер не можемо сами себи издавати потврду и склапати уговор сами са собом. У досадашњем искуству у јавним набавкама Наручиоци су нам признавали наведене документе као доказ пословног капацитета. Поседујемо и став Републичке комисије изражен у једном решењу о усвајању захтева за заштиту права са образложењем о валидности наведених доказа у случају кад су инвеститор и извођач на објекту једно правно лице?

Одговор: Да, али само ако наведеним документима јасно стоји укупна вредност изграђеног објекта.

3. **Питање:** У конкурсној документацији за јавну набавку радова - Изградња фискултурне сале са пратећим садржајима - Банатско Карађорђево - на страни 7 је постављен услов у делу кадровског капацитета за доказивањем 30 радника грађевинске струке. У одговорима на постављена питања сте прецизирали да ћете испуњавање наведеног услова ценити обзиром на стечено образовање грађевинских радника. Напомињемо да се стечено образовање стиче у средњој грађевинској школи која тренутно постоји у Београду, Новом Саду и Апатину. Уколико будете инсистирали на доказивању по стеченом образовању посредно постављате територијалну дискриминацију понуђача обзиром на локалитет на ком су пријављени и са ког послују.

Компетентност и спремност једног извођача се не цени школском спремом запослених на грађевини већ њиховим искуством које формирају на радним местима специфичним за грађевинске фирме(зидари, столари, тесари, армирачи, подоплагачи итд)

Сматрамо да тражене раднике треба ценити у складу са радним местом на које су распоређени а не по школи коју су завршили. Сви извођачи знају колика је реткост да је зидар завршио баш средњу грађевинску школу.

Молимо Вас да размотрите ову сугестију у супротном сте одговорни за постављање дискриминаторских услова који су незаконити и нелогични обзиром на предмет јавне набавке.?

Одговор: Наручилац конкурсном документацијом није предвидео одговарајуће смерове стручног образовања, самим тим оставио је велику могућност понуђачима да испуне наведени кадровски капацитет.

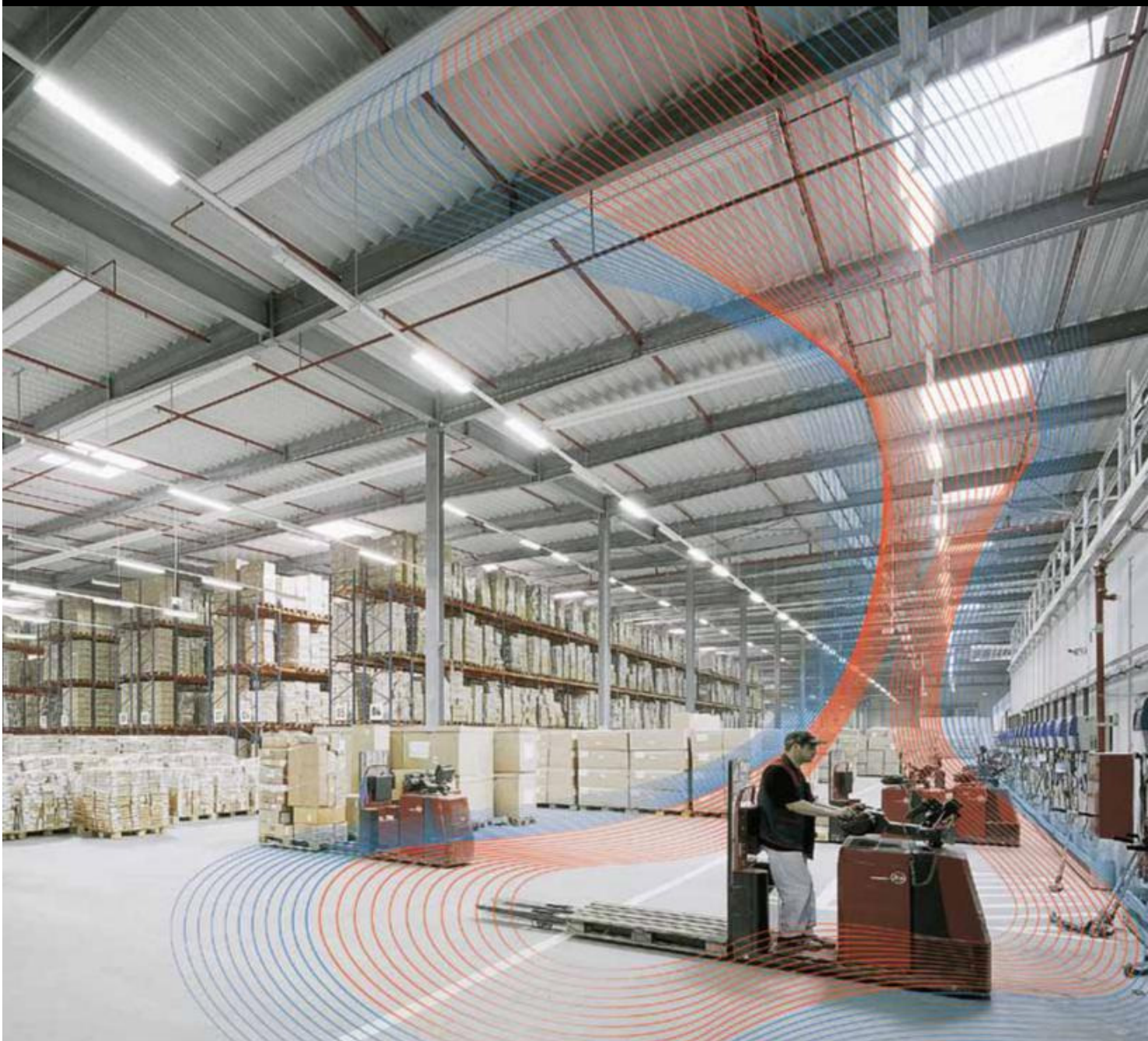
Комисија за јавне набавке

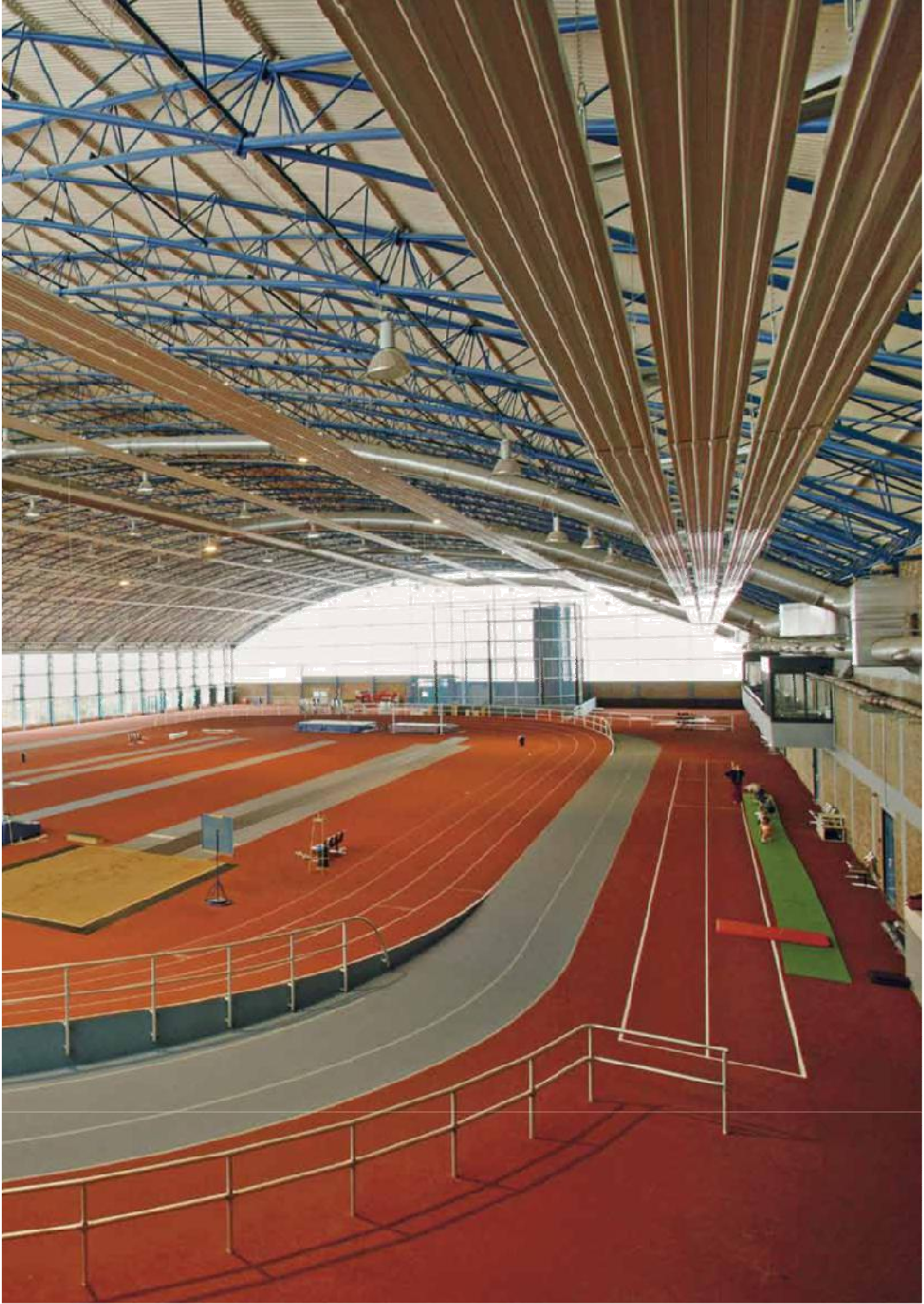
Zehnder ZIP
Heating and cooling ceiling system
Planning document

zehnder

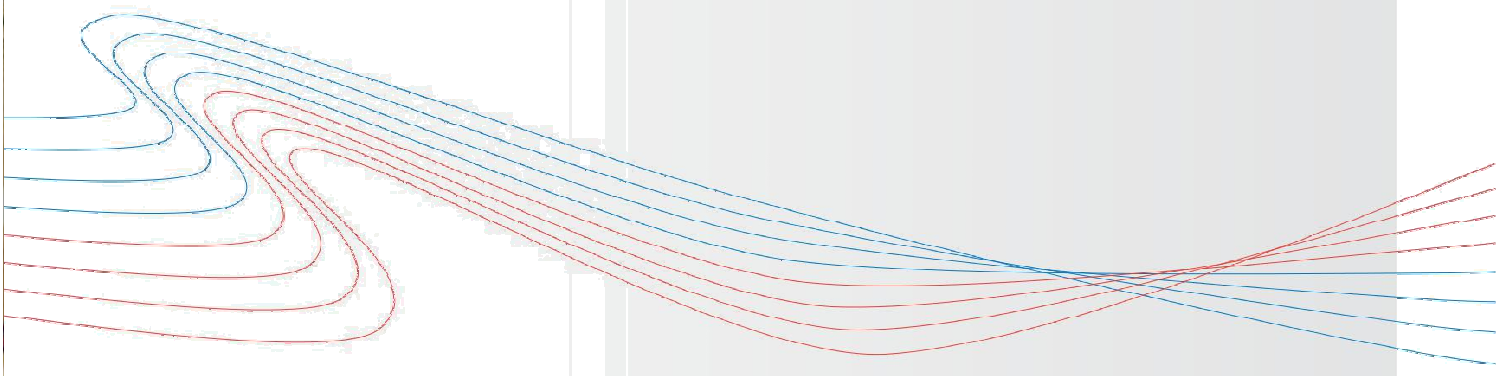
always
around you

Heating | Cooling | Fresh Air | Clean Air





Imitating the sun. The heating effect of solar radiation – a natural principle which is used by Zehnder ZIP radiant ceiling panels to heat interior areas – offers comfort, health and efficiency. These panels use no electrical energy and are totally maintenance-free. Since they do not disperse any dust, they help prevent allergic reactions and colds. The perceived temperature is around 3 K higher than the actual temperature, maximum comfort is achieved with minimum energy consumption. Zehnder ZIP radiant ceiling panels are ideally suited to rooms with high ceilings, such as production and storage halls, workshops, sports centres, garages, sales rooms, shipyards, maintenance halls, wet rooms etc. As a leading European supplier of radiant ceiling panels, Zehnder has decades of experience to draw on.



Sportforum sports complex, Berlin (DE)

Product benefits

Like all Zehnder products and systems, the Zehnder ZIP radiant ceiling panels offer many benefits which help to create a comfortable, healthy and efficient atmosphere.

1

Economic efficiency

- Possible energy savings of up to 40 %
- Air temperature may be up to 3 K lower (heating) or higher (cooling)
- Free choice of energy source
- No additional power costs
- No maintenance or servicing costs

2

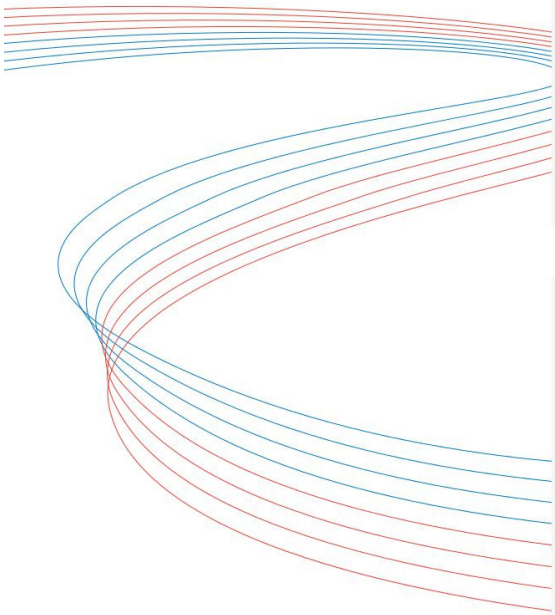
Comfortable climate

- Radiant heat principle Heating and cooling effect immediately noticeable
- Even distribution of heat throughout the room
- Even temperature gradient across the full height of the building
- No dust dispersal
- Completely silent system

3

Technology

- High heating and cooling outputs (in accordance with EN 14037 or based on DIN 4715-1)
- Low weight simplifies assembly
- Extremely fast response to changes in temperature
- Heat insulation installed ex works
- Protected against corrosion in accordance with DIN 50017
- The special version can also be used in wet rooms



4

Flexibility

- Modular design. Any combination of length and width possible. Lengths of 2, 3, 4, 5 and 6 m, width of 320 mm.
- Flexible fixing system simplifies assembly
- The panels can be press- or screw-fitted

- No welding required
- Unrestricted use of floor and wall space

Ohnhäuser production, Wallerstein (DE)

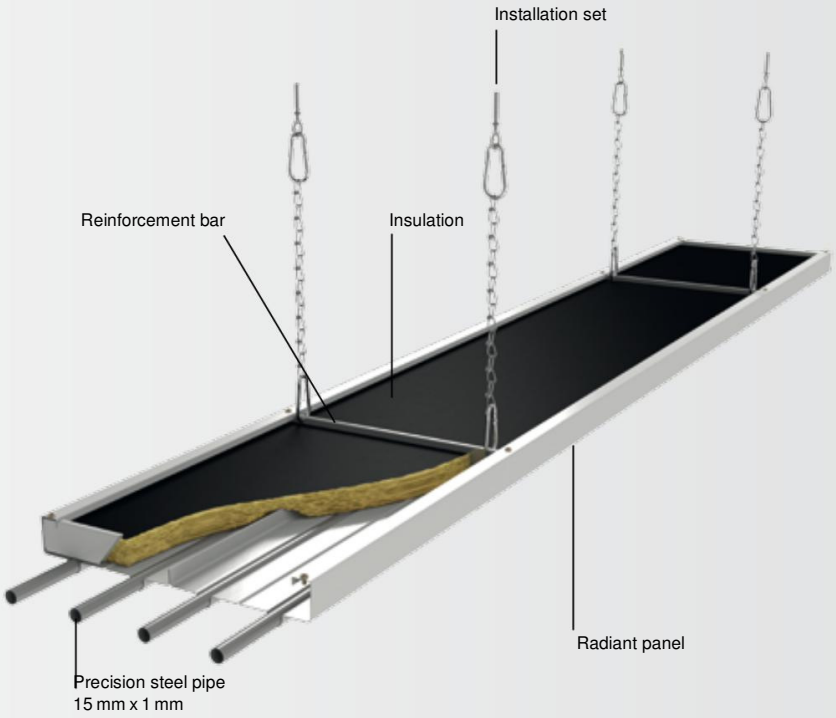
Zehnder ZIP: structure and versions

Zehnder stands for quality, functionality and design. The company is ISO 9001 and ISO 14001 certified and undertakes production in line with strict quality guidelines. Zehnder ZIP radiant ceiling panels are produced and tested in accordance with the EN 14037 standard and are therefore CE-compliant.

Structure of the panel

A steel panel with Zehnder special clip profiling forms the basis of the radiant module. Four galvanised precision steel pipes and the top insulation are then added. The panel is statically reinforced using chamfers and edgings.

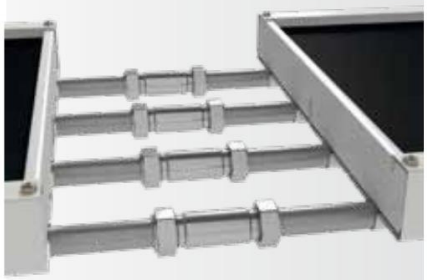
The Zehnder ZIP radiant ceiling panels are supplied with a smooth surface. This is galvanised and also coated with a high-quality polyester paint (similar to RAL 9016).



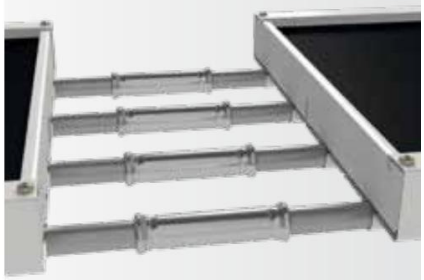
Connector technology

If you are using two or more individual sections, they will need to be connected to one another, with the pipes joined in one of two different ways. The individual sections are joined to produce the desired configuration using screw or press fittings and the connection points concealed by a cover to retain the harmonious appearance.

Screw fitting



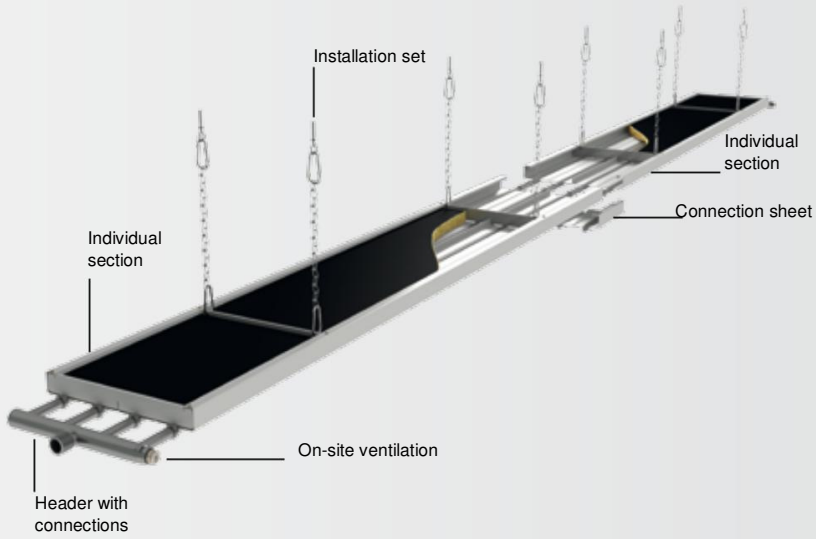
Press fitting

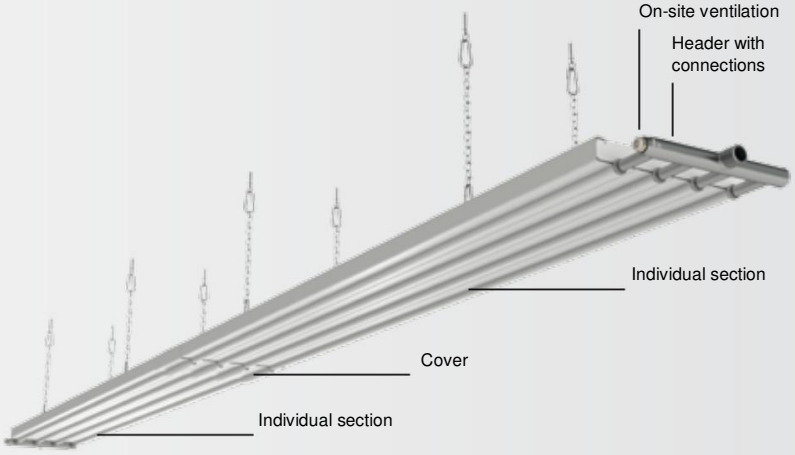


Designs

Zehnder ZIP radiant ceiling panels are available in a width of 320 mm.

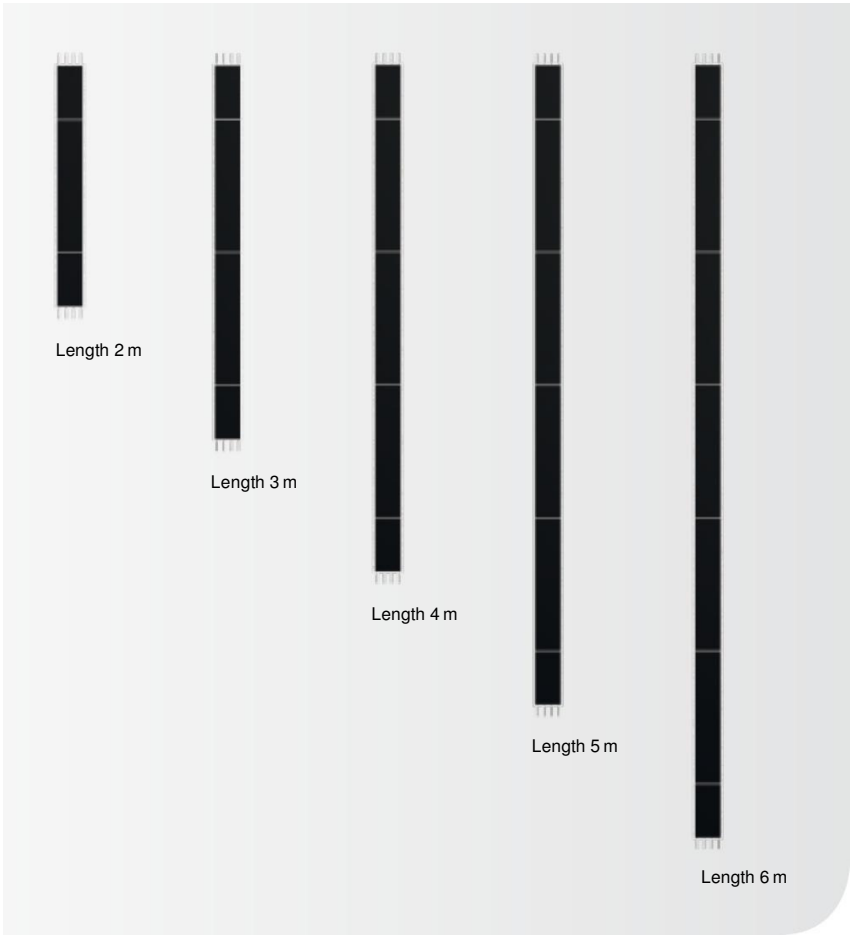
Panels can be produced in lengths of up to 6 m. Several individual sections can be positioned one after another to produce a strip of radiant ceiling panels using press or screw fittings.





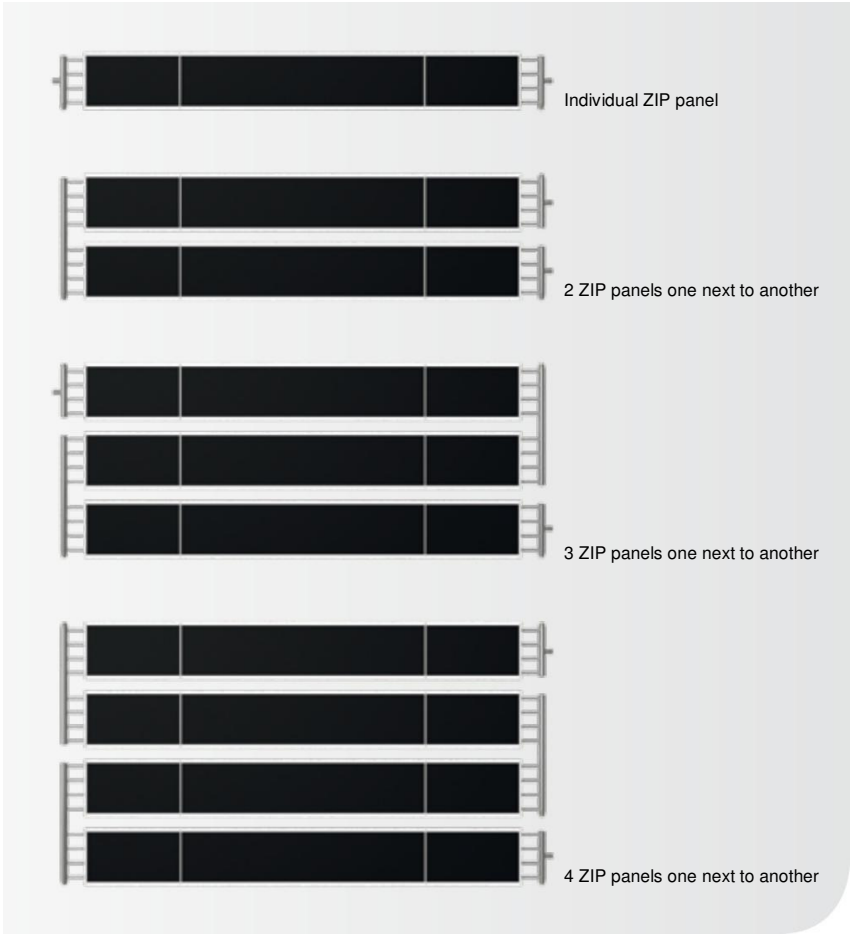
Standard lengths

The standard lengths for Zehnder ZIP radiant ceiling panels are 2, 3, 4, 5 and 6 m.
Longer strips can be produced by fitting several individual sections one after another.



Possible combinations

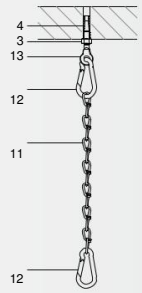
Zehnder ZIP radiant ceiling panels can be installed individually or as groups. Up to 4 panels can be fitted one next to the other.

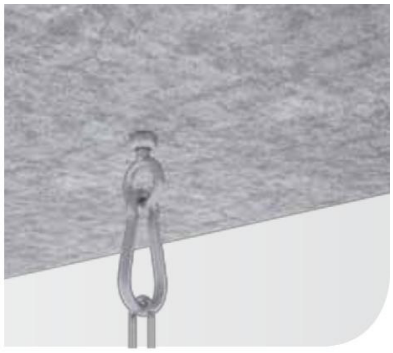


Standard installation sets

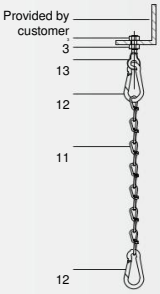
There are five standard installation sets for installing the radiant ceiling panels. In addition, Zehnder offers a number of customised solutions on request.

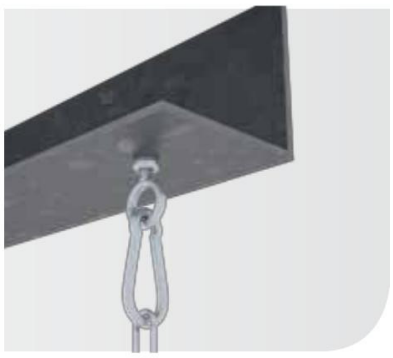
Concrete ceiling
Installation set
KN 53



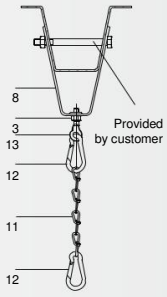


Section steel
Installation set
KN 54

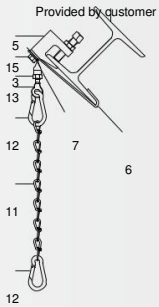




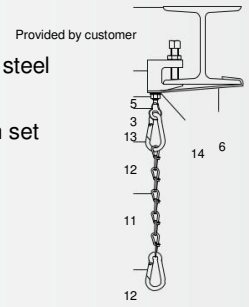
Trapezoid sheet
Installation set
KN 56



Angled steel carrier
Installation set
KN 57



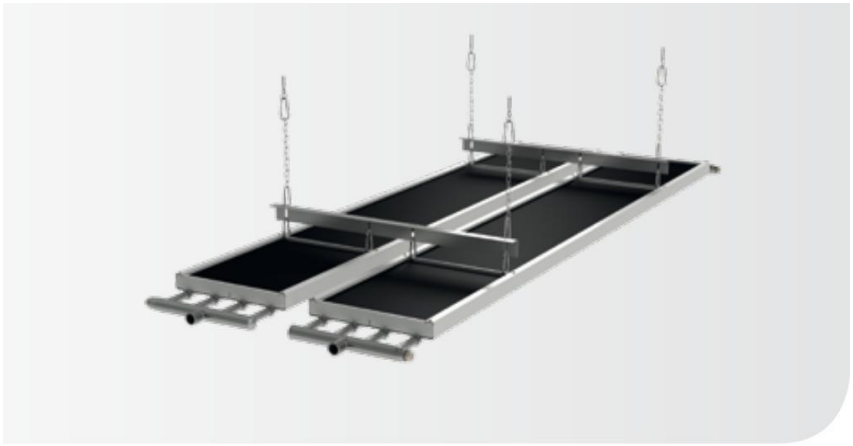
Horizontal steel carrier
Installation set
KN 58

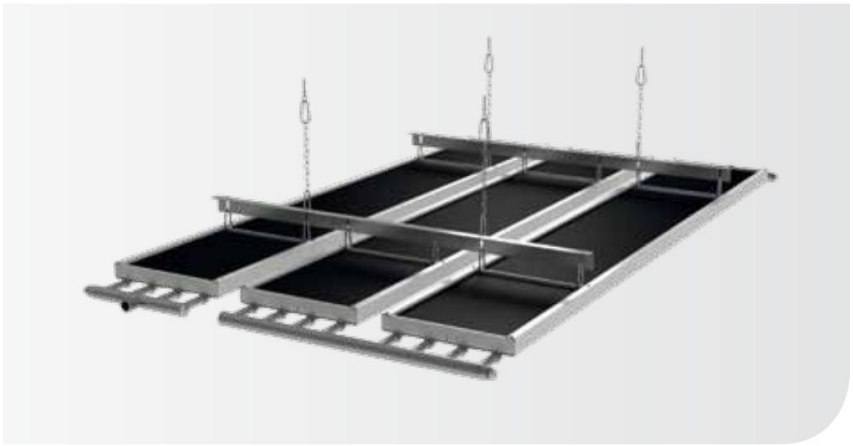


Key
3 M8 hex nut
4 M8 steel dowel
5 M8 girder clamp
6 Retaining lug
7 M8 flat leaf screw
8 M8 trapezoid hanger
11 K22 knotted link chain
12 Carabiner hook 5 x 50
13 M8 eyebolt
14 Washer
15 M8 x 40 hexagonal screw

Suspension technology

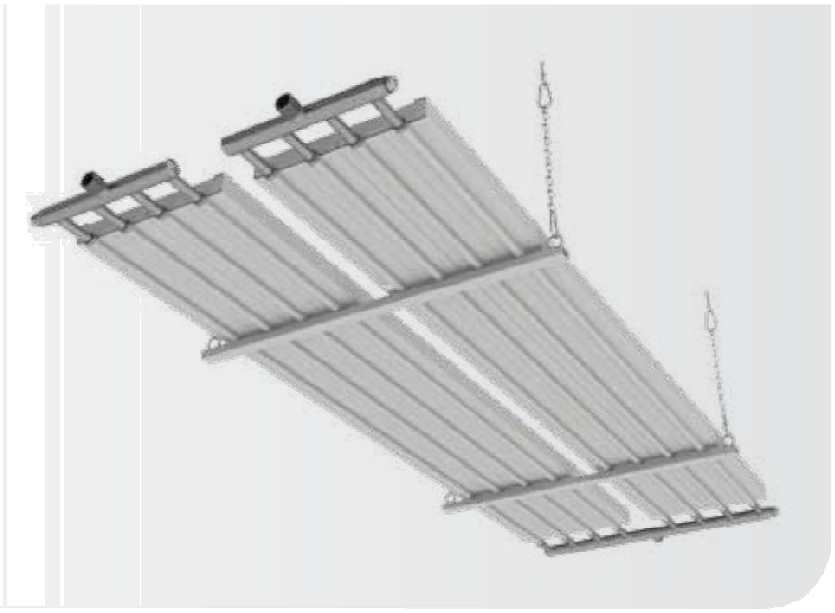
There are many different possible forms of suspension and fixing. Using multiple suspension bars when positioning several ZIP sections next to one another reduces the number of installation sets required.





Support tracks

One fixing option is support tracks on which the Zehnder ZIP modules are positioned. The tracks can be spaced up to 3 m apart. These tracks offer the benefit of keeping the radiant ceiling panel close to the ceiling.



Fixed swing

The fixed swings which are screwed into the ceiling allow the Zehnder ZIP radiant ceiling panels to be fitted flush with the ceiling.

Flexible swing

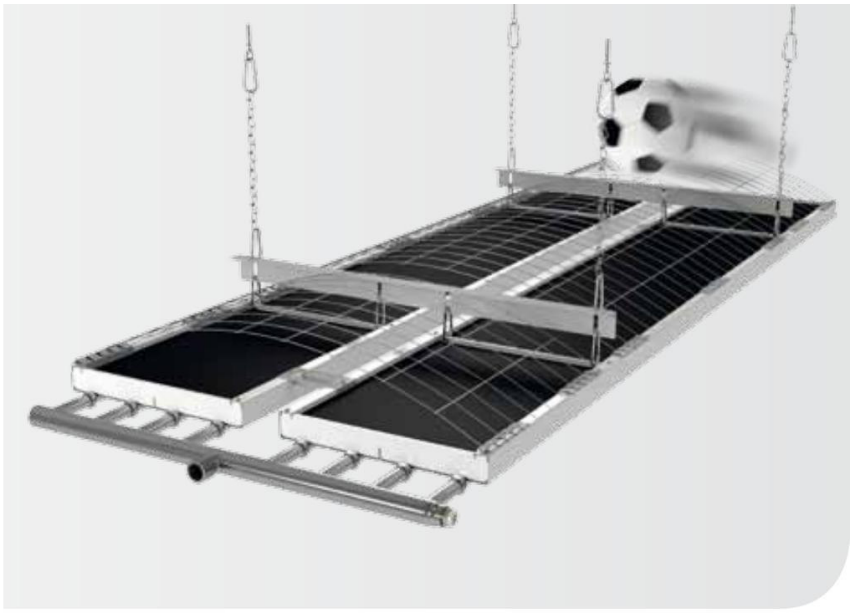
The flexible swings enable a tilted fitting across the width of the radiant ceiling panels. The modules engage precisely with the pipe seams in the flexible swings to prevent sideways slipping.

Special solutions

Zehnder ZIP radiant ceiling panels are very flexible: as well as the comprehensive standard range, there are also a number of special solutions available. Therefore, whatever the room and whatever the project, we have exactly what you need.

Ball deflector grid

Practical for sports centres. The curved, galvanised grid ensures that stray balls do not get stuck on the radiant ceiling panels. Zehnder ZIP radiant ceiling panels are also tested in line with DIN 18032 for ball resistance by the material test institute in Stuttgart.



Dust protector panel

If necessary Zehnder ZIP radiant ceiling panels can be sealed with a dust shroud. This easy-care and hygienic solution is ideal for rooms with a lot of dust.

Raised headers

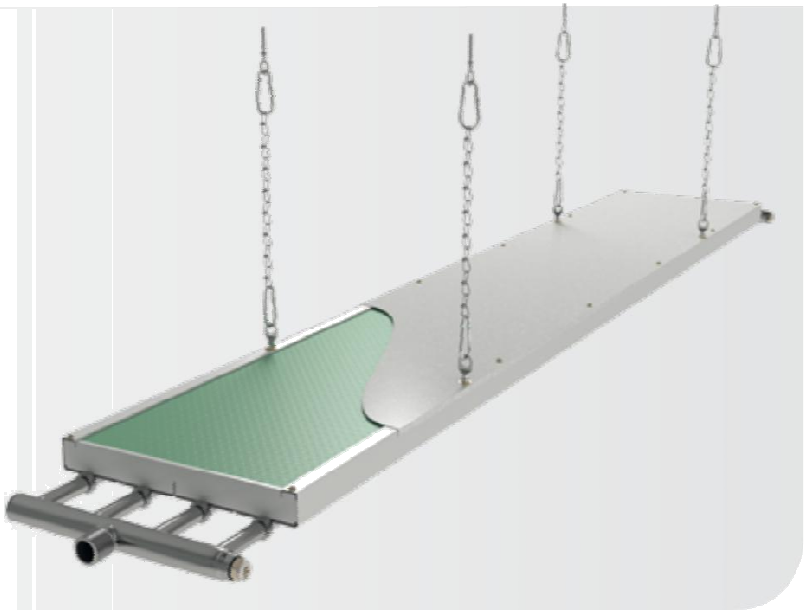
The headers end above the surface of the radiant panel and cannot therefore be seen by customers from underneath.

Non-continuous radiant panel

This variant allows light to enter freely, e. g. with skylights.

Wet room version

This version of the radiant panels is suited for use in wet rooms (water vapour).



Technical data

Legend

t_L	Air temperature (°C)
t_U	Ambient temperature (°C) = average radiation temperature = average surface temperature of all surrounding surfaces (°C)
$t_i = t_E$	Indoor temperature (°C) = perceived temperature (°C)
t_{HVL}	Heating flow temperature (°C)
t_{HRL}	Heating return temperature (°C)
t_{KVL}	Cooling flow temperature (°C)
t_{KRL}	Cooling return temperature (°C)
$\Delta t_{Über}$	Higher temperature (K)
Δt_{Unter}	Lower temperature (K)
K	Constant
n	Exponent

Physical units

Degree Celsius (°C)
Kelvin (K)
Cubic metre (m^3)
Metre (m)
Millimetre (mm)
Pascal (Pa)
Kilogram (kg)

Striebig logistics centre, Hatten (FR)

	Zehnder ZIP		Unit of measure-ment	Individual ZIP panel	2 ZIP panels one next to another	3 ZIP panels one next to another	4 ZIP panels one next to another
	Installation widths		mm	320	704	1088	1472
	Number of pipes		piece	4	8	12	16
Dimensions	Pipe material / dimension (outer diameter x pipe thickness)		-/mm	Precision steel pipe / 15 x 1 mm			
	Panel material		–	Steel			
	Pipe separation		mm	80			
	Spacing between panels		mm	–	64	64	64
	Min. installation length of individual panel		mm	2000			
	Max. installation length of individual panel		mm	6000			
	Number of points of suspension per axis		–	2	2	2	3
	Spacing of points of suspension per axis		mm	256	640	512	2 x 704
Parameters	Max. operating temperature [1]		°C	95			
	Max. operating overpressure [2]		bar	5			
Weights	Empty weight without water, with insulation	Radiant panel	kg/m	3.8	7.6	11.4	15.2
		Per collector	kg	0.9	1.7	2.6	3.4
	Weight of insulation		kg/m	0.32	0.64	0.96	1.28
	Water capacity		l/m	0.53	1.06	1.60	2.13
	Operating weight, including water content and insulation	Radiant panel	kg/m	4.3	8.7	13.0	17.3
		Per collector	kg	1.5	2.8	4.4	5.5
	Weight of ball deflector grid		kg/m	0.3	0.65	1	not available
Heating output	Thermal output in accordance with EN 14037 when t = 55K with insulation		W/m	208	417	625	834
	Thermal output constant (K)		–	2.0871	4.1742	6.2613	8.3484
	Thermal output exponent (n)		–	1.1489	1.1489	1.1489	1.1489
Cooling output	Cooling output based on DIN 4715-1 when t = 10K with insulation		W/m	36	71	107	142
	Cooling output constant (K)		–	3.283	6.566	9.849	13.132
	Cooling output exponent (n)		–	1.034	1.034	1.034	1.034

[1] Higher operating temperature possible on request
[2] Higher operating pressure possible on application

Heating and cooling output

The tables below show the Zehnder ZIP heating and cooling output depending on higher and lower temperatures. The heating output values are measured in accordance with EN 14037 and the cooling output results are based on DIN 4715-1.

Note: The removal of the insulation has a positive effect on the cooling output (see table). However, this additional output can only be attributed to the room if it has an open ceiling. Removing the insulation increases the thermal output, but only leads to a build-up of heat under the ceiling.

$$\text{Output} = K \cdot \Delta t^{n}$$

The higher and lower temperatures can be calculated arithmetically:

$$t_i = t_E = \frac{(t_{VL} + t_{RL})}{2}$$

$$\Delta t_{Über} = \frac{(t_{HVL} + t_{HRL})}{2} - t_i$$

$$\Delta t_{Unter} = t_i - \frac{(t_{KVL} + t_{KRL})}{2}$$

Cooling output without insulation

	Individual ZIP panel	2 ZIP panels one next to another	3 ZIP panels one next to another	4 ZIP panels one next to another
K n	3.960 1.0265	7.920 1.0265	11.880 1.0265	15.840 1.0265
t_{Unter} (K)	W/m	W/m	W/m	W/m
15	64	128	191	255
14	59	119	178	238
13	55	110	165	220
12	51	102	152	203
11	46	93	139	186
10	42	84	126	168
9	38	76	113	151
8	33	67	100	134
7	29	58	88	117
6	25	50	75	100
5	21	41	62	83

Cooling output with insulation

	Individual ZIP panel	2 ZIP panels one next to another	3 ZIP panels one next to another	4 ZIP panels one next to another
K n	3.283 1.034	6.566 1.034	9.849 1.034	13.132 1.034
t_{Unter} (K)	W/m	W/m	W/m	W/m
15	54	108	162	216
14	50	101	151	201
13	47	93	140	186
12	43	86	129	171
11	39	78	118	157
10	36	71	107	142
9	32	64	96	127
8	28	56	85	113
7	25	49	74	98
6	21	42	63	84
5	17	35	52	69

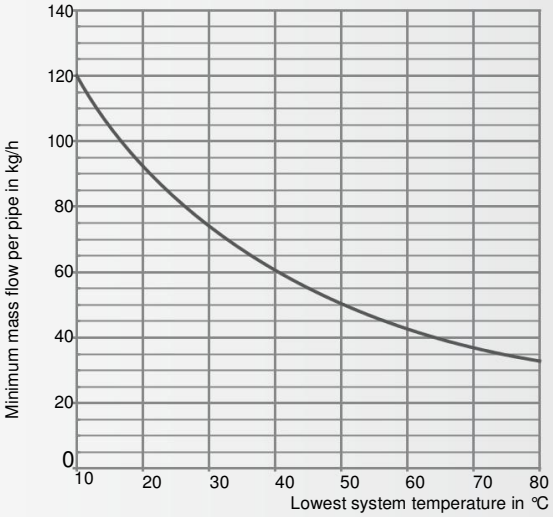
Heating output with insulation

	Individual ZIP panel		2 ZIP panels one next to another		3 ZIP panels one next to another		4 ZIP panels one next to another	
K n	2.0871 1.1489	0.2456 1.3524	4.1742 1.1489	0.4912 1.3524	6.2613 1.1489	0.7368 1.3524	8.3484 1.1489	0.9824 1.3524
t (K)	W/m	W/collector pair	W/m	W/collector pair	W/m	W/collector pair	W/m	W/collector pair
80	321	92.0	641	184	962	276	1283	368
78	311	88.9	623	178	934	267	1246	356
76	302	85.9	605	172	907	258	1209	343
74	293	82.8	586	166	879	248	1173	331
72	284	79.8	568	160	852	239	1136	319
70	275	76.8	550	154	825	230	1100	307
68	266	73.9	532	148	798	222	1064	296
66	257	71.0	514	142	771	213	1028	284
64	248	68.1	496	136	744	204	992	272
62	239	65.2	478	130	718	196	957	261
60	230	62.4	461	125	691	187	922	249
58	222	59.6	443	119	665	179	886	238
56	213	56.8	426	114	638	170	851	227
55	208	55.4	417	111	625	166	834	222
54	204	54.1	408	108	612	162	816	216
52	195	51.4	391	103	586	154	782	206
50	187	48.7	374	97.5	561	146	747	195
48	178	46.1	357	92.3	535	138	713	185
46	170	43.5	340	87.1	509	131	679	174
44	161	41.0	323	82.0	484	123	645	164
42	153	38.5	306	77.0	459	116	612	154
40	145	36.0	289	72.1	434	108	578	144
38	136	33.6	273	67.3	409	101	545	135
36	128	31.3	256	62.5	384	93.8	512	125
34	120	28.9	240	57.9	360	86.8	480	116
32	112	26.7	224	53.3	336	80.0	448	107
30	104	24.4	208	48.9	312	73.3	416	97.7
28	96.0	22.3	192	44.5	288	66.8	384	89.0
26	88.1	20.1	176	40.3	264	60.4	353	80.5
24	80.4	18.1	161	36.1	241	54.2	322	72.3
22	72.8	16.1	146	32.1	218	48.2	291	64.2
20	65.2	14.1	130	28.2	196	42.4	261	56.5
19	61.5	13.2	123	26.3	184	39.5	246	52.7
18	57.8	12.2	116	24.5	173	36.7	231	49.0
17	54.1	11.3	108	22.7	162	34.0	216	45.3
16	50.5	10.4	101	20.9	151	31.3	202	41.8
15	46.9	9.6	93.7	19.1	141	28.7	187	38.3
14	43.3	8.7	86.6	17.4	130	26.1	173	34.9
13	39.8	7.9	79.5	15.8	119	23.7	159	31.5
12	36.3	7.1	72.5	14.1	109	21.2	145	28.3
11	32.8	6.3	65.6	12.6	98.4	18.9	131	25.2
10	29.4	5.5	58.8	11.1	88.2	16.6	118	22.1
9	26.1	4.8	52.1	9.6	78.2	14.4	104	19.2
8	22.8	4.1	45.5	8.2	68.3	12.3	91.0	16.4
7	19.5	3.4	39.0	6.8	58.6	10.2	78.1	13.7
6	16.4	2.8	32.7	5.5	49.1	8.3	65.4	11.1
5	13.3	2.2	26.5	4.3	39.8	6.5	53.0	8.7

KIK logistics centre, Bönen (DE)

Minimal mass flow

To maintain the output shown in the table, a turbulent flow must be ensured within the pipes in the panels. This minimum flow of hot water depends on the lowest system temperature.
When heating, it 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 flow of hot water per pipe is not achieved, this can result in a drop in performance of about 15 %.



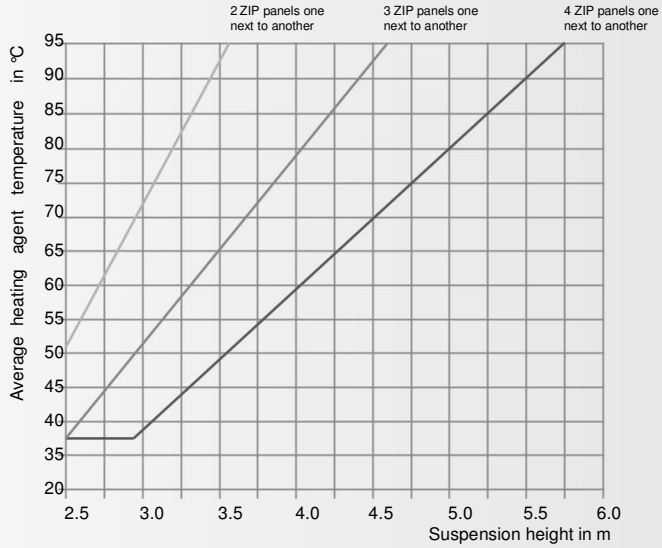
Limit temperatures

The right design temperature must be selected in order to ensure the radiant system delivers a comfortable climate throughout the room. You can use the adjacent table and graph to check this design temperature, which must be lower than the two limit temperatures (average heat transfer medium temperature). Higher limit temperatures can be used for rooms and corridors where people do not spend a great deal of time.

These values are only intended as a guide.
A detailed calculation can be performed according to ISO 7730.

Height	Proportion of ceiling area covered with Zehnder ZIP radiant ceiling panels					
m	10%	15%	20%	25%	30%	35%
	Average heating agent temperature in °C					
≤ 3	73	71	68	64	58	56
4			91	78	67	60
5				83	71	64
6				87	75	69
7				91	80	74
8					86	80
9					92	87
10						94

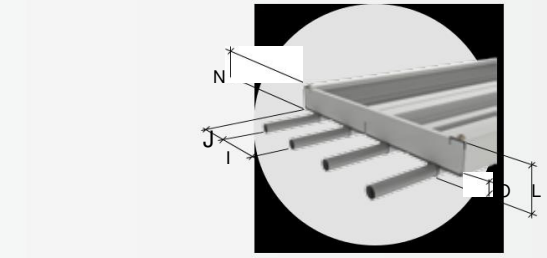
Step 1: Ceiling coverage. The design temperature must not exceed the defined thresholds.

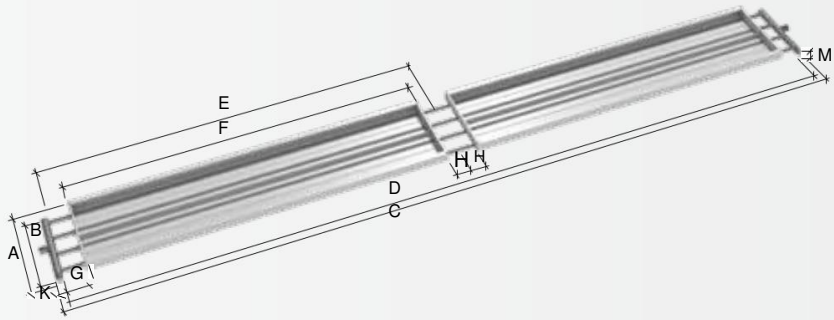


Step 2: Width of the radiant panel. The design temperature must not exceed the defined thresholds.

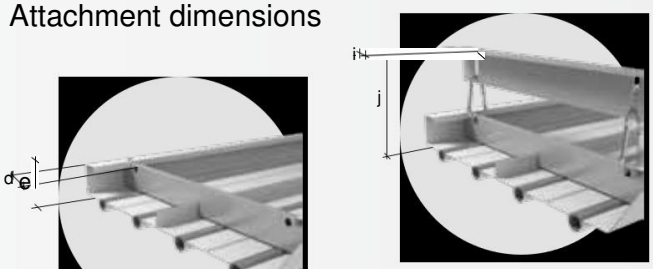
Dimensions

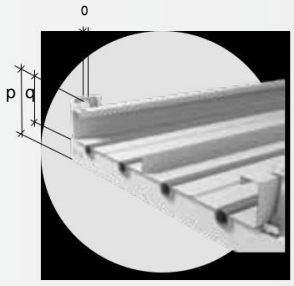
Module dimensions

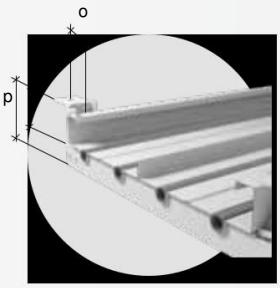


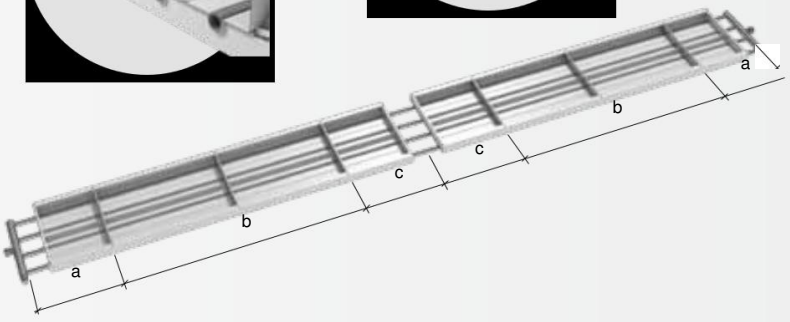


Attachment dimensions









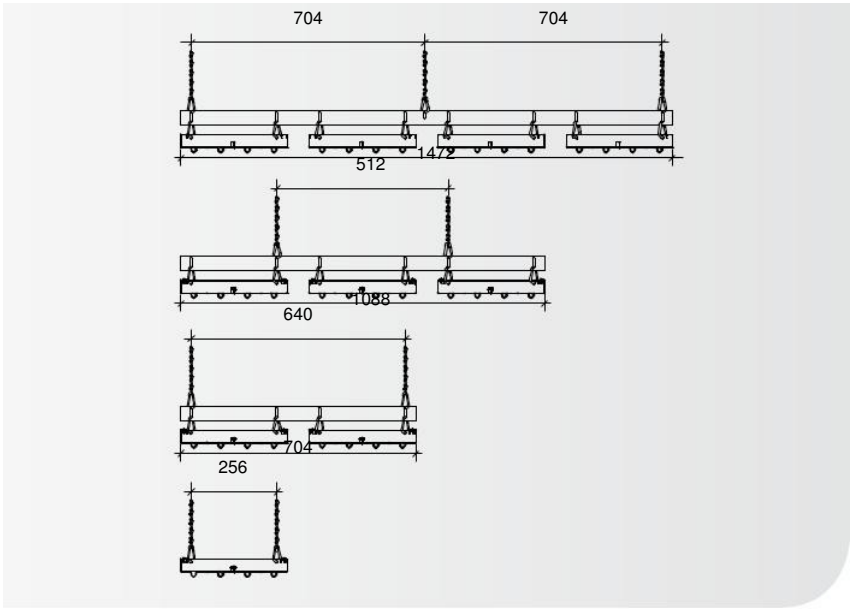
Module dimensions

Item	Description	Dimensions in mm	Min. dimensions in mm	Max. dimensions in mm	Note
A	Overall width	320	-	-	
B	Width of header	300	-	-	
C	Overall length (without connections)	Variable	2064	60064	Grid length 1000 mm
D	Length of pipe	Variable	2000	60000	Grid length 1000 mm
E	Length of individual section	Variable	2000	6000	Grid length 1000 mm
F	Length of radiant panel for individual section	Variable	1830	5830	Grid length 1000 mm
G	Pipe overlap to header	85	-	-	
H	Pipe overlap to connector piece	85	-	-	
I	Distance between two pipes	80	–	–	
J	Distance from pipe – side lip	40	-	-	
K	Length of header	32	–	–	
L	Overall height (without suspension)	55	–	–	
M	Height of header	32	–	–	
N	Height of side lip	42	–	–	
O	Height of pipe beading	13	–	–	

Attachment dimensions

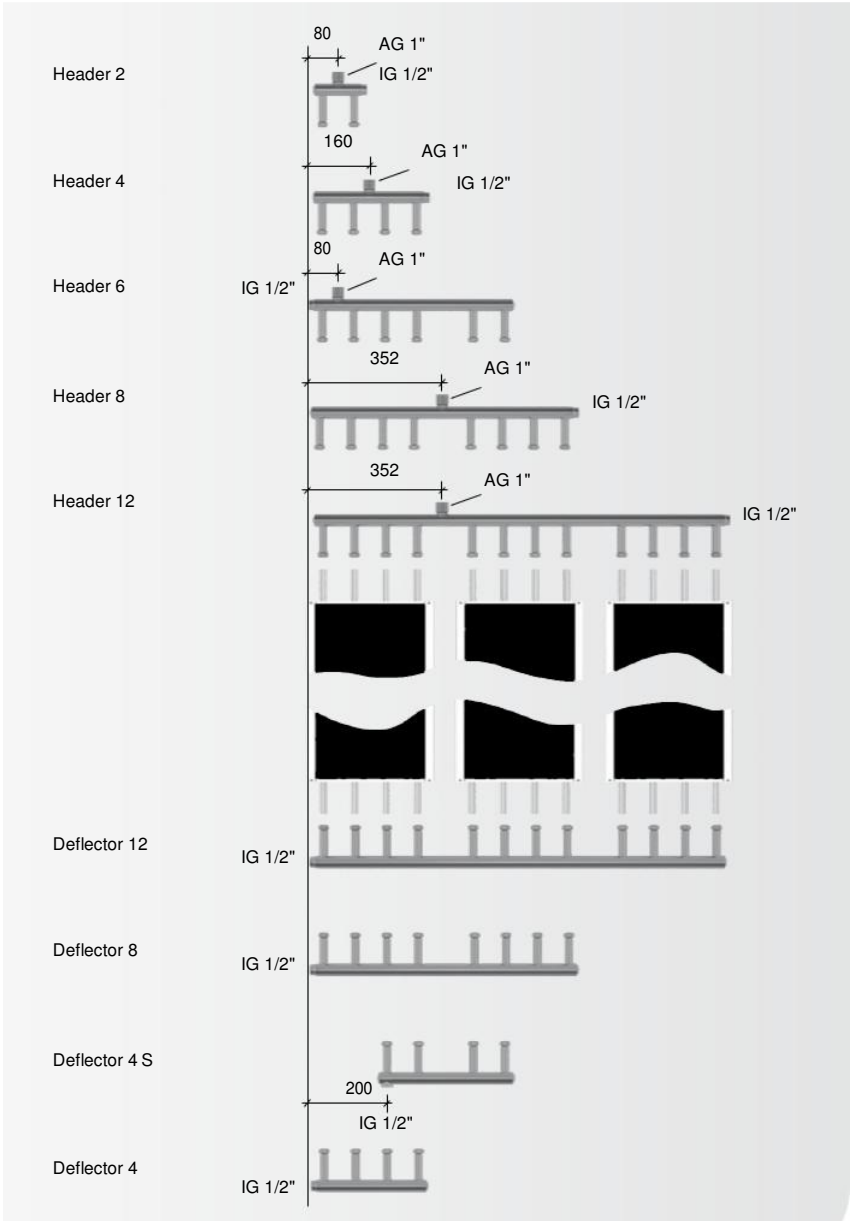
Item	Description	Dimensions in mm	Min. dimensions in mm	Max. dimensions in mm	Note
1	Attachment to reinforcement axis (individual ZIP modules)				
a	Header – axis	500	–	–	
b	Axis – axis	Variable	1000	3000	Grid spacing 1000 mm
c	Axis – connection point	500	–	–	
d	Outer edge of module – centre of 1st suspension point	32	–	–	
e	Bottom edge of radiant panel – top edge of point of suspension	39	–	–	
2	Attachment to multiple suspension axes (2, 3 or 4 ZIP modules one next to another)				
a	Header – axis	500	–	–	
b	Axis – axis	Variable	1000	3000	Grid spacing 1000 mm
c	Axis – connection point	500	–	–	
i	Outer edge of module – centre of 1st suspension point	32	–	–	
j	Bottom edge of radiant panel – top edge of point of suspension	108	–	–	
3	Attachment with suspension swing for direct side suspension (fixed swing)				
a	Header – fixed swing	500	–	–	
b	Fixed swing – fixed swing	Variable	1000	3000	
c	Fixed swing – connection point	500	–	–	
o	Outer edge of module – centre of 1st suspension point	32	–	–	
p	Bottom edge of fixed swing – bottom edge of concrete ceiling	91	–	–	
q	Bottom edge of radiant panel – bottom edge of concrete ceiling	55	–	–	
4	Attachment with suspension swing using installation sets (flexible swing)				
a	Header – flexible swing	500	–	–	
b	Flexible swing – flexible swing	Variable	1000	3000	
c	Flexible swing – connection point	500	–	–	
o	Outer edge of module – centre of 1st suspension point	14	–	–	
p	Bottom edge of flexible swing – bottom edge of suspension point	81	–	–	
q	Bottom edge of radiant panel – bottom edge of suspension point	50	–	–	

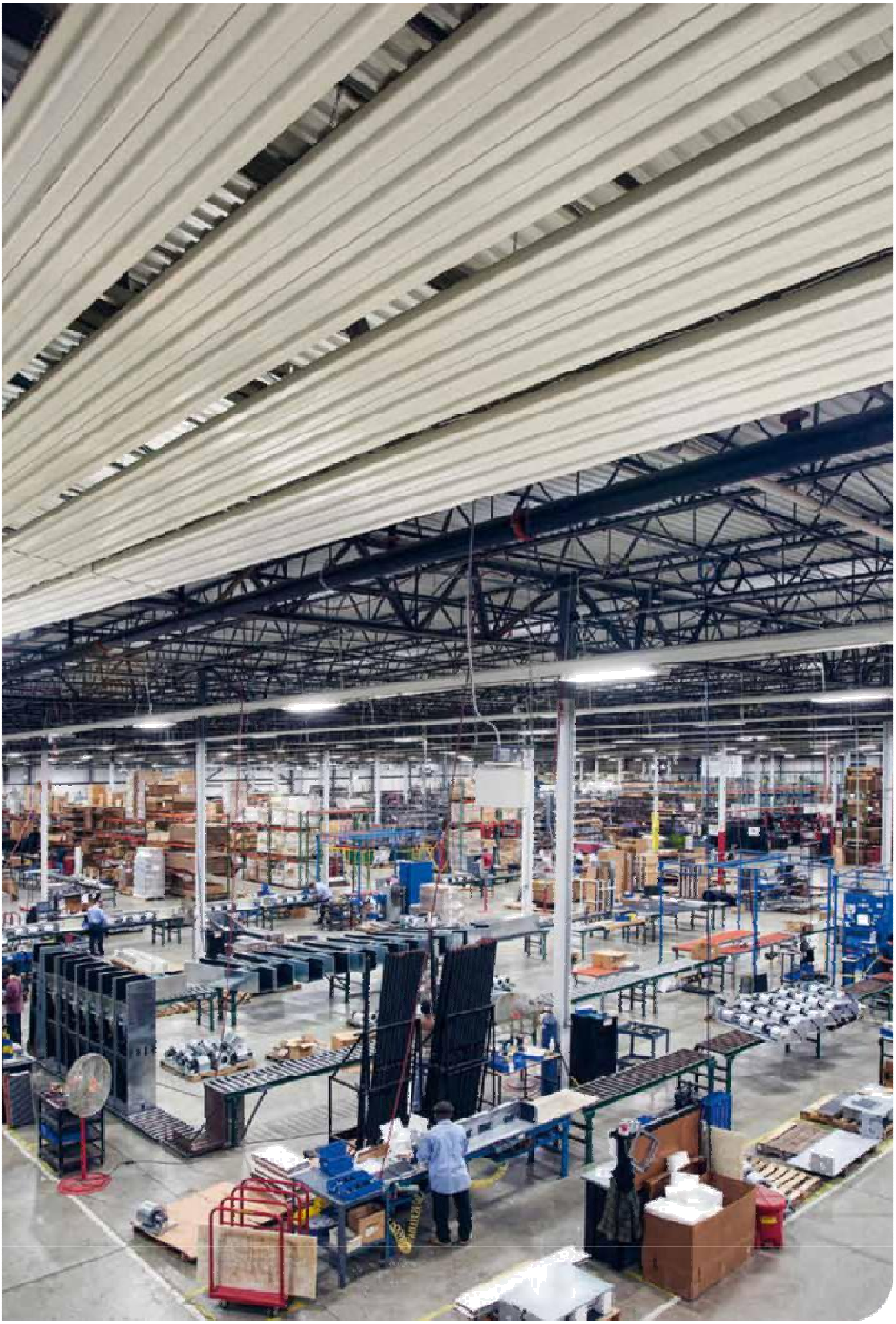
Spacing of points of suspension per axis



Headers and deflectors

The standardised headers and deflectors enable a large number of different possible conditions.





Rittling production, Buffalo (USA)

Dimensioning example

Dimensioning basics
The heating load of the room is calculated according to the applicable standard. If the air exchange rate of a room is above the usual level achieved with gap ventilation (max. 1/h), particularly with extraction systems, the air fed in to the room must be pre-heated. Radiant heating systems alone cannot prevent cold air from entering the room at gates or loading areas. Strip curtains or air curtains, for example, must be used to help rectify this situation.

Example of dimensioning and arrangement
The following example shows how a hall is dimensioned.

Goal
To achieve an even indoor temperature (20 °C) throughout the entire room.

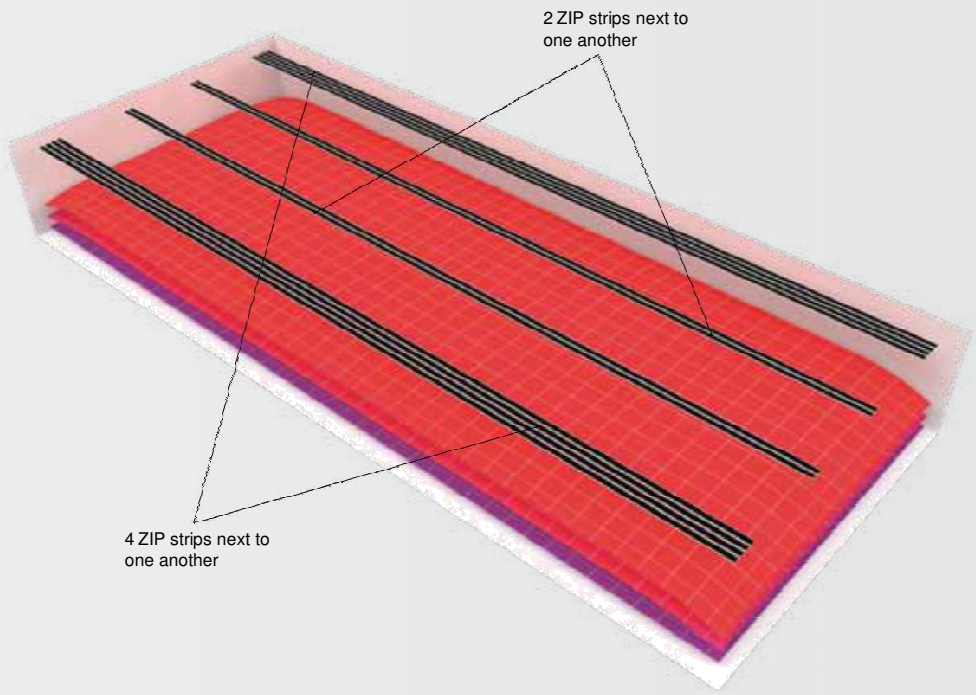
Specifications
Free-standing hall: length 50 m, width 20 m, height 8 m
Air exchange rate: 0.3 1/h
Outdoor temperature: -12 °C

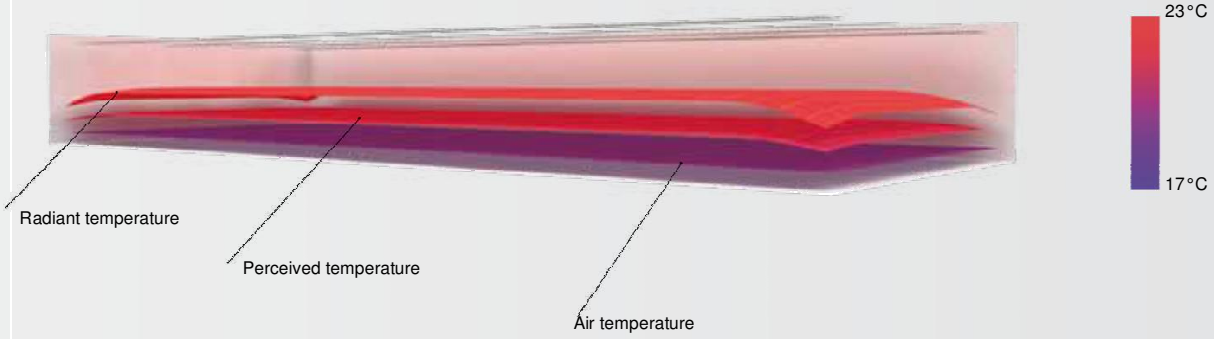
Heating load

Standard conducted heat loss:	57250 W
Standard air infiltration heat loss:	26112 W
Standard heat losses:	83362 W

Dimensioning of the radiant ceiling panels
Flow temperature: 70 °C
Return temperature: 50 °C

Thermal output							
Type	Installation length in m	Higher tempera-ture in K	W/m	W/collec-tor pair	Quantity	Total ther-mal output	Mass flow per strip
4 ZIP one next to another	48	40	145	36	2	55968 W	1203 kg/h
2 ZIP one next to another	48	40	145	36	2	27984 W	601 kg/h
						83952 W	



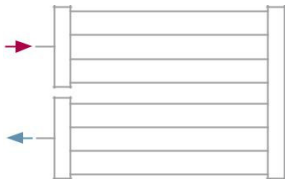


The local distribution of the indoor temperature is calculated for a height of 1 m above the floor. Even at the edges of the room, the indoor temperature deviates from the design value only slightly.

Pressure loss calculation

The drop in pressure of Zehnder ZIP radiant ceiling panels is calculated as a total of the pressure drop for the row of pipes and the drop in pressure in the connections between the register and the piping. When using Zehnder volume flow controllers, the additional drop in pressure of the volume flow controllers should be added to this.

Determining the pressure loss:



E. g. 2 ZIP next to one another; 48 m

1. Calculate total mass flow of the radiant ceiling panel in question, e. g. m = 601 kg/h (see p. 24)

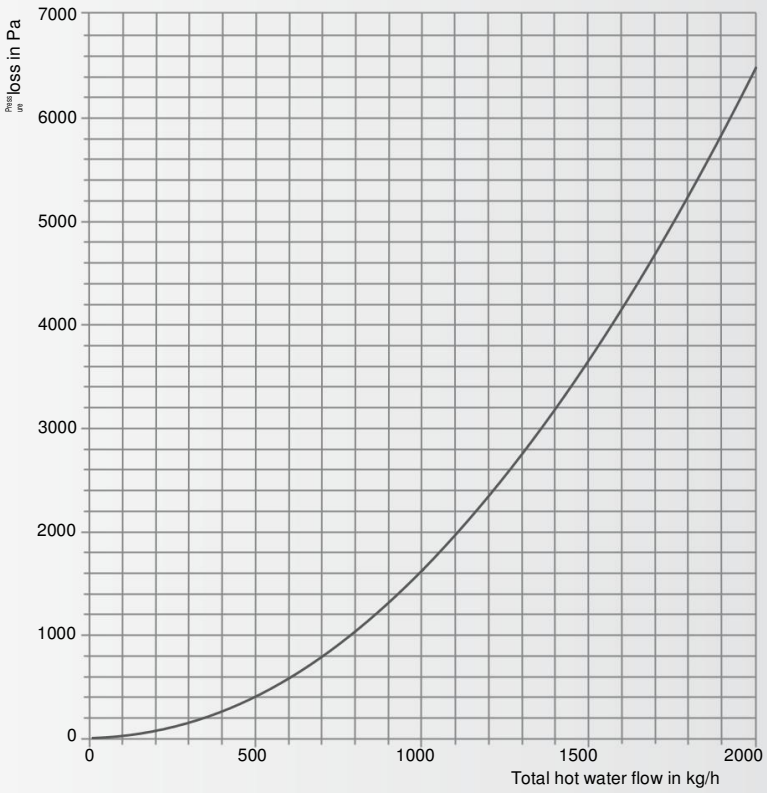
2. Read pressure loss of pair of headers from diagram, e. g. p = 600 Pa/pair of headers. Since the heating water flows into and out of a header twice, the value should be multiplied by 2.

3. Refer to the graph for the pressure loss of the pipe. The mass flow is produced by dividing the total mass flow by the number of pipes with parallel flow.

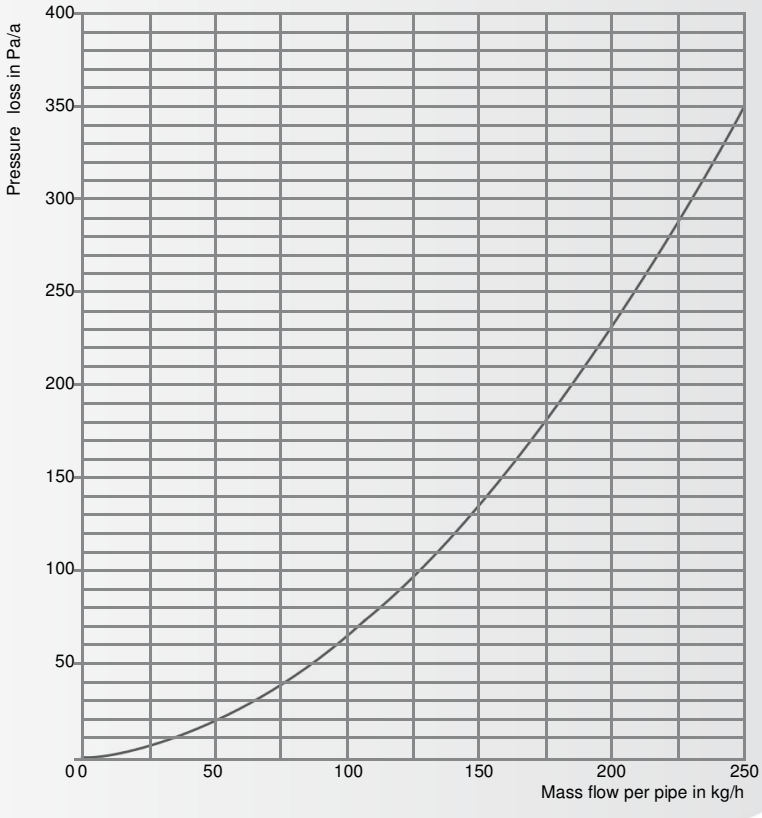
   e. g. 601 kg/h: 4 rows of pipes = 150 kg/h p = 135 Pa/m * 48 m * 2 (in both directions) = 12960 Pa

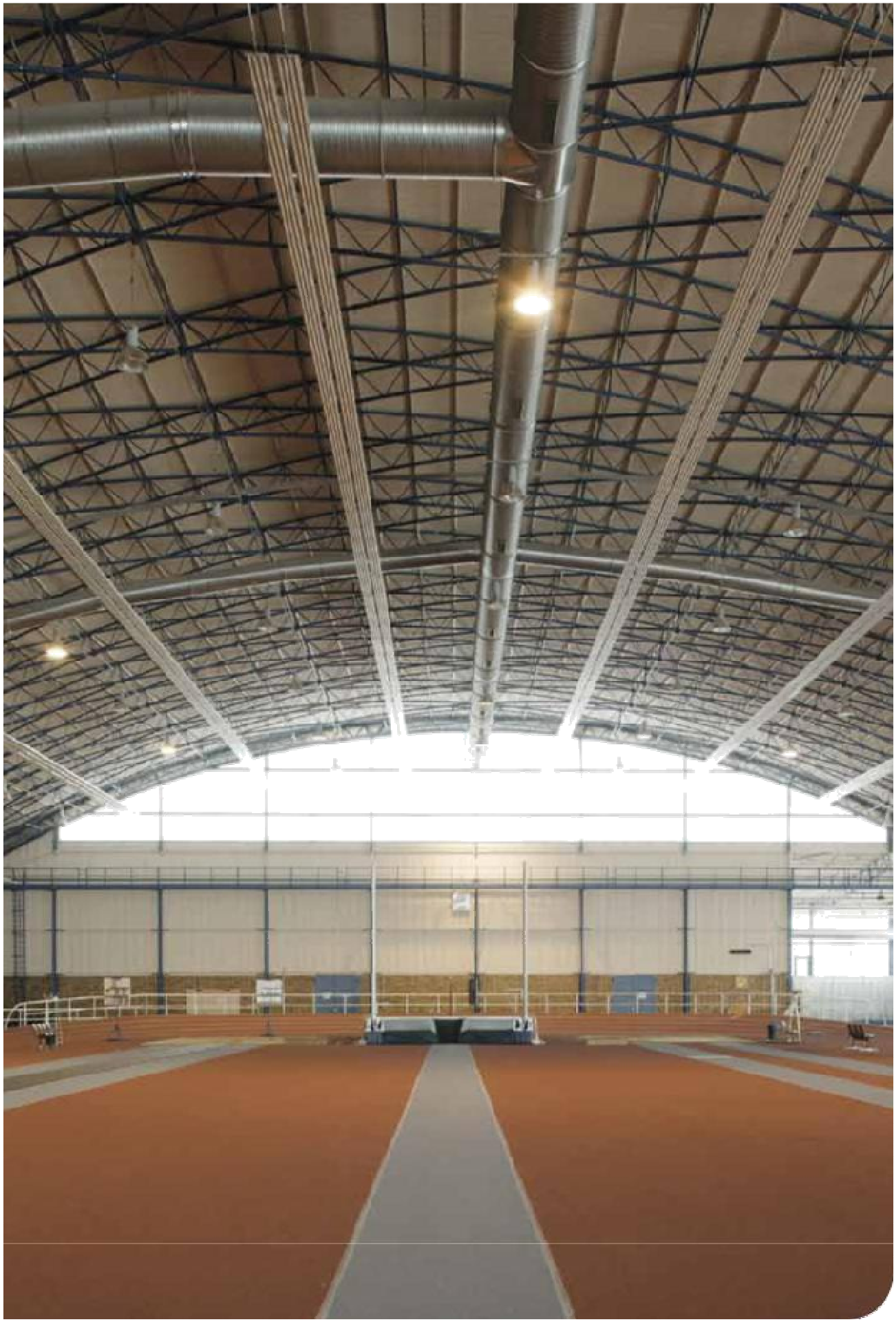
4. The total pressure loss for the radiant ceiling panel is simply the sum of the individual pressure losses calculated, e. g. 600 Pa * 2 + 12960 Pa = 14160 Pa

Pressure loss of the header pair including connections



Pressure loss per pipe





Sportforum sports complex, Berlin (DE)
Technical data

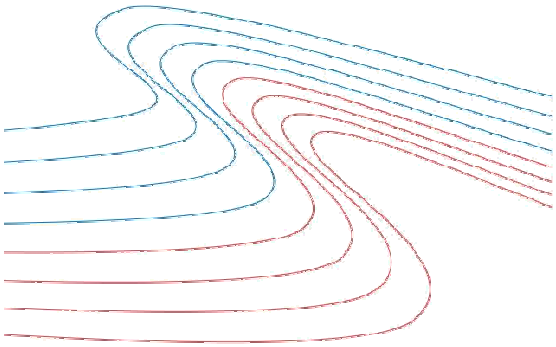
Hydraulics

Hydraulic balancing of radiant ceiling panels
In any branched heating or cooling system, the hot water flow must be correctly distributed for efficient operation.
(It should also be possible for all strips of radiant ceiling panels to be filled, shut off and drained separately.)

For systems where the radiant ceiling panels – and, therefore, the volume flows – are identical, laying pipes according to the Tichelmann system (two-pipe system with reverse return, see Fig. 1) will provide a solution with no hydraulic complications. However, the third pipe results in a considerable increase in costs where hall heating systems are concerned and is not advisable in many instances if panels of different sizes are used.

Systems where the individual panels have different outputs must be subjected to hydraulic balancing by means of piping calculations and adjustments. This process, however, demands a significant investment in terms of time and money.

Hydraulic balancing is made much easier with the Zehnder volume flow control combination (VSRK) (Fig. 2).



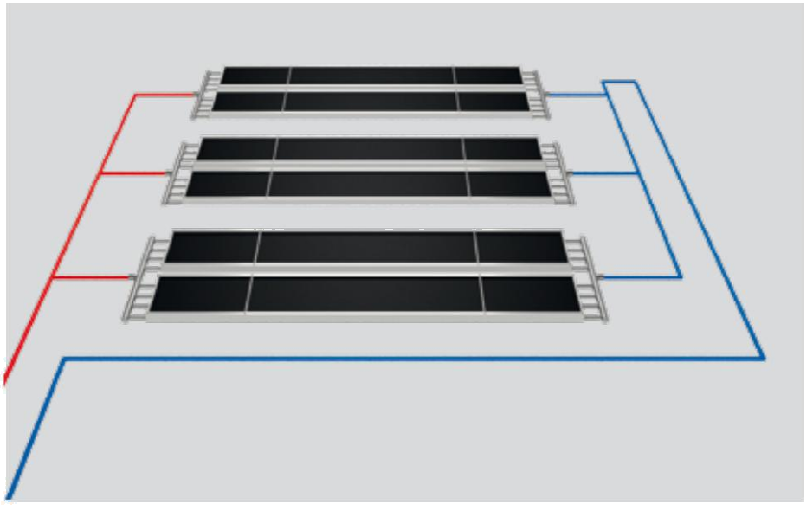


Fig. 1: Pipes laid according to the Tichelmann system (two-pipe system with reverse return)

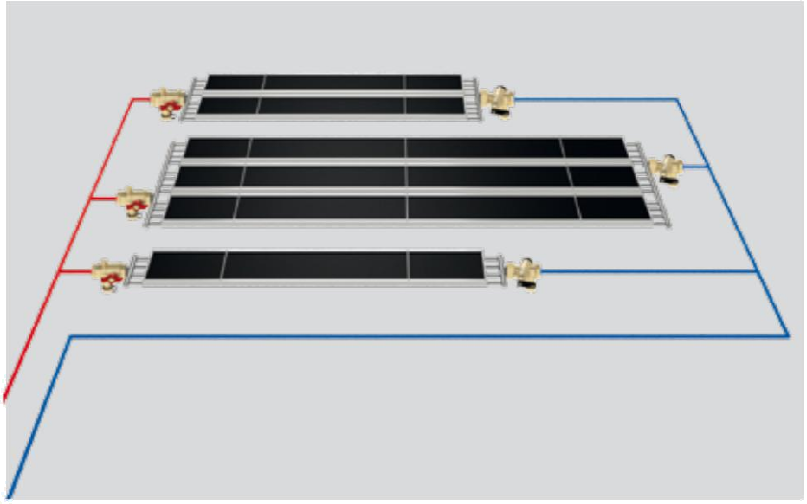


Fig. 2: Simpler piping using Zehnder volume flow control combination (VSRK)

The Zehnder volume flow control combination VSRK
The VSRK is a complete set consisting of a volume flow controller, shut-off ball valves and filling and emptying ball valves.

The controller (Fig. 3) is set to the volume flow of the strip ex works. This removes the need for any time-consuming adjustment work on site.

Other benefits of the VSRK: constant heating agent flow even when there is a high differential pressure, hydraulic balancing even for radiant panels of different sizes.

All panels must be connected with a flexible connection (reinforced hose).

Volume flow controller DN25	
Mass flow (kg/h)	Overall pressure loss (kPa)
150	20.1
180	21.3
210	22.5
240	23.6
270	24.7
300	25.7
330	26.7
360	27.7
390	28.6
420	29.5
450	30.4
480	31.2
510	32.0
540	32.7
570	33.4
600	34.1
630	34.8
660	35.4
690	36.0
720	36.6
750	37.2
780	37.7
810	38.3
840	38.8
870	39.3
900	39.7
930	40.2
960	40.6
990	41.1
1020	41.5
Volume flow controller combination VSRK DN1050-25	41.9

Volume flow controller DN32	
Mass flow (kg/h)	Overall pressure loss (kPa)
600	15.0
700	15.3
800	15.7
900	16.0
1000	16.3
1100	16.7
1200	17.0
1300	17.3
1400	17.7
1500	18.0
1600	18.3
1700	18.7
1800	19.0
1900	19.3
2000	19.7
2100	20.0
2200	20.3
2300	20.7
2400	21.0
2500	21.3
2600	21.7
2700	22.0
2800	22.3
2900	22.7
3000	23.0
3100	23.3
3200	23.7
3300	24.0
3400	24.3
3500	24.7
Volume flow controller combination VSRK 3600DN-32	25.0

Fig. 3: Zehnder volume flow control combination.

Zehnder – everything you need to create a comfortable, healthy and energy-efficient indoor climate

Heating, cooling, fresh and clean air: at Zehnder, you will find everything you need to create a comfortable, healthy and energy-efficient indoor climate. Zehnder's wide and clearly structured portfolio can offer the right product for any project, be it private, public or commercial, new build or refurbishment. And where service is concerned, you'll find that Zehnder is "always around you".

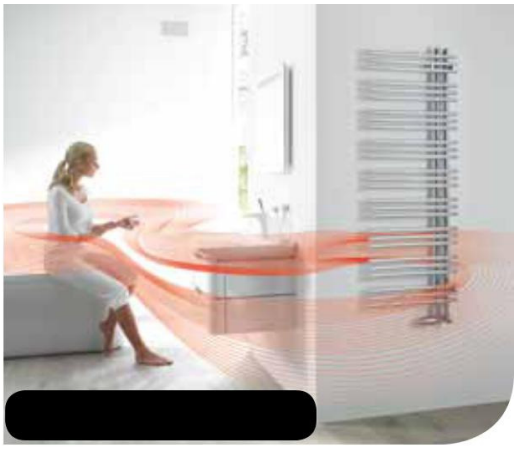
PLUS X AWARD
zehnder
MOST INNOVATIVE BRAND 2011

Most innovative brand in the category heating & climate

Heating

At Zehnder, heating doesn't just come in the form of designer radiators. We offer heating solutions in all shapes and sizes, from radiant ceiling panels to heat pumps with integrated ventilation devices.

- Designer radiators
- Compact energy station with integrated heat pump
- Heating and cooling ceiling systems
- Comfortable indoor ventilation with heat recovery



Cooling

Zehnder also offers sophisticated solutions for indoor cooling. These range from cooling ceiling systems to comfortable indoor ventilation with a supply of pre-cooled fresh air.

- Heating and cooling ceiling systems
- Compact energy station with heat pump and brine pipe
- Comfortable indoor ventilation with geothermal heat exchanger for fresh air pre-cooling

Zehnder heating and cooling ceiling systems

Fresh Air

Fresh Air – a product range with a long tradition at Zehnder. Zehnder Comfosystems provides products and solutions for comfortable indoor ventilation with heat recovery for houses and apartments, for new builds and for renovation projects.

- Comfortable indoor ventilation
- Compact energy station with integrated ventilation device

Zehnder Comfosystems

Clean Air

Zehnder Clean Air Solutions provide clean air in buildings which are particularly prone to dust. In residential applications, the comfortable indoor ventilation provided by Zehnder Comfosystems filters external pollutants out of the air.

- Comfortable indoor ventilation with integrated fresh-air filter
- Compact energy station with integrated fresh-air filter
- Systems for clean air

Zehnder Clean Air Solutions

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