Technical datasheet

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Metal ceilings as heated and chilled ceilings

Information for building designers, installers and system manufacturers

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1. Foreword

Modular metal ceilings executed as active heated and chilled ceilings (M-HCC*) have increased in Europe since the mid eighties. Meanwhile, metal heated and chilled ceilings have taken a strong position in high-end offices and commercial buildings.

The material metal with its excellent properties, offers the best thermal conduction capacity, comfortable load absorption and in addition, a range of possibilities as a design element for individual design. Excellent sound absorption as well as high level fire behaviour is an important feature of metal heated/chilled ceilings. Accessible ceiling panels enable access to technology in the ceiling plenum.

As this product sector is insufficiently regulated in the new ceiling standard “EN 13964:2004 + A1:2006 Suspended ceilings – requirements and test methods“, this data sheet should help engineers, consultants, manufacturers and installers with general, technical design assistance as well as clarifying the interfaces between design, manufacturing and installation of metal heated and chilled ceilings.

This data sheet deals exclusively with metal ceilings and their individual components with their integrated equipment that are used as modular, water-bearing, heated/chilled ceilings with removable connections to the connecting water pipes.

This data sheet contains important principles and documents the state of technology for this product sector.

Comfort criteria, heating/cooling capacities, control systems and water system connections (e.g. to the distribution pipe work) are not discussed in detail in this data sheet.

***M-HCC = metal - heated/chilled ceiling element**

2. Technical regulations for metal ceilings as heated and chilled ceilings

2.1 EN 13964 - 2004 + A1:2006 (D)

Suspended ceilings – requirements and test methods

At the time of the first edition of this European standard in 2004, heated and chilled ceilings were excluded from EN 13964. This exclusion was withdrawn in the revised and new edition of EN13964 A1:2006 (D).
Heated/chilled ceilings are being considered in principle for the first time in **"EN 13964 Suspended ceilings** – **Requirements and test methods"**. However, many questions remain unanswered and this data sheet should contribute by beginning to clarify some of those points.

2.2 EN 14240:2004

Ventilation for buildings - chilled ceilings - testing and rating

This European standard specifies the test conditions and methods for determining the cooling capacity of chilled ceilings or other large cooling surfaces.

2.3 Recknagel – Sprenger – Schramek (edition 05/06)

Taschenbuch für Heizung + Klimatechnik (pocket book for heating + air conditioning)

In this extensive book (approx. 2000 pages), the technical principles for heating and air conditioning technology are described. In addition, construction examples and the mode of function of active heated/chilled ceilings are given.

2.4 Draft – DIN 56927 April 2007

Entertainment technology
Safety rope to secure objects up to 60 kg self weight - measures, requirements and testing

This draft standard applies to safety ropes, which are used as protection against fall of mobile objects in terms of BGVC1/GUVC1*.
The possible fall distance may not be greater than 0.2m.

2.5 VDI 6031 – Acceptance test of cooling surfaces for rooms

In this VDI directive, very little attention is given to the impression of the system but more to function and integrity

2.6 DIN 18380 – VOB-C General technical specifications in construction contracts (ATV) - Installation of central heating systems and hot water supply systems

"ATV 18380"
gives valuable advice regarding the drafting of the specification in addition to "ATV DIN 18299, General rules applying to all types of construction work".
In case of contradictions, the regulations of ATV DIN 18380 take precedence.

3. Basic constructions – closed and open systems

3.1 Metal- HCC – as “closed systems”

These systems block rear ventilation from the room air to a large extent.
The ceiling panels are mainly installed next to each other without joints.

Important features are:
→ Joints and wall connection joints of the ceiling panel can be constructed with joints without seals and/or with backed joints up to10mm width.

→ In the joint areas of the ceiling panel, as well as their intersection with each other, distance holders can be inserted with/without backing such as sealing strips up to 10mm width.

→ Perforated ceiling panels as well as expanded metal with an inserted or glued acoustic tissue and/or sound absorbing mats on the reverse side.

3.2 Metal- HCC – as “open systems”

These systems do not block rear ventilation from the room air and use open joints and/or the free open area of the perforations for air to flow over the reverse side of the ceiling panel to improve performance. Due to the special, open design of the joints, the proportion of convection and therefore also the heating and cooling capacity can be positively influenced, depending on the different systems. In conjunction with appropriate, constructive measures, an increase in sound absorption is also possible.

Important features are:
→ open joints of the ceiling panel with a joint width from 11 mm
→ perforated ceiling panels, also expanded metal, without inlays on the reverse side
→ wall connection joints from 20mm with open, un-backed joints.

4. System components

4.1 Active heated/chilled ceiling elements made from metal

Metal ceiling elements or metal panels with an integrated, water-bearing pipe system on the reverse side. The visible metal areas of the ceiling panel are form and/or force locking (by means of clip connections, magnetic bars and weight contact pressure) or material locking (glued connections) connected to metal or plastic pipes or ducts where water is passed through in a closed circuit. In certain cases can be an additional air duct, with conditioned air which serves the room as an air supply.

4.2 Inactive or passive heated/chilled ceiling elements made from metal

Metal ceiling elements or metal panels that are mainly connected to active M-HCC and together with these, form a ceiling area. The inactive/passive element/panel achieves in terms of fire and sound protection as well as design, at least the same properties as the active M-HCC.

No thermal conduction profiles, integrated pipe systems and no further ancillary equipment, such as support cabling or similar, are required.

The inactive heated/chilled ceiling element, depending on the manufacturer’s instructions (differing from system to system), can be retrofitted to an active M-HCC.

4.3 Element

An element consists of a heat conducting profile (see 4.3.1) and meander (see 4.3.2) which are connected to each other. It consists of at least two rows of pipes in connection with the heat conducting profile. Centre spacing and geometry differ from manufacturer to manufacturer. Unless otherwise specified or arranged separately, it is at the manufacturer's discretion to determine the direction, number, module and dimensions as well as the type of insertion in the ceiling panel of the element to be installed.

Figure 01 shows a diagram of an element consisting of an aluminium heat conducting profile with a press-fitted copper pipe element.

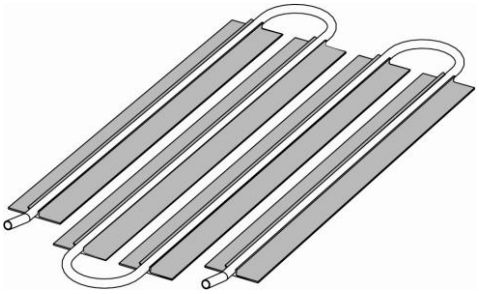


Figure 01

The elements are secured to the reverse side of the ceiling panel in different ways, depending on the requirements or the manufacturer.

The most commonly used possibilities for this are:
a) form locking connections with additional security measures from so called hold-down devices
b) glued elements
c) pipe element or heat conducting profile with incorporated grooves on the under side which are fitted with integrated magnetic strips.

Figure 02 shows a diagram of an active metal ceiling panel with an element secured on the reverse side.

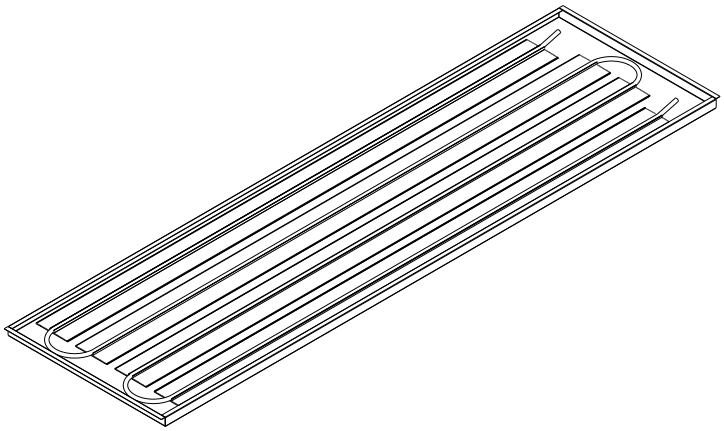


Figure 02

4.3.1 Heat conducting profiles

Heat conducting profiles consist mainly of extruded aluminium profiles that are secured to the reverse side of the metal panel and take in the water-bearing pipe work. The heat conducting profiles abet the thermal transmission from the metal surface of the ceiling panel to the water medium due to their form and material specific properties.

The heat conducting profiles are formed in different sizes depending on the manufacturer.

a) Example – heat conducting profile

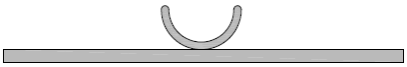


Figure 03

b) Example – heat conducting profile with magnet technology

Figure 04

4.3.2 Meander

A meander consists of at least two rows of pipes, s-shaped or formed into serpentines, copper or impermeable plastic pipes or multi-layer composite pipes; external diameter of the pipes approximately 8mm to 15mm. The meander is usually pushed into the heat conducting profile to improve thermal transfer.

a) Copper pipes
For the most cases, copper pipes according to EN 12735 part 2 are used.
Both ends of the copper meander, which serve to connect to the connecting pipes, are cut square and free of burrs. The surface condition of the end of the pipe such as longitudinal scoring, roundness, pipe tolerances, insertion depth and burr removal is determined by the manufacturer with the supplier of the plug fittings, unless otherwise agreed.
Further provisions regarding the location and condition of the meanders for the connections e.g. by means of plug connectors, are determined by the manufacturer of the active M-HCC, unless indicated otherwise.
For thin-walled copper pipes (< 0.75mm), the element ends are reinforced with internal, brass support sleeves.

b) Plastic and multi-layer composite pipes
Alternatively for pipe meanders, plastic pipes or multi-layer composite pipes oxygen diffusion proof according to DIN 4726 can be used.

4.4 Capillary tube mats

Plastic tube mats with an external diameter from approximately 4mm to 8mm. The individual plastic capillary tubes are usually connected on the short side by means of direct distribution and collection pipes.

In figures 05, 06 and 07 different variations of capillary tube mats are shown.

a) straight mat
distribution/ collection pipes at opposing ends

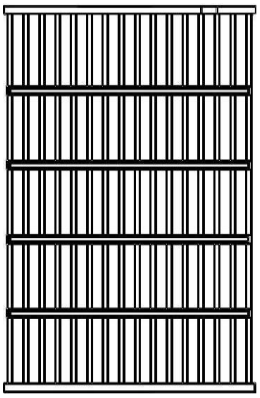


Figure 05

b) looped mat
distribution/ collection pipes side by side

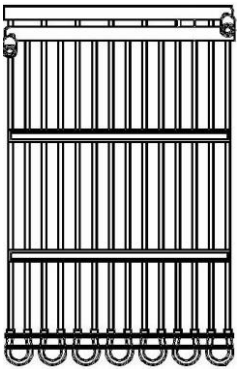


Figure 06

c) looped around mat
distribution/ collection pipes face to face

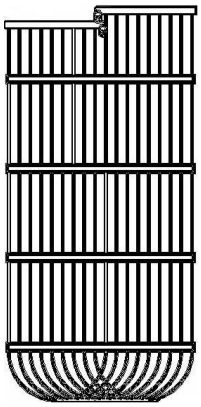


Figure 07

Unless otherwise specified, it is at the manufacturer's discretion to determine the direction, number, module and dimensions of the capillary tube mat for insertion into the ceiling panel. The installation is carried out in different ways, depending on the manufacturer.

Capillary tube mats can be secured to the reverse side of the ceiling panel by:
- loose insertion
- gluing
- means of special fixings

Figure 08 shows a metal ceiling panel with an inserted capillary tube mat.

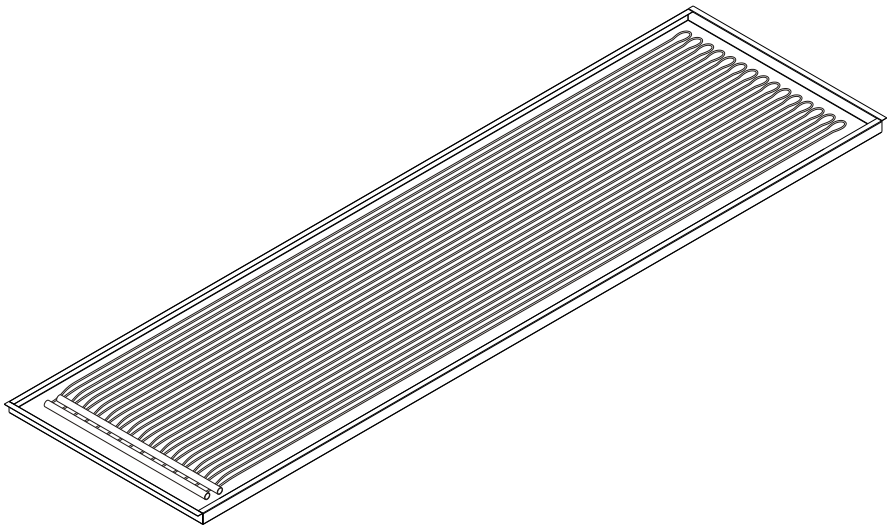


Figure 08

4.5 Supply/connection and distribution pipes

Supply, connection and distribution pipes can be produced as plastic tubes, stainless steel covered hoses, corrugated hoses or multi-layer composite pipes.

1) Supply pipes
Supply pipes serve to connect the active heated/chilled ceiling element with the distributor.

2) Connection pipes
Connection pipes produce the hydraulic connection between two active elements.

3) Distribution pipes
Distribution pipes can be used as collection and distribution pipes or as beams. They supply the individual fields with the heating or cooling medium.

Figure 09 shows the connection of the element of an active metal ceiling panels with the distribution pipes.

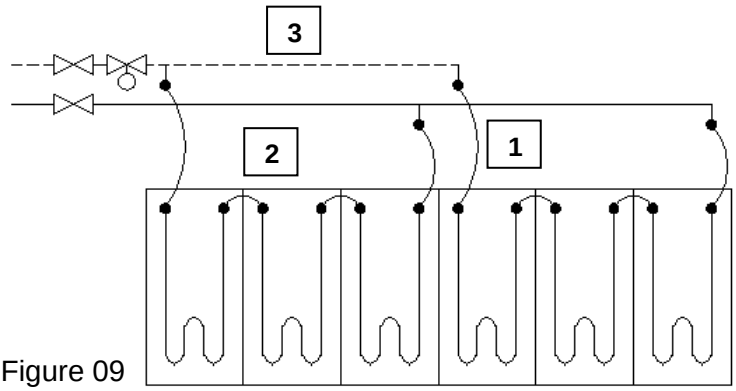


Figure 09

Supply, connection and distribution pipes as well as control units are not covered in this data sheet.

4.6 Plug fittings

Plug fittings serve to connect the supply and/or connection pipes with the meander and/or the collection pipes. There are no normative requirements for the connection method. The manufacturer's guidelines must be strictly adhered to otherwise there is risk of connections leaking. This may result in considerable damage to property from leaking water.

4.7 Installation aids and safety wires

The provision of normal suspension wire as an installation aid is sufficient. Alternatively, the delivery and installation of safety wires, tested according to DIN 56927 (draft), can be agreed with the system manufacturer.

4.7.1 Installation aids

Installation aids such as S-hooks, installation wires, installation hooks or hooked plates are used. Such installation aids are mainly used during the installation e.g. when filling and ventilating the M-HCC, to suspend the M-HCC during this work. They are considered exclusively as strain relief for the connection pipes, including the plug fittings.

Installation aids, unless otherwise stated, are designed for the fixing of static loads; their requirements can differ depending on the system.

They are no safety components, as described in point 4.7.2 and not designed for dynamic loads.

Installation aids, depending on the system and manufacturer's guidelines, can also be used later for maintenance work. Unless otherwise stated, the type and positioning of the installation aids is the responsibility of the system manufacturer. The occurring additional loads should be considered during design and dimensioning and necessary additional measures taken for the substructure.

4.7.2 Safety wires

The use of safety wires according to DIN 56927 (draft) can be agreed upon. A free fall height of up to 20cm is specified, which depending on size and weight of the ceiling panel, leads to additional reinforcements in the ceiling panel, but also special measures for the substructure including the soffit fixings. It should therefore be considered, that the suspension, substructure and ceiling panel are configured to take these loads.

A detailed specification is required from the design specialist.

4.8 Dew point sensor – corrosion protection

For efficient dew point control, no deviation under the dew point can occur.
Metal ceiling panels and substructures usually therefore require no additional corrosion protection.

Unless otherwise stated, metal ceilings as heated and chilled ceilings are delivered according to table 8 – class A of EN 13964. Delivery and installation of the dew point sensors must be agreed upon separately.

A detailed specification is required from the design specialist.

4.9 Additional safeguards

By delivery of active metal-HCC, upon special request, the ends of the built in meanders can be fitted with protective caps to prevent dust or debris penetration and to protect the pipe ends from damage.

A detailed specification is required from the design specialist.

5 Size limits and flatness tolerances of the ceiling panels

5.1 Element dimensions with plain borders

For element lengths (based on the longer side)	+ 0 - 0.4 mm/m
For lengths smaller than 1.0m	+ 0 - 0.5 mm
For element widths	+ 0 - 0.4 mm

The data applies to plain and perforated panels with plain borders on all sides.

5.2 Deflections

Table 4 of EN 13964 is not valid for the flatness of active M-HCC.
Flatness is depending on the selected system as well as the location and number of copper pipe elements/ capillary tube mats. Due to the integrated meanders on the reverse side, uneven deflection behaviour (wave formation) of the underside of the ceiling panel can occur. Necking in the middle of the metal ceiling panel in the edge areas is dependent on the deflection tolerances, whereby the straightness/angularity of the edges can be changed.
The system specific information from the manufacturer applies.

5.1 Angular dependence

The outer edge is based on the short side

Widths up to 625mm	± 0.5 mm
Widths from 625mm up to 1250mm	± 0.6 mm

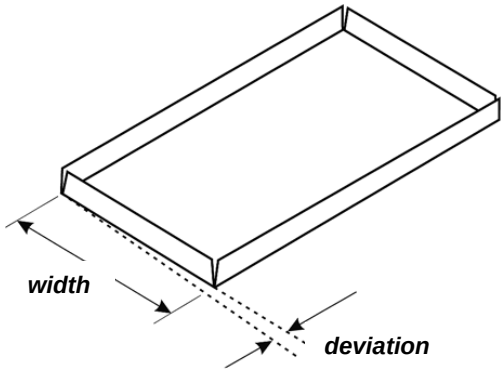


Figure 10

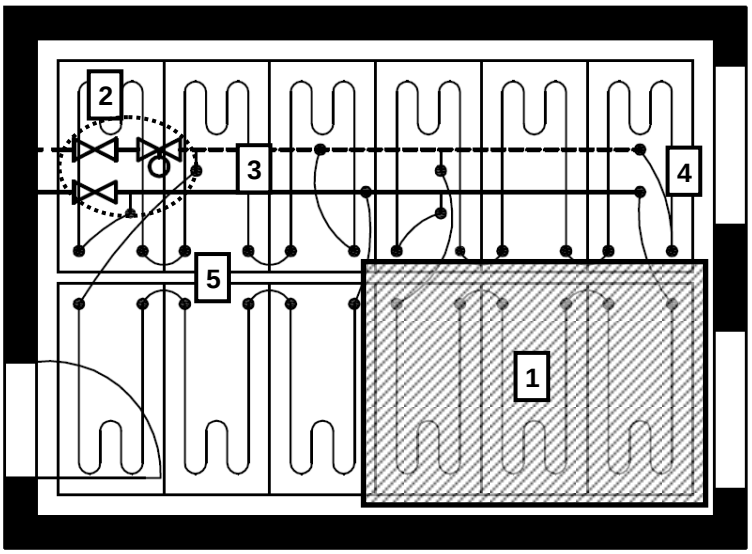
The data in figure 10 applies to plain and perforated panels with plain borders on all sides.

6 Additional Information

6.1 Terms – Hydraulic

6.1.1 Heating or cooling zone

A heating or cooling zone consists of one or more active metal heated/ chilled ceiling elements that are connected to each other in series. The number of active metal-HCC should be selected so that a certain reduction in pressure is created in the zone. The pressure reduction influences the specific heating or cooling capacity. For optimum thermal absorption of the medium, turbulent water flow, which arises from the reduction in pressure, is required.
In figure 11, a room layout is shown with the corresponding components of the active heated/chilled ceiling.

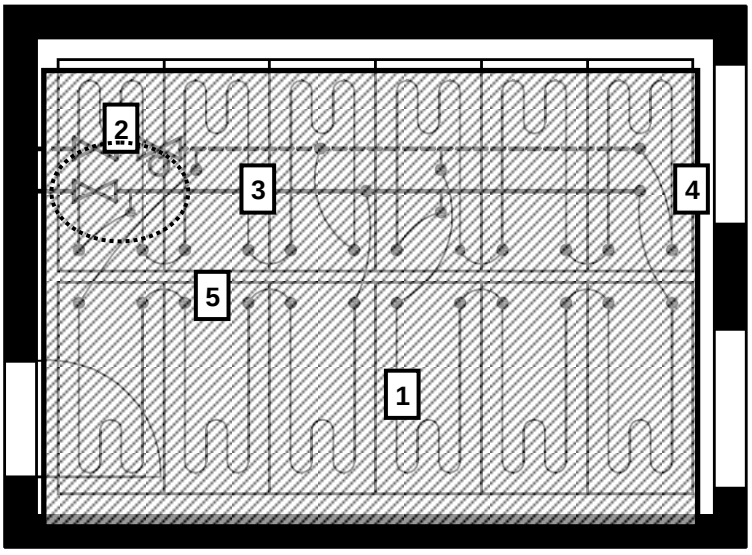


1) Heating/cooling zone
2) Regulation unit
3) Distribution pipe
4) Supply pipe
5) Connection pipe

Figure 11

6.1.2 Regulation area

A regulation area, see figure 12, consists of one or more heating or cooling zones, which are connected parallel. The regulation areas are mostly selected by room or axis. The size of the regulation area is limited by the regulation units.



1) Regulation area
2) Regulation unit
3) Distribution pipe
4) Supply pipe
5) Connection pipe

Figure 12

6.2 Structural physical characteristics

Active metal-HCC must fulfil a variety of characteristics.

→ Cooling capacity EN 14240:2004 “Ventilation for buildings - chilled ceilings - testing and rating“
→ Heating capacity according to EN 14037 “Ceiling mounted radiant panels supplied with water at temperature below 120 °C - Part 1: Technical specifications and requirements; German version EN 14037-1:2003“
→ Requirements according to EN 13964 “Suspended ceilings – Requirements and test methods“
→ Building material and component classification according to EN 13501-1 and/or DIN 4102
→ Sound absorption and sound attenuation, where required, in accordance with EN ISO 11654 – EN 20354 and EN ISO 10848:2006 “Acoustics - Laboratory measurement of the flanking transmission of airborne and impact sound between adjoining rooms“

Cooling capacity is measured and stated according to the criteria in EN 14240:2004.

The structural design of the metal-HCC is selected by the manufacturer so that the specific heating/cooling capacities are fulfilled according to the above mentioned standards.

The system provider must fulfil these performances. Sound and fire protection requirements by arrangement. The effect of the integrated meanders has to be taken into account. By delivery of individual components, unless otherwise stated, the design specialist has the responsibility for the system conformity and the performances to be fulfilled.

6.3 Interfaces with other trades

A clear separation of trades is required to ensure everything goes smoothly.
Interfaces must be specified by the design specialist.
As standard practice, the interfaces are specified as in front of the regulation units (see figure 13, interface 1) or behind the control units (figure 13, interface 2).

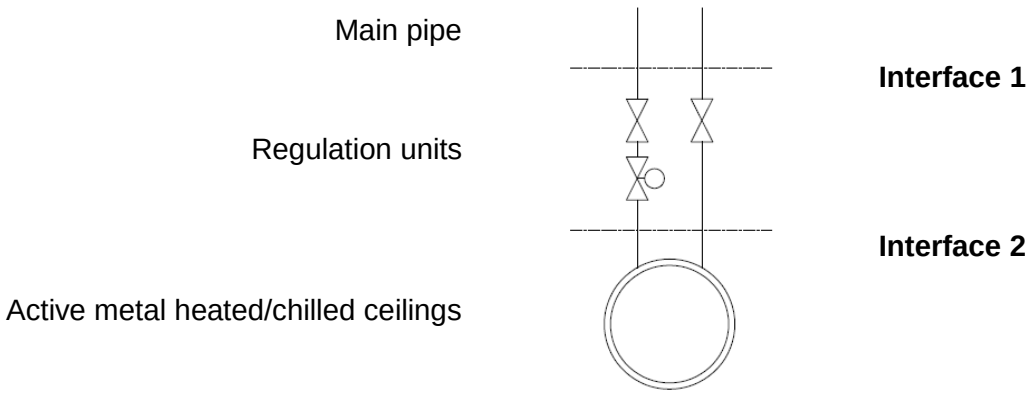


Figure 13

6.4 Standard metal ceilings are not suitable for use and application as heated and chilled ceilings without prior approval from the metal ceiling manufacturer.
The calibration and interaction of the individual components of a well functioning heated and chilled ceiling require extensive expertise, project specific design and precision machined components.

For example, the application of additional loads on the system specific accessories of the heated/chilled ceiling, such as the fixing of distribution pipes to the substructure or attaching the installation aids to the substructure and/or the ceiling panel must be determined and specified by the system manufacturer.

Additional loads that occur through the water-bearing pipes, copper pipe elements or capillary tube mats, including the loads from water, are to be taken into account by the system manufacturer.

Great attention is required by the designer to lasting quality and the most important features such as fire protection, heating and cooling capacity, sound protection, structural analysis, corrosion protection and last but not least the water-tightness of the system.

Special reference is given to the risk that the individual components do not meet the required performance in function due to the simple assembly of different systems and manufacturers **or even the collapse of the ceiling due to disregarded additional loads which can result in major damage**. The specification and quality control of the interfaces is one the most important roles of the design specialist.

6.5 Corner design
Type and location of corner reinforcements are to be given by the designer depending on system and panel size.

6.6 Material and surface of the ceiling panel
The material properties, such as aluminium, steel and stainless steel but also the surface treatment/ colour and the type of perforation can have a significant impact on the heating/ cooling capacity. Deviations or subsequent changes to the system manufacturer's specification can result in reduced performance. In unfavourable light, such as side light, an outline of the thermal conduction profile on the underside of the ceiling is possible.

6.7 Advice on drafting specifications – settlement of account
Important advice on drafting specifications and the settlement of accounts can be found in "General technical specifications for metal ceilings" (ATV), produced by TAIM www.taim.info.

6.8 Initial operation of metal heated/chilled ceilings
Approval, training, hand-over, inspection and maintenance
In addition to the usual approval criteria, the approval of the M-HCC also includes a full examination (flushing and pressure testing for the water-tightness of the system), compliance with technical and legal regulations and the completeness of all documents as well as a function test of the metal heated/chilled ceiling.
Training and hand-over to the operator follows according to the system manufacturer's guidelines.

For safe operation according to VDI 6031, regular maintenance by a specialist is required. The quality of the water, the water-tightness of the system and the functioning of the servo-motors, dew point sensors and the regulation valves are particularly checked and controlled.

6.9 Installation and user guidelines

For the installation and subsequent operation by the user, the system specific installation and user guidelines from the system manufacturer as well as the general installation and handling advice from TAIM has to be respected.

6.10 Heated/chilled ceilings and the CE marking

The marking is analogous to EN 13964, section 7 – Marking, labelling and packaging.